What is IPv4?

IPv4 is a version 4 of IP. It is a current version and the most commonly used IP address. It is a 32-bit address written in four numbers separated by 'dot', i.e., periods. This address is unique for each device.

For example, **66.94.29.13**

The above example represents the IP address in which each group of numbers separated by periods is called an Octet. Each number in an octet is in the range from 0-255. This address can produce 4,294,967,296 possible unique addresses.

In today's computer network world, computers do not understand the IP addresses in the standard numeric format as the computers understand the numbers in binary form only. The binary number can be either 1 or 0. The IPv4 consists of four sets, and these sets represent the octet. The bits in each octet represent a number.

Each bit in an octet can be either 1 or 0. If the bit the 1, then the number it represents will count, and if the bit is 0, then the number it represents does not count.

Drawback of IPv4

Currently, the population of the world is 7.6 billion. Every user is having more than one device connected with the internet, and private companies also rely on the internet. As we know that IPv4 produces 4 billion addresses, which are not enough for each device connected to the internet on a planet. Although the various techniques were invented, such as variable- length mask, network address translation, port address translation, classes, inter-domain translation, to conserve the bandwidth of IP address and slow down the depletion of an IP address. In these techniques, public IP is converted into a private IP due to which the user having public IP can also use the internet. But still, this was not so efficient, so it gave rise to the development of the next generation of IP addresses, i.e., IPv6.

What is IPv6?

IPv4 produces 4 billion addresses, and the developers think that these addresses are enough, but they were wrong. IPv6 is the next generation of IP addresses. The main difference between IPv4 and IPv6 is the address size of IP addresses. The IPv4 is a 32-bit address, whereas IPv6 is a 128-bit hexadecimal address. IPv6 provides a large address space, and it contains a simple header as compared to IPv4.

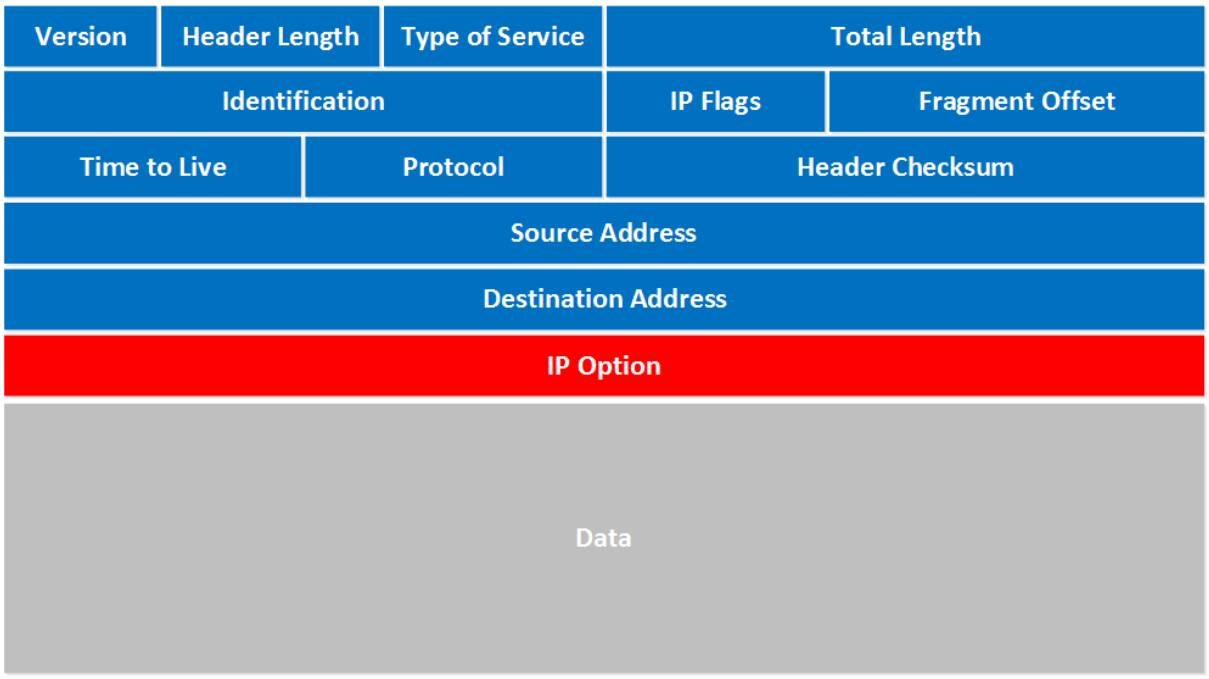
It provides transition strategies that convert IPv4 into IPv6, and these strategies are as follows:

- **Dual stacking:** It allows us to have both the versions, i.e., IPv4 and IPv6, on the same device.
- **Tunneling:** In this approach, all the users have IPv6 communicates with an IPv4 network to reach IPv6.
- **Network Address Translation:** The translation allows the communication between the hosts having a different version of IP.

This hexadecimal address contains both numbers and alphabets. Due to the usage of both the numbers and alphabets, IPv6 is capable of producing over 340 undecillion ($3.4*10^{38}$) addresses.

IPv6 is a 128-bit hexadecimal address made up of 8 sets of 16 bits each, and these 8 sets are separated by a colon. In IPv6, each hexadecimal character represents 4 bits. So, we need to convert 4 bits to a hexadecimal number at a time

IPv4 Packet Header



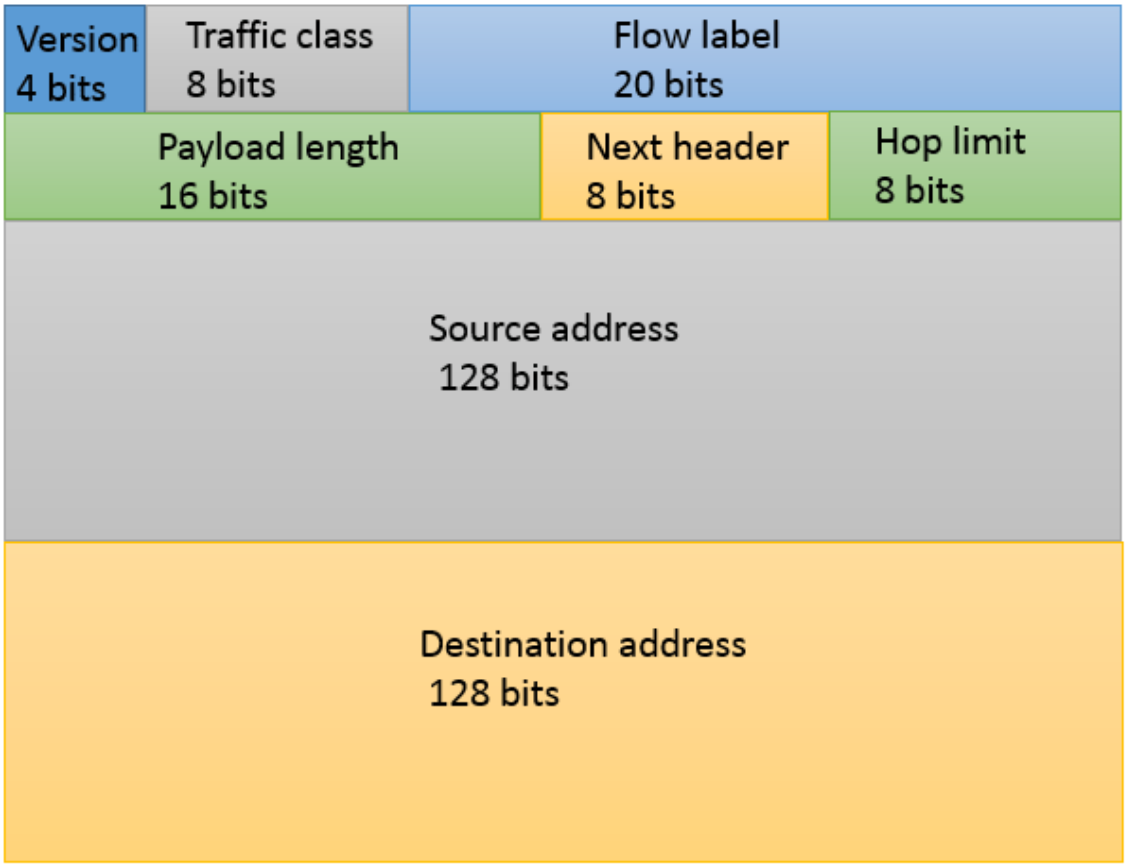
Following are various components/fields of IP packet header

- **Version:** The first IP header field is a 4-bit version indicator. In IPv4, the value of its four bits is set to 0100, which indicates 4 in binary. However, if the router does not support the specified version, this packet will be dropped.
- **Internet Header Length:** Internet header length, shortly known as IHL, is 4 bits in size. It is also called HELEN (Header Length). This IP component is used to show how many 32-bit words are present in the header.
- **Type of Service:** Type of Service is also called Differentiated Services Code Point or DSCP. This field is provided features related to the quality of service for data streaming or VoIP calls. The first 3 bits are the priority bits. It is also used for specifying how you can handle Datagram.
- **Total length:** The total length is measured in bytes. The minimum size of an IP datagram is 20 bytes and the maximum, it can be 65535 bytes . HELEN and Total length can be used to calculate the dimension of the payload. All hosts are required to be able to read 576-byte datagrams. However, if a datagram is too large for the hosts in the network, the fragmentation method is widely used.
- **Identification:** Identification is a packet that is used to identify fragments of an IP datagram uniquely. Some have recommended using this field for other things like adding information for packet tracing, etc.
- **IP Flags:** Flag is a three-bit field that helps you to control and identify fragments. The following can be their possible configuration:
  Bit 0: is reserved and has to be set to zero
  Bit 1: means do not fragment and indicates that this packet should not be fragmented.
  Bit 2: means more fragments and is set on all fragmented packets except the last one.
- **Fragment Offset:** Fragment Offset represents the number of Data Bytes ahead of the particular fragment in the specific Datagram. It is specified in terms of the number of 8 bytes, which has a maximum value of 65,528 bytes.
- **Time to live:** It is an 8-bit field that indicates the maximum time the Datagram will be live in the internet system. The time duration is measured in seconds, and when the value of TTL is zero, the Datagram will be erased. Every time a datagram is processed its TTL value is decreased by one second. TTL are used so that datagrams are not delivered and discarded automatically. The value of TTL can be 0 to 255.
- **Protocol:** This IPv4 header is reserved to denote that internet protocol is used in the latter portion of the Datagram. For Example, 6 number digit is mostly used to indicate TCP, and 17 is used to denote the UDP protocol.
- **Header Checksum:** The next component is a 16 bits header checksum field, which is used to check the header for any errors. The IP header is compared to

the value of its checksum. When the header checksum is not matching, then the packet will be discarded.

- **Source Address:** The source address is a 32-bit address of the source used for the IPv4 packet.
- **Destination address:** The destination address is also 32 bit in size stores the address of the receiver.
- **IP Options:** It is an optional field of IPv4 header used when the value of IHL (Internet Header Length) is set to greater than 5. It contains values and settings related with security, record route and time stamp, etc. You can see that list of options component ends with an End of Options or EOL in most cases.
- **Data:** This field stores the data from the protocol layer, which has handed over the data to the IP layer.

IPv6 Packet Format



Version (4 bits): The constant 6 (bit sequence 0110).

Traffic Class (8 bits): The bits of this field hold two values. The 6 most-significant bits are used for DSCP, which is used to classify packets. The remaining two bits are used

for ECN; priority values subdivide into ranges: traffic where the source provides congestion control and non-congestion control traffic.

Flow Label (20 bits): Originally created for giving real-time applications special service. Flow Label specifications and minimum requirements are described, and first uses of this field are emerging.

Payload Length (16 bits): The size of the payload in octets, including any extension headers. The length is set to zero when a Hop-by-Hop extension header carries a Jumbo Payload option.

Next Header (8 bits): Specifies the type of the next header. This field usually specifies the transport layer protocol used by a packet's payload. When extension headers are present in the packet this field indicates which extension header follows. The values are shared with those used for the IPv4 protocol field, as both fields have the same function

Hop Limit (8 bits): Replaces the time to live field of IPv4. This value is decremented by one at each intermediate node visited by the packet. When the counter reaches 0 the packet is discarded.

Source Address (128 bits): The IPv6 address of the sending node.

Destination Address (128 bits): The IPv6 address of the destination node(s).

IPv4 vs IPv6

	Ipv4	**Ipv6**
Address length	IPv4 is a 32-bit address.	IPv6 is a 128-bit address.
Fields	IPv4 is a numeric address that consists of 4 fields which are separated by dot (.).	IPv6 is an alphanumeric address that consists of 8 fields, which are separated by colon.
Classes	IPv4 has 5 different classes of IP address that includes Class A,	IPv6 does not contain classes of IP addresses.

	Class B, Class C, Class D, and Class E.	
Number of IP address	IPv4 has a limited number of IP addresses.	IPv6 has a large number of IP addresses.
VLSM	It supports VLSM (Virtual Length Subnet Mask). Here, VLSM means that Ipv4 converts IP addresses into a subnet of different sizes.	It does not support VLSM.
Address configuration	It supports manual and DHCP configuration.	It supports manual, DHCP, auto-configuration, and renumbering.
Address space	It generates 4 billion unique addresses	It generates 340 undecillion unique addresses.
End-to-end connection integrity	In IPv4, end-to-end connection integrity is unachievable.	In the case of IPv6, end-to-end connection integrity is achievable.
Security features	In IPv4, security depends on the application. This IP address is not developed in keeping the security feature in mind.	In IPv6, IPSEC is developed for security purposes.

Address representation	In IPv4, the IP address is represented in decimal.	In IPv6, the representation of the IP address in hexadecimal.
Fragmentation	Fragmentation is done by the senders and the forwarding routers.	Fragmentation is done by the senders only.
Packet flow identification	It does not provide any mechanism for packet flow identification.	It uses flow label field in the header for the packet flow identification.
Checksum field	The checksum field is available in IPv4.	The checksum field is not available in IPv6.
Transmission scheme	IPv4 is broadcasting.	On the other hand, IPv6 is multicasting, which provides efficient network operations.
Encryption and Authentication	It does not provide encryption and authentication.	It provides encryption and authentication.
Number of octets	It consists of 4 octets.	It consists of 8 fields, and each field contains 2 octets. Therefore, the total number of octets in IPv6 is 16.