Chapter 4.0 An overview of IPv6

IP version 6 (IPv6) is a new version of the Internet Protocol, designed as a successor to IP version 4 (IPv4). The changes from IPv4 to IPv6 fall primarily into the following categories:

- Expanded Addressing Capabilities
- Header Format Simplification
- Improved Support for Extension and Options
- Flow Labeling Capability
- Authentication and Privacy Capabilities.

4.1 Header format

The new IPv6 header format is completely remodeled from the previous IPv4 header. Some of the old fields from IPv4 are retained but the others are completely removed to accommodate new features. The figure below describes the new features in IPv6 with it new added width, which is 128bit four times IPv4.

← 128-bit →

Version	Priority	Flow Label	
Payload Length		Next Header	Hop Limit
Source IP Address			
Destination IP Address			

Figure 4.1 IPv6 Header Format

4.1.1 IPv6 header description

(i) Version

4-bit Internet Protocol version number 6.

(ii) Priority

4-bit priority value.

(iii) Flow Label

24-bit flow label.

(iv) Payload Length

16-bit unsigned integer. Length of payload, i.e., the rest of the packet following the IPv6 header, in octets. If zero, indicates that the payload length is carried in a Jumbo Payload hop-by-hop option.

(v) Next Header

8-bit selector. Identifies the type of header immediately following the IPv6 header. Uses the same values as the IPv4 Protocol field.

(vi) Hop Limit

8-bit unsigned integer. Decremented by 1 by each node that forwards the packet. The packet is discarded if Hop Limit is decremented to zero.

(vii) Source Address

128-bit address of the originator of the packet.

(viii) Destination Address

128-bit address of the intended recipient of the packet possibly not the ultimate recipient, if a Routing header is present.

IPv6 includes an improved option mechanism over IPv4 [8]. IPv6 options are placed in separate extension headers that are located between the IPv6 header and the transport-layer header in a packet. Most IPv6 extension headers are not examined or processed by any router along a packet's path until it arrives at its final destination, facilitating a major improvement in router performance for packets containing options. The IPv6 can be arbitrarily length, and the total number of options carried in a packet not limited to 40 bytes. A full implementation of IPv6 includes implementation of the following extensions headers:

(i) Hop-by-Hop Options

Special options, which require processing at every node.

(ii) Routing

Extended Routing (like source route).

(iii) Fragmentation

Fragmentation and Reassembly.

(iv) Destination Options

Optional information to be examined by the destination node only.

(v) Authentication

Integrity and Authentication.

(vii) Encapsulating Security Payload

Confidentiality

However the extension header is only used or processed in the host's interface, therefore this extension header does not have to be processed in the routers. This decreases considerable amount of time a frame spends on a router [7].

4.2 Addressing

The huge number of available addresses of IPv6 makes it possible to divide the address space into many large parts. This is achieved using special prefixes to identify the different parts of the address space. There are three types of IPv6 addresses: unicast, anycast, and multicast. It is important to note that IPV6 addresses are assigned to interfaces rather than nodes, since each interface belongs to single node.

The minimum binary prefix is 3 bits and the maximum is 10 bits. This can be seen from the allocation table in *appendix B*. The remaining bits of the half of 128 bits can be assigned to different addressed networks and the other half is used to address the individual interfaces on the network [14]. A graphical representation of the addressing scheme in IPv6 can be seen in figure 4.2 below:

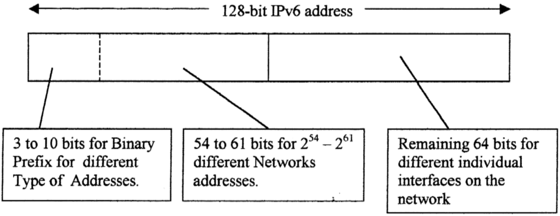

Figure 4.2 IPv6 three main division of its128 address allocation bit

An IPv6 address looks a little different from IPv4 because of the large number of digits it supports. Each address is eight hexadecimal numbers separated with colons. For example, one legal address is 2FFF: 80: 0: 0: 0: 0: 94: 1. For shorthand, you can replace the repeating zeros with two colons (2FFF: 80:: 94: 1). The IPv6 reserved loop back address id :: 1, the first 64 bits of that address is set to zero, the last bit is set to one.

IPv6 addresses are 128-bit identifiers for interfaces and sets of interfaces. The three types of broadcast addresses are:

(i) Unicast

An identifier for a single interface. A packet sent to a unicast address is delivered to the interface identified by that address.

(ii) Anycast

The principle of anycasting is to send a packet to generic address instead of sending it to specific server. This address is recognized by all the servers of a given type, for example printer servers. The routers forward the packet to one of those servers, preferably the nearest one. This could for example be used to find the nearest name server.

(iii) Multicast

Real-time transmissions to a group of receivers are a growing part of the Internet traffic. To make this effective, unicast cannot be used. Multicasting is to be supported by all IPV6 nodes. It is also a vital part of the IPv6 auto configuration processes.

IPv6 addresses of all types are assigned to interfaces, not nodes. An IPv6 unicast address refers to a single interface. Since each interface belongs to a single node, any of that node's interfaces' unicast addresses may be used as an identifier for the node. All interfaces are required to have at least one link-local unicast address [7]. A single interface may also be assigned multiple IPv6 addresses of any type (unicast, anycast, and multicast) [9].

4.3 IPv6 implementations in Linux

The IPv6 implementation in Linux is mainly based on the Berkeley Socket Distribution (BSD).There are a number of IPv6 host implementations. A group of the IPv6 implementations can be found on the IETF's IPNG working group home page. The host implementations support basic properties of IPv6. The host implementations included in this dissertation is the free Unix clone Linux.

4.3.1 Configuring a Linux host for IPv6

4.3.1.1 The Kernel

There are currently three options in the kernel configuration that considers IPV6, which are, CONFIG_IPV6, CONFIG_IP_EU164 and CONFIG_IPV6_NO_PB. The description of each individual configuration is described below:

(i) CONFIG_IPV6

This function basically provides IPV6 transportation mechanisms like TCP, UDP and ICMPV6. All interfaces provided are also auto configured with a link local address.

(ii) CONFIG_IPV6_EUI64

This enables the link local address configuration to use the IEEE EUI 64 standard. This standard regards a 64-bit Global identifier specification. This IEEE standard is the most commonly and accepted standard that is used. This address format has some changes as compared to the above.

(iii) **CONFIG_IPV6_NO_PB**

Setting this option disables the old-style link local auto configured address that used the interface identifier of the network card.

Once the new module for IPv6 has been compiled and installed in the systems kernel, the loop back address (::1) can be tested. The host that has successfully rebooted and executed IPv6 with the configured interfaces, can now receive new link local address.

4.3.1.2 Configuration files

After setting the kernel for the new IPv6 module, there are some configuration files that are supposed to be changed in the Linux configuration directory, which is the */etc* directory. This directory is in the user level and has to be set manually by the user or programmer himself.

The new IPV6 protocol numbers is to be added to *etc/protocols* file of the Linux host:

ipv6	*41*	*IPV6*	*# IPV6*
ipv6-route	*43*	*IPV6-Route*	*# Routing Header for IPV6*
ipv6-frag	*44*	*IPV6-Frag*	*# Fragment Header for IPV6*
ipv6-crypt	*50*	*IPV6-Crypt*	*# Encryption Header for IPV6*
ipv6-auth	*51*	*IPV6-Auth*	*# Authentication Header for IPV6*
icmpv6	*58*	*IPV6-ICMP*	*# ICMP for IPV6*
ipv6-nonxt	*59*	*IPV6-NoNxt*	*# No Next Header for IPV6*
ipv6-opts	*60*	*IPV6-Opts*	*# Destination Options for IPV6*

Some fundamental IPV6 addresses in */etc/hosts* file:

::1	*ipv6-localhost*	*ipv6-loop back*
fe00::0	*ipv6-localnet*	
ff00::0	*ipv6-mcastprefix*	
ff02::1	*ipv6-allnodes*	
ff02::2	*ipv6-allrouters*	
ff02::3	*ipv6-allhosts*	

In addition to this, some scripts must be executed during configuration of the network adapters to setup the global address of the default gateway. If the host is connected to an IPv6 router this is not necessary [14]. These parameters will be configured automatically. It is possible to set more than one IPv6 address on each interface.