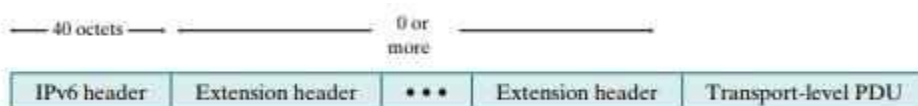# IPv6

Internet Protocol version 6 (IPV 6) is the replacement for version 4 (IPV 4). The phenomenal development of the Internet has begun to push IP to its limits. It provides a large address space, and it contains a simple header as compared to IPv4.

IPv6 includes the following enhancements over IPv4:

- Expanded address space: IPv6 uses 128-bit addresses instead of the 32-bit addresses of IPv4. This is an increase of address space by a factor of 296. It has been pointed out [HIND95] that this allows on the order of 6 * 1023 unique addresses per square meter of the surface of the Earth. Even if addresses are very inefficiently allocated, this address space seems inexhaustible.
- Improved option mechanism: IPv6 options are placed in separate optional headers that are located between the IPv6 header and the transport-layer header. Most of these optional headers are not examined or processed by any router on the packet's path. This simplifies and speeds up router processing of IPv6 packets compared to IPv4 datagrams. It also makes it easier to add additional options.
- Address autoconfiguration: This capability provides for dynamic assignment of IPv6 addresses.
- Increased addressing flexibility: IPv6 includes the concept of an anycast address, for which a packet is delivered to just one of a set of nodes. The scalability of multicast routing is improved by adding a scope field to multicast addresses.
- Support for resource allocation: IPv6 enables the labeling of packets belonging to a particular traffic flow for which the sender requests special handling. This aids in the support of specialized traffic such as real-time video.

IPv6 Structure
An IPv6 protocol data unit (known as a packet) has the following general form:

The only header that is required is referred to simply as the IPv6 header. This is of fixed size with a length of 40 octets, compared to 20 octets for the mandatory portion of the IPv4 header. The following extension headers have been defined:
- Hop-by-Hop Options header: Defines special options that require hop-by-hop processing
- Routing header: Provides extended routing, similar to IPv4 source routing
- Fragment header: Contains fragmentation and reassembly information
- Authentication header: Provides packet integrity and authentication
- Encapsulating Security Payload header: Provides privacy
- Destination Options header: Contains optional information to be examined by the destination node

The IPv6 standard recommends that when multiple extension headers are
used, the IPv6 headers appear in the following order:

1. IPv6 header: Mandatory, must always appear first
2. Hop-by-Hop Options header
3. Destination Options header: For options to be processed by the first destination that appears in the IPv6 Destination Address field plus subsequent destinations listed in the Routing header
4. Routing header
5. Fragment header
6. Authentication header
7. Encapsulating Security Payload header
8. Destination Options header: For options to be processed only by the final destination of the packet

IPv6 Header
The IPv6 header has a fixed length of 40 octets, consisting of the following fields
- Version (4 bits): Internet protocol version number; the value is 6.
- DS/ECN (8 bits): Available for use by originating nodes and/or forwarding routers for differentiated services and congestion functions, as described for the IPv4 DS/ECN field. This 8-bit field was originally referred to as the Traffic Class field, but the 6-bit DS and 2-bit ECN designation is now used.
- Flow Label (20 bits): May be used by a host to label those packets for which it is requesting special handling by routers within a network, discussed subsequently.
- Payload Length (16 bits): Length of the remainder of the IPv6 packet following the header, in octets. In other words, this is the total length of all of the extension headers plus the transport-level PDU.
- Next Header (8 bits): Identifies the type of header immediately following the IPv6 header; this will either be an IPv6 extension header or a higher-layer header, such as TCP or UDP.
- Hop Limit (8 bits): The remaining number of allowable hops for this packet. The hop limit is set to some desired maximum value by the source and decremented by 1 by each node that forwards the packet. The packet is discarded if Hop Limit is decremented to zero. This is a simplification over the processing required for the Time to Live field of IPv4. The consensus was that the extra effort in accounting for time intervals in IPv4 added no significant value to the protocol. In fact, IPv4 routers, as a general rule, treat the Time to Live field as a hop limit field.
- Source Address (128 bits): The address of the originator of the packet.
- Destination Address (128 bits): The address of the intended recipient of the packet. This may not in fact be the intended ultimate destination if a Routing header is present, as explained subsequently.