IPv6 Addressing

ICT 2255

Introduction

- Reason for migration.
- 128 bits or 16 bytes or 16 octets.

Notation

- Binary
- Dotted-Decimal
  - To be compatible with IPv4.
  - Too long for 16-byte addresses.
- Colon Hexadecimal (colon hex)
  - 128 bits divided into 8 sections.
  - Each section is 2 Bytes.
  - Uses **hex** digits separated by a **colon**.

```
1111111011110110     ...     1111111100000000
FEF6:BA98:7654:3210:ADEF:BBFF:2922:FF00
```

Colon Hexadecimal: Abbreviation

- Many of the digits are zeros, hence can be abbreviated.
- Leading zeros can be omitted.
- Zero Compression : Applied **only once per address**.

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

Mixed Representation

- Colon hex and dotted-decimal.
- Appropriate during the transition period in which an IPv4 address is embedded in an IPv6 address (as the rightmost 32 bits).
- Happens when **all or most** of the leftmost sections of the IPv6 address are 0s.
- Example

  (::130.24.24.18)

CIDR Notation

- IPv6 uses hierarchical addressing.
- Hence, allows classless addressing and CIDR notation.
- Example: FDEC::BBAA:0:FFFF/60

Questions

- Show the unabbreviated colon hex notation for the following IPv6 addresses.

a. 64 0s followed by 64 1s.

b. 128 0s.

c. 128 1s.

d. 128 alternative 1s and 0s.

- Show the zero contraction version of the above addresses.

Questions

- Abbreviate:

a. 0000: 0000: FFFF: 0000: 0000: 0000: 0000: 0000

b. 1234: 5678: 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

Questions

- Decompress

a. 1111 :: 2222

b. ::

c. 0: 1 ::

d. AAAA: A: AA :: 1234

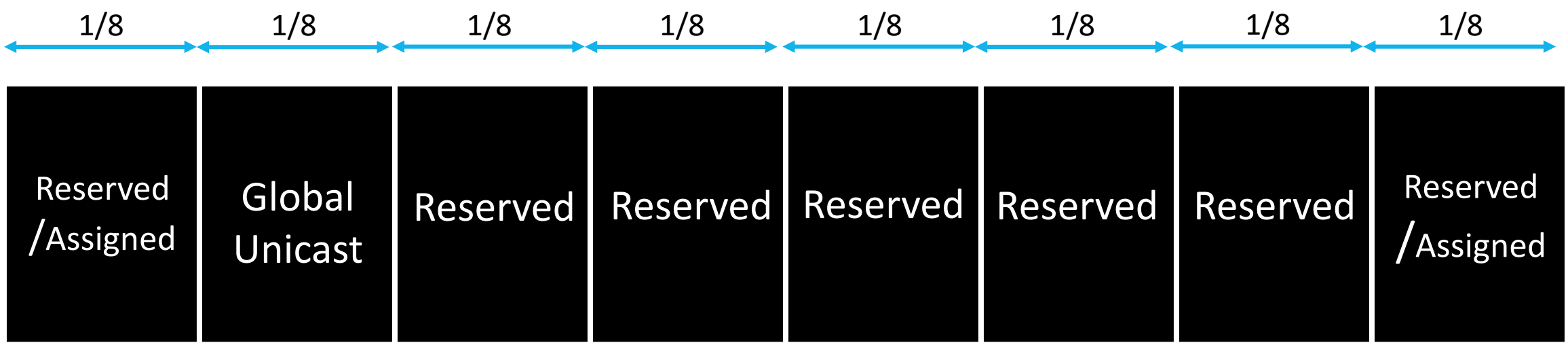
Address Types

- Unicast Address
- Anycast Address (No separate block assigned)
- Multicast Address
- Broadcasting??

Address Space

- 2^{128} addresses.
- 2^{96} times of IPv4.
- Current human population?
- With 16 billion humans (2^{34}), each person can have 2^{94} addresses.
- If we assign 2^{60} addresses to each user each year, it takes 2^{68} years to deplete address.

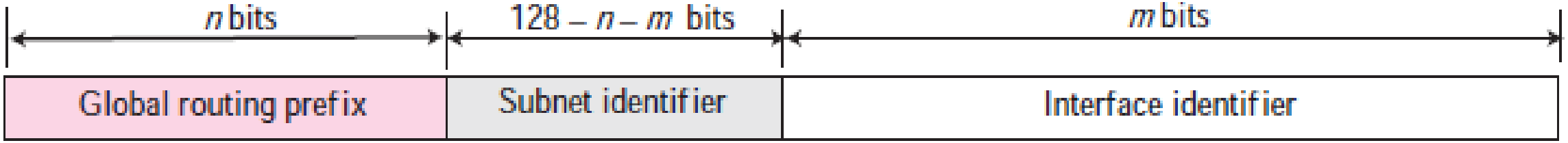
Address Space Allocation



1/8 = 2^{125} addresses in each section.

Global Unicast Addresses

- Block Prefix : 001
- CIDR: 2000:: /3 ➔3 leftmost bits are same for all addresses in the block.
- 3 Levels of Hierarchy.

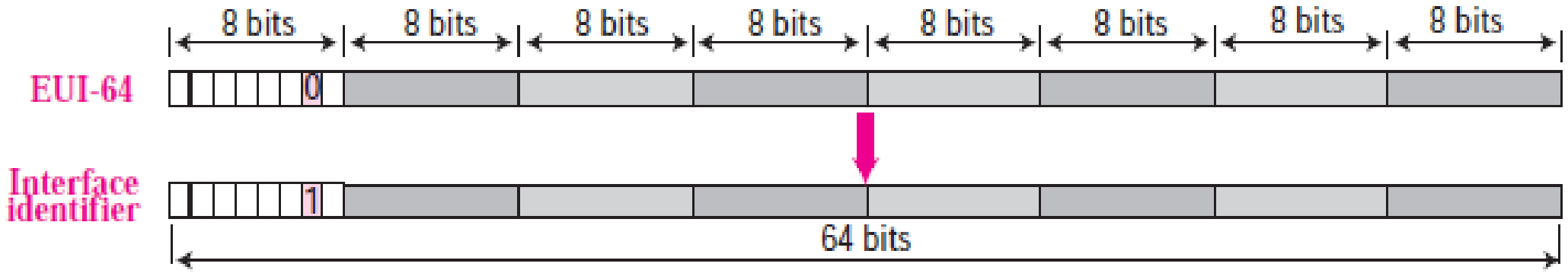


- Global Routing Prefix (48 bits):
  - Route the packet through the Internet to the organization site.
  - How many sites can be defined?
- Subnet Identifier (16 bits): How many subnets in an organization can be identified?

Global Unicast Addresses: Interface Identifier

- 64 bits (similar to hostid in IPv4). Nomenclature?
- Relation between the hostid (at the IP level) and MAC address (at DLL).
  - Not possible in IPv4. Why?
  - Possible in IPv6, albeit with a **constraint**.
- Embedding facility of physical address eliminates the mapping process.
- Two common physical addressing schemes to be considered:
  - Extended Unique Identifier (EUI-64) defined by IEEE.
  - MAC address defined by ethernet.

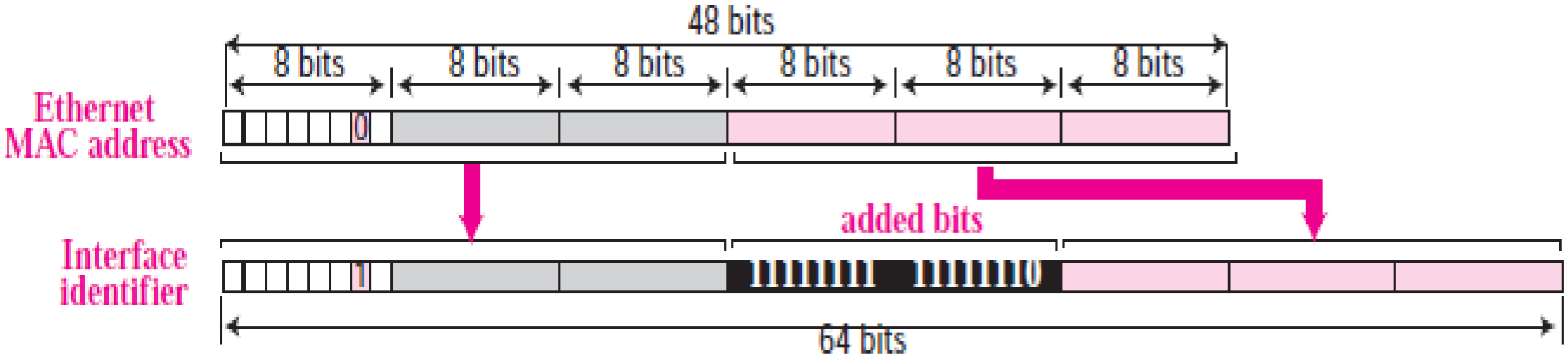
EUI-64 to Interface Identifier



- Find the interface identifier if the physical address in the EUI is

$$(\mathbf{F5\text{-}A9\text{-}23\text{-}EF\text{-}07\text{-}14\text{-}7A\text{-}D2})_{16}$$

MAC address to Interface Identifier



- Find the interface identifier if the Ethernet physical address is

$$(\mathbf{F5\text{-}A9\text{-}23\text{-}EF\text{-}07\text{-}14\text{-}7A\text{-}D2})_{16}$$

Questions

Q: 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?

Ans: 2000:1456:2474:0000/64 and 2000:1456:2474:0001/64.

Q: 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 $(\mathbf{F5\text{-}A9\text{-}23\text{-}14\text{-}7A\text{-}D2})_{16}$?

Ans: 2000:1456:2474:0002:F7A9:23FF:FE14:7AD2/128

IPv4 Compatible

Reserved/Assigned: First Section

Reserved/Assigned: First Section

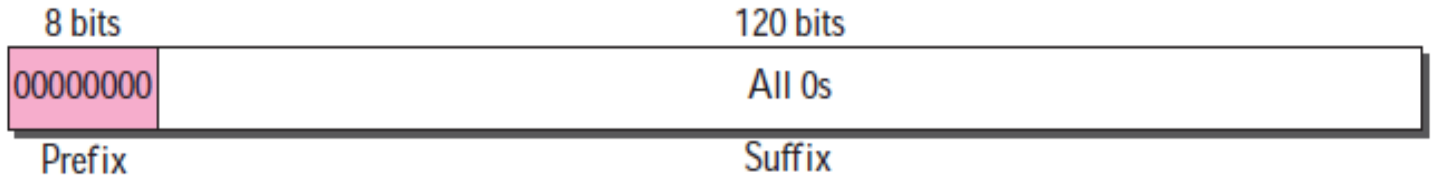
	Block Prefix	*CIDR*	*Block Assignment*	*Fraction*
1	0000 0000	0000::/8	Reserved (IPv4 compatible)	1/256
	0000 0001	0100::/8	Reserved	1/256
	0000 001	0200::/7	Reserved	1/128
	0000 01	0400::/6	Reserved	1/64
	0000 1	0800::/5	Reserved	1/32
	0001	1000::/4	Reserved	1/16

How many addresses for the first sub-block?

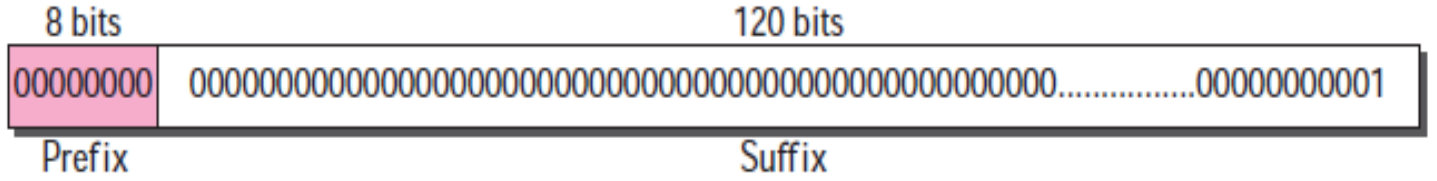
2^{120}

Reserved/Assigned: First Section

- Unspecified Address (::/128)
  - Used during Bootstrap.

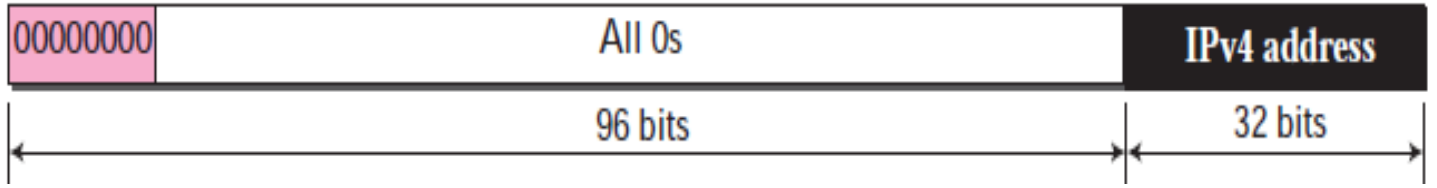


- Loopback Address (::1/128)



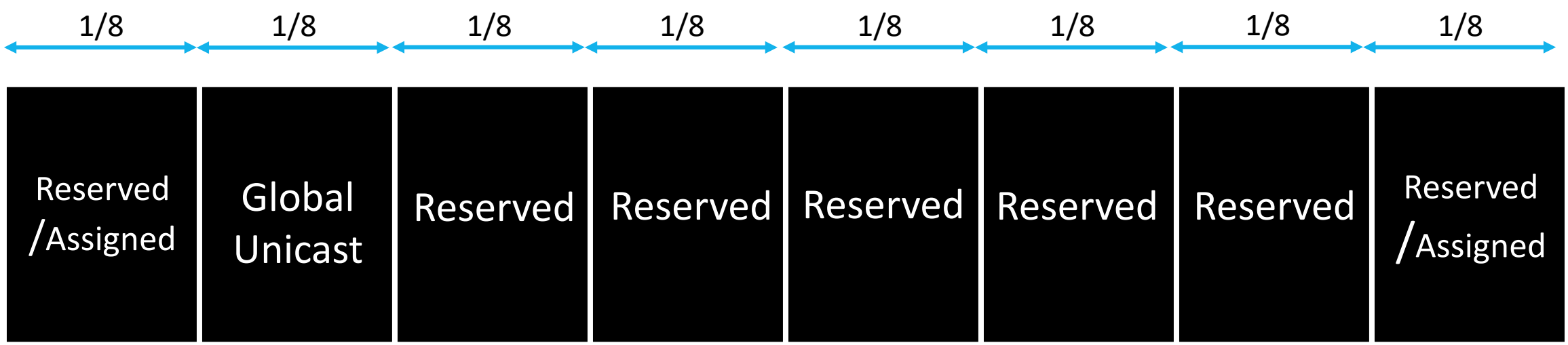
- Embedded IPv4 Address

Compatible



Mapped

Address Space Allocation



1/8 = 2^{125} addresses in each section.

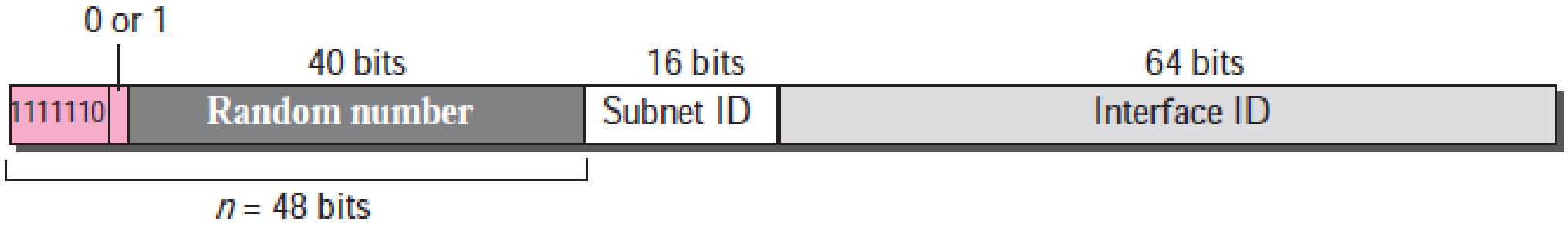
Reserved/Assigned: Last Section

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

IPv6 uses two large blocks for private addressing:
one at the site level and one at the link level.

Unique Local Unicast Block

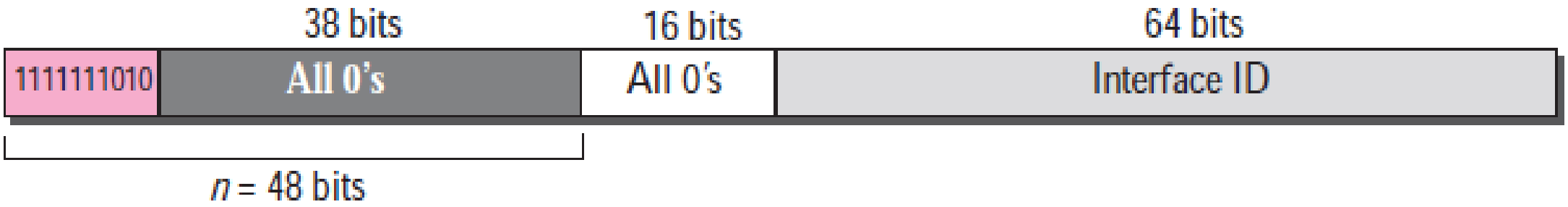
- A subblock in a **unique local unicast block** can be **privately created and used by a site.**



- The packet carrying this type of address as the destination address is **not expected to be routed.**
- 8th bit can be 0 or 1 to define how the address is selected (locally or by an authority).
- First 48 bits defines a subblock that looks like a global unicast address.

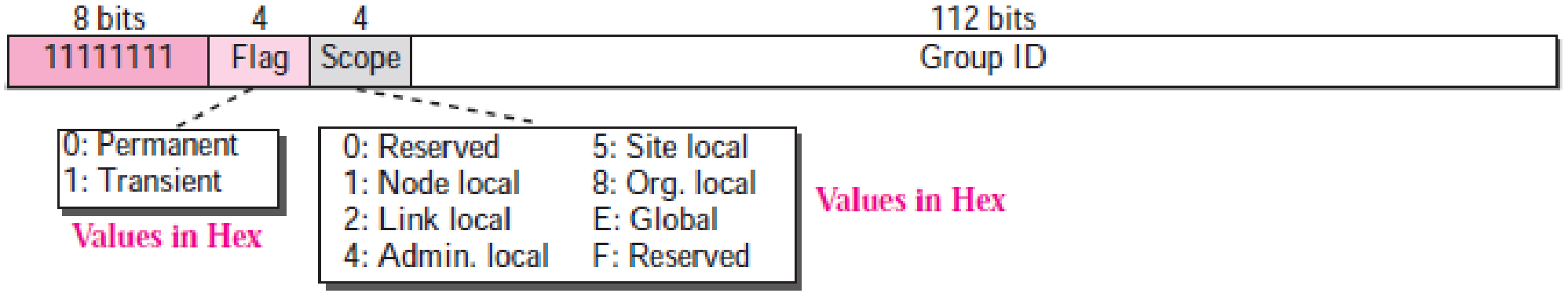
Link Local Block

- A subblock in this block can be used as a **private address in a network**.
- Has the block identifier 1111111010. The next 54 bits are set to zero.
- The last 64 bits can be changed to define the interface for each computer.



Multicast Block

- Multicast addresses are used to define **a group of hosts** instead of just one.
- In IPv6 a large block of addresses are assigned for multicasting.
- The third field defines the **scope of the group** address.



Autoconfiguration

1. The host first creates a link local address for itself. How?
2. The host then tests to see if this link local address **is unique** and not used by other hosts.
   - Sends a ***neighbor solicitation message*** and waits for ***neighbor advertisement message.***
   - If fails, uses other means for the purpose.
3. The host stores this address as its link-local address (for ?) and generates a global unicast address.
   - Sends a ***router solicitation message*** to a local router and waits for ***router advertisement message*** (content?).

Question

- Assume a host with Ethernet address (**F5-A9-23-11-9B-E2**)16 has joined the network.
- Global unicast prefix of the organization is 3A21:1216:2165.
- Subnet identifier is A245.
- What would be its global unicast address ?

Renumbering

- **Renumbering** of the address prefix (*n*) was built into IPv6 addressing.
- 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.
- During the transition period, a site has two prefixes.
- Problem?

Book

- Behrouz A. Forouzan, “TCP/IP Protocol Suite”, 4th Ed. Chapter 26.