SUBNET MASK

To define the network and host portions of an address, the devices use a separate 32-bit pattern called a subnet mask. We express the subnet mask in the same dotted decimal format as the IPv4 address. The subnet mask is created by placing a binary 1 in each bit position that represents the network portion and placing a binary 0 in each bit position that represents the host portion.

The prefix and the subnet mask are different ways of representing the same thing - the network portion of an address.

Default Subnet Mask:

Class A: 255.0.0.0

Class B: 255.255.0.0

Class C: 255.255.255.0

CIDR:

A routing system used by routers and gateways on the backbone of the Internet for routing packets. CIDR replaces the old class method of allocating 8, 16, or 24 bits to the network ID, and instead allows any number of contiguous bits in the IP address to be allocated as the network ID. For example, if a company needs a few thousand IP addresses for its network, it can allocate 11 or 12 bits of the address for the network ID instead of 8 bits for a class C (which wouldn't work because you would need to use several class C networks) or 16 bits for class B (which is wasteful).

How It Works

CIDR assigns a numerical prefix to each IP address. For example, a typical destination IP address using CIDR might be 177.67.5.44/13. The prefix 13 indicates that the first 13 bits of the IP address identify the network, while the remaining 32 - 13 = 19 bits identify the host. The prefix helps to identify the Internet destination gateway or group of gateways to which the packet will be forwarded. Prefixes vary in size, with longer prefixes indicating more specific destinations. Routers use the longest possible prefix in their routing tables when determining how to forward each packet. CIDR enables packets to be sent to groups of networks instead of to individual networks, which considerably simplifies the complex routing tables of the Internet's backbone routers.

How to Create Subnets

To create subnetworks, you take bits from the host portion of the IP address and reserve them to define the subnet address.

How many bits to borrow?

1. No of subnetwork = 2^{BB}
2. No. of usable hosts per subnetwork=2^{BR}-2

TB=BR + BB
TB=Total bits in host portion
BB=Bits borrowed
BR=Bits Remaining

Subnetting Class C Addresses

There are many different ways to subnet a network. The right way is the way that works best for you. In a Class C address, only 8 bits are available for defining the hosts. Remember that subnet bits start at the left and go to the right, without skipping bits. This means that the only

Class C subnet masks can be the following:

Binary	Decimal	CIDR
00000000 =	0	/24
10000000 =	128	/25
11000000 =	192	/26
11100000 =	224	/27
11110000 =	240	/28
11111000 =	248	/29
11111100 =	252	/30

We can't use a /31 or /32 because we have to have at least 2 host bits for assigning IP addresses to hosts.

All you need to do is answer five simple questions:

How many subnets does the chosen subnet mask produce?

How many valid hosts per subnet are available?

What are the valid subnets?

1. What's the broadcast address of each subnet?
2. What are the valid hosts in each subnet?

Subnetting Class C Address: 192.168.10.0/26

255.255.255.192 (/26)

In this second example, we're going to subnet the network address 192.168.10.0 using the subnet mask 255.255.255.192.

192.168.10.0 = Network address

255.255.255.192 = Subnet mask

Now, let's answer the big five:

How many subnets? Since 192 is 2 bits on (11000000), the answer would be $2^2 = 4$ subnets.

How many hosts per subnet? We have 6 host bits off (11000000), so the equation would be $2^6 – 2 = 62$ hosts.

What are the valid subnets? 256 – 192 = 64. Remember, we start at zero and count in our block size, so our subnets are 0, 64, 128, and 192. (Magic Number=256-Subnet Mask)

What's the broadcast address for each subnet? The number right before the value of the next subnet is all host bits turned on and equals the broadcast address. For the zero subnet, the

next subnet is 64, so the broadcast address for the zero subnet is 63.

What are the valid hosts? These are the numbers between the subnet and broadcast address.

The easiest way to find the hosts is to write out the subnet address and the broadcast address. This way, the valid hosts are obvious. The following table shows the 0, 64, 128, and 192 subnets, the valid host ranges of each, and the broadcast address of each subnet:

The subnets (do this first)	0	64	128	192
The broadcast address	63	127	191	255
Usable Host Range	1 – 62	65 – 126	129 – 190	193 - 254

Subnetting Class B Address: 172.16.0.0/17

255.255.128.0 (/17)

172.16.0.0 = Network address

255.255.128.0 = Subnet mask

Subnets? $2^1 = 2$ (same as Class C).

Hosts? $2^{15} – 2 = 32{,}766$ (7 bits in the third octet, and 8 in the fourth).

Valid subnets? 256 – 128 = 128. 0, 128. Remember that subnetting is performed in the third octet, so the subnet numbers are really 0.0 and 128.0, as shown in the next table.

These are the exact numbers we used with Class C; we use them in the third octet and add a 0 in the fourth octet for the network address.

Broadcast address for each subnet?

Valid hosts?

The following table shows the two subnets available, the valid host range, and the broadcast address of each:

Subnet	172.16.0.0	172.16.128.0
Broadcast	172.16.127.255	172.16.255.255
Usable Host Range	172.16.0.1 - 172.16.127.254	172.16.128.1 - 172.16.255.254

Another Example Subnetting Class B address: 172.16.0.0/18

255.255.192.0 (/18)
172.16.0.0 = Network address
255.255.192.0 = Subnet mask

Subnets? $2^2 = 4$.
Hosts? $2^{14} – 2 = 16{,}382$ (6 bits in the third octet, and 8 in the fourth).

Valid subnets? 256 – 192 = 64. 0, 64, 128, 192. Remember that the subnetting is performed in the third octet, so the subnet numbers are really 0.0, 64.0, 128.0, and 192.0,
as shown in the next table.

Broadcast address for each subnet?
Valid hosts?

The following table shows the four subnets available, the valid host range, and the broadcast address of each:

Subnet	0.0	64.0	128.0	192.0
Broadcast	63.255	127.255	191.255	255.255
First host	0.1	64.1	128.1	192.1
Last host	63.254	127.254	191.254	255.254

Another Example:172.16.0.0/25
255.255.255.128 (/25)
This is one of the hardest subnet masks you can play with. And worse, it actually is a really good subnet to use in production because it creates over 500 subnets with 126 hosts for each subnet—a nice mixture. So, don't skip over it!
172.16.0.0 = Network address
255.255.255.128 = Subnet mask

Subnets? $2^9 = 512$.

Hosts? $2^7 – 2 = 126$.

Valid subnets? Okay, now for the tricky part. 256 – 255 = 1. 0, 1, 2, 3, etc. for the third octet. But you can't forget the one subnet bit used in the fourth octet. You actually get two subnets for each third octet value, hence the 512 subnets. For example, if the third octet is showing subnet 3, the two subnets would actually be 3.0 and 3.128.

Broadcast address for each subnet?

Valid hosts?

The following table shows how you can create subnets, valid hosts, and broadcast addresses using the Class B 255.255.255.128 subnet mask (the first eight subnets are shown, and then the last two subnets):

Subnet	0.0	0.128	1.0	1.128	2.0	2.128	3.0	3.128 ...	255.0	255.128
Broadcast	0.127	0.255	1.127	1.255	2.127	2.255	3.127	3.255 ...	255.127	255.255
First host	0.1	0.129	1.1	1.129	2.1	2.129	3.1	3.129 ...	255.1	255.129
Last host	0.126	0.254	1.126	1.254	2.126	2.254	3.126	3.254 ...	255.126	255.254

Subnetting Class A network: 10.0.0.0/16

255.255.0.0 (/16)

Class A addresses use a default mask of 255.0.0.0, which leaves 22 bits for subnetting since you must leave 2 bits for host addressing. The 255.255.0.0 mask with a Class A address is using 8 subnet bits.

Subnets? $2^8 = 256$.

Hosts? $2^{16} – 2 = 65{,}534$.

Valid subnets? What is the interesting octet? 256 – 255 = 1. 0, 1, 2, 3, etc. (all in the second octet). The subnets would be 10.0.0.0, 10.1.0.0, 10.2.0.0, 10.3.0.0, etc., up to 10.255.0.0.

Broadcast address for each subnet?

Valid hosts?

The following table shows the first two and last two subnets, valid host range, and broad-

cast addresses for the private Class A 10.0.0.0 network:

Subnet	10.0.0.0	10.1.0.0 ...	10.254.0.0	10.255.0.0
Broadcast	10.0.255.255	10.1.255.255 ...	10.254.255.255	10.255.255.255
First host	10.0.0.1	10.1.0.1 ...	10.254.0.1	10.255.0.1
Last host	10.0.255.254	10.1.255.254 ...	10.254.255.254	10.255.255.254

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