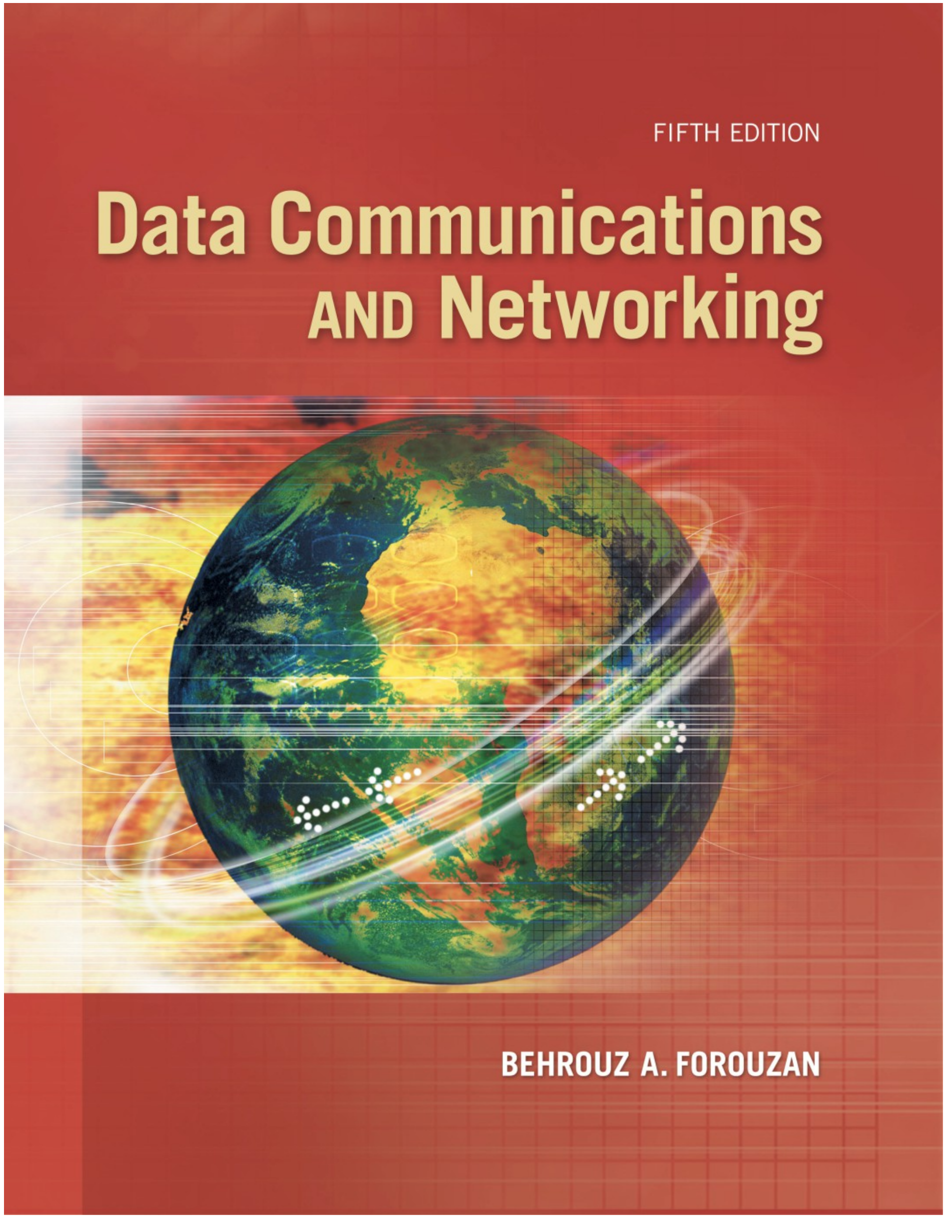
Chapter 22

Next Generation IP



22-1 IPv6 Addressing

The main reason for migration from IPv4 to IPv6 is the small size of the address space in IPv4. In this section, we show how the huge address space of IPv6 prevents address depletion in the future. We also discuss how the new addressing responds to some problems in the IPv4 addressing mechanism. An IPv6 address is 128 bits or 16 bytes (octets) long,

22.22.1 Representation

A computer normally stores the address in binary, but it is clear that 128 bits cannot easily be handled by humans. Several notations have been proposed to represent IPv6 addresses when they are handled by humans. The following shows two of these notations: binary and colon hexadecimal.

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

22.22.2 Address Space

The address space of IPv6 contains 2^{128} addresses. This address space is 2^{96} times the IPv4 address—definitely no address depletion—as shown, the size of the space is

340, 282, 366, 920, 938, 463, 374, 607, 431, 768, 211, 456.

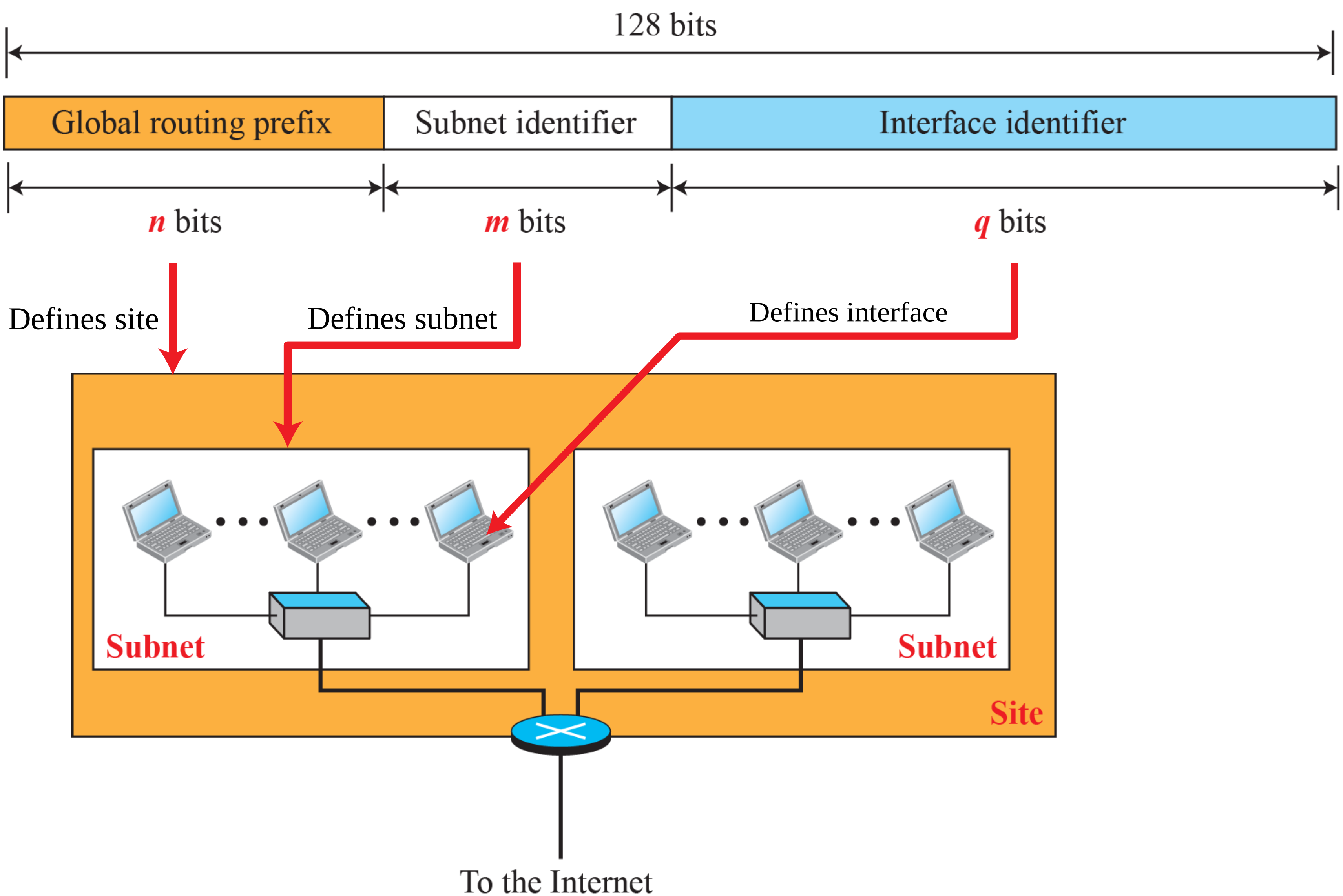
22.22.3 Address Space Allocation

Like the address space of IPv4, the address space of IPv6 is divided into several blocks of varying size and each block is allocated for a special purpose. Most of the blocks are still unassigned and have been set aside for future use. Table 22.1 shows only the assigned blocks. In this table, the last column shows the fraction each block occupies in the whole address space..

Table 22.1: Prefixes for assigned IPv6 addresses

Block prefix	*CIDR*	*Block assignment*	*Fraction*
0000 0000	0000::/8	Special addresses	1/256
001	**2000::/3**	**Global unicast**	**1/8**
1111 110	FC00::/7	Unique local unicast	1/128
1111 1110 10	FE80::/10	Link local addresses	1/1024
1111 1111	FF00::/8	Multicast addresses	1/256

Figure 22.1: *Global unicast address*



Example 22.1

An organization is assigned the global routing prefix 48 bit block as 2000:1456:2474. What is the CIDR notation for the blocks in the first and second subnets in this organization?

Solution

Theoretically, the first and second subnets should use the blocks with subnet identifier 0001_{16} and 0002_{16}. This means that the blocks are 2000:1456:2474:0000/64 and 2000:1456:2474:0001/64.

Example 22.2

Using the format we defined for Ethernet addresses, find the interface identifier if the physical address in the EUI is $(F5\text{-}A9\text{-}23\text{-}EF\text{-}07\text{-}14\text{-}7A\text{-}D2)_{16}$.

Solution

We only need to change the seventh bit of the first octet from 0 to 1 and change the format to colon hex notation. The result is F7A9:23EF:0714:7AD2.

Example 22.3

Using the format we defined for Ethernet addresses, find the interface identifier if the Ethernet physical address is (F5-A9-23-14-7A-D2)16.

Solution

We only need to change the seventh bit of the first octet from 0 to 1, insert two octets $FFFE_{16}$ and change the format to colon hex notation. The result is F7A9:23FF:FE14:7AD2 in colon hex.

Example 22.4

An organization is assigned the 48 bit global routing prefix block as 2000:1456:2474. What is the IPv6 address of an interface in the third subnet if the IEEE physical address of the computer is (F5-A9-23-14-7A-D2)16?

Solution

The interface identifier for this interface is F7A9:23FF:FE14:7AD2 (see Example 22.3). If we append this identifier to the global prefix and the subnet identifier, we get:

2000:1456:2474:0003:F7A9:23FF:FE14:7AD2/128

Figure 22.4: Special addresses

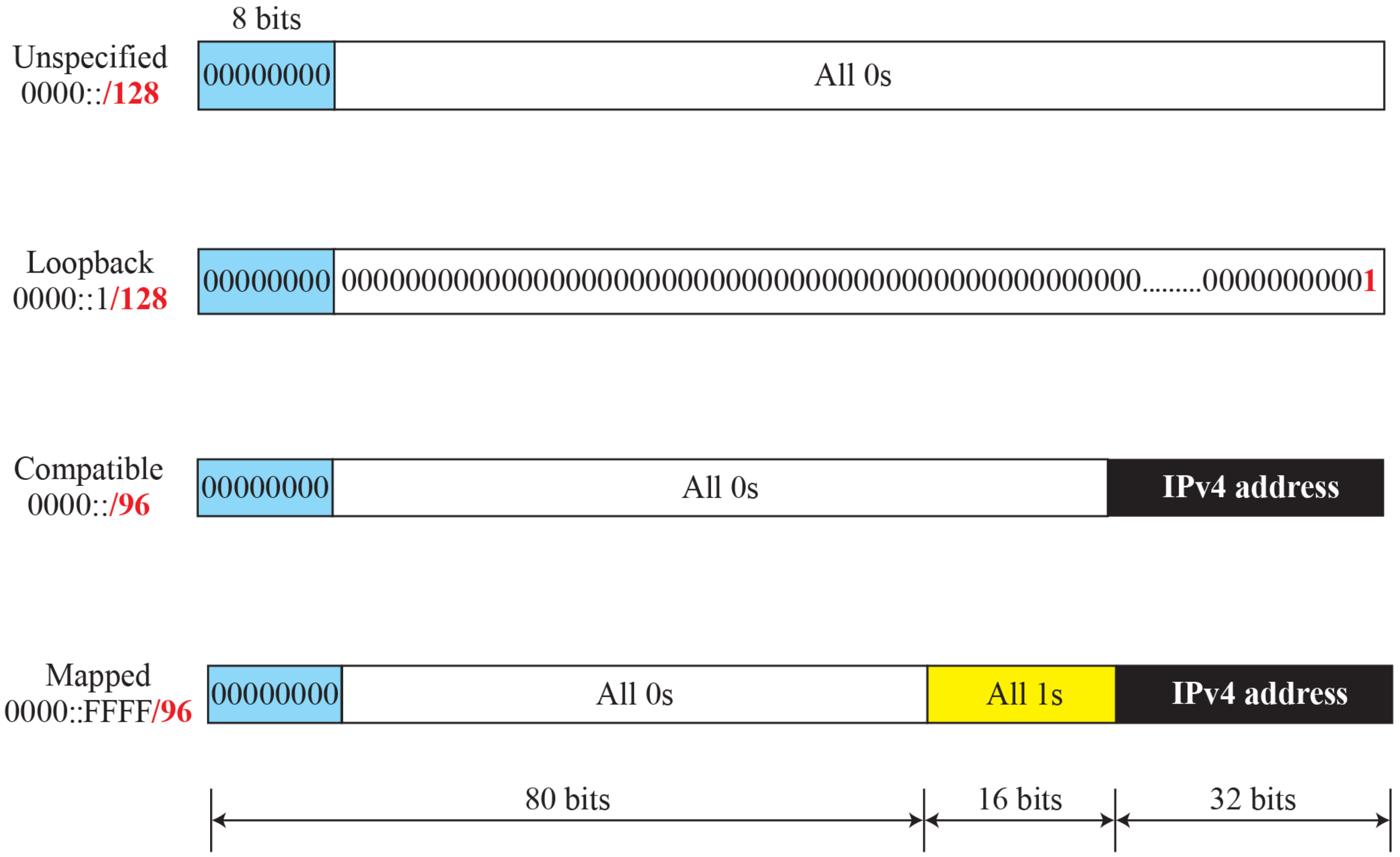
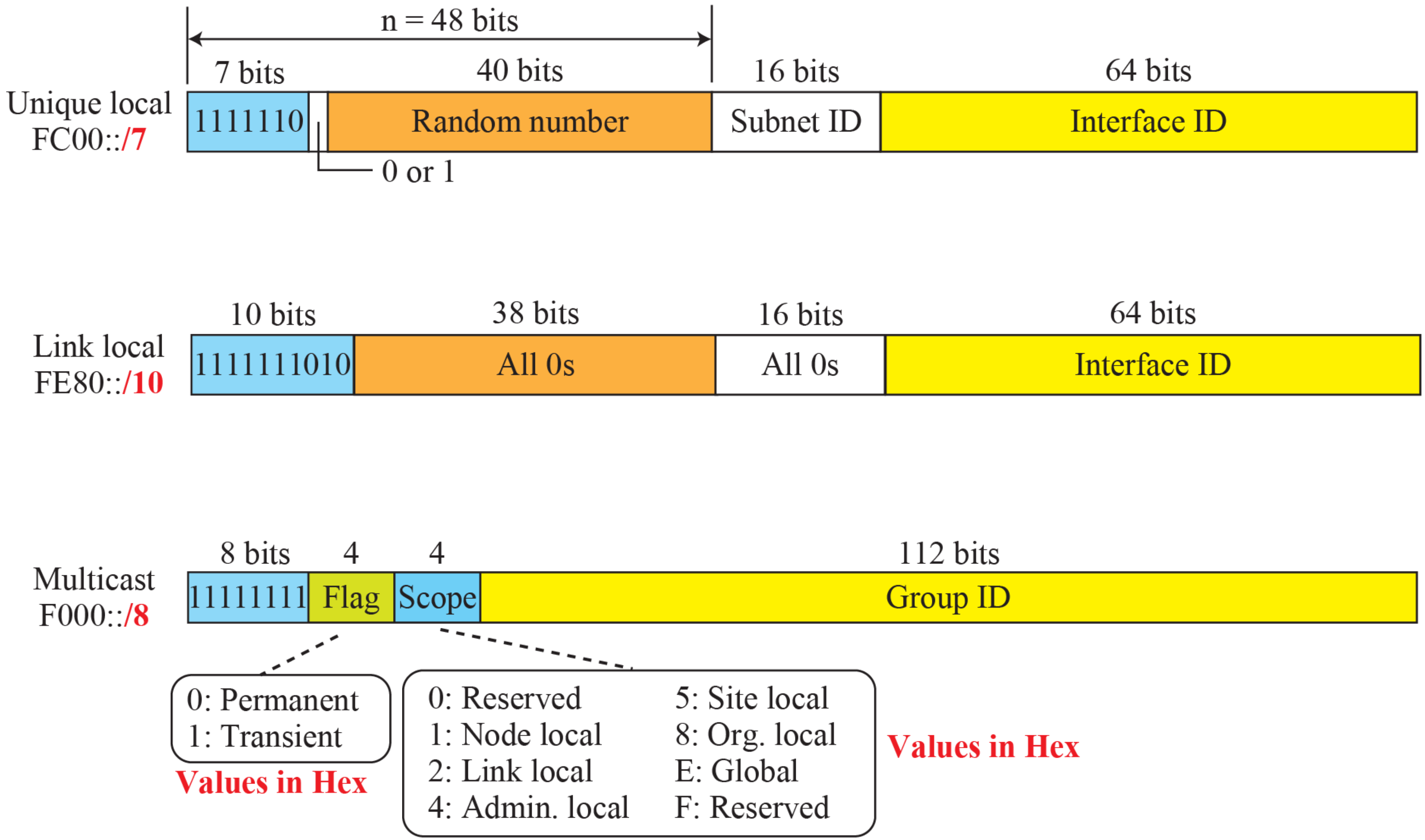


Figure 22.5: Unique local unicast block



22-2 THE IPv6 PROTOCOL

The change of the IPv6 address size requires the change in the IPv4 packet format. The designer of IPv6 decided to implement remedies for other shortcomings now that a change is inevitable. The following shows other changes implemented in the protocol in addition to changing address size and format.

22.2.1 Packet Format

The IPv6 packet is shown in Figure 22.6. Each packet is composed of a base header followed by the payload. The base header occupies 40 bytes, whereas payload can be up to 65,535 bytes of information. The description of fields follows.

Figure 22.6: IPv6 datagram

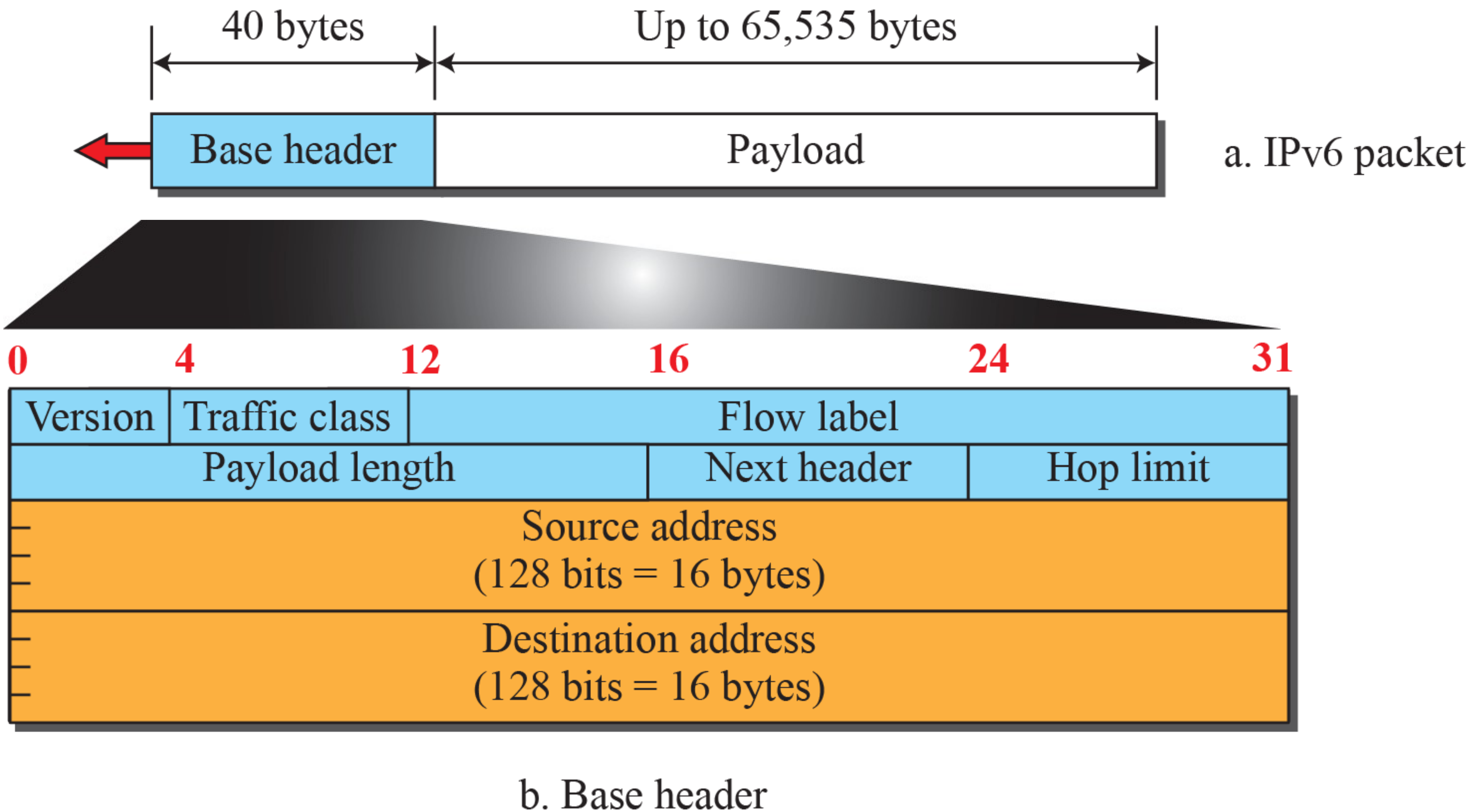
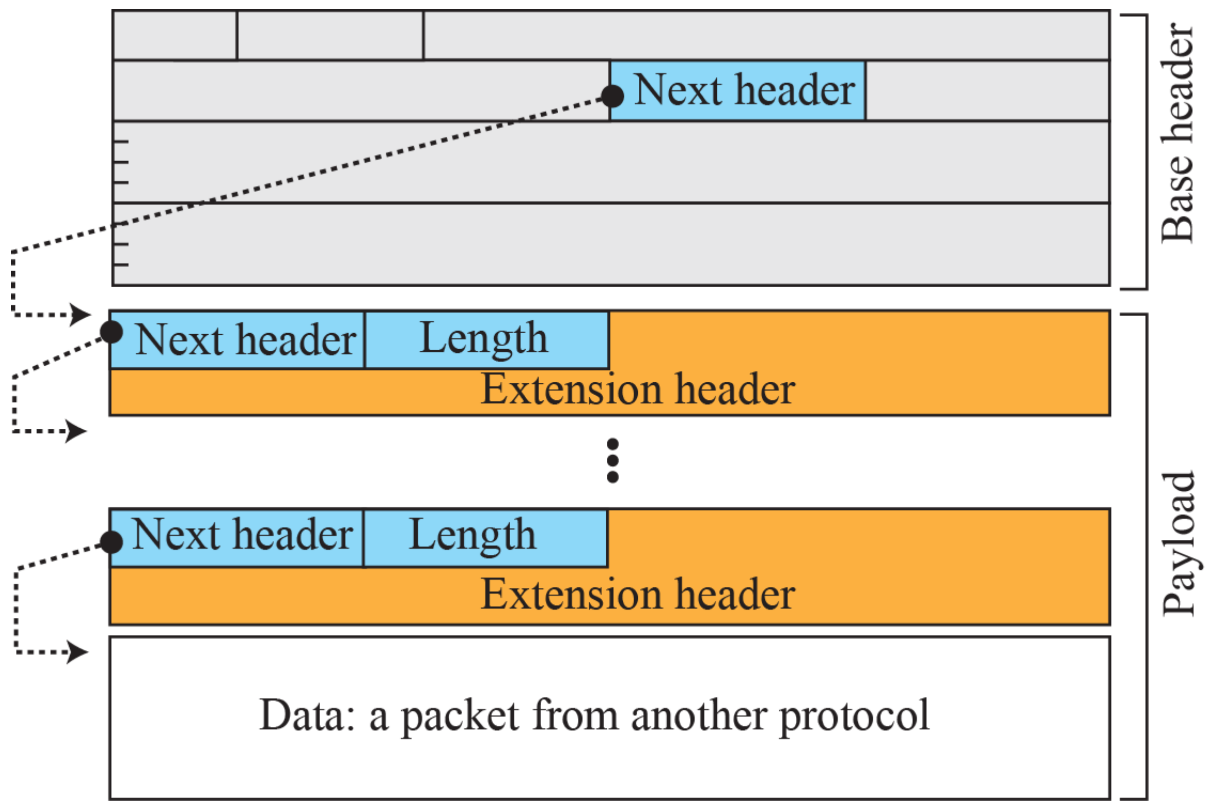


Figure 22.7: Payload in an IPv6 datagram



Some next-header codes

00: Hop-by-hop option
02: ICMPv6
06: TCP
17: UDP
43: Source-routing option
44: Fragmentation option
50: Encrypted security payload
51:Authentication header
59: Null (no next header)
60: Destination option

Figure 20.15 ***IPv6 datagram header and payload***

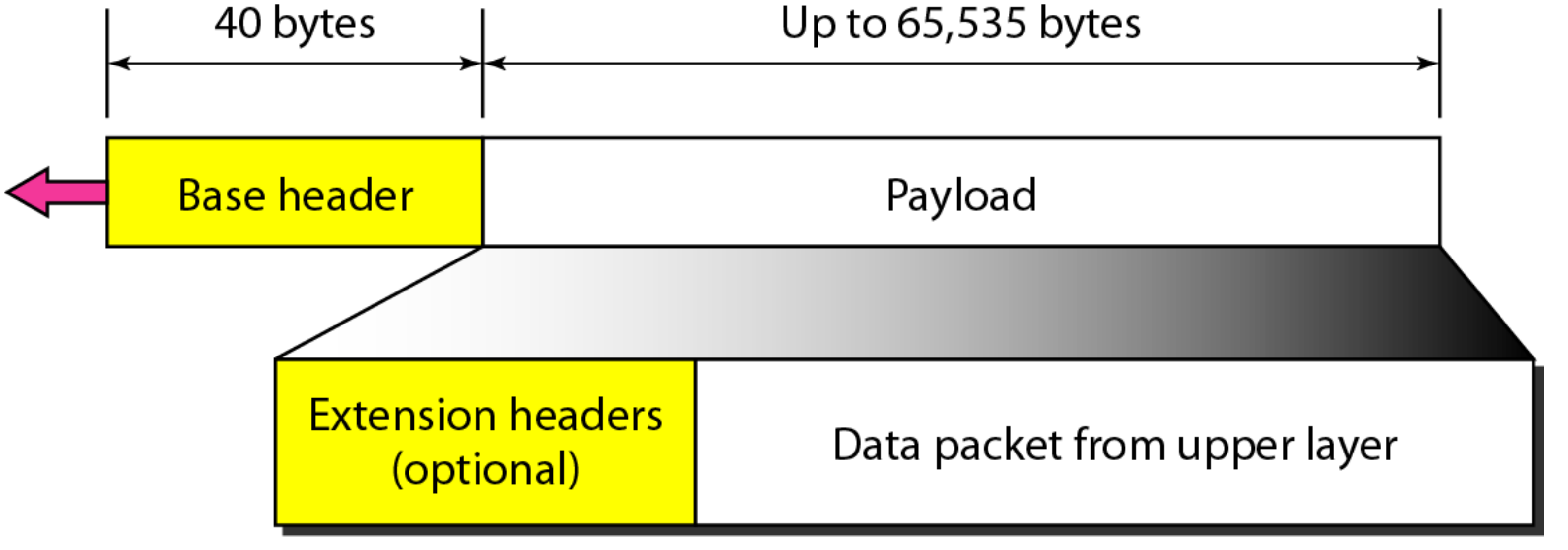


Figure 20.16 *Format of an IPv6 datagram*

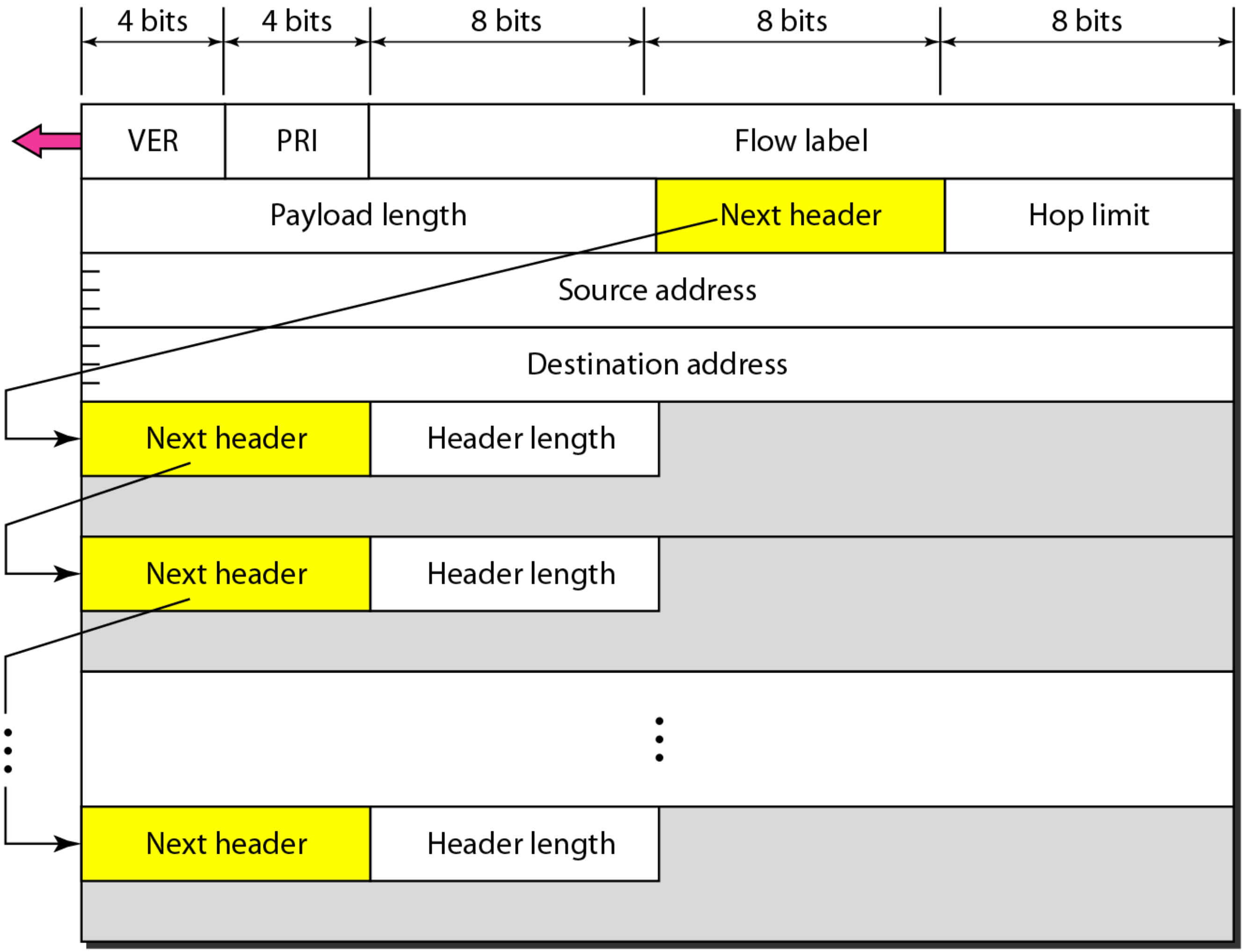


Table 20.6 *Next header codes for IPv6*

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

Table 20.7 ***Priorities for 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

Table 20.8 ***Priorities for noncongestion-controlled traffic***

Priority	*Meaning*
8	Data with greatest redundancy
. . .	. . .
15	Data with least redundancy

22.2.2 Extension Header

An IPv6 packet is made of a base header and some extension headers. The length of the base header is fixed at 40 bytes. However, to give more functionality to the IP datagram, the base header can be followed by up to six extension headers. Many of these headers are options in IPv4. Six types of extension headers have been defined. These are hop-by-hop option, source routing, fragmentation, authentication, encrypted security payload, and destination option (see Figure 22.8).

Figure 20.17 *Extension header types*

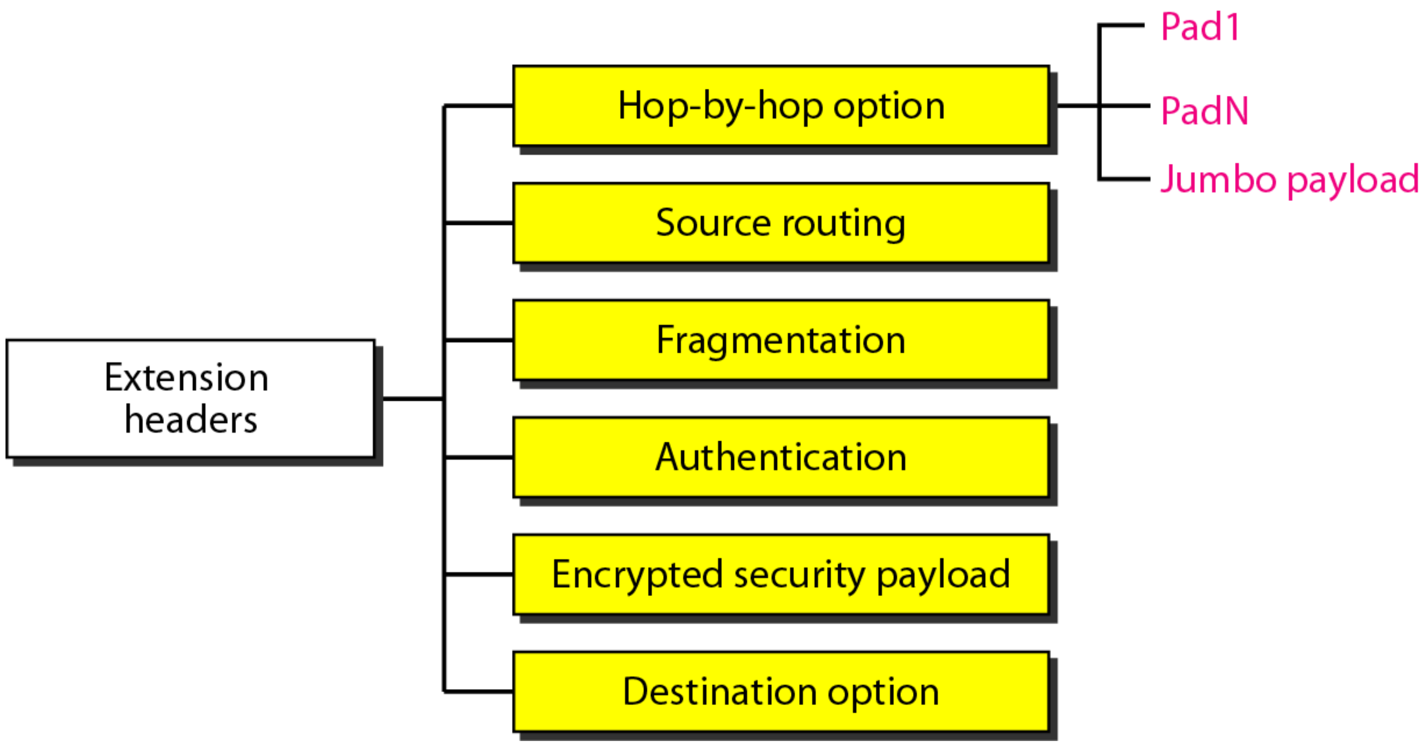


Table 20.9 Comparison between IPv4 and IPv6 packet headers

Comparison
1. The header length field is eliminated in IPv6 because the length of the header is fixed in this version.
2. The service type field is eliminated in IPv6. The priority and flow label fields together take over the function of the service type field.
3. The total length field is eliminated in IPv6 and replaced by the payload length field.
4. The identification, flag, and offset fields are eliminated from the base header in IPv6. They are included in the fragmentation extension header.
5. The TTL field is called hop limit in IPv6.
6. The protocol field is replaced by the next header field.
7. The header checksum is eliminated because the checksum is provided by upper-layer protocols; it is therefore not needed at this level.
8. The option fields in IPv4 are implemented as extension headers in IPv6.

22-4 TRANSITION FROM IPv4 TO IPv6

Although we have a new version of the IP protocol, how can we make the transition to stop using IPv4 and start using IPv6? in the Internet can move The transition must be smooth to prevent any problems between IPv4 and IPv6 systems.

22.4.1 Strategies

Three strategies have been devised for transition: dual stack, tunneling, and header translation. One or all of these three strategies can be implemented during the transition period..

Figure 22.11: Dual stack

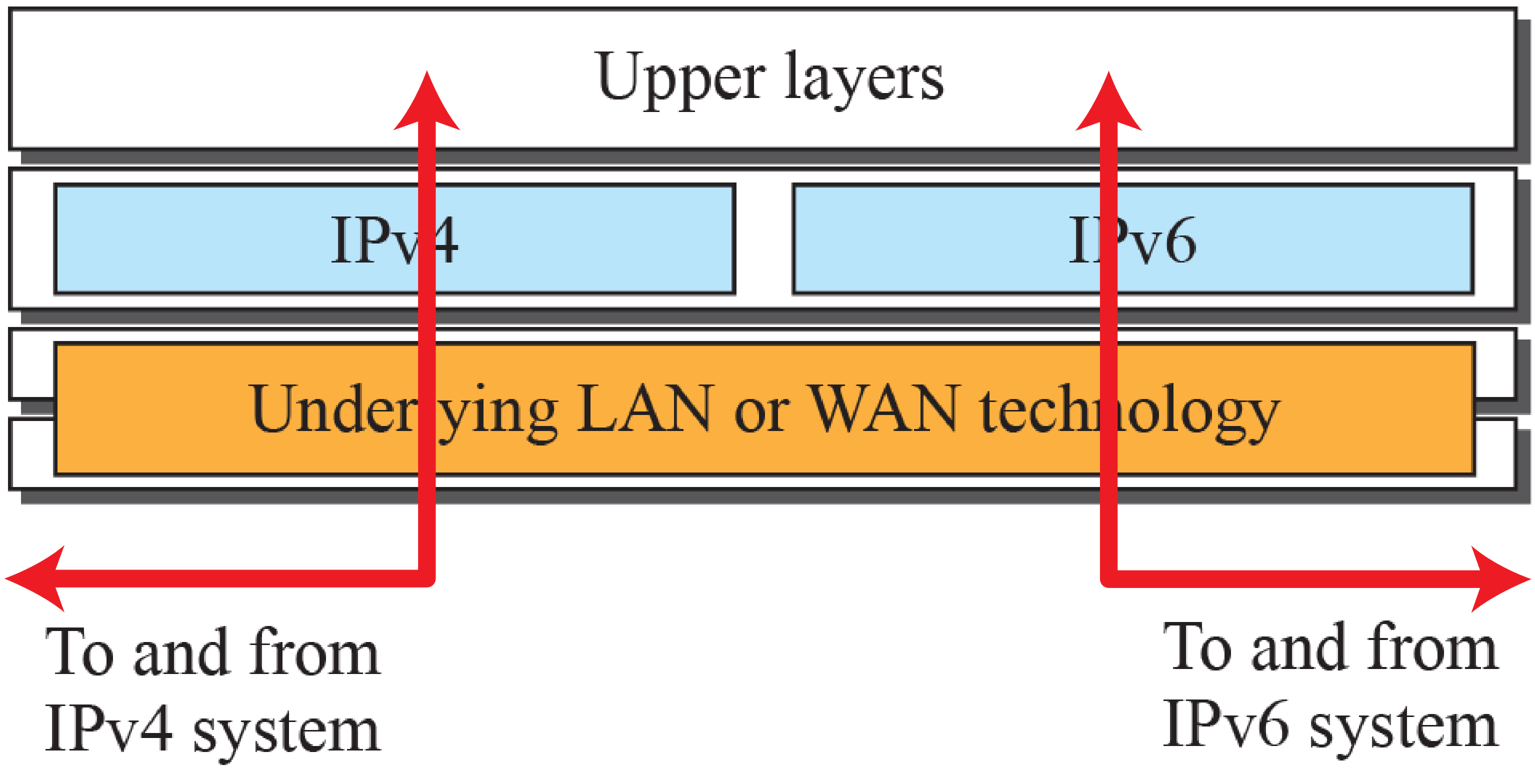


Figure 22.12: Tunneling strategy

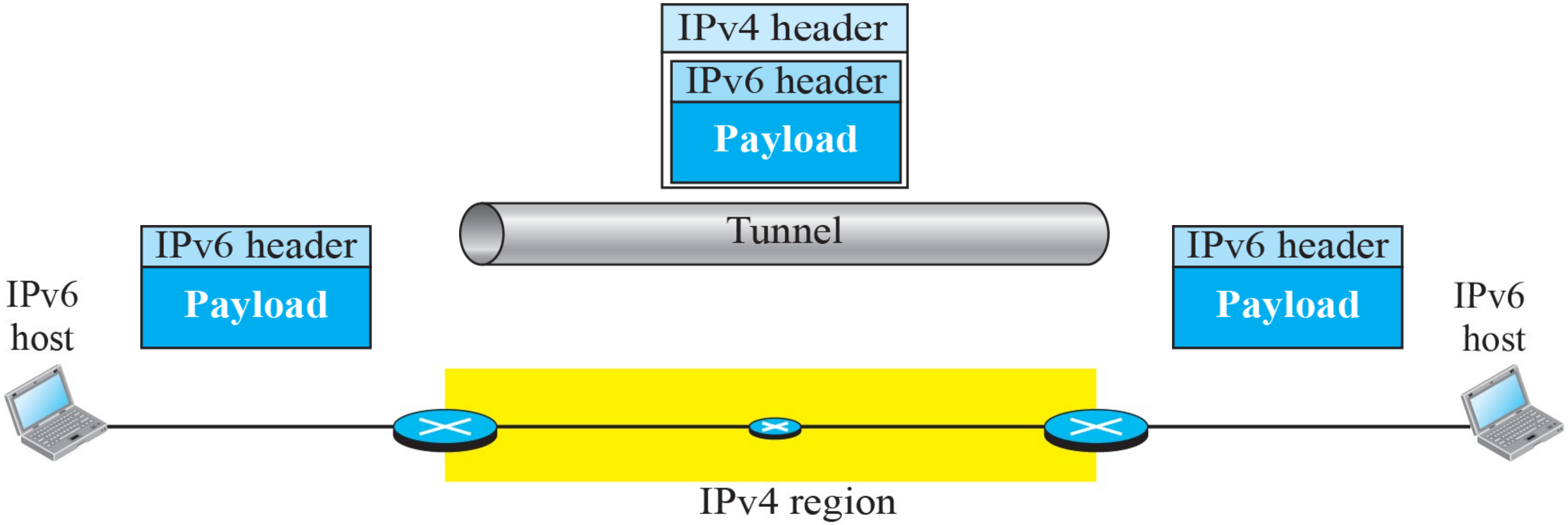


Figure 22.13: *Header translation strategy*