COMPUTER NETWORKS LAB

COURSE CODE:UE19CS255

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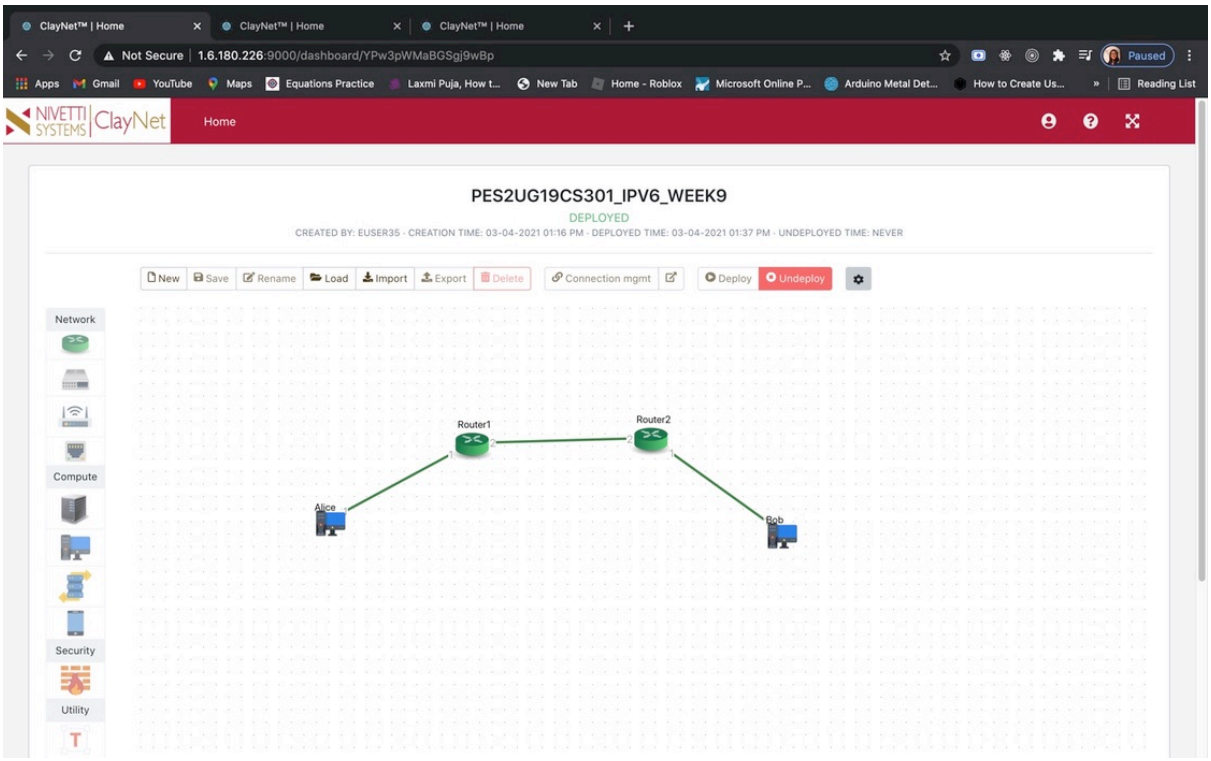
SECTION:E DATE:04/04/2021

EXPERIMENT : IPv6 Configuration and Static Routing

TOPOLOGY :

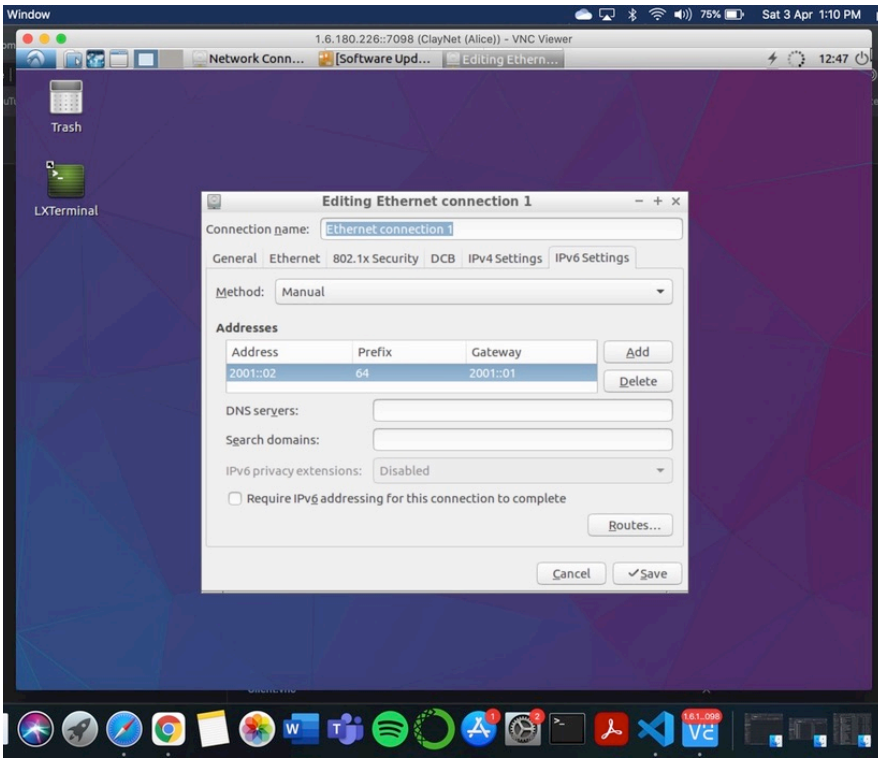


STEP : Configure the PC/Workstation IP address as mentioned in topology.

ALICE :

IPV6 ADDRESS : 2001::02/64

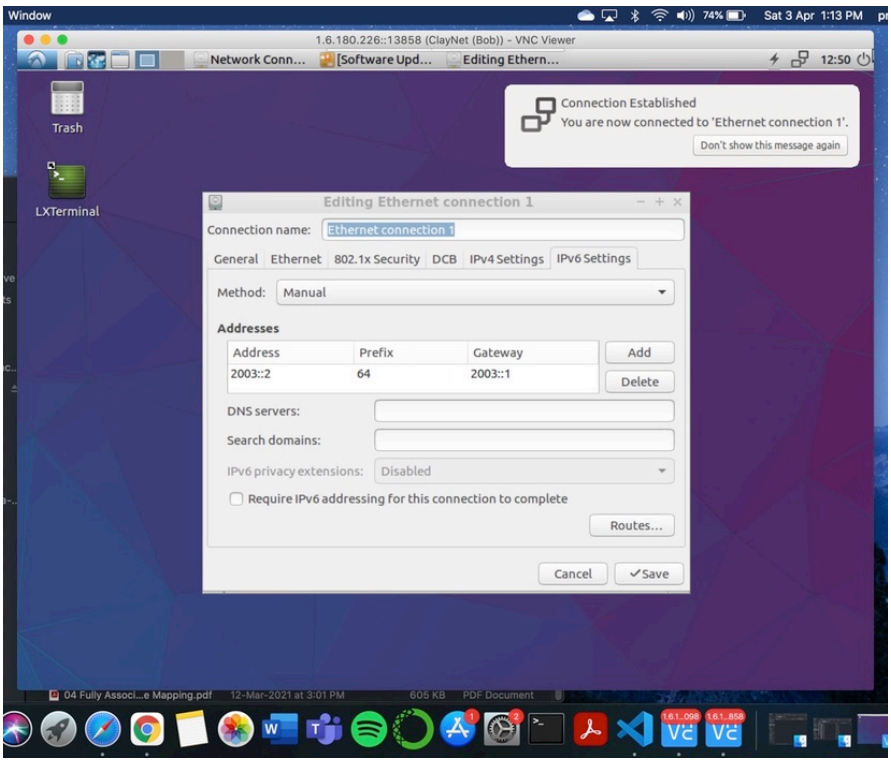
GATEWAY : 2001::01



BOB :

IPV6 ADDRESS : 2003::02/64

GATEWAY : 2003::01



ENABLE IPV6 IN ROUTER-1

OPERATIONAL > CONFIGURE

```
nivappadmin@ClayNet:~$ telnet 127.0.0.1  57284
Trying 127.0.0.1...
Connected to 127.0.0.1.
Escape character is '^]'.

Login: admin
Password:

operational> modify parameter-group router data
Error: Command not available
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
operational>
```

Check IPv6 information in router details

operational> show router details data

```
operational> show router details data

> Router : data

 General information
 -------------------
 Router ID              : 16387
 State                  : up
 Interfaces             : 9
 Routing gateways       : 4
 Local addresses        : 4
 Sockets                : 2
 Flags                  : ----- -----
 Last state transition  : 21:46:54, Saturday, April 03, 2021 IST

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

 IPv4 routes
 -----------
 Active routes             :          4
 Backup routes             :          2
 Total routes              :          6

 IPv4 routes by source
 ---------------------
 Directly connected routes :          4
 Static routes             :          0
 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
```

```
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

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>
```

Configure IPv6 interfaces in Router-1

Configure IPv6 global address 2001::01/64 to 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> 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

```
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::01/64
configure> save
Info: Parameter group interface "if-port-2" saved
configure> exit
operational>
```

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:fe00:29a/64
 if-port-2                       up        ethernet  2002::1/64
                                                     fe80::2826:ff:fe00:29b/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

> 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 : 21:57:36, 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:fe00:29a
 Link local Netmask    : ffff:ffff:ffff:ffff::
 Scope Zone            : 33488915
```

```
 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 : 22:00:26, Saturday, April 03, 2021 IST
 Work flags            : -- -- ----- -----

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

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

 IPv6 information
 ----------------
```

```
 IPv6 information
 ----------------
 Address               : 2002::1
 Netmask               : ffff:ffff:ffff:ffff::
 Link local Address    : fe80::2826:ff:fe00:29b
 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 as 2002::02(Router-2)

```
operational> configure
Entering configuration mode with exclusive access.
configure> create parameter-group ip-router v6-route-2003-nw
Error: 'ip-router' is not a valid parameter group
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>
```

```
configure> set next-hop gateway 2002:02
Error: Parameter set operation failed - Invalid value


 Only IPv4/IPv6 unicast addresses are allowed.

 IPv4 addresses must be provided in "dotted quad" notation -
   a.b.c.d

 '*' can be used to set wild-card IPv4 address, which is 0.0.0.0

 Addresses in loopback address range (127.0.0.0/8) are not allowed

 IPv6 addresses must be provided in "colon" notation -
   abcd:efgh:ijkl:mnop:qrst:uvwx:yzab:cdef
   abcd:efgh::cdef
   abcd:efgh:ijkl:mnop:qrst:uvwx:yzab:a.b.c.d
configure> set next-hop gateway 2002::02
configure> save
Info: Parameter group ip-route "v6-route-2003-nw" saved
configure> exit
operational>
```

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>
operational>
```

Enable IPv6 in Router-2

```
nivappadmin@ClayNet:~$ telnet 127.0.0.1  51594
Trying 127.0.0.1...
Connected to 127.0.0.1.
Escape character is '^]'.

Login: admin
Password:

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
```

Check IPv6 information in router details
operational> show router details data

```
configure> exit
operational> show router details data

> Router : data

 General information
 -------------------
 Router ID               : 16387
 State                   : up
 Interfaces              : 9
 Routing gateways        : 4
 Local addresses         : 4
 Sockets                 : 2
 Flags                   : ----- -----
 Last state transition   : 22:18:24, Saturday, April 03, 2021 IST

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

 IPv4 routes
 -----------
 Active routes             :           4
 Backup routes             :           2
 Total routes              :           6

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

```
 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
```

```
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

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

perational>
perational>
```

Configure IPv6 interfaces in Router-2

Configure IPv6 global address 2003::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> 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
operational>
```

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
configure> exit
operational>
```

Verify Interface configurations

```
operational> show interface all

 Interface name                  Status    Encaps-   IP address
                                           ulation
 ------------------------------------------------------------------------------
 if-port-1                       up        ethernet  2003::1/64
                                                     fe80::2826:ff:fe00:2a3/64
 if-port-2                       up        ethernet  2002::2/64
                                                     fe80::2826:ff:fe00:373/64
 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

> 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   : 22:24:05, Saturday, April 03, 2021 IST
 Work flags              : -- -- ----- -----

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

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

 IPv6 information
 ----------------
 Address                 : 2003::1
 Netmask                 : ffff:ffff:ffff:ffff::
 Link local Address      : fe80::2826:ff:fe00:2a3
 Link local Netmask      : ffff:ffff:ffff:ffff::
 Scope Zone              : 33488915
 Preference              : 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   : 22:30:45, Saturday, April 03, 2021 IST
 Work flags              : -- -- ----- -----

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

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

 IPv6 information
 ----------------
 Address                 : 2002::2
```

```
IPv6 information
----------------
Address                : 2002::2
Netmask                : ffff:ffff:ffff:ffff::
Link local Address     : fe80::2826:ff:fe00:373
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

operational>
```

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)

```
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>
```

```
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> exit
operational>
```

Display IPv6 routing table in Router-2

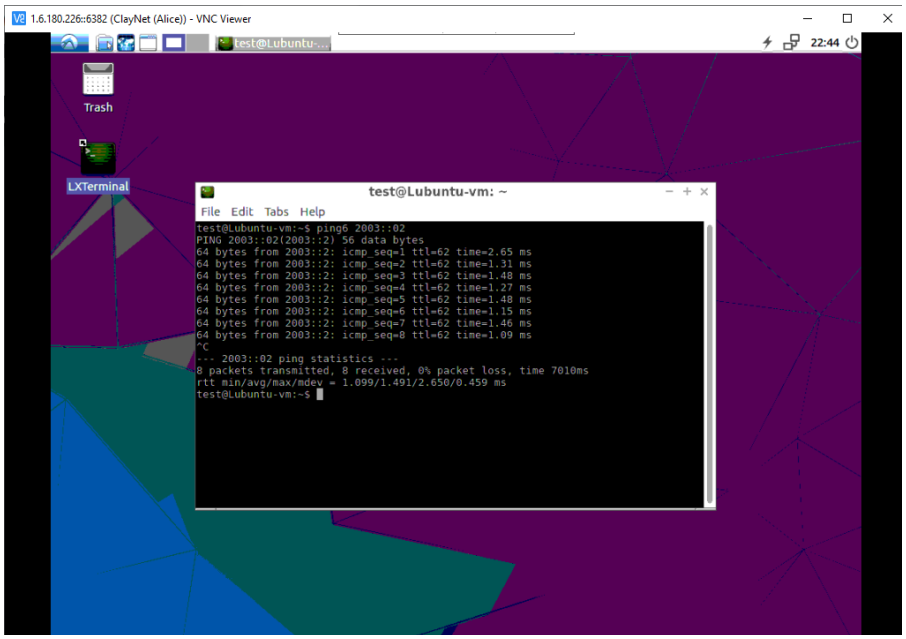
```
configure> exit
operational> show route summary -F ipv6 data

> 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
```

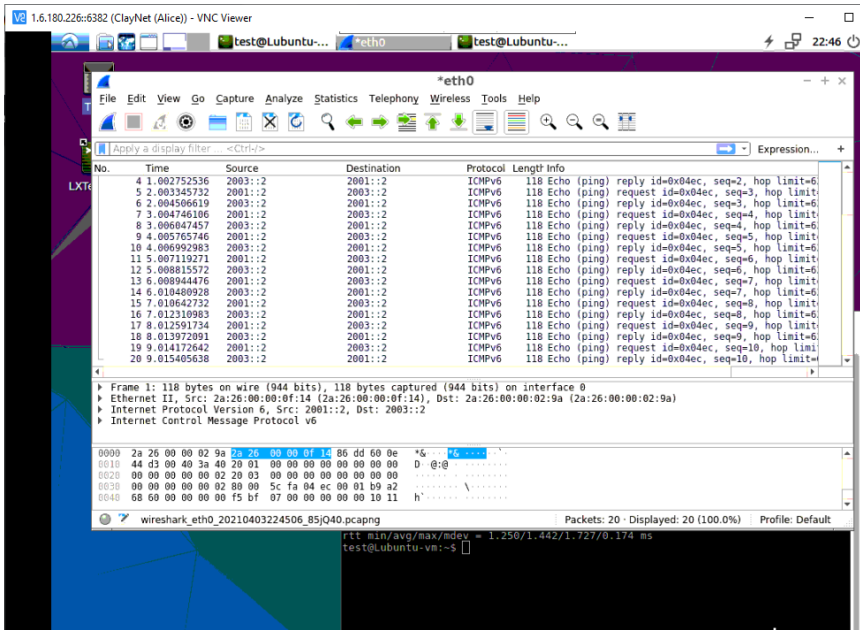
```
>> Destination : fe80::/64
   Gateway(s)  : { if-port-1
                  :: }
   Source      : direct
   Flags       : -

>> 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>
operational>
```

Verify traffic flow between Alice and Bob

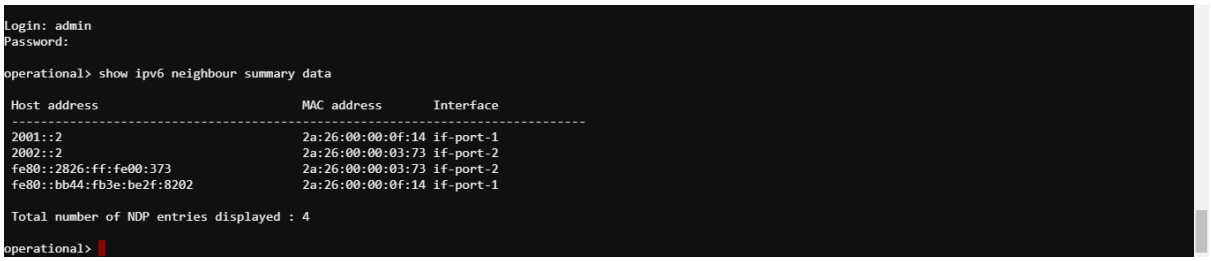
From Alice workstation ping Bob, observe the packet from and TTL in ping reply

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





Check IPv6 NDP table on Router-1
This is similar to ARP Table in IPv4.



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                    : 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 : 21:57:35, 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:fe00:29a
 Link local Netmask    : ffff:ffff:ffff:ffff::
 Scope Zone            : 33488915
```

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 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.

```
operational> ping data:fe80::2826:ff:fe00:62e%if-port-2
PING fe80:0:1ff:14:2826:ff:fe00:625 --> fe80::2826:ff:fe00:62e%33488916
16 bytes from fe80::2826:ff:fe00:62e%33488916: icmp_seq=0 hoplimit=64 time=0.936
 ms
16 bytes from fe80::2826:ff:fe00:62e%33488916: icmp_seq=1 hoplimit=64 time=0.654
 ms
16 bytes from fe80::2826:ff:fe00:62e%33488916: icmp_seq=2 hoplimit=64 time=0.425
 ms
16 bytes from fe80::2826:ff:fe00:62e%33488916: icmp_seq=3 hoplimit=64 time=0.509
 ms
^C
---- PING Statistics----
4 packets transmitted, 4 packets received, 0.0% packet loss
round-trip min/avg/max/std-dev = 0.000/0.631/0.936/0.194 ms
operational> ping -c 5 data:fe80::2826:ff:fe00:62e


Error: No source address found for this destination


operational>
```