COMPUTER NETWORKS LABORATORY WEEK 9

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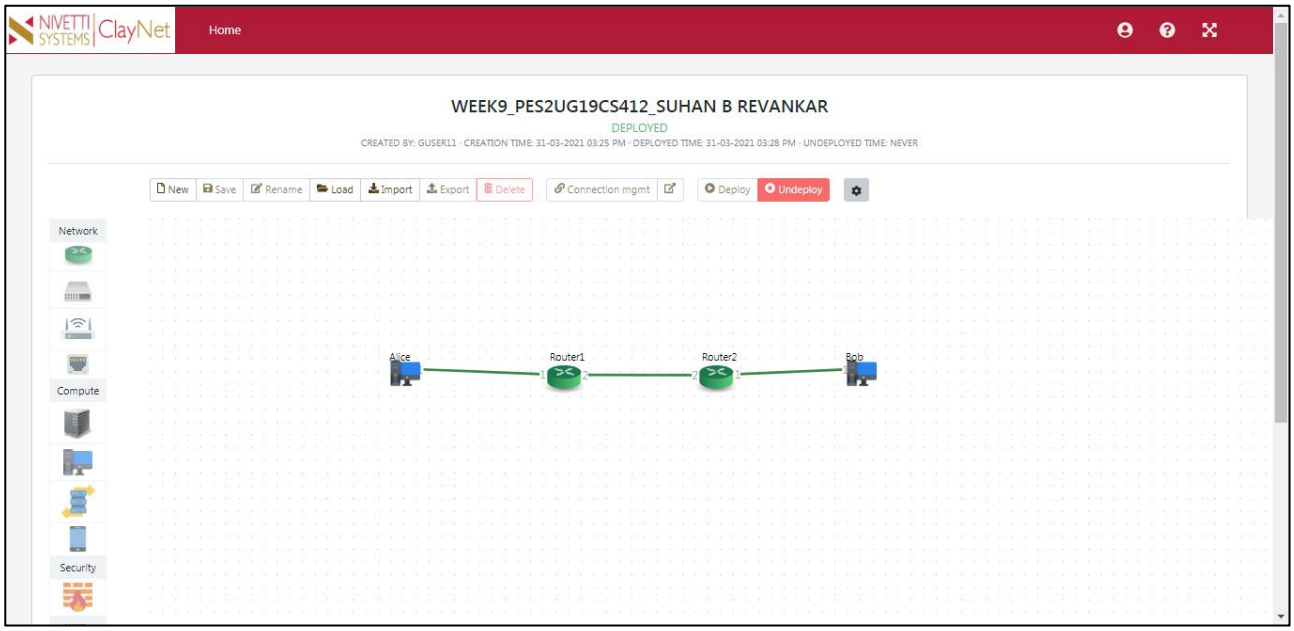
Name of the experiment: IPv6 Configuration and Static Routing.

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

The topology:



Assigning the IP addresses:

Alice:

IPv6 address -> `2001::02/64`

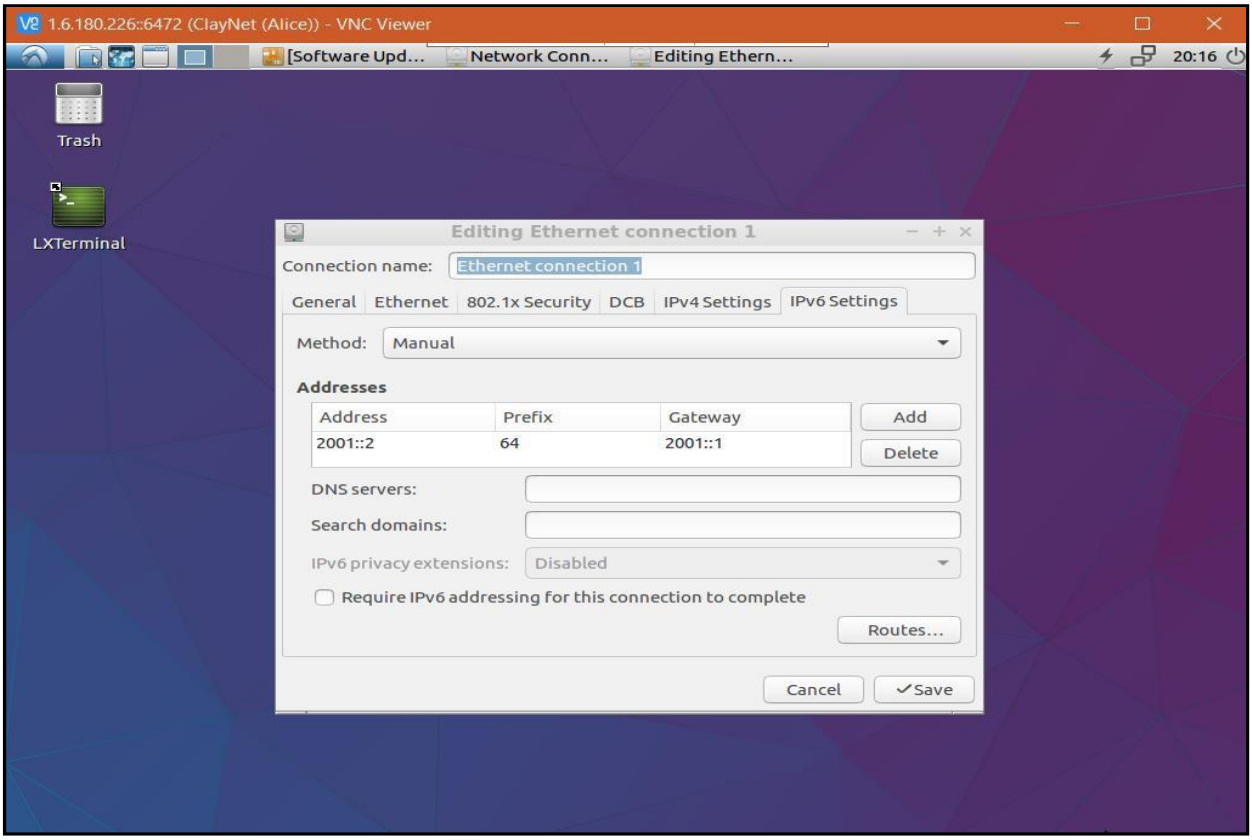
Gateway -> `2001::01`

Bob:

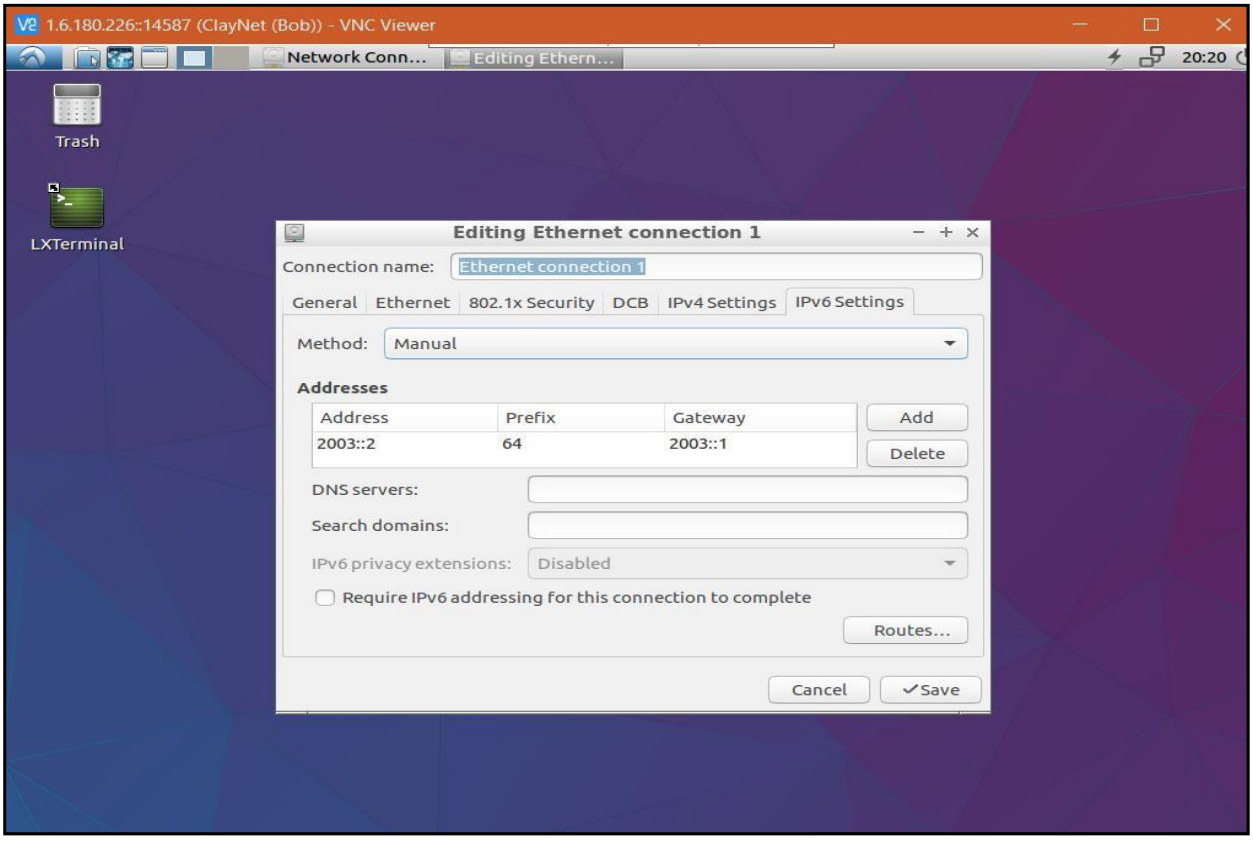
IPv6 address -> `2003::02/64`

Gateway -> `2003::01`

Alice:


1.6.180.226::6472 (ClayNet (Alice)) - VNC Viewer
[Software Upd...
Network Conn...
Editing Ethern...
20:16
Trash
LXTerminal
Editing Ethernet connection 1
Connection name:
Ethernet connection 1
General
Ethernet
802.1x Security
DCB
IPv4 Settings
IPv6 Settings
Method:
Manual
Addresses
Address
Prefix
Gateway
2001::2
64
2001::1
Add
Delete
DNS servers:
Search domains:
IPv6 privacy extensions:
Disabled
Require IPv6 addressing for this connection to complete
Routes...
Cancel
Save

Bob:


1.6.180.226::14587 (ClayNet (Bob)) - VNC Viewer
Network Conn...
Editing Ethern...
20:20
Trash
LXTerminal
Editing Ethernet connection 1
Connection name:
Ethernet connection 1
General
Ethernet
802.1x Security
DCB
IPv4 Settings
IPv6 Settings
Method:
Manual
Addresses
Address
Prefix
Gateway
2003::2
64
2003::1
Add
Delete
DNS servers:
Search domains:
IPv6 privacy extensions:
Disabled
Require IPv6 addressing for this connection to complete
Routes...
Cancel
Save

Router 1:

Configuring Ipv6 address:

```
operational> show router details data

> Router : data

 General information
 -------------------
 Router ID               : 1
 State                   : up
 Interfaces              : 9
 Routing gateways        : 3
 Local addresses         : 1
 Sockets                 : 1
 Flags                   : ----- -----
 Last state transition   : 20:11:06, Sunday, April 04, 2021 IST

 IPv4 information
 ----------------
 Default source address    : 0.0.0.0
 Default TTL               : 64
 Interfaces                : 9

 IPv4 routes
 -----------
 Active routes             :           3
 Backup routes             :           0
 Total routes              :           3

 IPv4 routes by source
 ---------------------
 Directly connected routes :           2
 Static routes             :           0
 RIP routes                :           0
 OSPFv2 routes             :           1
 BGP routes                :           0

 IPv4 listeners and connections
 ------------------------------
 TCP listeners             :           1
 TCP connections           :           0
 TCP sockets               :           1
 UDP sockets               :           0
```

```
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> exit
```

```
IPv6 information
----------------
Default Hop Limit          : 64
Interfaces                 : 1

IPv6 routes
-----------
Active routes              :           1
Backup routes              :           0
Total routes               :           1

IPv6 routes by source
---------------------
Directly connected routes  :           1
Static routes              :           0
BGP routes                 :           0

IPv6 listeners and connections
------------------------------
TCP listeners              :           1
TCP connections            :           0
TCP sockets                :           1
UDP sockets                :           0
```

Hence, the Ipv6 address is enabled.

Configure IPv6 global address 2001::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> entre ip ipv6
Error: Command not available
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>
configure>
configure> set enable yes
configure> set address 2001::01/64
configure> save
Info: Parameter group interface "if-port-1" saved
```

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
operational> show interface all

 Interface name                 Status    Encaps-   IP address
                                          ulation
 ------------------------------------------------------------------------------
 if-port-1                      up        ethernet  2001::1/64
                                                    fe80::2826:ff:fe00:bc1/64
 if-port-2                      up        ethernet  2002::1/64
                                                    fe80::2826:ff:fe00:bc3/64
 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
```

Check IPv6 information in `show interface details` command output.

Use the command: `show interface details if-port-1 if-port-2`

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

> Interface : if-port-1

 General Information
 -------------------
 ID                      : 19
 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   : 19:38:31, Saturday, April 03, 2021 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::2826:ff:fe00:bc1
 Link local Netmask      : ffff:ffff:ffff:ffff::
 Scope Zone              : 33488915
 Preference              : 1
 Metric                  : 1

 TE information
 --------------
 Maximum Bandwidth                   : 10000 kbps
 Maximum Reservable Bandwidth        : 10000 kbps
 Update threshold percentage         : 10
```

```
> Interface : if-port-2

 General Information
 -------------------
 ID                       : 20
 Encapsulation            : ethernet
 MTU                      : 1500
 Base port type           : fast-ethernet
 Base port location       : { shelf-1 { active-controller base-slot } port-2 }

 State Information
 -----------------
 State                    : up
 Last state transition    : 19:40:37, Saturday, April 03, 2021 IST
 Work flags               : -- -- ----- -----

 Ethernet information
 --------------------
 VLAN tagging             : disabled

 IP information
 --------------
 Router                   : data

 IPv6 information
 ----------------
 Address                  : 2002::1
 Netmask                  : ffff:ffff:ffff:ffff::
 Link local Address       : fe80::2826:ff:fe00:bc3
 Link local Netmask       : ffff:ffff:ffff:ffff::
 Scope Zone               : 33488916
 Preference               : 1
 Metric                   : 1

 TE information
 --------------
 Maximum Bandwidth                    : 10000 kbps
 Maximum Reservable Bandwidth         : 10000 kbps
 Update threshold percentage          : 10
```

Configure IPv6 static routes in Router 1

** Configure a static route to reach 2003:00/64 network (Bob) with gateway as2002::02(Router 2)*

```
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
```

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
```

The IP routing for the first router is hence completed.

Enable IPv6 in Router-2

The similar procedure as above is followed.

```
operational> configure
Entering configuration mode with exclusive access.
configure> modify parameter-group router data2
Error: Parameter group instance does not exist
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> exit
operational> show router details data

> Router : data

 General information
 -------------------
 Router ID                : 16387
 State                    : up
 Interfaces               : 9
 Routing gateways         : 5
 Local addresses          : 4
 Sockets                  : 2
 Flags                    : ----- -----
 Last state transition    : 19:49:41, Saturday, April 03, 2021 IST

 IPv4 information
 ----------------
 Default source address    : 0.0.0.0
 Default TTL               : 64
 Interfaces                : 9

 IPv4 routes
 -----------
 Active routes             :           5
 Backup routes             :           2
 Total routes              :           7

 IPv4 routes by source
 ---------------------
 Directly connected routes :           4
 Static routes             :           1
 RIP routes                :           0
 OSPFv2 routes             :           2
 BGP routes                :           0
```

```
IPv4 listeners and connections
------------------------------
TCP listeners                 :                1
TCP connections               :                0
TCP sockets                   :                1
UDP sockets                   :                0

OSPFv2 information
------------------
Router ID             : 1.1.1.1
Number of areas       : 1
Preference            : 50
SPF hold count        : 0

IPv6 information
----------------
Default Hop Limit             : 64
Interfaces                    : 1

IPv6 routes
-----------
Active routes                 :                1
Backup routes                 :                0
Total routes                  :                1

IPv6 routes by source
---------------------
Directly connected routes :                1
Static routes             :                0
BGP routes                :                0

IPv6 listeners and connections
------------------------------
TCP listeners                 :                1
TCP connections               :                0
TCP sockets                   :                1
UDP sockets                   :                0

SSH server
----------
Enabled             : Yes
TCP keep alives     : enabled
Allowed versions    : ssh-version-2

Telnet server
-------------
Enabled             : No

SNMP
----
Enabled             : No
```

Configure IPv6 interfaces in Router 2

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

```
 XMP server
 ----------
 Enabled                          : No

 Quality of Service
 ------------------
 Default class for forwarded traffic        : class-1
 Default drop-profile for forwarded traffic : green
 Default class for local traffic            : class-1
 Default drop-profile for local traffic     : green

operational>
operational>
operational>
operational> modify parameter-group interface if-port-1
Error: Command not available
operational> modify parameter-group interface if-port-1
Error: Command not available
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> set ipv6 enable yes
Error: 'ipv6' is not a valid parameter name
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*

```
operational> configure
Entering configuration mode with exclusive access.
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  2001::1/64
                                                     fe80::2826:ff:fe00:38d/64
 if-port-2                       up        ethernet  2002::1/64
                                                     fe80::2826:ff:fe00:38e/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
```

Check IPv6 in formation in “show interface details” command output

show interface details if-port-1 if-port-2

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

> Interface : if-port-1

 General Information
 -------------------
 ID                      : 10
 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   : 22:46:12, Saturday, April 03, 2021 IST
 Work flags              : -- -- ----- -----

 Ethernet information
 --------------------
 VLAN tagging            : disabled

 IP information
 --------------
 Router                  : data

 IPv4 information
 ----------------
 Address                 : 0.0.0.0
 Netmask                 : 0.0.0.0
 Preference              : 1
 Metric                  : 1

 IPv6 information
 ----------------
 Address                 : 2001::1
 Netmask                 : ffff:ffff:ffff:ffff::
 Link local Address      : fe80::2826:ff:fe00:38d
 Link local Netmask      : ffff:ffff:ffff:ffff::
 Scope Zone              : 33488906
 Preference              : 1
 Metric                  : 1

 TE information
 --------------
 Maximum Bandwidth                  : 10000 kbps
 Maximum Reservable Bandwidth       : 10000 kbps
 Update threshold percentage        : 10
```

```
> Interface : if-port-2

 General Information
 -------------------
 ID                      : 11
 Encapsulation           : ethernet
 MTU                     : 1500
 Base port type          : fast-ethernet
 Base port location      : { shelf-1 { active-controller base-slot } port-2 }

 State Information
 -----------------
 State                   : up
 Last state transition   : 22:46:14, Saturday, April 03, 2021 IST
 Work flags              : -- -- ----- -----

 Ethernet information
 --------------------
 VLAN tagging            : disabled

 IP information
 --------------
 Router                  : data

 IPv4 information
 ----------------
 Address                 : 0.0.0.0
 Netmask                 : 0.0.0.0
 Preference              : 1
 Metric                  : 1

 IPv6 information
 ----------------
 Address                 : 2002::1
 Netmask                 : ffff:ffff:ffff:ffff::
 Link local Address      : fe80::2826:ff:fe00:38e
 Link local Netmask      : ffff:ffff:ffff:ffff::
 Scope Zone              : 33488907
 Preference              : 1
 Metric                  : 1

 TE information
 --------------
 Maximum Bandwidth                   : 10000 kbps
 Maximum Reservable Bandwidth        : 10000 kbps
 Update threshold percentage         : 10
```

```
 TE information
 --------------
 Maximum Bandwidth                  : 10000 kbps
 Maximum Reservable Bandwidth       : 10000 kbps
 Update threshold percentage        : 10

operational>
operational>
operational>
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 drraft -e

Error: Unknown argument(s) specified

 Usage : show <sub-command>

 List of sub-commands available are:

 cli                            Displays CLI related information
 configuration                  Displays configuration information
 draft                          Displays contents of parameter group draft bu-
                                ffer
 parameter-group                Displays parameter group related information
 pki                            Displays public key infrastructure related in-
                                formation
 script                         Displays event script information
 version                        Displays software version information

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
```

Therefore, Ipv6 is set.

Configure IPv6 static route in Router-2

** Configure a static route to reach 2001:00/64 network (Alice) with gateway as2002::01(Router-1)*

```
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
```

The gateway is finally set.

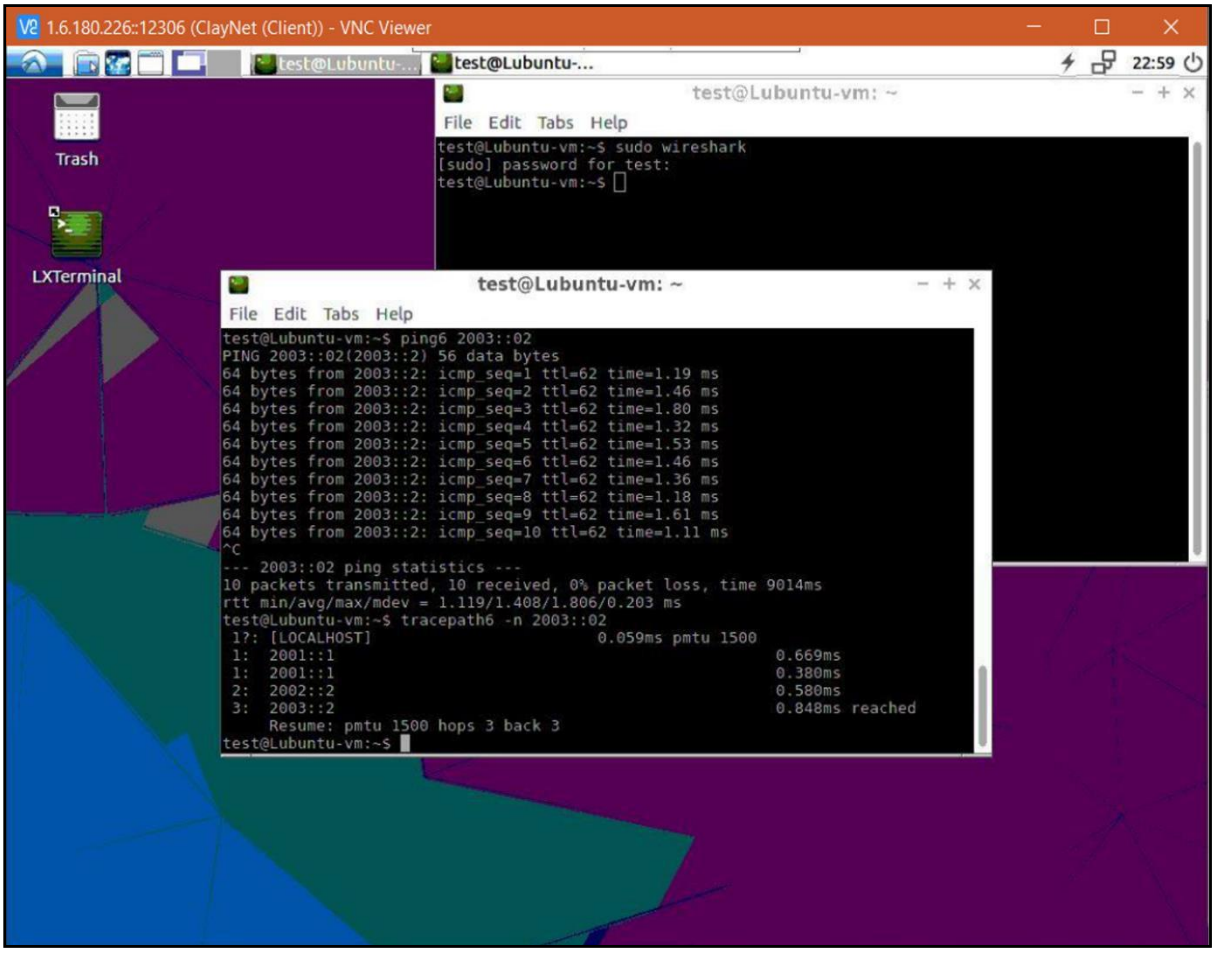
Display IPv6 routing table in Router-2

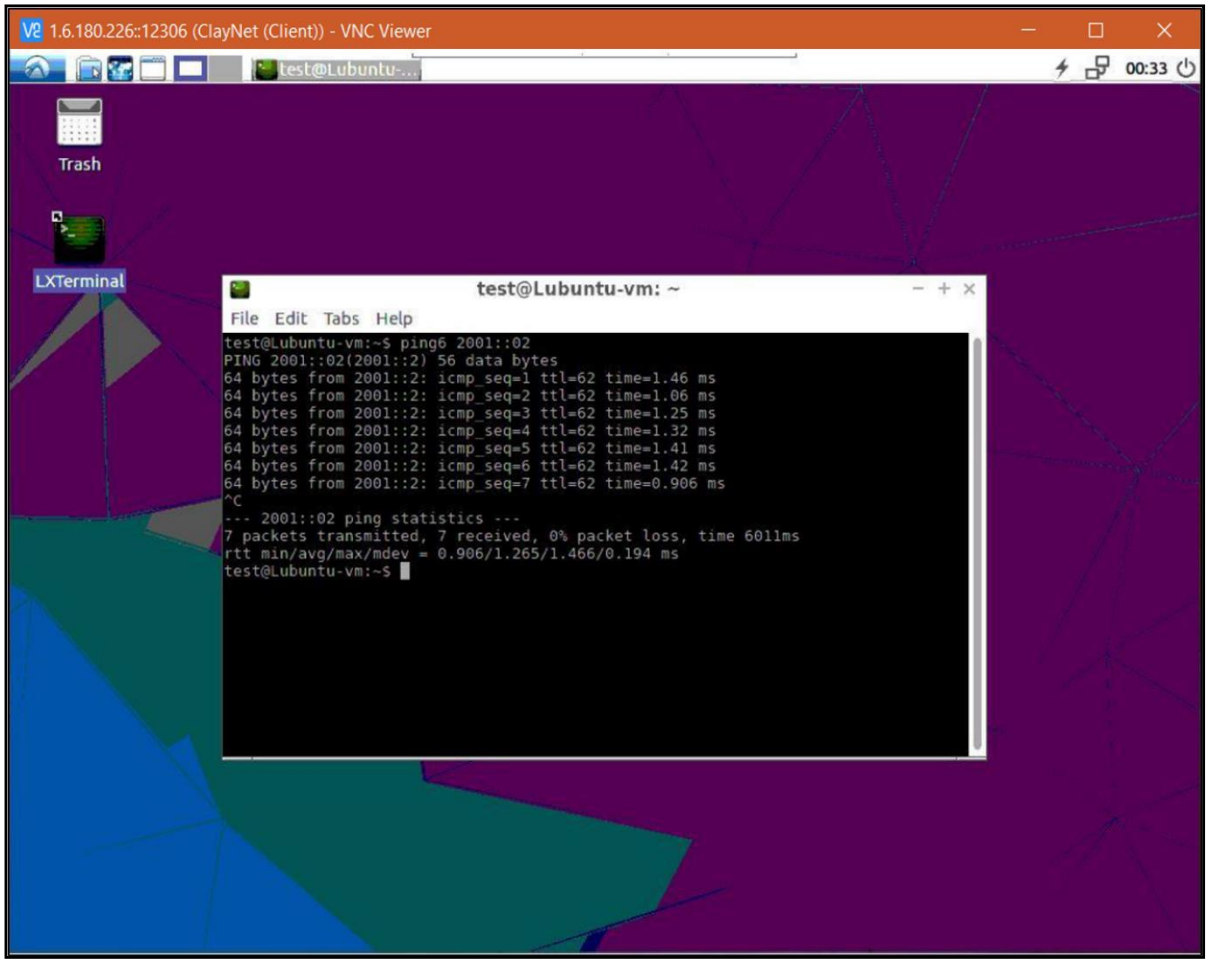
```
operational> show route summary -F ipv6 data

> 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
```

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 intermediatehops





Check IPv6 NDP table on Router-1

```
operational> show ipv6 neighbour summary data

 Host address                              MAC address       Interface
 ------------------------------------------------------------------------------
 2001::2                                   2a:26:00:00:0f:08 if-port-1
 2002::2                                   2a:26:00:00:03:97 if-port-2
 fe80::2826:ff:fe00:397                    2a:26:00:00:03:97 if-port-2
 fe80::98b5:3961:dab3:45b                  2a:26:00:00:0f:08 if-port-1

 Total number of NDP entries displayed : 4
```

The neighbours to Route 1

```
operational> show ipv6 neighbour summary data

 Host address                              MAC address       Interface
 ------------------------------------------------------------------------------
 2002::1                                   2a:26:00:00:03:8e if-port-2
 2003::2                                   2a:26:00:00:0f:1d if-port-1
 fe80::2826:ff:fe00:38e                    2a:26:00:00:03:8e if-port-2
 fe80::b1be:e368:3d9f:14b6                 2a:26:00:00:0f:1d if-port-1

 Total number of NDP entries displayed : 4
```

The neighbours to Route 2

A local ping between Router 1 and Router 2

```
operational> ping data:fe80::2826:ff:fe00:397%if-port-2
PING fe80:0:1ff:b:2826:ff:fe00:38e --> fe80::2826:ff:fe00:397%33488907
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=0 hoplimit=64 time=0.290 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=1 hoplimit=64 time=0.642 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=2 hoplimit=64 time=0.560 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=3 hoplimit=64 time=0.582 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=4 hoplimit=64 time=0.669 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=5 hoplimit=64 time=0.424 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=6 hoplimit=64 time=0.518 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=7 hoplimit=64 time=0.396 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=8 hoplimit=64 time=0.685 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=9 hoplimit=64 time=0.503 ms

16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=10 hoplimit=64 time=0.703 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=11 hoplimit=64 time=0.508 ms
16 bytes from fe80::2826:ff:fe00:397%33488907: icmp_seq=12 hoplimit=64 time=0.601 ms
^C
---- PING Statistics----
13 packets transmitted, 13 packets received, 0.0% packet loss
round-trip min/avg/max/std-dev = 0.000/0.545/0.703/0.118 ms
operational>
```

****