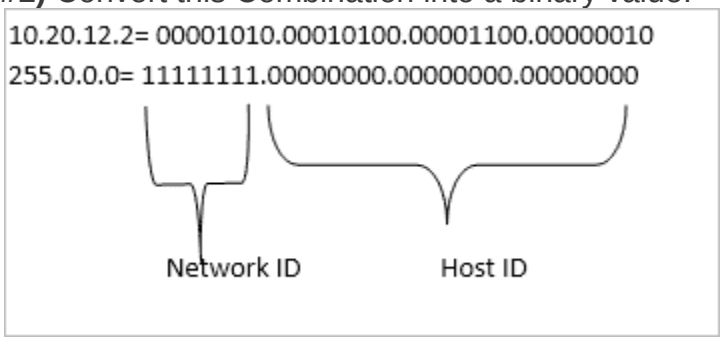
Let us assume the case of a class A IP address:
For Example, take a pair of IP address and subnet mask 10.20.12.2 and 255.0.0.0
#1) Convert this Combination into a binary value:



#2) The bits corresponding to the subnet mask with all 1's represent the network ID as it is a class A network and the first octet represents the network ID. The bits corresponding to all 0's of the subnet mask is the host ID. Thus the network ID is 10 and the host ID is 20.12.2
#3) From the given subnet, we can also calculate the IP range of a particular network. If the IP is 10.68.27.128 (assuming class A case)
Subnet mask: 255.255.255.224
IP range =256-224= 32.
Out of 32 IP's, ideally one is used for the gateway, second is for the network IP and the third is for broadcast IP.
Thus total usable IP's are 32-3= 29 IP's.

The IP range will be 10.68.27.129 to 10.68.27.158.

Subnetting

Subnetting allows us to create various sub-networks or logical networks within one network of a particular class of the network. Without subnetting, it is almost unrealistic to create big networks.

For constructing a big networking system, every link must have a unique IP address with every device on that linked network which is being the participant of that network.

With the help of a subnetting technique, we can split the large networks of a particular class (A, B or C) into smaller subnetworks for inter-connection between each node which are situated at different locations.

Each node on the network would have a distinctive IP and subnet mask IP. Any switch, router or gateway that connects n networks has n unique Network ID and one subnet mask for each of the network it interconnects with.

The formulae of subnetting is as follows:
2^n >= requirement.

The formulae of a number of hosts per subnet is as follows:
2^n -2

Now let's understand the overall process with the help of an Example:
We have taken an example of Class C network ID with a default subnet mask.
Suppose Network ID/IP address is: 192.168.1.0
Default Subnet mask: 255.255.255.0 (in decimal)
Default Subnet mask: 11111111.11111111.11111111.00000000 (in binary)
Thus the number of bits are 8+8+8+0= 24 bits. As mentioned earlier, for subnetting in class C network, we will borrow bits from the host portion of the subnet mask.

Therefore, to customize the subnet as per requirement:
We take a subnet mask of 255.255.255.248 (in decimal)

11111111.11111111.11111111.11111000 (in binary).

From the above binary notation, we can see that the last 3 bits of the last octet can be used for host ID addressing purpose.

Thus the number of subnets= 2^n = 2^3= 8 subnets (n=3).

Number of hosts per subnet= 2^n -2= 2^3 -2= 8-2= 6 Subnets i.e. usable Host IP.

Now the IP addressing scheme is as follows:

Network IP	First Usable IP	Last Usable IP	Broadcast IP
192.168.1.0	192.168.1.1	192.168.1.6	192.168.1.7
192.168.1.8	192.168.1.9	192.168.1.14	192.168.1.15
192.168.1.16	192.168.1.17	192.168.1.22	192.168.1.23
192.168.1.24	192.168.1.25	192.168.1.30	192.168.1.31
192.168.1.32	192.168.1.33	192.168.1.38	192.168.1.39
192.168.1.40	192.168.1.41	192.168.1.46	192.168.1.47
192.168.1.48	192.168.1.49	192.168.1.54	192.168.1.55
192.168.1.56	192.168.1.57	192.168.1.62	192.168.1.63

The subnet mask for all the above IP's in the table is common i.e. 255.255.255.248.

With the help of the above example, we can clearly see, how subnetting helps us to construct inter-networking between various links and nodes of the same subnetwork. All these above IP's can be used for inter-networking the devices within the overall network.

Note: Subnet mask is most widely used everywhere in a computer networking system. Hence, there is one more method to represent the subnet mask of a particular network which is chosen and standardized as it is easy to denote and memorize.
Subnet mask– 255.255.255.248 (binary)
11111111.11111111.11111111.11111000 (decimal notation)

From the decimal notation we can calculate the number of bits having 1 in each octet:
8+8+8+5= 29

Thus the Subnet mask can be denoted as /29.
With Network ID it can be denoted as 192.168.1.9/29.
From the above notation, anyone who knows the standard notation and formulae of subnetting can understand that the IP is using a subnet mask of 255.255.255.248 or /29.

The different Subnetting scheme in binary and decimal notation is shown below:

Subnet Mask	Notation in decimal	Notation in Binary	Number of Usable IP
/24	255.255.255.0	11111111.11111111.11111111.00000000	254
/25	255.255.255.128	11111111.11111111.11111111.10000000	126
/26	255.255.255.192	11111111.11111111.11111111.11000000	62
/27	255.255.255.224	11111111.11111111.11111111.11100000	30
/28	255.255.255.240	11111111.11111111.11111111.11110000	14
/29	255.255.255.248	11111111.11111111.11111111.11111000	6
/30	255.255.255.252	11111111.11111111.11111111.11111100	2

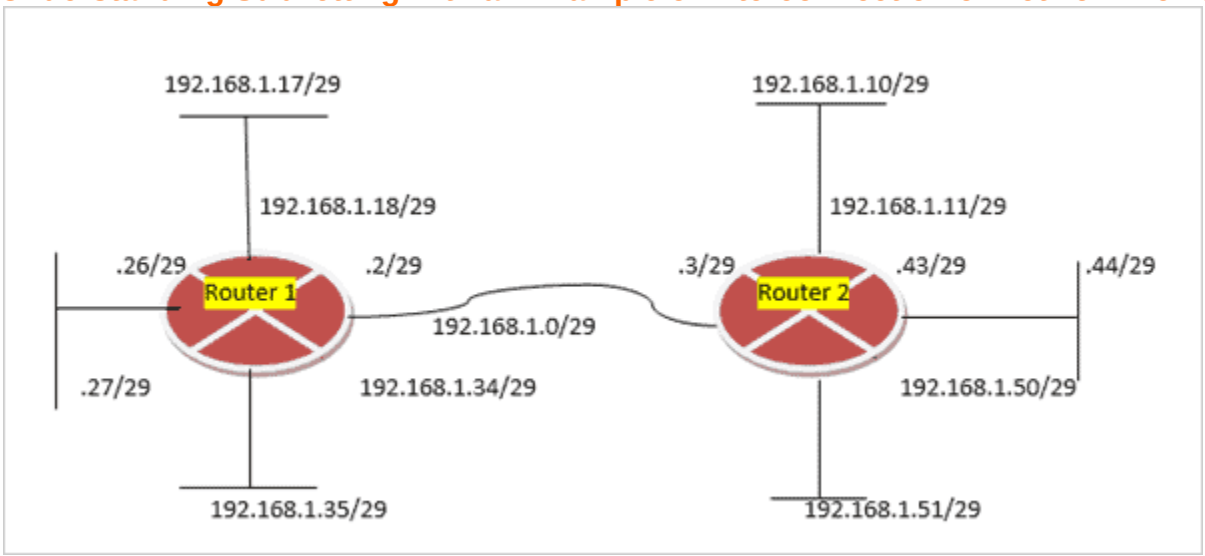
The '/' notation method of the subnet mask is most widely used as it is easy to memorize and the binary notation and decimal are very lengthy in size.

As we are denoting the mask scheme while interconnecting the network components through the figure, if we use the decimal and binary method then the overall diagram will become very complex and difficult to understand.

There are so many IP's on the platform to be shown and it becomes difficult to memorize as well. Thus generally, people who are familiar with routing and IP addressing scheme use short notation methods in figures and diagrams.

Example 1:

Understanding Subnetting with an Example of Interconnection of Network Devices:



The above figure shows how subnetting is used for interconnection of subnetworks. Firstly, as per our need for the number of hosts required to be connected and meet the other requirements of the network, we customize the subnet mask and network ID accordingly and assign to the devices thereafter.

The above network is using class C network mask and /29 subnet mask means network IP can be divided into 8 subnets. Each router has a unique IP address for each linked subnetwork.

There is an important point to be noticed that the more the bits we carry from the subnet mask for host ID then the more will be the subnets obtainable for the network.

Example 2:

Class B Network:

Subnet mask	Notation in binary	Number of Usable IP	Number of Subnets
255.255.128.0	11111111.11111111.10000000.00000000	32766	2
255.255.192.0	11111111.11111111.11000000.00000000	16382	4
255.255.224.0	11111111.11111111.11100000.00000000	8190	8
255.255.240.0	11111111.11111111.11110000.00000000	4094	16
255.255.248.0	11111111.11111111.11111000.00000000	2046	32
255.255.252.0	11111111.11111111.11111100.00000000	1022	64
255.255.254.0	11111111.11111111.11111110.00000000	510	128
255.255.255.0	11111111.11111111.11111111.00000000	254	256
255.255.255.128	11111111.11111111.11111111.10000000	126	512
255.255.255.192	11111111.11111111.11111111.11000000	62	1024
255.255.255.224	11111111.11111111.11111111.11100000	30	2048
255.255.255.240	11111111.11111111.11111111.11110000	14	4096
255.255.255.248	11111111.11111111.11111111.11111000	6	8192
255.255.255.252	11111111.11111111.11111111.11111100	2	16384

The above table shows the details of the number of subnets and hosts that can be connected per subnet mask by using Class B subnetting Scheme.

For connecting a host in big quantity and WAN communication systems, the Class B subnetting is very effective as it gives a wide range of IP's for configuration.

What Is IP Subnet Calculator?

As mentioned in detail above the concept of IP addressing and subnetting, the subnets and supernet networks are derived from a big network to create small networks for interconnection of various network devices, situated far apart with each other and assigning the unique IP address and subnet mask to them for communication with each other.

The IP calculator will give output for the value of broadcast IP address, usable IP range of the host devices, subnet mask, IP class and the total number of hosts by entering the subnet mask and the IP address of the particular network as the input value.

The IP calculator gives the result for both IPV4 and IPV6 network protocol classes of networks.

Why Is IP Calculator Needed?

There are different classes of networks that are used for networking systems and out of those for commercial purposes the class A, B and C are most widely used.

Now let us understand the need for an IP calculator with the help of an example. If we need to calculate the host range, broadcast IP, etc.

Example #1: For a class C network with the network IP 190.164.24.0 and subnet mask 255,255.255.240 means /28 in CIDR notation.
Then we can manually calculate it as by the mathematical formulae which we have explained earlier in this tutorial.

We will borrow the host IP from the last octet for the subnetting which is 11111111.11111111.11111111.11110000

Here the no. of subnets are 2^n = 2^4 = 16 subnets (n=4).
Number of host per subnet is 2^n -2 = 2^4 -2 = 14 subnets means 14 usable host IP.
For the network IP 190.164.24.0,

Network IP	First Usable IP	Last Usable IP	Broadcast IP
190.164.24.0	190.164.24.1	190.164.24.14	190.164.24.15
190.164.24.16	190.164.24.17	190.164.24.30	192.164.24.31
190.164.24.32	190.164.24.33	190.164.24.46	192.164.24.47
190.164.24.48	190.164.24.49	190.164.24.62	192.164.24.63
190.164.24.64	190.164.24.65	190.164.24.78	192.164.24.79
190.164.24.80	190.164.24.81	190.164.24.94	192.164.24.95
190.164.24.96	190.164.24.97	190.164.24.110	192.164.24.111
190.164.24.112	190.164.24.113	190.164.24.126	192.164.24.127
190.164.24.128	190.164.24.129	190.164.24.142	192.164.24.143
190.164.24.144	190.164.24.145	190.164.24.158	192.164.24.159
190.164.24.160	190.164.24.161	190.164.24.174	192.164.24.175
190.164.24.176	190.164.24.177	190.164.24.190	192.164.24.191
190.164.24.192	190.164.24.193	190.164.24.206	192.164.24.207
190.164.24.208	190.164.24.209	190.164.24.222	192.164.24.223
190.164.24.224	190.164.24.225	190.164.24.238	192.164.24.239
190.164.24.240	190.164.24.241	190.164.24.254	192.164.24.255

The subnet mask is common for all these IP ranges which are 255.255.255.240.

The whole procedure of calculating this manually is lengthy.

Subnetting Worked Examples and Exercises

1- You have been allocated a class A network address of **29.0.0.0**. You need to create at least 20 networks and each network will support a maximum of 160 hosts. Would the following two subnet masks Work?

255.255.0.0 and or **255.255.255.0**

Yes both would work.

Mask **255.255.0.0** has 8 bits for the subnet and 16 bits for the host

8 bits would accommodate 2^8=256 subnets

16 bits would accommodate 2^{16}= over 64000 hosts

Mask 255.255.255.0 has 16 bits for the subnet and 8 bits of the host.

Have possible 2^8 -2 hosts =254 which is enough

2. – You have been allocated a class B network address of 135.1.0.0 and and need to create 4 subnets each with around 200 hosts what is the easiest mask to use to satisfy the criteria?

Easiest is to sub net on a byte boundary which would mean a subnet mask of **255.255.255.0**

This would allocate **8 bits** for the **subnet** and **8 bits** for the **host.**

We need to accommodate around 200 hosts which requires 8 bits which we have.

We need 4 subnets which require 4 bits and we have 8 bits. So we have more than enough.

3. Write the IP address 222.1.1.20 mask 255.255.255.192 in CIDR notation

Decimal 192 =11000000 binary which means that 2 bits of this octet are used for the subnet. Now add the 24 bits 255.255.255 and we have 26 bits. So we write:

222.1.1.20/26

4. Write the IP address 135.1.1.25 mask 255.255. 248.0 in CIDR notation

Decimal 248 =11111000 binary which means that 5 bits of this octet are used for the subnet. Now add the 16 bits 255.255. and we have 21 bits. So we write:

135..1.1.25/21

5 – You have been allocated a class C network address of 211.1.1.0 and are using the default subnet mask of 255.255.255.0 how may hosts can you have?

A class C address has 8 bits of the host which will give 2^8 -2 =254 hosts

6 .Subnet the Class C IP Address 195.1.1.0 So that you have 10 subnets each with a maximum 12 hosts on each subnet. List the Address on host 1 on subnet 0,1,2,3,10

Current mask= 255.255.255.0

Bits needs for 10 subnets =4 =2^4 =16 possible subnets

Bits needs for 12 hosts = 4 = 2^4 = 16-2=14 possible hosts.

So our mask in binary =**11110000**= **240** decimal

Final Mask =**255.255.255.240**

Hosts on Subnets 0,1,2,3,10

- Subnet 0 host 1 IP address = 195.1.1.1 **0000 0001**
- Subnet 1 host 1 IP address = 195.1.1.17 **0001 0001**
- Subnet 2 host 1 IP address = 195.1.1.33 **0010 0001**
- Subnet 3 host 1 IP address = 195.1.1.49 **0011 0001**
- Subnet 10 host 1 IP address = 195.1.1.161 **1010 0001**

7. Subnet the Class C IP Address 205.11.2.0 so that you have 30 subnets.

What is the subnet mask for the maximum number of hosts?

How many hosts can each subnet have?

What is the IP address of host 3 on subnet 2 ?

Current mask= 255.255.255.0

Bits needs for 30 subnets =5 =2^5 =32 possible subnets

Bits left for hosts = 3 = 2^3 = 8-2=6 possible hosts.

So our mask in binary =**11111000**= **248** decimal

Final Mask =**255.255.255.248**

Address of host 3 on subnet 2 is

subnet 2 =00010000 host 3 =000000011

Add the two together =00010011=19

therefore IP address of host 3 on subnet 2 =205.11.2.19

8. Subnet the Class C IP Address 195.1.1.0 So that you have at least 2 subnets each subnet must have room for 48 hosts .

What are the two possible subnet masks?

Current mask= 255.255.255.0

Bits needs for 48 hosts = 6 = 2^6 = 64-2=62 possible hosts.

Bits needs for 2 subnets =1 =2^1 =2 possible subnets

Total of 7 bits needed so therefore we can use either 1 bit or 2 bits for the subnet. So we could have

1 bit subnet 7 bits hosts or 2 bits subnet 6 bit host

masks are 10000000 and 11000000 =128 decimal and 192 decimal.

Final possible masks are:

255.255.255.128 and **255.255.255.192**

9 .Given the subnet Mask **255.255.255.192** What is the host address and subnet of the following IP address 197.1.2.67.

192 in binary =11000000 gives 4 possible subnets of (showing 2 most significant bits):

00,01,10,11

67 in binary =01000011

So Applying Mask: