

Subnetting TCP/IP Networks

April 24, 2010

Why Subnet?

We use subnetting to reduce collisions which occur when two computers on the same network broadcast simultaneously. Having less computers transmitting on the same net, limits the broadcasts and the administrator better control.

The network technician needs to know how to convert base 10 numbers to binary and binary to base 10 to create subnets.



Converting Base 10 to Binary

We want to write the base 10 number 9 in base 2 or binary, so we have to know how a base two number is concatenated.

The first column of the binary number is one's column. We can only have two figures in a base 2 column, a one or a zero. If we need to count to two, we need to add another column to the left, the two column. In a two digit binary number, we can count to three. For example 11 is one 2 and one 1, and 2 plus 1 equals 3.

The next column is four, the fourth column is the eight column. We keep on doubling the number for each column to the left.

In the example shown, to obtain the base 10 number 9, we write a 1 in the eight column and 1 in the one column to get a total of none.

128	64	32	16	8	4	2	1	Tot
0	0	0	0	1	0	0	1	9

Practice

Convert the following conversions, answering in binary.

18

101

7

67

83

34

187

228

0

44

Converting Binary to Base 10

In our conversion from binary to base 10, we just write the binary number in the chart and add any column heading that contains a 1.

In our example 10101011, we place the binary number in the table. Now, we add any column number that shows a number 1 in the binary figure.

$$128 + 32 + 8 + 2 + 1 = 171$$

The total is 171. This technique works with any binary number conversion.

128	64	32	16	8	4	2	1	Tot
1	0	1	0	1	0	1	1	171

Practice

Convert the following conversions, answering in base 10 numbers.

0000 0011

0010 0111

1011 1010

1110 1110

0011 0101

1001 1111

1100 0011

1110 1001

1111 1111

0000 1110

Subnetting

Class B Subnetting of IP Address 128.32.0.0

Subnetting a larger class B into 256 subnets, we change the subnet mask 255.255.0.0 to 255.255.255.0. That only allows the devices to reside in the last octet. The table shows the ranges of each subnet.

Subnet Mask	No. of Subnets	Number of Hosts	Network Address	Usable IP Range	Broadcast Address
255.255.0.0	1	65534	128.32.0.0	128.32.0.1 - 128.32.255.254	128.32.255.255
255.255.255.0	256	254	128.32.0.0	128.32.0.1 - 128.32.0.254	128.32.0.255
			128.32.1.0	128.32.1.1 - 128.32.1.254	128.32.1.255
			128.32.2.0	128.32.2.1 - 128.32.2.254	128.32.2.255
			128.32.3.0	128.32.3.1 - 128.32.3.254	128.32.3.255
			128.32.4.0	128.32.4.1 - 128.32.4.254	128.32.4.255
			128.32.5.0	128.32.5.1 - 128.32.5.254	128.32.5.255
			128.32.6.0	128.32.6.1 - 128.32.6.254	128.32.6.255
			128.32.7.0	128.32.7.1 - 128.32.7.254	128.32.7.255
			128.32.8.0	128.32.8.1 - 128.32.8.254	128.32.8.255
			128.32.9.0	128.32.9.1 - 128.32.9.254	128.32.9.255
			128.32.10.0	128.32.10.1 - 128.32.10.254	128.32.10.255
			128.32.11.0	128.32.11.1 - 128.32.11.254	128.32.11.255
			128.32.12.0	128.32.12.1 - 128.32.12.254	128.32.12.255
			128.32.13.0	128.32.13.1 - 128.32.13.254	128.32.13.255
			128.32.14.0	128.32.14.1 - 128.32.14.254	128.32.14.255
			up to		up to
			128.32.255.0	128.32.255.1 - 128.32.255.254	128.32.255.255

Subnetting a Class B Network

Class B Subnetting of IP Address 128.32.0.0

For more complex subnetting of the class B network, we borrow the first bit of the subnet mask as shown below. The subnet is 2^1 or 2, so there are two subnets as shown in the table with the network addresses of 128.32.0.0 and 128.32.128.0. The subnet mask is 255.255.128.0.

Subnet Mask	No. of Subnets	Number of Hosts	Network Address	Usable IP Range	Broadcast Address
255.255.0.0	1	65534	128.32.0.0	128.32.0.1 - 128.32.255.254	128.32.255.255
255.255.128.0	2	32768	128.32.0.0	128.32.0.1 - 128.32.127.254	128.32.127.255
			128.32.128.0	128.32.128.1 - 128.32.255.254	128.32.255.255
255.255.192.0	4	16384	128.32.0.0	128.32.0.1 - 128.32.0.254	128.32.0.255
			128.32.64.0	128.32.64.1 - 128.32.127.254	128.32.127.255
			128.32.128.0	128.32.128.1 - 128.32.191.254	128.32.191.255
			128.32.192.0	128.32.192.1 - 128.32.255.254	128.32.255.255
255.255.224.0	8	8190	128.32.0.0	128.32.0.1 - 128.32.31.254	128.32.31.255
			128.32.32.0	128.32.32.1 - 128.32.63.254	128.32.63.255
			128.32.64.0	128.32.64.1 - 128.32.95.254	128.32.95.255
			128.32.96.0	128.32.96.1 - 128.32.127.254	128.32.127.255
			128.32.128.0	128.32.128.1 - 128.32.159.254	128.32.159.255
			128.32.160.0	128.32.160.1 - 128.32.191.254	128.32.191.255
			128.32.192.0	128.32.192.1 - 128.32.223.254	128.32.223.255
			128.32.224.0	128.32.224.1 - 128.32.255.254	128.32.255.255

11111111.11111111.10000000.00000000 or 255.255.128.0

Subnetting a Class B Network

Class B Subnetting of IP Address 128.32.0.0

For more subnets of the class B network, we borrow the first two bits of the subnet mask as shown below. The subnet is 2^2 or 4, so there are four subnets as shown in the table with the network addresses of 128.32.0.0, 128.32.64.0, 128.32.128.0, 128.32.192.0. The subnet mask is 255.255.192.0.

Subnet Mask	No. of Subnets	Number of Hosts	Network Address	Usable IP Range	Broadcast Address
255.255.0.0	1	65534	128.32.0.0	128.32.0.1 - 128.32.255.254	128.32.255.255
255.255.128.0	2	32768	128.32.0.0	128.32.0.1 - 128.32.127.254	128.32.127.255
			128.32.128.0	128.32.128.1 - 128.32.255.254	128.32.255.255
255.255.192.0	4	16384	128.32.0.0	128.32.0.1 - 128.32.0.254	128.32.0.255
			128.32.64.0	128.32.64.1 - 128.32.127.254	128.32.127.255
			128.32.128.0	128.32.128.1 - 128.32.191.254	128.32.191.255
			128.32.192.0	128.32.192.1 - 128.32.255.254	128.32.255.255
255.255.224.0	8	8190	128.32.0.0	128.32.0.1 - 128.32.31.254	128.32.31.255
			128.32.32.0	128.32.32.1 - 128.32.63.254	128.32.63.255
			128.32.64.0	128.32.64.1 - 128.32.95.254	128.32.95.255
			128.32.96.0	128.32.96.1 - 128.32.127.254	128.32.127.255
			128.32.128.0	128.32.128.1 - 128.32.159.254	128.32.159.255
			128.32.160.0	128.32.160.1 - 128.32.191.254	128.32.191.255
			128.32.192.0	128.32.192.1 - 128.32.223.254	128.32.223.255
			128.32.224.0	128.32.224.1 - 128.32.255.254	128.32.255.255

11111111.11111111.11000000.00000000 or 255.255.192.0

Subnetting a Class B Network

For even more subnets of the class B network, we borrow the first three bits of the subnet mask as shown below. The subnet is 2^3 or 8, so there are eight subnets as shown in the table with the network addresses of 128.32.0.0, 128.32.32.0, 128.32.64.0, 128.32.96.0, 128.32.128.0, 128.32.160.0, 128.32.192.0 and 128.32.224.0. The subnet mask is 255.255.224.0.

Class B Subnetting of IP Address 128.32.0.0

Subnet Mask	No. of Subnets	Number of Hosts	Network Address	Usable IP Range	Broadcast Address
255.255.0.0	1	65534	128.32.0.0	128.32.0.1 - 128.32.255.254	128.32.255.255
255.255.128.0	2	32768	128.32.0.0	128.32.0.1 - 128.32.127.254	128.32.127.255
			128.32.128.0	128.32.128.1 - 128.32.255.254	128.32.255.255
255.255.192.0	4	16384	128.32.0.0	128.32.0.1 - 128.32.0.254	128.32.0.255
			128.32.64.0	128.32.64.1 - 128.32.127.254	128.32.127.255
			128.32.128.0	128.32.128.1 - 128.32.191.254	128.32.191.255
			128.32.192.0	128.32.192.1 - 128.32.255.254	128.32.255.255
255.255.224.0	8	8190	128.32.0.0	128.32.0.1 - 128.32.31.254	128.32.31.255
			128.32.32.0	128.32.32.1 - 128.32.63.254	128.32.63.255
			128.32.64.0	128.32.64.1 - 128.32.95.254	128.32.95.255
			128.32.96.0	128.32.96.1 - 128.32.127.254	128.32.127.255
			128.32.128.0	128.32.128.1 - 128.32.159.254	128.32.159.255
			128.32.160.0	128.32.160.1 - 128.32.191.254	128.32.191.255
			128.32.192.0	128.32.192.1 - 128.32.223.254	128.32.223.255
			128.32.224.0	128.32.224.1 - 128.32.255.254	128.32.255.255

11111111.11111111.11100000.00000000 or 255.255.224.0

Practice

Class B Subnetting of IP Address 128.32.0.0

Create 16 subnets
for the IP address
128.32.0.0

Subnet Mask	No. of Subnets	Number of Hosts	Network Address	Usable IP Range	Broadcast Address
	16				

11111111.11111111._____ .00000000 or _____

Subnetting a Class C Network

Class C Subnetting of IP Address 192.168.0.0

For more complex subnetting of the class C network, we borrow the first bit of the subnet mask as shown below. The subnet is 2^1 or 2, so there are two subnets as shown in the table with the network addresses of 192.168.0.0 and 192.168.0.128. The subnet mask is 255.255.255.128.

Subnet Mask	No. of Subnets	Number of Hosts	Network Address	Usable IP Range	Broadcast Address
255.255.255.0	1	254	192.168.0.0	192.168.0.1 - 192.168.0.254	192.168.0.255
255.255.255.128	2	128	192.168.0.0	192.168.0.1 - 192.168.0.126	192.168.0.127
			192.168.128.0	192.168.0.129 - 192.168.0.254	192.168.0.255
255.255.255.192	4	64	192.168.0.0	192.168.0.1 - 192.168.0.62	192.168.0.63
			192.168.0.64	192.168.0.65 - 192.168.0.126	192.168.0.127
			192.168.0.128	192.168.0.129 - 192.168.0.190	192.168.0.191
			192.168.0.192	192.168.0.192 - 192.168.0.254	192.168.0.255
255.255.255.224	8	32	192.168.0.0	192.168.0.1 - 192.168.0.30	192.168.0.31
			192.168.0.32	192.168.0.33 - 192.168.0.62	192.168.0.63
			192.168.0.64	192.168.0.65 - 192.168.0.94	192.168.0.95
			192.168.0.96	192.168.0.97 - 192.168.0.126	192.168.0.127
			192.168.0.128	192.168.0.129 - 192.168.0.158	192.168.0.159
			192.168.0.160	192.168.0.161 - 192.168.0.190	192.168.0.191
			192.168.0.192	192.168.0.193 - 192.168.0.222	192.168.0.223
			192.168.0.224	192.168.0.225 - 192.168.0.254	192.168.0.255

11111111.11111111.11111111.10000000 or 255.255.255.128

Subnetting a Class C Network

Class C Subnetting of IP Address 192.168.0.0

For even more subnets of the class C network, we borrow the first two bits of the subnet mask as shown below. The subnet is 2^2 or 4, so there are four subnets as shown in the table with the network addresses of 192.168.0.0, 192.168.0.64, 192.168.0.128 and 192.168.0.192. The subnet mask is 255.255.255.192.

Subnet Mask	No. of Subnets	Number of Hosts	Network Address	Usable IP Range	Broadcast Address
255.255.255.0	1	254	192.168.0.0	192.168.0.1 - 192.168.0.254	192.168.0.255
255.255.255.128	2	128	192.168.0.0	192.168.0.1 - 192.168.0.126	192.168.0.127
			192.168.128.0	192.168.0.129 - 192.168.0.254	192.168.0.255
255.255.255.192	4	64	192.168.0.0	192.168.0.1 - 192.168.0.62	192.168.0.63
			192.168.0.64	192.168.0.65 - 192.168.0.126	192.168.0.127
			192.168.0.128	192.168.0.129 - 192.168.0.190	192.168.0.191
			192.168.0.192	192.168.0.192 - 192.168.0.254	192.168.0.255
255.255.255.224	8	32	192.168.0.0	192.168.0.1 - 192.168.0.30	192.168.0.31
			192.168.0.32	192.168.0.33 - 192.168.0.62	192.168.0.63
			192.168.0.64	192.168.0.65 - 192.168.0.94	192.168.0.95
			192.168.0.96	192.168.0.97 - 192.168.0.126	192.168.0.127
			192.168.0.128	192.168.0.129 - 192.168.0.158	192.168.0.159
			192.168.0.160	192.168.0.161 - 192.168.0.190	192.168.0.191
			192.168.0.192	192.168.0.193 - 192.168.0.222	192.168.0.223
			192.168.0.224	192.168.0.225 - 192.168.0.254	192.168.0.255

11111111.11111111.11111111.11000000 or 255.255.255.192

Subnetting a Class C Network

Class C Subnetting of IP Address 192.168.0.0

For more complex subnetting of the class C network, we borrow the first three bits of the subnet mask as shown below. The subnet is 2^3 or 8, so there are eight subnets as shown in the table with the network addresses of 192.168.0.0, 192.168.0.32, 192.168.0.64, 192.168.0.96, 192.168.0.128, 192.168.0.160, 192.168.0.192, and 192.168.0.224.

The subnet mask is 255.255.255.224.

Subnet Mask	No. of Subnets	Number of Hosts	Network Address	Usable IP Range	Broadcast Address
255.255.255.0	1	254	192.168.0.0	192.168.0.1 - 192.168.0.254	192.168.0.255
255.255.255.128	2	128	192.168.0.0 192.168.128.0	192.168.0.1 - 192.168.0.126 192.168.0.129 - 192.168.0.254	192.168.0.127 192.168.0.255
255.255.255.192	4	64	192.168.0.0 192.168.0.64 192.168.0.128 192.168.0.192	192.168.0.1 - 192.168.0.62 192.168.0.65 - 192.168.0.126 192.168.0.129 - 192.168.0.190 192.168.0.192 - 192.168.0.254	192.168.0.63 192.168.0.127 192.168.0.191 192.168.0.255
255.255.255.224	8	32	192.168.0.0 192.168.0.32 192.168.0.64 192.168.0.96 192.168.0.128 192.168.0.160 192.168.0.192 192.168.0.224	192.168.0.1 - 192.168.0.30 192.168.0.33 - 192.168.0.62 192.168.0.65 - 192.168.0.94 192.168.0.97 - 192.168.0.126 192.168.0.129 - 192.168.0.158 192.168.0.161 - 192.168.0.190 192.168.0.193 - 192.168.0.222 192.168.0.225 - 192.168.0.254	192.168.0.31 192.168.0.63 192.168.0.95 192.168.0.127 192.168.0.159 192.168.0.191 192.168.0.223 192.168.0.255

11111111.11111111.11111111.11100000 or 255.255.255.224

Practice

Class C Subnetting of IP Address 192.168.0.0

Create 16 subnets
for the IP address
192.168.0.0

Subnet Mask	No. of Subnets	Number of Hosts	Network Address	Usable IP Range	Broadcast Address
	16				

11111111.11111111.11111111._____ or _____

Questions

If you have questions about subnetting, or would like to have more practice, just ask.

