# Chapter 1. IPv6 Versus IPv4

IPv6 is sometimes called the Next Generation Internet Protocol, or IPng. Even though the Internet is seen as a relatively new technology, the protocols and technologies that make it work were developed in the 1970s and 1980s. The current Internet and all our corporate and private intranets use IPv4. Now, with IPv6, the first major upgrade of the Internet protocol suite is on the horizon or maybe even closer. Close enough, anyway, to start taking it seriously.

## 1.1 The History of IPv6

The effort to develop a successor protocol to IPv4 was started in the early 1990s by the Internet Engineering Task Force (IETF). Several parallel efforts began simultaneously, all trying to solve the foreseen address space limitation as well as provide additional functionality. The IETF started the IPng area in 1993 to investigate the different proposals and to make recommendations for further procedures.

The IPng area directors of the IETF recommended the creation of IPv6 at the Toronto IETF meeting in 1994. Their recommendation is specified in RFC 1752, "The Recommendation for the IP Next Generation Protocol." The Directors formed an Address Lifetime Expectation (ALE) working group, whose job was to determine whether the expected lifetime for IPv4 would allow the development of a protocol with new functionality or if the remaining time would only allow for developing an address space solution. In 1994, the ALE working group projected the IPv4 address exhaustion to occur sometime between 2005 and 2011, based on the statistics that were available at that time.

For those of you who are interested in the different proposals, here's some more information about it (from RFC 1752). There were four main proposals called CNAT, IP Encaps, Nimrod, and Simple CLNP. Three more proposals followed: the P Internet Protocol (PIP), the Simple Internet Protocol (SIP), and TP/IX. After the March 1992 San Diego IETF meeting, Simple CLNP evolved into TCP and UDP with Bigger Addresses (TUBA) and IP Encaps evolved into IP Address Encapsulation (IPAE). IPAE merged with PIP and SIP and called itself Simple Internet Protocol Plus (SIPP). The TP/IX working group changed its name to Common Architecture for the Internet (CATNIP). The main proposals were now CATNIP, TUBA, and SIPP. For a short discussion of the proposals, refer to RFC 1752.

> CATNIP is specified in RFC 1707, TUBA in RFC 1347, RFC 1526, and RFC 1561, and SIPP in RFC 1710.

The Internet Engineering Steering Group approved the IPv6 recommendation and drafted a Proposed Standard on November 17, 1994. The core set of IPv6 protocols became an IETF Draft Standard on August 10, 1998.

> Why is the new protocol not IPv5? The version number 5 could not be used because it had been allocated to an experimental stream protocol.

## 1.2 Overview of Functionality

IPv6 is one of the most significant network and technology upgrades in history. It will slowly grow into your existing IPv4 infrastructure and positively impact your network. Reading this book will prepare you for the next step of networking technology evolution. IPv6 product development and implementation efforts are already underway all over the world. IPv6 is designed as an evolutionary step from IPv4. It is a natural increment to IPv4, can be installed as a normal software upgrade in most Internet devices, and is interoperable with the current IPv4. IPv6 is designed to run well on high performance networks like Gigabit Ethernet, ATM, and others, as well as low bandwidth networks (e.g., wireless). In addition, it provides a platform for new Internet functionality that will be required in the near future, such as extended addressing, better security, and quality of service (QoS) features.

IPv6 includes transition and interoperability mechanisms that are designed to allow users to adopt and deploy IPv6 step by step as needed and to provide direct interoperability between IPv4 and IPv6 hosts. The transition to a new version of the Internet Protocol (IP) must be incremental, with few or no critical interdependencies, if it is to succeed. The IPv6 transition allows users to upgrade their hosts to IPv6 and network operators to deploy IPv6 in routers with very little coordination between the two groups.

The main changes from IPv4 to IPv6 can be summarized as follows:

*Expanded addressing capability and autoconfiguration mechanisms*

The address size for IPv6 has been increased to 128 bits. This solves the problem of the limited address space of IPv4 and offers a deeper addressing hierarchy and simpler configuration. There will come a day when you will hardly remember how it felt to have only 32 bits in an IP address. Network administrators will love the autoconfiguration mechanisms built into the protocol. Multicast routing has been improved, with the multicast address being extended by a scope field. And a new address type has been introduced, called Anycast address, which can send a message to the nearest single member of a group.

*Simplification of the header format*

The IPv6 header has a fixed length of 40 bytes. This actually accommodates only an 8-byte header plus two 16-byte IP addresses (source and destination address). Some fields of the IPv4 header have been removed or become optional. This way, packets can be handled faster with lower processing costs.

*Improved support for extensions and options*

With IPv4, options were integrated into the basic IPv4 header. With IPv6, they are handled as *Extension headers*. Extension headers are optional and only inserted between the IPv6 header and the payload, if necessary. This way the IPv6 packet can be built very flexible and streamlined. Forwarding IPv6 packets is much more efficient. New options that will be defined in the future can be integrated easily.

*Extensions for authentication and privacy*

Support for authentication, and extensions for data integrity and data confidentiality, have been specified and are inherent.

*Flow labeling capability*

Packets belonging to the same traffic flow, requiring special handling or quality of service, can be labeled by the sender. Real-time service is an example where this would be used.

> For a current list of the standardization status of IPv6, you can refer to http://playground.sun.com/pub/ipng/html/specs/standards.html.