

Computer Networks Lab

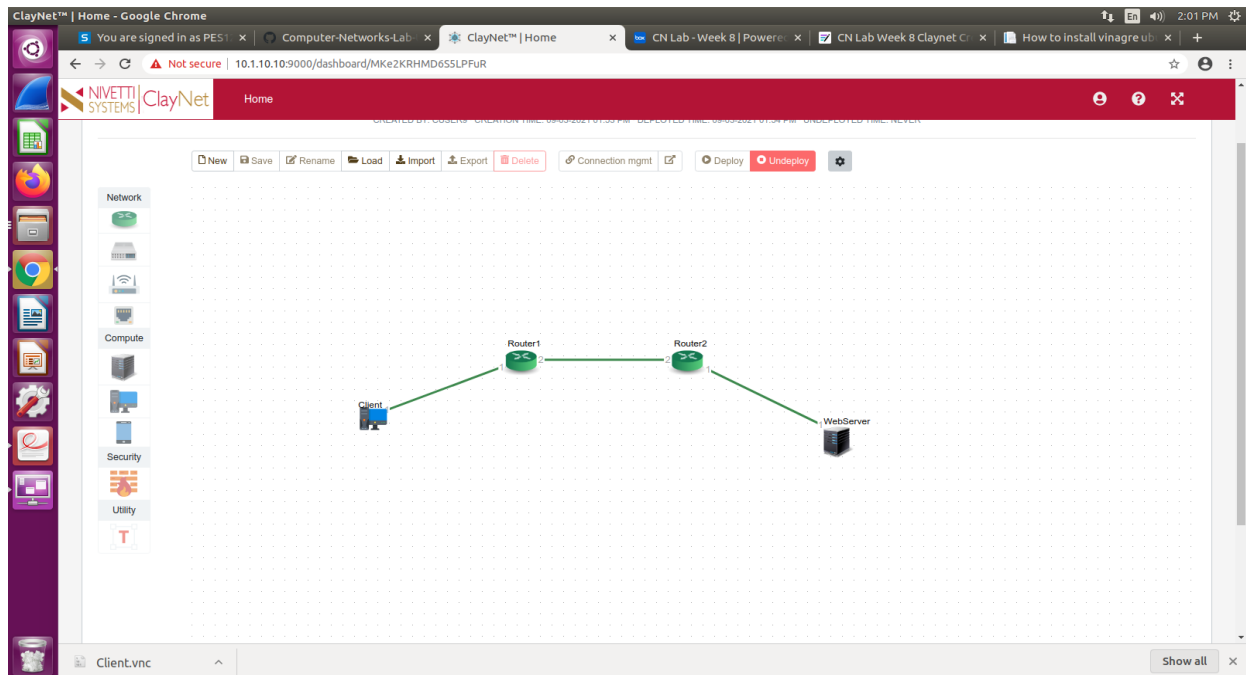
Week 8

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Topology -1

1. IPv4 Addressing and Topology Creation

- The following topology is created and deployed on ClayNet.



- The configuration of all the end-system devices is shown below.

End System	IP Address	Gateway
Client	10.10.10.2/24	10.10.10.1
WebServer	30.30.30.2/24	30.30.30.1

- Similarly, the routers are configured in the same manner.

Router	Interface Number (Port)	IP Address
Router 1	1	10.10.10.1/24
Router 1	2	20.20.20.1/24
Router 2	1	30.30.30.1/24
Router 2	2	20.20.20.2/24

2. Ping Command

- From Client, a ping command is made to WebServer.
- However, this ping command fails because the routing table entries have not been configured yet for Router1 and Router2.
- We obtain a **Destination Host Unreachable** status.

The screenshot shows a remote terminal window titled 'test@Lubuntu-vm: ~'. The terminal output shows a ping command being executed from the client to the web server (30.30.30.2). The output indicates that the ping failed with a 'Destination Host Unreachable' status for all four attempts. The statistics show 4 packets transmitted, 0 received, and a 100% packet loss.

```

test@Lubuntu-vm:~$ ping 30.30.30.2
PING 30.30.30.2 (30.30.30.2) 56(84) bytes of data:
From 10.10.10.1 icmp_seq=1 Destination Host Unreachable
From 10.10.10.1 icmp_seq=2 Destination Host Unreachable
From 10.10.10.1 icmp_seq=3 Destination Host Unreachable
From 10.10.10.1 icmp_seq=4 Destination Host Unreachable
^C
--- 30.30.30.2 ping statistics ---
4 packets transmitted, 0 received, 100% packet loss, time 3033ms
test@Lubuntu-vm:~$

```

3. Configuration of Routing Table Entries

3.1 Router 1

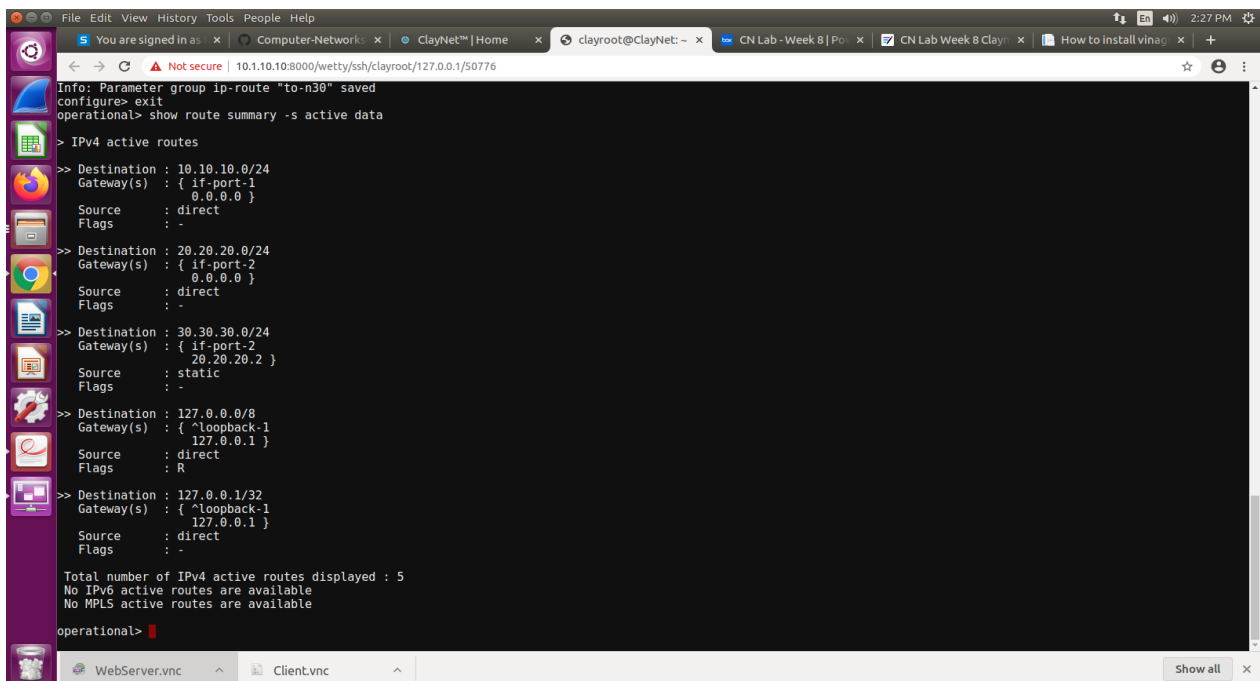
- The Routing Table entries for Router 1 are configured using the below commands in the console window.

```

configure> create parameter-group ip-route to-n30
Confirm: Modifications not saved. Do you want to discard ? (y/N) y
Info: Parameter group instance created.
configure> set enable yes
configure> set router data
configure> set destination 30.30.30.0/24
configure> set next-hop gateway 20.20.20.2
configure> save
Info: Parameter group ip-route "to-n30" saved
configure> exit
operational>

```

- The resulting Routing Table Entry is shown below.



```

Info: Parameter group ip-route "to-n30" saved
configure> exit
operational> show route summary -s active data

> IPv4 active routes
>> Destination : 10.10.10.0/24
Gateway(s) : { if-port-1
              0.0.0.0 }
Source      : direct
Flags      : -
>> Destination : 20.20.20.0/24
Gateway(s) : { if-port-2
              0.0.0.0 }
Source      : direct
Flags      : -
>> Destination : 30.30.30.0/24
Gateway(s) : { if-port-2
              20.20.20.2 }
Source      : static
Flags      : -
>> Destination : 127.0.0.0/8
Gateway(s) : { ^loopback-1
              127.0.0.1 }
Source      : direct
Flags      : R
>> Destination : 127.0.0.1/32
Gateway(s) : { ^loopback-1
              127.0.0.1 }
Source      : direct
Flags      : -

Total number of IPv4 active routes displayed : 5
No IPv6 active routes are available
No MPLS active routes are available

operational>

```

3.2 Router 2

- The Routing Table entries for Router 2 are configured using the below commands in the console window.

```

operational> configure
Entering configuration mode with exclusive access.
configure> create parameter-group ip-route to-n30
Info: Parameter group instance created.
configure> set enable yes
configure> set router data
configure> set destination 10.10.10.0/24
configure> set next-hop gateway 20.20.20.1
configure> save
Info: Parameter group ip-route "to-n30" saved
configure> exit
operational>

```

- The resulting Routing Table Entry is shown below.

```

clayroot@ClayNet: ~ - Google Chrome
Info: Parameter group ip-route "to-n30" saved
configure> exit
operational> show route summary -s active data

> IPv4 active routes

>> Destination : 10.10.10.0/24
Gateway(s) : { if-port-2
20.20.20.1 }
Source : static
Flags : -

>> Destination : 20.20.20.0/24
Gateway(s) : { if-port-2
0.0.0.0 }
Source : direct
Flags : -

>> Destination : 30.30.30.0/24
Gateway(s) : { if-port-1
0.0.0.0 }
Source : direct
Flags : -

>> Destination : 127.0.0.0/8
Gateway(s) : { ^loopback-1
127.0.0.1 }
Source : direct
Flags : R

>> Destination : 127.0.0.1/32
Gateway(s) : { ^loopback-1
127.0.0.1 }
Source : direct
Flags : -

Total number of IPv4 active routes displayed : 5
No IPv6 active routes are available
No MPLS active routes are available

operational>
  
```

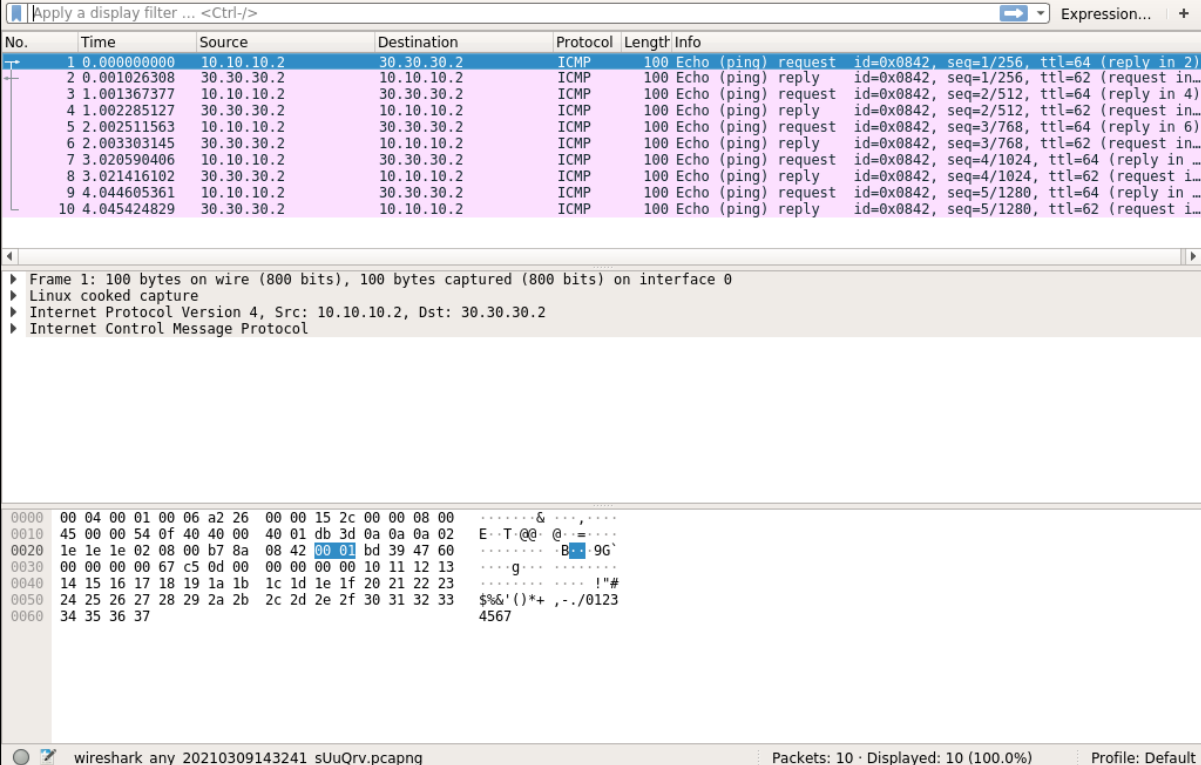
4. Observations

- Client and WebServer are now reachable from each other.
- To verify this, the **ping** command is again used to ICMP request packets to the other.
- Since there are 2 hops between the systems, the TTL value is decremented by 2. Hence the value is decremented from its default value of 64 to 62.

```

test@Lubuntu-vm:~$ ping 30.30.30.2
PING 30.30.30.2 (30.30.30.2) 56(84) bytes of data:
64 bytes from 30.30.30.2: icmp_seq=1 ttl=62 time=1.06 ms
64 bytes from 30.30.30.2: icmp_seq=2 ttl=62 time=0.943 ms
64 bytes from 30.30.30.2: icmp_seq=3 ttl=62 time=0.806 ms
64 bytes from 30.30.30.2: icmp_seq=4 ttl=62 time=0.837 ms
64 bytes from 30.30.30.2: icmp_seq=5 ttl=62 time=0.831 ms
^C
--- 30.30.30.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4044ms
rtt min/avg/max/mdev = 0.806/0.896/1.065/0.100 ms
test@Lubuntu-vm:~$
  
```

- The following Wireshark Packet Capture shows ICMP request packets being sent from Client to WebServer.



Apply a display filter ... <Ctrl-/> Expression... +

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	10.10.10.2	30.30.30.2	ICMP	100	Echo (ping) request id=0x0842, seq=1/256, ttl=64 (reply in 2)
2	0.001026308	30.30.30.2	10.10.10.2	ICMP	100	Echo (ping) reply id=0x0842, seq=1/256, ttl=62 (request in 1)
3	1.001367377	10.10.10.2	30.30.30.2	ICMP	100	Echo (ping) request id=0x0842, seq=2/512, ttl=64 (reply in 4)
4	1.002285127	30.30.30.2	10.10.10.2	ICMP	100	Echo (ping) reply id=0x0842, seq=2/512, ttl=62 (request in 3)
5	2.002511563	10.10.10.2	30.30.30.2	ICMP	100	Echo (ping) request id=0x0842, seq=3/768, ttl=64 (reply in 6)
6	2.003303145	30.30.30.2	10.10.10.2	ICMP	100	Echo (ping) reply id=0x0842, seq=3/768, ttl=62 (request in 5)
7	3.020590406	10.10.10.2	30.30.30.2	ICMP	100	Echo (ping) request id=0x0842, seq=4/1024, ttl=64 (reply in 7)
8	3.021416102	30.30.30.2	10.10.10.2	ICMP	100	Echo (ping) reply id=0x0842, seq=4/1024, ttl=62 (request in 7)
9	4.044605361	10.10.10.2	30.30.30.2	ICMP	100	Echo (ping) request id=0x0842, seq=5/1280, ttl=64 (reply in 9)
10	4.045424829	30.30.30.2	10.10.10.2	ICMP	100	Echo (ping) reply id=0x0842, seq=5/1280, ttl=62 (request in 9)

Frame 1: 100 bytes on wire (800 bits), 100 bytes captured (800 bits) on interface 0
 Linux cooked capture
 Internet Protocol Version 4, Src: 10.10.10.2, Dst: 30.30.30.2
 Internet Control Message Protocol

0000 00 04 00 01 00 06 a2 26 00 00 15 2c 00 00 08 00&.....
 0010 45 00 00 54 0f 40 40 00 40 01 db 3d 0a 0a 0a 02 E..T.@@. @.-...
 0020 1e 1e 1e 02 08 00 b7 8a 08 42 00 01 bd 39 47 60B...9G`
 0030 00 00 00 00 67 c5 0d 00 00 00 00 10 11 12 13g.....
 0040 14 15 16 17 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23!""#
 0050 24 25 26 27 28 29 2a 2b 2c 2d 2e 2f 30 31 32 33 \$%&'()*+,-./0123
 0060 34 35 36 37 4567

wireshark_any_20210309143241_sUuQrv.pcapng Packets: 10 · Displayed: 10 (100.0%) Profile: Default

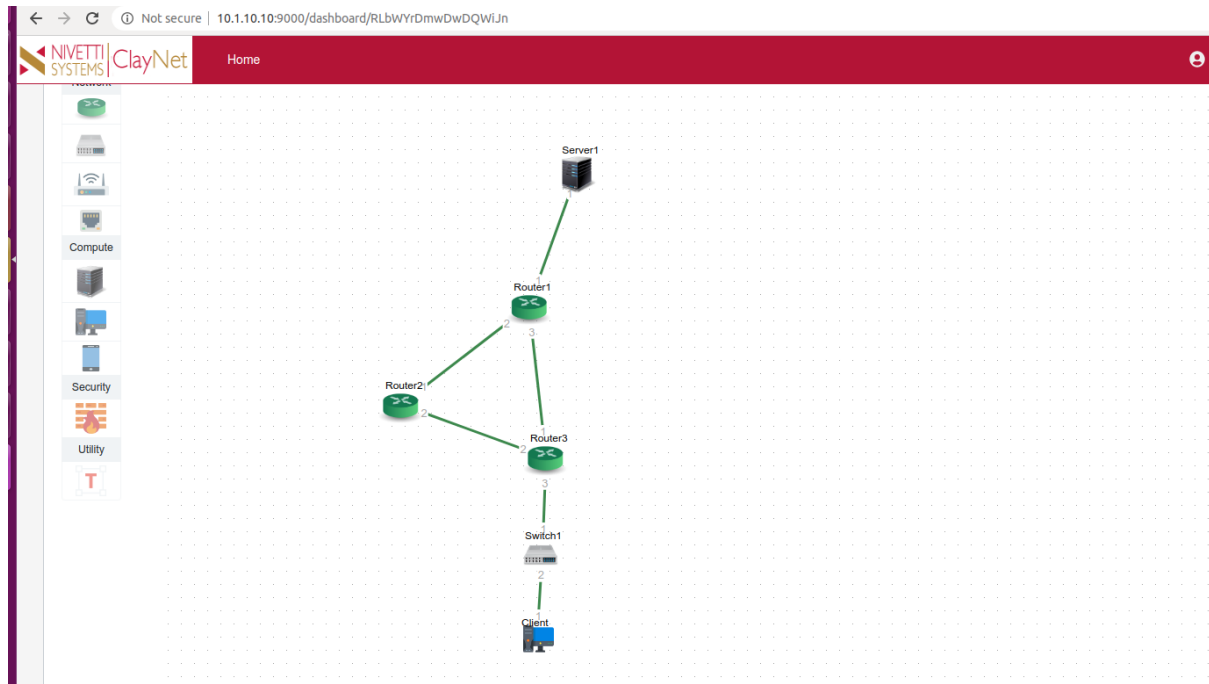
- The following screenshot displays the outcome of the traceroute command from Client to WebServer.

```
test@Lubuntu-vm:~$ tracepath -n 30.30.30.2
1?: [LOCALHOST] pmtu 1500
1: 10.10.10.1 0.552ms
1: 10.10.10.1 0.218ms
2: 20.20.20.2 0.590ms
3: 30.30.30.2 0.788ms reached
Resume: pmtu 1500 hops 3 back 3
test@Lubuntu-vm:~$
```

Topology -2

1. IPv4 Addressing and Topology Creation

- The following topology is created and deployed on ClayNet.



- The configuration of all the end-system devices is shown below.

End System	IP Address	Gateway
Client	50.50.50.2	50.50.50.1
Server	10.10.10.2	10.10.10.1

- Similarly, the routers are configured in the same manner.

Router	Interface Number (Port)	IP Address
Router 1	1	10.10.10.1/24
Router 1	2	20.20.20.1/24
Router 1	3	30.30.30.1/24
Router 2	1	20.20.20.2/24
Router 2	2	40.40.40.1/24
Router 3	1	30.30.30.2/24
Router 3	2	40.40.40.2/24
Router 3	3	50.50.50.1/24

2. Ping Command

- From the Client, a ping command is made to Server1.
- However, this ping command fails because the routing table entries have not been configured for Router 1 , Router 2, Router 3.
- We obtain a **Destination Host Unreachable** status.

```
test@Lubuntu-vm:~$ ping 10.10.10.2
PING 10.10.10.2 (10.10.10.2) 56(84) bytes of data.
From 30.30.30.1 icmp_seq=1 Destination Host Unreachable
From 30.30.30.1 icmp_seq=2 Destination Host Unreachable
From 30.30.30.1 icmp_seq=3 Destination Host Unreachable
^C
--- 10.10.10.2 ping statistics ---
3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 2041ms

test@Lubuntu-vm:~$ █
```

- From the Server1, a ping command is made to Client
- However, this ping command fails because the routing table entries have not been configured for Router 1 , Router 2, Router 3.
- We obtain a **Destination Host Unreachable** status.

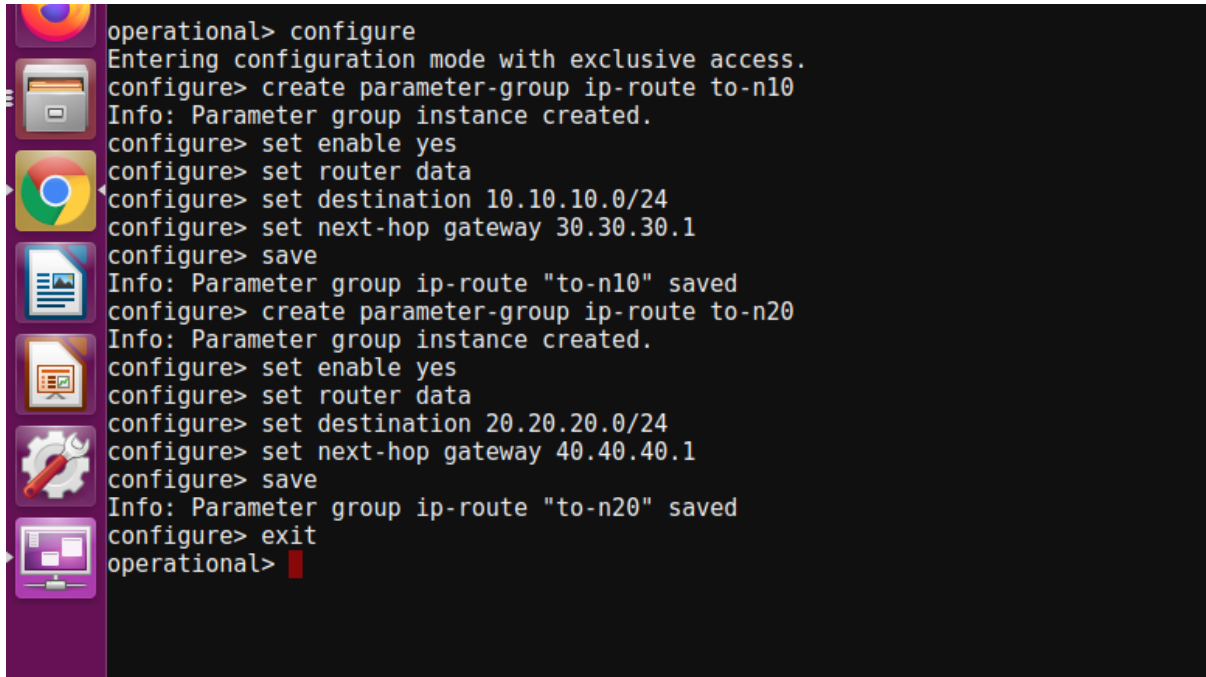
```
test@Lubuntu-vm:~$ ping 50.50.50.2
PING 50.50.50.2 (50.50.50.2) 56(84) bytes of data.
From 10.10.10.1 icmp_seq=1 Destination Host Unreachable
From 10.10.10.1 icmp_seq=2 Destination Host Unreachable
From 10.10.10.1 icmp_seq=3 Destination Host Unreachable
^C
--- 50.50.50.2 ping statistics ---
3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 2029ms

test@Lubuntu-vm:~$ █
```

3. Configuration of Routing Table Entries

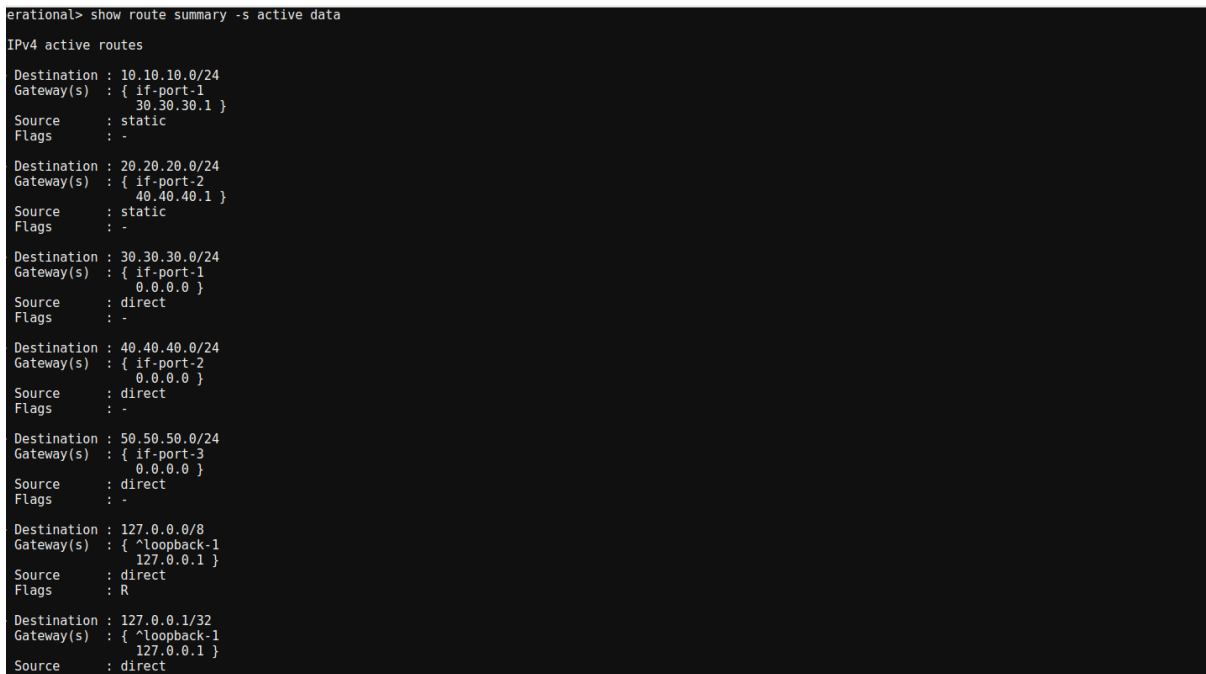
3.1 Router 3

- The Routing Table entries for Router 3 are configured using the below commands in the console window.



```
operational> configure
Entering configuration mode with exclusive access.
configure> create parameter-group ip-route to-n10
Info: Parameter group instance created.
configure> set enable yes
configure> set router data
configure> set destination 10.10.10.0/24
configure> set next-hop gateway 30.30.30.1
configure> save
Info: Parameter group ip-route "to-n10" saved
configure> create parameter-group ip-route to-n20
Info: Parameter group instance created.
configure> set enable yes
configure> set router data
configure> set destination 20.20.20.0/24
configure> set next-hop gateway 40.40.40.1
configure> save
Info: Parameter group ip-route "to-n20" saved
configure> exit
operational>
```

- The resulting Routing Table Entry is shown below.



```
operational> show route summary -s active data
IPv4 active routes

Destination : 10.10.10.0/24
Gateway(s)  : { if-port-1
                30.30.30.1 }
Source      : static
Flags      : -

Destination : 20.20.20.0/24
Gateway(s)  : { if-port-2
                40.40.40.1 }
Source      : static
Flags      : -

Destination : 30.30.30.0/24
Gateway(s)  : { if-port-1
                0.0.0.0 }
Source      : direct
Flags      : -

Destination : 40.40.40.0/24
Gateway(s)  : { if-port-2
                0.0.0.0 }
Source      : direct
Flags      : -

Destination : 50.50.50.0/24
Gateway(s)  : { if-port-3
                0.0.0.0 }
Source      : direct
Flags      : -

Destination : 127.0.0.0/8
Gateway(s)  : { ^loopback-1
                127.0.0.1 }
Source      : direct
Flags      : R

Destination : 127.0.0.1/32
Gateway(s)  : { ^loopback-1
                127.0.0.1 }
Source      : direct
```

3.2 Router 1

- The Routing Table entries for Router 1 are configured using the below commands in the console window.


```

configure> create parameter-group ip-route to-n31
Confirm: Modifications not saved. Do you want to discard ? (y/N) y
Info: Parameter group instance created.
configure> set enable yes
configure> set router data
configure> set destination 40.40.40.0/24
configure> set next-hop gateway 20.20.20.2
configure> save
Info: Parameter group ip-route "to-n31" saved
configure> exit

```

```

operational> configure
Entering configuration mode with exclusive access.
configure> create parameter-group ip-route to-n30
Info: Parameter group instance created.
configure> set enable yes
configure> set router data
configure> set destination 50.50.50.0/24
configure> set next-hop gateway 30.30.30.2
configure> save
Info: Parameter group ip-route "to-n30" saved

```

- The resulting Routing Table Entry is shown below.

```

> IPv4 active routes
>> Destination : 10.10.10.0/24
  Gateway(s) : { if-port-1
                 0.0.0.0 }
  Source      : direct
  Flags       : -
>> Destination : 20.20.20.0/24
  Gateway(s) : { if-port-2
                 0.0.0.0 }
  Source      : direct
  Flags       : -
>> Destination : 30.30.30.0/24
  Gateway(s) : { if-port-3
                 0.0.0.0 }
  Source      : direct
  Flags       : -
>> Destination : 40.40.40.0/24
  Gateway(s) : { if-port-2
                 20.20.20.2 }
  Source      : static
  Flags       : -
>> Destination : 50.50.50.0/24
  Gateway(s) : { if-port-3
                 30.30.30.2 }
  Source      : static
  Flags       : -
>> Destination : 127.0.0.0/8
  Gateway(s) : { ^loopback-1
                 127.0.0.1 }
  Source      : direct
  Flags       : R
>> Destination : 127.0.0.1/32
  Gateway(s) : { ^loopback-1
                 127.0.0.1 }
  Source      : direct
  Flags       : -

```

3.3 Router 2

- The Routing Table entries for Router 2 are configured using the below commands in the console window.

```
operational> configure
Entering configuration mode with exclusive access.
configure> create parameter-group ip-route to-n10
Info: Parameter group instance created.
configure> set enable yes
configure> set router data
configure> set destination 10.10.10.0/24
configure> set next-hop gateway 20.20.20.1
configure> save
Info: Parameter group ip-route "to-n10" saved
configure> create parameter-group ip-route to-n30
Info: Parameter group instance created.
configure> set enable yes
configure> set router data
configure> set destination 30.30.30.0/24
configure> set next-hop gateway 20.20.20.1
configure> save
Info: Parameter group ip-route "to-n30" saved
configure> create parameter-group ip-route to-n50
Info: Parameter group instance created.
configure> set enable yes
configure> set router data
configure> set destination 50.50.50.0/24
configure> set next-hop gateway 40.40.40.2
configure> save
Info: Parameter group ip-route "to-n50" saved
configure> exit
operational>
```

- The resulting Routing Table Entry is shown below.

```
IPv4 active routes
Destination : 10.10.10.0/24
Gateway(s) : { if-port-1
               20.20.20.1 }
Source      : static
Flags      : -
Destination : 20.20.20.0/24
Gateway(s) : { if-port-1
               0.0.0.0 }
Source      : direct
Flags      : -
Destination : 30.30.30.0/24
Gateway(s) : { if-port-1
               20.20.20.1 }
Source      : static
Flags      : -
Destination : 40.40.40.0/24
Gateway(s) : { if-port-2
               0.0.0.0 }
Source      : direct
Flags      : -
Destination : 50.50.50.0/24
Gateway(s) : { if-port-2
               40.40.40.2 }
Source      : static
Flags      : -
Destination : 127.0.0.0/8
Gateway(s) : { ^loopback-1
               127.0.0.1 }
Source      : direct
Flags      : R
Destination : 127.0.0.1/32
Gateway(s) : { ^loopback-1
               127.0.0.1 }
Source      : direct
Flags      : -
```

4. Observations

- Client and Server1 are now reachable from each other.
- To verify this, the **ping** command is again used to ICMP request packets to the other.

```
test@Lubuntu-vm: ~  
File Edit Tabs Help  
test@Lubuntu-vm:~$ ping 10.10.10.2  
PING 10.10.10.2 (10.10.10.2) 56(84) bytes of data:  
64 bytes from 10.10.10.2: icmp_seq=1 ttl=62 time=2.93 ms  
64 bytes from 10.10.10.2: icmp_seq=2 ttl=62 time=1.55 ms  
64 bytes from 10.10.10.2: icmp_seq=3 ttl=62 time=1.43 ms  
64 bytes from 10.10.10.2: icmp_seq=4 ttl=62 time=1.33 ms  
64 bytes from 10.10.10.2: icmp_seq=5 ttl=62 time=1.04 ms  
^C  
--- 10.10.10.2 ping statistics ---  
5 packets transmitted, 5 received, 0% packet loss, time 4006ms  
rtt min/avg/max/mdev = 1.047/1.659/2.931/0.658 ms  
test@Lubuntu-vm:~$
```

- The following Wireshark Packet Capture shows ICMP request packets being sent from Client to Server1.

The image shows a Wireshark packet capture window titled "any". The filter bar is set to "icmp". The packet list shows 10 packets, all of which are ICMP Echo (ping) requests from 10.10.10.2 to 50.50.50.2. The packet details pane shows the selected packet (No. 31) as an ICMP Echo (ping) request with ID 0x07da, sequence number 1, and TTL 62. The packet bytes pane shows the raw data of the packet, including the IP header and ICMP header.

No.	Time	Source	Destination	Protocol	Length	Info
31	42.962651816	10.10.10.2	50.50.50.2	ICMP	100	Echo (ping) request id=0x07da, seq=1/256, ttl=62 (reply in ...)
32	42.963926963	10.10.10.2	50.50.50.2	ICMP	100	Echo (ping) reply id=0x07da, seq=1/256, ttl=62 (request in ...)
33	43.963016474	50.50.50.2	10.10.10.2	ICMP	100	Echo (ping) request id=0x07da, seq=2/512, ttl=64 (reply in ...)
34	43.964551688	10.10.10.2	50.50.50.2	ICMP	100	Echo (ping) reply id=0x07da, seq=2/512, ttl=62 (request in ...)
36	44.964657533	50.50.50.2	10.10.10.2	ICMP	100	Echo (ping) request id=0x07da, seq=3/768, ttl=64 (reply in ...)
37	44.966069719	10.10.10.2	50.50.50.2	ICMP	100	Echo (ping) reply id=0x07da, seq=3/768, ttl=62 (request in ...)
38	45.966157078	50.50.50.2	10.10.10.2	ICMP	100	Echo (ping) request id=0x07da, seq=4/1024, ttl=64 (reply in ...)
39	45.967477280	10.10.10.2	50.50.50.2	ICMP	100	Echo (ping) reply id=0x07da, seq=4/1024, ttl=62 (request in ...)
41	46.967564703	50.50.50.2	10.10.10.2	ICMP	100	Echo (ping) request id=0x07da, seq=5/1280, ttl=64 (reply in ...)
42	46.968598810	10.10.10.2	50.50.50.2	ICMP	100	Echo (ping) reply id=0x07da, seq=5/1280, ttl=62 (request in ...)

Frame 31: 100 bytes on wire (800 bits), 100 bytes captured (800 bits) on interface 0
Linux cooked capture
Internet Protocol Version 4, Src: 50.50.50.2, Dst: 10.10.10.2
Internet Control Message Protocol

0000 00 04 00 01 00 06 a2 26 00 00 15 98 00 00 08 006.....
0010 45 00 00 54 12 08 40 00 40 01 b0 61 32 32 32 02 E..T.:@..a222.
0020 0a 0a 0a 02 00 00 6b 8a 07 da 00 01 75 4a 47 60k...uJG
0030 00 00 00 00 ff 1c 0a 00 00 00 00 00 11 12 13
0040 14 15 16 17 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23!"#
0050 24 25 26 27 28 29 2a 2b 2c 2d 2e 2f 30 31 32 33 %%'()*+,-./0123
0060 34 35 36 37 4567

5. Questions

Q1 . How many hops will the client take to reach the Server?

Answer. 3 hops (maximum) for longest path and 2 hops (minimum)for shortest path

Q2. Observe the RTT and justify your observation.

Answer. Initially, the TTL will be high because the sender does an ARP request to find the MAC address of the Router. This is additional work and takes some time. The second packet RTT is faster because the ARP data is cached on the device. After that, it appears to be within the margin of error. The times are so close to each other and they are in milliseconds that it is hard to say the reduction is significant.

Q3. While Pinging, cut the link between Router 1 and Router 3. What will happen now ?

Answer. When Router 1 and Router 3 link is cut, the only path left for packets to travel is between Router 3 and Router 1 via Router 2, so there will be 3 hops between the client and the server.