Practical No. 09

AIM: Subnet the IP address 192.168.10.44 into 30 hosts in each subnet.

A. Subnetting

Subnetting is the strategy used to partition a single physical network into more than one smaller logical sub-networks (subnets). An IP address includes a network segment and a hostsegment. Subnets are designed by accepting bits from the IP address's host part and using these bits to assign a number of smaller sub-networks inside the original network. Subnettingallows an organization to add sub-networks without the need to acquire a new network number via the Internet service provider (ISP). Subnetting helps to reduce network traffic and conceals network complexity. Subnetting is essential when a single network number hasto be allocated over numerous segments of a local area network (LAN).

Subnets were initially designed for solving the shortage of IP addresses over the Internet.

Each IP address consists of a subnet mask. All the class types, such as Class A, Class B, and Class C include the subnet mask known as the default subnet mask. The subnet mask is intended for determining the type and number of IP addresses required for a given local network. The firewall or router is called the default gateway. The default subnet mask is as follows:

- Class A: 255.0.0.0
- Class B: 255.255.0.0
- Class C: 255.255.255.0

The subnetting process allows the administrator to divide a single Class A, Class B, or Class Cnetwork number into smaller portions. The subnets can be subnetted again into sub-subnets.

Dividing the network into a number of subnets provides the following benefits:

- Conservation of IP addresses: Imagine having a network of 20 hosts. Using a Class Cnetwork will waste a lot of IP addresses (254-20=234). Breaking up large networks into smaller parts would be more efficient and would conserve a great number of addresses.
- Reduced network traffic: The smaller networks that created the smaller broadcast domains are formed, hence less broadcast traffic on network boundaries.
- Simplification: Breaking large networks into smaller ones could simplify fault troubleshooting by isolating network problems down to their specific existence.

How to Subnet

To better understand the concept of subnetting, imagine a network with a total of 256 addresses (a Class C network). One of these addresses is used to identify the network address and another one is used to identify the broadcast address on the network. Therefore, we are left with 254 addresses available for addressing hosts.

If we take all these addresses and divide them equally into 8 different subnets we still keep the total number of original addresses, but we have now split them into 8 subnets with 32 addresses in each. Each new subnet needs to dedicate 2 addresses for the subnet and broadcast address within the subnet.

The result is that we eventually come up with 8 subnets, each one possessing 30 subnet addresses available for hosts. You can see that the total amount of addressable hosts is reduced (240 instead of 254) but better management of addressing space is gained.

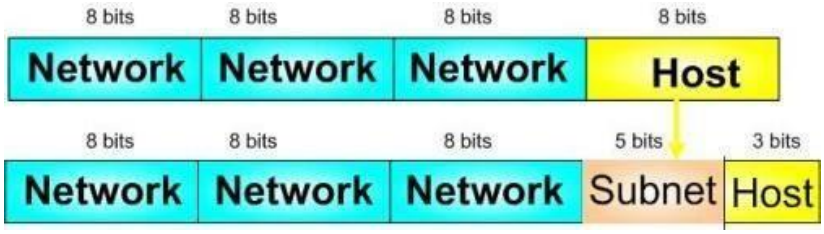
How to Subset a Class C Address Using the Binary Method

It can be helpful to know how to be your own subnet mask calculator. Subset a Class C address with the binary method by following these four steps (which will be explained in more detail below):

1. Convert to binary.
2. Calculate the subnet address.
3. Find host range.
4. Calculate the total number of subsets and the hosts per subnet.

We will use a Class C address, which takes 5 bits from the Host field for subnetting and leaves 3 bits for defining hosts as shown in Figure 1 below. Having 5 bits available for defining subnets means that we can have up to 32 (2^5) different subnets.

It should be noted that in the past using subnet zero (00000---) and all-ones subnet (11111---) was not allowed. This is not true nowadays. Since Cisco IOS Software Release 12.0 the entire address space including all possible subnets is explicitly allowed.



Let's use IP address 192.168.10.44 with subnet mask 255.255.255.248 or /29.

- Step 1: Convert to Binary

IP Address (Decimal)	192.	168.	10.	44
IP Address (Binary)	11000000	10101000	00001010	00101100
Subnet Mask (Binary)	11111111	11111111	11111111	11111000
Subnet Mask (Decimal)	255.	255.	255.	248

- Step 2: Calculate the Subnet Address

To calculate the IP Address Subnet you need to perform a bit-wise AND operation (1+1=1, 1+0 or 0+1 =0, 0+0=0) on the host IP address and subnet mask. The result is the subnet address in which the host is situated.

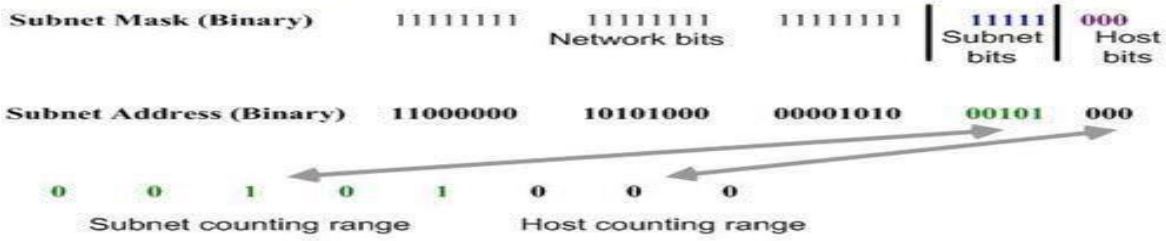
- Step 3: Find Host Range

We know already that for subnetting this Class C address we have borrowed 5 bits from the Host field. These 5 bits are used to identify the subnets. The remaining 3 bits are used for defining hosts within a particular subnet.

The Subnet address is identified by all 0 bits in the Host part of the address. The first host within the subnet is identified by all 0s and a 1. The last host is identified by all 1s and a 0. The broadcast address is the all 1s. Now, we move to the next subnet and the process is repeated the same way.

The following diagram clearly illustrates this process:

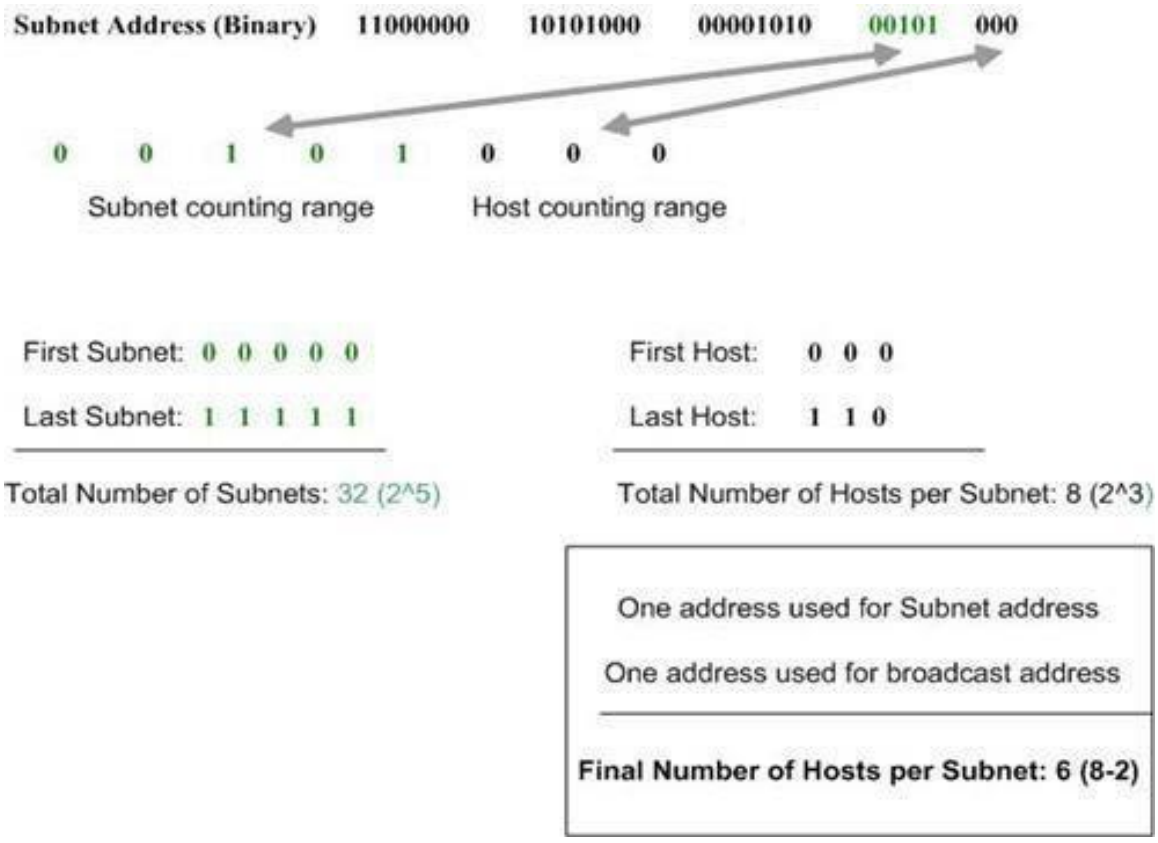
IP Address (Decimal)	192.	168.	10.	44
IP Address (Binary)	11000000	10101000	00001010	00101100
Subnet Mask (Binary)	11111111	11111111	11111111	11111000
Subnet Address (Binary)	11000000	10101000	00001010	00101000
Subnet Address (Decimal)	192.	168.	10.	40



Subnet:	11000000	10101000	00001010	00101	000
Subnet:	192.	168.	10.	40	
First Host:	11000000	10101000	00001010	00101	001
First Host:	192.	168.	10.	41	
Last Host:	11000000	10101000	00001010	00101	110
Last Host:	192.	168.	10.	46	
Broadcast:	11000000	10101000	00001010	00101	111
Broadcast:	192.	168.	10.	47	
Next Subnet:	11000000	10101000	00001010	00110	000
Next Subnet:	192.	168.	10.	48	

- Step 4: Calculate the Total Number of Subnets and Hosts Per Subnet

Knowing the number of Subnet and Host bits we can now calculate the total number of possible subnets and the total number of hosts per subnet. We assume in our calculationsthat all-zeros and all-ones subnets can be used. The following diagram illustrates the calculation steps.



EXERSICE

Let's suppose we have purchased the address 192.168.100.0 we required to break that address into **62 hosts per network.**

Step 1: Identify class of IP address and note the Default Subnet Mask.

Here address 192.168.100.0 belongs to Class C and Default Subnet Mask of Class C is255.255.255.0. In class C we have possibilities of 256 IP address but we can't use firstIP address and last IP address as first IP address is network address and last IP address is broadcast address. So we have 254 IP addresses but here we need only 62.

Step 2: Identify Convert Default subnet mask into binary

255.255.255.0=11111111.11111111.11111111.00000000

Step 3:Note the number of hosts required per network and find the Subnet Generator(SG) and Octet position

No. of hosts per subnet = 62 (So convert 64 into binary)62 = 111110 (6bits)

Reserve 6 bits in the subnet mask

So, we need 6 bits in the host portion of the address in our default subnet mask. Ourdefault subnet mask is

255.255.255.0=11111111.11111111.11111111.00000000

Here we need to reserve from right to left in last octet of default subnet mask iekeeping rightmost 6 zeros and remaining bits are to converted to 1's
255.255.255.192=11111111.11111111.11111111.11000000

So the new subnet mask is 255.255.255.192 or /26. So, 62 hosts' needs 6 bits in the host portion.

SG is 64 as first one is at 6^{th} position and 2^6=64 and Octet where we find first one is4^{th} octet so Octet position=4.

Step 4: Generate new Subnet Mask

The new subnet mask is 255.255.255.192 or /26 is already generated in the last step.

Step 5: Network Ranges (Subnets)

Now for finding the network ranges, our increment is 64 (ie value of SG).

Net	**Network ID**	**Broadcast IP**	**Total IP Addresses**
Net-0	**192.168.100.0** + 000.000.000.64	**192.168.100.63** + 000.000.000.64	64
Net-1	**192.168.100.64** + 000.000.000.64	**192.168.100.127** + 000.000.000.64	64
Net-2	**192.168.100.128** + 000.000.000.64	**192.168.100.191** + 000.000.000.64	64
Net-3	**192.168.100.192** + 000.000.000.64	**192.168.100.255** + 000.000.000.64	64

*****