Chapter No.- 5

IP Addressing

11 IP Addressing: Overview

- An IP address is an address used to uniquely identify a device on an IP network.
- In Layer 3 logical address assigned by an administrator.
- Every device on internet has a unique IP address.

IP Addressing:- IPv4

- The address is made up of **32** binary bits which can be divisible into a **network portion** and **host portion** with the help of a subnet mask. (Hierarchical addressing structure.)
- Layer 3 or Network layer protocol.
- Packet treated independently.
- Best effort delivery-there is No guarantee for packet delivery. Packet may be Mis or Lost.
- No data recovery features.
- No built in session
- No retransmission.

IP Addressing:- IPv4

- An IP address is an address used in order to uniquely identify a device on an IP network.
- The address is made up of **32 binary bits**, which can be divisible into a **network portion and host portion** with the help of a subnet mask.
- The 32 binary bits are broken into four octets (1 octet = 8 bits).
- Each octet is converted to decimal and separated by a period (dot). For this reason, an IP address is said to be expressed **in dotted decimal format** (for example, 172.16.81.100).
- The value in each octet ranges from 0 to 255 decimal, or 00000000 - 11111111 binary.

IPv4 Format:-

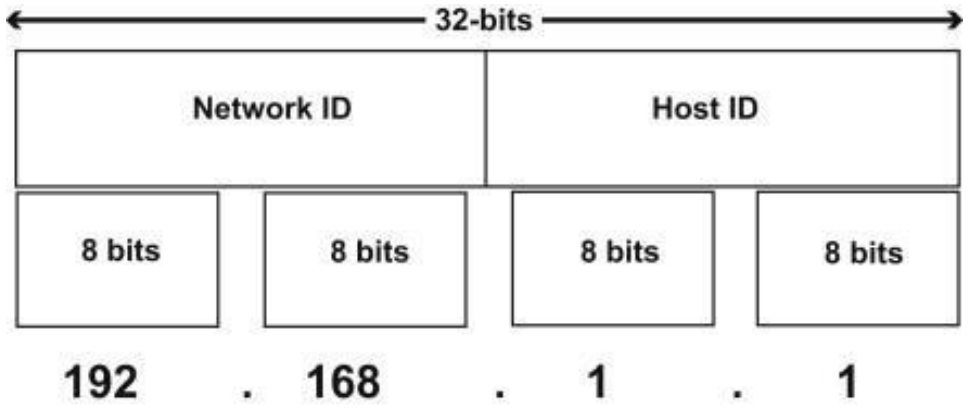
- IP address 32 binary bits are broken into four octets(1 octet = 8 bits)

X. X. X. X Each X 8 bits Octets OR 192.168.1.1

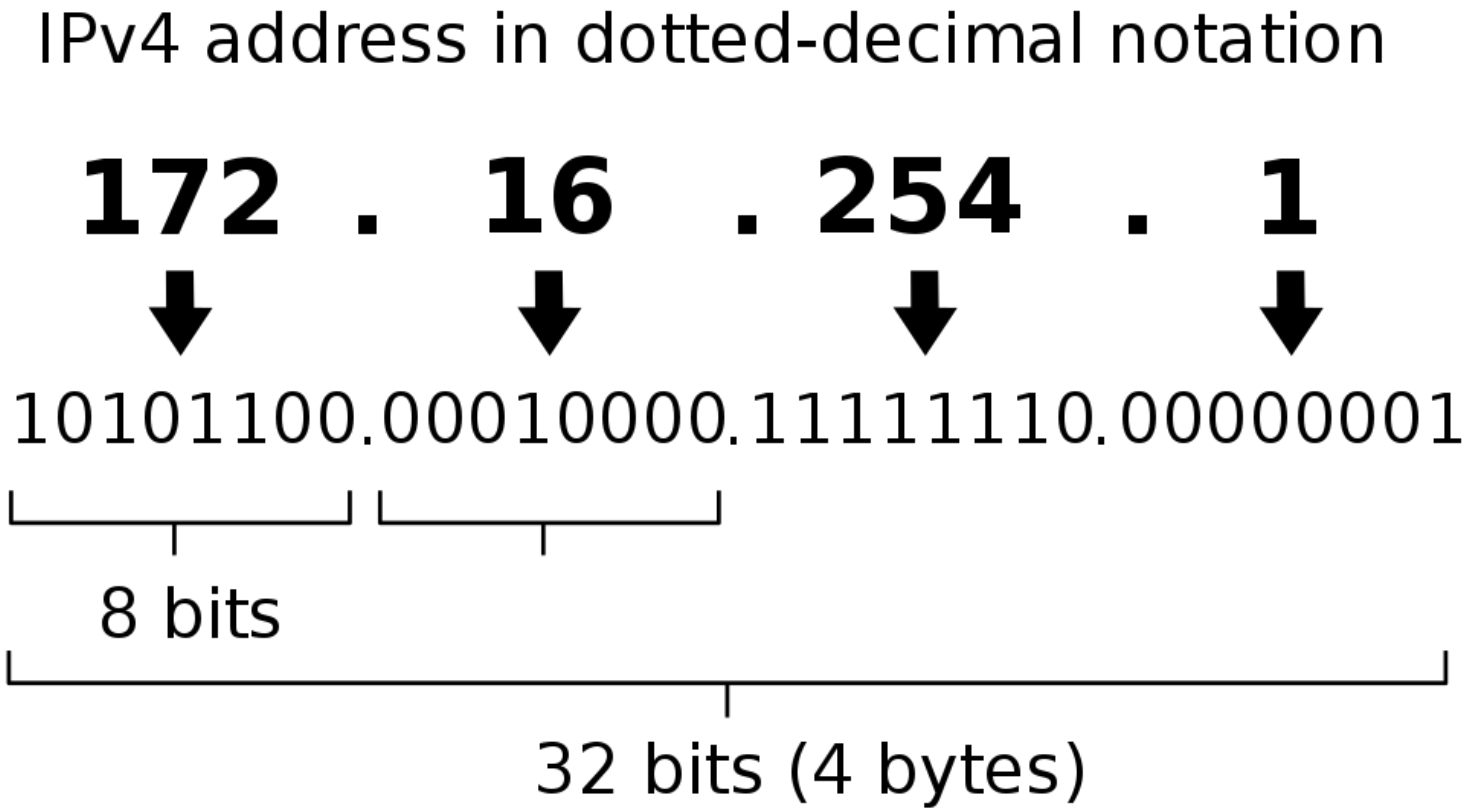
- It has hierarchical structure to enable routing.

  -**Network Portion:-** Identifies a specific network.

  -**Host Portion:-** identifies a specific endpoint on a network.

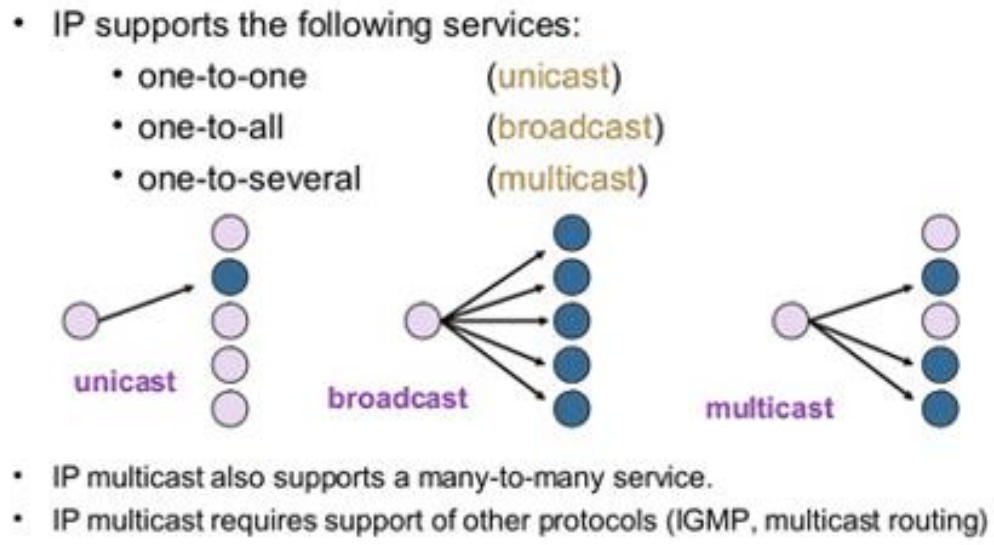


Example of an IP Address



IP Address Classes

- **Class A**
- **Class B** Unicast Traffic
- **Class C**
- **Class D** Multicast
- **Class E** Reserved for future or experimental purposes.



IPv6- does not use address classes.

IPv4- address classes was replaced by CIDR(Classless inter- domain routing)

ex. 192.168.1.1 /26

Classes of IP Addresses

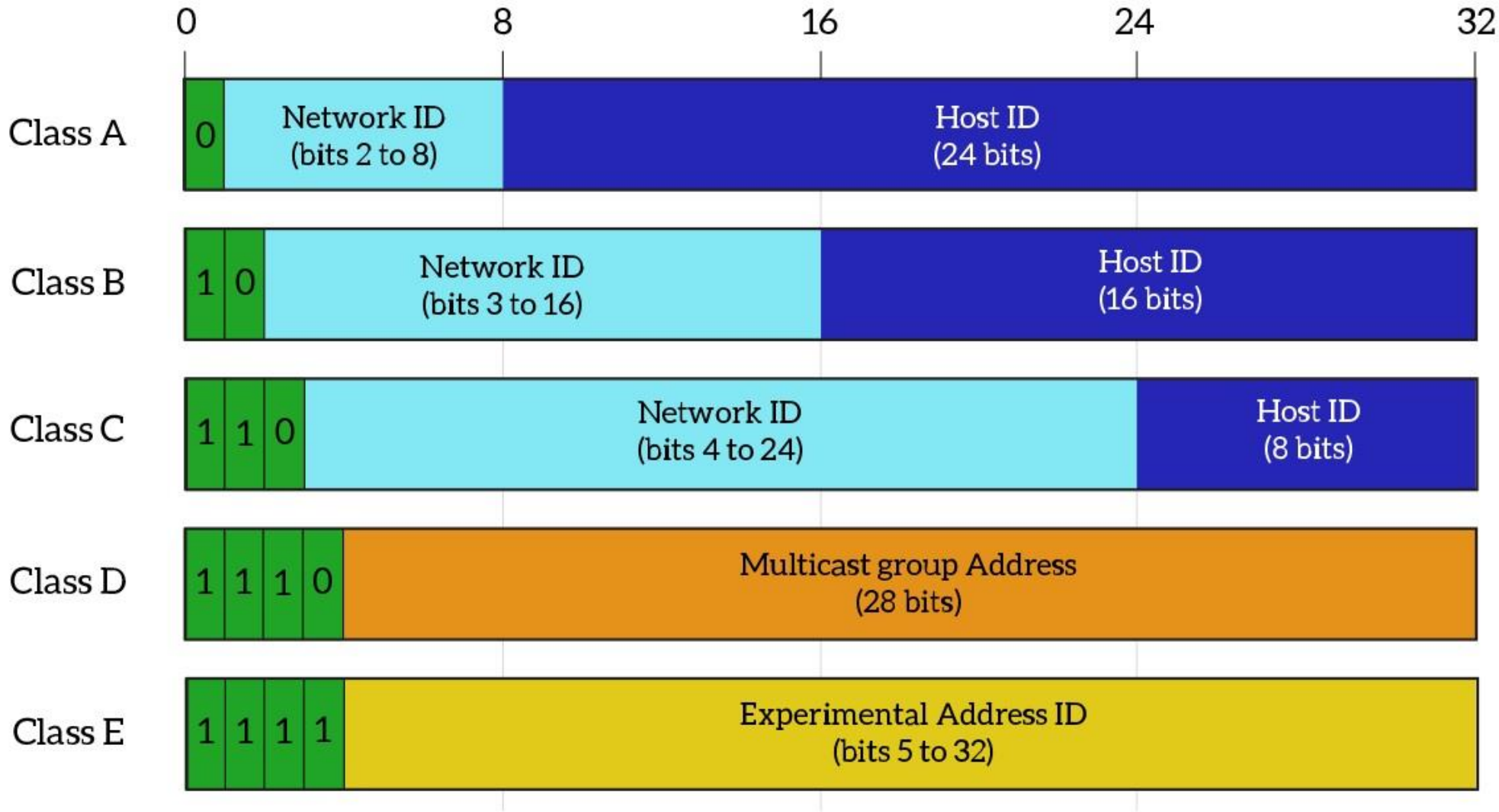
Class	From	To
A	0.0.0.0	127.255.255.255
B	128.0.0.0	191.255.255.255
C	192.0.0.0	223.255.255.255
D	224.0.0.0	239.255.255.255
E	240.0.0.0	255.255.255.255

Which IP belongs to Which Class?

Class	Start with a binary	Range	First Octet Binary Start	**First Octet Binary** End
Class A	0	0.0.0.0 to 127*.255.255.255	0000 0000 = 0	0111 1111 =127*
Class B	10	128.0.0.0 to 191.255.255.255	1000 0000 =128	1011 1111 =191
Class C	110	192.0.0.0 to 223.255.255.255	1100 0000 =192	1101 1111 =223
Class D	1110	224.0.0.0 to 239.255.255.255	1110 0000 = 224	1110 1111 =239
Class E	1111	240.0.0.0 to 255.255.255.255	1111 0000 = 240	1111 1111 =255

Note:- Exception 127* is reserved for loopback address (127.0.0.1)

Which IP belongs to Which Class?



How many Host's and Network are available in Each Class?

Name Of Class	Network & Host		Nos. of Network	Nos. of Hosts
class A	N.H.H.H	N=8 H=24	2^8-1=2^7=128	2^24=16777216
Class B	N.N.H.H	N=16 H=16	2^16-2=2^14=16384	2^16= 65536
Class C	N.N.N.H	N=24 H=8	2^24-3=2^21=2097152	2^8 =256

Quiz 1?

Find the error, if any in the following IPv4 address.

a. **111.56.045.78**

b. **221.32.7.8.20**

c. **75.45.301.14**

d. **11100010.23.14.67**

Quiz 1?

Find the error, if any in the following IPv4 address.

a. 111.56.045.78

b. 221.32.7.8.20

c. 75.45.301.14

d. 11100010.23.14.67

a. Error at 045.

b. Only 4 Octets.

c. Decimal no not allow more than 255

d. Do not allow a combination of binary and decimal.

Quiz 2 ?

Q. Change the following IPv4 addresses from binary notation to dotted decimal notation.

a. 10000001 00001011 00001011 11101111
b. 11000001 10000011 10001011 01101111
c. 11100111 11011011 10011011 01101111
d. 11111001 10011011 11111011 00001111

Quiz 2 ?

Solutions:-

a. 129.11.11.239

b. 193.131.139.111

c. 231.219.155.111

d. 249.155.251.15

Quiz 3 ?

Q. Find the class of each address.

a. 227.12.14.87
b. 193.14.56.22
c. 14.23.120.8
d. 1.2.3.4

Quiz 3 ?

Q. Find the class of each address.

a. 227.12.14.87
b. 193.14.56.22
c. 14.23.120.8
d. 1.2.3.4

First octet = 227 Class D (224–239)

First octet = 193 Class C (192–223)

First octet = 14 Class A (1–126)

First octet = 1 Class A

Example of Network & Host Address:-

- 10.0.0.0 = Network Address
- 10.1.2.3 = Host Address

Class A Networks Range 1 to 126

Example of Network & Host Address:-

- 172.16.0.0 = Network Address
- 172.16.1.2 = Host Address

Class B Networks Range 128 to 191

Example of Network & Host Address:-

- 192.168.1.0 = Network Address
- 192.168.1.1 = Host Address

Class C Networks Range 192 to 223

Private IP Address

A private IP address is a unique identifier assigned to devices within a private network, like your home or office Wi-Fi, that allows them to communicate with each other without connecting to the internet. Unlike public IP addresses, private IP addresses are not visible or routable outside of the private network, enhancing security within that network.

Key Characteristics of Private IP Addresses:

- Internal Use
- Not Publicly Routable
- Security
- Assigned by Router
- Network Address Translation (NAT)

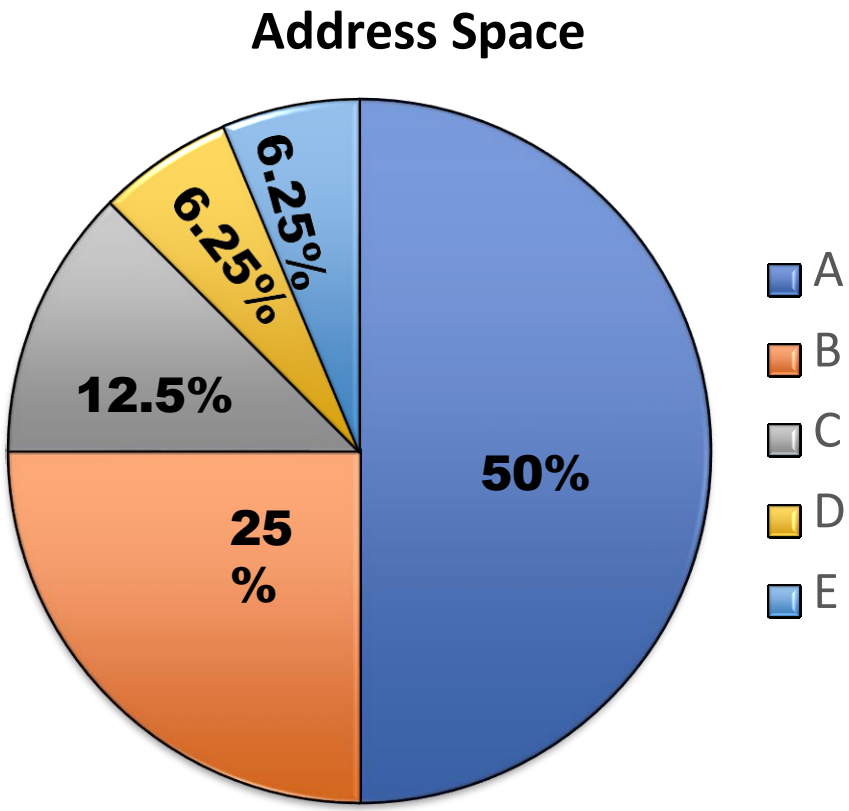
Private Address Range

Address Class	Reserved Address Space
Class A	10.0.0.0 - 10.255.255.255
Class B	172.16.0.0 - 172.31.255.255
Class C	192.168.0.0 - 192.168.255.255
Loopback	127.0.0.0-127.255.255.255
Research	169.254.0.0-169.254.255.255

Address Space

- An IPv4 address has a size of 32 bits, which limits the address space to 4,294,967,296 (4 billion addresses) (or 2^{32}) addresses.
- Of this number, some addresses are reserved for special purposes such as private networks (~18 million addresses) and multicast addressing (~270 million addresses).
- In Classful addressing the addressing space is divided into five classes as shown in below fig.

Address Space



Sr. No.	Class	Number of Addresses
1	A	2^{31} =2,147,483,648
2	B	2^{30} =1,073,741,824
3	C	2^{29} =536,870,912
4	D	2^{28} =268,435,456
5	E	2^{28} =268,435,456

Network or Subnet Masks

- It used to determine network portion and host portion.
- Is a device remote or local?
- A subnet mask is a number that distinguishes the network address and the host address within an IP address.
- A subnet is a smaller network within a network that requires a subnet mask.
- Subnetting is the process of dividing a network into two or more subnets.

Benefits of subnets

- Subnets help to reduce network traffic
- Subnets help to improve security
- Subnets make it easier to organize and manage IP addresses
- Subnets make routing data within a network more efficient

Default Masks

Class A
Subnet Mask

Netwok	Host	Host	Host
255	0	0	0

Class B
Subnet Mask

Netwok	Network	Host	Host
255	255	0	0

Class C
Subnet Mask

Netwok	Network	Network	Host
255	255	255	0

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Network or Subnet Masks

1- Networks
0- Hosts

- The subnet mask follow two rules:
  1. If a binary bit is **set to a 1 (or *on*)** in a subnet mask, the corresponding bit in the address identifies the **network**.
  2. If a binary bit is **set to a 0 (or *off*) in** a subnet mask, the corresponding bit in the address identifies the **host**.

Binary Rules:
Network / subnet address
✓ Fill the host portion of an address with binary 0's

Network or Subnet Masks

1- Networks
0- Hosts

Example 1:- Class A network

10.1.1.1/8 Or 255.0.0.0

Convert the address and mask to binary numbers

AND Rules
0*0=0
0*1=0
1*0=0
1*1=1

10.1.1.1 = 0000 1010.0000 0001.0000 0001.0000 0001

255.0.0.0 = 1111 1111.0000 0000.0000 0000.0000 0000

AND

10.0.0.0= 0000 1010.0000 0000.0000 0000.0000 0000

10.0.0.0

10 =Network Portion
1.1.1 = Host Portion

Network or Subnet Masks

Example 2:- Class B network

172.16.1.1 /16 Or 255.255.0.0

Convert the address and mask to binary numbers

172 . 16 . 1.1 = 1010 1100. 0001 0000. 0000 0001.0000 0001

255. 255.0.0 = 1111 1111. 1111 1111. 0000 0000.0000 0000

AND

172 .16 . 0 . 0 = 1010 1100 . 0001 0000.0000 0000.0000 0000

Network Portion = 101011100.00010000 = 172.16

Host Portion = 00000001.00000001 = 1.1

Network Address

- The network address is an address that defines the network itself.

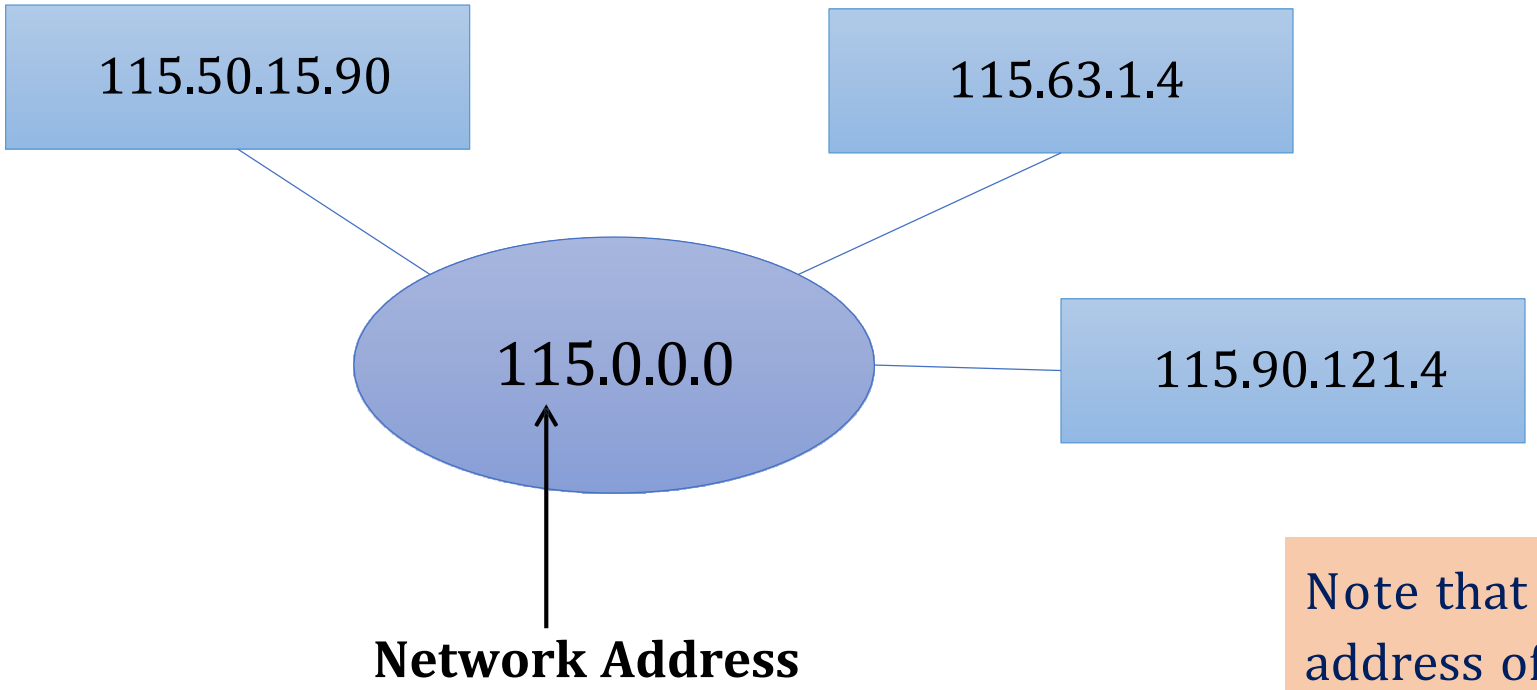
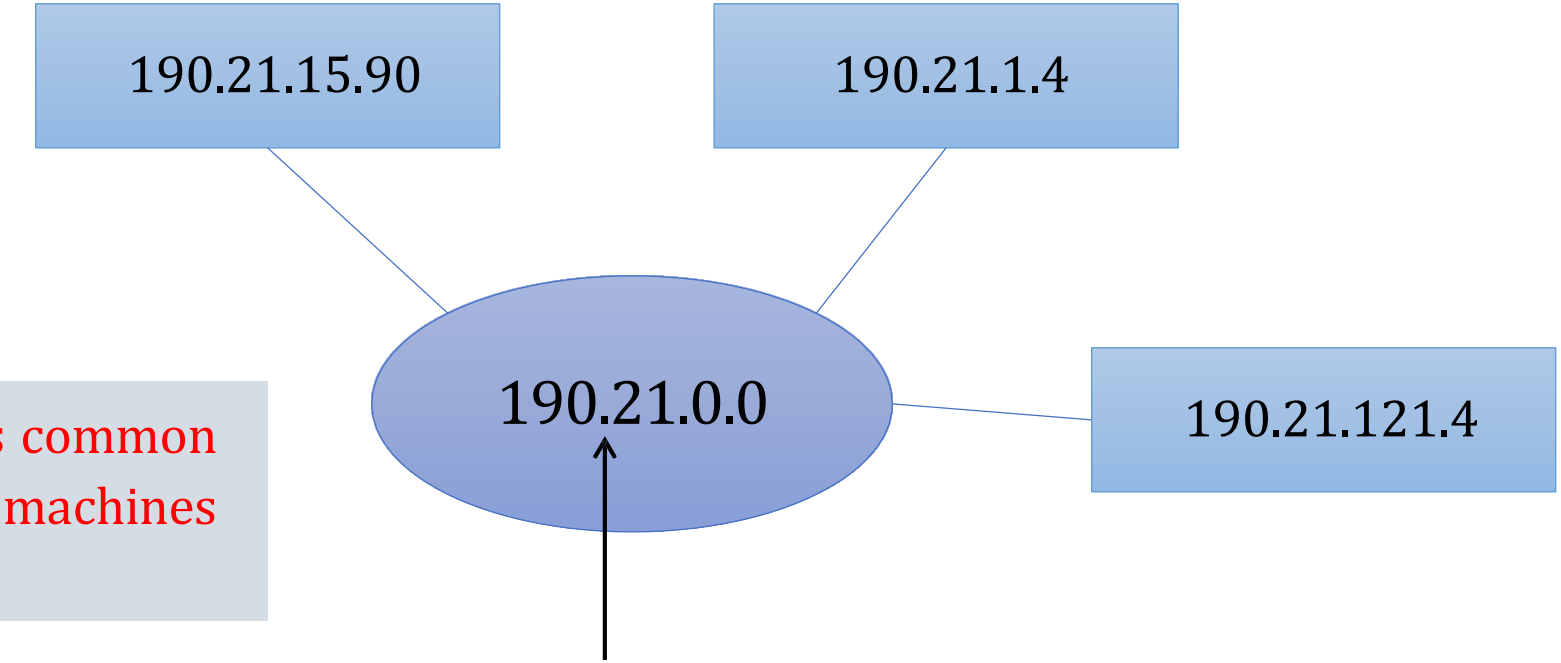


Fig. Class A network address

Note that 115 is common in the address of all machines in class A network

Network Address



Note that 190.21 is common in the address of all machines in Class B network

Fig. Class B network address

Network Address

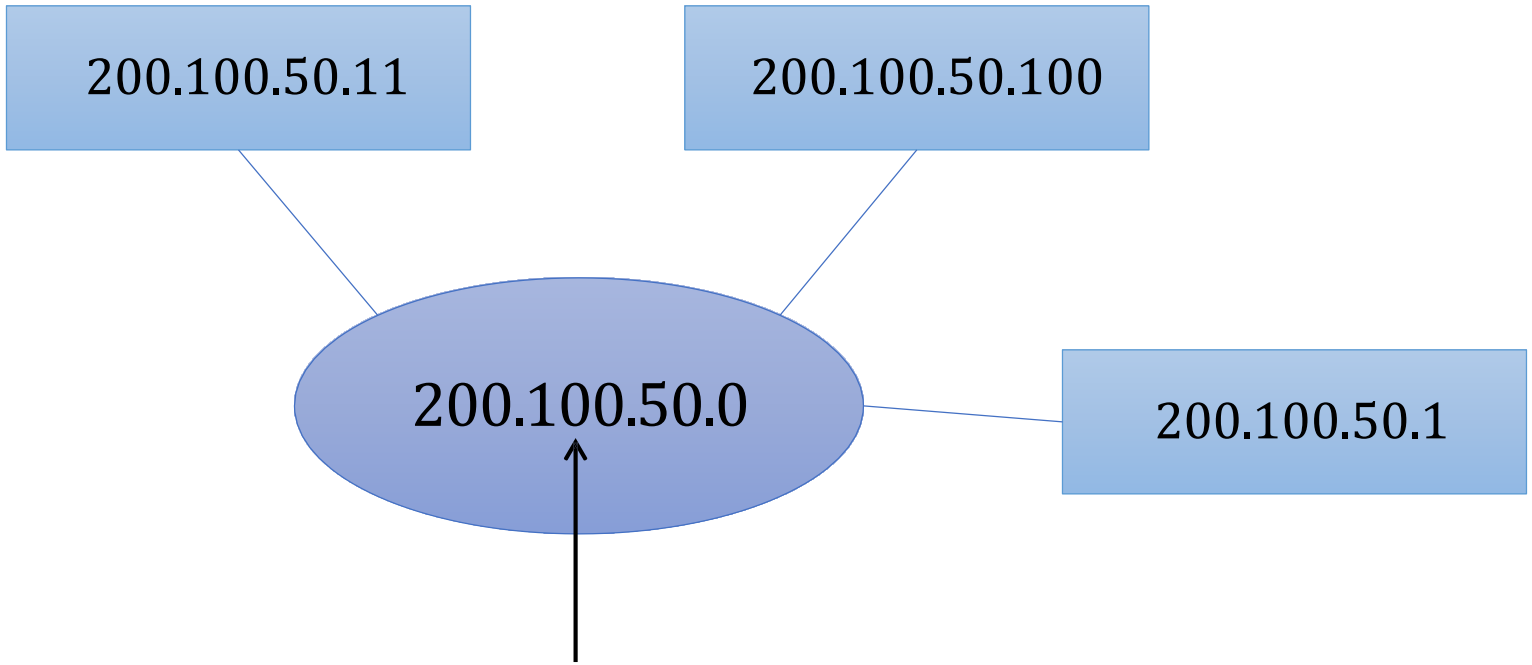


Fig. Class C network address

Note that 200.100.50 is common in the address of all machines in Class C network

Example 1:-

For the address 120.46.50.95 identify the type of network and find the network address. (default mask)

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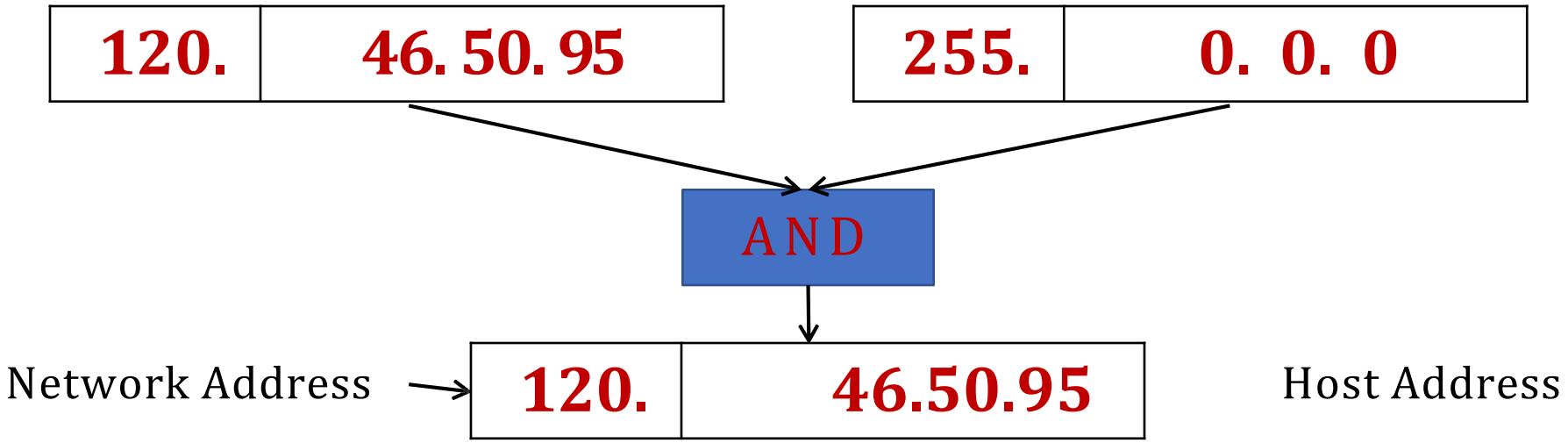
For the address 120.46.50.95 identify the type of network and find the network address. (default mask)

Solution:-

Examine the first byte. Its value is 120 i.e. it is between 0 to 126. so it is a Class A network. So only the first byte defines the **Network ID**. So we can find the network address by replacing the **Host Id** with 0s. Mask used is 255.0.0.0



Example 2:- For the address 192.168.1.18/24 identify the type of network and find the network address.

Example 2:- For the address 192.168.1.18/24 identify the type of network and find the network address.

Solution :-

1. Examine the first byte. Its value is 192 i.e. it is between 191 to 223. so it is a Class C network.
2. Subnet mask is **255.255.255.0**
3. /24 (CIDR) it means network portion is first 3 octets i.e. 192.168.1 & 18 is host portion

Example 3:- IP address 172.16.35.123 /20

Find subnet mask and Network Address, Host Address

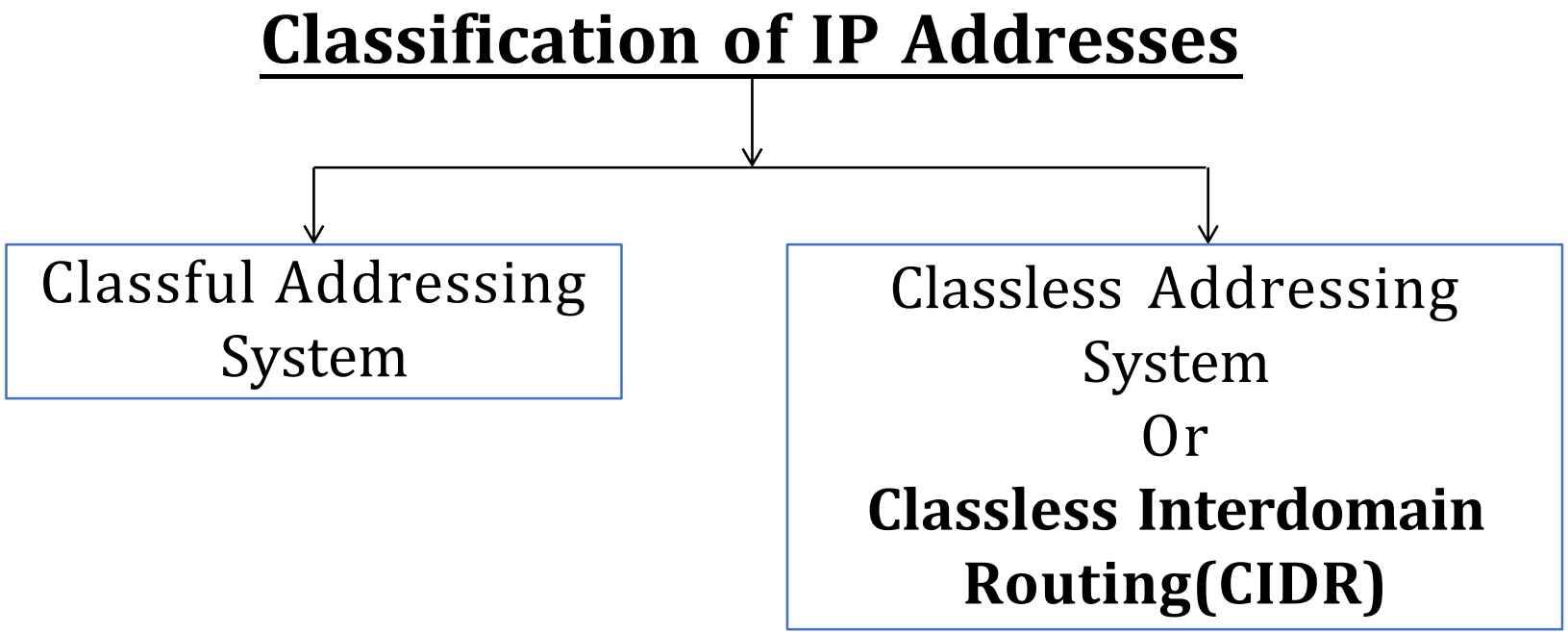
Example 3:- IP address 172.16.35.123 /20

Find subnet mask and Network Address, Host Address

Solution:-

- **20 bits** are used for the **network portion**
- The **remaining 12 bits** are for **hosts**
- Convert to binary 11111111.11111111.11110000.00000000
- Convert to decimal →Subnet Mask = 255.255.240.0
- 3rd octet = 35 in binary → 00100011
- Use only the first 4 bits: 0010 = 32 (base subnet)
- So, the subnet starts at 172.16.32.0
- And the host part is 0.0.3.123

IP Addressing-



Classless Addressing- /CIDR

- It is also known as **Classless Inter Domain Routing (CIDR)**.
- Introduced in 1993.
- Replace classful IP addressing.
- Variable length subnet mask(VLSM).
- Classless Addressing is an improved IP Addressing system.
- It makes the allocation of IP Addresses more efficient.
- It replaces the older classful addressing system based on classes.
- Improve address space utilization
- Routing scalability in the Internet

/X CIDR notation
Ex. 10.0.0.0 **/8**

Before CIDR

- **Class A**
  - ✓16777214 host addresses (16 million)
  - ✓Mask of 255.0.0.0
- **Class B**
  - ✓It support 65534 host addresses.
  - ✓Mask of 255.255.0.0
- **Class C**
  - ✓it support 254 host addresses
  - ✓Mask of 255.255.255.0

Replaced with CIDR subnetting.
- ✓ How to subnet a network?
- ✓ maximum host

CIDR working?

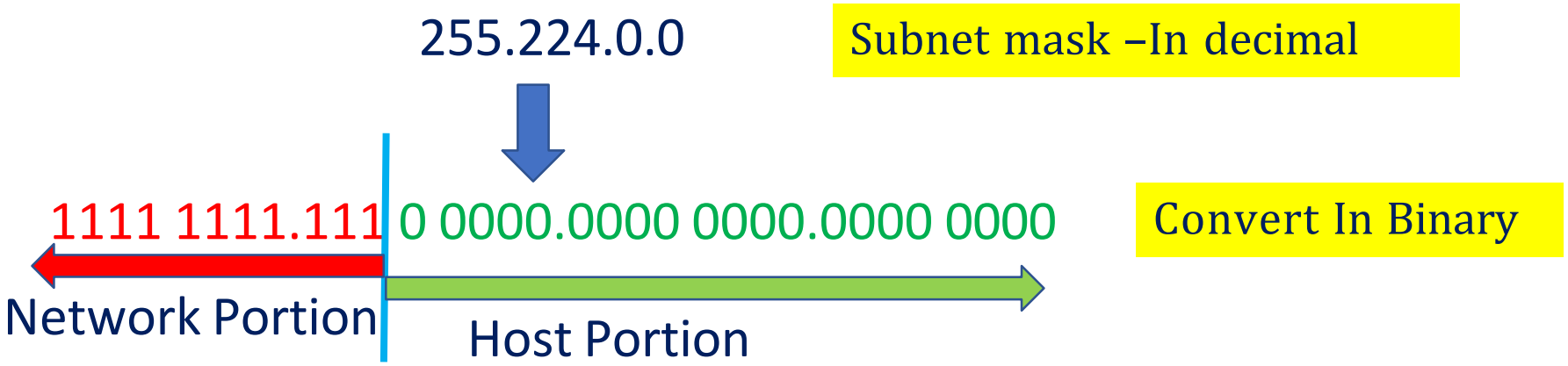
- ✓ Company? Needs to support 5000 host
- ✓ If company want to support 5000 host for example which of these 3 address classes with company get,
- ✓ They could get class B address, but also waste of lot of address about 65534 host address available in Class B.

  But in this example company only need 5000 host address.
- ✓ They could get multiple class C, but that means it can be allocated many C address which has negative effect on internet routing table.
  Rather than doing this we move subnet mask.

Replaced with CIDR subnetting.

CIDR working

Example



11 binary 1's or /11
255.224.0.0/11

Left hand side is network portion & right hand side is host portion

Quiz?

Q. A subnet mask of 255.255.255.240 mention CIDR notation

Quiz?

Q. A subnet mask of 255.255.255.240 mention CIDR notation

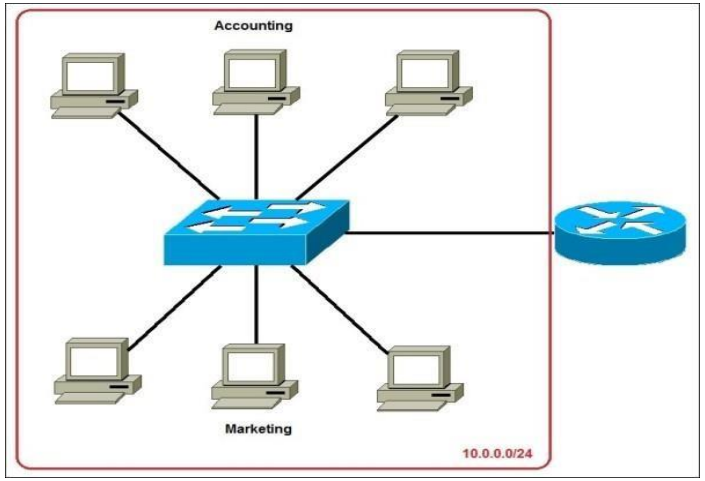
Solution:-

- ✓ It would be represented as follows in binary:
  11111111.11111111.11111111.11110000

- ✓ The first 28 bits of the above subnet mask are set to 1.
- ✓ The CIDR notation for this subnet mask would thus be /28.

Subnetting-

- ✓ **Subnetting** is the process of creating new networks.
- ✓ **Subnetting** is the practice of dividing a network into two or more smaller networks.
- ✓ It increases routing efficiency, enhances the security of the network and reduces the size of the broadcast domain.
- ✓ Example



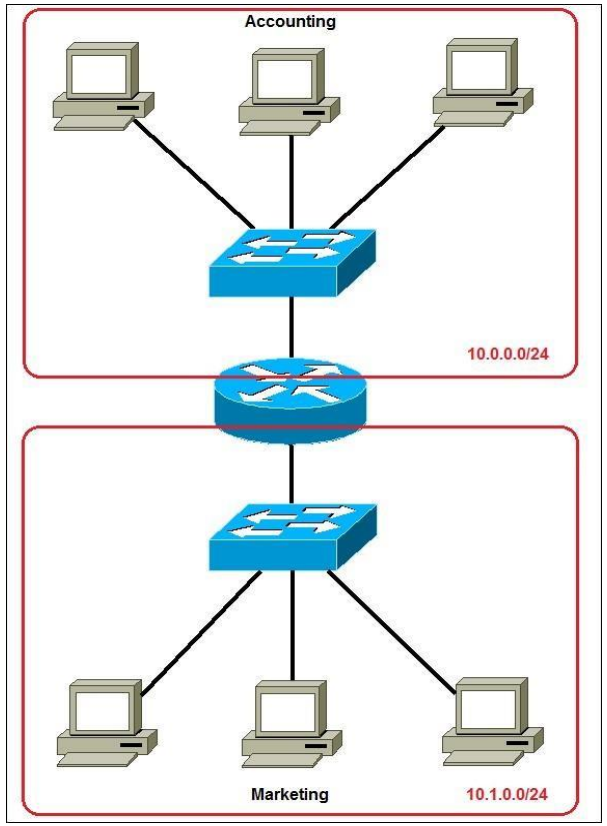
- In this picture we have one huge network: **10.0.0.0/24.**
- All hosts on the network are in the same subnet, which has following disadvantages:

Subnetting-

- ✓ **A single broadcast domain** – all hosts are in the same broadcast domain.
- ✓ **Network security** – each device can reach any other device on the network, which can present security problems.
- ✓ **Organizational problems** – in a large networks, different departments are usually grouped into different subnets.
  - ✓ For example, you can group all devices from the **Accounting** department in the same subnet and then give access to sensitive financial data only to hosts from that subnet.

Subnetting-

✓ The network above could be subnetted like this:



- Now, two subnets were created for different departments: **10.0.0.0/24** for Accounting and **10.1.0.0/24** for Marketing.
- Devices in each subnet are now in a different broadcast domain.
- This will reduce the amount of traffic flowing on the network and allow us to implement packet filtering on the router.

Benefits of Subnetting-

1) Reduced network traffic.
2) Optimized network performance.
3) Simplified management.
4) Facilitated spanning of large geographical distances.

Create Subnets or subnetting calculation-

Before we start subnetting, we have to ask ourselves these two questions:

1. **How many subnets do we need?(Formula)**

Number of subnets= 2^n (**n** is the number of 1s in the subnet mask)

With 1 subnet bit, we can have 2^1 or 2 subnets. With 2 bits, 2^2 or 4 subnets, with 3 bits, 2^3 or 8 subnets, etc.

2. **How many hosts per subnet do we need?**

Number of hosts per subnet = $2^n - 2$ (**n** is the number of 0s in the subnet mask.)

Example:-1 IP address of 192.168.1.1 /25

Mention:-
Class?
Network bits?
Host bits?
Subnet mask?
Host ID?
No of Hosts?

Example:-1 IP address of 192.168.1.1 /25 what is subnet mask? And how many hosts are allowed?

Solution:- As it is a Class C IP address, the first three octets will remain unchanged for subnet calculation.

Now, we shall convert the IP address to binary it will be,

Decimal	192	168	1	1
Binary	1100 0000	1010 1000	0000 0001	0 000 0001
	Network Bits			Host bits

In this case, 25 bits are used as network bits not 24 bits as used by default in Class C. this means one host bit is borrowed to be used for subnetting purpose.

Hence Subnet mask will be 255.255.255.128

The number of hosts per subnet will be=2^7-2=126.

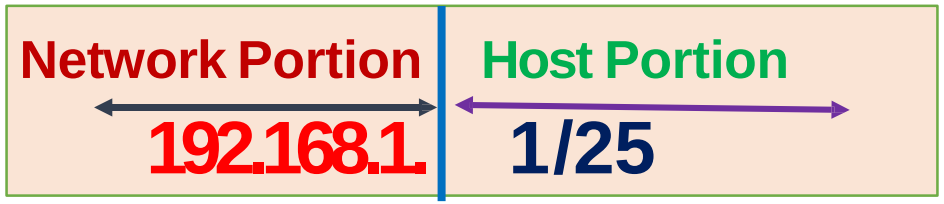
Binary Rules:- There are 4 rules

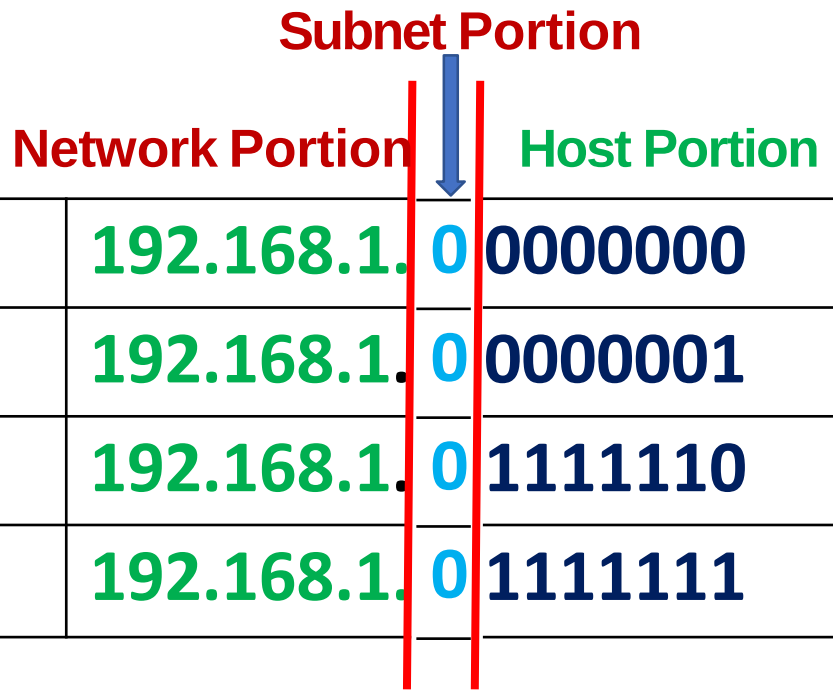
1. Network /Subnet address:-
   - ✓Fill the host portion of an address with binary 0's.
2. Broadcast address:-
   - ✓Fill the host portion of an address with binary 1's.
3. First Address:-
   - ✓Fill the host portion of an address with binary 0's except for last bit which is set to binary 1
4. Last Address:-
   - ✓Fill the host portion of an address with binary 1's. except for last bit which is set to binary 0

IP Address : 192. 168. 1 .1 /25

- ✓ Number of **subnets will be = 2 ^1 =2.**
  Number of **hosts per subnet will be=2^7-2=126.**

Class C

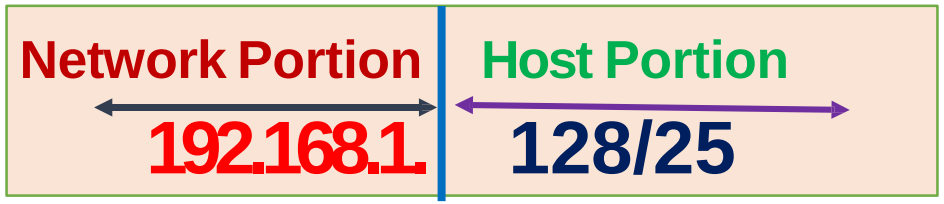




Network/ Subnet	192.168.1.	0 0000000	192.168.1.0/25
1st Address	192.168.1.	0 0000001	192.168.1.1/25
Last Address	192.168.1.	0 1111110	192.168.1.126/25
Broadcast Address	192.168.1.	0 1111111	192.168.1.127/25

IP Adress 192.168.1.128 /25

- ✓ Number of subnets will be = 2 ^1 =2.
  Number of hosts per subnet will be=2^7-2=126.



Subnet Portion

Network Portion | Host Portion

Network/ Subnet	192.168.1.	1	0000000	192.168.1.128/25
1st Address	192.168.1.	1	0000001	192.168.1.129/25
Last Address	192.168.1.	1	1111110	192.168.1.254/25
Broadcast Address	192.168.1.	1	1111111	192.168.1.255/25

Example:- 2 IP address of 172.16.35.123 /20

Find :
Class
Subnet Mask
First Address
Last Address
Network/ subnet
Broadcast address

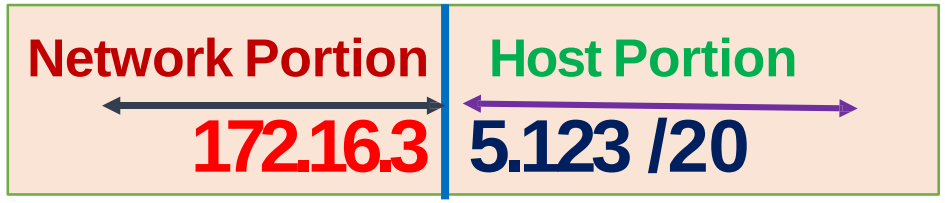
Example:- 2 IP address of 172.16.35.123 /20 OR

Class B

255.255.240.0

/20 it means 20 bits of 32 bit IP address are used for network / subnet & the remaining 12 bits are used as the Host Portion

Step1:-



Decimal	172	16	3 5	123
Binary	1010 1100	0001 0000	0010 0011	0111 1011
	Network Bits			Host bits

Step 2:- Convert octet 3 & 4 into binary (because they both have host bits)

IP Address= 172.16.0010 0011. 0111 1011 =172.16.35.123

Network Portion | Host Portion

- ✓ Number of subnets will be = 2 ^ 4 = 16.
  Number of hosts per subnet will be=2^12-2 = 4096.

Step3:- Apply 4 binary rules

Network Portion			Host Portion	
Network/ Subnet	172.16.	0010	0000.0000 0000	172.16.32.0/20
1st Address	172.16.	0010	0000.0000 0001	172.16.32.1/20
Last Address	172.16.	0010	1111.1111 1110	172.16.47.254/20
Broadcast Address	172.16.	0010	1111.1111 1111	172.16.47.255/20

Quiz?

Q.1 What is the network address for host 172.16.1.1 with network mask 255.255.192.0?

a. 172.16.0.0/16
b.172.16.0.1/16
c. 172.16.0.0/18
d.172.16.1.1/18

Quiz?

Q.1 What is the network address for host 172.16.1.1 with network mask 255.255.192.0?

a. 172.16.0.0/16
b.172.16.0.1/16
c. 172.16.0.0/18
d.172.16.1.1/18

172.16.00 00 0000.00000000 /18

✓**Correct Ans. C**

Private Network

- Private IP network is an IP network that is not directly connected to the Internet.
- Three address ranges are reserved for private usage (non-routable addresses):
  Class A : 10.0.0.0/8
  Class B : 172.16.0.0/16to 172.31.0.0/16
  Class C : 192.168.0.0/24to 192.168.255.0/24
- A private IP is mapped to a Public IP, when the machine has to access the Internet.

Why IPv6?

- **Shortage of IPv4 addresses**
  - Internet is expanding very rapidly in developing countries like India, China.
  - New devices like phones need IP address.
- **End-to-End Reachability is not possible without IPv6**
- **New Features** like Auto-configuration, better support for QoS, Mobility and Security, Route Aggregation, Jumbo Frames.

Why IPv6?

- Internet Protocol Version 6(IPv6) is the latest revision of the Internet Protocol, the communication protocol that provides an identification and location system for computers on networks and routes traffic across the internet.
- IPv6 was developed by IETF(Internet Engg. & task Force) to deal with the long-anticipated problem of IPv4 address exhaustion.
- In contrast to IPv4, which defined an **IP address as a 32-bit value, IPv6 addresses have a size of 128 bits.** Therefore, IPv6 has a **vastly enlarged** address space compared to IPv4.

FEATURES OF IPV6

- New Header Format
- Large Address Space
- Efficient and Hierarchical addressing and routing infrastructure
- Stateless and stateful address configuration
- Built-in Security
- Better support for Quality of Service
- New support for neighboring node interaction
- Extensibility

1.1 IPv6 address - Representation

- IPV6 address is 128 bit long.
- The 128-bit address is divided into 16-bits, and each 16-bit block is converted into 4-digit hexadecimal number and separated by colons. This type of representation is called colon hexadecimal.
- The format o f IPv6 address is

xxxx: xxxx: xxxx: xxxx: xxxx: xxxx: xxxx: xxxx

where each x is a hexadecimal representing 4 bits or a nibble.

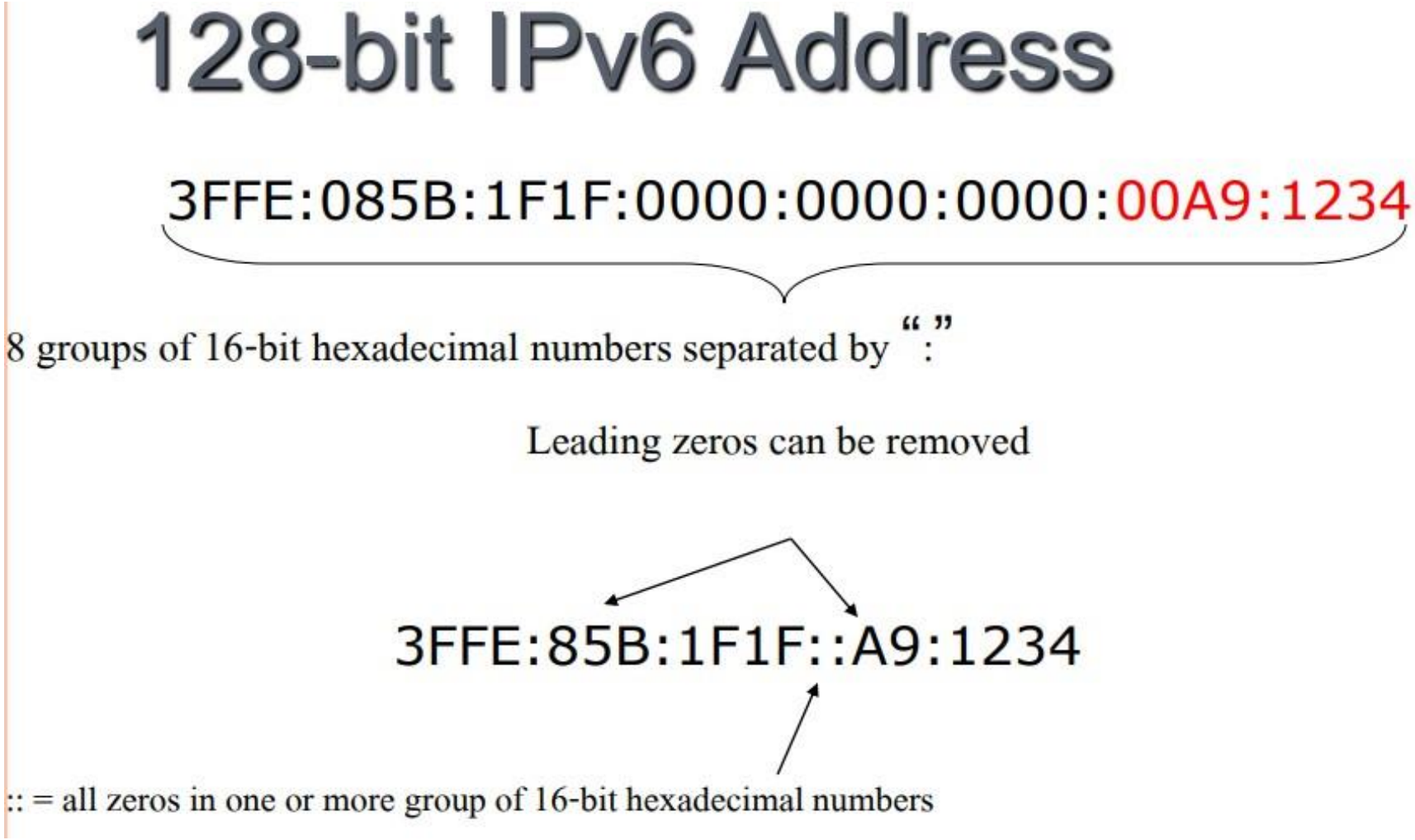
- IPv6 address range from

0000:0000 :0000 :0000 :0000:0000 :0000:0000

to

FFFF: FFFF: FFFF: FFFF: FFFF: FFFF: FFFF: FFFF

IPv6 address - Representation



IPv6 Address – Examples-1

Ex1. show the unabbreviated colon hex notation for the following IPV6 addresses:

1. **An address with 64 0's followed by 64 1's.**
2. **An address with 128 0's**
3. **An address with 128 1's**
4. **An address with 128 alternative 1's & 0's**

IPv6 Address – Examples-1

Ex1. show the unabbreviated colon hex notation for the following IPV6 addresses:

1. **An address with 64 0's followed by 64 1's.**
2. **An address with 128 0's**
3. **An address with 128 1's**
4. **An address with 128 alternative 1's & 0's**

Solution:

1. 0000:0000:0000:0000:FFFF:FFFF:FFFF:FFFF

2. 0000:0000:0000:0000:0000:0000:0000:0000

3. FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF

4. AAAA:AAAA:AAAA:AAAA:AAAA:AAAA:AAAA:AAAA

IPv6 Address – Examples-2

Ex2. show abbreviations & Unabbreviated. for the following addresses:

i. 0000:0000:FFFF:0000:0000:0000:0000:0000
ii. 1234:2345:0000:0000:0000:0000:0000:1111
iii. 0000:0001:0000:0000:0000:0000:1200:1000
iv. 1111::2222
v. ::

IPv6 Address – Examples-2

Ex2. show abbreviations & Unabbreviated. for the following addresses:

i. 0000:0000:FFFF:0000:0000:0000:0000:0000
ii. 1234:2345:0000:0000:0000:0000:0000:1111
iii. 0000:0001:0000:0000:0000:0000:1200:1000
iv. 1111::2222
v. ::

Solution:

1. 0:0:FFFF::

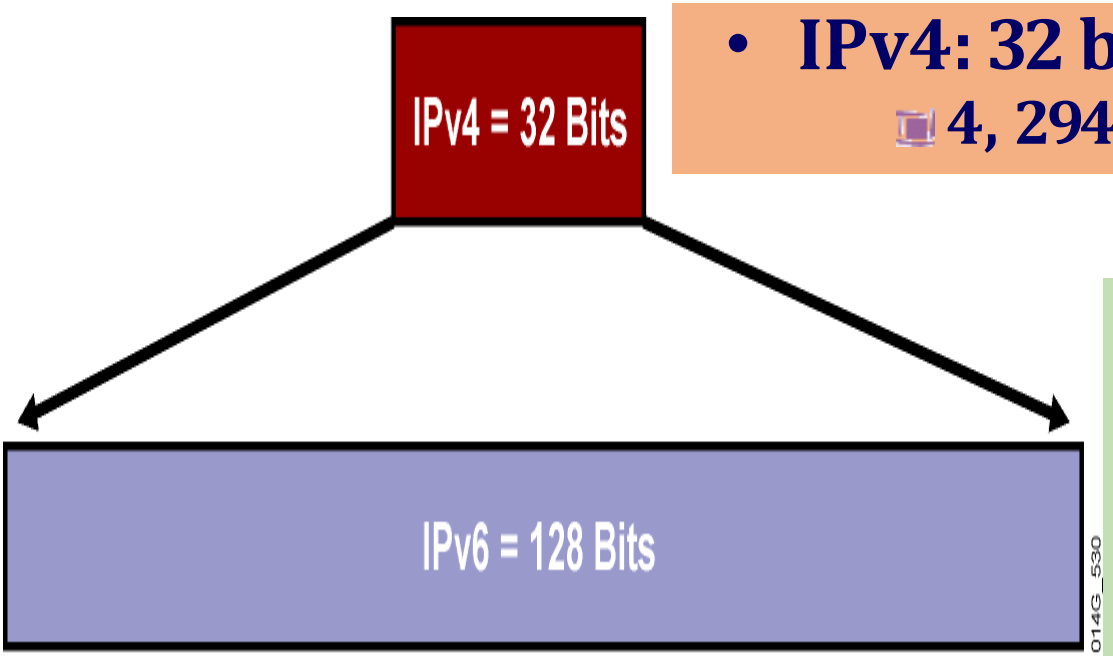
2. 1234:2345::1111

3. 0:1::1200:1000

4.1111:0000:0000:0000:0000:0000:0000:2222

5. 0000:0000:0000:0000:0000:0000:0000:0000

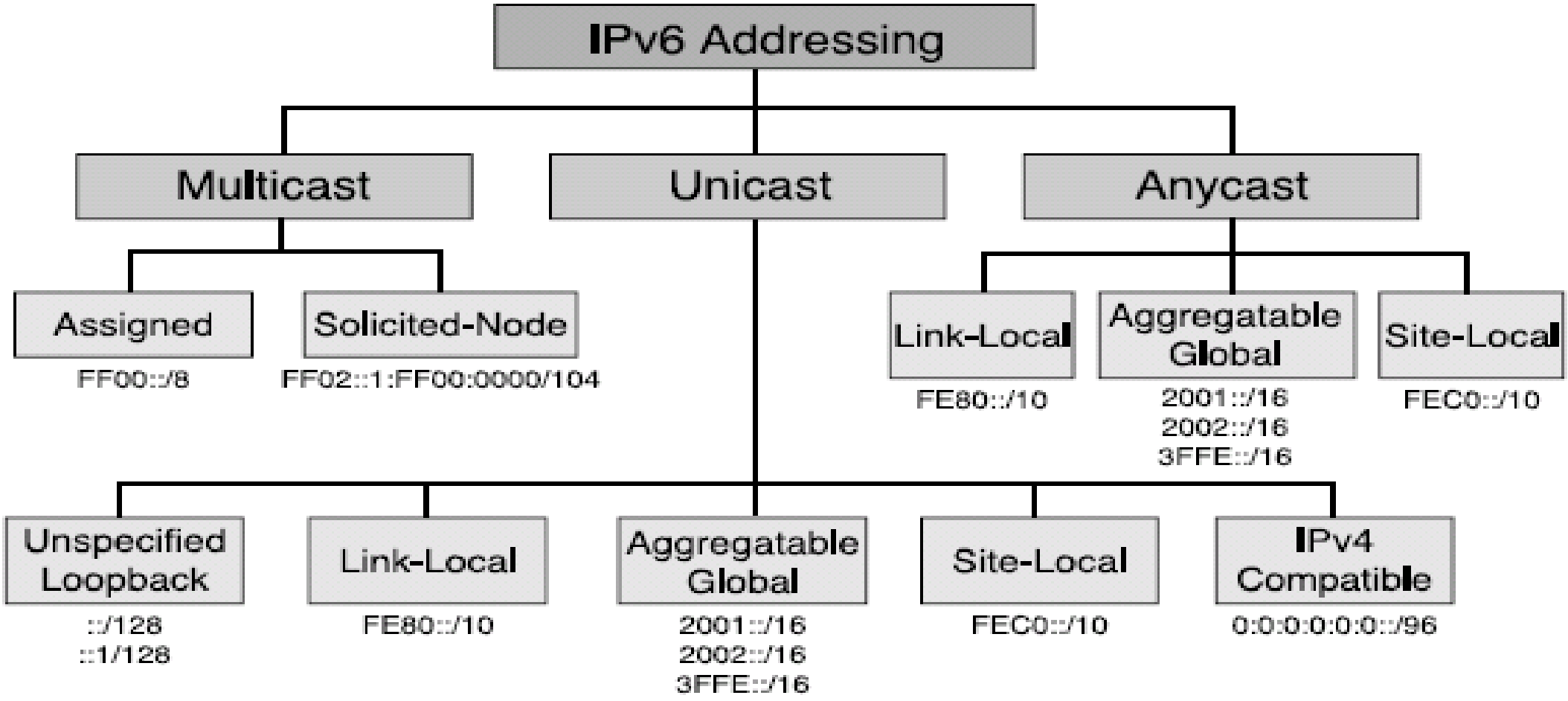
1.2 IPv6 Address Space



- **IPv4: 32 bits or 4 bytes long**
  - **4, 294,467,295 IP addresses**

- **IPv6: 128 bits or 16 bytes**
  - **$3.4 * 10^{38}$ possible addressable nodes**
  - **340,282,366,920,938,463,374,607,432,768, 211,456**
  - **The IPv6 address is represented in hexadecimals.**

IPv6 Address Types

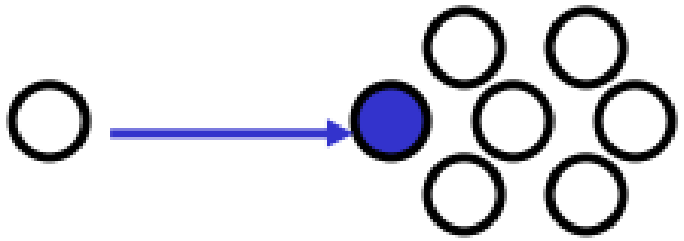


IPv6 Address Types

There are three types:-

1. Unicast

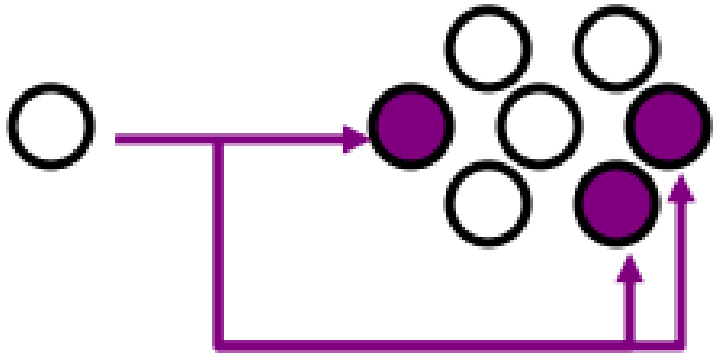
- Address is for a single interface.
- A packet sent to a unicast address is meant to be delivered to the computer specified by the address.



IPv6 Address Types

2. Multicast

- One-to- Many.
- Enables more efficient use of the network.
- Uses a larger address range
- Multicast is the delivery of a message or information to a group of destination computers simultaneously in a single transmission from the source.
- Multicast addresses: FF00::<Group ID>

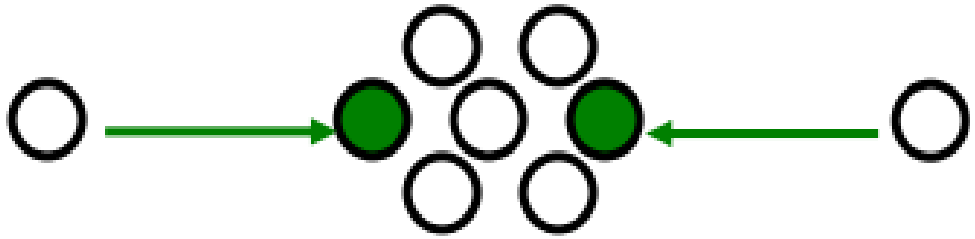


Note That:- There are no broadcast addresses in IPv6 (multicast replaces broadcast).

IPv6 Address Types

3. Anycast

- Anycast addresses are new in IPv6.
- One-to-nearest (allocated from unicast address space) Anycast packets are routed to the nearest host. .
- Multiple devices share the same address.
- All anycast nodes should provide uniform service.
- Source devices send packets to anycast address.

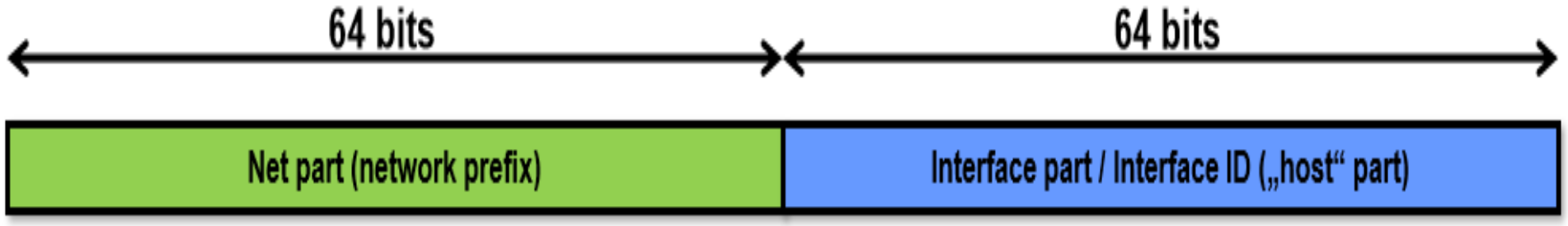


Address Space Allocation

- Like the address space of IPv4, The IPV6 address is divided into several categories & the category of address can be determined from the few leftmost bits of address.
- These leftmost bits that determines the category of address is called type prefix.
- Most of the blocks are still unassigned and have been left aside for future use.
- To better understand the allocation and the location of each block in address space, we first divide the whole address space into eight equal ranges.
- This division does not show the block allocation, but we believe it shows where each actual block is located.

Address Space Allocation

- General structure of IPv6 address



Network prefix:- Where are you connected to.
Interface ID:- Who are you. Created from MAC address or from IPv4 address (IPv6 compatible addresses).

Difference Between IPv4 and IPv6:

IPV4	IPV6
IPv4 has 32-bit address length	IPv6 has 128-bit address length
It Supports Manual and DHCP address configuration	It supports Auto and renumbering address configuration.
In IPv4 end to end connection integrity is Unachievable	In IPv6 end to end connection integrity is Achievable
It can generate 4.29×109 address space	Address space of IPv6 is quite large it can produce 3.4×1038 address space
Security feature is dependent on application	IPSEC is inbuilt security feature in the IPv6 protocol
Address representation of IPv4 in decimal	Address Representation of IPv6 is in hexadecimal

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