IPv4 Header

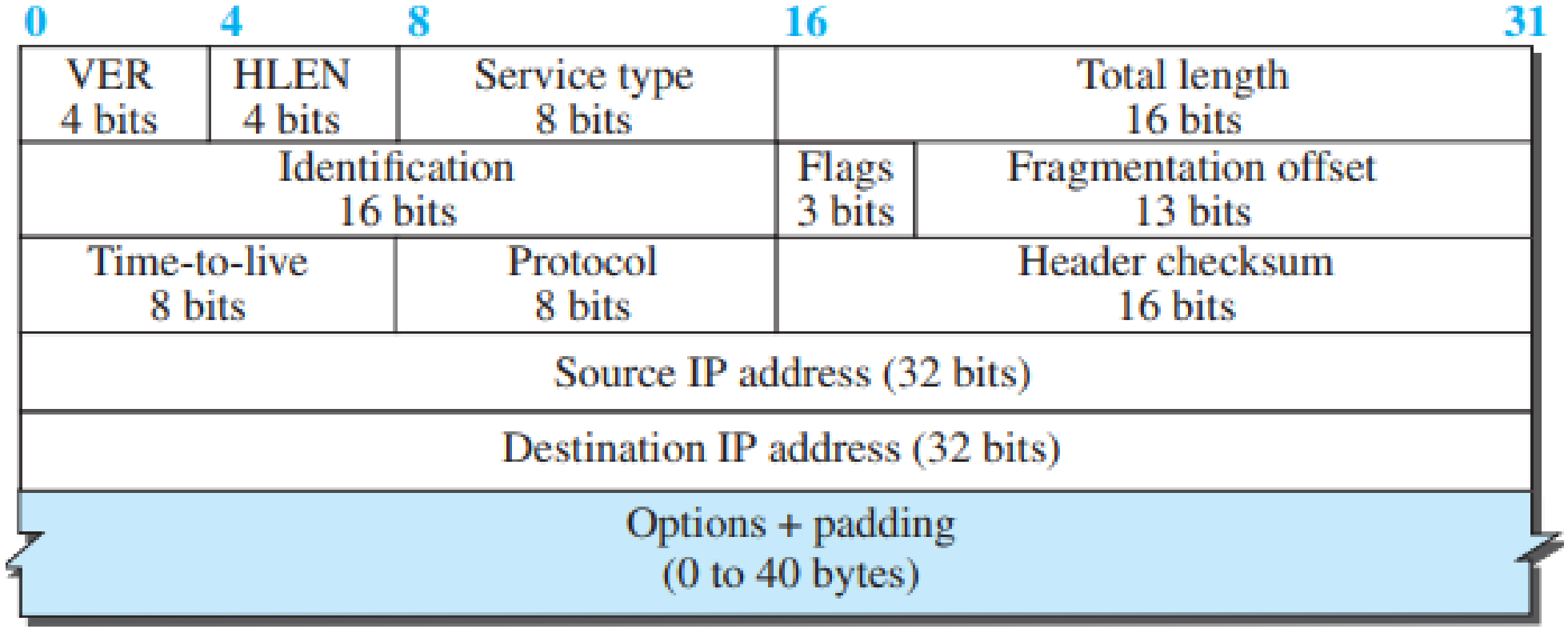


Fig 1(a). IPv4 Header

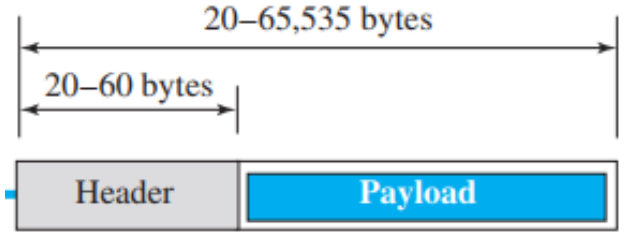


Fig 1(b). IPv4 Datagram

IPv4 Header

- **Version Number (4 bits)**
  - Defines version of IP protocol

- **Header Length (4 bits)**
  - Defines total length of datagram header
  - Multiply by 4 to get the length in bytes
  - Device needs to know when the header stops, and actual data started

- **Service Type (8 bits)**
  - Defines type of service
  - How datagram should be handled
  - Also called ***Differentiated Services Code Point (DSCP)***

- **Total Length (16 bits)**
  - Defines total length (header + data) of IP datagram
  - Receiving device knows when the packet arrived completely
  - Length of data = Total length – (Header length * 4)

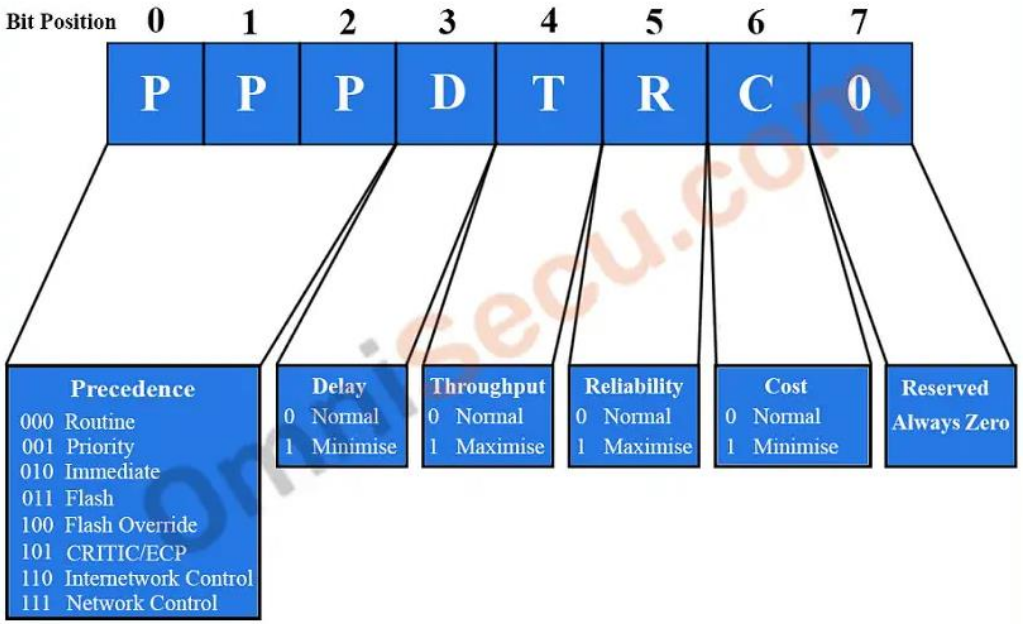


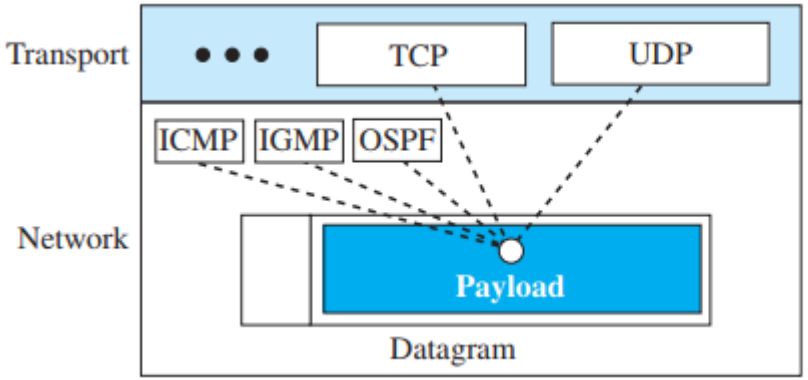
Fig 2. Service Type

- **Identification, Flags, and Fragmentation Offset (16 bits +3 bits +13 bits)**

IPv4 Header

- **Time-to-live (8 bits)**
  - Datagram may be circulating from one node to another
  - Create extra traffic on the internet
  - Use to control maximum number of hops to be travelled
  - Each router decrements this number by 1
  - When the value reaches 0, router discards the datagram

- **Protocol (8 bits)**
  - A packet (payload) from upper layer belongs to different protocol (TCP/UDP)
  - A packet can be from IP layer
  - Destination knows which protocol packet belongs to
  - Multiplexing at source, demultiplexing at destination



Some protocol values

ICMP	01
IGMP	02
TCP	06
UDP	17
OSPF	89

Fig 3. Protocol

IPv4 Header

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- **Header checksum (16 bits)**
  - Error checking of payload is done by Transport layer
  - Datagram header added by IP
  - Any error in the header is disastrous
  - Needs to be recalculated and checked at each router
- **Source IP address (32 bits)**
- **Destination IP address (32 bits)**
- **Options (40 bytes)**
  - Used for network testing, management, and debugging purpose
  - Optional field
  - Generally used by network administrator
- **Padding**
  - IP header length should be multiple of 32-bits
  - 0 bits are padded

Fragmentation

- **Maximum Transfer Unit (MTU)**
  - Maximum size of IP datagram that can be encapsulated in a Frame
  - Size of frame payload <= MTU

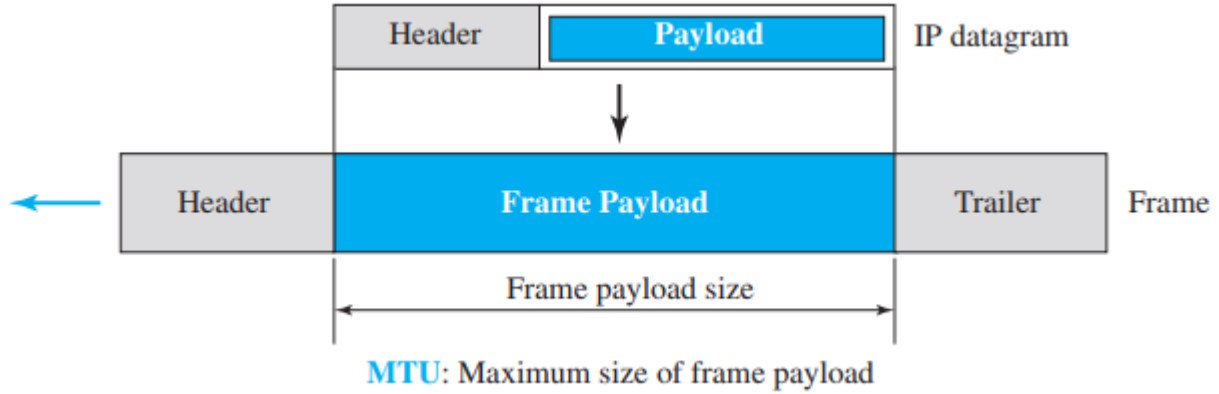

Fig 4. Maximum Transfer Unit

- **Fragmentation**
  - Payload of IP datagram is fragmented
  - When payload of IP datagram is fragmented, each fragment has its own header
  - Fragmented datagram can be further fragmented if it encounters a network with smaller MTU
  - Datagram may be fragmented several times before it reaches the destination

- **Reassembly**
  - Done at the Destination
  - Each fragment is an independent entity

Fragmentation Fields

- **Identification (16 bits)**
  - Provide uniqueness to each datagram
  - Positive number called counter is used
  - Fragmented datagram uses the same identification field
  - It helps the destination for reassembly of the datagram

- **Flags (3 bits)**
  - Leftmost bit is reserved
  - Second bit (D bit) is *do not fragment* bit (0: fragment, 1: don't fragment)
  - Third bit (M bit) is *more fragment* bit (0: no more fragments, 1: more fragments to come)

- **Fragmentation Offset (13 bits)**
  - Relative position of the fragment w.r.t the datagram
  - Measured in unit of 8 bytes

Fragmentation Example

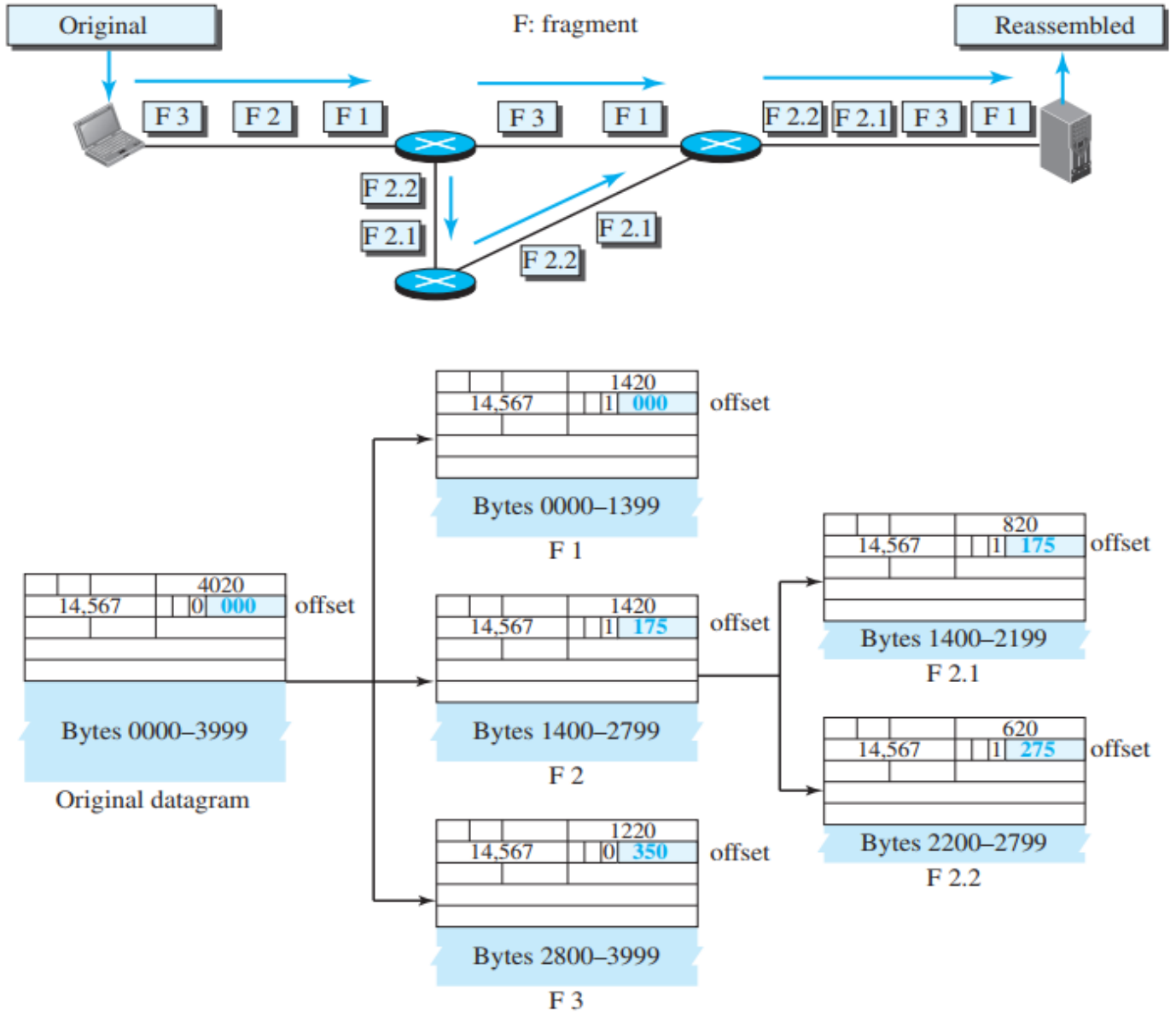

Fig 5. Example

IPv6 Addressing

- **IPv6 address is 128 bits (16 bytes) long**
- **Representation**

Binary (128 bits)	**1111111011110110**	**...**	**1111111100000000**
Colon Hexadecimal	**FEF6:BA98:7654:3210:ADEF:BBFF:2922:FF00**		

Fig 6(a). IPv6 Representation

FDEC:0:0:0:0:BBFF:0:FFFF ⟶ **FDEC::BBFF:0:FFFF**

Fig 6(b). IPv6 Representation

- **Transition from IPv4 to IPv6?**

Transition from IPv4 to IPv6

- **Dual Stack**
  - Source queries the DNS
  - DNS reply with IPv4/IPv6 address

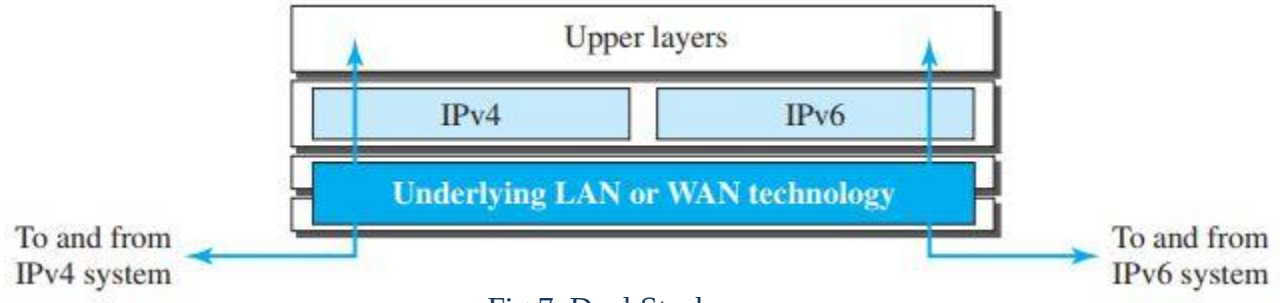

Fig 7. Dual Stack

- **Tunneling**
  - Source and Destination uses IPv6
  - Packet pass through a route which uses IPv4
  - IPv6 address encapsulated in IPv4 address
  - IPv4 packet carries IPv6 packet as data
  - Protocol value as 41

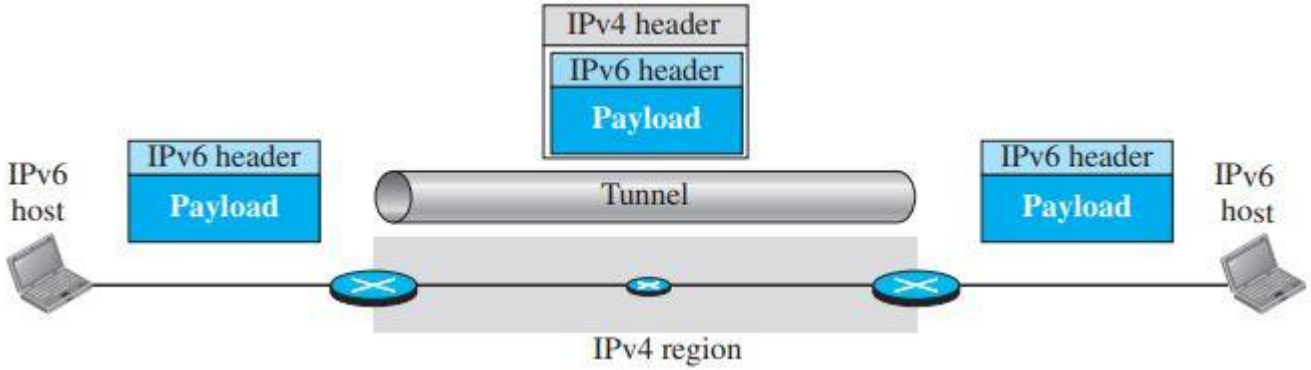

Fig 8. Tunneling

Transition from IPv4 to IPv6

- **Header Translation**
  - Source uses IPv6, but destination doesn't
  - Header of IPv6 packet gets converted to IPv4

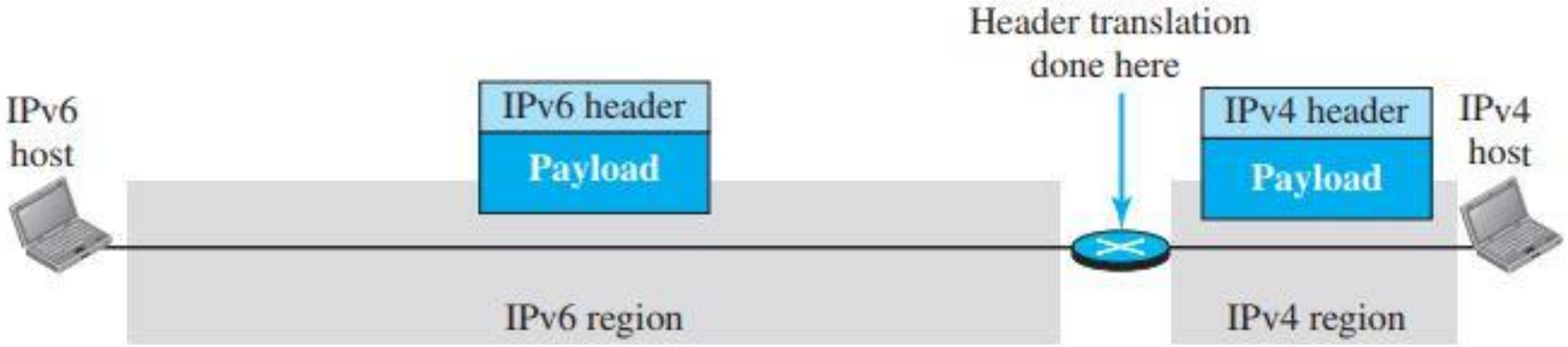

Fig 9. Header Translation