



Lab 9.2.7 IP Addressing Basics – Instructor Version

Objective

- Name the five different classes of IP addresses
- Describe the characteristics and use of the different IP address classes
- Identify the class of an IP address based on the network number
- Determine which part, or octet, of an IP address is the network ID and which part is the host ID
- Identify valid and invalid IP host addresses based on the rules of IP addressing
- Define the range of addresses and default subnet mask for each class

Background / Preparation

This lab exercise helps develop an understanding of IP addresses and how TCP/IP networks operate. It is primarily a written lab exercise. However, it would be worthwhile to review some real network IP addresses using the command line utilities `ipconfig` for Windows NT/2000/XP or `windowsipcfg` for Windows 9x/ME. IP addresses are used to uniquely identify individual TCP/IP networks and hosts, such as computers and printers, on those networks in order for devices to communicate. Workstations and servers on a TCP/IP network are called hosts and each has a unique IP address. This address is referred to as its host address. TCP/IP is the most widely used protocol in the world. The Internet or World Wide Web only uses IP addressing. In order for a host to access the Internet, it must have an IP address.

In its basic form, the IP address has two parts:

- A network address
- A host address

The network portion of the IP address is assigned to a company or organization by the Internet Network Information Center (InterNIC). Routers use the IP address to move data packets between networks. IP addresses are 32 bits long according to the current version IPv4 and are divided into 4 octets of 8 bits each. They operate at the network layer (Layer 3) of the Open System Interconnection (OSI) model, which is the Internet layer of the TCP/IP model. IP addresses are assigned in the following ways:

- Statically – manually, by a network administrator
- Dynamically – automatically, by a Dynamic Host Configuration Protocol (DHCP) server

The IP address of a workstation, or host is a logical address, meaning it can be changed. The Media Access Control (MAC) address of the workstation is a 48-bit physical address. This address is burned into the network interface card (NIC) and cannot change unless the NIC is replaced. The combination of the logical IP address and the physical MAC address helps route packets to their proper destination.

There are five different classes of IP addresses, and depending on the class, the network and host part of the address will use a different number of bits. In this lab, different classes of IP addresses will be worked with and to help become familiar with the characteristics of each. The understanding of IP addresses is critical to the understanding of TCP/IP and internetworks in general. The following resources are required:

- PC workstation with Windows 9x/NT/2000/XP installed
- Access to the Windows Calculator

Step 1 Review IP address classes and their characteristics

Address classes

There are five classes of IP addresses, A through E. Only the first three classes are used commercially. A Class A network address is discussed in the table to get started. The first column is the class of IP address. The second column is the first octet, which must fall within the range shown for a given class of addresses. The Class A address must start with a number between 1 and 126. The first bit of a Class A address is always a zero, meaning the High Order Bit (HOB) or the 128 bit cannot be used. 127 is reserved for loopback testing. The first octet alone defines the network ID for a Class A network address.

Default subnet mask

The default subnet mask uses all binary ones, decimal 255, to mask the first 8 bits of the Class A address. The default subnet mask helps routers and hosts determine if the destination host is on this network or another one. Because there are only 126 Class A networks, the remaining 24 bits, or 3 octets, can be used for hosts. Each Class A network can have 2^{24} , or over 16 million hosts. It is common to subdivide the network into smaller groupings called subnets by using a custom subnet mask, which is discussed in the next lab.

Network and host address

The network or host portion of the address cannot be all ones or all zeros. As an example, the Class A address of 118.0.0.5 is a valid IP address. The network portion, or first 8 bits, which are equal to 118, is not all zeros and the host portion, or last 24 bits, is not all zeros or all ones. If the host portion were all zeros, it would be the network address itself. If the host portion were all ones, it would be a broadcast for the network address. The value of any octet can never be greater than decimal 255 or binary 11111111.

Class	1 st Octet Decimal Range	1 st Octet High Order Bits	Network/Host ID (N=Network, H=Host)	Default Subnet Mask	Number of Networks	Hosts per Network (Usable Addresses)
A	1 – 126 *	0	N.H.H.H	255.0.0.0	126 ($2^7 - 2$)	16,777,214 ($2^{24} - 2$)
B	128 – 191	10	N.N.H.H	255.255.0.0	16,382 ($2^{14} - 2$)	65,534 ($2^{16} - 2$)
C	192 – 223	110	N.N.N.H	255.255.255.0	2,097,150 ($2^{21} - 2$)	254 ($2^8 - 2$)
D	224 – 239	1110	Reserved for Multicasting			
E	240 – 254	11110	Experimental; used for research			

Note: Class A address 127 cannot be used and is reserved for loopback and diagnostic functions.

Step 2 Determine basic IP addressing

Use the IP address chart and your knowledge of IP address classes to answer the following questions:

- What is the decimal and binary range of the first octet of all possible Class B IP addresses?
 Decimal: From: 128 To: 191
 Binary: From: 10000000 To: 10111111
- Which octet(s) represent the network portion of a Class C IP address? The first three
- Which octet(s) represent the host portion of a Class A IP address? The last three
- What is the maximum number of useable hosts with a Class C network address? 254
- How many Class B networks are there? 16,384 (less 2 = 16,382)
- How many hosts can each Class B network have? 65,536 less 2 = 65,534
- How many octets are there in an IP address? 4 How many bits per octet? 8

Step 3 Determine the host and network portions of the IP address

With the following IP host addresses, indicate the following:

- Class of each address
- Network address or ID
- Host portion
- Broadcast address for this network
- Default subnet mask

The host portion will be all zeros for the network ID. Enter just the octets that make up the host. The host portion will be all ones for a broadcast. The network portion of the address will be all ones for the subnet mask. Fill in the following table:

Host IP Address	Address Class	Network Address	Host Address	Network Broadcast Address	Default Subnet Mask
216.14.55.137	<u>C</u>	<u>216.14.55.0</u>	<u>.137</u>	<u>216.14.55.255</u>	<u>255.255.255.0</u>
123.1.1.15	<u>A</u>	<u>123.0.0.0</u>	<u>.1.1.15</u>	<u>123.255.255.255</u>	<u>255.0.0.0</u>
150.127.221.244	<u>B</u>	<u>150.127.0.0</u>	<u>.221.244</u>	<u>150.127.255.255</u>	<u>255.255.0.0</u>
194.125.35.199	<u>C</u>	<u>194.125.35.0</u>	<u>.199</u>	<u>194.125.35.255</u>	<u>255.255.255.0</u>
175.12.239.244	<u>B</u>	<u>175.12.0.0</u>	<u>.239.244</u>	<u>175.12.255.255</u>	<u>255.255.0.0</u>

Step 4 Given an IP address of 142.226.0.15 and a subnet mask of 255.255.255.0, answer the following questions:

- What is the binary equivalent of the second octet? 11100010
- What is the class of the address? B (with a class C subnet mask)
- What is the network address of this IP address? 142.226.0.0
- Is this a valid IP host address (Y/N)? Yes

Why or why not?

The zero in the third octet can be routed as long as the last octet does not contain either zero or 255.

Step 5 Determine which IP host addresses are valid for commercial networks

For the following IP host addresses, determine which are valid for commercial networks and indicate why or why not. Valid means it could be assigned to any of the following:

- Workstation
- Server
- Printer
- Router interface
- Any other compatible device

Fill in the following table:

IP Host Address	Valid Address? (Yes/No)	Why or Why Not
150.100.255.255	<u>No</u>	<u>Broadcast (All ones in the host portion)</u>
175.100.255.18	<u>Yes</u>	<u>Valid host address within the 175.100.0.0 network range</u>
195.234.253.0	<u>No</u>	<u>Network Number (All zeros in the host portion)</u>
100.0.0.23	<u>Yes</u>	<u>Valid host address within the 100.0.0.0 network range</u>
188.258.221.176	<u>No</u>	<u>258 is not a valid octet</u>
127.34.25.189	<u>No</u>	<u>127 is reserved for loopback</u>
224.156.217.73	<u>No</u>	<u>Class D is reserved for multicasting</u>