PARSHWANATH CHARITABLE TRUST'S

A.P. SHAH INSTITUTE OF TECHNOLOGY

Department of Computer Science and Engineering

Data Science

CSE DATA SCIENCE

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IPV6

IP address is your digital identity. It's a network address for your computer so the Internet knows where to send you emails, data, etc.

IPv6 or Internet Protocol Version 6 is a network layer protocol that allows communication to take place over the network. IPv6 was designed by Internet Engineering Task Force (IETF) in December 1998 with the purpose of superseding the IPv4 due to the global exponentially growing internet users.

IPv4 vs IPv6

The common type of IP address (is known as IPv4, for "version 4"). Here's an example of what an IP address might look like:

25.59.209.224

An IPv4 address consists of four numbers, each of which contains one to three digits, with a single dot (.) separating each number or set of digits. Each of the four numbers can range from 0 to 255. This group of separated numbers creates the addresses that let you and everyone around the globe to send and retrieve data over our Internet connections. The IPv4 uses a 32-bit address scheme allowing to store 2^32 addresses which is more than 4 billion addresses. To date, it is considered the primary Internet Protocol and carries 94% of Internet traffic. Initially, it was assumed it would never run out of addresses but the present situation paves a new way to IPv6, let's see why? An IPv6 address consists of eight groups of four hexadecimal digits. Here's an example IPv6 address:

3001:0da8:75a3:0000:0000:8a2e:0370:7334

This new IP address version is being deployed to fulfil the need for more Internet addresses. It was aimed to resolve issues which are associated with IPv4. With 128-bit address space, it allows 340 undecillion unique address space. IPv6 also called IPng (Internet Protocol next generation).

IPv6 support a theoretical maximum of 340, 282, 366, 920, 938, 463, 463, 374, 607, 431, 768, 211, 456. To keep it straightforward, we will never run out of IP addresses again.

Types of IPv6 Address

Now that we know about what is IPv6 address let's take a look at its different types.

- **Unicast addresses** It identifies a unique node on a network and usually refers to a single sender or a single receiver.
- **Multicast addresses** It represents a group of IP devices and can only be used as the destination of a datagram.
- **Anycast addresses** It is assigned to a set of interfaces that typically belong to different nodes.

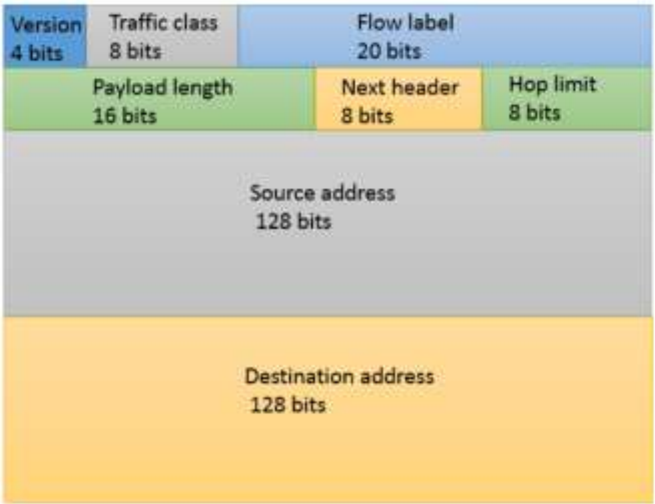
Advantages of IPv6

- Reliability
- **Faster Speeds:** IPv6 supports multicast rather than broadcast in IPv4.This feature allows bandwidth-intensive packet flows (like multimedia streams) to be sent to multiple destinations all at once.
- **Stronger Security:** IPSecurity, which provides confidentiality, and data integrity, is embedded into IPv6.
- Routing efficiency
- Most importantly it's the final solution for growing nodes in Global-network.

Disadvantages of IPv6

- **Conversion:** Due to widespread present usage of IPv4 it will take a long period to completely shift to IPv6.
- **Communication:** IPv4 and IPv6 machines cannot communicate directly with each other. They need an intermediate technology to make that possible.

IPv6 header

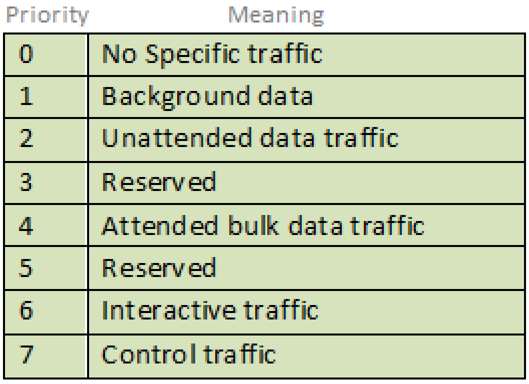


Version 4 bits | Traffic class 8 bits | Flow label 20 bits
Payload length 16 bits | Next header 8 bits | Hop limit 8 bits
Source address 128 bits
Destination address 128 bits

Version (4-bits): Indicates version of Internet Protocol which contains bit sequence 0110.

Traffic Class (8-bits): The Traffic Class field indicates class or priority of IPv6 packet which is similar to *Service Field* in IPv4 packet. It helps routers to handle the traffic based on the priority of the packet. If congestion occurs on the router then packets with the least priority will be discarded.

As of now, only 4-bits are being used (and the remaining bits are under research), in which 0 to 7 are assigned to Congestion controlled traffic and 8 to 15 are assigned to Uncontrolled traffic.
Priority assignment of Congestion controlled traffic:



Priority	Meaning
0	No Specific traffic
1	Background data
2	Unattended data traffic
3	Reserved
4	Attended bulk data traffic
5	Reserved
6	Interactive traffic
7	Control traffic

Uncontrolled data traffic is mainly used for Audio/Video data. So we give higher priority to Uncontrolled data traffic.

The source node is allowed to set the priorities but on the way, routers can change it. Therefore, the destination should not expect the same priority which was set by the source node.

Flow Label (20-bits): Flow Label field is used by a source to label the packets belonging to the same flow in order to request special handling by intermediate IPv6 routers, such as non-default quality of service or real-time service. In order to distinguish the flow, an intermediate router can use the source address, a destination address, and flow label of the packets. Between a source and destination, multiple flows may exist because many processes might be running at the same time. Routers or Host that does not support the functionality of flow label field and for default router handling, flow label field is set to 0. While setting up the flow label, the source is also supposed to specify the lifetime of the flow.

Payload Length (16-bits): It is a 16-bit (unsigned integer) field, indicates the total size of the payload which tells routers about the amount of information a particular packet contains in its payload. The payload Length field includes extension headers(if any) and an upper-layer packet. In case the length of the payload is greater than 65,535 bytes (payload up to 65,535 bytes can be indicated with 16-bits), then the payload length field will be set to 0 and the jumbo payload option is used in the Hop-by-Hop options extension header.

Next Header (8-bits): Next Header indicates the type of extension header(if present) immediately following the IPv6 header. Whereas In some cases it indicates the protocols contained within upper-layer packets, such as TCP, UDP.

Hop Limit (8-bits): Hop Limit field is the same as TTL in IPv4 packets. It indicates the maximum number of intermediate nodes IPv6 packet is allowed to travel. Its value gets decremented by one, by each node that forwards the packet and the packet is discarded if the value decrements to 0. This is used to discard the packets that are stuck in an infinite loop because of some routing error.

Source Address (128-bits): Source Address is the 128-bit IPv6 address of the original source of the packet.

Destination Address (128-bits): The destination Address field indicates the IPv6 address of the final destination(in most cases). All the intermediate nodes can use this information in order to correctly route the packet.

Extension Headers: In order to rectify the limitations of the *IPv4 Option Field*, Extension Headers are introduced in IP version 6. The extension header mechanism is a very important part of the IPv6 architecture. The next Header field of IPv6 fixed header points to the first Extension Header and this first extension header points to the second extension header and so on.

1. Any extension header can appear at most once except Destination Header because Destination Header is present two times in the above list itself.
2. If Destination Header is present before Routing Header then it will be examined by all intermediate nodes specified in the routing header.
3. If Destination Header is present just above the Upper layer then it will be examined only by the Destination node.