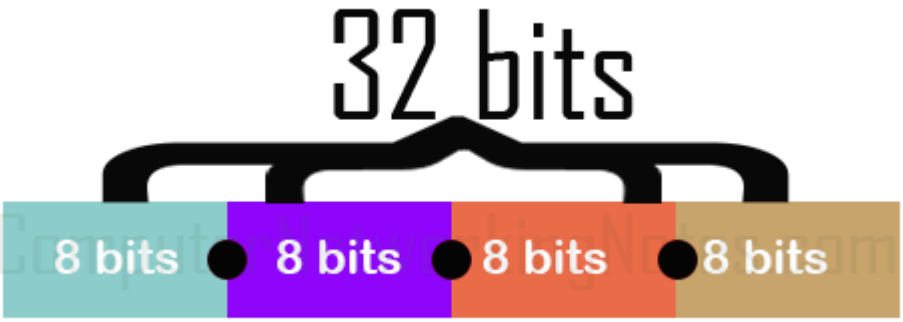
LAB 3 – Subnetting and Building a Simple Internetwork Conceptual Notes

IP Address

An IP address is a unique identity of an interface in IP network. IP addresses are just like postal addresses. In order to send and receive packages through postal system, every house needs a unique postal address. Just like it, in order to send and receive IP packets in IP network, every interface needs a unique IP address.

IP address format

An IP address consists 32 bits. These bits are divided in four equal sections. Sections are separated by periods and written in a sequence.



Subnet Mask

In an IP address, how many bits are used in network address and how many bits are left for host address is determined by a subnet mask. Just like an IP address, subnet mask is also a 32 bits long address and can be written in both binary and decimal notations.

IP classes

There are 4,294,967,296 IP addresses. Based on following rules, IP addresses are categorized in five classes; A, B, C, D and E.

- In class A, first bit of the first byte always remains off (0).
- In class B, first bit of first byte always remains on and the second bit of the first byte always remains off.
- In class C, first two bits of first byte always remain on and the third bit of the first byte always remains off.

- In class D, first three bits of first byte always remain on and the fourth bit of the first byte always remains off.
- In class E, first four bits of first byte always remain on.

By turning all remaining bits of the first byte on and off, we can make first and last address of that class.

Class	Starting bit(s) in binary	Decimal Value of first octet in range
A	0	0 to 127
B	10	128 to 191
C	110	192 to 223
D	1110	224 to 239
E	1111	240 to 255

Class of an IP address is determined by the value of first byte or octet.

- If value in first byte is in range **0 to 127**, it is a Class **A** address.
- If value in first byte is in range **128 to 191**, it is a Class **B** address.
- If value in first byte is in range **192 to 223**, it is a Class **C** address.
- If value in first byte is in range **224 to 239**, it is a Class **D** address.
- If value in first byte is in range **240 to 255**, it is a Class **E** address.

Although we have nearly 4.3 billion IP addresses but not all are available for end devices. From these addresses, following addresses are reserved and cannot be assigned to end devices.

0.0.0.0:- This address represents all networks.

127.0.0.0 to 127.255.255.255: - This IP range is reserved for loopback testing.

224.0.0.0 to 239.255.255.255 (Class D): - This IP class is reserved for multicast.

240.0.0.0 to 255.255.255.254 (Class E): - This IP class is reserved for future use.

255.255.255.255: - This address represents all hosts.

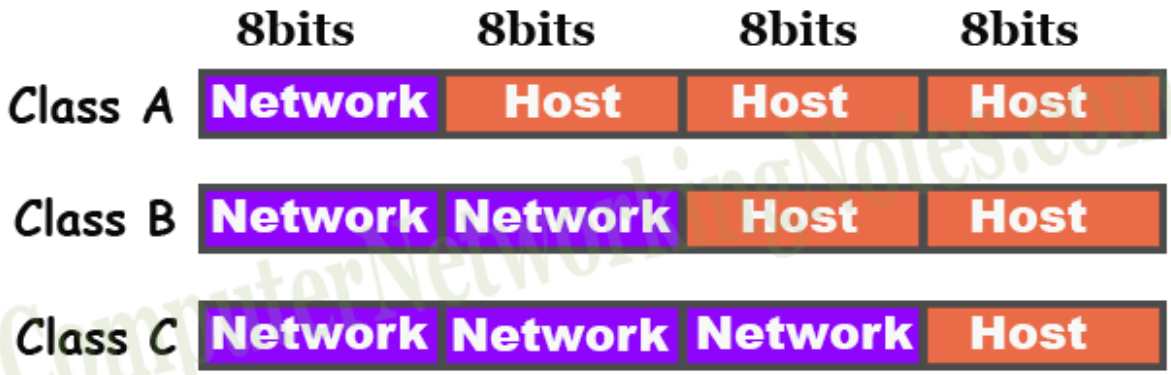
Besides these reserved address, we also cannot use the first and the last IP address of each network. First IP address is reserved for the network address and last IP address is reserved for

the broadcast address. We can use only the addresses available between the network address and the broadcast address for end devices.

IP address vs Network Address

As discussed, an IP address is the combination of two separate addresses, network address and host address. If we exclude host address from IP address, we will get network address. In simple term, a network address is an IP address without host address. In technical term, a network address is an IP address in which all host bits are turned off.

We can only turn on or off host bits. We cannot turn on or off reserved network bits. In class A, B and C first 8, 16 and 24 bits are reserved respectively for network addresses.



IP address vs Host Address

Any IP operation such as building a network address or host address and Subnetting are always performed in the host portion of an IP address. We can turn on and off host bits as per our requirement. In class A, B and C last 24 bits, 16 bits and 8 bits are defined as host bits respectively.

Private IP addresses vs Public IP addresses

In class A, B and C following IP addresses are defined as private IP addresses:-

- In class A: - 10.0.0.0 to 10.255.255.255
- In class B: - 172.16.0.0 to 172.31.255.255
- In class C: - 192.168.0.0 to 192.168.255.255

Except private IP addresses and reserved IP addresses, all remaining IP addresses of Class A, B and C are considered as public IP addresses.

Public IP addresses are used in public network such as Internet. Public IP addresses are maintained and regulated by ICANN (Internet Corporation for Assigned Names and Numbers).

Private IP addresses are used in private network. Private IP addresses are locally significant and not routable in public network.

Network addressing

There are three types of network address; unicast, multicast and broadcast.

Unicast address

Unicast address represents an individual end device. If an IP packet is sent on a unicast address, it is intended only for that particular recipient. Unicast addresses are usually used by end devices for end to end communication.

Multicast address

Multicast address represents a group of devices. If an IP packet is sent on a multicast address, it is intended for all members of that group. Multicast addresses are usually used by networking devices for running their own services.

The differences between multicast address and broadcast address are following: -

- Multicast address represents only a group of devices from a particular network while broadcast address represents all devices of that particular network.
- Based on configuration, messages which are sent on a multicast address are normally allowed to pass through the router. Messages which are sent on a broadcast address are not allowed to pass through the router under any circumstances.

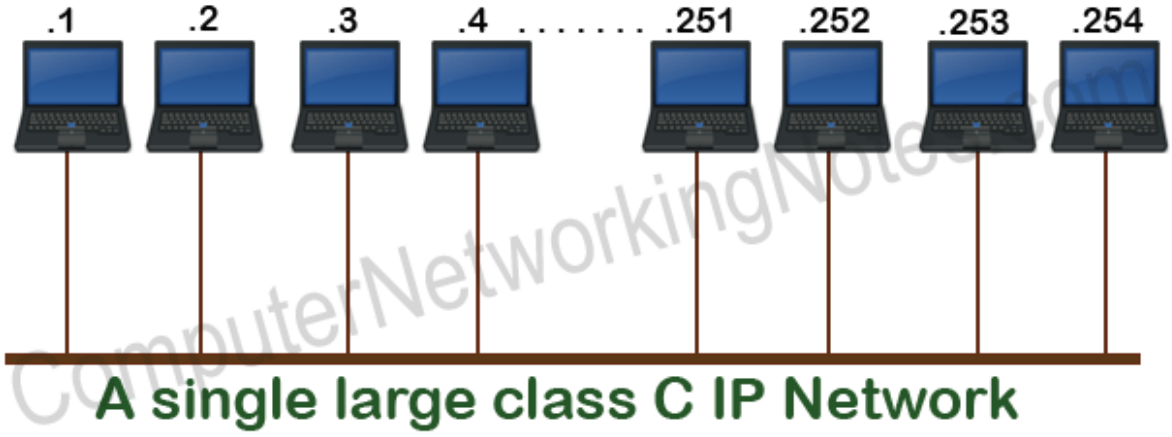
What is Subnetting?

Subnetting is a process of dividing a single large network in multiple smaller networks. A single large network is just like a town without any sector and street address. In such a town, a postman may take 3 to 4 days in finding a single address. While if town is divided in sectors and streets, he can easily find any address in less than one hour.

In computer networking, Subnetting is used to divide a large IP network in smaller IP networks known as subnets.

A default class A, B and C network provides 16777214, 65534, 254 hosts respectively. Having so many hosts in a single network always creates several issues such as broadcast, collision, congestion, etc.

Let’s take a simple example. In a company there are four departments; sales, production, development and management. In each department there are 50 users. Company used a private class C IP network. Without any Subnetting, all computers will work in a single large network.

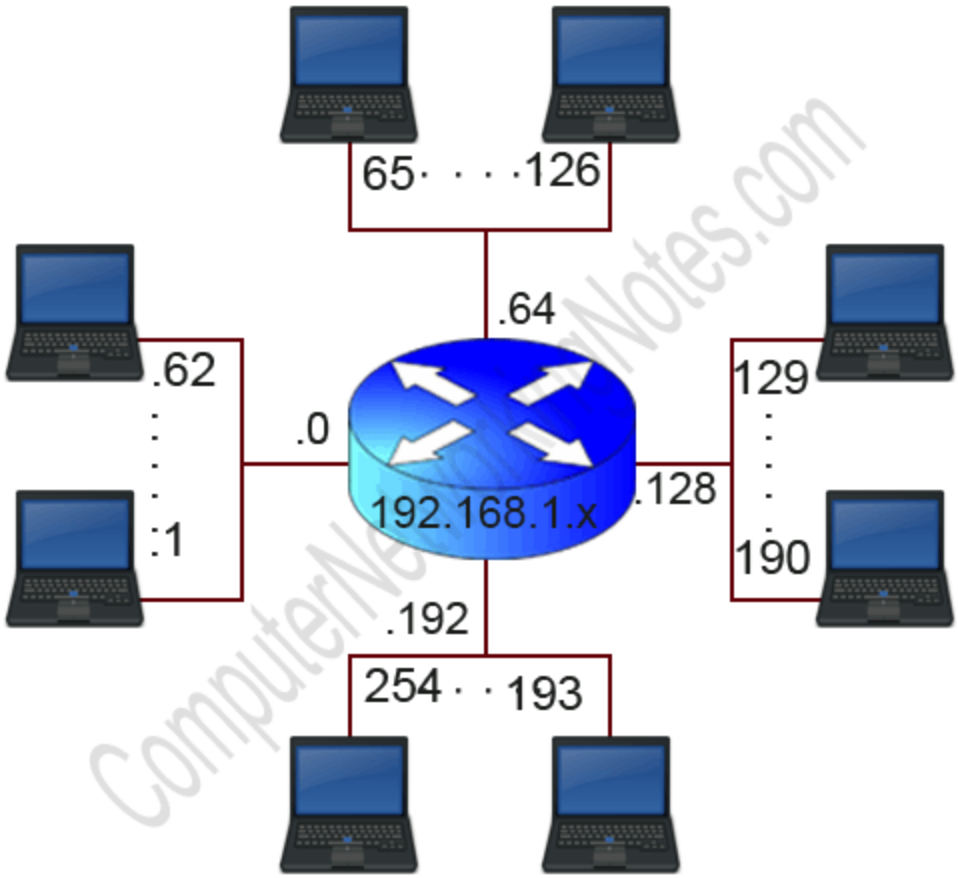


Computers use broadcast messages to access and provide information in network. A broadcast message is an announcement message in computer network which is received by all hosts in network.

In this example since all computers belong to same network, they will receive all broadcast messages regardless the broadcast messages which they are receiving are relevant to them or not.

this network can also be divided in subnets. Once network is divided in subnets, computers will receive only the broadcasts which belong to them.

Since company has four departments, it can divide its network in four subnets. Following figure shows same network after Subnetting.



Subnetting table

Description	Network 1	Network 2	Network 3	Network 4
Network address	192.168.1.0	192.168.1.64	192.168.1.128	192.168.1.192
valid hosts	192.168.1.1 to 192.168.1.62	192.168.1.65 to 192.168.1.126	192.168.1.129 to 192.168.1.190	192.168.1.193 to 192.168.1.254
Broadcast address	192.168.1.63	192.168.1.127	192.168.1.191	192.168.1.255

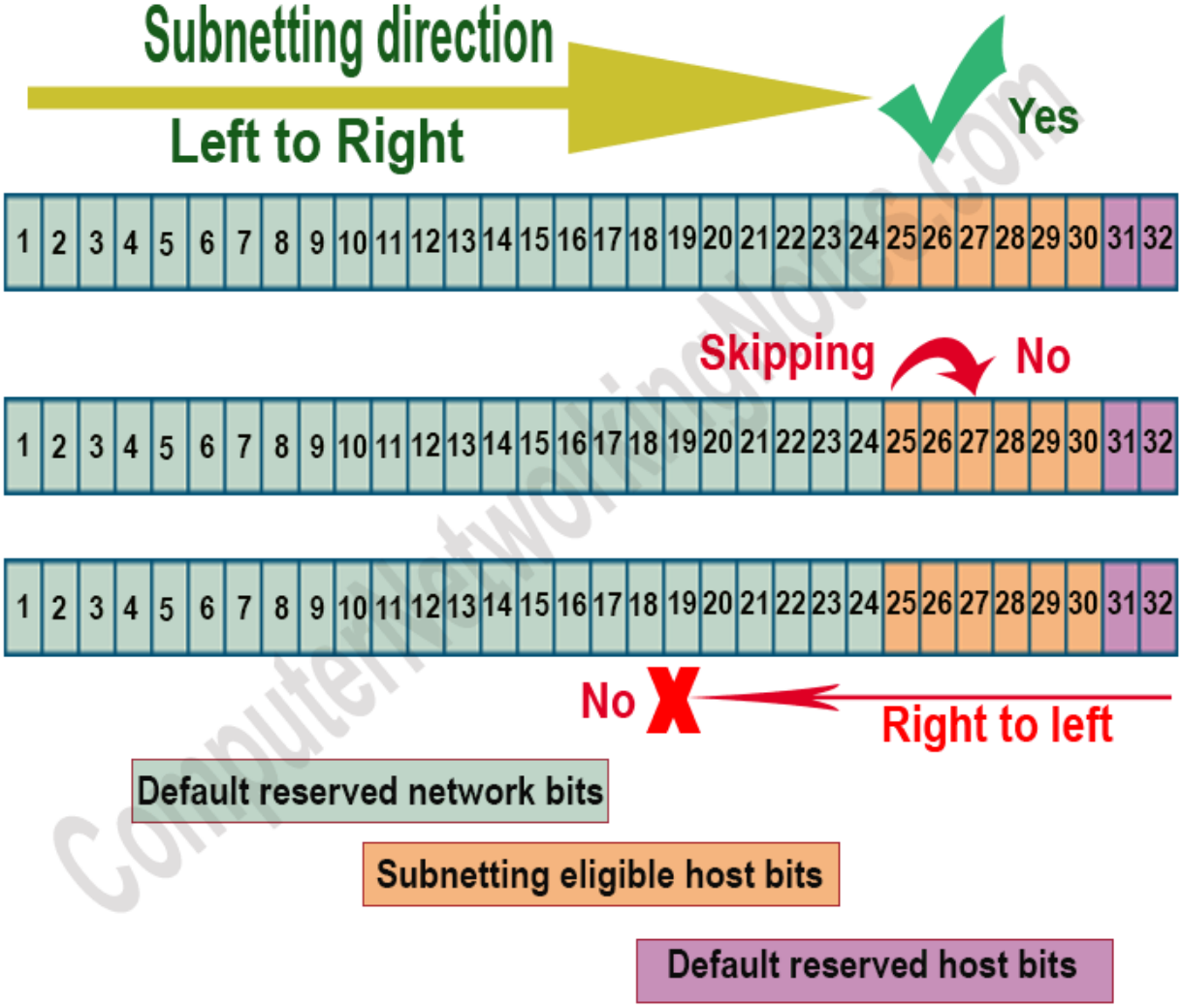
Advantage of Subnetting

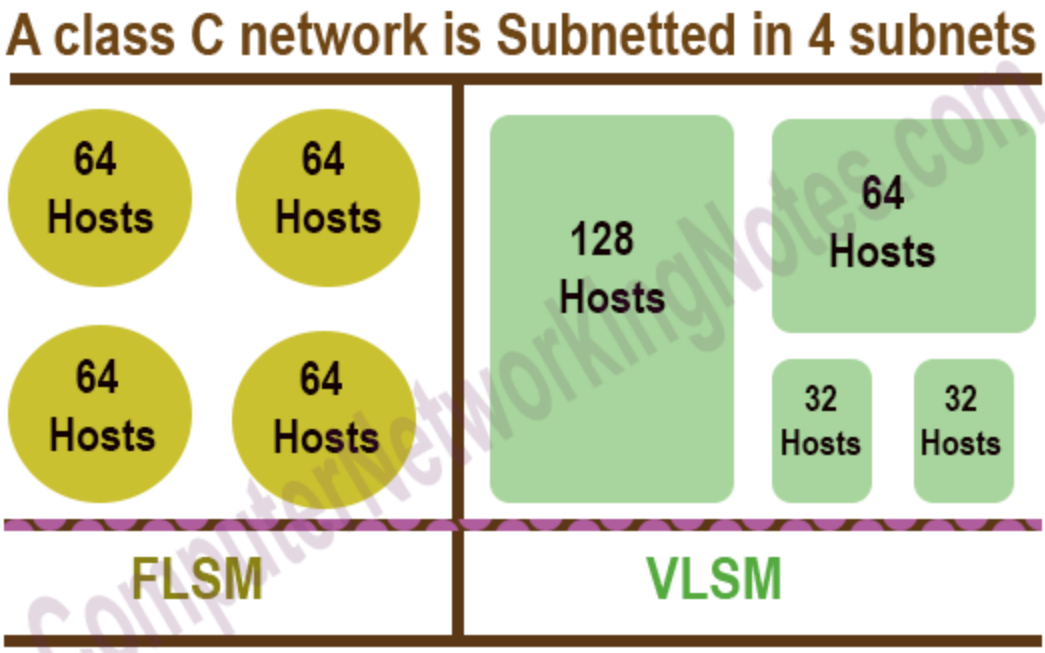
- Subnetting allows us to break a single large network in smaller networks. Small networks are easy to manage.
- Subnetting reduces network traffic by allowing only the broadcast traffic which is relevant to the subnet.

- By reducing unnecessary traffic, Subnetting improves overall performance of the network.
- By blocking a subnet' traffic in subnet, Subnetting increases security of the network.
- Subnetting reduces the requirement of IP range.

Disadvantage of Subnetting

- Different subnets need an intermediate device known as router to communicate with each other.
- Since each subnet uses its own network address and broadcast address, more subnets mean more wastage of IP addresses.
- Subnetting ads complexity in network. An experienced network administrator is required to manage the subnetted network.





Differences between FLSM Subnetting and VLSM Subnetting

FLSM (Fixed Length Subnet Masks) Subnetting	VLSM (Variable Length Subnet Masks) Subnetting
All subnets are equal in size.	Subnets are variable in size.
All subnets have equal number of hosts.	Subnets have variable number of hosts.
All subnets use same subnet mask.	Subnets use different subnet masks.
It is easy in configuration and administration.	It is complex in configuration and administration.
It wastes a lot of IP addresses.	It wastes minimum IP addresses.
It is also known as classfull Subnetting.	It is also known as classless Subnetting.
It supports both classfull and classless routing protocols.	It supports only classless routing protocols.