# Week 9

IPv6 Configuration and Static Routing

Learning Objectives:

- Perform basic IPv6 configurations on a Desktop and Router.
- Distinguish between IPv4 and IPv6 addresses
- Configure IPv6 static routes in Router
- Observe traffic flow using IPv6 static routes.
- IPv6 neighbor cache entries
- Understanding IPv6 Link Local Address
- Working with ping6 and tracepath6

LAB Network Topology:
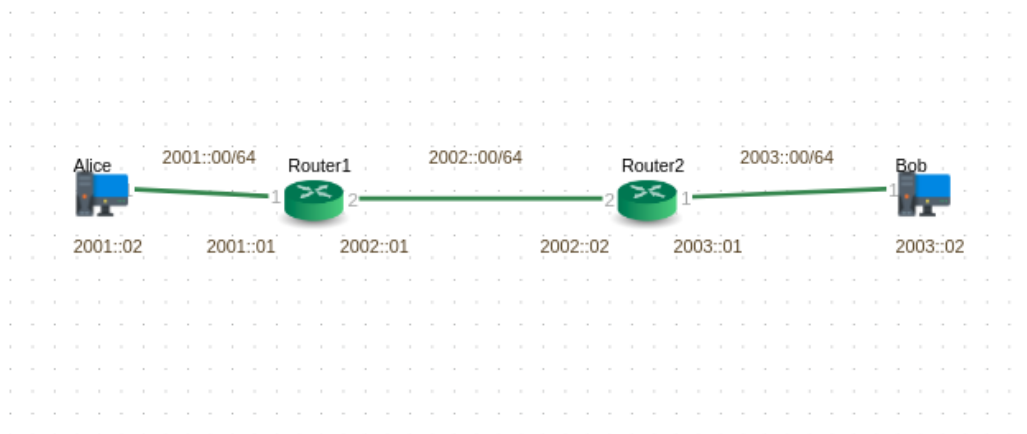
<u>Steps :</u>

1. Create and deploy the given topology.

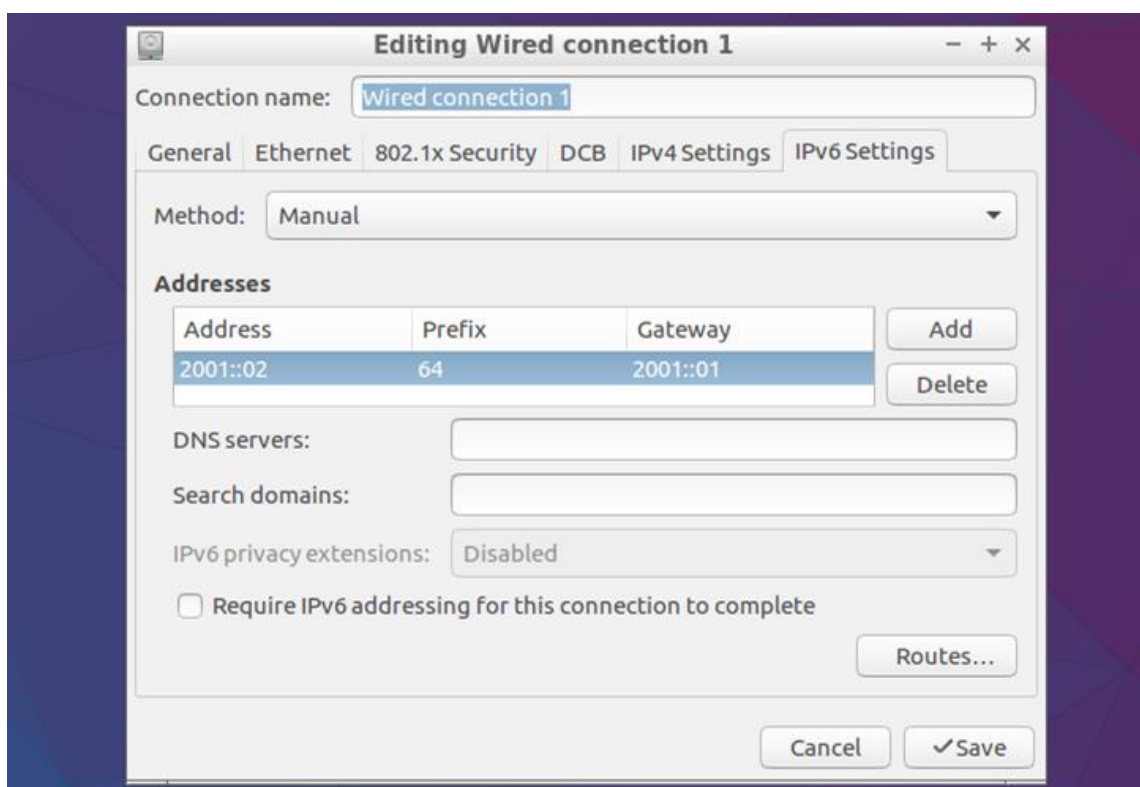2. Configure the PC/Workstation IP address as mentioned in topology.

Alice
IPv6 address – 2001::02/64 , Gateway – 2001::01

Bob
IPv6 address – 2003::02/64 , Gateway – 2003::01

Example :

3. Enable IPv6 in Router-1

```
operational> configure
Entering configuration mode with exclusive access.
configure> modify parameter-group router data
Info: Parameter group instance loaded for modification.
configure> set ipv6 enable yes
configure> save
Info: Parameter group router "data" saved
configure>

Check IPv6 information in router details

operational> show router details data
```

4. Configure IPv6 interfaces in Router-1

* Configure IPv6 global address 2001::01/64 to interface if-port-1

```
operational> configure
Entering configuration mode with exclusive access.
configure> modify parameter-group interface if-port-1
Info: Parameter group instance loaded for modification.
configure> default ip ipv4
configure> enter ip ipv6
[ interface:"if-port-1" > ip > ipv6 ]
configure> show draft -e
[ interface:"if-port-1" > ip > ipv6 ]
 enable no
 address 0000:0000:0000:0000:0000:0000:0000:0000
 netmask 0000:0000:0000:0000:0000:0000:0000:0000
 peer-address 0000:0000:0000:0000:0000:0000:0000:0000
 peer-netmask 0000:0000:0000:0000:0000:0000:0000:0000
 link-local-address 0000:0000:0000:0000:0000:0000:0000:0000
 link-local-netmask 0000:0000:0000:0000:0000:0000:0000:0000
 preference 1
 metric 1
 ndp {
     cache-timeout 1200
     unsolicited-learning enable
 }
 vrrp {
     enable no
     virtual-router [+] {
     }
 }

configure> set enable yes
configure> set address 2001::01/64
configure> save
Info: Parameter group interface "if-port-1" saved
configure>
```

Configure IPv6 global address 2002::01/64 to interface if-port-2

```
configure> modify parameter-group interface if-port-2
Info: Parameter group instance loaded for modification.
configure> default ip ipv4
configure> set ip ipv6 enable yes
configure> set ip ipv6 address 2002::01/64
configure> save
Info: Parameter group interface "if-port-2" saved
configure> exit
```

Verify Interface configurations

```
operational> show interface all

 Interface name                Status   Encaps-  IP address
                                        ulation
 -------------------------------------------------------------------------
 if-port-1                     up       ethernet 2001::1/64
                                                 fe80::226:f7ff:fe00:6d/64
```

```
if-port-2                        up       ethernet  2002::1/64
                                                    fe80::226:f7ff:fe00:6e/64
if-port-3                        down     ethernet  -
if-port-4                        down     ethernet  -
if-port-5                        down     ethernet  -
if-port-6                        down     ethernet  -
if-port-7                        down     ethernet  -
if-port-8                        down     ethernet  -
management                       disabled ethernet  10.0.0.12/24

Total number of interfaces displayed : 9

operational>
```

Check IPv6 information in "show interface details" command output

```
operational> show interface details if-port-1 if-port-2
```

5. Configure IPv6 static routes in Router-1

Configure a static route to reach 2003:00/64 network (Bob) with gateway as 2002::02(Router-2)

```
operational> configure
Entering configuration mode with exclusive access.
configure> create parameter-group ip-route v6-route-2003-nw
Info: Parameter group instance created.
configure> show draft -e
[ ip-route:"v6-route-2003-nw" ]
*name "v6-route-2003-nw"
 enable no
 router ""
 destination 0.0.0.0
 netmask 0.0.0.0
 next-hop {
     router ""
     gateway 0.0.0.0
     label-switched-path ""
 }
 preference 30
 metric 2

configure> set enable yes
configure> set router data
configure> set destination 2003::/64
configure> set next-hop gateway 2002::02
configure> save
Info: Parameter group ip-route "v6-route-2003-nw" saved
configure>
configure>
```

6. Display IPv6 routing table in Router-1

The configured static route should appear in the IPv6 routing table

```
operational> show route summary -F ipv6 data
> IPv6 active routes
>> Destination : ::1/128
   Gateway(s)  : { ^loopback-16387
```

```
                    ::1 }
    Source      : direct
    Flags       : -
>> Destination : 2001::/64
    Gateway(s)  : { if-port-1
                    :: }
    Source      : direct
    Flags       : -
>> Destination : 2002::/64
    Gateway(s)  : { if-port-2
                    :: }
    Source      : direct
    Flags       : -
>> Destination : 2003::/64
    Gateway(s)  : { if-port-2
                    2002::2 }
    Source      : static
    Flags       : -
>> Destination : fe80::/64
    Gateway(s)  : { if-port-1
                    :: }
    Source      : direct
    Flags       : -
>> Destination : fe80::/64
    Gateway(s)  : { if-port-2
                    :: }
    Source      : direct
    Flags       : -
 Total number of IPv6 active routes displayed : 6
 No IPv6 backup routes are available
operational>
```

7. Enable IPv6 in Router-2

```
operational> configure
Entering configuration mode with exclusive access.
configure> modify parameter-group router data
Info: Parameter group instance loaded for modification.
configure> set ipv6 enable yes
configure> save
Info: Parameter group router "data" saved
configure>
```

Check IPv6 information in router details

```
operational> show router details data
```

8. Configure IPv6 interfaces in Router-2

Configure IPv6 global address 2003::01/64 to interface if-port-1

```
configure> modify parameter-group interface if-port-1
Info: Parameter group instance loaded for modification.
configure> default ip ipv4
configure> set ip ipv6 enable yes
configure> set ip ipv6 address 2003::01/64
configure> save
Info: Parameter group interface "if-port-1" saved
configure> exit
```

* Configure IPv6 global address 2002::02/64 to interface if-port-2

```
configure> modify parameter-group interface if-port-2
Info: Parameter group instance loaded for modification.
configure> default ip ipv4
configure> set ip ipv6 enable yes
configure> set ip ipv6 address 2002::02/64
configure> save
Info: Parameter group interface "if-port-2" saved
```
* Verify Interface configurations

```
operational> show interface all
 Interface name                   Status    Encaps-   IP address
                                             ulation
 ---------------------------------------------------------------------------
 if-port-1                        up        ethernet  2003::1/64
                                                      fe80::226:f7ff:fe00:76/64
 if-port-2                        up        ethernet  2002::2/64
                                                      fe80::226:f7ff:fe00:77/64
 if-port-3                        down      ethernet  -
 if-port-4                        down      ethernet  -
 if-port-5                        down      ethernet  -
 if-port-6                        down      ethernet  -
 if-port-7                        down      ethernet  -
 if-port-8                        down      ethernet  -
 management                       disabled  ethernet  10.0.0.12/24
 Total number of interfaces displayed : 9
operational>
```

Check IPv6 information in "show interface details" command output

```
operational> show interface details if-port-1 if-port-2
```

9. Configure IPv6 static route in Router-2

* Configure a static route to reach 2001:00/64 network (Alice) with gateway as 2002::01(Router-1)

```
operational> configure
Entering configuration mode with exclusive access.
configure> create parameter-group ip-route v6-route-2001-nw
Info: Parameter group instance created.
configure> show draft -e
[ ip-route:"v6-route-2001-nw" ]
*name "v6-route-2001-nw"
 enable no
 router ""
 destination 0.0.0.0
 netmask 0.0.0.0
 next-hop {
     router ""
     gateway 0.0.0.0
     label-switched-path ""
 }
 preference 30
 metric 2

configure> set enable yes
configure> set router data
configure> set destination 2001::/64
```

```
configure> set next-hop gateway 2002::01
configure> save
Info: Parameter group ip-route "v6-route-2001-nw" saved
configure> show draft -e
[ ip-route:"v6-route-2001-nw" ]
*name "v6-route-2001-nw"
 enable yes
 router "data"
 destination 2001:0000:0000:0000:0000:0000:0000:0000
 netmask ffff:ffff:ffff:ffff:0000:0000:0000:0000
 next-hop {
     router ""
     gateway 2002:0000:0000:0000:0000:0000:0000:0001
     label-switched-path ""
 }
 preference 30
 metric 2
configure>
```

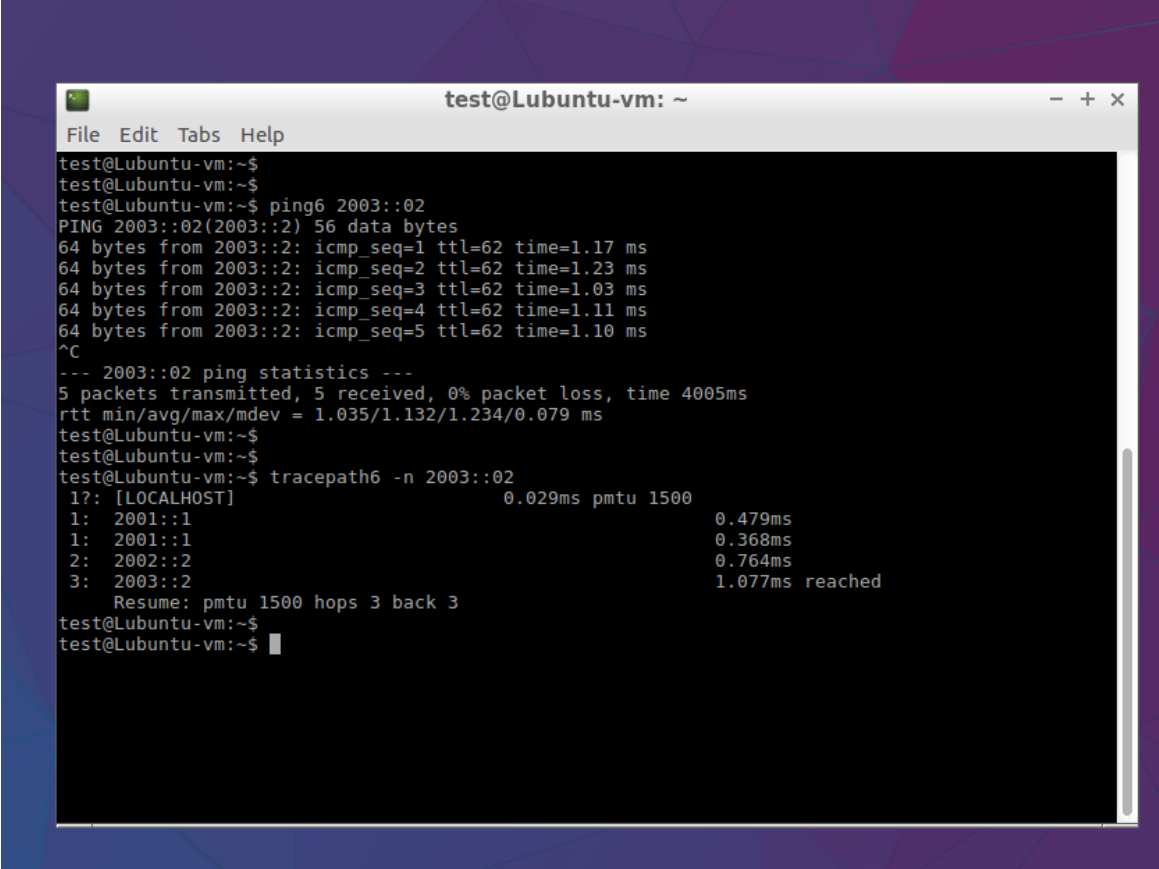10. Display IPv6 routing table in Router-2

```
operational> show route summary -F ipv6 data
> IPv6 active routes
>> Destination : ::1/128
   Gateway(s)  : { ^loopback-16387
                   ::1 }
   Source      : direct
   Flags       : -
>> Destination : 2001::/64
   Gateway(s)  : { if-port-2
                   2002::1 }
   Source      : static
   Flags       : -
>> Destination : 2002::/64
   Gateway(s)  : { if-port-2
                   :: }
   Source      : direct
   Flags       : -
>> Destination : 2003::/64
   Gateway(s)  : { if-port-1
                   :: }
   Source      : direct
   Flags       : -
>> Destination : fe80::/64
   Gateway(s)  : { if-port-1
                   :: }
   Source      : direct
   Flags       : -
>> Destination : fe80::/64
   Gateway(s)  : { if-port-2
                   :: }
   Source      : direct
   Flags       : -
 Total number of IPv6 active routes displayed : 6
 No IPv6 backup routes are available
operational>
```

11. Verify traffic flow between Alice and Bob

* From Alice workstation ping Bob, observe the packet from and TTL in ping reply

* From Alice workstation run tracepath to Bob's IP. Observer the intermediate hops

```
test@Lubuntu-vm: ~                                          – + ×
File  Edit  Tabs  Help
test@Lubuntu-vm:~$
test@Lubuntu-vm:~$
test@Lubuntu-vm:~$ ping6 2003::02
PING 2003::02(2003::2) 56 data bytes
64 bytes from 2003::2: icmp_seq=1 ttl=62 time=1.17 ms
64 bytes from 2003::2: icmp_seq=2 ttl=62 time=1.23 ms
64 bytes from 2003::2: icmp_seq=3 ttl=62 time=1.03 ms
64 bytes from 2003::2: icmp_seq=4 ttl=62 time=1.11 ms
64 bytes from 2003::2: icmp_seq=5 ttl=62 time=1.10 ms
^C
--- 2003::02 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4005ms
rtt min/avg/max/mdev = 1.035/1.132/1.234/0.079 ms
test@Lubuntu-vm:~$
test@Lubuntu-vm:~$
test@Lubuntu-vm:~$ tracepath6 -n 2003::02
 1?: [LOCALHOST]                        0.029ms pmtu 1500
 1:  2001::1                                       0.479ms
 1:  2001::1                                       0.368ms
 2:  2002::2                                       0.764ms
 3:  2003::2                                       1.077ms reached
     Resume: pmtu 1500 hops 3 back 3
test@Lubuntu-vm:~$
test@Lubuntu-vm:~$
```

12. Check IPv6 NDP table on Router-1

This is similar to ARP Table in IPv4.

```
operational> show ipv6 neighbour summary data

 Host address                           MAC address         Interface
 -------------------------------------------------------------------------------
 2002::1                                00:26:f7:00:00:6e if-port-2
 2003::2                                00:26:f7:00:09:3c if-port-1
 fe80::226:f7ff:fe00:6e                 00:26:f7:00:00:6e if-port-2
 fe80::5d97:cf2f:4a3:d8cb               00:26:f7:00:09:3c if-port-1

 Total number of NDP entries displayed : 4

operational>
```

13. Verify auto-configured Link Local Address on IPv6 interfaces

All IPv6 enabled interfaces will have a link-local address. IPv6 link-local address is a unicast address that is configured automatically using the prefix FE80::/10 and port MAC in the modified EUI-64 format. The link-local address can also be manually configured.
Link-local addresses are used for a addressing on a single physical link. These addresses can be used to reach the neighboring nodes attached to the same link. Routers will not forward packets using link-local addresses. Two routers can have same link-local address and can still communicate over directly connected network. But, the global unicast address should be unique in a network as they are routable.

Login to Router-1 and check the auto-configured link local address.

For Example :

```
operational> show interface details if-port-1

> Interface : if-port-1
 General Information
 ------------------
 ID                   : 21
 Encapsulation        : ethernet
 MTU                  : 1500
 Base port type       : fast-ethernet
 Base port location   : { shelf-1 { active-controller base-slot } port-1 }
 State Information
 ----------------
 State                : up
 Last state transition : 15:19:44, Monday, March 18, 2019 IST
 Work flags           : -- -- ----- -----
 Ethernet information
 --------------------
 VLAN tagging         : disabled
 IP information
 --------------
 Router               : data
 IPv6 information
 ----------------
 Address              : 2001::1
 Netmask              : ffff:ffff:ffff:ffff::
 Link local Address   : fe80::226:f7ff:fe00:6d <====== Combination of FE08 and port MAC
 Link local Netmask   : ffff:ffff:ffff:ffff::
 Scope Zone           : 33488917
 Preference           : 1
 Metric               : 1
 TE information
 --------------
 Maximum Bandwidth            : 10000 kbps
 Maximum Reservable Bandwidth : 10000 kbps
 Update threshold percentage  : 10

operational>

operational> show fast-ethernet details { shelf-1 { active-controller base-slot } port-1 }

> Port : { shelf-1 { active-controller base-slot } port-1 }
 Port details
 ------------
 Name                 :
 MAC address          : 00:26:f7:00:00:6d  <=============
 POST                 : passed
 Media                : copper
 Loop back mode       : no-loopback
 State                : up
 Duplex mode          : half-duplex
 Speed                : ten-mbps
 Work flags           : ---- ----
operational>
```

14. Check the connectivity between Router-1 and Router-2 using   Link Local Address

Login to Router-2 and get the link-local address of interface connected to Router-1.

Now, Login to Router-1 and ping the link-local address on Router-2 and observe the response. When pinging link-local address, the the name if out-going interface should be specified in the command. If no interface or wrong interface name is specified, ping will result in error or unsuccessful.

Example:

```
Router-1


operational> ping data:fe80::226:f7ff:fe00:77%if-port-2
PING fe80:0:1ff:16:226:f7ff:fe00:6e --> fe80::226:f7ff:fe00:77%33488918
16 bytes from fe80::226:f7ff:fe00:77%33488918: icmp_seq=0 hoplimit=64 time=0.496
ms
16 bytes from fe80::226:f7ff:fe00:77%33488918: icmp_seq=1 hoplimit=64 time=0.505
ms
16 bytes from fe80::226:f7ff:fe00:77%33488918: icmp_seq=2 hoplimit=64 time=0.470
ms
16 bytes from fe80::226:f7ff:fe00:77%33488918: icmp_seq=3 hoplimit=64 time=0.427
ms
16 bytes from fe80::226:f7ff:fe00:77%33488918: icmp_seq=4 hoplimit=64 time=0.475
ms

---- PING Statistics----
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/std-dev = 0.000/0.475/0.505/0.027 ms
operational>


operational> ping -c 5 data:fe80::226:f7ff:fe00:77
Error: No source address found for this destination
operational>

operational>  ping data:fe80::226:f7ff:fe00:77%if-port-1
PING fe80:0:1ff:15:226:f7ff:fe00:6d --> fe80::226:f7ff:fe00:77%33488917

---- PING Statistics----
8 packets transmitted, 0 packets received, 100.0% packet loss
operational>
```