

# **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





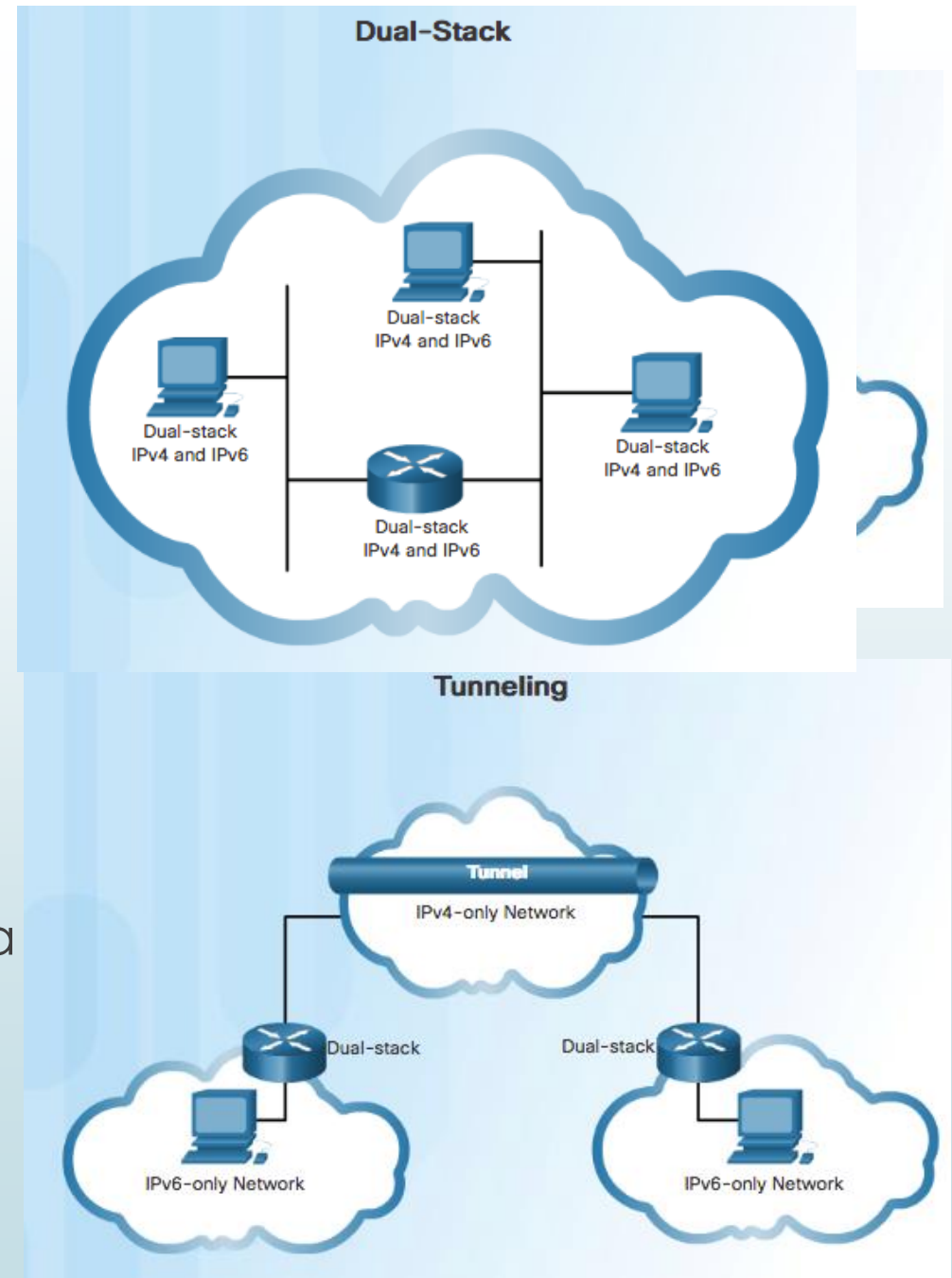
# How it looks like

- 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 hexadecimal

# 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 (hexets) consisting of all 0's

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

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 hexet has a range of (2000) to (3FFF).)

## ➤ Link-local

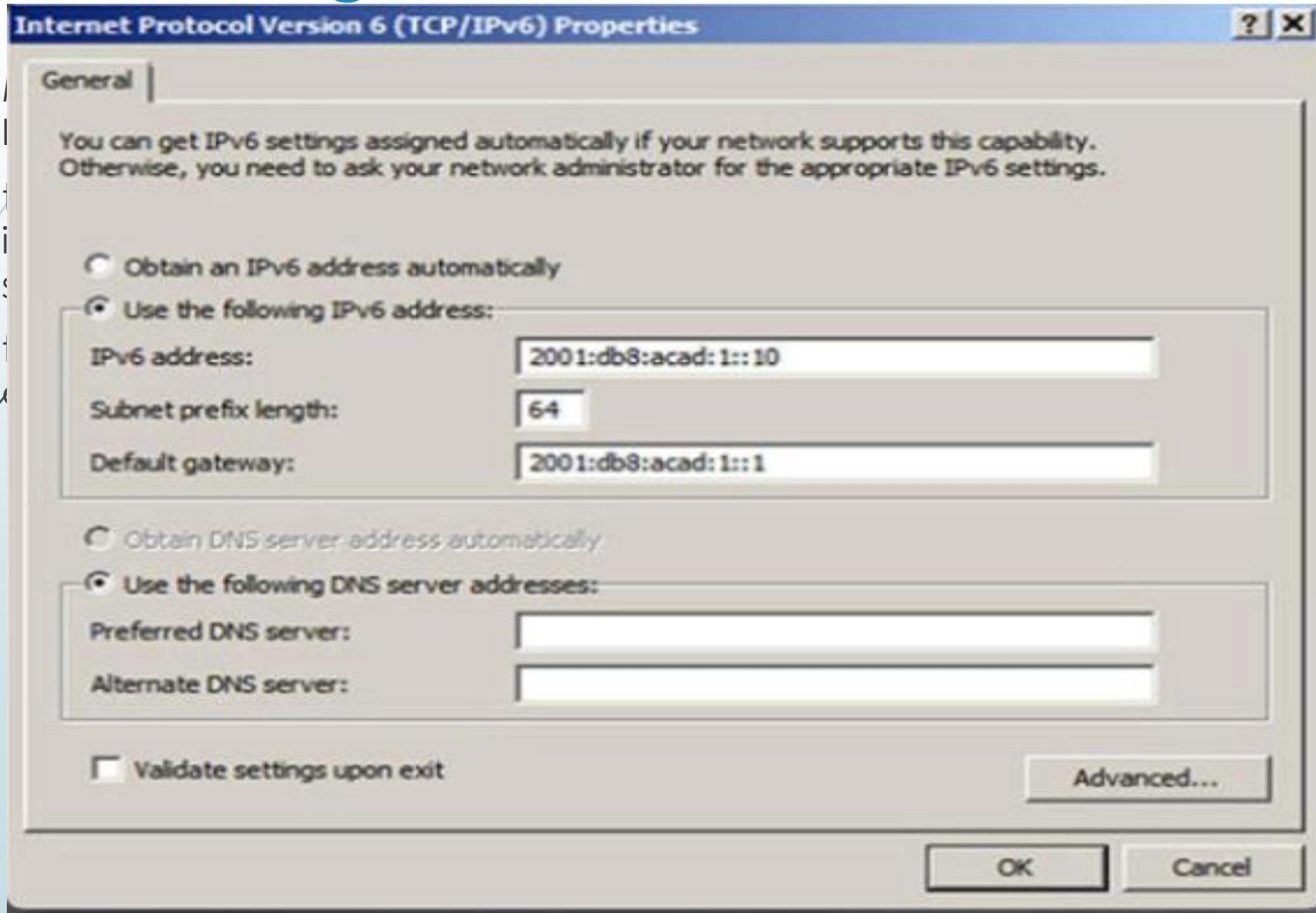
- Link-local addresses are used to communicate with other devices on the same local link. (The first hexet has a range of (FE80) to (FEBF).)

## ➤ 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



The image shows a screenshot of the 'Internet Protocol Version 6 (TCP/IPv6) Properties' dialog box, specifically the 'General' tab. The dialog box has a title bar with a question mark and a close button. The 'General' tab is selected, and the text inside reads: 'You can get IPv6 settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IPv6 settings.'

There are two radio button options for IPv6 address assignment:

- ☐ Obtain an IPv6 address automatically
- ☒ Use the following IPv6 address:

When the second option is selected, a group box contains three text fields:

- IPv6 address: 2001:db8:acad:1::10
- Subnet prefix length: 64
- Default gateway: 2001:db8:acad:1::1

Below this group box, there are two more radio button options for DNS server address assignment:

- ☐ Obtain DNS server address automatically
- ☒ Use the following DNS server addresses:

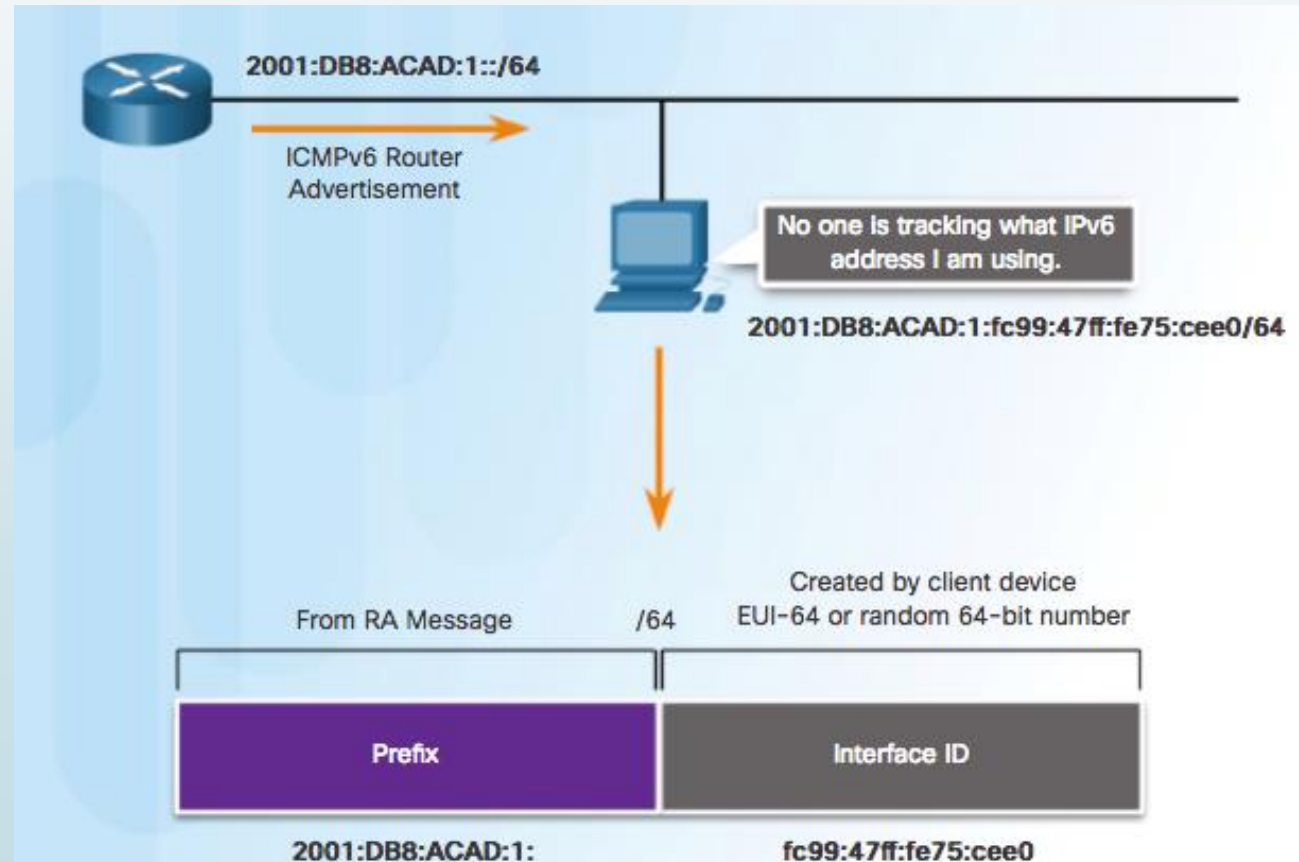
When the second option is selected, a group box contains two text fields:

- Preferred DNS server: (empty)
- Alternate DNS server: (empty)

At the bottom left, there is a checkbox labeled 'Validate settings upon exit' which is currently unchecked. At the bottom right, there is an 'Advanced...' button. At the very bottom of the dialog box, there are 'OK' and 'Cancel' buttons.

# 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

## EUI-64 Process

OUI  
24 bits

Device Identifier  
24 bits

EUI-64 Process  
**Step 1: Split the MAC address**

Binary

1111 1100 1001 1001 0100 0111

0111 0101 1100 1110 1110 0000

**Step 2: Insert FFFE**

Binary

1111 1100 1001 1001 0100 0111

1111 1111 1111 1110

0111 0101 1100 1110 1110 0000

**Step 3: Flip the U/L bit**

Binary

1111 1110 1001 1001 0100 0111

1111 1111 1111 1110

0111 0101 1100 1110 1110 0000

**Modified EUI-64 Interface ID in Hexadecimal Notation**

Binary

FE

99

47

FF

FE

75

CE

E0



Questions ?