

## IP 101

**Note:** This is a very brief introduction to IP networking. For more in depth information, there are a number of excellent references. In particular, Douglas Comer's Internetworking with TCP/IP (Prentice Hall) is one of the standard references and provides a wealth of information on the subject.

### IP Addresses

Each device on an IP network requires 3 different pieces of information in order to correctly communicate with other devices on the network: an IP address, a subnet mask, and a broadcast address. You will usually see each of these numbers written as four "octets," for example - 198.41.12.151, 255.255.255.0, and 198.41.12.255.

Every IP address is really made up of two pieces: a "network" portion (tells routers what group of devices a packet should go to - typically representing a company, a campus, etc.) and a "host" portion (tells routers what specific device among that group the packet should go to).

By examining the destination address in an IP packet that must be forwarded, and by using information that has either been statically configured or dynamically gathered from other routers, any router can determine the optimal path for forwarding packets from one group to another.

Each group of devices on an IP internet needs to have a unique network portion, and each device within that group also needs a unique host portion. In the case of the Internet, this uniqueness is made possible by indirectly getting all network portion assignments through a central clearinghouse called the Network Information Center or "NIC." The NIC assigns blocks of addresses to Internet Service Providers (ISPs), who then assign these addresses to their customers.

If your network is, or will be, connected to the Internet, you will need to get a unique network address from your ISP or network administrator.

How much of any given address is the network part and how much

is the host part is determined by the "class" of the network. In each case, the part of the address not used for the network portion is left as the host portion.

<u>Class</u>	<u>Network Portion</u>	<u>Hosts Allowed</u>
A	1.-127.0	about 16 million
B	128.0-191.255	65536
C	192.0.0-223.255.255	255

Chart 1: IP Address Classes

You can always tell what class an address is by looking at the first octet and comparing it to the chart above. For instance, the address at the top of this appendix has 198 as the first octet, so it is Class C.

### Subnet Masks

A subnet mask tells a router how much of an address it should treat as the network portion. The masks for traditional Class A, B, and C networks are shown below.

<u>Class</u>	<u>Subnet Mask</u>
A	255.0.0.0
B	255.255.0.0
C	255.255.255.0

Chart 2: Standard IP Subnets

Comparing the masks above to the first chart, you can see that the 255's in a mask identify the network portion of the address. Just as the masks above specify what portion of the global IP address range a network is using, a subnet mask can also be used to subdivide a Class A, B, or C network range into multiple groups of hosts, or "subnets."

This is done by telling the router that more than the traditional number of bits in the mask are to be treated as the network portion of the address. The chart below shows all of the possible Class C subnet masks, and how many hosts are then allowed on each subnet.

<u>Subnet Mask</u>	<u>Host Range</u>
255.255.255.0	1-254 (traditional C)
255.255.255.128	1-126, 129-254
255.255.255.192	1-62, 65-126, 129-190, 193-254
255.255.255.224	1-30, 33-62, 65-94, 97-126, 129-158, 161-190, 193-222, 225- 254
255.255.255.240	1-14, 17-30, 33-46, 49-62, 65-78, 81-94, 97-110, 113-126, 129-142, 145-158, 161-174, 177-190, 193- 206, 209-222, 225-238, 241-254

Chart 3: Subnetted Class C Host Ranges

**Note:** The lowest calculated address in each range (0 in the traditional C range) is not shown, can not be used, and is skipped in the chart. The highest address in each range (255 in the traditional C range) is also not shown, and is the broadcast address for the subnet.

With each mask above, the 1's in the binary value represent the network portion, and the 0's represent the host portion (128 is 10000000, 192 is 11000000, etc.). As you use more bits to represent the network portion, fewer bits are left to use as host addresses. The same idea can be extended to Class A and Class B networks.

### Broadcast Addresses

The broadcast address is the address to which devices send packets meant for all other devices. All devices "listen" for broadcasts in addition to their own address. Address Resolution Protocol (ARP) packets and routing information are examples of packets sent to the broadcast address. Most often, the broadcast address is the last address in the network (or subnet), with the host portion being all 1's binary (some networks use 0.0.0.0 or 255.255.255.255, however). Below are some examples of broadcast addresses.

<u>Class</u>	<u>Network</u>	<u>Subnet Mask</u>	<u>Broadcast Address</u>
A	45.0.0.0	255.0.0.0	45.255.255.255
B	128.138.0.0	255.255.0.0	128.138.255.255
C	198.41.9.0	255.255.255.0	198.41.9.255
A*	45.21.16.0	255.255.252.0	45.21.19.255
B*	198.41.9.64	255.255.255.224	198.41.9.95

Chart 4: Broadcast Address Examples

The first three entries are traditional Class A, B, and C network addresses and use traditional masks. The last two are less traditional, "real world" examples. Note in line 4 the change in the third octet between network address and broadcast address. Line 5 shows what happens when a Class C network has been subnetted.

### Assigning an IP address

Use the network portion you were given by your administrator or ISP. Assign the router port a unique (i.e. unused) host portion. For example, if your ISP tells you your network portion is 198.41.9, you could assign a port to 198.41.9.1. If you have a router with more than one port, the network (+ subnet) portions of each port's IP address must be different.

## **Assigning a Subnet Mask**

If you are using traditional Class A, B, or C networks, CompaView will automatically calculate the value for you. If you wish to compute it yourself, use the values in Chart 2.

If you are subnetting, use Chart 3 as a guide for Class C, or follow the same scheme for Class A or B. Note that the IP address for a subnetted port (including the router port on that subnet) must be in the correct subnet range, as shown in Chart 3.

## **Assigning a Broadcast Address**

CompaView will automatically compute the broadcast address for you. If you wish to compute it yourself, use the examples in Chart 4 above as a guide. You can then use CompaView to check your results.

## **Static Routes & Routing Protocols**

In addition to the three required values, you must also decide whether to use an IP routing protocol. Routing protocols are how routers tell each other about networks they are responsible for. Virtually all routers, support the IP Routing Information Protocol (RIP). There are also a variety of other routing protocols which have been developed, some proprietary, and some open. A router which is using one of these other protocols can always accept routes using RIP and then supply information about them using the other protocol.

If you choose not to use RIP, or other routers on your network are not broadcasting routing information, you may need to set a default router or define some static routes. The default router is the place where your router will send any packets addressed to IP networks that it does not know about. With RIP turned off, it will only know about statically configured routes. For very simple IP connections, such as a small network being connected out to the Internet through an ISP, a default route is probably the only routing information needed by your router.

Where a default router provides a generic location for packets to be sent to, static routes are more specific definitions where you specify the route for certain networks, and a "metric" which defines how attractive the route should be considered.

When specifying default routes, you must provide a mask value (as discussed earlier) which tells the router how much of the address you are entering the route for should be considered as the network

portion.

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