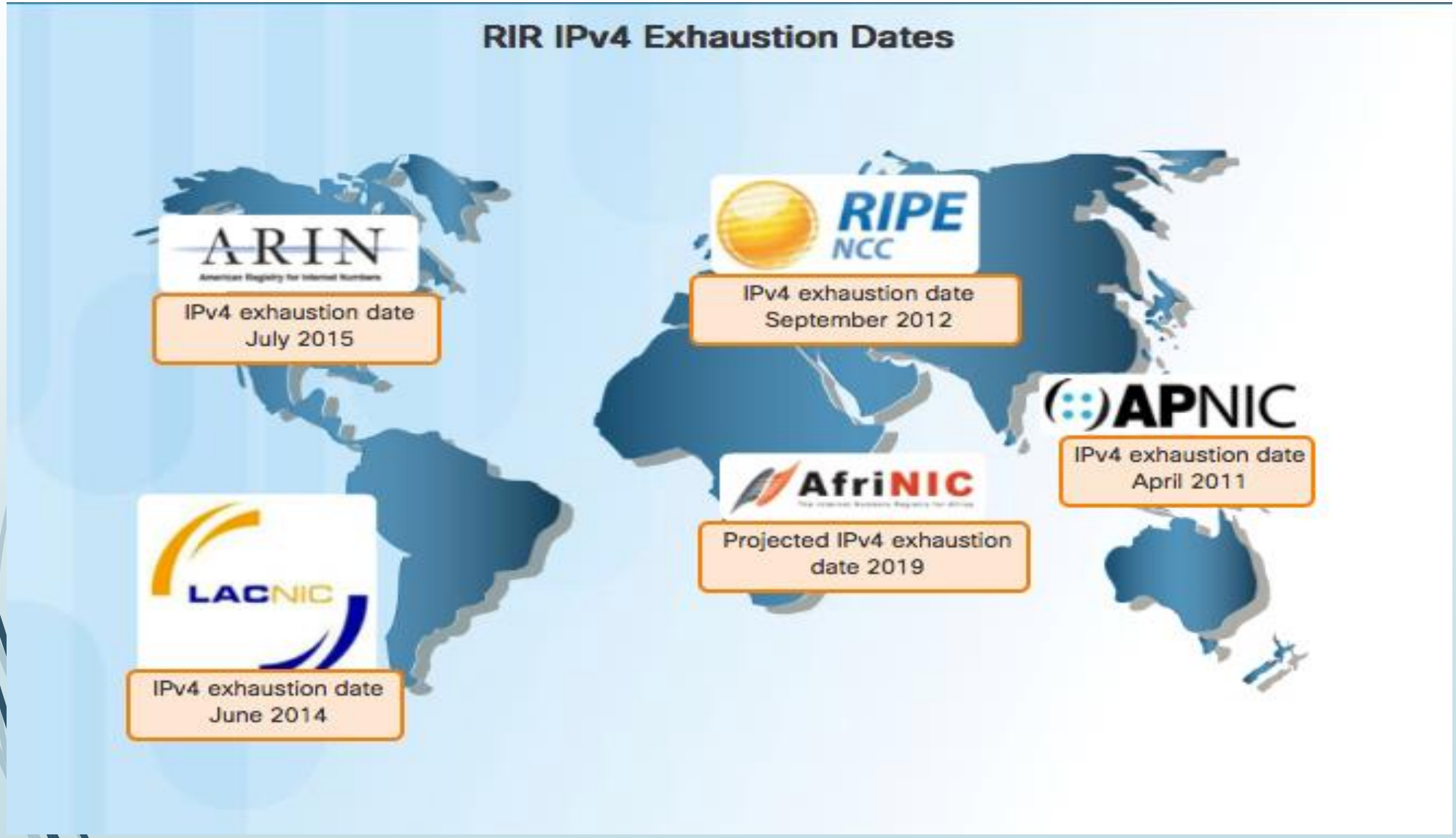
Computer Networks
Lecture 3

IPv6 Addressing

Why IPv6

- IPv4 has a theoretical maximum of 4.3 billion addresses
- plus private addresses in combination with NAT
- NAT having limitations in peer-to-peer communications
- With an Internet of things, devices other than computers, tablets, and smartphones, sensors, Internet-ready devices, automobiles, biomedical devices, household appliances, natural ecosystems etc… need to connect to the internet.

Why IPv6


RIR IPv4 Exhaustion Dates
ARIN
IPv4 exhaustion date
July 2015
RIPE
NCC
IPv4 exhaustion date
September 2012
APNIC
IPv4 exhaustion date
April 2011
AfriNIC
Projected IPv4 exhaustion
date 2019
LACNIC
IPv4 exhaustion date
June 2014

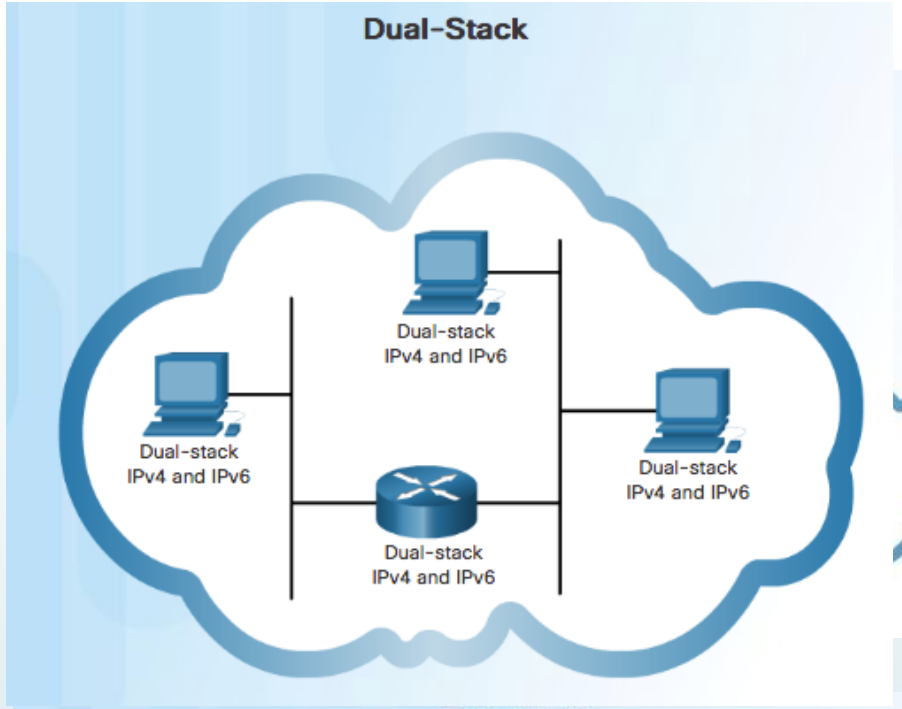
How it looks like

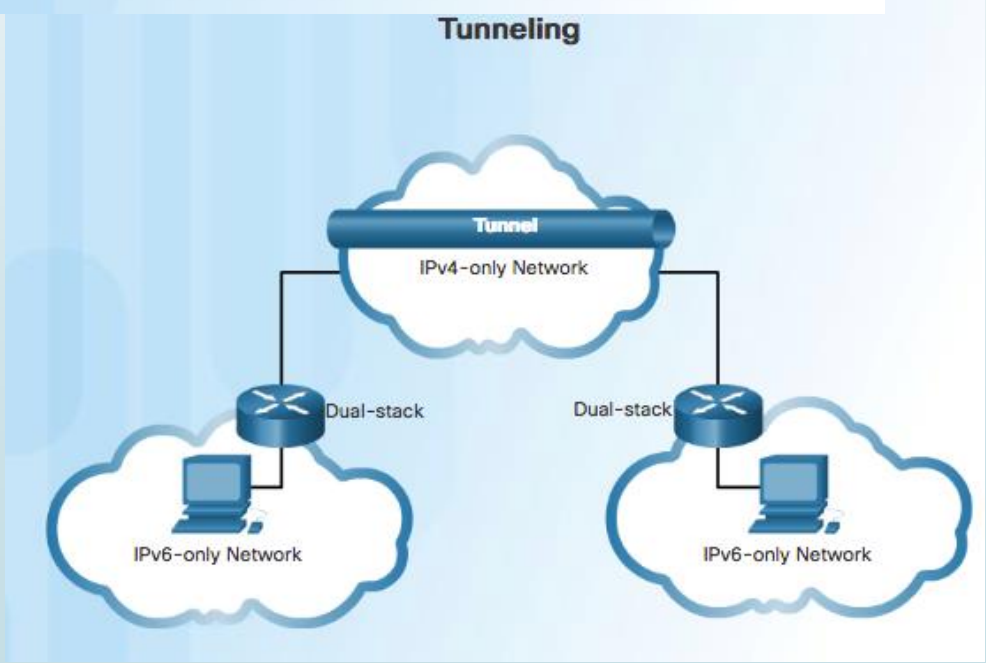
- IPv6 has a larger 128-bit address space
- 340 undecillion addresses. (That is the number 340, followed by 36 zeroes.)
- When the IETF began its development of a successor to IPv4, so it fix the limitations of IPv4 and include additional enhancements
- Ex- 2001:0DB8:0000:1111:0000:0000:0000:0200

Hextet used to refer to a segment of 16 bits or four hexadecimals

IPv4 and IPv6 Coexistence

- **Dual Stack** –dual stack allows **IPv4 and IPv6 to coexist on the same network segment**. Dual stack devices run both IPv4 and IPv6 protocol stacks simultaneously.
- **Tunneling** –tunneling is a method of transporting an IPv6 packet over an IPv4 network. **The IPv6 packet is encapsulated inside an IPv4 packet**, similar to other types of data.
- **Translation** – Network Address Translation 64 (NAT64) allows IPv6-enabled devices to communicate with IPv4-enabled devices using a translation technique similar to NAT for IPv4**. An IPv6 packet is translated to an IPv4 packet** and vice versa.





Term	Description
IPv6	128-bit address/340 undecillion addresses.
IPv4	32-bit address/4.3 billion addresses.
Tunneling	Transports an IPv6 packet over IPv4 networks.
Translation	Uses NAT64 to convert between IPv6 and IPv4.
Dual Stack	Allows IPv4 and IPv6 to coexist on the same network segment.

Address formats

2001	0DB8	0000	1111	0000	0000	0000	0200
2001	0DB8	0000	00A3	ABCD	0000	0000	1234
2001	0DB8	000A	0001	0000	0000	0000	0100
2001	0DB8	AAAA	0001	0000	0000	0000	0200
FE80	0000	0000	0000	0123	4567	89AB	CDEF
FE80	0000	0000	0000	0000	0000	0000	0001
FF02	0000	0000	0000	0000	0000	0000	0001
FF02	0000	0000	0000	0000	0001	FF00	0200
0000	0000	0000	0000	0000	0000	0000	0001
0000	0000	0000	0000	0000	0000	0000	0000

IPv6 Address - Rule 1 (Omitting Leading 0s)

- The first rule to help reduce the notation of IPv6 addresses is any leading 0s (zeros) in any 16-bit section or hextet can be omitted
  - 01AB can be represented as 1AB
  - 09F0 can be represented as 9F0
  - 0A00 can be represented as A00
  - 00AB can be represented as AB

Preferred	2001:0DB8:0000:1111:0000:0000:0000:0200
No leading 0s	2001:DB8:0:1111:0:0:0:200

IPv6 Address -Rule 2 (Omitting All 0 Segments)

- A double colon (::) can replace any single, contiguous string of one or more 16-bit segments (hextets) consisting of all 0's

Preferred	2001:0DB8:0000:0000:ABCD:0000:0000:0100
Compressed	2001:DB8:0:0:ABCD::100

Preferred	2001:0DB8:0000:1111:0000:0000:0000:0200
No leading 0s	2001:DB8:0:1111:0:0:0:200
Compressed	2001:DB8:0:1111::200

Only one :: may be used.

IPv6 Address Types

- There are three types of IPv6 addresses:
  - Unicast
  - Multicast
  - Anycast

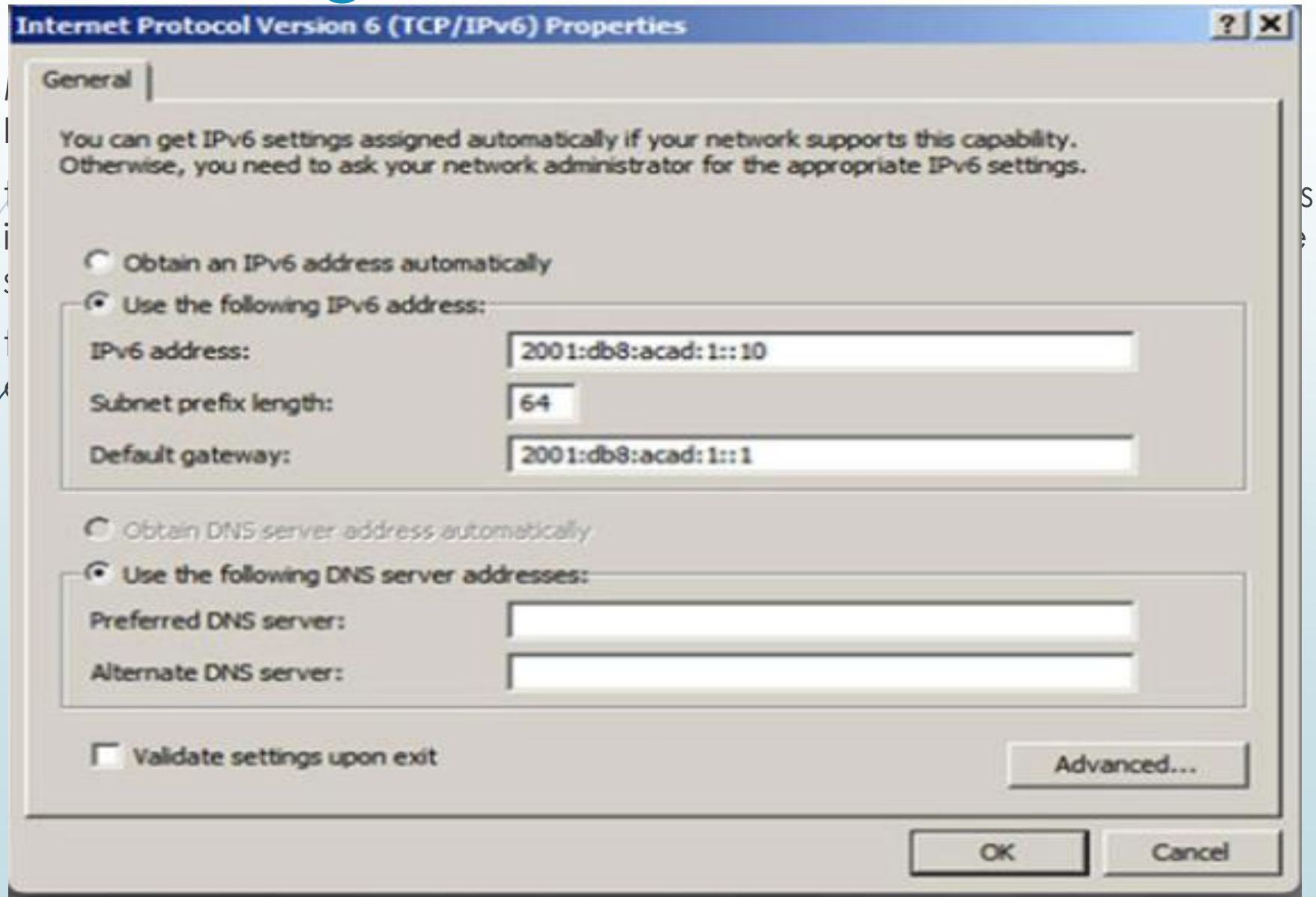
*** IPv6 does not have broadcast addresses.

IPv6 Unicast Addresses

- **Global unicast**
  - Similar to a public IPv4 address.
  - Globally unique, Internet routable addresses.
  - Global unicast addresses can be configured statically or assigned dynamically.
  - Currently, only global unicast addresses with the first three bits of 001 or 2000::/3 are being assigned. (The first hextet has a range of (2000) to (3FFF).
- **Link-local**
  - Link-local addresses are used to communicate with other devices on the same local link. (The first hextet has a range of (FE80) to (FEBF).)
- **Unique local**
  - Similar to the private addresses for IPv4, but there are significant differences.
  - (FC00::/7 to FDFF::/7)

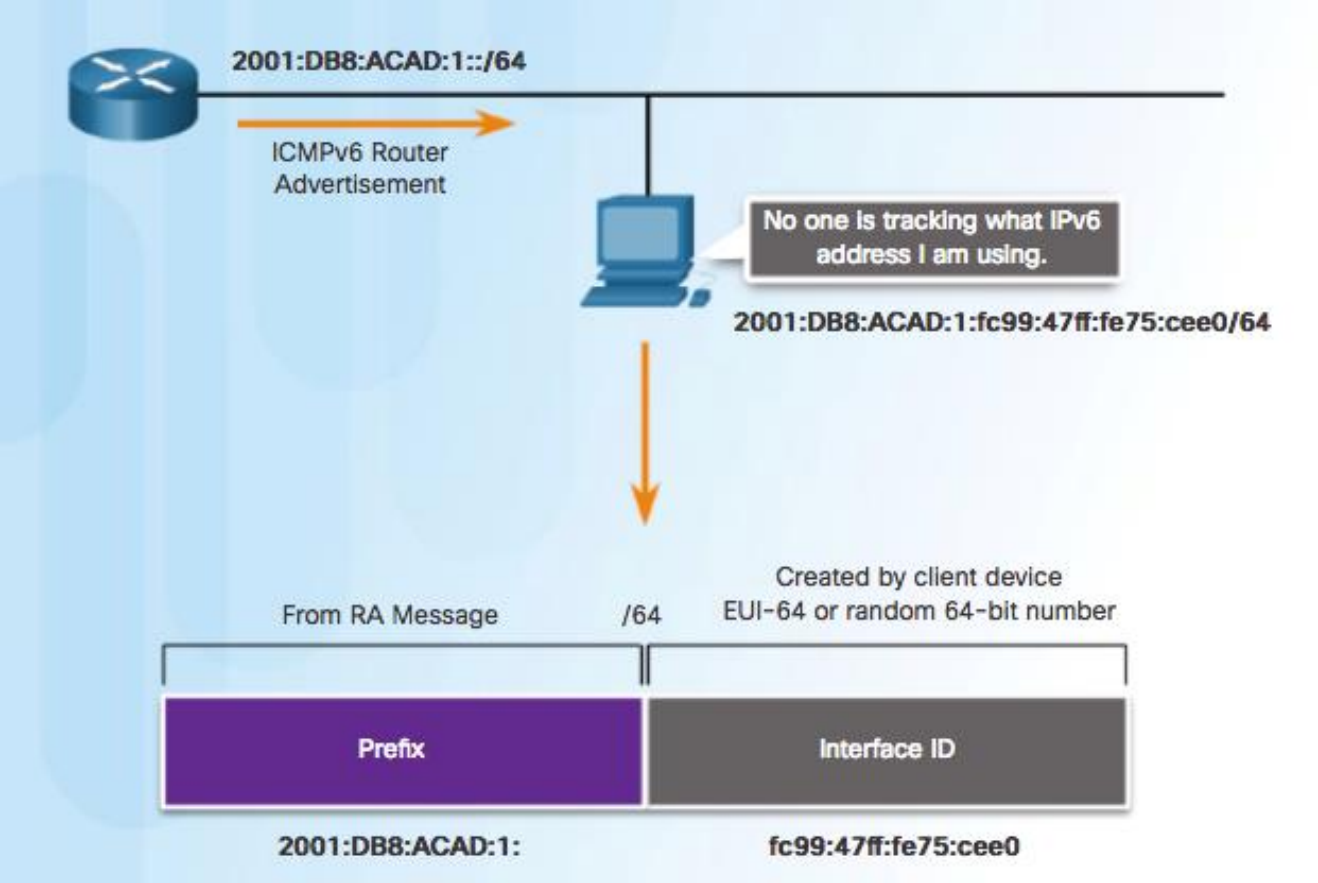
*** 2001:0DB8::/32 address has been reserved for documentation purposes

Host Configuration



Dynamic Configuration - SLAAC

- Stateless Address Autoconfiguration (SLAAC) is a method that allows a device to obtain its prefix, prefix length, default gateway address, and other information from an *IPv6 router* without the use of a DHCPv6 server.



EUI-64 Process

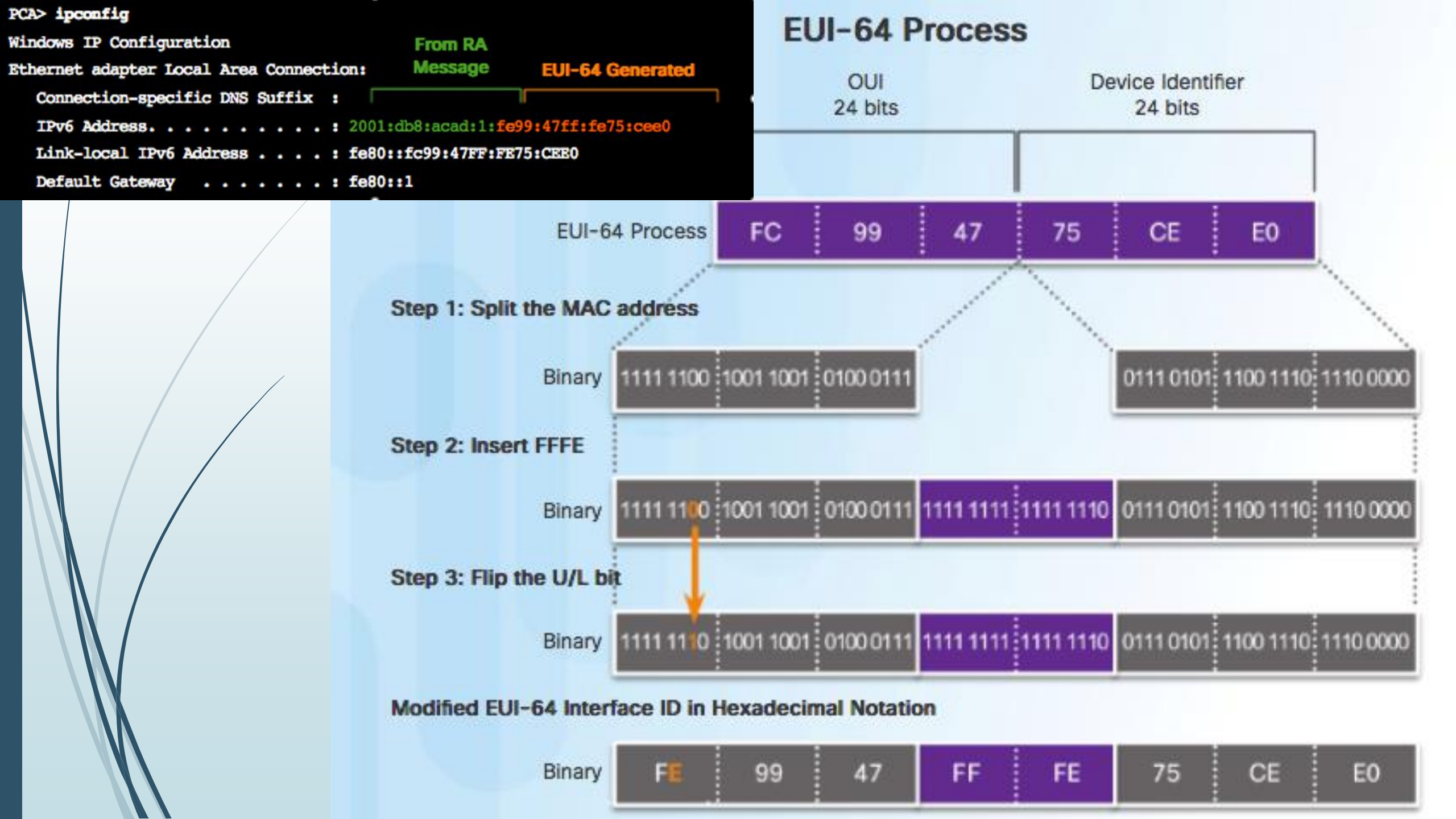
- IEEE defined the Extended Unique Identifier (EUI) or modified EUI-64 process. This process uses a client's 48-bit Ethernet MAC address, and inserts another 16 bits in the middle of the 48-bit MAC address to create a 64-bit Interface ID.

  - **Step 1:** Divide the MAC address between the OUI and device identifier.
  - **Step 2:** Insert the hexadecimal value FFFE, which in binary is: 1111 1111 1111 1110
  - **Step 3:** Convert the first 2 hexadecimal values of the OUI to binary and flip the U/L bit (bit 7). In this example, the 0 in bit 7 is changed to a 1

```
PCA> ipconfig
Windows IP Configuration
Ethernet adapter Local Area Connection:
   Connection-specific DNS Suffix  :
   IPv6 Address. . . . . . . . . . . : 2001:db8:acad:1:fe99:47ff:fe75:cee0
   Link-local IPv6 Address . . . . . : fe80::fc99:47FF:FE75:CEE0
   Default Gateway . . . . . . . . . : fe80::1
```

From RA Message

EUI-64 Generated



Questions ?