Asst. Lect. Noor Razaq Obaid

COLLEGE OF INFORMATION TECHNOLOGY
DEPARTMENT OF INFORMATION SECURITY

Lecture 4

Internet Protocol version 6
(IPv6)

OBJECTIVES:

- To give the format of an IPv6 datagram composed of a base header and a payload.
- To discuss different fields used in an IPv6 datagram based header and compare them with the fields in IPv4 datagram..
- To discuss three strategies used to handle the transition from IPv4 to IPv6: dual stack, tunneling, and header translation.

Lecture Outline

1. INTRODUCTION

In this introductory section, we discuss two topics:

A. Rationale for a new protocol.

B. Reasons for delayed adoption.

A. Rationale for Change

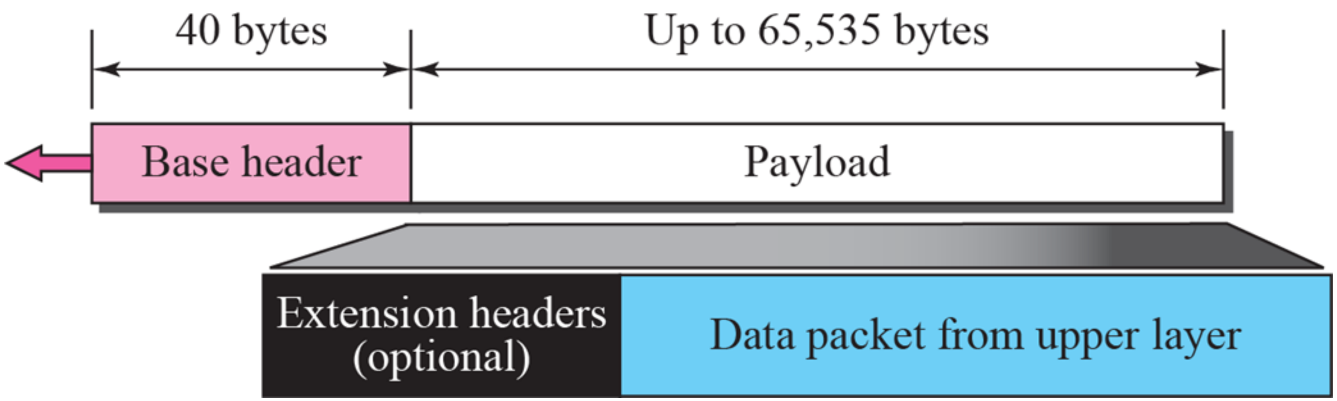
- **The main reason** for the need of a new protocol (**IPv6**) was **the address depletion.**
- **Other reasons** are related to:
  - ✓ **The slowness of the process due to some unnecessary processing.**
  - ✓ **The need for new options, support for multimedia.**
  - ✓ **The desperate need for security.**
- **IPv6 protocol responds** to the above issues using the following main changes in the protocol:
  - ✓ **Larger address space.**
  - ✓ **Better header format.**
  - ✓ **New options.**
  - ✓ **Allowance for extension.**
  - ✓ **Support for resource allocation.**
  - ✓ **Support for more security.**

B. Reason for Delay in Adoption

- **The adoption of IPv6 has been slow.** The reason is that the original motivation for its development, depletion of IPv4 addresses, has been slowed down because of **three short-term remedies**:
  - ✓ **Classless Addressing.**
  - ✓ **Use of DHCP for dynamic address allocation.**
  - ✓ **Using Network Address Translation (NAT) technology.**
- **However**, the fast-spreading use of the Internet, and **new services**, such as **mobile IP**, **IP telephony**, and **IP-capable mobile telephony**, may require the total replacement of IPv4 with IPv6.

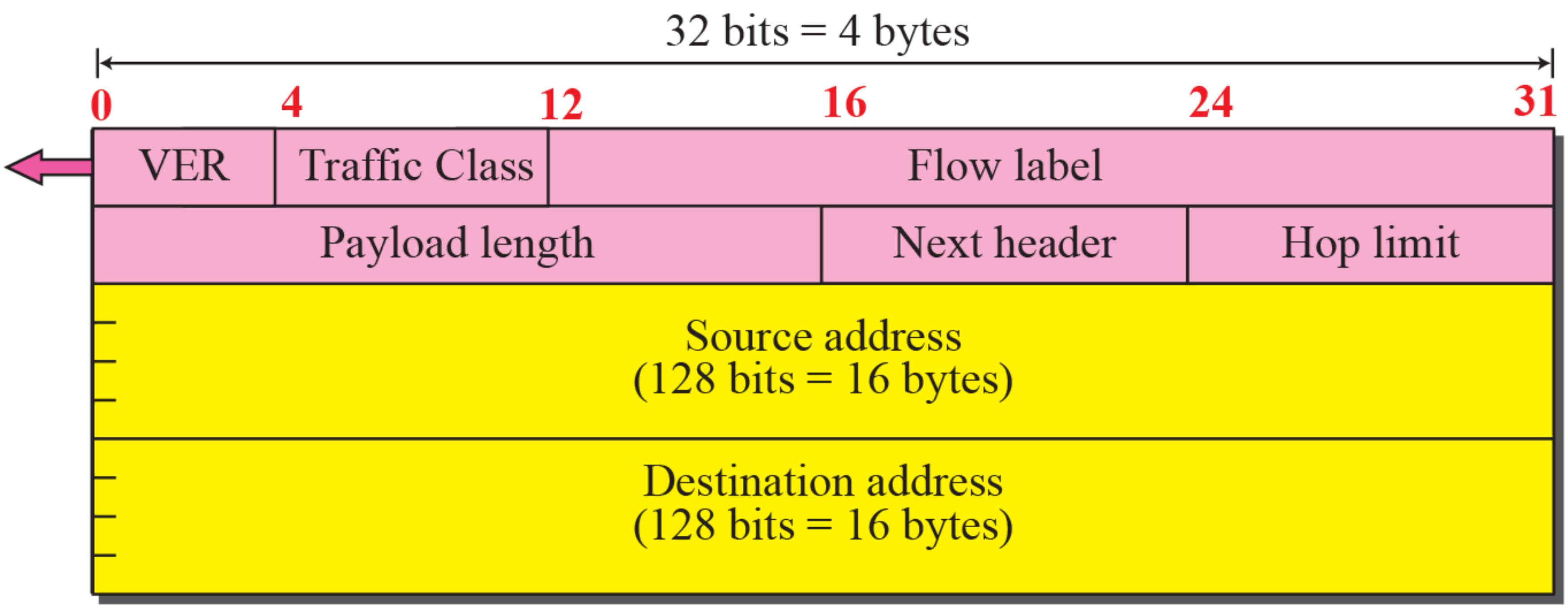
2. PACKET FORMAT

- The following figure shows the IPv6 packet.
- Each packet is composed of a mandatory **base header** followed by **the payload**. The payload consists of two parts:
  - ✓ Optional extension headers.
  - ✓ Data from an upper layer.
- **The base header** occupies **40 bytes**, whereas **the extension headers and data** from the upper layer contain up to **65,535 bytes** of information.



Base Header

The following Figure shows the format of the base header:



Base Header Fields

These fields are as follows:

- **Version:** This **4-bit** field defines the version number of the IP. For IPv6, the value is 6.
- **Traffic Class:** This **8-bit** field is used to distinguish different payloads with different delivery requirements. It replaces the service class field in IPv4.
- **Flow label:** The flow label is a **20-bit** field that is designed to provide **special handling** for a particular flow of data.
- **Payload length:** The **2-byte** payload length field defines the length of the IP datagram excluding the base header.
- **Next header:** The next header is an **8-bit** field defining the header that follows the base header in the datagram.
- **Hop limit:** This **8-bit** hop limit field serves the same purpose as the TTL field in IPv4.

Base Header Fields

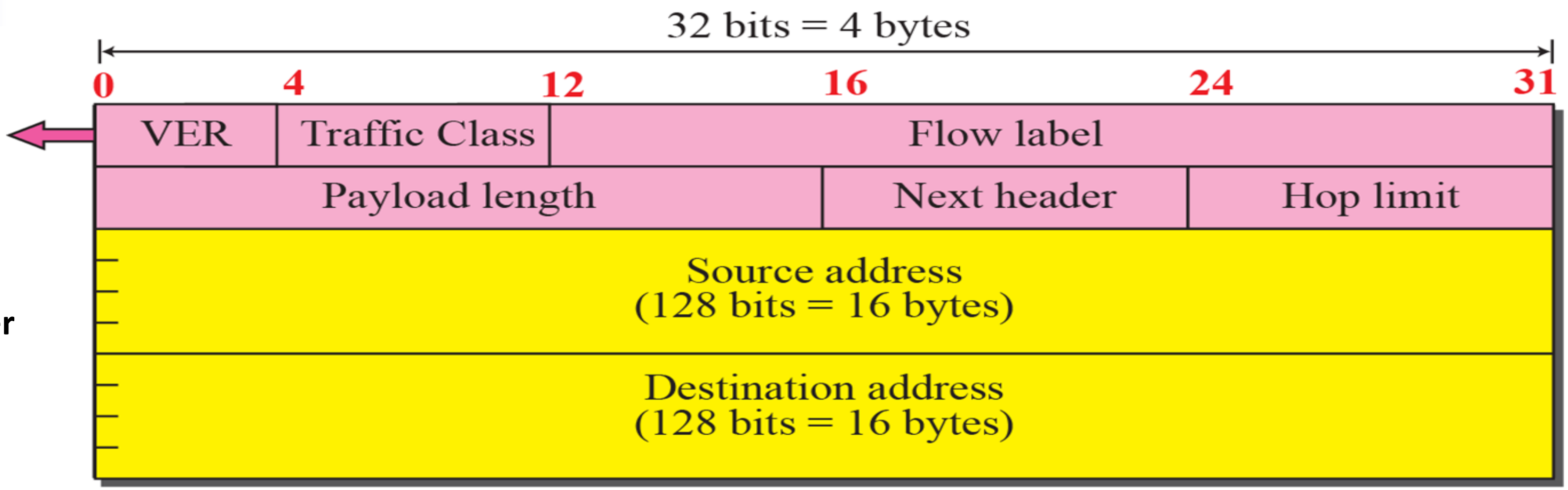
- **Source address:** The source address field is a **16-byte** (**128-bit**) Internet address that identifies the original source of the datagram.
- **Destination address:** The destination address field is a **16-byte** (**128-bit**) Internet address that usually identifies the final destination of the datagram.

The following Table shows Next Header Codes

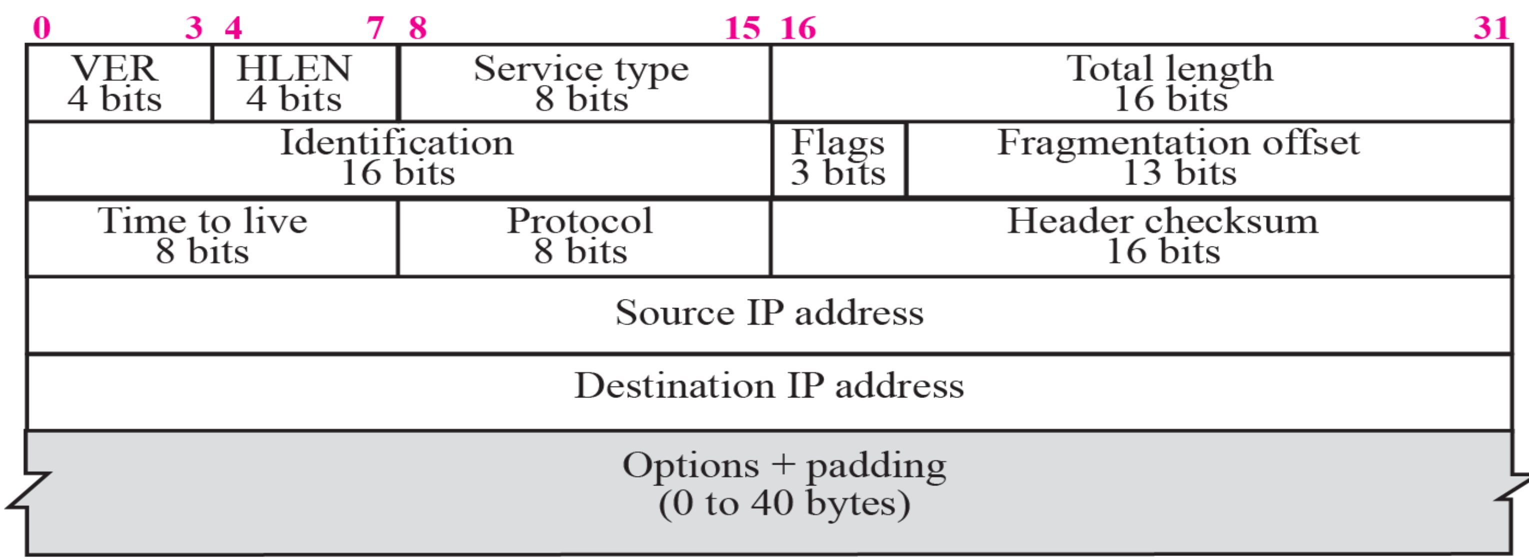
Code	*Next Header*	*Code*	*Next Header*
0	Hop-by-hop option	44	Fragmentation
2	ICMP	50	Encrypted security payload
6	TCP	51	Authentication
17	UDP	59	Null (No next header)

Comparison between IPv4 and IPv6 Headers

IPv6 Header



IPv4 Header



Comparison between IPv4 and IPv6 Headers

The following shows the comparison between IPv4 and IPv6 headers:

- **The header length field** is eliminated in IPv6 because the length of the header is fixed in this version.
- **The service type field** is eliminated in IPv6. The traffic class and flow label fields together take over the function of the service type field.
- **The total length field** is eliminated in IPv6 and replaced by the payload length field.
- **The identification, flag, and offset fields** are eliminated from the base header in IPv6. They are included in the fragmentation extension header.

Comparison between IPv4 and IPv6 Headers

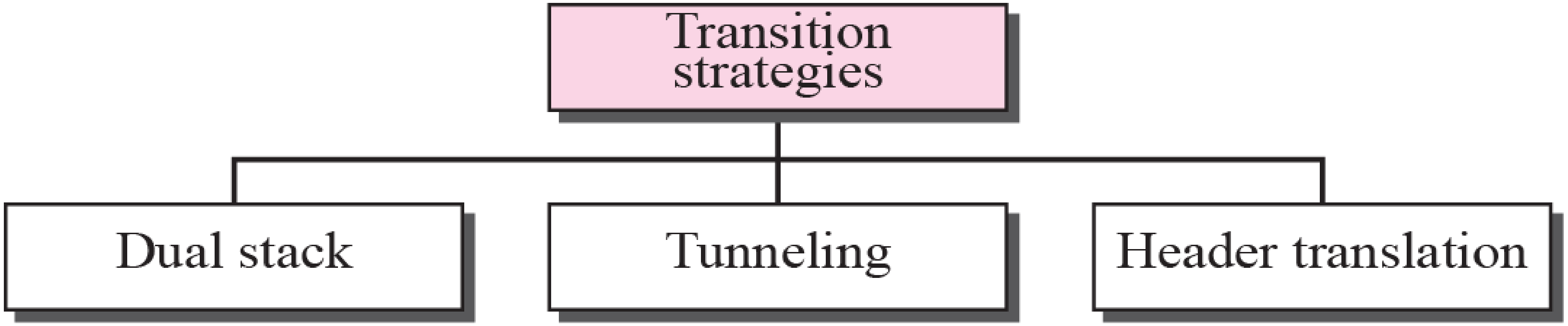
- **The TTL field** is called hop limit in IPv6.
- **The protocol field** is replaced by the next header field.
- **The header checksum** is eliminated because the checksum is provided by upper layer protocols; it is therefore not needed at this level.
- **The option fields** in IPv4 are implemented as extension headers in IPv6.

3. TRANSITION FROM IPv4 TO IPv6

Because of the huge number of systems on the Internet, the transition from IPv4 to IPv6 cannot happen suddenly. It will take a considerable amount of time before every system in the Internet can move from IPv4 to IPv6. The transition must be smooth to prevent any problems between IPv4 and IPv6 systems.

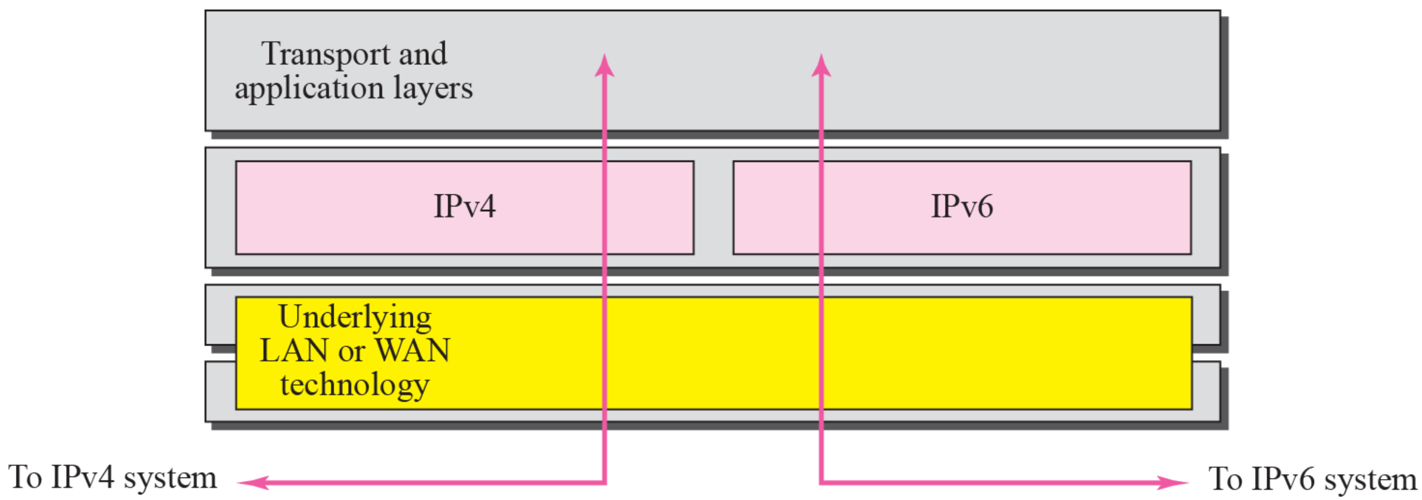
Three Transition Strategies

Three strategies have been devised by the Internet Engineering Task Force (IETF) to help the transition:



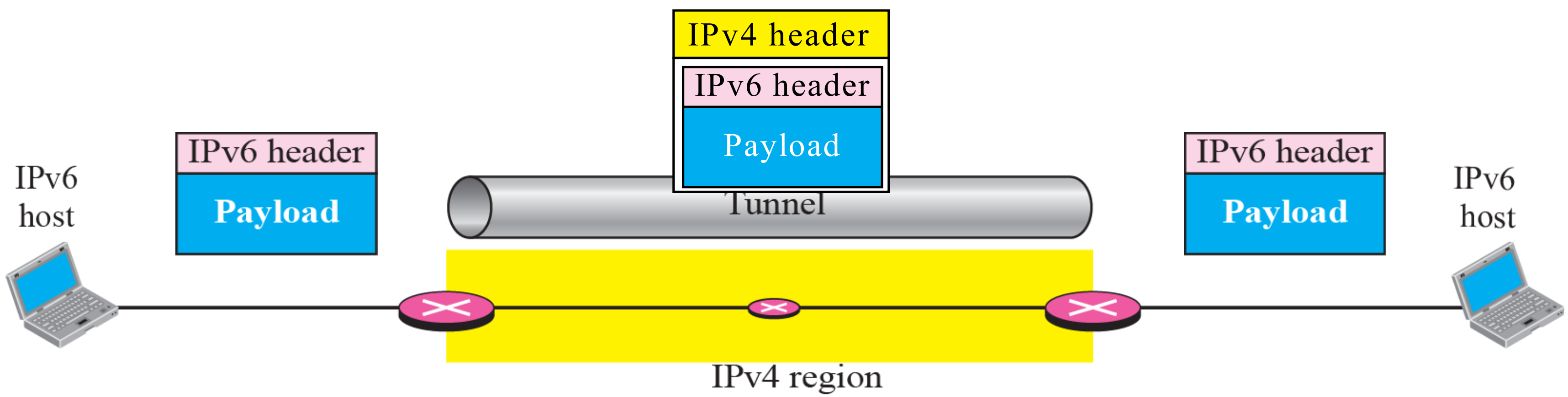
Dual stack

- It is recommended that all hosts, before migrating completely to version 6, have a dual stack of protocols. In other words, a station must run IPv4 and IPv6 simultaneously until all the Internet uses IPv6.
- To determine which version to use when sending a packet to a destination, the source host queries the DNS. If the DNS returns an IPv4 address, the source host sends an IPv4 packet. If the DNS returns an IPv6 address, the source host sends an IPv6 packet.



Tunneling Strategy

- Tunneling is a strategy used when two computers using IPv6 want to communicate with each other and the packet must pass through a region that uses IPv4. To pass through this region, the packet must have an IPv4 address. So the IPv6 packet is encapsulated in an IPv4 packet when it enters the region, and it leaves its capsule when it exits the region.



Header Translation Strategy

- Header translation is necessary when the majority of the Internet has moved to IPv6 but some systems still use IPv4.
- The sender wants to use IPv6, but the receiver does not understand IPv6. Tunneling does not work in this situation because the packet must be in the IPv4 format to be understood by the receiver. In this case, the header format must be totally changed through header translation. The header of the IPv6 packet is converted to an IPv4 header