

# PES UNIVERSITY EC CAMPUS, BANGALORE

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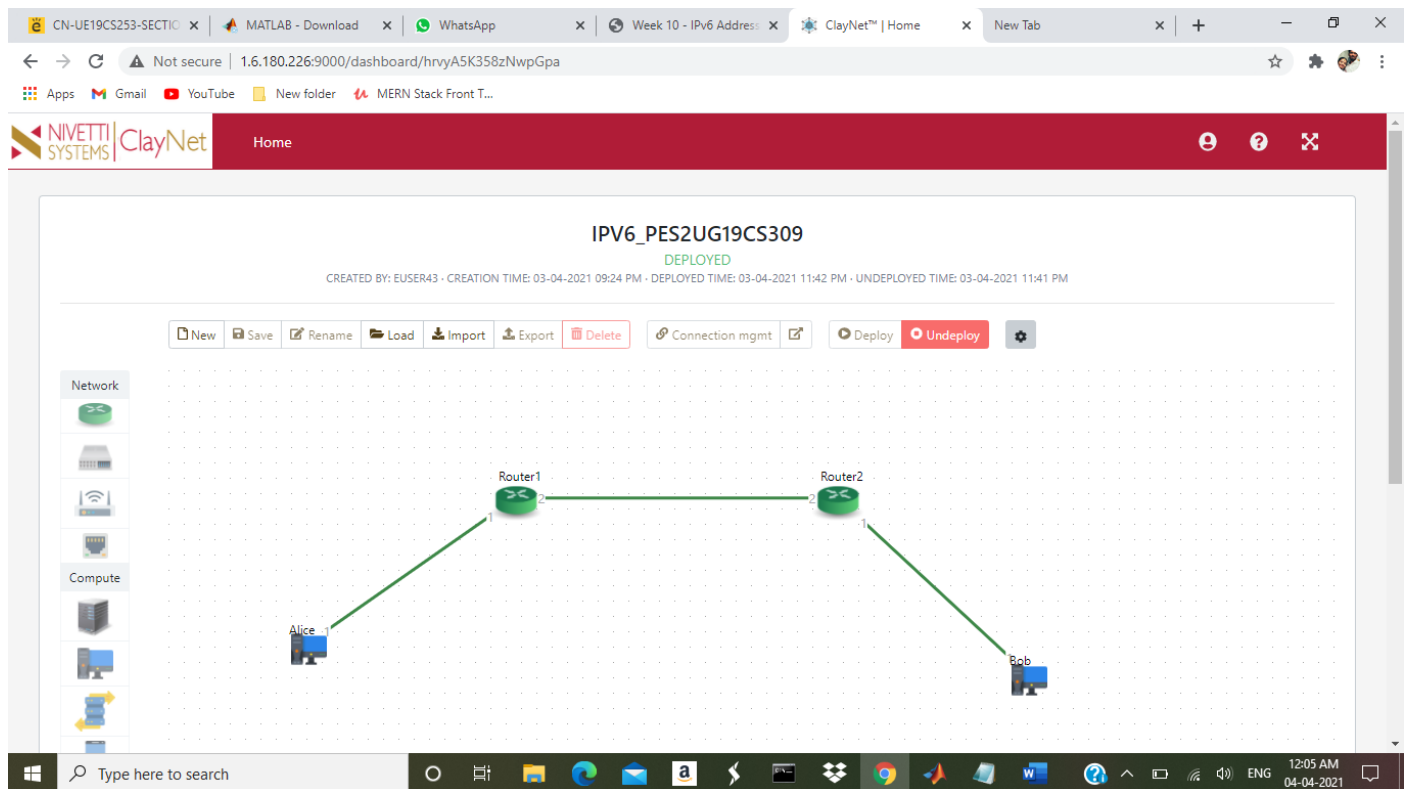
**Date:** 03/04/2021

**Subject:** Computer Network Laboratory

**WEEK No:** 10

**Objective:** IPv6 Configuration and Static Routing

## LAB Network Topology:

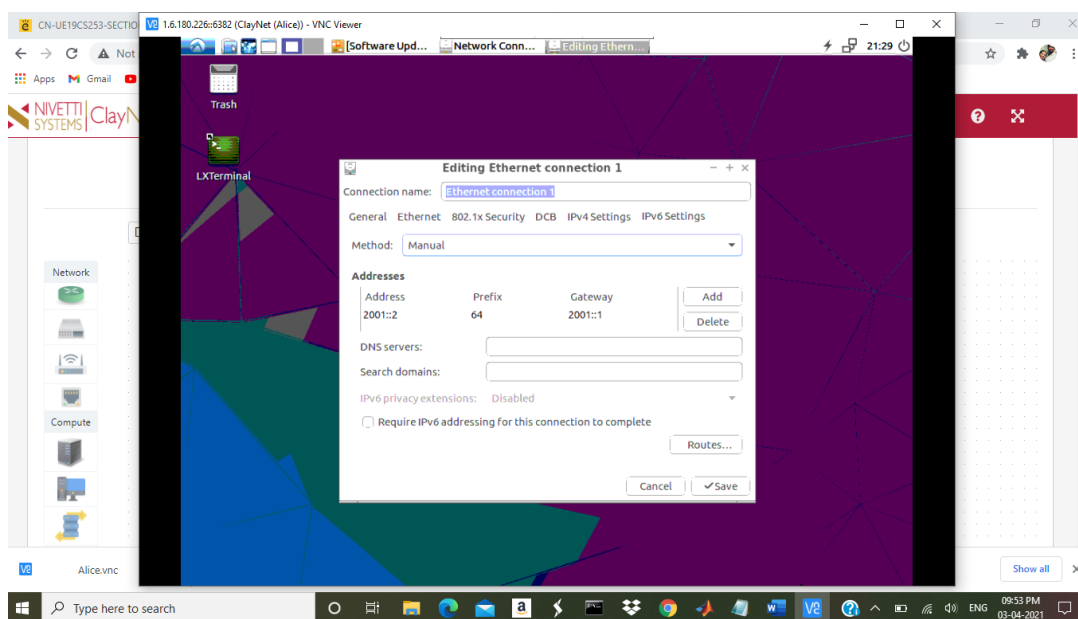


### Steps :

1. Create and deploy the given topology.
2. Configure the PC/Workstation IP address as mentioned in topology.

#### **Alice**

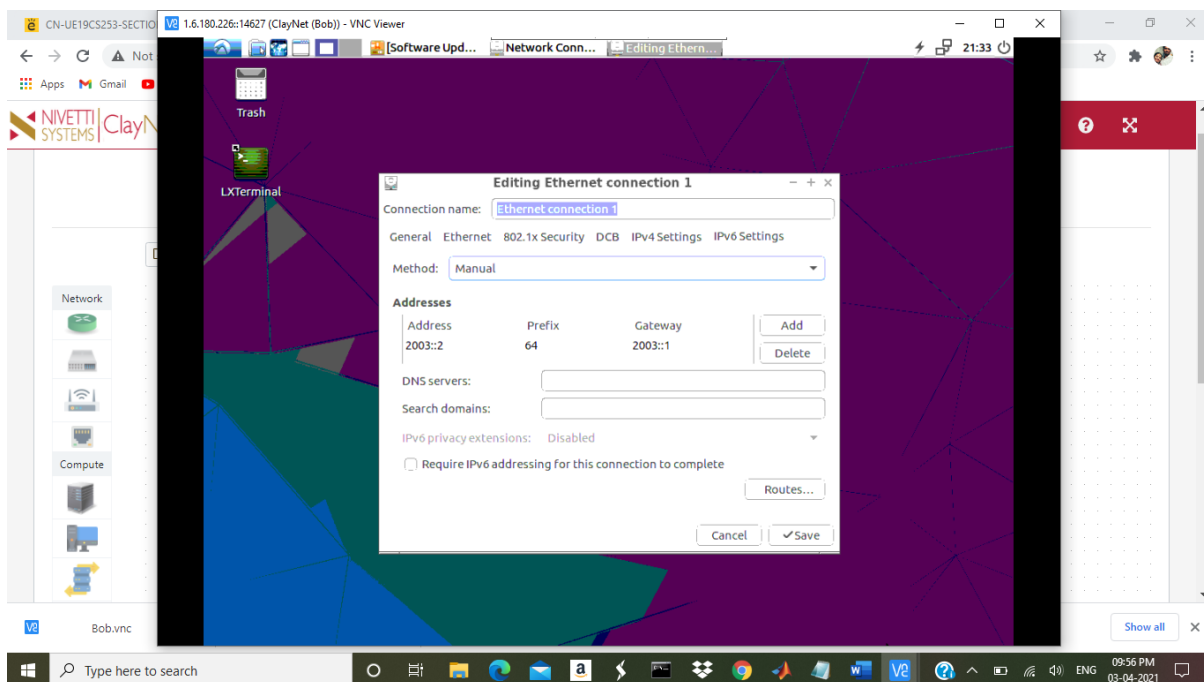
*IPv6 address –2001::02/64 , Gateway –2001::01*



**Bob**

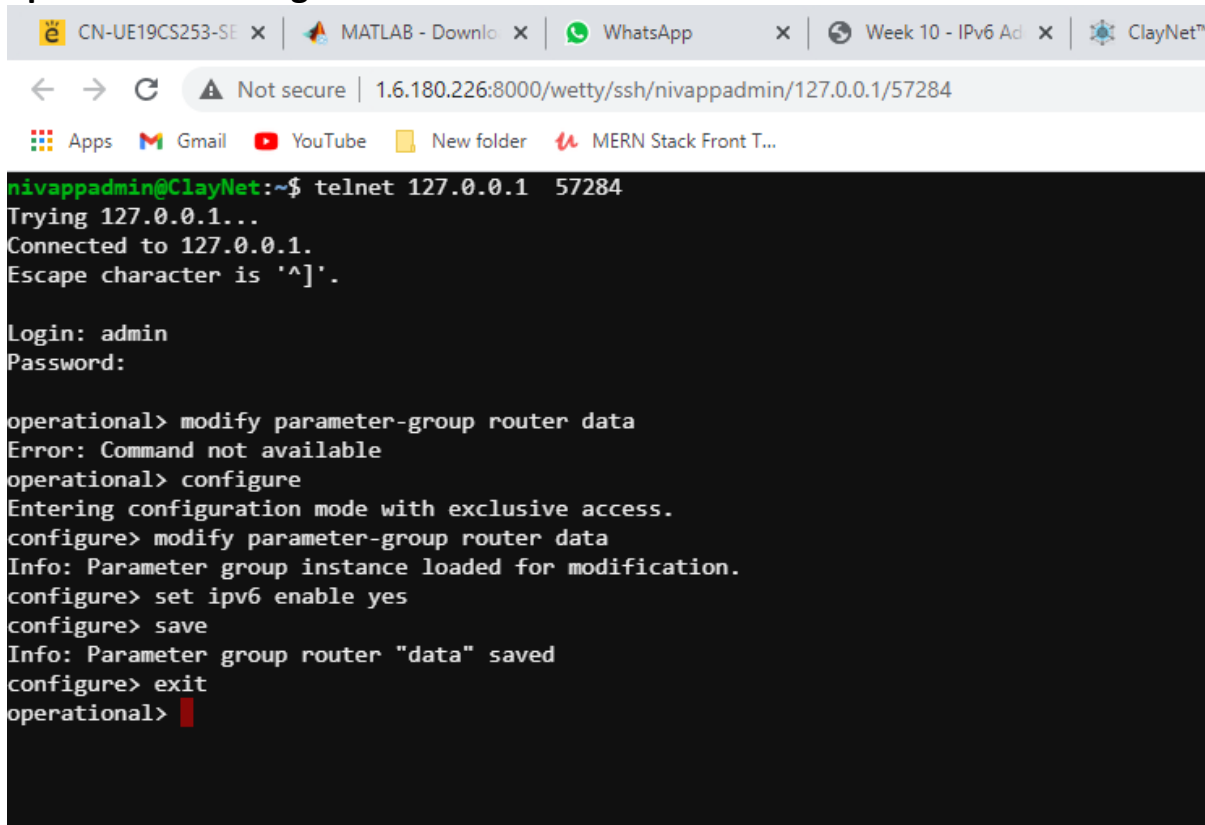
IPv6 address –2003::02/64 , Gateway –2003::01

Example :



### 3. Enable IPv6 in Router-1

#### operational> configure



## 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
-----
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

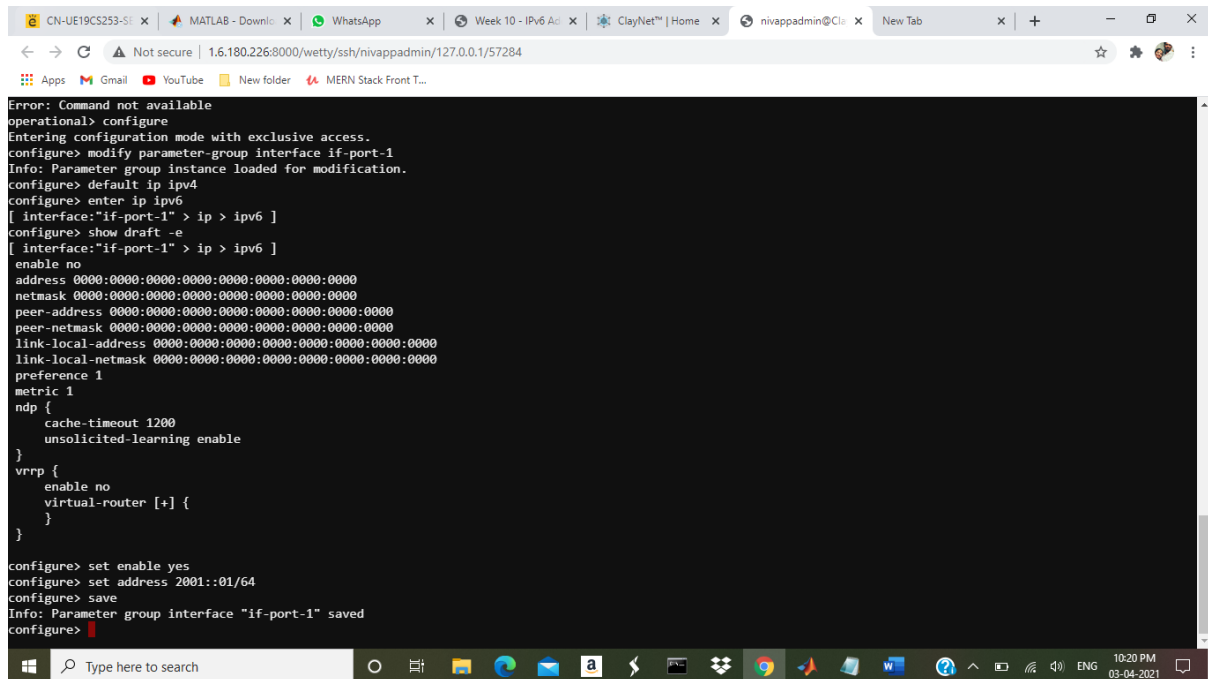
XMP server
-----
Enabled           : No

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>
```

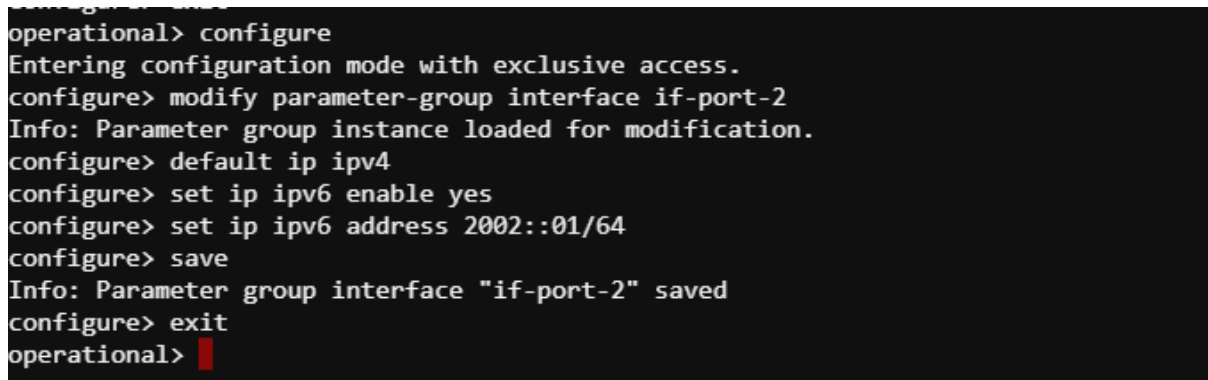
#### 4. Configure IPv6 interfaces in Router-1

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



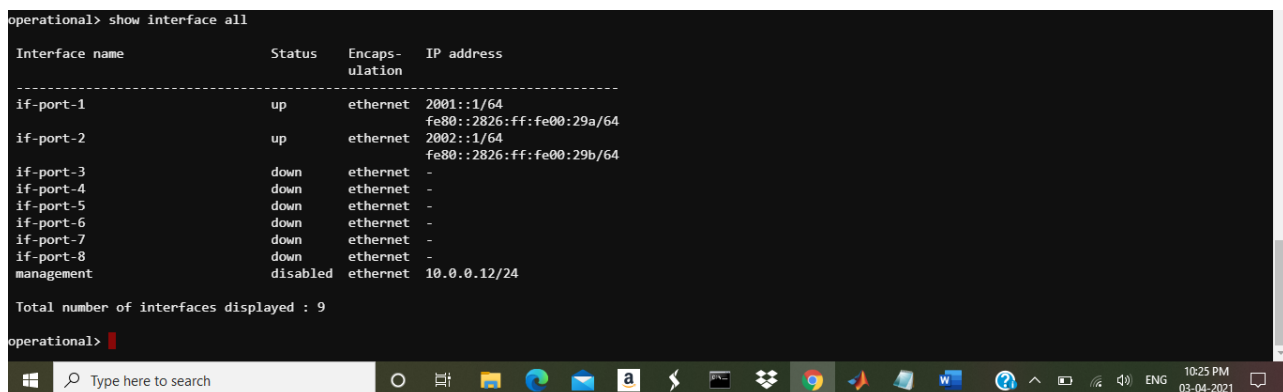
```
operational> configure
Entering configuration mode with exclusive access.
configure> modify parameter-group interface if-port-1
Info: Parameter group instance loaded for modification.
configure> default ip ipv4
configure> enter ip ipv6
[ interface:"if-port-1" > ip > ipv6 ]
configure> show draft -e
[ 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



```
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-ulation	IP address
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
-----
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
```

## 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-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:uvw:xyzab:cdef
abcd:efgh::cdef
abcd:efgh:ijkl:mnop:qrst:uvw:xyzab: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>
```

## 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>
operational>
```

## 7. 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

```



```
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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>
operational>
```

## 8. 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
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>
```

## 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)*

```
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>
```

## 10. Display IPv6 routing table in Router-2

```
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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 : -

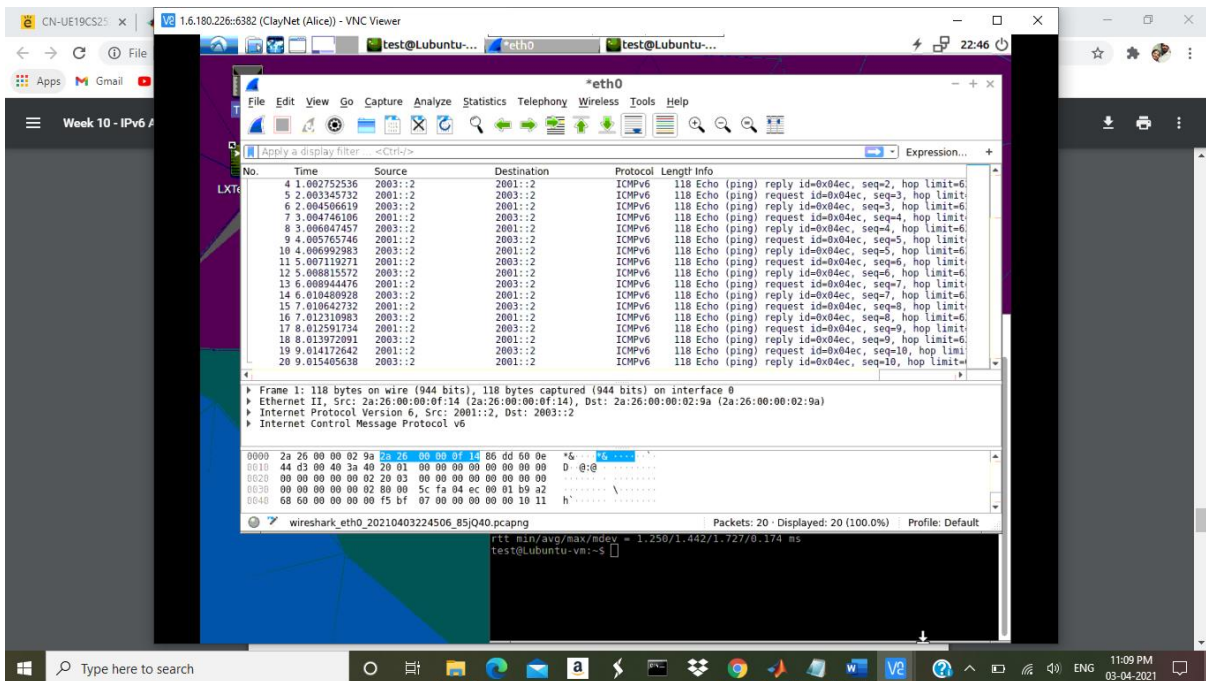
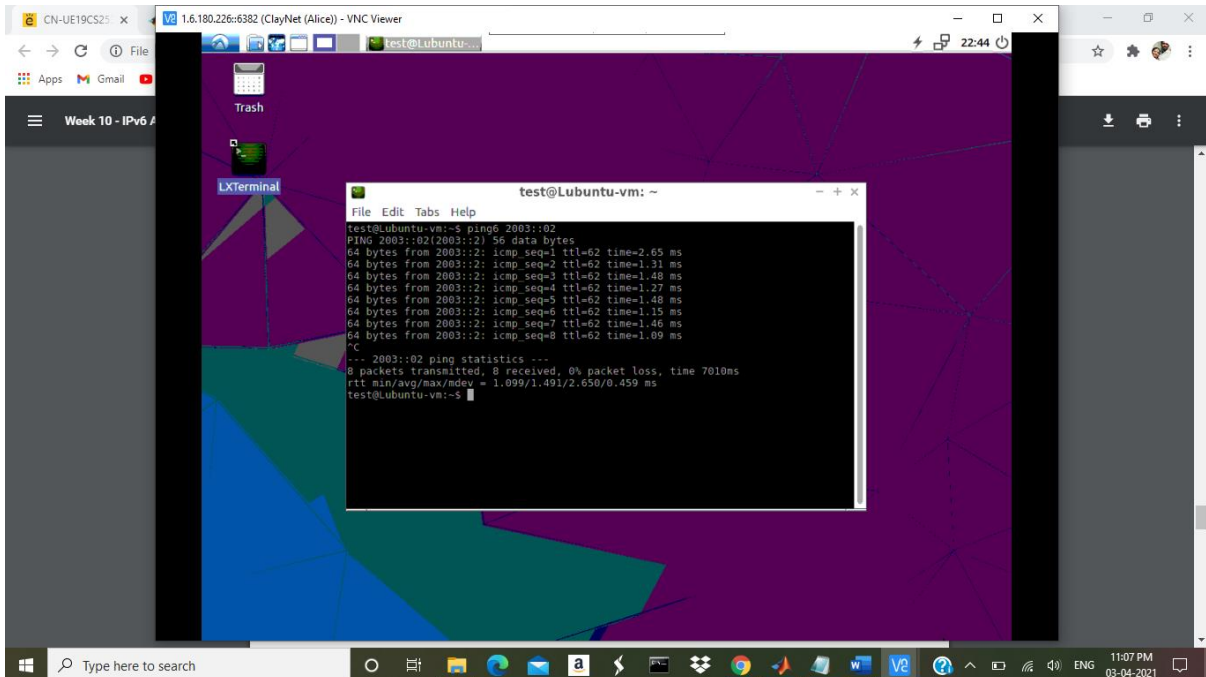
Total number of IPv6 active routes displayed : 6

No IPv6 backup routes are available

operational>
operational>
```

## 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. Observe the intermediate hops



## 12. Check IPv6 NDP table on Router-1

This is similar to ARP Table in IPv4.

```
Login: admin
Password:

operational> show ipv6 neighbour summary data

Host address          MAC address          Interface
-----
2001::2               2a:26:00:00:0f:14    if-port-1
2002::2               2a:26:00:00:03:73    if-port-2
fe80::2826:ff:fe00:373 2a:26:00:00:03:73    if-port-2
fe80::bb44:fb3e:be2f:8202 2a:26:00:00:0f:14    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 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
```

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. Page 10/10

Now, Login to Router-1 and ping the link-local address on Router-2 and observe the response. When pingging link-local address, the name of outgoing 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>
```