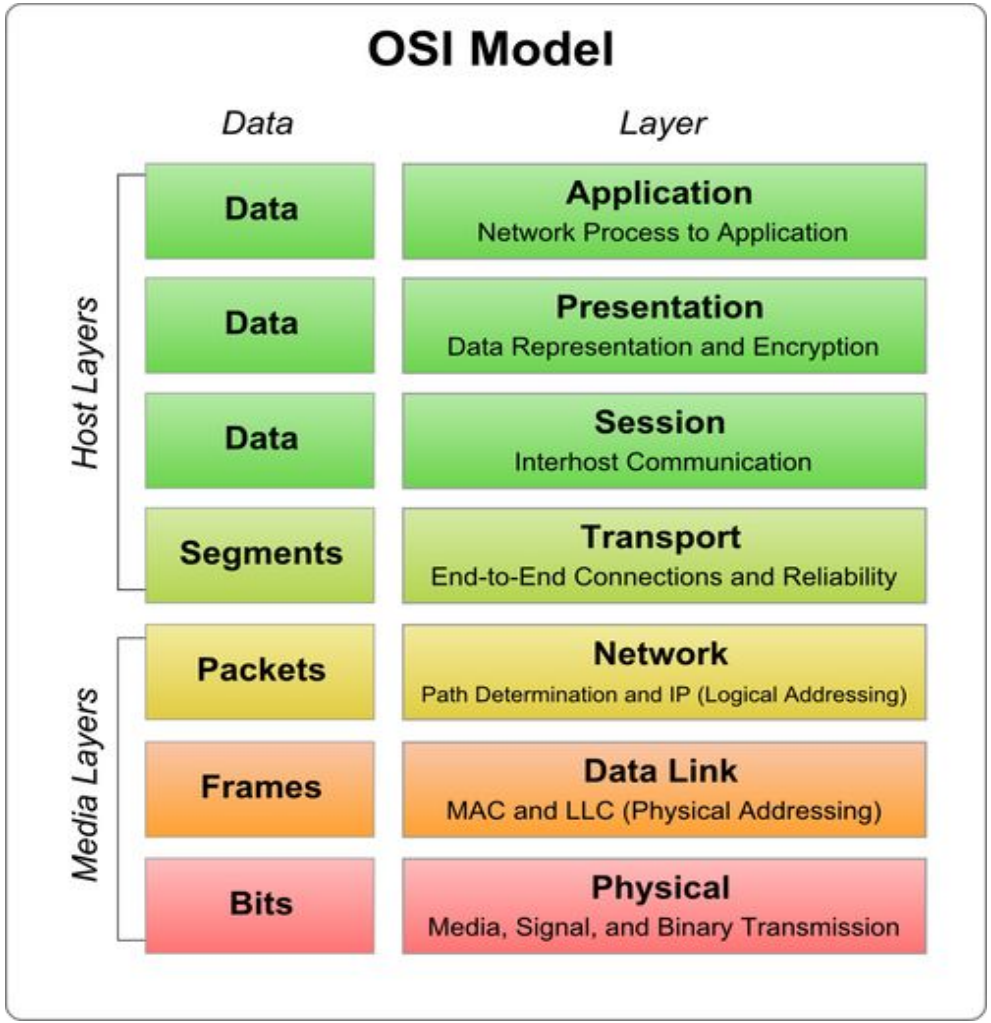
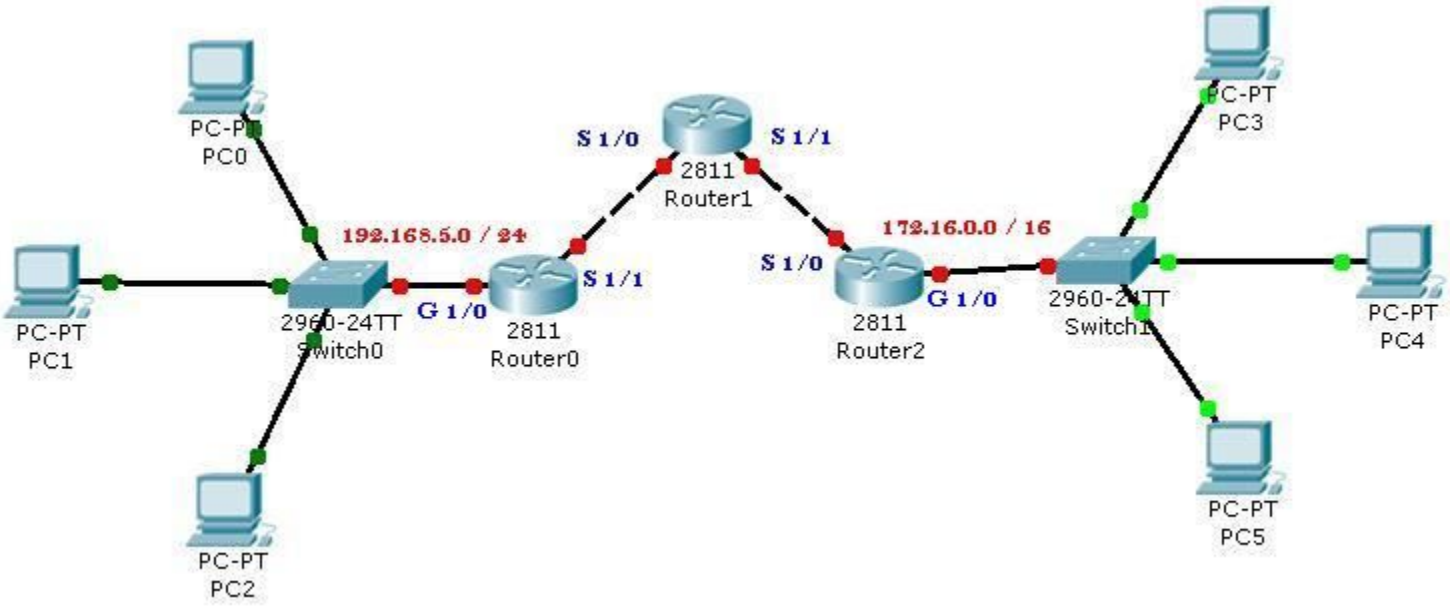
IPv4

Internet Protocol

- **What is the task of Network layer in OSI model?**
  - Carrying data from one host to another.
  - Provides means to allocate logical addresses to the hosts.
  - Converts data units from Transport layer into smaller units called data packets.
  - Provides data path.
  - Router works in this layer.
  - Fragmentation

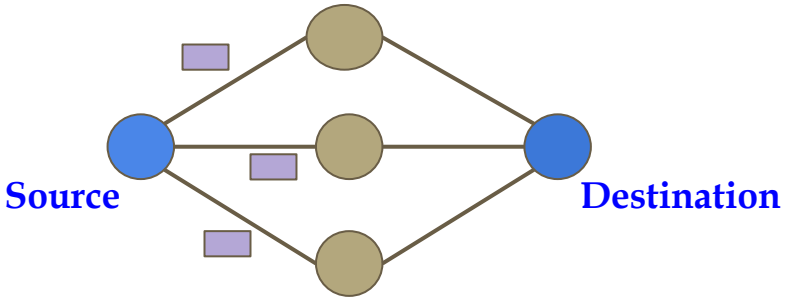

OSI Model
Data
Layer
Host Layers
Media Layers
Data
Application
Network Process to Application
Data
Presentation
Data Representation and Encryption
Data
Session
Interhost Communication
Segments
Transport
End-to-End Connections and Reliability
Packets
Network
Path Determination and IP (Logical Addressing)
Frames
Data Link
MAC and LLC (Physical Addressing)
Bits
Physical
Media, Signal, and Binary Transmission

Example:


PC-PT
PC0
PC-PT
PC1
PC-PT
PC2
192.168.5.0 / 24
2960-24TT
Switch0
G 1/0
S 1/1
2811
Router0
S 1/0
S 1/1
2811
Router1
S 1/0
172.16.0.0 / 16
2811
Router2
G 1/0
2960-24TT
Switch1
PC-PT
PC3
PC-PT
PC4
PC-PT
PC5

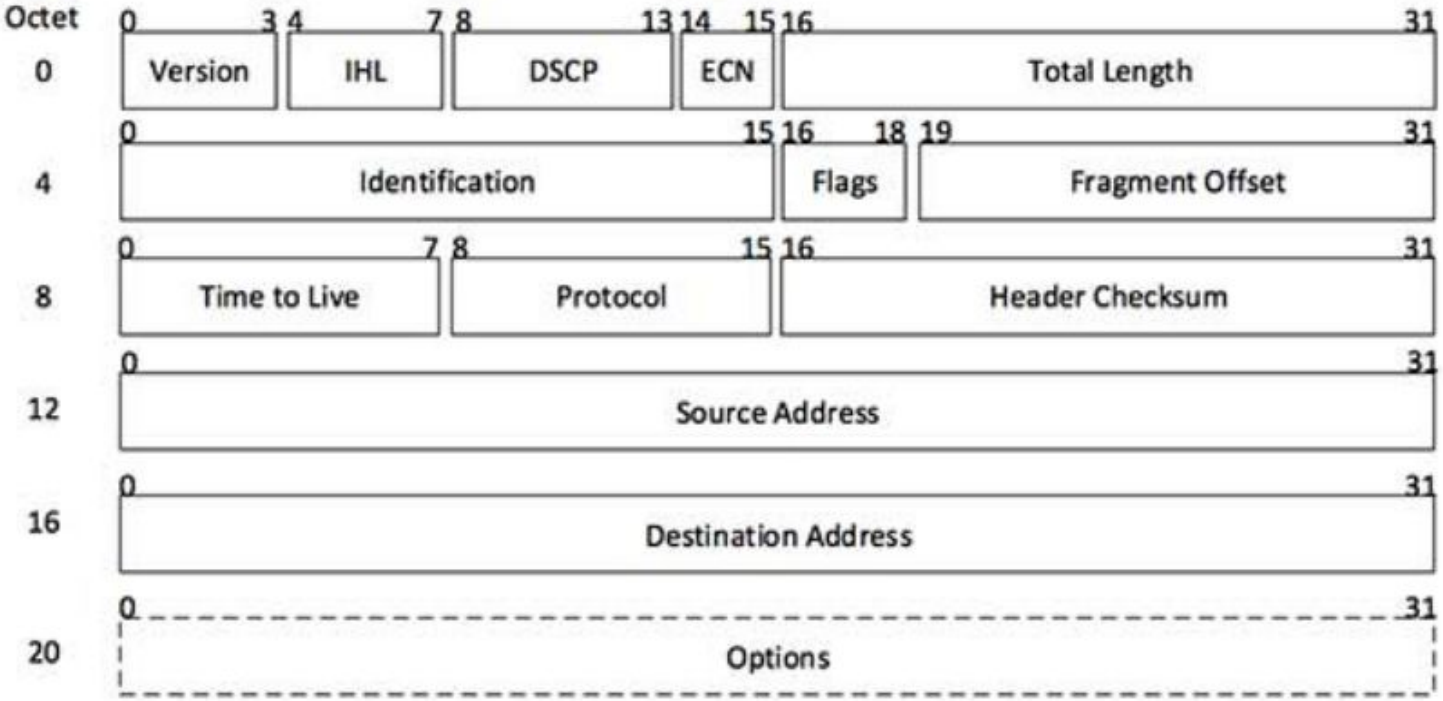
Internet Protocol

- Internet Protocol (IP) is a major protocol in TCP/IP protocol suite.
- **What is IP's task?**
  - Provides a mechanism to uniquely identify host by IP addressing scheme.
  - Uses best effort delivery.
  - IPv4 uses 32 bit logical address.
    - Connectionless
    - Datagram Service



IPv4 Header

Internet Header Length– Ex: 1010, 10*4(using multiply by 4 method)=**40 bytes**



[Image: IP Header]

4bits- 0000 to 1111

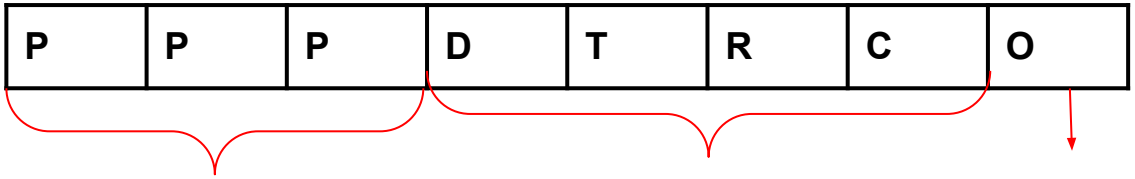
Datagram

Header Size- 20-60 bytes
Payload- 0 to 65,515 bytes

Header+Payload=20+65,515=**65,535 bytes(2^{16} value)**

Contd…

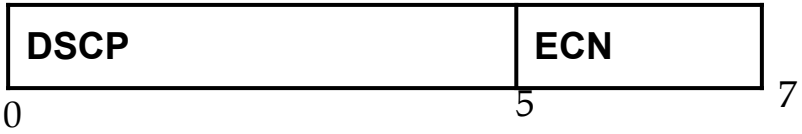
Type of service(DSCP and ECN)-



Precedence

Delay
Throughput
Reliability
Cost

Future
purpose

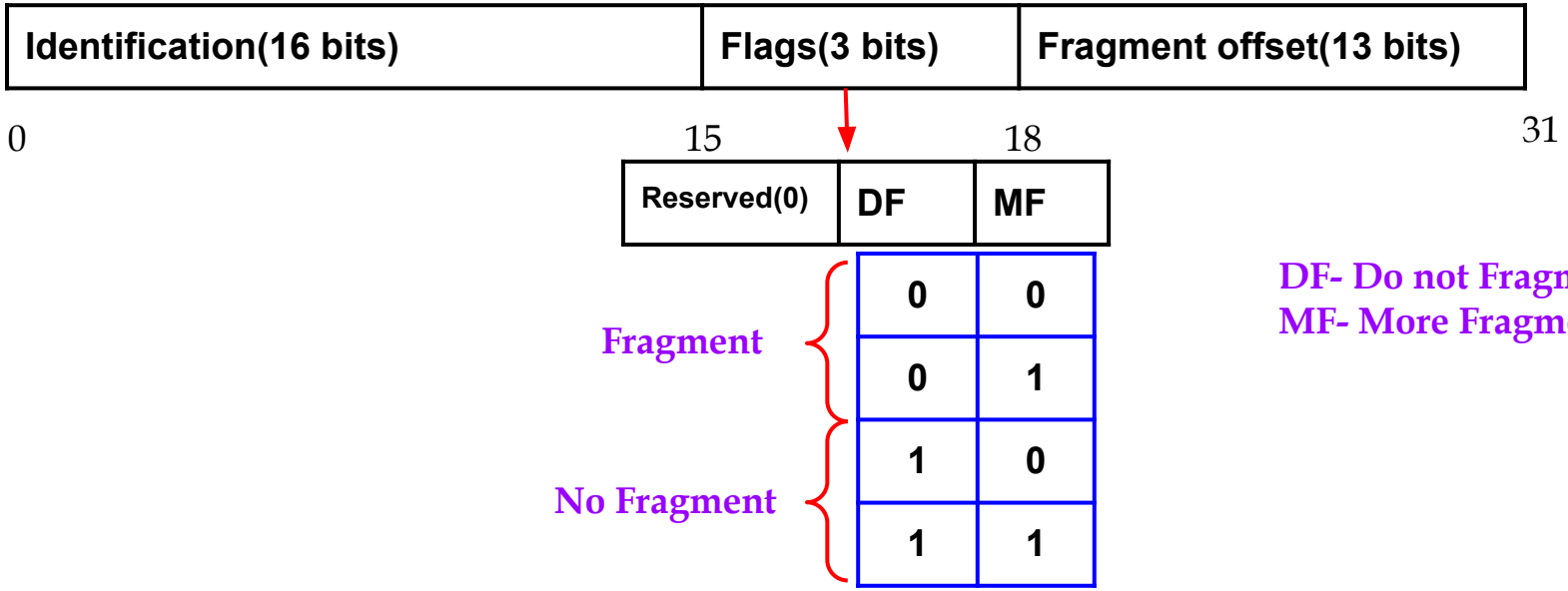


Differentiated Services Code Point (DSCP)

Explicit Congestion Notification (ECN)

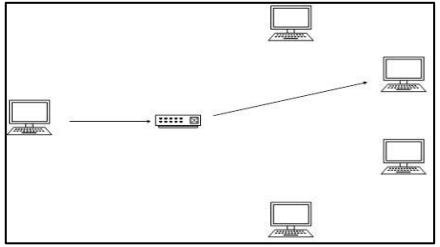
Total Length- 16 bits, 2^{16}=65,535 bytes(Datagram size)

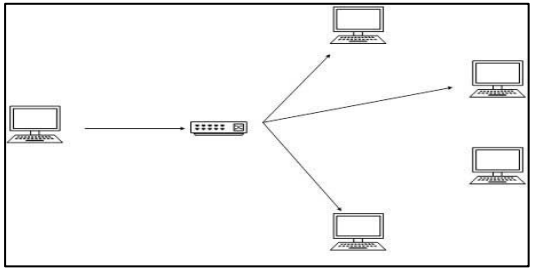
Fragmentation:



IPv4

(a)

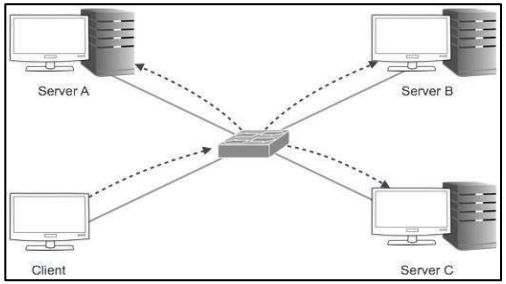




(b)

- IPv4 Addressing modes:
  - Unicast addressing mode(a).
  - Multicast addressing mode(b).
  - Broadcast addressing mode(c).

(c)



- IPv4 follows hierarchical addressing scheme : Classful Addressing - Network and Host Part
- Too many fields in the Header to be processed by the intermediate nodes.

Contd…

Classful Addressing

Classful addressing is an IPv4 addressing architecture that divides addresses into five groups.

The 32 bit IP address is divided into five sub-classes. These are:

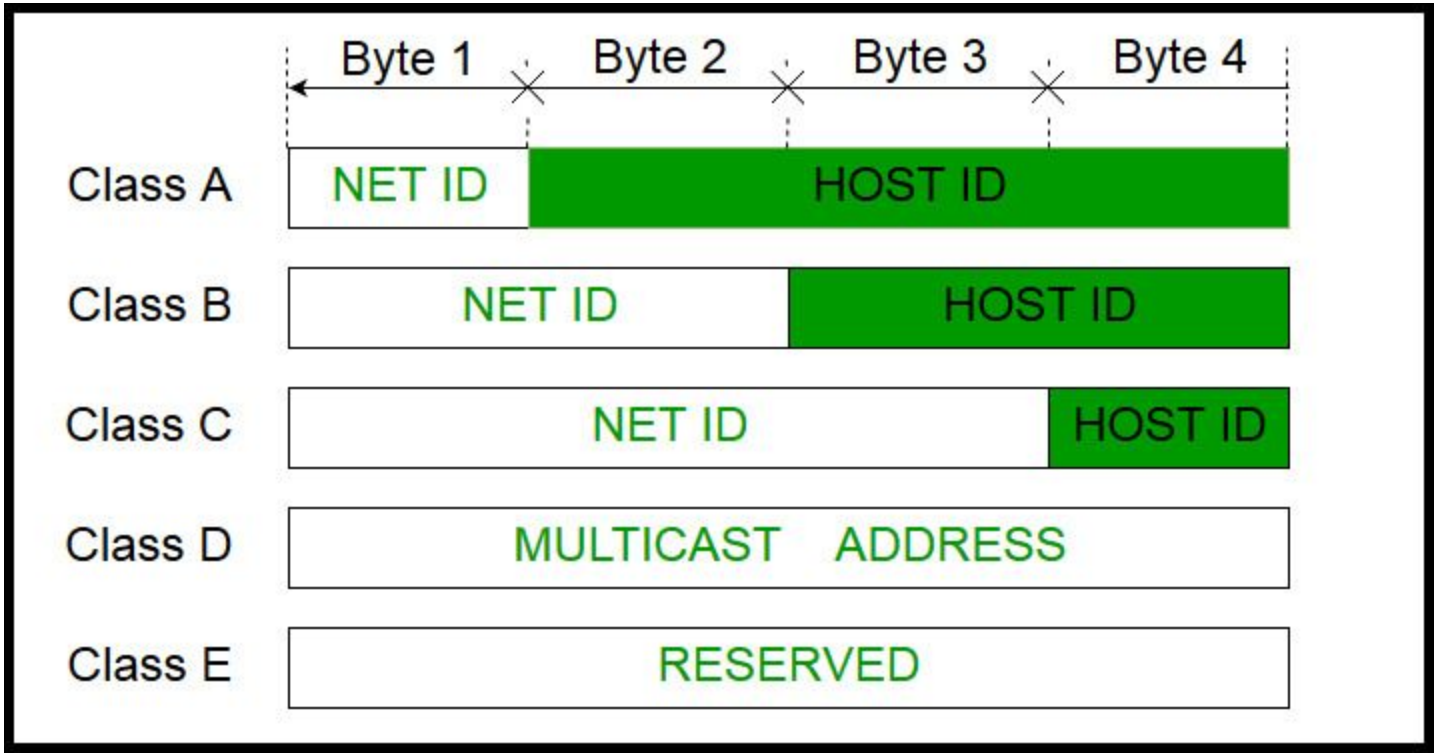
- Class A
- Class B
- Class C
- Class D
- Class E

Contd…

Each of these classes has a valid range of IP addresses. Classes D and E are reserved for multicast and experimental purposes respectively. The order of bits in the first octet determine the classes of IP address.

IP address is divided into two parts:

- **Network ID**
- **Host ID**


Byte 1
Byte 2
Byte 3
Byte 4
Class A
NET ID
HOST ID
Class B
NET ID
HOST ID
Class C
NET ID
HOST ID
Class D
MULTICAST ADDRESS
Class E
RESERVED

Contd…

Problems with Classful Addressing:

- Wastage of IP addresses
- Maintenance is time consuming
- More prone to errors

For example, suppose our example organization needs 500 IP addresses. Going up to a Class B network means wasting 65,034 addresses (65,534 *usable* Class B host addresses minus 500). Similarly, if it needed just 2 public IP addresses, a Class C would waste 252 (254 usable addresses – 2).

IPv4

- Wastage of IP addresses can be minimized:
  - Subnetting
  - Classless addressing, classless Interdomain routing(CIDR).
  - Network address translation.
    - NAT compromises the performance, robustness, and security of the Internet.
    - NAT increases complexity and reduces manageability of the local network.

Classless Addressing:

- 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.
- It is also known as **Classless Inter Domain Routing (CIDR)**.

Some values calculated in subnetting :

1. Number of subnets : Given bits for mask – No. of bits in default mask

2. Subnet address : AND result of subnet mask and the given IP address

3. Broadcast address : By putting the host bits as 1 and retaining the network bits as in the IP address

4. Number of hosts per subnet : $2^{(32 - \text{Given bits for mask})} - 2$

5. First Host ID : Subnet address + 1 (adding one to the binary representation of the subnet address)

6. Last Host ID : Subnet address + Number of Hosts

Example : Given IP Address – 172.16.0.0/25, find the number of subnets and the number of hosts per subnet. Also, for the first subnet block, find the subnet address, first host ID, last host ID and broadcast address.

Solution : This is a class B address. So, no. of subnets = $2^{(25-16)} = 2^9 = 512$.

No. of hosts per subnet = $2^{(32-25)} - 2 = 2^7 - 2 = 128 - 2 = 126$

For the first subnet block, we have subnet address = 0.0, first host id = 0.1, last host id = 0.126 and broadcast address = 0.127

Rules For Creating CIDR Block-

A CIDR block is created based on the following 3 rules-

Rule-01:

- All the IP Addresses in the CIDR block must be contiguous.

Rule-02:

- The size of the block must be presentable as power of 2.
- Size of the block is the total number of IP Addresses contained in the block.
- Size of any CIDR block will always be in the form 2^1, 2^2, 2^3, 2^4, 2^5 and so on.

Rule-03:

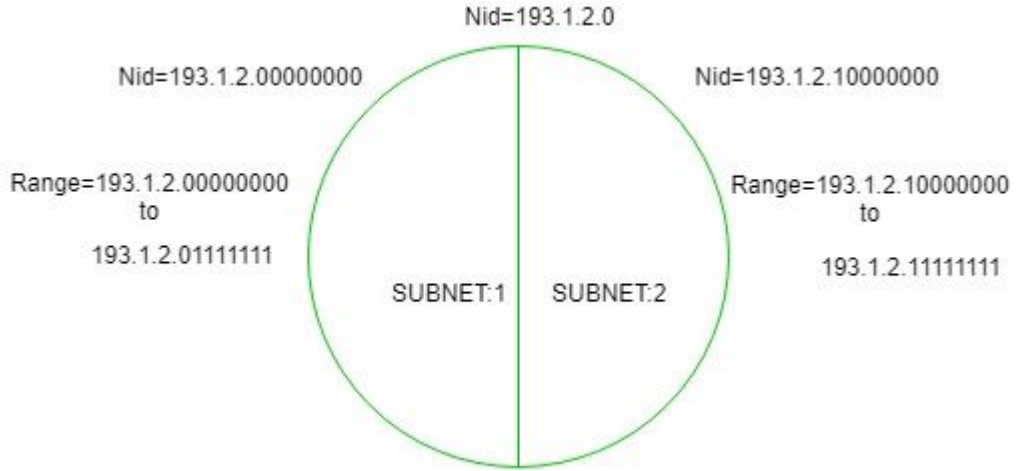
- First IP Address of the block must be divisible by the size of the block.

Subnetting: Subnetting is **the practice of dividing a network into two or more smaller networks**.

When a bigger network is divided into smaller networks, in order to maintain security, then that is known as Subnetting. so, maintenance is easier for smaller networks.

Now, let's talk about dividing a network into two parts:

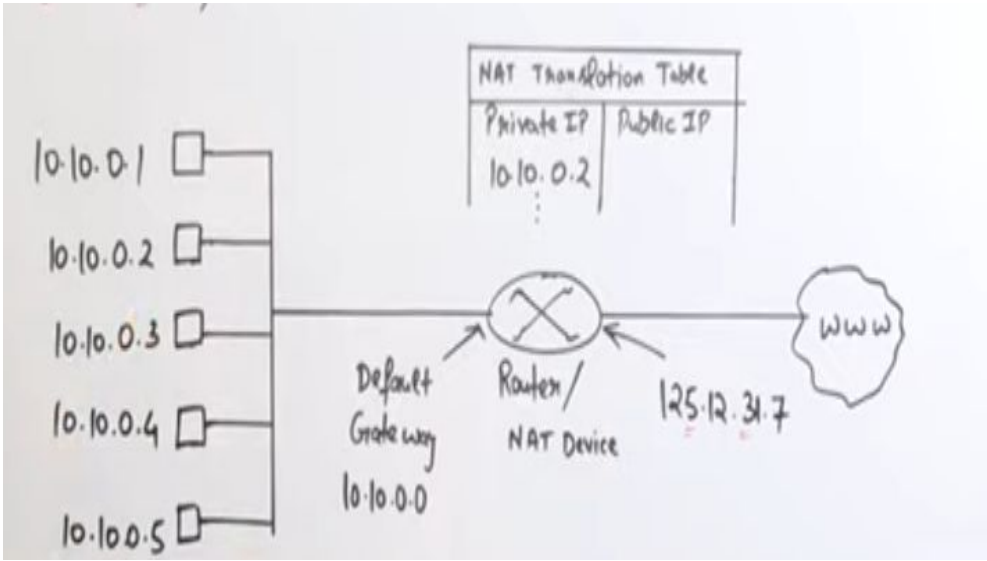
so to divide a network into two parts, you need to choose one bit for each Subnet from the host ID part.



Network Address Translation: **It** is a process in which one or more local IP address is translated into one or more Global IP address and vice versa in order to provide Internet access to the local hosts.

Private IP addresses range as follows −

- 192.168.0.0 - 192.168.255.255 (65,536 IP addresses)
- 172.16.0.0 - 172.31.255.255 (1,048,576 IP addresses)
- 10.0.0.0 - 10.255.255.255 (16,777,216 IP addresses)



IPv4

- **IPv4 did not anticipate the following conditions:**
  - Exhaustion of IPv4 address space.
  - Routers are able to maintain large routing table.
  - Requirement for security at the IP level (IPSec).
  - Need for better support for real-time delivery of data, known as quality of service (QoS).