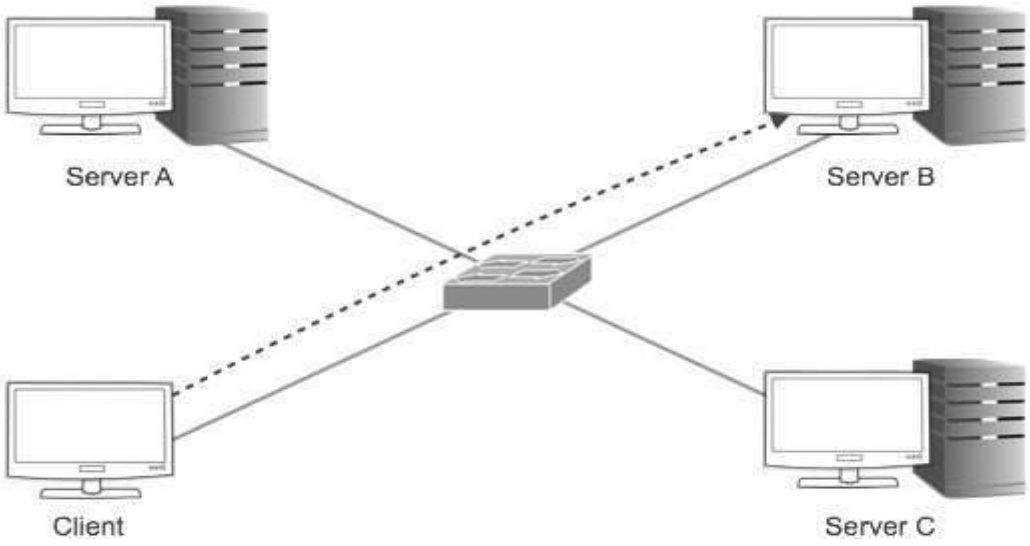
IPv4 – Addressing

IPv4 supports three different types of addressing modes:

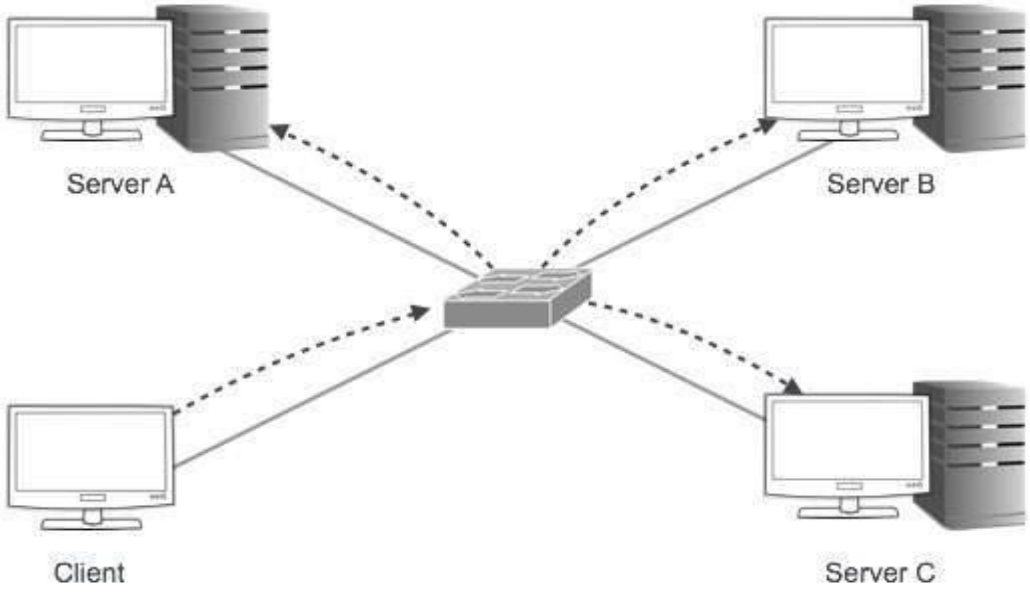
1. **Unicast Addressing Mode:**

In this mode, data is sent only to one destined host. The Destination Address field contains 32- bit IP address of the destination host. Here the client sends data to the targeted server:



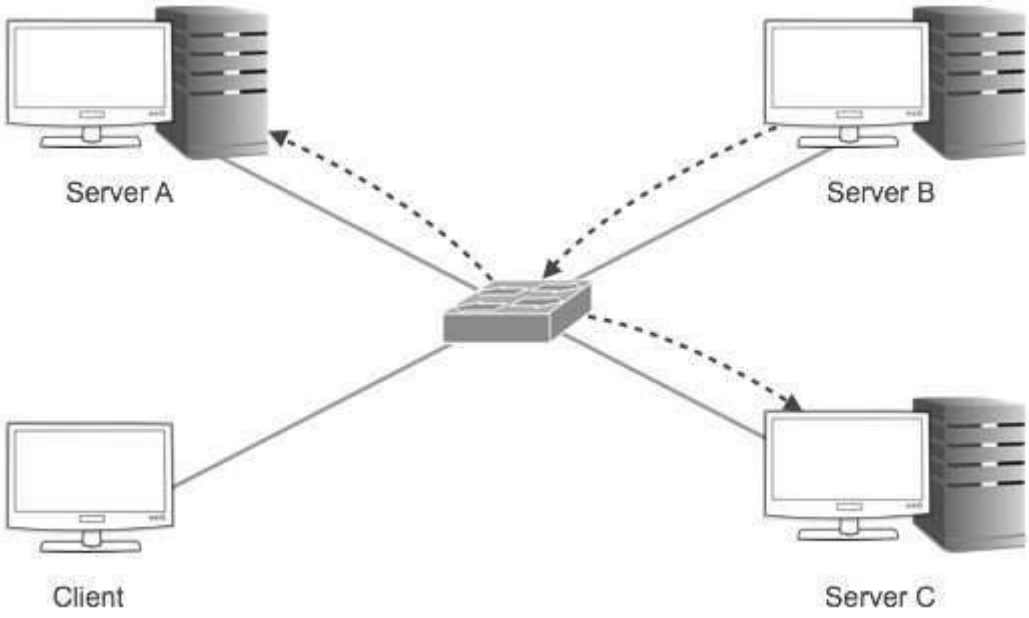
2. **Broadcast Addressing Mode:**

In this mode, the packet is addressed to all the hosts in a network segment. The Destination Address field contains a special broadcast address, i.e. (**255.255.255.255**). When a host sees this packet on the network, it is bound to process it. Here the client sends a packet, which is entertained by all the Servers:



3. Multicast Addressing Mode:

This mode is a mix of the previous two modes, i.e. the packet sent is neither destined to a single host nor all the hosts on the segment. In this packet, the Destination Address contains a special address which starts with **(224.x.x.x)** and can be entertained by more than one host.



Here a server sends packets which are entertained by more than one servers. Every network has one IP address reserved for the Network Number which represents the network and one IP address reserved for the Broadcast Address, which represents all the hosts in that network.

Binary Representation

The positional value method is the simplest form of converting binary from decimal value. IP address is 32 bit value which is divided into 4 octets. A binary octet contains 8 bits and the value of each bit can be determined by the position of bit value '1' in the octet.

MSB	8th	7th	6th	5th	4th	3rd	2nd	1st	LSB
	1	1	1	1	1	1	1	1	
Positional Value	128	64	32	16	8	4	2	1	

Positional value of bits is determined by 2 raised to power (position – 1), that is the value of a bit 1 at position 6 is $2^{(6-1)}$ that is 2^5 that is 32. The total value of the octet is determined by

adding up the positional value of bits. The value of 11000000 is 128+64 = 192. Some examples are shown in the table below:

128	64	32	16	8	4	2	1	Value
0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0	2
0	0	0	0	0	0	1	1	3
0	0	0	0	0	1	0	0	4
0	0	0	0	0	1	0	1	5
0	0	0	0	0	1	1	0	6
0	0	0	0	0	1	1	1	7
0	0	0	0	1	0	0	0	8
0	0	0	0	1	0	0	1	9
0	0	0	0	1	0	1	0	10
0	0	0	1	0	0	0	0	16
0	0	1	0	0	0	0	0	32
0	1	0	0	0	0	0	0	64
0	1	1	0	0	1	0	0	100
0	1	1	1	1	1	1	1	127
1	0	0	0	0	0	0	0	128
1	0	1	0	1	0	0	0	168
1	1	0	0	0	0	0	0	192
1	1	1	1	1	1	1	1	255

The "IP" in IP addresses refers to the Internet Protocol, where protocol is loosely defined as "rules of communication". Imagine using a two-way radio in a police car. Your conversations would probably end with "over" to indicate you are finishing a particular part of the conversation. You might also say "over and out" when you are finished the

conversation itself. These are nothing more than the rules of talking over a two-way radio - or the protocol.

So what is an IP address? Technically, it is the means whereby an entity on a network can be addressed. It is made up solely of numbers, and these numbers are conventionally written in the particular form of:

(X•X•X•X)

Which is referred to as dotted decimal format.

Any number between the dots can be between 0 and 255, so example IP addresses include:

- 205.112.45.60
- 34.243.44.155

These numbers can also be written in binary form by taking each of the decimal values separated by dots and converting to binary. So a number like 205.112.45.60 could be written as:

11001101.01110000.00101101.00111100

Each of these binary components is referred to as an octet.

Why is each number limited to 0 to 255? Well, IP addresses are limited to 32 bits in length and the maximum number of combinations of binary numbers you could have in an octet is 256. Hence, the largest IP address you could have would be 255.255.255.255, given that any one octet could be from 0 to 255.

There is one more aspect of an IP address that is important to understand - the concept of a class. Each IP address belongs to a class of IP addresses depending on the number in the first octet. These classes are:

First Octet value	Class	Example IP address
0 -126	Class A	34.126.35.125
128 - 191	Class B	134.23.45.123
192 - 223	Class C	212.11.123.3
224 - 239	Class D	225.2.3.40
240 - 255	Class E	245.192.1.123

Notice that the number 127 is not included. That's because it is used in a special, self-reflecting number called a **loopback address**. Think of this as an address that says, "***This is my address.***" Note that only the first three classes - A, B and C - are used by network administrators. These are the commonly used classes. The other two, D and E, are reserved. You define the class of an IP address by looking at its first octet value, but the structure of an IP address for any one class is different. Each IP address has a network address and a host address. The network part of the address is the common address for any one network, while the host address part is for each individual device on that network. So, if your phone number is 711-612-1234, the area code (711) would be the common, or network, component of the telephone system, while your individual phone number of (612-1234) would be your host address.

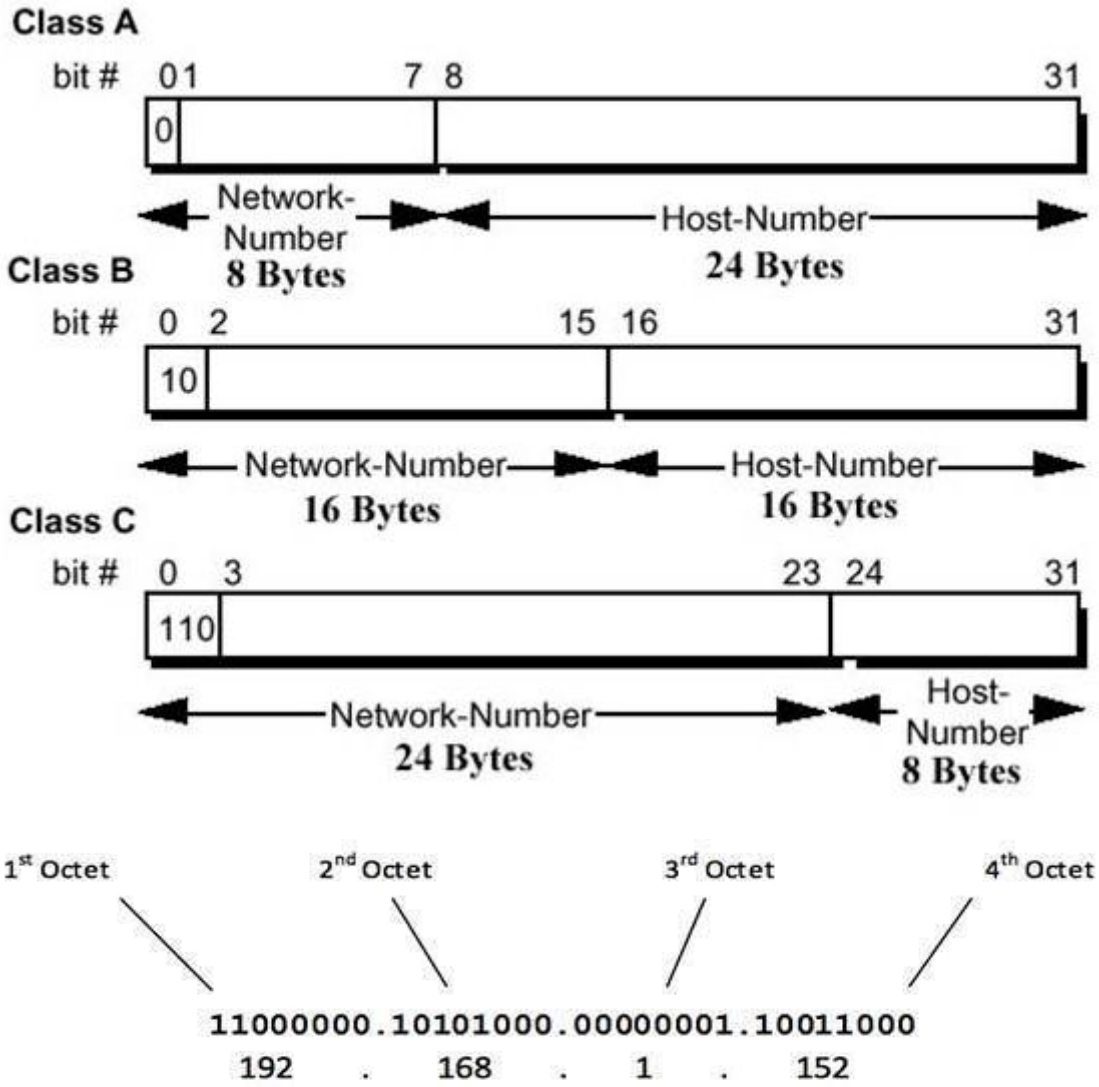
The network and host components of class IP addresses are:

Class	Address components	Network / Host
Class A	Network.Host.Host.Host	**34.**126.35.125
Class B	Network. Network.Host.Host	**134.23.**45.123
Class C	Network. Network Network.Host	**212.11.123.**3
Class D	Not Defined	Not Defined
Class E	Not Defined	Not Defined

The technical numbers behind class addressing are as follows:

Class	Size of network number	Size of host number	Number of networks	Number of hosts per network	Starting address	Ending address
A	8 bits	24 bits	128 (2^7)	16,777,216 (2^{24})	0.0.0.0	127.255.255.255
B	16 bits	16 bits	16,384 (2^{14})	65,536 (216)	128.0.0.0	191.255.255.255
C	24 bits	8 bits	2,097,152 (2^{21})	256 (2^8)	192.0.0.0	223.255.255.255
D	Not Defined		Not Defined	Not Defined	224.0.0.0	239.255.255.255
E	Not Defined		Not Defined	Not Defined	240.0.0.0	255.255.255.255

The following figure refers to the three most used classes (A, B, and C):



The number of networks and the number of hosts per class can be derived by this formula:

Number of networks = 2^network_bits

Number of Hosts/Network = 2^host_bits – 2

When calculating hosts' IP addresses, 2 IP addresses are decreased because they cannot be assigned to hosts, i.e. the first IP of a network is network number and the last IP is reserved for Broadcast IP.

Class A Address

The first bit of the first octet is always set to 0 (zero). Thus the first octet ranges from 1 – 127, i.e.

00000001 – 01111111
1 – 127

Class A addresses only include IP starting from (1.x.x.x to 126.x.x.x) only. The IP range 127.x.x.x is reserved for loopback IP addresses.

The default subnet mask for Class A IP address is 255.0.0.0 which implies that Class A addressing can have 126 networks (2^7-2) and 16777214 hosts (2^{24}-2).

Class A IP address format is thus:

0NNNNNNN.HHHHHHHH.HHHHHHHH.HHHHHHHH

Class B Address

An IP address which belongs to class B has the first two bits in the first octet set to 10, i.e.

10000000 – **10**111111
128 – 191

Class B IP Addresses range from (128.0.x.x to 191.255.x.x.) The default subnet mask for Class B is 255.255.x.x. Class B has 16384 (2^{14}) Network addresses and 65534 (2^{16}-2) Host addresses. Class B IP address format is:

10NNNNNN.NNNNNNNN.HHHHHHHH.HHHHHHHH

Class C Address

The first octet of Class C IP address has its first 3 bits set to 110, that is:

11000000 – **110**11111
192 – 223

Class C IP addresses range from 192.0.0.x to 223.255.255.x. The default subnet mask for Class C is 255.255.255.x.

Class C gives 2097152 (2^{21}) Network addresses and 254 (2^8-2) Host addresses.

Class C IP address format is:

110NNNNN.NNNNNNNN.NNNNNNNN.HHHHHHHH

Class D Address

Very first four bits of the first octet in Class D IP addresses are set to 1110, giving a range of:

11100000 – **1110**1111
224 – 239

Class D has IP address rage from (224.0.0.0 to 239.255.255.255). Class D is reserved for Multicasting. In multicasting data is not destined for a particular host.

Class E Address

This IP Class is reserved for experimental purposes only for R&D (Research and Development) or Study. IP addresses in this class ranges from (240.0.0.0 to 255.255.255.254).

What is public IP address?

A public IP address is the address that is assigned to a computing device to allow direct access over the Internet. A web server, email server and any server device directly accessible from the Internet are candidate for a public IP address. A public IP address is globally unique, and can only be assigned to a unique device.

What is private IP address?

Is used to assign computers within your private space without letting them directly expose to the Internet. For example, if you have multiple computers within your home you may want to use private IP addresses to address each computer within your home.

The address space allocated by InterNIC (the Network Information Center) to allow organizations to create their own private network. There are three IP blocks (1 class A, 1 class B and 1 class C) reserved for a private use. The computers, tablets and smartphones sitting behind your home, and the personal computers within an organizations are usually assigned private IP addresses. A network printer residing in your home is assigned a private address so that only your family can print to your local printer.

Class	Starting IP Address	Ending IP Address	No. of Hosts
A	10.0.0.0	10.255.255.255	16,777,216
B	172.16.0.0	172.31.255.255	1,048,576
C	192.168.0.0	192.168.255.255	65,536

When a computer is assigned a private IP address, the local devices sees this computer via its private IP address. However, the devices residing outside of your local network cannot directly communicate via the private IP address, but uses your router's public IP address to communicate. To allow direct access to a local device which is assigned a private IP address, a Network Address Translator (NAT) should be used.