Planning for Information Network

Lecture 8 and 9:

Introduction to IPv6

IPv6 Features

The ability to scale networks for future demands requires a limitless supply of IP addresses; IPv6 combines expanded addressing with a more efficient and feature-rich header to meet these demands. IPv6 satisfies the increasingly complex requirements of hierarchical addressing that IPv4 does not support.

IPv6 Features

**The main benefits of IPv6 include the following:

■ **Larger address space:** IPv6 addresses are 128 bits, compared to IPv4's 32 bits. This larger addressing space allows more support for addressing hierarchy levels, a much greater number of addressable nodes, and simpler auto configuration of addresses.

■ **Globally unique IP addresses:** Every node can have a unique global IPv6 address, which eliminates the need for NAT.

■ **Header format efficiency:** A simplified header with a fixed header size makes processing more efficient.

IPv6 Features

■ **Improved privacy and security:** IPsec is the IETF standard for IP network security, available for both IPv4 and IPv6. Although the functions are essentially identical in both environments, IPsec is mandatory in IPv6. IPv6 also has optional security headers.

■ **Flow labeling capability:** A new capability enables the labeling of packets belonging to particular traffic flows for which the sender requests special handling, such as nondefault quality of service (QoS) or real-time service.

■ **Increased mobility and multicast capabilities:** Mobile IPv6 allows an IPv6 node to change its location on an IPv6 network and still maintain its existing connections. With Mobile IPv6, the mobile node is always reachable through one permanent address. A connection is established with a specific permanent address assigned to the mobile node, and the node remains connected no matter how many times it changes locations and addresses.

IPv6 Address Format

Rather than using dotted-decimal format, IPv6 addresses are written as hexadecimal numbers with colons between each set of four hexadecimal digits (which is 16 bits); we like to call this the “coloned hex” format. The format is x:x:x:x:x:x:x:x, where x is a 16-bit hexadecimal field. A sample address is as follows:

2035:0001:2BC5:0000:0000:087C:0000:000A

IPv6 Address Format

Note:

We can shorten the written form of IPv6 addresses. Leading 0s within each set of four hexadecimal digits can be omitted, and a pair of colons (::) can be used, once within an address, to represent any number of successive 0s.

For example, the previous address can be shortened to the following:

2035:1:2BC5::87C:0:A

An all-0s address can be written as :: .

IPv6 Address Format

Note:

A pair of colons (::) can be used only once within an IPv6 address. This is because an address parser identifies the number of missing 0s by separating the two parts and entering 0 until the 128 bits are complete. If two :: notations were to be placed in the address, there would be no way to identify the size of each block of 0s.

IPv6 Address Format

Example:

3FFE:0501:0008:0000:0260:97FF:FE40:EFAB

= 3FFE:501:8:0:260:97FF:FE40:EFAB

= 3FFE:501:8::260:97FF:FE40:EFAB

IPv6 Addressing in an Enterprise Network

An IPv6 address consists of two parts:

- **A subnet prefix** representing the network to which the interface is connected. Usually 64-bits in length.

- **An interface ID**, sometimes called a local identifier or a token. Usually 64-bits in length.

Subnet Prefix

IPv6 uses the "/prefix-length" to denote how many bits in the IPv6 address represent the subnet.

The syntax is **ipv6-address/prefix-length**

- ipv6-address is the 128-bit IPv6 address.
- /prefix-length is a decimal value representing how many of the left most contiguous bits of the address comprise the prefix.

For example:

fec0:0:0:1::1234/64

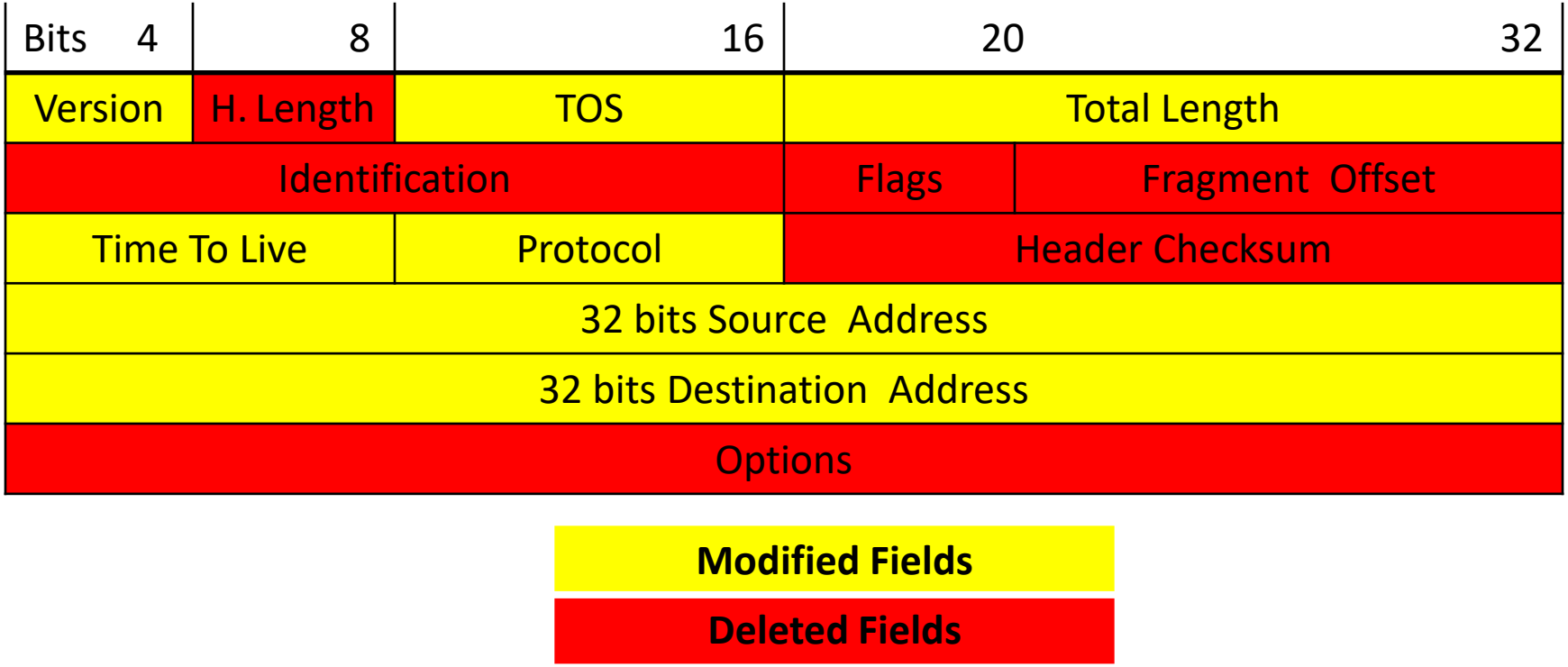
is really

fec0:0000:0000:0001:**0000:0000:0000:1234**/64

- The first 64-bits (**fec0:0000:0000:0001**) forms the address prefix.
- The last 64-bits (**0000:0000:0000:1234**) forms the Interface ID.

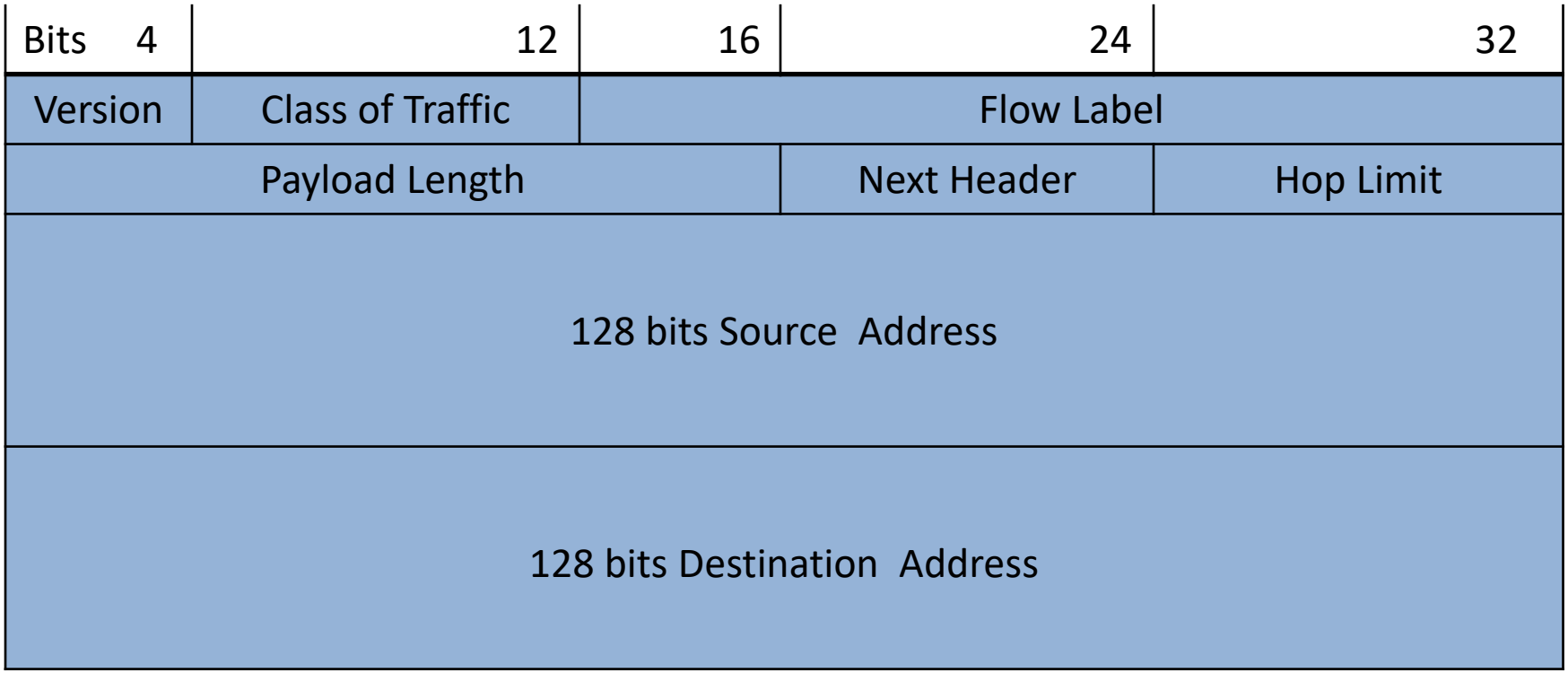
IPv4 Packet Header

20 Bytes + Options



IPv6 Packet Header

From 12 to 8 fields (40 Bytes)



IPv6 Packet Header

The IPv6 header has 40 octets, in contrast to the 20 octets in the IPv4 header. IPv6 has fewer fields, and the header is 64-bit-aligned to enable fast, efficient, hardware-based processing. The IPv6 address fields are four times larger than in IPv4.

The IPv4 header contains 12 basic header fields, followed by an options field and a data portion (which usually includes a transport layer segment). The basic IPv4 header has a fixed size of 20 octets; the variable-length options field increases the size of the total IPv4 header. IPv6 contains fields similar to 7 of the 12 IPv4 basic header fields (5 plus the source and destination address fields) but does not require the other fields.

IPv6 Packet Header

The IPv6 header contains the following fields:

- **Version:** A 4-bit field, the same as in IPv4. For IPv6, this field contains the number 6; for IPv4, this field contains the number 4.
- **Traffic class:** An 8-bit field similar to the type of service (ToS) field in IPv4. This field tags the packet with a traffic class that it uses in differentiated services (DiffServ) QoS. These functions are the same for IPv6 and IPv4.
- **Flow label:** This 20-bit field is new in IPv6. It can be used by the source of the packet to tag the packet as being part of a specific flow, allowing multilayer switches and routers to handle traffic on a per-flow basis rather than per-packet, for faster packet-switching performance. This field can also be used to provide QoS.
- **Payload length:** This 16-bit field is similar to the IPv4 total length field.

IPv6 Packet Header

- **Next header:** The value of this 8-bit field determines the type of information that follows the basic IPv6 header. It can be transport-layer information, such as Transmission Control Protocol (TCP) or User Datagram Protocol (UDP), or it can be an extension header. The next header field is similar to the protocol field of IPv4.
- **Hop limit:** This 8-bit field specifies the maximum number of hops that an IPv6 packet can traverse. Similar to the time to live (TTL) field in IPv4, each router decreases this field by 1. Because there is no checksum in the IPv6 header, an IPv6 router can decrease the field without re-computing the checksum; in IPv4 routers, the re-computation costs processing time. If this field ever reaches 0, a message is sent back to the source of the packet, and the packet is discarded.
- **Source address:** This field has 16 octets (128 bits). It identifies the source of the packet.
- **Destination address:** This field has 16 octets (128 bits). It identifies the destination of the packet.

Thank you