Understanding Class C Subnet Masking

In the day to day support operations a Symertix tech support agent will most often come across customers that have their PC and Symetrix DSP on a Class C Subnet Mask of 255.255.255.0. However, this document covers what Class C subnets mean when they are further partitioned, such as a subnet mask of 255.255.255.128, and how Symetrix support agents can help to support a PC or Symetrix DSP that is assigned to a subnet such as this.

Subnet Mask 101:

The first thing to understand is where the 255 comes from. Each number in an IP address, subnet mask, or gateway consists of an 8 bit number, which is why these numbers are also referred to as an "octet". Four octets make a single IP address, subnet mask, or gateway.

How 8 bit numbers, octets, work are similar to dip switches on old SymNet Designer boxes. In other words, a bit can either be on or off, it is a power of two based upon its position, and to get the full value of the octet we add up each of the bit's values to the previous bit's value. An 8 bit number can be looked at in several ways, which doing so can sometimes help to make sense of the binary math:

11111111= 264 232 216 28 24 22 21 20 = 128 64 32 16 8 4 2 1

So, if the subnet mask was 11111111, we would add up all relevant bits such that 128+64+32+16+8+4+2+1 = 255

When a 255 is used in a mask, this indicates that all IP address numbers that have a mask below them must match for two devices to be in the same subnet.

For instance, if the IP address is 192.168.100.5 with a subnet mask of 255.255.255.0, then in order for two devices to be on the same subnet their IPs must both contain 192.168.100.n (where n=node address that can vary between 0 and 255).

When placed vertically we see:

192.168.100.5

255.255.255.0

Every number with a 255 in the same octet must match, so in this case the first three octets of 192.168.100 is masked and must match for devices to be in the same subnet. Only the last octet, 5, is not masked. This is the octet that will vary for all devices in the 192.168.100.n subnet in order for the devices to have unique IP addresses.

So, in this instance the subnet consists of all IP addresses between 192.168.100.0 - 192.168.100.255, which is a total of 256 IP addresses within this subnet.

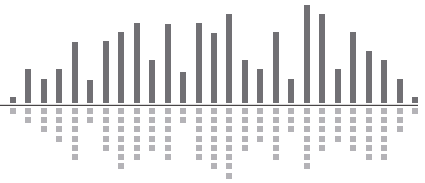
Reserved Addresses within a Subnet:

It is also import to remember that every subnet on a network has two reserved IP addresses, also called host addresses.

(Note: in a point to point network, the reserved addresses are not needed. "Point to point network" meaning a direct connection or simply a few IP capable units on an unmanaged switch, however, reserving these host addresses on a point to point network certainly doesn't hurt anything, so these host addresses can always be implemented as a rule)

The first reserved IP address in a subnet is the "network" address. This is typically the gateway address, or that of the router that manages the subnet. It is sometimes referred to as the network ID.

The second reserved address is the broadcast address, which is always the last IP address in the subnet. Any data sent to the broadcast address will automatically be routed to all nodes within that particular subnet. Many auto-discovery software features use the broadcast address to send a hello/ discovery packet to find units on a network. Symetrix Connection Managers



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or search features of the System Manager in Composer use the broadcast address for discovery of DSP units.

Looking at the previous example of a 192.168.100.5 IP address with a 255.255.255.0 subnet mask, the network address would be 192.1683.100.0 and the broadcast address would be 192.168.100.255, leaving 192.168.100.1 through 192.168.100.254 as available IP addresses for all devices (also called "nodes") on this subnet. In other words, if there are 256 IP addresses and two of those addresses are reserved for the network and broadcast address, then a subnet mask of 255.255.255.0 creates 254 possible IP addresses for additional hosts, also known as IP capable devices or nodes, on the defined subnet.

Dividing Up Subnets using the Subnet Mask:

While the previous section covered the most common class C subnet mask of 255.255.255.0 which creates 254 available IP addresses for nodes on the subnet, the class C subnet mask can be further divided up.

As we mentioned above, each octet is an 8 bit number, so a subnet mask of 255.255.255.0 actually looks like this in binary math 11111111.11111111.1111 1111.00000000.

If on the last octet a 1 is added to the far left bit we get 11111111.11111111.1 1111111.10000000, which is to say the subnet mask is now 255.255.255.128. Changing the last octet from 0 to 128 effectively divides the IP address ranges into two completely different subnets of 128 addresses each.

However, it important to remember that within each subnet there are two host addresses reserved for the network and broadcast address.

Take a network of 192.168.100.0 with a subnet mask of 255.255.255.128, below are the two defined subnets, their reserved addresses, and available host addresses.

Subnet 1:

network address = 192.168.100.0

Host range = 192.168.100.1 to 192.168.100.126

Broadcast address = 192.168.100.127

Subnet 2:

network address = 192.168.100.128

Host range = 192.168.100.129 to 192.168.100.254

Broadcast address = 192.168.100.255

If a customer had a Symetrix DSP and they could not located it, then support would need to insure the PC running the Symetrix software and the Symetrix DSP is on the same subnet. So, if the Symetrix DSP was at 192.168.100.5 then the customer's PC would need to be assigned to an open IP address in the range of 192.168.100.1 to 192.168.100.126, excluding of course the DSP's address of 192.168.100.5 (When looking for an available IP address on the subnet, ping the address before assigning the customer's PC and only after it is confirmed that no devices respond to the ping request, then assign the customers PC to the available IP address).

How Many Divisions of the Class C Subnet are there?

Now that it is apparent how a subnet mask can create multiple subnets (networks) within a single address base, how many types of divisions are possible and what ranges for hosts are available in each range. First, in the previous example a single bit was added to the last octet of the subnet mask (left side of the 8 bit number) such that 10000000= 128 making the subnet mask 255.255.255.128

This however is not the only possible division. Additional bits can be added to the last octet as follows:

10000000=128

11000000=192

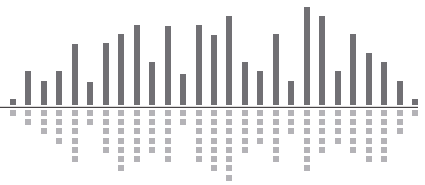
11100000=224

11110000=240

11111000=248

11111100=252

11111110=254



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When these divisions are made, subnet mask then creates the following network topology:

Subnet Mask	# of Subnets	Total # IP per Subnet	Network & Broadcast	Host IP per Subnet
255.255.255.0	1	256	2	254
255.255.255.128	2	128	2	126
255.255.255.192	4	64	2	60
255.255.255.224	8	32	2	30
255.255.255.240	16	16	2	14
255.255.255.248	32	8	2	6
255.255.255.252	64	4	2	2
255.255.255.254	128	2	2	0

It is important to note that while a 255.255.255.254 subnet mask may work for a point to point network or direct connection between a DSP and a PC, since in that scenario the subnet mask would provide two IP addresses per subnet, which means this subnet could only support a single Symetrix DSP and a PC. Even more important is that if this subnet mask is used on a managed network, then the two available IP addresses are used for the network and broadcast IP addresses, which does not leave any available host IP addresses for the Symetrix device nor the PC running Composer.

IP Address Ranges per Subnet Mask:

Below is a spreadsheet for each subnet listing the network and broadcast address, as well as the available ranges of available host IP addresses per subnet:

192.168.100.n

255.255.255.0

Subnet #	Network IP	First Host IP	Last Host IP	Broadcast IP
Subnet 1	192.168.100.0	192.168.100.1	192.168.100.254	192.168.100.255

192.168.100.n

255.255.255.128

Subnet #	Network IP	First Host IP	Last Host IP	Broadcast IP
Subnet 1	192.168.100.0	192.168.100.1	192.168.100.126	192.168.100.127
Subnet 2	192.168.100.128	192.168.100.129	192.168.100.254	192.168.100.255

192.168.100.n

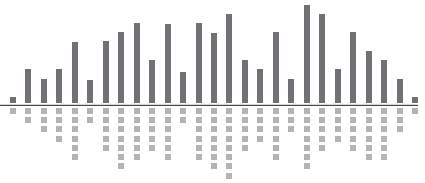
255.255.255.192

Subnet #	Network IP	First Host IP	Last Host IP	Broadcast IP
Subnet 1	192.168.100.0	192.168.100.1	192.168.100.62	192.168.100.63
Subnet 2	192.168.100.64	192.168.100.65	192.168.100.126	192.168.100.127
Subnet 3	192.168.100.128	192.168.100.129	192.168.100.190	192.168.100.191
Subnet 4	192.168.100.192	192.168.100.193	192.168.100.254	192.168.100.255

192.168.100.n

255.255.255.224

Subnet #	Network IP	First Host IP	Last Host IP	Broadcast IP
Subnet 1	192.168.100.0	192.168.100.1	192.168.100.30	192.168.100.31
Subnet 2	192.168.100.32	192.168.100.33	192.168.100.62	192.168.100.63
Subnet 3	192.168.100.64	192.168.100.65	192.168.100.94	192.168.100.95
Subnet 4	192.168.100.96	192.168.100.97	192.168.100.126	192.168.100.127
Subnet 5	192.168.100.128	192.168.100.129	192.168.100.158	192.168.100.159
Subnet 6	192.168.100.160	192.168.100.161	192.168.100.190	192.168.100.191
Subnet 7	192.168.100.192	192.168.100.193	192.168.100.222	192.168.100.223
Subnet 8	192.168.100.224	192.168.100.225	192.168.100.254	192.168.100.255



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192.168.100.n

255.255.255.240

Subnet #	Network IP	First Host IP	Last Host IP	Broadcast IP
Subnet 1	192.168.100.0	192.168.100.1	192.168.100.14	192.168.100.15
Subnet 2	192.168.100.16	192.168.100.17	192.168.100.30	192.168.100.31
Subnet 3	192.168.100.32	192.168.100.33	192.168.100.46	192.168.100.47
Subnet 4	192.168.100.48	192.168.100.49	192.168.100.62	192.168.100.63
Subnet 5	192.168.100.64	192.168.100.65	192.168.100.78	192.168.100.79
Subnet 6	192.168.100.80	192.168.100.81	192.168.100.94	192.168.100.95
Subnet 7	192.168.100.96	192.168.100.97	192.168.100.110	192.168.100.111
Subnet 8	192.168.100.112	192.168.100.113	192.168.100.126	192.168.100.127
Subnet 9	192.168.100.128	192.168.100.129	192.168.100.142	192.168.100.143
Subnet 10	192.168.100.144	192.168.100.145	192.168.100.158	192.168.100.159
Subnet 11	192.168.100.160	192.168.100.161	192.168.100.174	192.168.100.175
Subnet 12	192.168.100.176	192.168.100.177	192.168.100.190	192.168.100.191
Subnet 13	192.168.100.192	192.168.100.193	192.168.100.206	192.168.100.207
Subnet 14	192.168.100.208	192.168.100.209	192.168.100.222	192.168.100.223
Subnet 15	192.168.100.224	192.168.100.225	192.168.100.238	192.168.100.239
Subnet 16	192.168.100.240	192.168.100.241	192.168.100.254	192.168.100.255

192.168.100.n

255.255.255.248

Subnet #	Network IP	First Host IP	Last Host IP	Broadcast IP
Subnet 1	192.168.100.0	192.168.100.1	192.168.100.	192.168.100.7
Subnet 2	192.168.100.8	192.168.100.9	192.168.100.	192.168.100.15
Subnet 3	192.168.100.16	192.168.100.17	192.168.100.	192.168.100.23
Subnet 4	192.168.100.24	192.168.100.25	192.168.100.	192.168.100.31
Subnet 5	192.168.100.32	192.168.100.33	192.168.100.	192.168.100.39

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Subnet 6	192.168.100.40	192.168.100.41	192.168.100.	192.168.100.47
Subnet 7	192.168.100.48	192.168.100.49	192.168.100.	192.168.100.55
Subnet 8	192.168.100.56	192.168.100.57	192.168.100.	192.168.100.63
Subnet 9	192.168.100.64	192.168.100.65	192.168.100.	192.168.100.71
Subnet 10	192.168.100.72	192.168.100.73	192.168.100.	192.168.100.79
Subnet 11	192.168.100.80	192.168.100.81	192.168.100.	192.168.100.87
Subnet 12	192.168.100.88	192.168.100.89	192.168.100.	192.168.100.95
Subnet 13	192.168.100.96	192.168.100.97	192.168.100.	192.168.100.103
Subnet 14	192.168.100.104	192.168.100.105	192.168.100.110	192.168.100.111
Subnet 15	192.168.100.112	192.168.100.113	192.168.100.118	192.168.100.119
Subnet 16	192.168.100.120	192.168.100.121	192.168.100.126	192.168.100.127
Subnet 17	192.168.100.128	192.168.100.129	192.168.100.134	192.168.100.135
Subnet 18	192.168.100.136	192.168.100.137	192.168.100.142	192.168.100.143
Subnet 19	192.168.100.144	192.168.100.145	192.168.100.150	192.168.100.151
Subnet 20	192.168.100.152	192.168.100.153	192.168.100.158	192.168.100.159
Subnet 21	192.168.100.160	192.168.100.161	192.168.100.166	192.168.100.167
Subnet 22	192.168.100.168	192.168.100.169	192.168.100.174	192.168.100.175
Subnet 23	192.168.100.176	192.168.100.177	192.168.100.182	192.168.100.183
Subnet 24	192.168.100.184	192.168.100.185	192.168.100.190	192.168.100.191
Subnet 25	192.168.100.192	192.168.100.193	192.168.100.198	192.168.100.199
Subnet 26	192.168.100.200	192.168.100.201	192.168.100.206	192.168.100.207
Subnet 27	192.168.100.208	192.168.100.209	192.168.100.214	192.168.100.215
Subnet 28	192.168.100.216	192.168.100.217	192.168.100.222	192.168.100.223
Subnet 29	192.168.100.224	192.168.100.225	192.168.100.230	192.168.100.231
Subnet 30	192.168.100.232	192.168.100.233	192.168.100.238	192.168.100.239
Subnet 31	192.168.100.240	192.168.100.241	192.168.100.246	192.168.100.247
Subnet 32	192.168.100.248	192.168.100.249	192.168.100.254	192.168.100.255

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Because the last two possible subnet masks create 64 and 128 subnets respectively with such a minimal amount of available hosts, these two subnet masks have been omitted from the listed tables. In a practical sense it will be highly unlikely that a Symetrix support agent will come in contact with either of the following subnet mask; however, should a Symetrix support agent encounter either subnet mask in the field, using the above data and understanding the pattern should allow them to figure out the available host IP addresses.

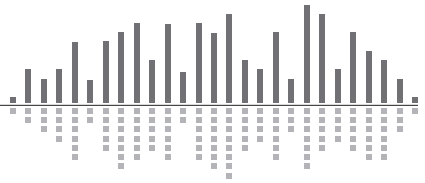
Subnet Mask	# of Subnets	Total # IP per Subnet	Network & Broadcast	Host IP per Subnet
255.255.255.252	64	4	2	2
255.255.255.254	128	2	2	0

Abbreviations:

To conclude this document, one final piece of the puzzle is that sometimes these subnet masks are abbreviated. And abbreviated subnet mask would be displayed in the form of 192.168.100.0/26 where the /26 indicates the subnet mask that is being used. Below is a chart of the abbreviations.

Subnet Mask	Abbreviation
255.255.255.0	/24
255.255.255.128	/25
255.255.255.192	/26
255.255.255.224	/27
255.255.255.240	/28
255.255.255.248	/29
255.255.255.252	/30

As such, it is apparent that 192.168.100.0/26 indicates that the network is 192.168.100.0 with a subnet mask of 255.255.255.192 so Symetrix support would know this subnet mask creates 4 subnets with 64 total IP addresses of which 2 are reserved for the network and broadcast addresses, so there are 62 available host IP addresses per network.



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