SUBNETTING

• Class A networks
– First octet values range from 1 through 126.
– First octet starts with bit 0.
– Network mask is 8 bits, written /8 or 255.0.0.0.
1.0.0.0 through 126.0.0.0 are class A networks with 16777214 hosts each.

• Class B networks
– First octet values range from 128 through 191.
– First octet starts with binary pattern 10.
– Network mask is 16 bits, written /16 or 255.255.0.0.
128.0.0.0 through 191.255.0.0 are class B networks, with 65534 hosts each.

• Class C networks
– First octet values range from 192 through 223.
– First octet starts with binary pattern 110.
– Network mask is 24 bits, written /24 or 255.255.255.0.
192.0.0.0 through 223.255.255.0 are class C networks, with 254 hosts each.

Two additional classes, and reserved
addresses
• Class D addresses
– First octet values range from 224 through 239.
– First octet starts with binary pattern 1110.
– Class D addresses are multicast addresses, which will not be discussed in this tutorial.
• Class E addresses
– Essentially everything that's left.
– Experimental class, which will not be discussed in this tutorial.
• Reserved addresses
– 0.0.0.0 is the default IP address, and it is used to specify a default route. The
default route will be discussed later.
– Addresses beginning with 127 are reserved for internal loopback addresses.
It is common to see 127.0.0.1 used as the internal loopback address on many devices. Try pinging this address on a PC or Unix station

The need to improve IP addressing efficiency

• As IP networking and internetworking progressed, it became very apparent that class A and B networks were simply too large.

• 254 hosts on one network segment is manageable, but 65534 hosts or more on a single network segment is difficult to manage.

– This would result in class A and B networks not being fully utilized, meaning that not all the host addresses would get used.

– Or it would result in more hosts being put onto a single network segment than could reasonably be managed.

• For these and other reasons, there was a need to improve the efficiency of IP addressing. That is, to provide a way to limit the number of host addresses per network segment to what is actually needed, regardless of the network class.

• This need was met progressively through the conceptions of subnet masks, variable-length subnet masks, and classless inter-domain routing.

Subnet capacity – number of subnets a network can support
Host capacity – number of hosts on each subnet

Example 1

Let us say that you have a Class C network with the IP address 195.201.10.5. You have created 2 subnets on this network. What is the host capacity of each subnet?

In order to calculate the host capacity you must first find out the subnet identifier.
(no of bits borrowed from the host)
Step 1: Find out the binary value of decimal 2 (given number of subnets)
2/2 = 1 0
Step 2: Count the number of bits in the result = 2 (your subnet identifer is 2 bits)
This means you need to borrow 2 bits from the host. For a class C network the host carries 8 bits.

195.201.10. 5
Network Host

255.255.255.0

Step 3: 8 host bits minus 2 bits = 6 (you now have 6 host bits left.)
Step 4: 2^6-2 (64-2)
Answer is 62

Subnet mask would now change to

255	255	255	192
11111111	11111111	11111111	11000000

To calculate the no of subnets you would take the subnet identifier (which is 2 bits)
2^2-2 =2   (4-2)

Given a class A network of 10.0.0.0/19
Calculate the number of subnets, the host capacity of each subnet and the subnet mask

11111111	00000000	00000000	00000000
10	0	0	0/19
11111111	11111111	111000000	00000000

Number of Subnets

Step:1 In order to increase the network bits from 8 to 19 we need to borrow 11 bits from the the host.
The bits that are borrowed are referred to at the subnet identifier
Step: 2 2^{11}-2   = (2048-2) = 2048

Number of hosts or IP addresses in each subnet

Step 1: The number of host remaining after you borrowed 11 would be 13
Step 2: 2^{13}-2   =8190

Subnet Mask

10	00000000	000000000	00000000/19
11111111	11111111	111000000	00000000
255	255	224	0

From a Class A network determine the number of subnets you would need to support 900 hosts per subnet

1. 900 hosts (binary value of decimal 900 = 1110000100 so we know we have 10 bits for the host part of the address.
2. We are then left with 22 bits for the rest of the network

3. A Class A address would normally have 8 bits for the network section so the borrowed bits 22-8 =14
4. 2^{14}-2 = 16382
5. The host capacity would be 2^{10}=2 =1,022

From a Class B network of 190.201.0.0. how many subnets can you have if you have at least 4000 host.

1. 4000 host = 111110100000 = 12 host bit
2. We are left with 20 bits for the network (32-12)
3. A class B has 16 bits for the network so to get 20 we need to borrow 4
4. 4 would be the subnet identifier
5. 2^4-2 = 14 subnets

Memorize this table of high-bit sums:

1-bit sum	**128**	(128 alone)
2-bit sum	**192**	(128+64)
3-bit sum	**224**	(128+64+32)
4-bit sum	**240**	(128+64+32+16)
5-bit sum	**248**	(128+64+32+16+8)
6-bit sum	**252**	(128+64+32+16+8+4)
7-bit sum	**254**	(128+64+32+16+8+4+2)
8-bit sum	**255**	(128+64+32+16+8+4+2+1)

Suppose a company has a Class B IP address and you need to determine the number of subnets required to support at least 2000 hosts per subnet.

1. Find out the binary equivalent of 2000
   Binary equivalent of 2000 =11111010000
   = 11 bits so you reserve 11 host bits
2. Subtract 11 from 32 to find out the network bits =21
3. The default subnet mask for class B network is 16.
   Subtract 16 from 21 to find out how many bits extend the network
   = 5
4. So the subnet capacity is 2^5 -2
5. SO THE SUBNET CAPACITY IS 32
6. THE HOST CAPACITY WOULD BE 2^{11}-2
   2046

Class B network address 190.210.0.0
How many subnets can you have if you need at least 4000 hosts per subnet.

Binary of 4000 = 111110100000 = 12 bits
32- 12 =20
16 is the default…so 20-14 = 4
SUBNETS = 2^4-2
ANSWER 14 SUBNETS
HOST CAPACITY = 2^{12}-2
=4096

Suppose you have a network with a class C address 200.89.62.0/24 and you want to create a minimum of 6 subnets.

Notice that you are not given the number of hosts required.

1. The first thing you need to find out is the subnet identifier (no of bits to borrow from the host id.
2. The decimal value of 6 is 110 = 3 bits
3. So you need to borrow 3 bits from the host id section to add to the network id
4. The network prefix is now 200.89.62.0/27 because you borrowed 3 bits from the host id 24+3
5. the subnet mask is no longer 255.255.255.0 because you changed the network id structure
6. the mask is now 255.255.255.244 11100000 converted to decimal is 224

ONLY 5 BITS REMAIN FOR THE HOST ADDRESS
THE NUMBER OF HOSTS AVAILABLE PER SUBNET = 2^5-2 = 30

If we needed to calculate the subnets we would convert the 30 into binary, count the number of bits (5). So the Host bits are 5 that means that the network bit are 27 (32-5). Because the network is a class C we already have 24 bits for the network so we will have to borrow 3 bits (24+3) to make 27. The significant amount here is the 3 borrowed bits or subnet indentifier. To find out the subnets we use the formulae 2^3-2

= 6 subnets

SUBNETS =

30 = 11110 = 5 BITS

32-5 = 27

27-24 =3

2^3-2
=6 SUBNETS

Question

Suppose that the IP address of your Class C network is 195.201.105.0, and you've created three subnets.

What is the host capacity of each subnet?

Correct. A Class C network uses 8 bits for host addresses. The binary equivalent for three subnets is 11, which therefore requires 2 network ID bits. This leaves 6 host ID bits. So 2^6 equals the maximum 64 hosts. You subtract 2 from this for the 62 hosts per subnet.

FIRST AND LAST SUBNET

To calculate the network address of the first subnet, begin by taking the decimal value of the quad in the subnet mask that contains both subnet and host identifier bits and subtracting it from 256. Using an example of a class C address with the subnet mask 255.255.255.224, the result of 256 minus 224 is 32. The network address of the first subnet is therefore 192.168.42.32. To calculate the network addresses of the other subnets, you repeatedly increment the result of your previous subtraction by itself. Fro example, if the network address of the first subnet is 192.168.42.32, the addresses of the remaining five subnets are as follows:

192.168.42.64
192.168.42.96
192.168.42.128
192.168.42.160
192.168.42.192

To calculate the IP address in each subnet, you repeatedly increment the host identifier by one. The IP addresses in the first subnet are therefore 192.168.42.33 to 192.168.42.33 to 192.168.42.62. The 192.168.42.63 address is omitted because this address would have a binary host identifier value of 11111, which is a broadcast address. The IP address ranges for the subsequent subnets are as follows:

192.168.42.65 to 192.168.42.94
192.168.42.97 to 192.168.42.126
192.168.42.129 to 192.168.42.158
192.168.42.161 to 192.168.42.190
192.168.42.193 to 192.168.42.222

Practice: Subnetting IP Addresses

For each of the following IP address assignments, specify the number of bits in the subnet identifier, the number of possible IP addresses in each subnet, the mask for the IP addresses, and the IP address ranges for the first and last subnet.

10.0.0.0/19

1. Number of bits in subnet identifier:______________________
2. Number of subnets __________________
3. Number of possible IP addresses in each subnet______________
4. Subnet mask _______________
5. First subnet_______________
6.. Last subnet ______________

192.168.214.0/29

1. Number of bits in subnet identifier:______________________
2. Number of subnets __________________
3. Number of possible IP addresses in each subnet______________
4. Subnet mask _______________
5. First subnet_______________
6.. Last subnet ______________

172.28.0.0./20

1. Number of bits in subnet identifier:______________________
2. Number of subnets __________________
3. Number of possible IP addresses in each subnet______________
4. Subnet mask _______________
5. First subnet_______________
6.. Last subnet ______________