

Example 26.1

Show the unabbreviated colon hex notation for the following IPv6 addresses:

- a. An address with 64 0s followed by 64 1s.
- b. An address with 128 0s.
- c. An address with 128 1s.
- d. An address with 128 alternative 1s and 0s.

Solution

- a. 0000:0000:0000:0000:FFFF:FFFF:FFFF:FFFF
- b. 0000:0000:0000:0000:0000:0000:0000:0000
- c. FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF
- d. AAAA:AAAA:AAAA:AAAA:AAAA:AAAA:AAAA:AAAA

Example 26.2

The following shows the zero contraction version of addresses in Example 26.1 (part c and d cannot be abbreviated)

a. ::FFFF:FFFF:FFFF:FFFF

b. ::

c. FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF

d. AAAA:AAAA:AAAA:AAAA:AAAA:AAAA:AAAA:AAAA

Example 26.3

Show abbreviations for the following addresses:

- a. 0000:0000:FFFF:0000:0000:0000:0000:0000
- b. 1234:2346:0000:0000:0000:0000:0000:1111
- c. 0000:0001:0000:0000:0000:0000:1200:1000
- d. 0000:0000:0000:0000:0000:FFFF:24.123.12.6

Solution

- a. 0:0:FFFF::
- b. 1234:2346::1111
- c. 0:1::1200:1000
- d. ::FFFF:24.123.12.6

Example 26.4

Decompress the following addresses and show the complete unabbreviated IPv6 address:

- a. 1111::2222
- b. ::
- c. 0:1::
- d. AAAA:A:AA::1234

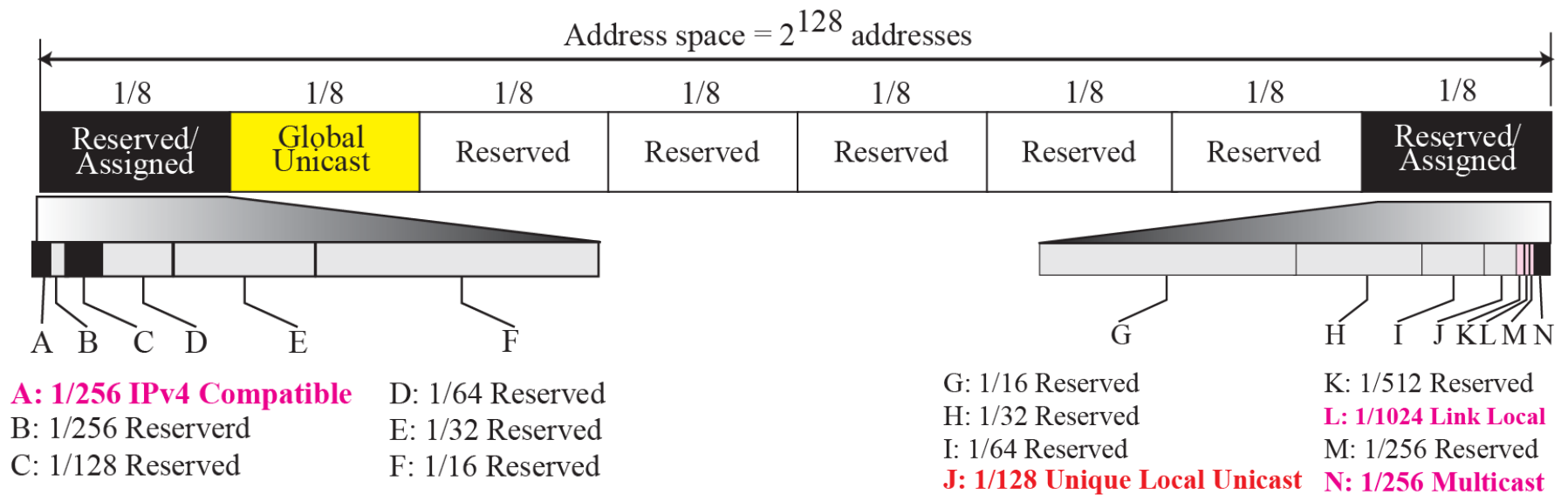
Solution

- a. 1111:0000:0000:0000:0000:0000:0000:0000:2222
- b. 0000:0000:0000:0000:0000:0000:0000:0000
- c. 0000:0001:0000:0000:0000:0000:0000:0000
- d. AAAA:000A:00AA:0000:0000:0000:0000:1234

26-2 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 special purpose. Most of the blocks are still unassigned and have been left aside for future use. To better understand the allocation and the location of each block in address space, we first divide the whole address space into eight equal ranges. This division does not show the block allocation, but we believe it shows where each actual block is located (Figure 26.5).

Figure 26.5 *Address space allocation*



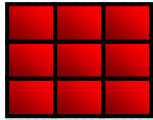


Table 26.1 *Prefixes for IPv6 Addresses*

	<i>Block Prefix</i>	<i>CIDR</i>	<i>Block Assignment</i>	<i>Fraction</i>
1	0000 0000	0000::/8	Reserved (IPv4 compatible)	1/256
	0000 0001	0100::/8	Reserved	1/256
	0000 001	0200::/7	Reserved	1/128
	0000 01	0400::/6	Reserved	1/64
	0000 1	0800::/5	Reserved	1/32
	0001	1000::/4	Reserved	1/16
2	001	2000::/3	Global unicast	1/8
3	010	4000::/3	Reserved	1/8
4	011	6000::/3	Reserved	1/8
5	100	8000::/3	Reserved	1/8
6	101	A000::/3	Reserved	1/8
7	110	C000::/3	Reserved	1/8
8	1110	E000::/4	Reserved	1/16
	1111 0	F000::/5	Reserved	1/32
	1111 10	F800::/6	Reserved	1/64
	1111 110	FC00::/7	Unique local unicast	1/128
	1111 1110 0	FE00::/9	Reserved	1/512
	1111 1110 10	FE80::/10	Link local addresses	1/1024
	1111 1110 11	FEC0::/10	Reserved	1/1024
	1111 1111	FF00::/8	Multicast addresses	1/256

Example 26.8

Figure 26.5 shows that only a portion of the address space can be used for global unicast communication. How many addresses are in this block?

Solution

This block occupies only one-eighth of the address spaces. To find the number of addresses, we can divide the total address space by 8 or 2^3 . The result is $(2^{128})/(2^3) = 2^{125}$ —a huge block.

Figure 26.6 *Algorithm for finding the allocated blocks*

Legend

◆ Check next bit or bits

▭ Assigned

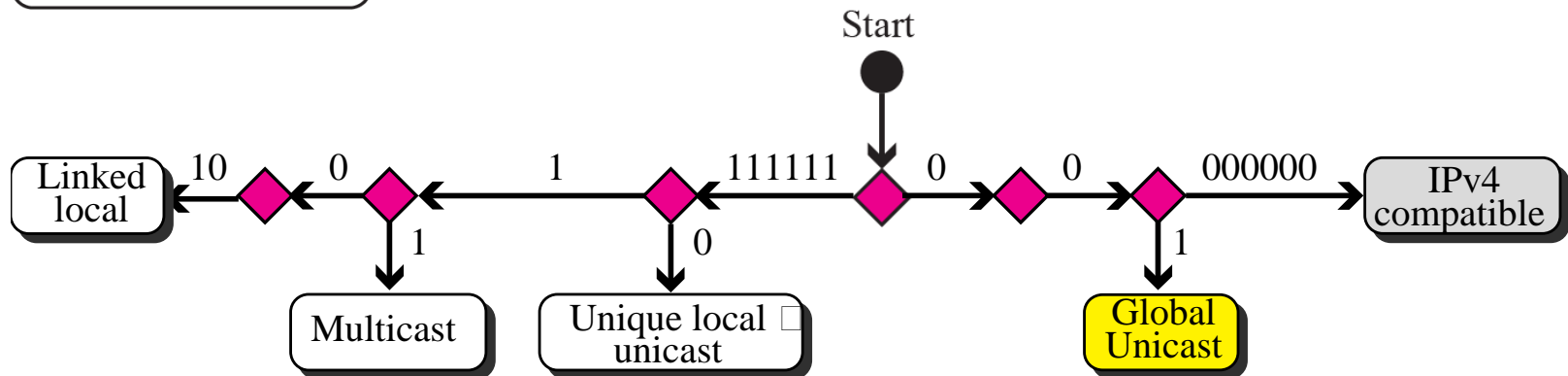
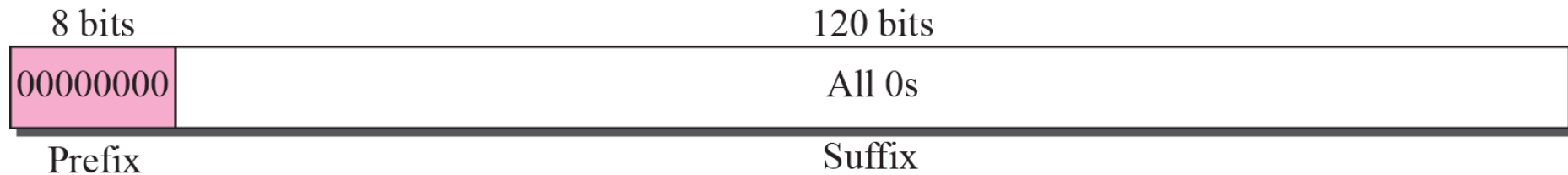


Figure 26.7 *Unspecified address*



The unspecified address is used during bootstrap when a host does not know its own address and wants to send an inquiry to find it. Since any IPv6 packet needs a source address, the host uses this address for this purpose. This address cannot be used as a destination address.

The unspecified address in IPv6 is ::/128. It should never be used as a destination address.

Example 26.9

Comparing the unspecified address in IPv4 to the unspecified addresses in IPv6.

Solution

In both architectures, an unspecified address is an all-zero address. In IPv4 this address is part of class A address; in IPv6 this address is part of the reserved block.



Very useful for testing the functions of software packages in these layers before even connecting the computer to the network

***The loopback address in IPv6 is ::1/128.
It should never be used as a
destination address.***

Example 26.10

Compare the loop addresses in IPv4 to the loopback address in IPv6.

Solution

There are two differences in this case. In classful addressing, a whole block is allocated for loopback addresses; in IPv6 only one address is allocated as the loopback address. In addition, the loopback block in classful addressing is part of the class A block. In IPv6, it is only one single address in the reserved block.

Figure 26.9 *Compatible address*

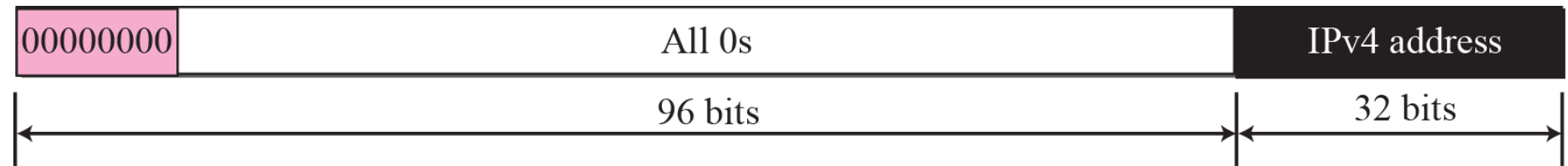


Figure 26.10 *Mapped address*

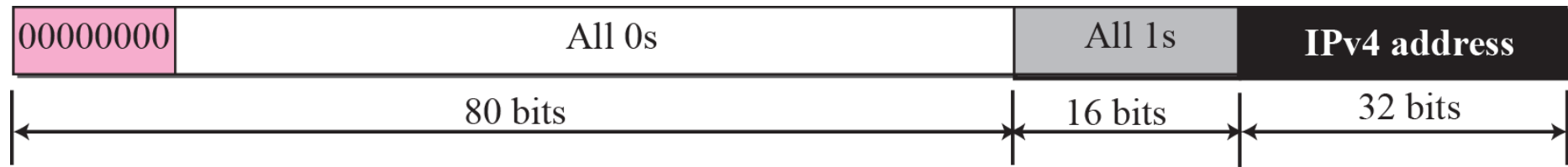


Figure 26.11 *Unique local unicast address*

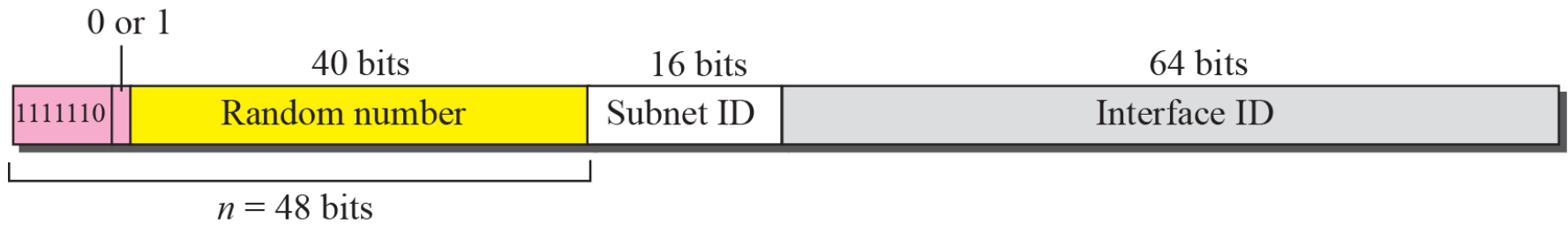


Figure 26.12 *Link local address*

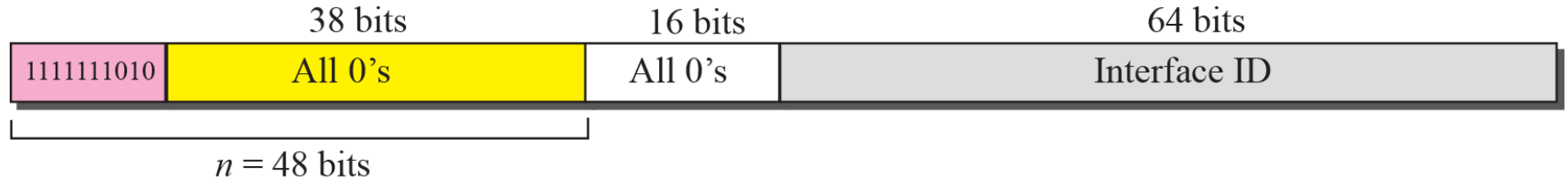
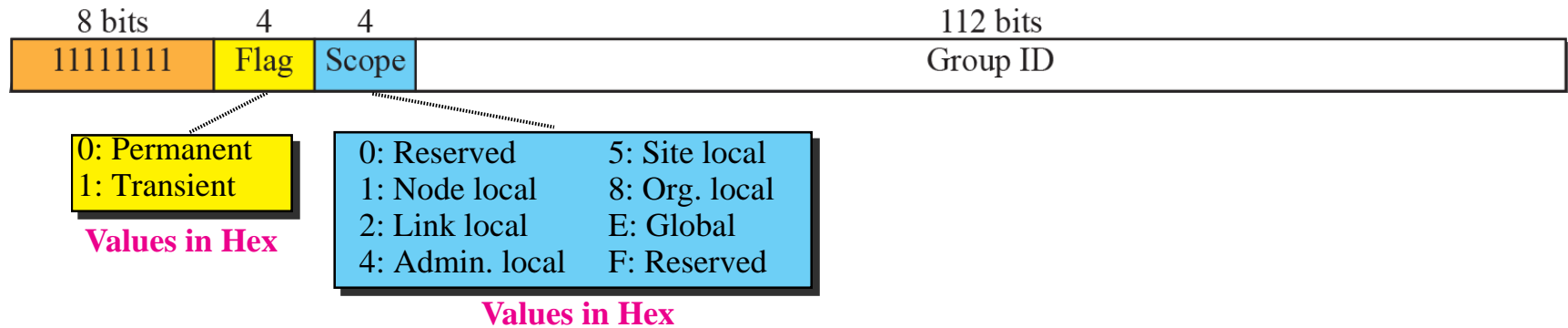


Figure 26.13 *Multicast address*



26-3 GLOBAL UNICAST ADDRESSES

This block in the address space that is used for unicast (one-to-one) communication between two hosts in the Internet is called global unicast address block. CIDR notation for the block is 2000::/3, which means that the three leftmost bits are the same for all addresses in this block (001). The size of this block is 2^{125} bits, which is more than enough for the Internet expansion in the many years to come.

Figure 26.14 *Global unicast address*

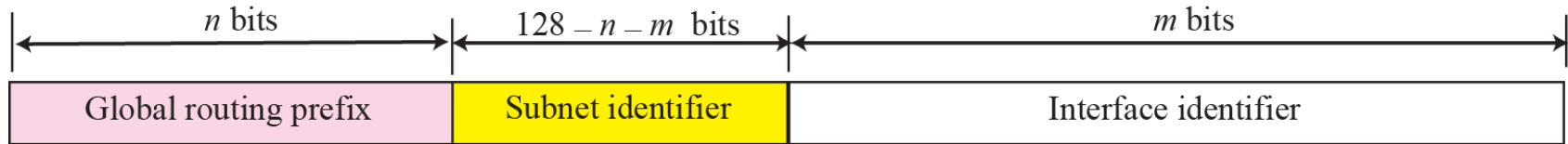
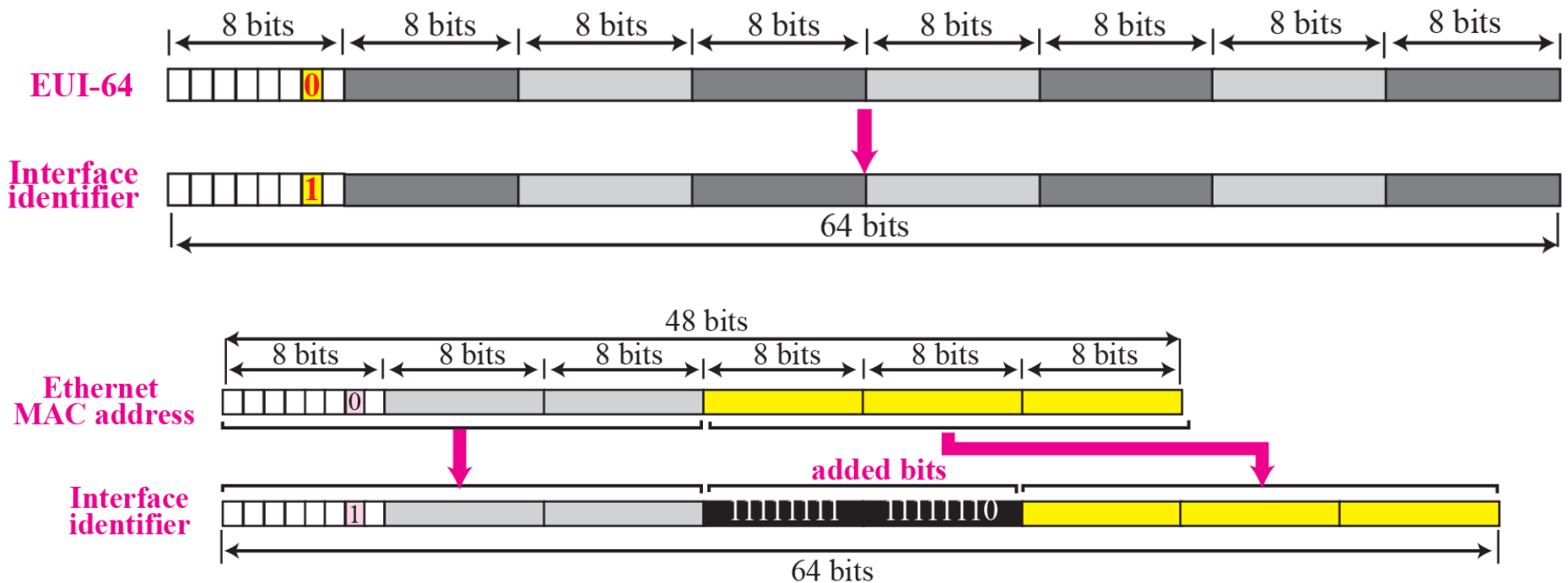


Table 26.2 *Recommended Length of Different Parts in Unicast Addressing*

<i>Block Assignment</i>	<i>Length</i>
Global routing prefix (n)	48 bits
Subnet identifier ($128 - n - m$)	16 bits
Interface identifier (m)	64 bits

Figure 26.15 Mapping for EUI-64



Rule:
For both EUI-64 and MAC, make the F5 an F7 (changing the second last bit from 0 to 1) to get Int Identifier
If MAC address then put an FFFE in the middle

Example 26.11

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

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 26.12

Find the interface identifier if the Ethernet physical address is $(F5-A9-23-14-7A-D2)_{16}$ using the format we defined for Ethernet addresses.

Solution

We only need to change the seventh bit of the first octet from 0 to 1, insert two octet FFFE₁₆ and change the format to colon hex notation. The result is **F7A9:23FF:FE14:7AD2** in colon hex.

Example 26.13

An organization is assigned the block 2000:1456:2474/48. 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 block 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 26.14

An organization is assigned the block **2000:1456:2474/48**. 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 is **F7A9:23FF:FE14:7AD2** (see Example 26.12). If we add this identifier to the global prefix and the subnet identifier, we get:

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

26-4 AUTOCONFIGURATION

One of the interesting features of IPv6 addressing is the autoconfiguration of hosts. As we discussed in IPv4, the host and routers are originally configured manually by the network manager. However, the Dynamic Host Configuration Protocol, DHCP, can be used to allocate an IPv4 address to a host that joins the network. In IPv6, DHCP protocol can still be used to allocate an IPv6 address to a host, but a host can also configure itself.

Example 26.15

Assume a host with Ethernet address $(F5-A9-23-11-9B-E2)_{16}$ has joined the network. What would be its global unicast address if the global unicast prefix of the organization is $3A21:1216:2165$ and the subnet identifier is $A245:1232$.

Solution

The host first creates its interface identifier as

$F7A9:23FF:FE11:9BE2$

using the Ethernet address read from its card. The host then creates its link-local address as

$FE80::F7A9:23FF:FE11:9BE2$

Example 26.15 *Continued*

Assuming that this address is unique, the host sends a router solicitation message and receives the router advertisement message that announces the combination of global unicast prefix and the subnet identifier as **3A21:1216:2165:A245:1232**. The host then appends its interface identifier to this prefix to find and store its global unicast address as:

```
3A21:1216:2165:A245:1232:F7A9:23FF:FE11:9BE2
```

26-5 RENUMBERING

To allow sites to change the service provider, Renumbering of the address prefix (n) was built into IPv6 addressing. As we discussed before, each site is given a prefix by the service provider to which it is connected. If the site changes the provider, the address prefix needs to be changed. A router to which the site is connected can advertise a new prefix and let the site use the old prefix for a short time before disabling it. In other words, during the transition period, a site has two prefixes.