IP Addressing (contd.)

IPv6

- IPv6 was developed by the Internet Engineering Task Force (IETF) to deal with the long anticipated problem of IPv4 address exhaustion
- IPv6 is the successor of IPv4, designed to enable high-performance, scalable Internet.
- **Advantages of IPv6:**
  - Larger address space
    - It has 128-bit address space, that is 4 times wider than IPv4's 32-bit address space.
  - More security

    It includes encryption of packets (ESP: Encapsulated Security Payload) and authentication of the sender of packets (AH: Authentication Header)
  - Support to Resource allocation

    To implement better support for real-time traffic (such as video conferencing), IPv6 includes flow label in specification. With flow label mechanism, routers can recognize to which end-to-end flow the packet belongs.
  - Plug & Play

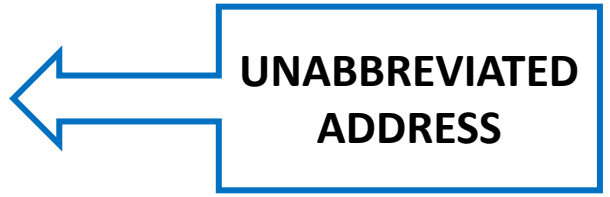
    Makes it easier for novice users to connect their machines to the network, it will be done automatically.
  - More efficient routing

IPv6 Addresses

- An IPv6 address is represented as eight groups of four hexadecimal digits, each group representing 16 bits (two octets). The groups are separated by colons (:). Such a notation is called **Hexadecimal Colon Notation**.

- IP v6 is 128-bits address having an address space of 2^{128}, which is way bigger than IPv4.

- **E.g.** AC81 : 9840 : **00**86 : 3210 : **000**A : BBFF : **0000** : FFFF



AC81 : 9840 : 86 :3210 : A : BBFF : 0 : FFFF

E.g. AC81 : 0 : 0 : 0 : 0 : BBFF : 0 : FFFF

AC81 :: BBFF : 0 : FFFF

❑**NOTE:**

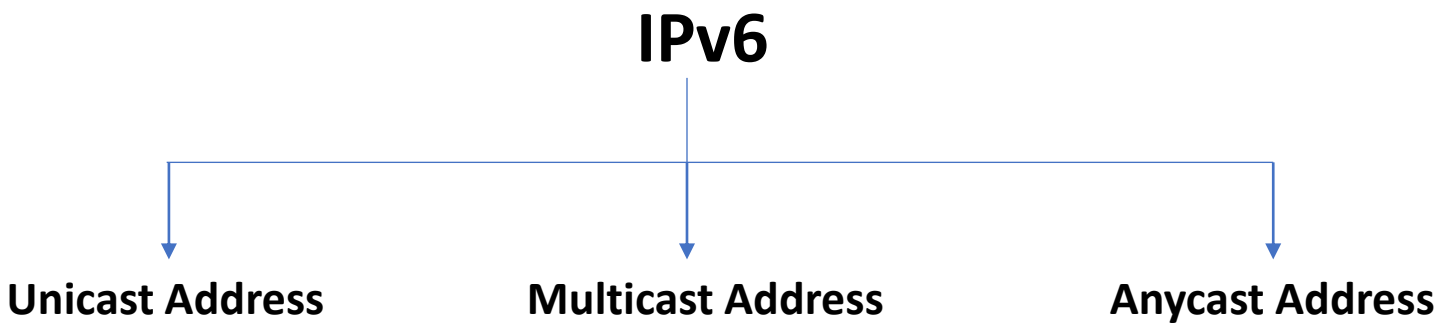
- Abbreviation is allowed only once per address.
- If there are two runs of zero sections, then only one of them can be abbreviated.

- **E.g.** AC81 : 0 : 0 : BBFF : 0 : 0 : 211A : FFFF

AC81 :: BBFF : 0 : 0 : 211A : FFFF

OR

AC81 : 0 : 0 : BBFF :: 211A : FFFF



Unicast address:

Unicast Address defines a single computer or a single network interface. A packet sent to unicast address is delivered to that specific computer or interface identified by that address.

Multicast address:

Multicast Address is used by multiple hosts, called as Group, acquires a multicast destination address. If any packet is sent to this multicast address, it will be distributed to all interfaces corresponding to that multicast address.

No broadcast address is used in IPv6 because it's functions can be implemented using multicast address.

All multicast address begin with **FF(1111 1111).**

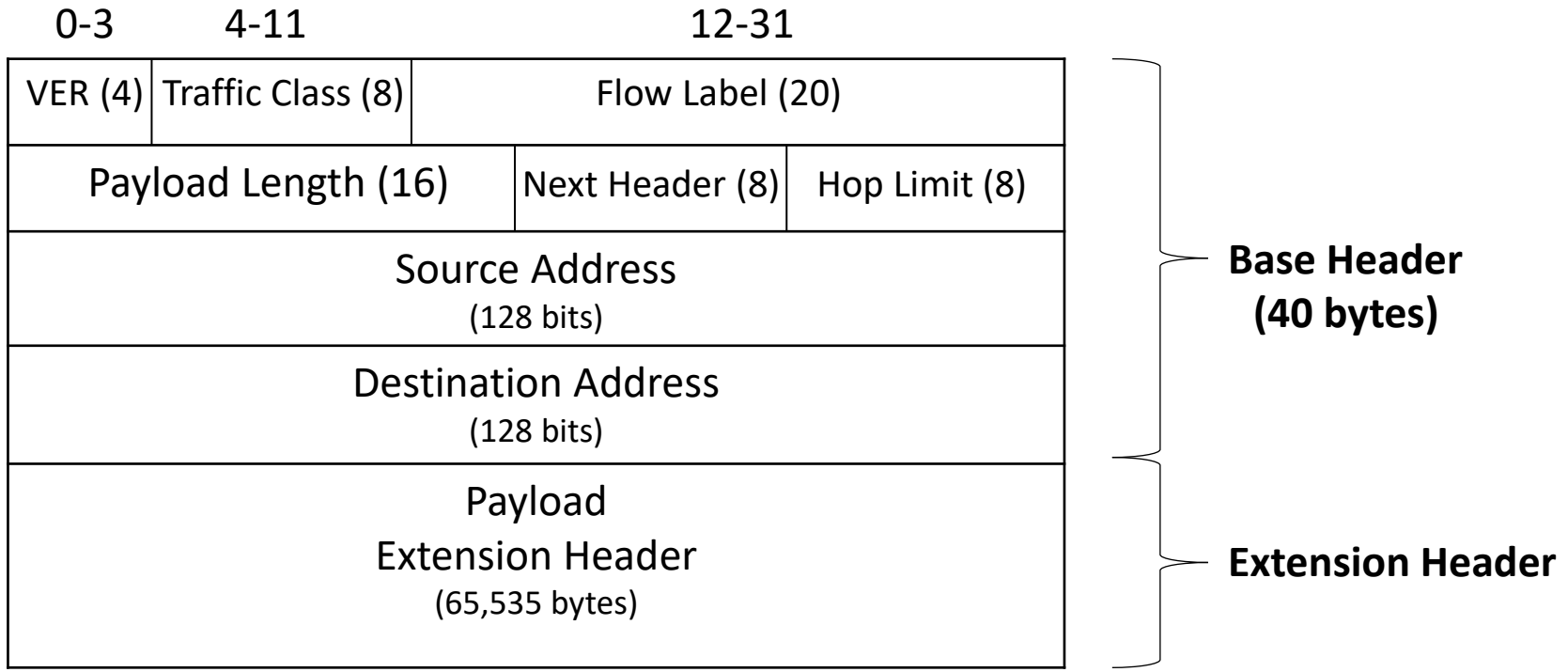
Anycast address:

Anycast Address is assigned to a group of interfaces. Any packet sent to anycast address will be delivered to only one member interface (mostly nearest host possible).

Restriction: it is not used as source address in IPv6 and it may not be assigned to hosts, but only to routers.

IPv6 Header

- IPv6 headers have one Fixed Header and zero or more Optional (Extension) Headers. All the necessary information that is essential for a router is kept in the Fixed Header. The Extension Header contains optional information that helps routers to understand how to handle a packet/flow.



- **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 priority of the packet. If congestion occurs on router then packets with least priority will be discarded. These 8 bits are divided into two parts. The most significant 6 bits are used for Type of Service to let the Router know what services should be provided to this packet. The least significant 2 bits are used for Explicit Congestion Notification (ECN).
- **Flow Label (20-bits) :** This label is used to maintain the sequential flow of the packets belonging to a communication. The source labels the sequence to help the router identify that a particular packet belongs to a specific flow of information. This field helps avoid re-ordering of data packets. It is designed for streaming/real-time media.

- **Payload Length (16-bits) :** This field is used to tell the routers how much information a particular packet contains in its payload. Payload is composed of Extension Headers and Upper Layer data. With 16 bits, up to 65535 bytes can be indicated; but if the Extension Headers contain Hop-by-Hop Extension Header, then the payload may exceed 65535 bytes and this field is set to 0.

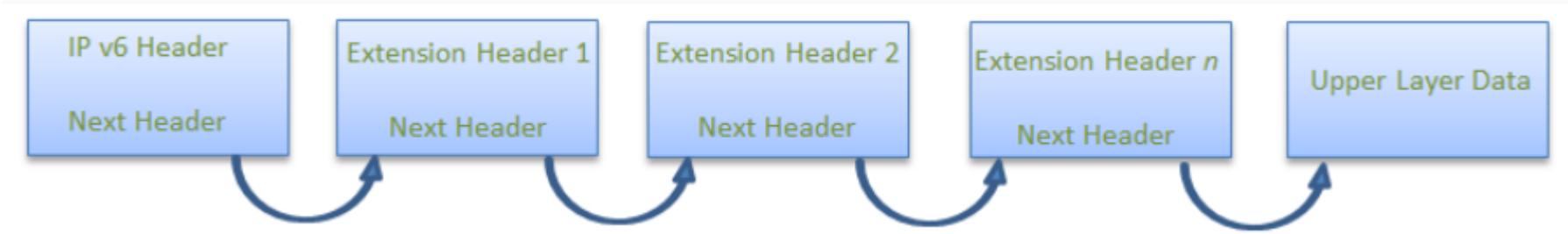
- **Next Header (8-bits) :** This field is used to indicate either the type of Extension Header, or if the Extension Header is not present then it indicates the Upper Layer PDU. The values for the type of Upper Layer PDU are same as IPv4's.

- **Hop Limit (8-bits) :** This field is used to stop packet to loop in the network infinitely. This is same as TTL in IPv4. The value of Hop Limit field is decremented by 1 as it passes a link (router/hop). When the field reaches 0 the packet is discarded.

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

- **Destination Address (128-bits) :** Destination Address field indicates the IPv6 address of the final destination.

- **Extension Headers:** In IPv6, the Fixed Header contains only that much information which is necessary, avoiding those information which is either not required or is rarely used. All such information is put between the Fixed Header and the Upper layer header in the form of Extension Headers. Each Extension Header is identified by a distinct value.
- When Extension Headers are used, IPv6 Fixed Header's Next Header field points to the first Extension Header. If there is one more Extension Header, then the first Extension Header's 'Next-Header' field points to the second one, and so on. The last Extension Header's 'Next-Header' field points to the Upper Layer Header. Thus, all the headers points to the next one in a linked list manner.



The following Extension Headers must be supported as per RFC 2460:

Extension Header	Next Header Value	Description
Hop-by-Hop Options header	0	read by all devices in transit network
Routing header	43	contains methods to support making routing decision
Fragment header	44	contains parameters of datagram fragmentation
Destination Options header	60	read by destination devices
Authentication header	51	information regarding authenticity
Encapsulating Security Payload header	50	encryption information

The sequence of Extension Headers should be:

IPv6 header
Hop-by-Hop Options header
Destination Options header[1]
Routing header
Fragment header
Authentication header
Encapsulating Security Payload header
Destination Options header[2]
Upper-layer header

These headers:

- 1. should be processed by First and subsequent destinations.
- 2. should be processed by Final Destination.