

COMPUTER NETWORKS

LABORATORY

WEEK 8

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Name of the experiment: Understand the building blocks and usage of ClayNet Network Virtualization platform with reference to OSI Layer.

Objectives:

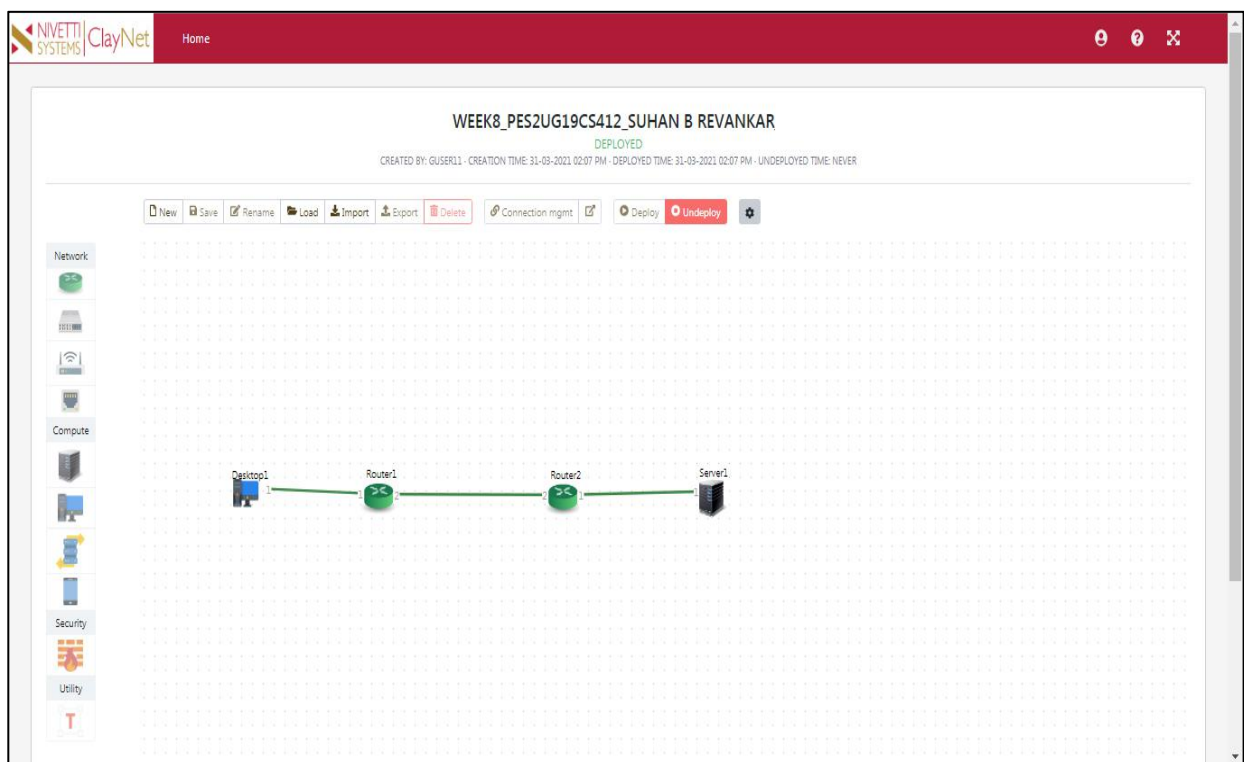
- Understand the building blocks of ClayNet.
 - Build a simple client-server network using routers, switches, and network hosts.
 - To learn the static IP routing behavior such as default and static routes and routing tables.
 - Use common network utilities to verify LAN operation and analyze data traffic.
-

Prerequisites:

This lab assumes some understanding of the building blocks of communication networks and basic client-server architecture.

Topology 1:

Create a topology in ClayNet, as shown in following figure



Execution Tasks:

Task 1: Understand the network and compute components available in ClayNet.

Task 2: Drag and drop the necessary components to create the given topology. Provide the names for compute, select OS (Ubuntu 16.04 – Lite or Ubuntu 16.04 – CLI) and RAM (512 MB) as shown below.

Client

Name

Client

OS

Ubuntu 16.04 - Lite

▼

RAM

512 MB

▼

Close

Server

Name

Server

OS

Ubuntu 16.04 - Lite

▼

RAM

1 GB

▼

Close

Task 3: Drag and drop the Routers and set the IP addresses for all the necessary router ports. (You can also set them later by right clicking on the router icon and selecting ‘Device Configuration’.)

Router1

NameRouter1

Port	IP Address	Netmask	Port	IP Address	Netmask
1	10.10.10.1	/ 24	5	0.0.0.0	/ 0
2	20.20.20.1	/ 24	6	0.0.0.0	/ 0
3	0.0.0.0	/ 0	7	0.0.0.0	/ 0
4	0.0.0.0	/ 0	8	0.0.0.0	/ 0

Close

Router2

NameRouter2

Port	IP Address	Netmask	Port	IP Address	Netmask
1	30.30.30.1	/ 24	5	0.0.0.0	/ 0
2	20.20.20.2	/ 24	6	0.0.0.0	/ 0
3	0.0.0.0	/ 0	7	0.0.0.0	/ 0
4	0.0.0.0	/ 0	8	0.0.0.0	/ 0

Close

Task 4: Go to connection manager and select appropriate Source, Source ports, Target and Target ports and save the connection.

Task 5: To deploy the topology, save the topology first and deploy it by clicking ‘Deploy’ button available on the top. (Note: It will take few seconds or even minutes to deploy the topology for the first time).

Task 6: Go to 'Remote Desktop' by right clicking on client and server icons and set the IP addresses accordingly. Also add the gateway address. (Login: user - test, password - test)

Client:

IP Address →

10.10.10.2 Gateway

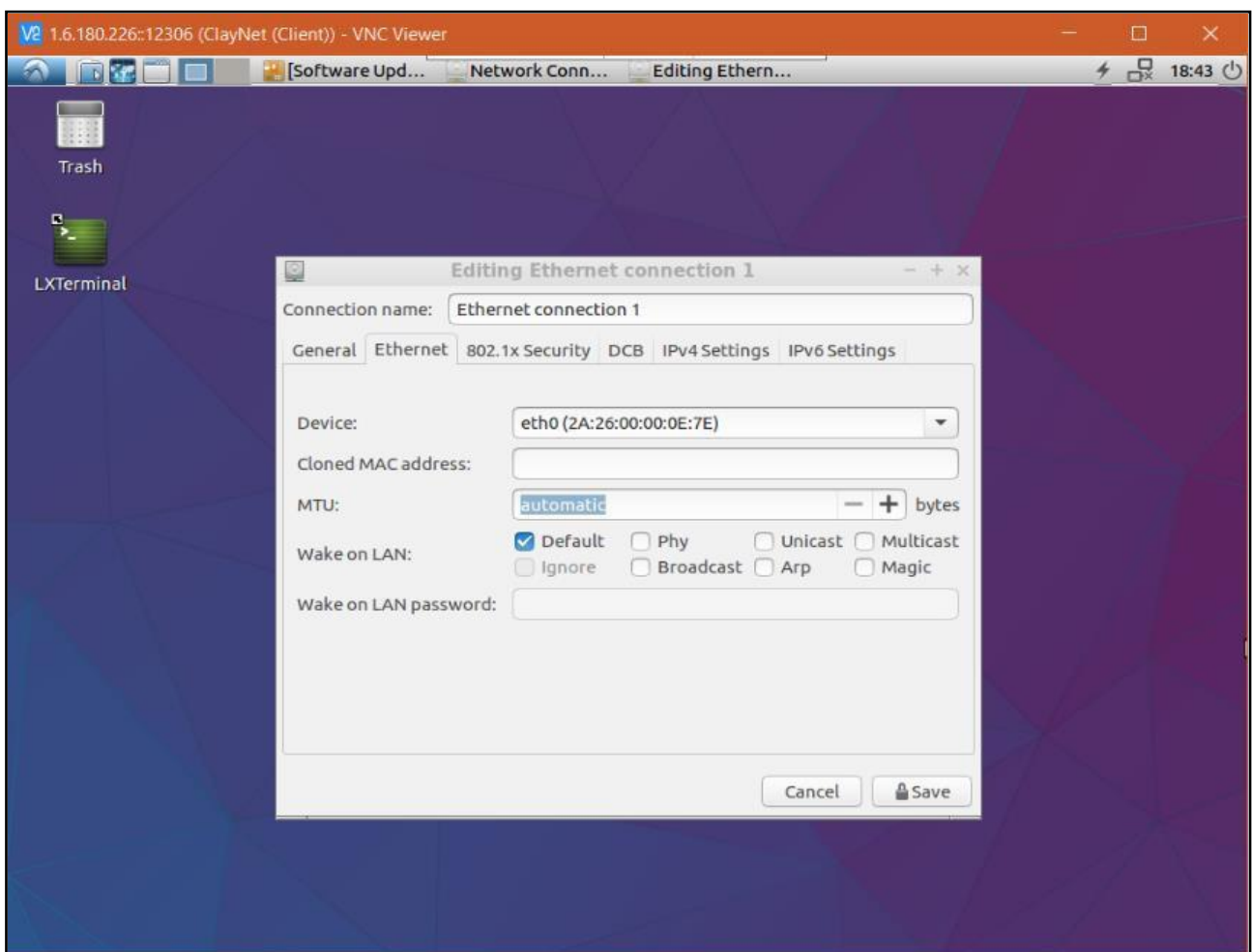
→ 10.10.10.1

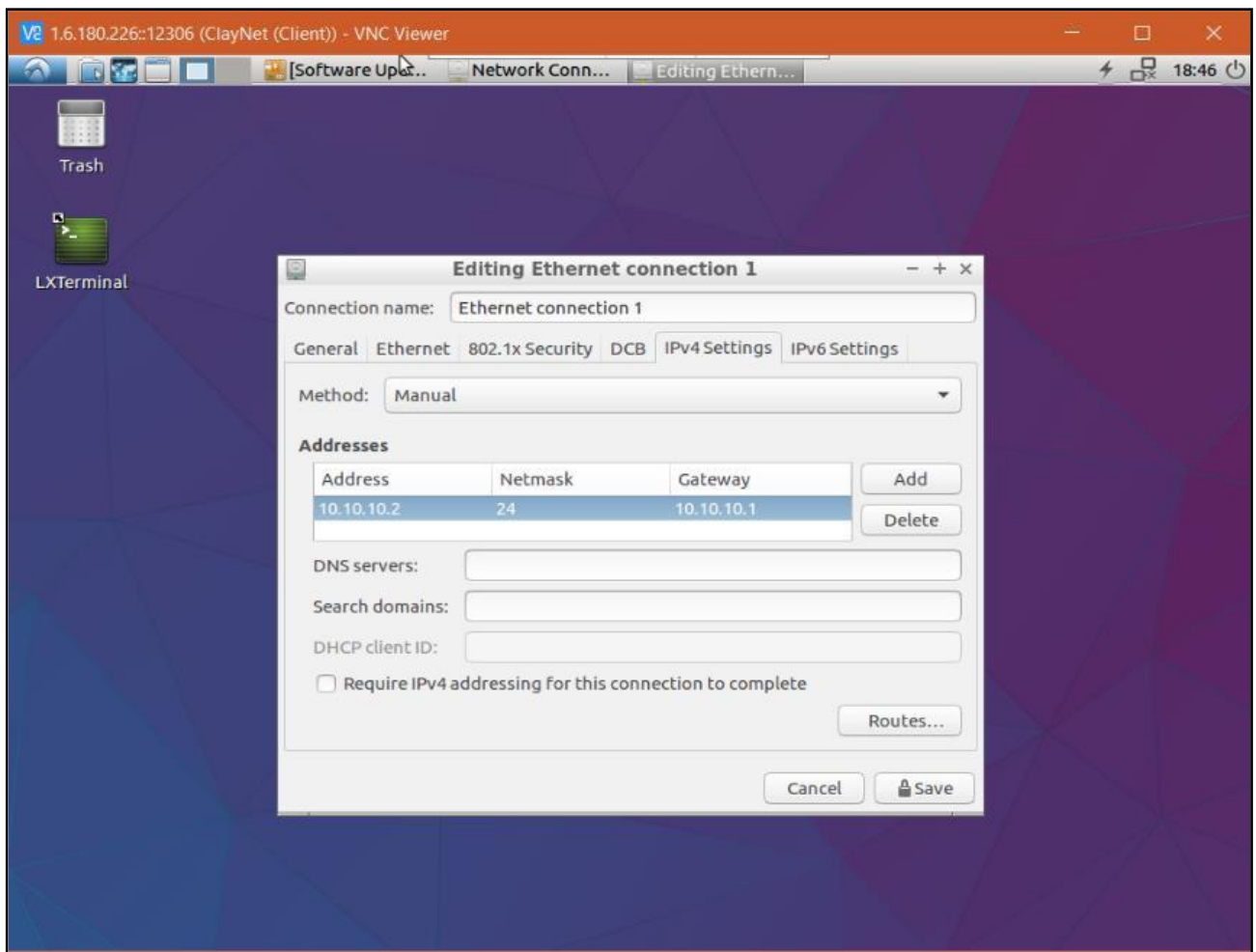
Server:

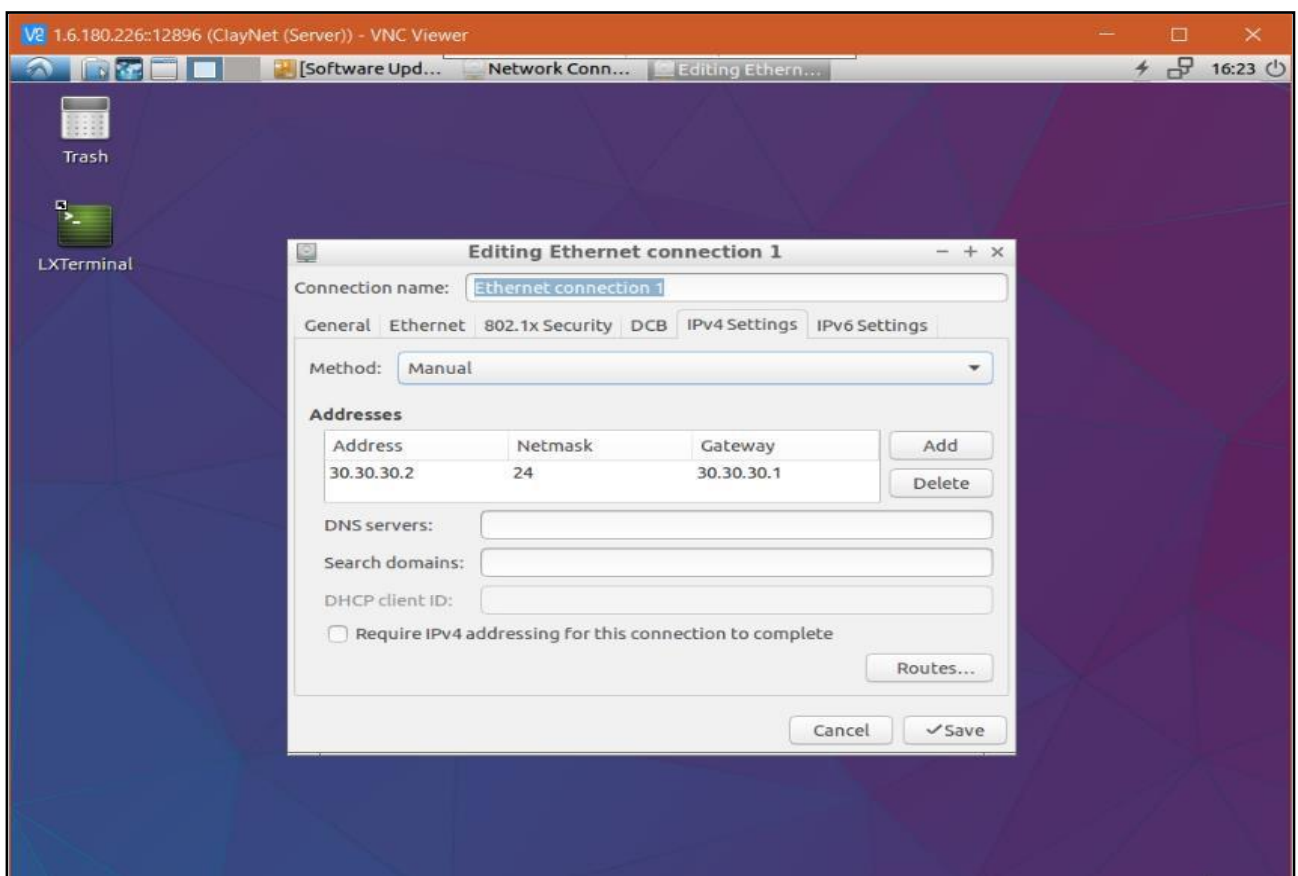
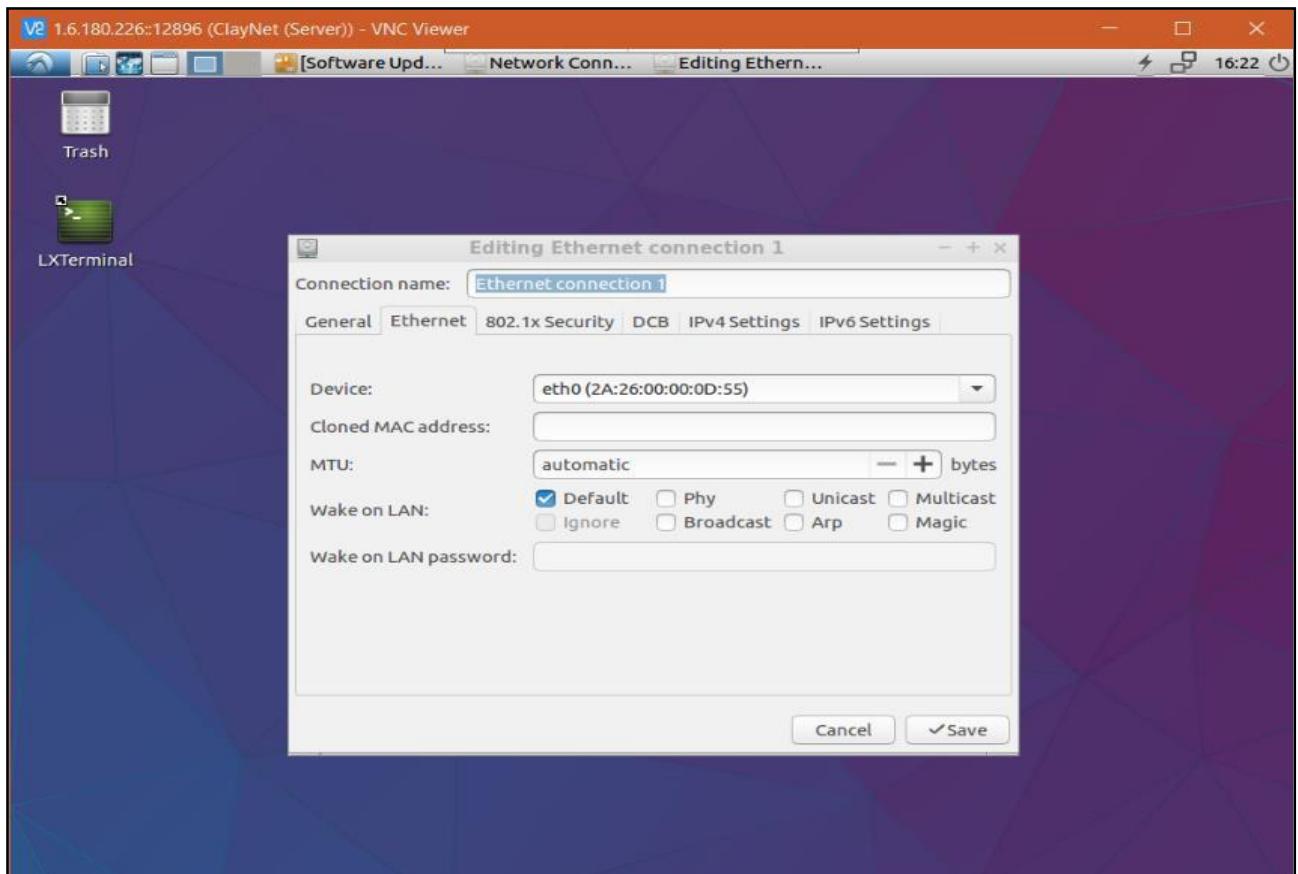
IP Address →

30.30.30.2 Gateway

→ 30.30.30.1







```
1.6.180.226:12306 (ClayNet (Client)) - VNC Viewer
[Software Upd... test@Lubuntu-... 18:49
test@Lubuntu-vm: ~
File Edit Tabs Help
test@Lubuntu-vm:~$ ifconfig
eth0      Link encap:Ethernet  HWaddr 2a:26:00:00:0e:7e
          inet addr:10.10.10.2  Bcast:10.10.10.255  Mask:255.255.255.0
          inet6 addr: fe80::e93e:2fa7:ad6f:9868/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:99 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:19750 (19.7 KB)

eth1      Link encap:Ethernet  HWaddr 2a:26:00:00:0e:7f
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:94 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:19796 (19.7 KB)

eth2      Link encap:Ethernet  HWaddr 2a:26:00:00:0e:80
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:4492 errors:673 dropped:0 overruns:0 frame:673
          TX packets:93 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:1340656 (1.3 MB)  TX bytes:19454 (19.4 KB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:248 errors:0 dropped:0 overruns:0 frame:0
          TX packets:248 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:19248 (19.2 KB)  TX bytes:19248 (19.2 KB)

test@Lubuntu-vm:~$ ping 10.10.10.1
PING 10.10.10.1 (10.10.10.1) 56(84) bytes of data:
64 bytes from 10.10.10.1: icmp_seq=1 ttl=64 time=0.866 ms
64 bytes from 10.10.10.1: icmp_seq=2 ttl=64 time=0.335 ms
64 bytes from 10.10.10.1: icmp_seq=3 ttl=64 time=0.637 ms
64 bytes from 10.10.10.1: icmp_seq=4 ttl=64 time=0.360 ms
^C
--- 10.10.10.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3054ms
rtt min/avg/max/mdev = 0.335/0.549/0.866/0.219 ms
test@Lubuntu-vm:~$
```



```
1.6.180.226::12896 (ClayNet (Server)) - VNC Viewer
[Software Upd... test@Lubuntu-vm: ~
test@Lubuntu-vm: ~
File Edit Tabs Help
test@Lubuntu-vm:~$ ifconfig
eth0      Link encap:Ethernet  HWaddr 2a:26:00:00:0d:55
          inet addr:30.30.30.2  Bcast:30.30.30.255  Mask:255.255.255.0
          inet6 addr: fe80::a623:862c:3d9d:910b/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:419 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:86210 (86.2 KB)

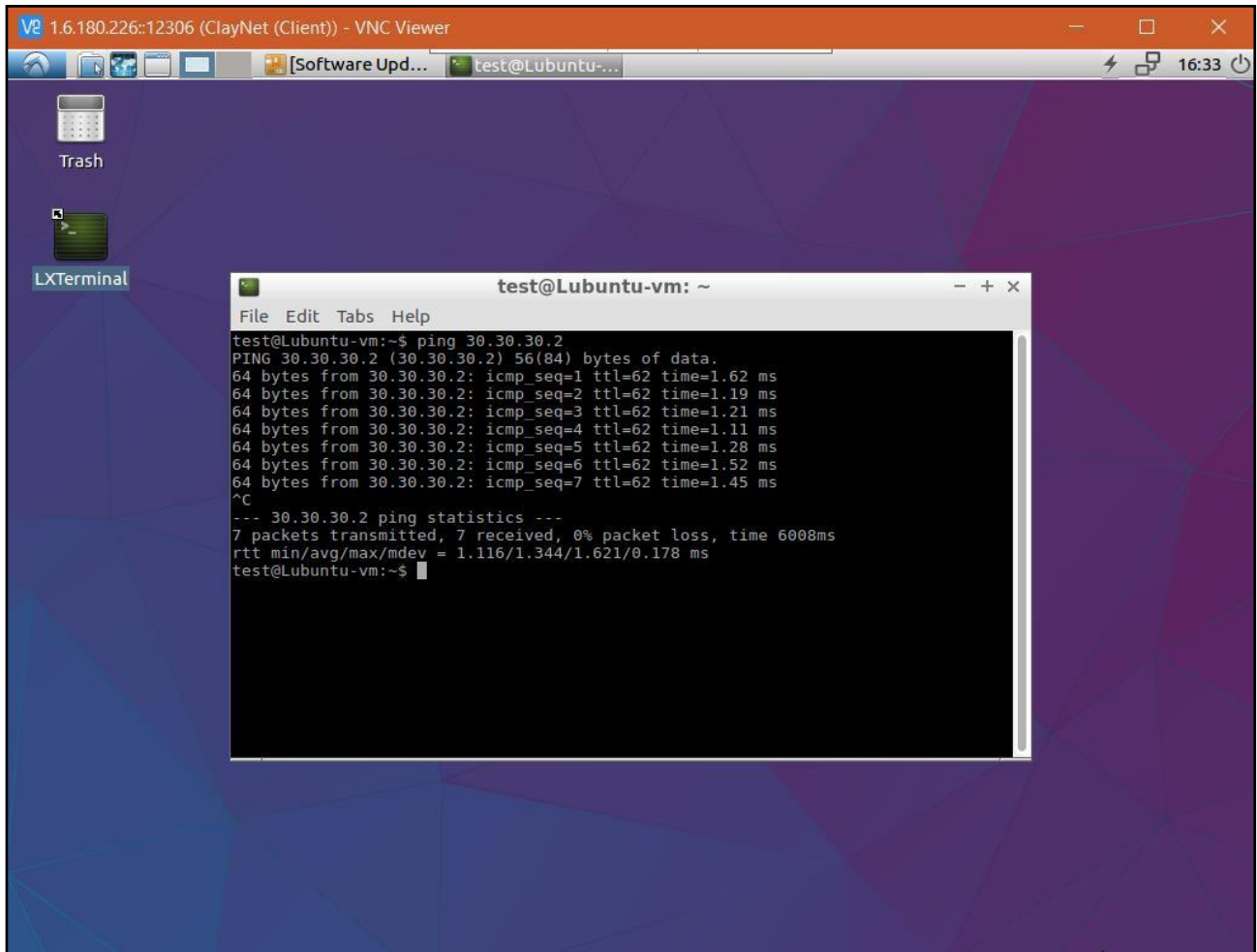
eth1      Link encap:Ethernet  HWaddr 2a:26:00:00:0d:56
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:417 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:87030 (87.0 KB)

eth2      Link encap:Ethernet  HWaddr 2a:26:00:00:0d:57
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:5547 errors:896 dropped:0 overruns:0 frame:896
          TX packets:420 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:1631206 (1.6 MB)  TX bytes:88056 (88.0 KB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:248 errors:0 dropped:0 overruns:0 frame:0
          TX packets:248 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:19248 (19.2 KB)  TX bytes:19248 (19.2 KB)

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=64 time=0.036 ms
64 bytes from 30.30.30.2: icmp_seq=2 ttl=64 time=0.049 ms
64 bytes from 30.30.30.2: icmp_seq=3 ttl=64 time=0.042 ms
64 bytes from 30.30.30.2: icmp_seq=4 ttl=64 time=0.023 ms
^C
--- 30.30.30.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3078ms
rtt min/avg/max/mdev = 0.023/0.037/0.049/0.011 ms
test@Lubuntu-vm:~$
```

Task 6: From client, ping to server 30.30.30.2. Ping will not be successful and Router1 will reply with ‘Destination host unreachable’.



```
1.6.180.226:12306 (ClayNet (Client)) - VNC Viewer
[Software Upd... test@Lubuntu-... 16:33
Trash
LXTerminal
test@Lubuntu-vm: ~
File Edit Tabs Help
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=1.62 ms
64 bytes from 30.30.30.2: icmp_seq=2 ttl=62 time=1.19 ms
64 bytes from 30.30.30.2: icmp_seq=3 ttl=62 time=1.21 ms
64 bytes from 30.30.30.2: icmp_seq=4 ttl=62 time=1.11 ms
64 bytes from 30.30.30.2: icmp_seq=5 ttl=62 time=1.28 ms
64 bytes from 30.30.30.2: icmp_seq=6 ttl=62 time=1.52 ms
64 bytes from 30.30.30.2: icmp_seq=7 ttl=62 time=1.45 ms
^C
--- 30.30.30.2 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6008ms
rtt min/avg/max/mdev = 1.116/1.344/1.621/0.178 ms
test@Lubuntu-vm:~$
```

Task 7: Set up the following routing table entries for Routers 1 & 2.

Routers	Destination	Next hop gateway	Via
Router 1	30.30.30.0	20.20.20.2	Direct
Router 2	10.10.10.0	20.20.20.1	Direct

Steps to add the routing table entries:

Step 1: Login to Router1 by right clicking on Router icon and selecting 'Console Access'. (Type 'Enter' key once to get into Login screen.

Username – admin , Password- admin@12345)

Step 2: Display the routing table to view all static routes using the command.

```
show route summary -s active
data
```

```
nivappadmin@ClayNet:~$ telnet 127.0.0.1 58111
Trying 127.0.0.1...
Connected to 127.0.0.1.
Escape character is '^]'.

Login: admin
Password:

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 : 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
Line : 1-23, Press 'q' to quit.
```

Note in routing table of Router1 that there is no route to reach the destination network 30.30.30.0/24. Go to configure mode and start configuring the router for all the possible routes.

Step 3: Configure a static route in Router1 for destination 30.30.30.0/24 with next-hop gateway as 20.20.20.2, which is the IP address of Router2

```
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 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> █
```

Step 4: Check routing table again and verify that the route is added.

The routing table is successfully completed.

Step 5: Repeat the steps 3 & 4 to configure a static route in Router2 for destination 10.10.10.0/24 with next-hop gateway as 20.20.20.1, which is the IP address of Router1.

```
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
```

```
nivappadmin@ClayNet:~$ telnet 127.0.0.1 51616
Trying 127.0.0.1...
Connected to 127.0.0.1.
Escape character is '^['.
```

```
Login: admin
Password:
```

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

```
> IPv4 active routes
```

```
>> 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 : 4
No IPv6 active routes are available
No MPLS active routes are available
```

```
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> exit
operational> show route summary -s active data
```



```
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
```

The routing is successfully completed

Task 8: Now Ping will be successful as all the required routers are now configured. Observe the TTL getting decremented by 2 because two hops/routers are in between. Also keep the Wireshark ready for observation.

The screenshot shows a VNC viewer window titled "1.6.180.226::12306 (ClayNet (Client)) - VNC Viewer". Inside the viewer, there is a terminal window with the prompt "test@Lubuntu-..." and a Wireshark network traffic capture window. The Wireshark window shows a list of captured packets with columns for No., Time, Source, Destination, Protocol, Length, and Info. The packets are filtered by "Apply a display filter ... <Ctrl-/>". The list shows several ICMP Echo (ping) requests and replies, as well as DHCP Discover messages. The first packet is an ICMP Echo (ping) request from 10.10.10.2 to 30.30.30.2 with a TTL of 64. The second packet is an ICMP Echo (ping) reply from 30.30.30.2 to 10.10.10.2 with a TTL of 62. The third packet is an ICMPv6 Router Solicitation from fe80::1cc:4094:4d11::ff02::2 to ff02::2. The fourth packet is an ICMP Echo (ping) request from 10.10.10.2 to 30.30.30.2 with a TTL of 64. The fifth packet is an ICMP Echo (ping) reply from 30.30.30.2 to 10.10.10.2 with a TTL of 62. The sixth packet is a DHCP Discover message from 0.0.0.0 to 255.255.255.255 with a Transaction ID of 0x13f5dc10. The seventh packet is a DHCP Discover message from 0.0.0.0 to 255.255.255.255 with a Transaction ID of 0x13f5dc10. The eighth packet is an ICMP Echo (ping) request from 10.10.10.2 to 30.30.30.2 with a TTL of 64. The ninth packet is an ICMP Echo (ping) reply from 30.30.30.2 to 10.10.10.2 with a TTL of 62. The tenth packet is a DHCP Discover message from 0.0.0.0 to 255.255.255.255 with a Transaction ID of 0xf4479f2d. The eleventh packet is a DHCP Discover message from 0.0.0.0 to 255.255.255.255 with a Transaction ID of 0xa7fab404. The twelfth packet is an ICMP Echo (ping) request from 10.10.10.2 to 30.30.30.2 with a TTL of 64. The thirteenth packet is an ICMP Echo (ping) reply from 30.30.30.2 to 10.10.10.2 with a TTL of 62. The bottom of the Wireshark window shows the packet details for the first packet, which is an ICMP Echo (ping) request. The details pane shows the ICMP header and the payload, which is the ASCII string "E..T@. @..)".

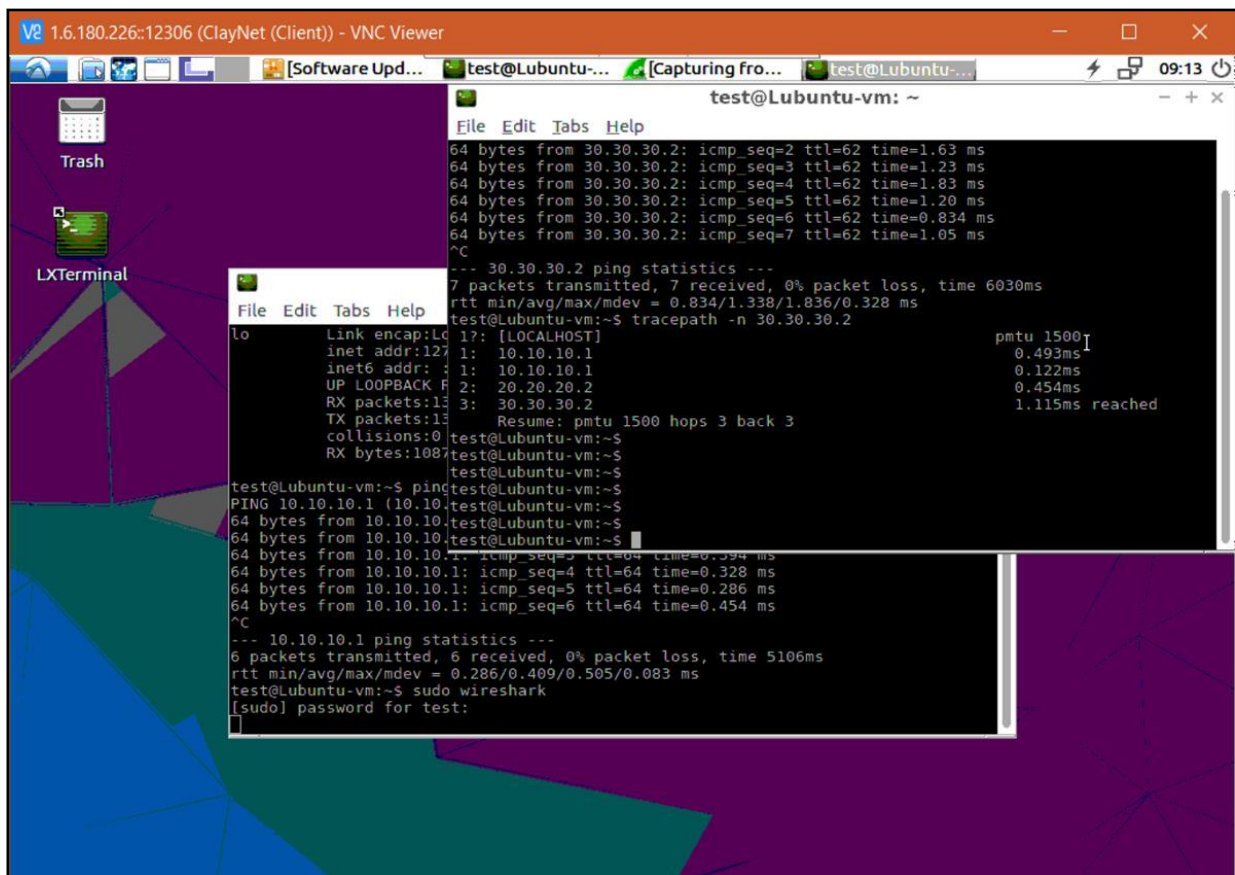
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	10.10.10.2	30.30.30.2	ICMP	100	Echo (ping) request id=0x0915, seq=1/256, ttl=64 (rep...
2	0.001033294	30.30.30.2	10.10.10.2	ICMP	100	Echo (ping) reply id=0x0915, seq=1/256, ttl=62 (req...
3	0.825200963	fe80::1cc:4094:4d11...	ff02::2	ICMPv6	64	Router Solicitation
4	1.001234436	10.10.10.2	30.30.30.2	ICMP	100	Echo (ping) request id=0x0915, seq=2/512, ttl=64 (rep...
5	1.002708156	30.30.30.2	10.10.10.2	ICMP	100	Echo (ping) reply id=0x0915, seq=2/512, ttl=62 (req...
6	1.550808016	0.0.0.0	255.255.255.255	DHCP	344	DHCP Discover - Transaction ID 0x13f5dc10
7	1.994132613	0.0.0.0	255.255.255.255	DHCP	344	DHCP Discover - Transaction ID 0x13f5dc10
8	2.002682444	10.10.10.2	30.30.30.2	ICMP	100	Echo (ping) request id=0x0915, seq=3/768, ttl=64 (rep...
9	2.003856862	30.30.30.2	10.10.10.2	ICMP	100	Echo (ping) reply id=0x0915, seq=3/768, ttl=62 (req...
10	2.027676381	0.0.0.0	255.255.255.255	DHCP	344	DHCP Discover - Transaction ID 0xf4479f2d
11	2.396083855	0.0.0.0	255.255.255.255	DHCP	344	DHCP Discover - Transaction ID 0xa7fab404
12	3.003988272	10.10.10.2	30.30.30.2	ICMP	100	Echo (ping) request id=0x0915, seq=4/1024, ttl=64 (re...
13	3.005526479	30.30.30.2	10.10.10.2	ICMP	100	Echo (ping) reply id=0x0915, seq=4/1024, ttl=62 (re...

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 2a 26 00 00 0e 7e 00 00 08 00*&
0010 45 00 00 54 df 54 40 00 40 01 0b 29 0a 0a 0a 02 E..T@. @..)
0020 1e 1e 1e 02 08 00 aa 15 09 15 00 01 87 9e 69 60i`
0030 00 00 00 00 87 02 0e 00 00 00 00 00 10 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

wireshark_any_20210404163958_kAHrXW.pcapng Packets: 37 · Displayed: 37 (100.0%) Profile: Default

Task 9: Also observe the output of `tracert -n 30.30.30.2` command on Client.



The screenshot shows a VNC viewer window titled "1.6.180.226::12306 (ClayNet (Client)) - VNC Viewer". The desktop background is purple with a geometric pattern. There are icons for "Trash" and "LXTerminal". A terminal window titled "test@Lubuntu-vm: ~" is open, displaying the output of several network commands. The output shows successful ping tests to 30.30.30.2 and 10.10.10.1, and a successful tracepath to 30.30.30.2. The terminal also shows the output of the `sudo wireshark` command, which prompts for a password.

```
test@Lubuntu-vm: ~  
64 bytes from 30.30.30.2: icmp_seq=2 ttl=62 time=1.63 ms  
64 bytes from 30.30.30.2: icmp_seq=3 ttl=62 time=1.23 ms  
64 bytes from 30.30.30.2: icmp_seq=4 ttl=62 time=1.83 ms  
64 bytes from 30.30.30.2: icmp_seq=5 ttl=62 time=1.20 ms  
64 bytes from 30.30.30.2: icmp_seq=6 ttl=62 time=0.834 ms  
64 bytes from 30.30.30.2: icmp_seq=7 ttl=62 time=1.05 ms  
^C  
--- 30.30.30.2 ping statistics ---  
7 packets transmitted, 7 received, 0% packet loss, time 6030ms  
rtt min/avg/max/mdev = 0.834/1.338/1.836/0.328 ms  
test@Lubuntu-vm:~$ tracert -n 30.30.30.2  
  0  17: [LOCALHOST] pmtu 1500  
  1  10.10.10.1      0.493ms  
  2  20.20.20.2     0.122ms  
  3  30.30.30.2     0.454ms  
      Resume: pmtu 1500 hops 3 back 3  
test@Lubuntu-vm:~$  
test@Lubuntu-vm:~$ ping 10.10.10.1  
PING 10.10.10.1 (10.10.10.1): 64 bytes of data: 0.286 ms  
64 bytes from 10.10.10.1: icmp_seq=1 ttl=64 time=0.286 ms  
64 bytes from 10.10.10.1: icmp_seq=2 ttl=64 time=0.328 ms  
64 bytes from 10.10.10.1: icmp_seq=3 ttl=64 time=0.286 ms  
64 bytes from 10.10.10.1: icmp_seq=4 ttl=64 time=0.454 ms  
64 bytes from 10.10.10.1: icmp_seq=5 ttl=64 time=0.286 ms  
64 bytes from 10.10.10.1: icmp_seq=6 ttl=64 time=0.454 ms  
^C  
--- 10.10.10.1 ping statistics ---  
6 packets transmitted, 6 received, 0% packet loss, time 5106ms  
rtt min/avg/max/mdev = 0.286/0.409/0.505/0.083 ms  
test@Lubuntu-vm:~$ sudo wireshark  
[sudo] password for test:
```

The server is henceforth reachable
