APPENDIX A

TCP/IP Overview

This appendix provides an introduction to fundamentals of Transmission Control Protocol/Internet Protocol (TCP/IP).

IP Addresses and Subnets

An IP address is a 32-bit binary number. For convenience, it is often written as a series of four decimal numbers separated by periods (dotted-decimal notation). Each decimal number represents eight bits and is referred to as a byte or octet.

IP addresses are made up of two parts. The first part identifies the network, and the second part identifies the local or host address. There are five classes of address, labeled A through E, according to how the address divides the network and local parts. An IP address obtained from the Internet Network Information Center (NIC) and used for communication on the Internet is called an Internet address.

Class A Addresses

In a class A address, the highest-order bit is set to 0; the next 7 bits are used for the network part; and the remaining 24 bits are used for the local address. In dotted decimal notation, the first byte represents the network number, and the other three bytes are available for the host number. Class A addresses are assigned the numbers 1 through 126 as the first byte.

This division allows 128 class A network numbers and over 16 million hosts for each network number.

An example of a class A Internet address might be 9.255.253.254. The Internet, MILNET, and some large commercial networks use class A addresses.

Class B Addresses

In a class B address, the 2 highest-order bits are set to 10; the next 14 bits are used for the network part; and the remaining 16 bits are used for the local address. In dotted decimal notation, the first two bytes represent the network number, and the remaining two bytes are available for the host number. Class B addresses are assigned the numbers 128.1 through 191.255 as the first two bytes.

This division allows 16,384 class B network numbers and over 64,000 hosts for each class B network number.

An example of a class B Internet address might be 128.127.42.101. Many large organizations use class B addresses.

Class C Addresses

In a class C address, the 3 highest-order bits are set to 110; the next 21 bits are used for the network part; and the remaining 8 bits are used for the local address. In dotted decimal notation, the first three bytes represent the network number, and the remaining byte is available for the host number. Class C addresses are assigned the numbers 192.0.1 through 225.255.255 as the first three bytes.

This division allows just over 2 million class C network numbers and 254 hosts for each class C network number.

An example of a class C Internet address might be 192.32.5.35. Smaller organizations often use one or more class C addresses.

Class D Addresses

In a class D address, the 4 highest-order bits are set to 1110, and the remaining 28 bits are used for a multicast address.

For more information on IP multicast addresses, refer to RFC-1112.

Class E Addresses

No addresses are allowed with the highest-order bits set to 1111. These addresses, called class E addresses, are reserved by the NIC for future use.

Subnets

Organizations with class A and B (and very infrequently class C) network numbers often split their networks into pieces called subnets. Subnets are usually defined by administrative splitting between departments or sponsors, by location (such as several offices of a corporation), or by physical medium (such as Ethernet, Token Ring, or X.25). Each subnet is connected to the others by routers that transfer data among the networks and, if necessary, translate the protocols used on different networks.

When an organization uses subnets, it decides how many bits of the local address will be used to designate a subnet number. The remaining bits of the local address then designate the host number, and determine how many hosts can be on each subnet. For instance, a class B network obtains its 2-byte network number from the NIC and therefore has 2 bytes, or 16 bits, left to represent local addresses. If the organization does not expect to have 64,000 hosts on a single network, it can use 4 of these 16 bits for subnet numbers and the remaining 12 bits for host numbers. This division allows the organization to have 16 subnets with 2,046 hosts on each subnet (certain addresses are reserved).

The network distinguishes the subnet number and host number portions of an IP address by means of a 32-bit number called a subnet mask. The subnet mask contains 1s in the network and subnet portion of the address and 0s in the host number portion. For example, in a class B address with 16 bits of network address, 4 bits of subnet information, and 12 bits of host address, the subnet mask would be 11111111 11111111 11110000 00000000 (255.255.240.0). When the IP address is logically ANDed with the subnet mask, the result gives the network number plus the subnet number.

When a router receives a packet, it compares the network and subnet portion of the destination address with the corresponding portion of the sender’s address. If these values are different, the destination is assumed to be on another subnet, and the routing algorithms send the packet to the appropriate gateway. If the values are the same, the destination is assumed to be on the same LAN as the host, and the remaining (host) portion of the destination address is used to determine the proper physical address.

References

Internet protocol specifications and other documents are issued as Requests for Comments (RFCs). These documents are then made available on the Internet for sharing information or fostering discussion. Each RFC is assigned a unique number, which is used for identification. RFCs can be accessed as online text files. For further information on obtaining RFCs, contact Network Solutions at the following address:

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body: document-by-name rfc *xxxx*, where *xxxx* is the number of the RFC document.

The following references provide further information about Internet protocols:

- Comer, Douglas E., Internetworking with TCP/IP, Volume I: Principles, Protocols, and Architecture, second edition, Prentice Hall, 1990. The classic introductory text has been recently revised and updated.
- Department of Defense, Internet Protocol (IP), MIL-STD-1777, August 1983.
- Internet Control Messsage Protocol (ICMP), RFC 972.

  This RFC supersedes RFC 1098 of April 1989, which in turn superseded RFC 1067. The protocol is the same in all three versions; only the introductory text was changed. Cisco Hub/Ring Manager's implementation of SNMP complies with all three documents.
- Case, J., M. Fedor, M. Schoffstall, and J. Davin, *A Simple Network Management Protocol (SNMP)*, RFC 1157, May 1990.
- McCloghrie, K., and D. McMaster, Definitions of Managed Objects for IEEE 802.3 Repeater Device, RFC 1516, September 1993.