CSE 4512 [Computer Networks Lab]
Lab # 04

1. Objectives:
- Describe the concept of IPv6
- Configure IPv6 addressing scheme in a network topology

2. Theory:
As with other labs, this lab will also build up on the concepts and techniques of previous labs. So, make sure you've properly understood the previous lab contents.

IPv6:
Internet Protocol version 6 or IPv6 is the successor to IPv4 or Internet Protocol version 4. In nineties, it became evident that IPv4 can't accommodate the explosion of connected devices in the internet. Theoretically, IPv4 can support 2^{32} unique addresses whereas IPv6 can support 2^{128} addresses as an IPv6 address uses 128 bits. Though the actual number is less than that due to some reserved address ranges but still the available address space is deemed large enough for the foreseeable future.

Like its IPv4 counterpart, an IPv6 address also has two portions: *Network Identifier* (most significant 64-bit) and *Interface Identifier* (least significant 64-bit). Note that, this division into two parts is only valid for IPv6 unicast and anycast address, not for multicast address. The network identifier or network prefix is used for routing and interface identifier works the same as the host identifier of IPv4.

An IPv6 address is represented as *eight* groups of *four* hexadecimal digits, where each group is 16 bits in length (as a single hex digit is 4-bits wide). Considering IPv4 terminology, each group is formed of two octets. The groups are separated by colons (:). An example IPv6 address is:
$$2001:0db8:85a3:0000:0000:8a2e:0370:7334$$

To keep the representation of an IPv6 address concise, two rules are followed.

- If there are one or more leading zeros in a group, those are removed. For example, the group 0069 will become 69.
- Consecutive groups of zeros are replaced with a double colon (::). This can only be used once in an address, as using double colon multiple times would make the address indeterminate.

Lets see these rules in action on an example IPv6 address.

Initial address: ***2001:0db8:0000:0000:0000:ff00:0042:8329***

After removing all leading zeros in each group: ***2001:db8:0:0:0:ff00:42:8329***

After omitting consecutive sections of zeros: ***2001:db8::ff00:42:8329***

An extreme example of these two rules can be seen in the IPv6 loopback address. The loopback address in IPv6 is *0000:0000:0000:0000:0000:0000:0000:0001,* which after applying the above two rules becomes *::1.* Pretty concise, right?

Unlike IPv4, there's a special address called link-local address which has to be assigned on every IPv6 enabled interface. So, each IPv6 hosts usually has more than one IPv6 address assigned to each of their IPv6 enabled interface. The name link-local comes from the fact that this address is only valid for communicating within the network segment or the broadcast domain of the connected host. The link-local address of the router is used as the default gateway for the connected hosts. Link-local address is also used as part of the neighbor discovery protocol and automatic address configuration. Link-local address uses the prefix *fe80::/10.* Of the 64 bits of a link-local addresses' network component, the most significant 10 bits (*1111111010*) correspond to the IANA-reserved "global routing prefix" for link-local addresses, while the "subnet ID" (the remaining 54 bits) is *zero.* Rest 64-bits are used as interface identifier.

3. Configure IPv6 addressing:

In this section, we'll configure IPv6 addressing in the given network topology.

- **I.** Command *IPv6 unicast routing* enables IPv6 routing**.** Execute this command in the privileged EXEC mode of the router.
- **II.** Assign IPv6 addresses in the router interfaces using the following commands.
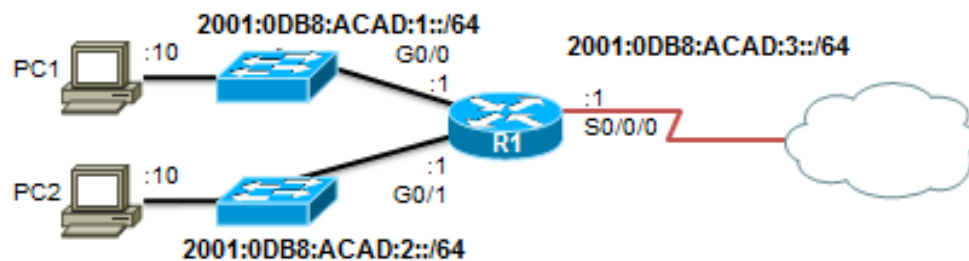
```
R1(config)#interface gigabitethernet 0/0
R1(config-if)#ipv6 address 2001:db8:acad:1::1/64
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#interface gigabitethernet 0/1
R1(config-if)#ipv6 address 2001:db8:acad:2::1/64
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#interface serial 0/0/0
R1(config-if)#ipv6 address 2001:db8:acad:3::1/64
R1(config-if)#clock rate 56000
R1(config-if)#no shutdown
```

III. Assign link-local addresses to the router interfaces.

```
R1(config)#interface gigabitethernet 0/0
R1(config-if)#ipv6 address fe80::1 ?
  link-local  Use link-local address

R1(config-if)#ipv6 address fe80::1 link-local
R1(config-if)#exit
R1(config)#interface gigabitethernet 0/1
R1(config-if)#ipv6 address fe80::1 link-local
R1(config-if)#exit
R1(config)#interface serial 0/0/0
R1(config-if)#ipv6 address fe80::1 link-local
R1(config-if)#
```

IV. Verify addressing.

```
R1#show ipv6 interface brief
GigabitEthernet0/0        [up/up]
    FE80::1
    2001:DB8:ACAD:1::1
GigabitEthernet0/1        [up/up]
    FE80::1                                    Statically configured link-
    2001:DB8:ACAD:2::1                         local addresses
Serial0/0/0               [up/up]
    FE80::1
    2001:DB8:ACAD:3::1
Serial0/0/1               [administratively down/down]
    unassigned
R1#
```

4. Tasks:

I. You will implement IPv6 addressing scheme following the address configurations in a given network topology in this task. The task description for this task is provided in the pdf *Task-1_configure-ipv6-addressing*. You're provided a .pka file for this task.

II. You'll do the **Part 3** of the task provided in *Task-2_configure-layer-3-switching-and-inter-vlan-routing* that was omitted before in Lab-3. You'll configure the IPv6 addressing on top of your solution of Task 2 of Lab 3 following the instructions in Part 3.

Packet Tracer - Configure IPv6 Addressing

Addressing Table

Device	Interface	IPv6 Address/Prefix	Default Gateway
R1	G0/0	2001:db8:1:1::1/64	N/A
		fe80::1	
	G0/1	2001:db8:1:2::1/64	N/A
		fe80::1	
	S0/0/0	2001:db8:1:a001::2/64	N/A
		fe80::1	
Sales	NIC	2001:db8:1:1::2/64	fe80::1
Billing	NIC	2001:db8:1:1::3/64	fe80::1
Accounting	NIC	2001:db8:1:1::4/64	fe80::1
Design	NIC	2001:db8:1:2::2/64	fe80::1
Engineering	NIC	2001:db8:1:2::3/64	fe80::1
CAD	NIC	2001:db8:1:2::4/64	fe80::1
ISP	S0/0/0	2001:db8:1:a001::1	fe80::1

Objectives

Part 1: Configure IPv6 Addressing on the Router

Part 2: Configure IPv6 Addressing on Servers

Part 3: Configure IPv6 Addressing on Clients

Part 4: Test and Verify Network Connectivity

Background

In this activity, you will practice configuring IPv6 addresses on a router, servers, and clients. You will also

practice verifying your IPv6 addressing implementation.

Part 1: Configure IPv6 Addressing on the Router

Step 1: Enable the router to forward IPv6 packets.

    a. Click **R1** and then the **CLI** tab. Press **Enter**.

    b. Enter privileged EXEC mode.

    c. Enter the **ipv6 unicast-routing** global configuration command. This command must be entered to enable the router to forward IPv6 packets.

```
R1(config)# ipv6 unicast-routing
```

Packet Tracer - Configure IPv6 Addressing

Step 2: Configure IPv6 addressing on GigabitEthernet0/0.

    a. Enter the commands necessary to move to interface configuration mode for GigabitEthernet0/0.

    b. Configure the IPv6 address with the following command:

```
R1(config-if)# ipv6 address 2001:db8:1:1::1/64
```

    c. Configure the link-local IPv6 address with the following command:

```
R1(config-if)# ipv6 address fe80::1 link-local
```

    d. Activate the interface.

```
R1(config-if)# no shutdown
```

Step 3: Configure IPv6 addressing on GigabitEthernet0/1.

    a. Enter the commands necessary to move to interface configuration mode for GigabitEthernet0/1.

    b. Refer to the **Addressing Table** for the correct IPv6 address.

    c. Configure the IPv6 address, the link-local address and activate the interface.

Step 4: Configure IPv6 addressing on Serial0/0/0.

    a. Enter the commands necessary to move to interface configuration mode for Serial0/0/0.

    b. Refer to the **Addressing Table** for the correct IPv6 address.

c. Configure the IPv6 address, the link-local address and activate the interface.

Step 5: Verify IPv6 addressing on R1.

It is good practice to verify addressing when it is complete by comparing configured values with the values in the addressing table.

a. Exit configuration mode on R1.

b. Verify the addressing configured by issuing the following command:

```
R1# show ipv6 interface brief
```

c. If any addresses are incorrect, repeat the steps above as necessary to make any corrections.

Note: To make a change in addressing with IPv6, you must remove the incorrect address or else both the correct address and incorrect address will remain configured on the interface.

Example:

```
R1(config-if)# no ipv6 address 2001:db8:1:5::1/64
```

d. Save the router configuration to NVRAM.

Part 2: Configure IPv6 Addressing on the Servers
Step 1: Configure IPv6 addressing on the Accounting Server.

a. Click **Accounting** and click the **Desktop** tab > **IP Configuration**.

b. Set the **IPv6 Address** to **2001:db8:1:1::4** with a prefix of **/64**.

c. Set the **IPv6 Gateway** to the link-local address, **fe80::1**.

Packet Tracer - Configure IPv6 Addressing

Step 2: Configure IPv6 addressing on the CAD Server.

Configure the **CAD** server with addresses as was done in Step 1. Refer to the **Addressing Table** for the addresses to use.

Part 3: Configure IPv6 Addressing on the Clients
Step 1: Configure IPv6 addressing on the Sales and Billing Clients.

a. Click **Billing** and then select the **Desktop** tab followed by **IP Configuration**.

b. Set the **IPv6 Address** to **2001:db8:1:1::3** with a prefix of **/64**.

c. Set the **IPv6 Gateway** to the link-local address, **fe80::1**.

d. Repeat Steps 1a through 1c for **Sales**. Refer to the **Addressing Table** for the IPv6 address.

Step 2: Configure IPv6 Addressing on the Engineering and Design Clients.

a. Click **Engineering** and then select the **Desktop** tab followed by **IP Configuration**.

b. Set the IPv6 Address to 2001:db8:1:2::3 with a prefix of /64.

c. Set the **IPv6 Gateway** to the link-local address, **fe80::1**.

d. Repeat Steps 2a through 2c for **Design**. Refer to the **Addressing Table** for the IPv6 address.

Part 4: Test and Verify Network Connectivity

Step 1: Open the server web pages from the clients.

a. Click **Sales** and click the **Desktop** tab. Close the **IP Configuration** window, if necessary.

b. Click **Web Browser**. Enter **2001:db8:1:1::4** in the URL box and click **Go**. The **Accounting** website should appear.

c. Enter **2001:db8:1:2::4** in the URL box and click **Go**. The **CAD** website should appear.

d. Repeat steps 1a through 1c for the rest of the clients.

Step 2: Ping the ISP.

a. Click on any client.

b. Click the Desktop tab > Command Prompt.

c. Test connectivity to the ISP by entering the following command:

```
PC> ping 2001:db8:1:a001::1
```

d. Repeat the **ping** command with other clients until full connectivity is verified.