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WHITE PAPER

Understanding IP Addressing: Everything You Ever Wanted To Know

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Everything You Ever Wanted To Know

The Internet continues to grow at a phenomenal rate. This is reflected in the tremendous popularity of the World Wide Web (WWW), the opportunities that businesses see in reaching customers from virtual storefronts, and the emergence of new ways of doing business. It is clear that expanding business and public awareness will continue to increase demand for access to resources on the Internet.

Internet Scaling Problems

Over the past few years, the Internet has experienced two major scaling issues as it has struggled to provide continuous and uninterrupted growth:

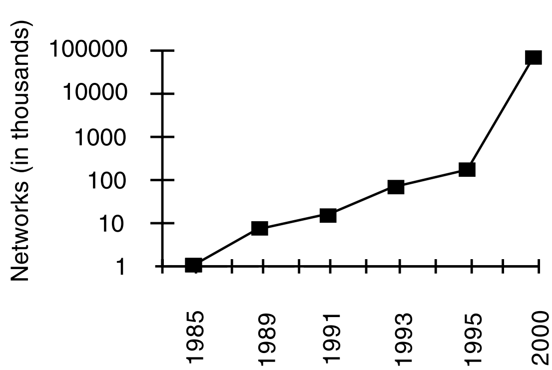
- The eventual exhaustion of IP version 4 (IPv4) address space

- The need to route traffic between the ever increasing number of networks that comprise the Internet

The first problem is concerned with the eventual depletion of the IP address space. IPv4 defines a 32-bit address which means that there are only 232 (4,294,967,296) IPv4 addresses available. As the Internet continues to grow, this finite number of IP addresses will eventually be exhausted.

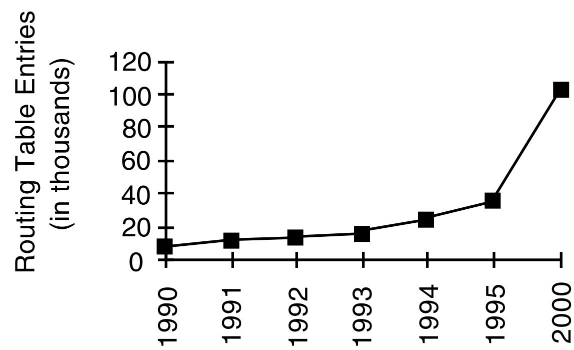
The address shortage problem is aggravated by the fact that portions of the IP address space have not been efficiently allocated. Also, the traditional model of classful addressing does not allow the address space to be used to its maximum potential. The Address Lifetime Expectancy (ALE) Working Group of the Internet Engineering Task Force (IETF) has expressed concerns that if the current address allocation policies are not modified, the Internet will experience a near to medium term exhaustion of its unallocated address pool. If the Internet's address supply problem is not solved, new users may be unable to connect to the global Internet. More than half of all possible IPv4 addresses have been assigned to ISPs, corporations, and government agencies, but only an estimated 69 million addresses are actually in use.

FIGURE 1. Network Number Growth



The second problem is caused by the rapid growth in the size of the Internet routing tables. Internet backbone routers are required to maintain complete routing information for the Internet. Over recent years, routing tables have experienced exponential growth as increasing numbers of organizations connect to the Internet. In December 1990 there were 2,190 routes, in December 1995 there were more than 30,000 routes, and in December 2000 more than 100,000 routes.

FIGURE 2. Growth of Internet Routing Tables



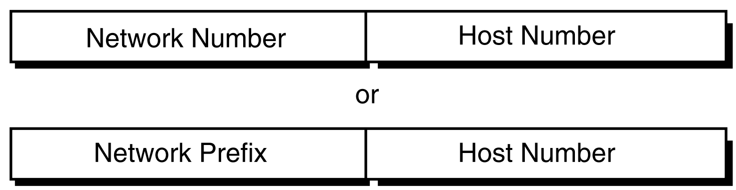
Unfortunately, the routing problem cannot be solved by simply installing more router memory and increasing the size of the routing tables. Other factors related to the capacity problem include the growing demand for CPU horsepower to compute routing table/topology changes, the increasingly dynamic nature of WWW connections and their effect on router forwarding caches, and the sheer volume of information that needs to be managed by people and machines. If the number of entries in the global routing table is allowed to increase without bounds, core routers will be forced to drop routes and portions of the Internet will become unreachable.

The long-term solution to these problems can be found in the widespread deployment of IP Next Generation (IPng or IPv6). Currently, IPv6 is being tested and implemented on the 6Bone network, which is an informal collaborative project covering North America, Europe, and Japan. 6Bone supports the routing of IPv6 packets, since that function has not yet been integrated into many production routers. Until IPv6 can be deployed worldwide, IPv4 patches will need to be used and modified to continue to provide the universal connectivity users have come to expect.

Classful IP Addressing

When IP was first standardized in September 1981, the specification required that each system attached to an IP-based Internet be assigned a unique, 32-bit Internet address value. Systems that have interfaces to more than one network require a unique IP address for each network interface. The first part of an Internet address identifies the network on which the host resides, while the second part identifies the particular host on the given network. This creates the two-level addressing hierarchy that is illustrated in Figure 3.

FIGURE 3. Two-Level Internet Address Structure



In recent years, the network number field has been referred to as the network prefix because the leading portion of each IP address identifies the network number. All hosts on a given network share the same network prefix but must have a unique host number. Similarly, any two hosts on different networks must have different network prefixes but may have the same host number.

Primary Address Classes

To provide the flexibility required to support networks of varying sizes, the Internet designers decided that the IP address space should be divided into three address classes-Class A, Class B, and Class C. This is often referred to as classful addressing. Each class fixes the boundary between the network prefix and the host number at a different point within the 32-bit address. The formats of the fundamental address classes are illustrated in Figure 4.

FIGURE 4. Principle Classful IP Address Formats