Understand Host and Subnet Quantities

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Introduction

This document describes how IP addresses are used within hosts and subnets.

Prerequisites

Requirements

There are no specific requirements for this document.

Components Used

This document is not restricted to specific software and hardware versions.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Conventions

Refer to Use Format Conventions for Technical Tips and Other Content for more information on document conventions.

Background Information

An IP address is 32 bits long and made up of two components, a network portion and a host portion. The network address is used to identify the network and is common to all the devices attached to the network. The host (or node) address is used to identify a particular device attached to the network. The IP address is generally represented with the dotted-decimal notation, where 32 bits are divided into four octets. Each of the octets can be represented in a decimal format, separated by decimal points. For more information on IP

addresses, refer to Configure IP Addresses and Unique Subnets for New Users.

Classes

These are the classes of IP addresses:

- Class Aâ€”The first octet denotes the network address, and the last three octets are the host portion. Any IP address whose first octet is between 1 and 126 is a Class A address. Notice that 0 is reserved as a part of the default address, and 127 is reserved for internal loopback testing.
- Class Bâ€”The first two octets denote the network address, and the last two octets are the host portion. Any address whose first octet is in the range 128 to 191 is a Class B address.
- Class Câ€”The first three octets denote the network address, and the last octet is the host portion. The first octet range of 192 to 223 is a Class C address.
- Class Dâ€”Used for multicast. Multicast IP addresses have their first octets in the range 224 to 239.
- Class Eâ€”Reserved for future use and includes the range of addresses with a first octet from 240 to 255.

Subnetting and Tables

As a concept, subnetting divides the network into smaller portions called subnets. This is done with borrowed bits from the host portion of the IP address, and this enables a more efficient use of the network address. A subnet mask defines which portion of the address is used to identify the network and which denotes the hosts.

The next tables show all possible ways a major network can be subnetted, and, in each case, how many effective subnets and hosts are possible.

There are three tables, one for each class of addresses.

- The first column shows how many bits are borrowed from the host portion of the address for subnetting.
- The second column shows the resulting subnet mask in dotted decimal format.
- The third column shows how many subnets are possible.
- The fourth column shows how many valid hosts are possible on each of these subnets.
- The fifth column shows the number of subnet mask bits.

Class A Host/Subnet Table

Class A Number of Bits Borrowed from Host Portion	Subnet Mask	Effective Subnets	Number of Hosts/Subnet	Number of Subnet Mask Bits
1	255.128.0.0	2	8388606	/9
2	255.192.0.0	4	4194302	/10

3	255.224.0.0	8	2097150	/11
4	255.240.0.0	16	1048574	/12
5	255.248.0.0	32	524286	/13
6	255.252.0.0	64	262142	/14
7	255.254.0.0	128	131070	/15
8	255.255.0.0	256	65534	/16
9	255.255.128.0	512	32766	/17
10	255.255.192.0	1024	16382	/18
11	255.255.224.0	2048	8190	/19
12	255.255.240.0	4096	4094	/20
13	255.255.248.0	8192	2046	/21
14	255.255.252.0	16384	1022	/22
15	255.255.254.0	32768	510	/23
16	255.255.255.0	65536	254	/24
17	255.255.255.128	131072	126	/25
18	255.255.255.192	262144	62	/26
19	255.255.255.224	524288	30	/27
20	255.255.255.240	1048576	14	/28
21	255.255.255.248	2097152	6	/29
22	255.255.255.252	4194304	2	/30
23	255.255.255.254	8388608	2*	/31

Class B Host/Subnet Table

Class B Bits	Subnet Mask	Effective Subnets	Effective Hosts	Number of Subnet Mask Bits
1	255.255.128.0	2	32766	/17
2	255.255.192.0	4	16382	/18
3	255.255.224.0	8	8190	/19
4	255.255.240.0	16	4094	/20
5	255.255.248.0	32	2046	/21
6	255.255.252.0	64	1022	/22
7	255.255.254.0	128	510	/23
8	255.255.255.0	256	254	/24
9	255.255.255.128	512	126	/25
10	255.255.255.192	1024	62	/26
11	255.255.255.224	2048	30	/27
12	255.255.255.240	4096	14	/28
13	255.255.255.248	8192	6	/29
14	255.255.255.252	16384	2	/30
15	255.255.255.254	32768	2*	/31

Class C Host/Subnet Table

Class C Bits	Subnet Mask	Effective Subnets	Effective Hosts	Number of Subnet Mask Bits
1	255.255.255.128	2	126	/25
2	255.255.255.192	4	62	/26
3	255.255.255.224	8	30	/27
4	255.255.255.240	16	14	/28
5	255.255.255.248	32	6	/29

```
  6      255.255.255.252     64          2        /30
  7      255.255.255.254    128          2*       /31
```

Subnet Example

The first entry in the Class A table (/10 subnet mask) borrows two bits (the leftmost bits) from the host portion of the network for subnetting, then with two bits you have four (2^2) combinations, 00, 01, 10, and 11. Each of these can represent a subnet.

<#root>

```
Binary Notation                                          Decimal Notation
-------------------------------------------------     -----------------
xxxx xxxx.

00

00 0000.0000 0000.0000 0000/10    ------> X.0.0.0/10
xxxx xxxx.

01

00 0000.0000 0000.0000 0000/10    ------> X.64.0.0/10
xxxx xxxx.

10

00 0000.0000 0000.0000 0000/10    ------> X.128.0.0/10
xxxx xxxx.

11

00 0000.0000 0000.0000 0000/10    ------> X.192.0.0/10
```

Out of these four subnets, 00 and 11 are called subnet zero and the all-ones subnet, respectively. Prior to Cisco IOS® Software Release 12.0, the **ip subnet-zero** global configuration command was required to be able to configure subnet zero on an interface. In Cisco IOS Software Release12.0, **ip subnet-zero** is enabled by default. For more information on the all-ones subnet and subnet zero, refer to Configure Subnet Zero and All-Ones Subnet.

> **Note**: The subnet zero and all-ones subnet are included in the effective number of subnets as shown in the third column.

Since the host portion has now lost two bits, the host portion can have only 22 bits (out of the last three octets). This means the complete Class A network is now divided (or subnetted) into four subnets, and each subnet can have 2^{22} hosts (4194304). A host portion with all zeros is network number itself, and a host portion with all ones is reserved for broadcast on that subnet, this leaves the effective number of hosts to 4194302 (2^{22} â€“ 2), as shown in the fourth column. An exception to this rule is 31-bit prefixes, marked with an asterisk (*).

Use 31-Bit Prefixes on IPv4 Point-to-Point Links

RFC 3021 describes the use of 31-bit prefixes for point-to-point links. This leaves 1 bit for the host-id portion of the IP address. Normally a host-id of all zeros is used to represent the network or subnet, and a

host-id of all ones is used to represent a directed broadcast. When 31-bit prefixes are used, the host-id of 0 represents one host, and a host-id of 1 represents the other host of a point-to-point link.

Local link (limited) broadcasts (255.255.255.255) can still be used with 31-bit prefixes. But directed broadcasts are not possible to a 31-bit prefix. This is not really a problem because most routing protocols use multicast, limited broadcasts, or unicasts.

Note: Only registered Cisco users can access internal Cisco sites, tools, and information.

Related Information

- **Configure IP Addresses and Unique Subnets for New Users**
- **Configure and Filter IP Access Lists**
- **Technical Support & Documentation - Cisco Systems**