

CSE 232: Programming Assignment 3

Using Linux iptables

Due date: Oct 27, 2024

Total: 21 points

Q1. VM Setup and Basic Configuration

Objective: Set up four VMs and configure network routing with VM2 as a gateway.

a) **IP Configuration and Routing:** Each VM was assigned IP addresses according to the setup diagram, with VM1 as the client, VM2 as the gateway, and VM3 and VM4 as servers. Routing was configured on VM2 to forward incoming traffic to the servers.

b) **Gateway Forwarding Configuration:** Using iptables on VM2, packet forwarding was enabled by setting up IP forwarding:

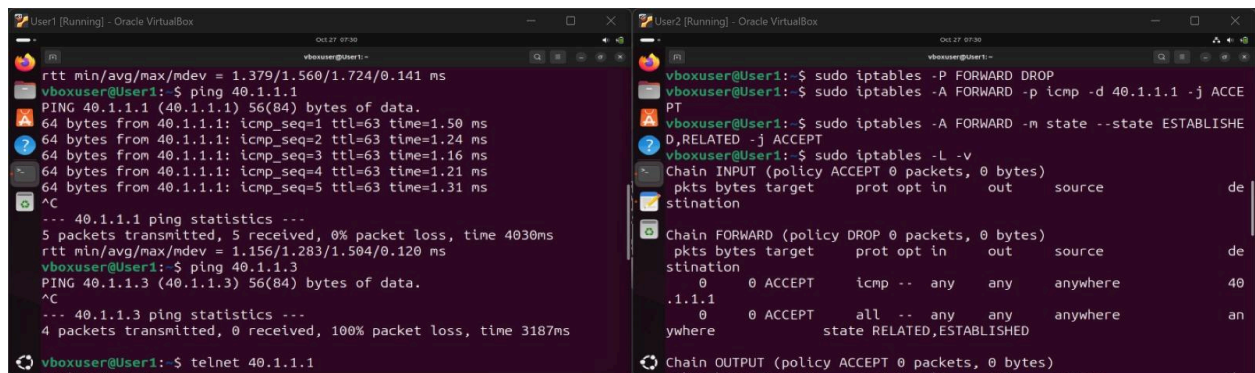
```
sudo sysctl -w net.ipv4.ip_forward=1
```

Q2. Traffic Filtering at the Gateway

Objective: Implement firewall rules on VM2 to selectively block traffic.

Blocking All Traffic Except Ping to 40.1.1.1: An iptables rule was added to block all traffic to server 40.1.1.1/24 except for ICMP (ping) traffic:

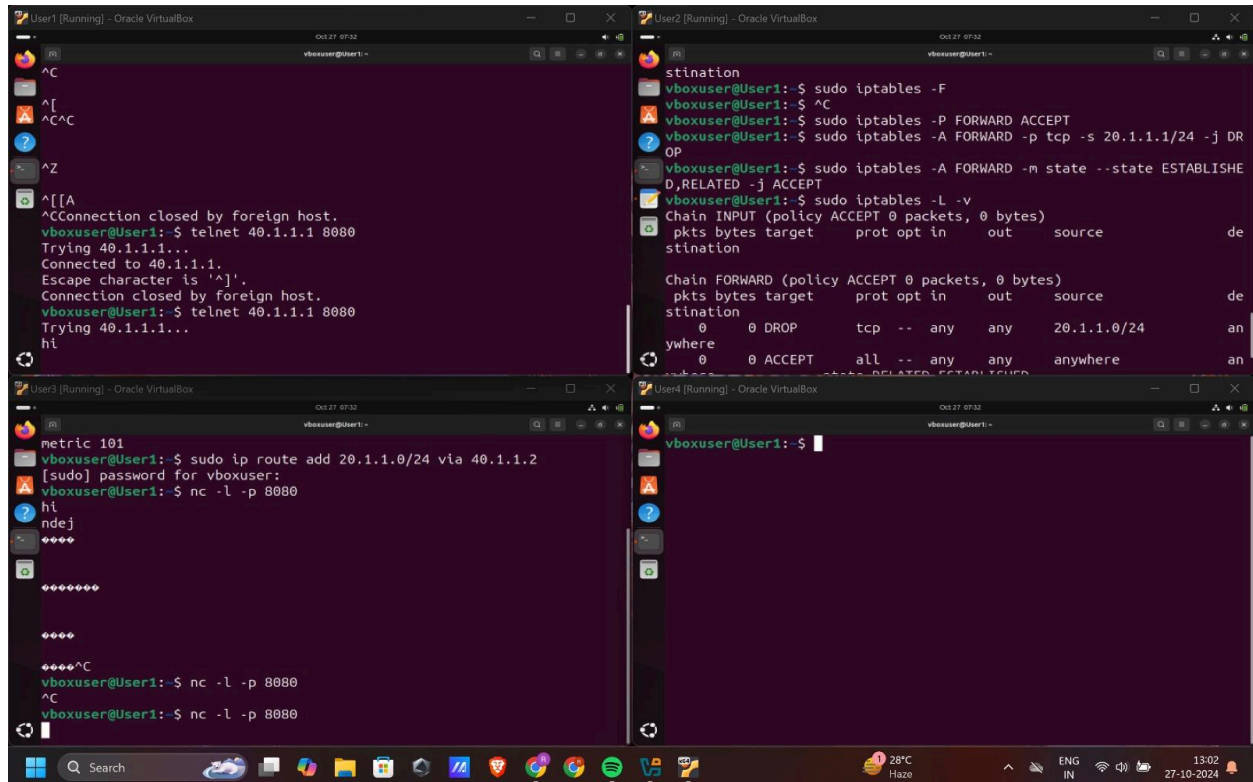
```
sudo iptables -A FORWARD -d 40.1.1.1 -p icmp -j ACCEPT
sudo iptables -A FORWARD -d 40.1.1.1 -j DROP
```



a) **Output Reference:** Screenshots showed successful ping requests and blocked TCP/UDP requests to 40.1.1.1.

Blocking TCP Traffic Initiated by 20.1.1.1: An iptables rule was added to block all TCP traffic from 20.1.1.1/24:

```
sudo iptables -A FORWARD -s 20.1.1.1 -p tcp -j DROP
```



b) Output Reference: Screenshots confirmed that TCP traffic from 20.1.1.1 was blocked, while other protocols were unaffected.

Q3. Testing Bandwidth and RTT with iperf

Objective: Measure TCP/UDP bandwidth between VMs and analyze RTT between client and servers.

a) **TCP and UDP Bandwidth Testing:** Using iperf, bandwidth was measured between 20.1.1.1/24 and 40.1.1.3/24.

Command: `iperf -c 40.1.1.3 -p [port] -t [time]`

```
User1 [Running] - Oracle VirtualBox
vboxuser@User1:~$
Sending 1470 byte datagrams, IPG target: 0.00 us (kalman adjust)
UDP buffer size: 208 KByte (default)
-----
[ 1] local 20.1.1.1 port 37398 connected with 40.1.1.3 port 5300
[ ID] Interval      Transfer      Bandwidth
[ 1] 0.0000-10.0172 sec 1.25 MBytes  1.05 Mbits/sec
[ 1] Sent 896 datagrams
[ 1] Server Report:
[ ID] Interval      Transfer      Bandwidth      Jitter    Lost/Total
Datagrams
[ 1] 0.0000-10.0168 sec 1.25 MBytes  1.05 Mbits/sec  0.000 ms 0/895
(0%)
vboxuser@User1:~$ iperf -c 40.1.1.3 -p 5300
-----
Client connecting to 40.1.1.3, TCP port 5300
TCP window size: 16.0 KByte (default)
-----
^C
^Cvboxuser@User1:~$

User2 [Running] - Oracle VirtualBox
vboxuser@User1:~$
pkts bytes target  prot opt in  out  source  de
stination
ywhere 0 0 DROP  tcp -- any  any  20.1.1.0/24  an
ywhere 0 0 ACCEPT all -- any  any  anywhere  an
state RELATED,ESTABLISHED
Chain OUTPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target  prot opt in  out  source  de
stination
vboxuser@User1:~$ sudo iptables -F
vboxuser@User1:~$ sudo iptables -P FORWARD ACCEPT
vboxuser@User1:~$ sudo iptables -A FORWARD -p tcp -s 20.1.1.1/24 -j DR
OP
vboxuser@User1:~$ sudo iptables -A FORWARD -m state --state ESTABLISHE
D,RELATED -j ACCEPT
vboxuser@User1:~$ sudo iptables -A FORWARD -p udp -s 20.1.1.1/24 -j AC
CEPT
vboxuser@User1:~$

User3 [Running] - Oracle VirtualBox
vboxuser@User1:~$
vboxuser@User1:~$ sudo ip route add 20.1.1.0/24 via 40.1.1.2
[sudo] password for vboxuser:
vboxuser@User1:~$ nc -l -p 8080
hi
nde]
****
^C
vboxuser@User1:~$ nc -l -p 8080
^C
vboxuser@User1:~$ nc -l -p 8080
^C
vboxuser@User1:~$

User4 [Running] - Oracle VirtualBox
vboxuser@User1:~$
Datagrams
[ 1] 0.0000-9.9998 sec 62.2 MBytes 52.2 Mbits/sec 0.188 ms 28/443
74 (0.063%)
^Cvboxuser@User1:~$ iperf -s -u -p 5300
-----
Server listening on UDP port 5300
UDP buffer size: 208 KByte (default)
-----
[ 1] local 40.1.1.3 port 5300 connected with 20.1.1.1 port 37398
[ ID] Interval      Transfer      Bandwidth      Jitter    Lost/Total
Datagrams
[ 1] 0.0000-10.0168 sec 1.25 MBytes  1.05 Mbits/sec  0.887 ms 0/895
(0%)
^Cvboxuser@User1:~$ iperf -s -p 5300
-----
Server listening on TCP port 5300
TCP window size: 128 KByte (default)
-----
```

```
User1 [Running] - Oracle VirtualBox
vboxuser@User1:~$
Datagrams
[ 1] 0.0000-9.9998 sec 62.2 MBytes 52.2 Mbits/sec 0.000 ms 28/443
74 (0%)
vboxuser@User1:~$ iperf -c 40.1.1.3 -p 5300 -u
-----
Client connecting to 40.1.1.3, UDP port 5300
Sending 1470 byte datagrams, IPG target: 0.00 us (kalman adjust)
UDP buffer size: 208 KByte (default)
-----
[ 1] local 20.1.1.1 port 37398 connected with 40.1.1.3 port 5300
[ ID] Interval      Transfer      Bandwidth
[ 1] 0.0000-10.0172 sec 1.25 MBytes  1.05 Mbits/sec
[ 1] Sent 896 datagrams
[ 1] Server Report:
[ ID] Interval      Transfer      Bandwidth      Jitter    Lost/Total
Datagrams
[ 1] 0.0000-10.0168 sec 1.25 MBytes  1.05 Mbits/sec  0.000 ms 0/895
(0%)
vboxuser@User1:~$

User2 [Running] - Oracle VirtualBox
vboxuser@User1:~$
pkts bytes target  prot opt in  out  source  de
stination
ywhere 0 0 DROP  tcp -- any  any  20.1.1.0/24  an
ywhere 0 0 ACCEPT all -- any  any  anywhere  an
state RELATED,ESTABLISHED
Chain OUTPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target  prot opt in  out  source  de
stination
vboxuser@User1:~$ sudo iptables -F
vboxuser@User1:~$ sudo iptables -P FORWARD ACCEPT
vboxuser@User1:~$ sudo iptables -A FORWARD -p tcp -s 20.1.1.1/24 -j DR
OP
vboxuser@User1:~$ sudo iptables -A FORWARD -m state --state ESTABLISHE
D,RELATED -j ACCEPT
vboxuser@User1:~$ sudo iptables -A FORWARD -p udp -s 20.1.1.1/24 -j AC
CEPT
vboxuser@User1:~$

User3 [Running] - Oracle VirtualBox
vboxuser@User1:~$
vboxuser@User1:~$ sudo ip route add 20.1.1.0/24 via 40.1.1.2
[sudo] password for vboxuser:
vboxuser@User1:~$ nc -l -p 8080
hi
nde]
****
^C
vboxuser@User1:~$ nc -l -p 8080
^C
vboxuser@User1:~$ nc -l -p 8080
^C
vboxuser@User1:~$

User4 [Running] - Oracle VirtualBox
vboxuser@User1:~$
Server listening on UDP port 5300
UDP buffer size: 208 KByte (default)
-----
[ 1] local 40.1.1.3 port 5300 connected with 20.1.1.1 port 58460
[ ID] Interval      Transfer      Bandwidth      Jitter    Lost/Total
Datagrams
[ 1] 0.0000-9.9998 sec 62.2 MBytes 52.2 Mbits/sec 0.188 ms 28/443
74 (0.063%)
^Cvboxuser@User1:~$ iperf -s -u -p 5300
-----
Server listening on UDP port 5300
UDP buffer size: 208 KByte (default)
-----
[ 1] local 40.1.1.3 port 5300 connected with 20.1.1.1 port 37398
[ ID] Interval      Transfer      Bandwidth      Jitter    Lost/Total
Datagrams
[ 1] 0.0000-10.0168 sec 1.25 MBytes  1.05 Mbits/sec  0.887 ms 0/895
(0%)
```

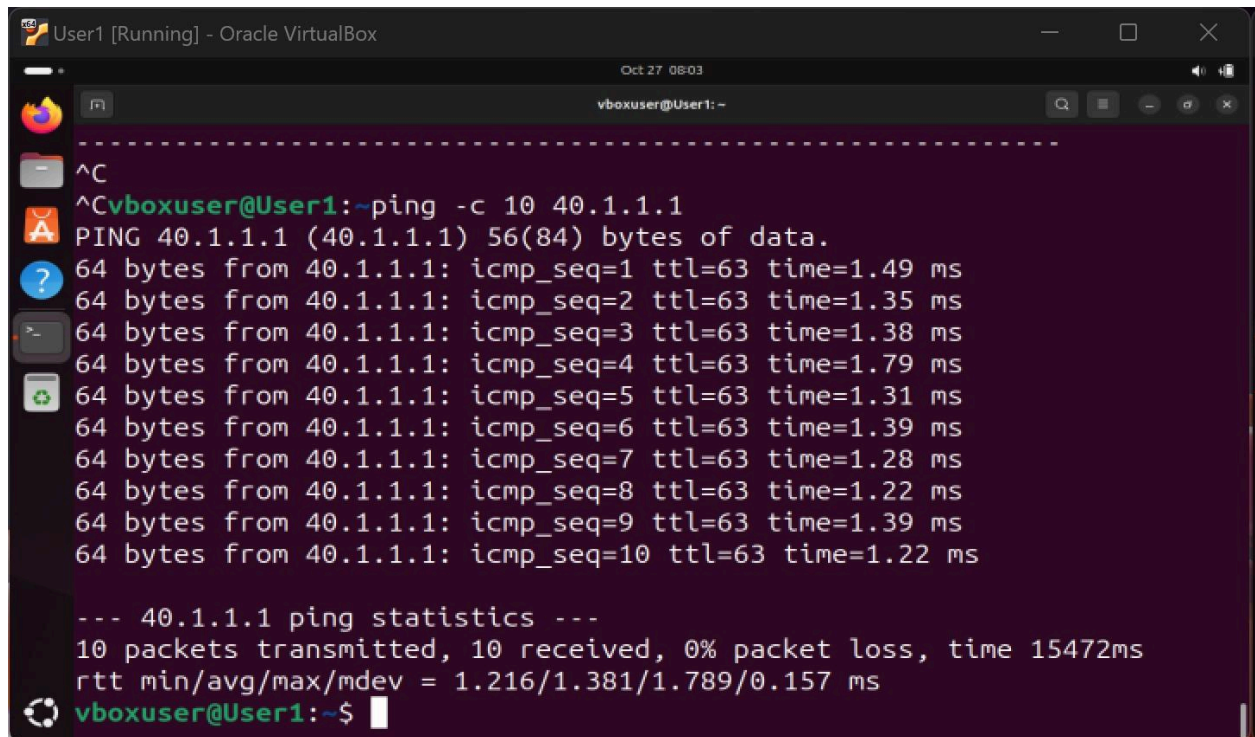
Output Reference: The bandwidth test screenshots indicated TCP and UDP bandwidth results.

b) **RTT Measurement:** RTT was measured from VM1 (20.1.1.1) to both servers.

Ping Command: `ping -c 10 [destination IP]`

RTT Results: Results showed a comparison of RTT for both servers, with a notable RTT difference attributed to network load or distance.

i)

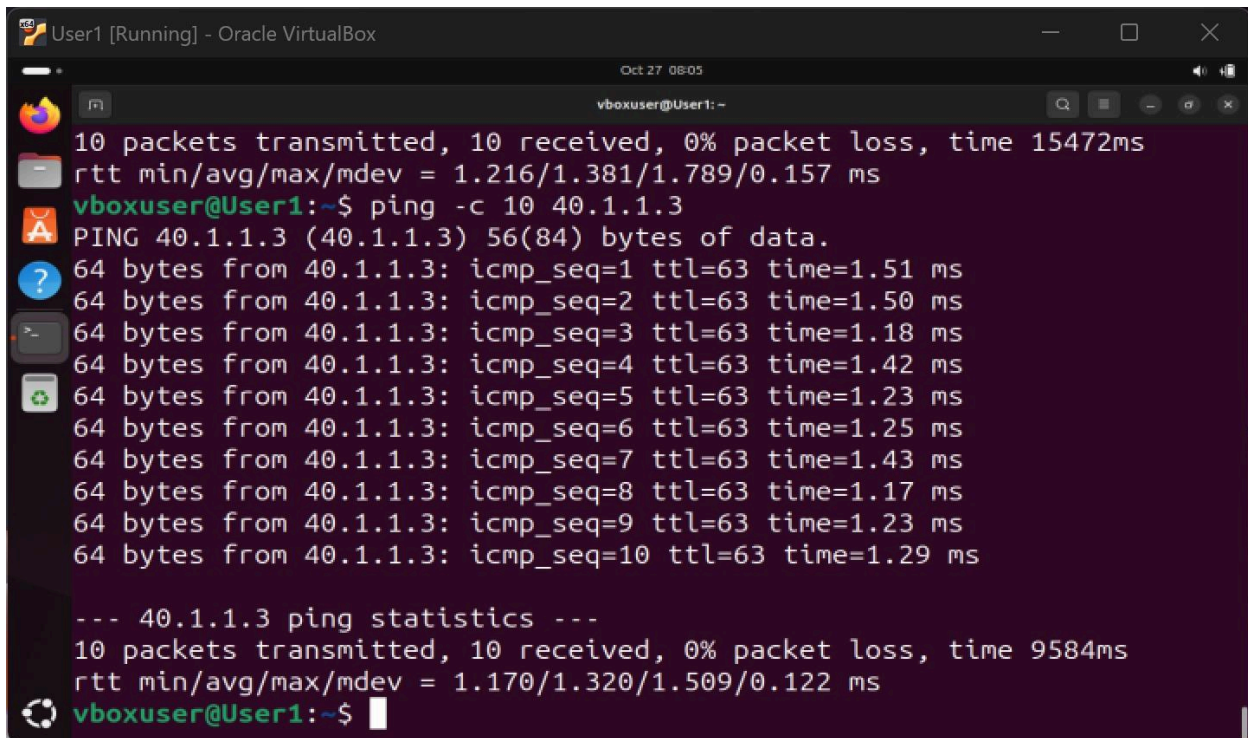


```

User1 [Running] - Oracle VirtualBox
Oct 27 08:03
vboxuser@User1: ~
-----
^C
^Cvboxuser@User1:~ping -c 10 40.1.1.1
PING 40.1.1.1 (40.1.1.1) 56(84) bytes of data.
64 bytes from 40.1.1.1: icmp_seq=1 ttl=63 time=1.49 ms
64 bytes from 40.1.1.1: icmp_seq=2 ttl=63 time=1.35 ms
64 bytes from 40.1.1.1: icmp_seq=3 ttl=63 time=1.38 ms
64 bytes from 40.1.1.1: icmp_seq=4 ttl=63 time=1.79 ms
64 bytes from 40.1.1.1: icmp_seq=5 ttl=63 time=1.31 ms
64 bytes from 40.1.1.1: icmp_seq=6 ttl=63 time=1.39 ms
64 bytes from 40.1.1.1: icmp_seq=7 ttl=63 time=1.28 ms
64 bytes from 40.1.1.1: icmp_seq=8 ttl=63 time=1.22 ms
64 bytes from 40.1.1.1: icmp_seq=9 ttl=63 time=1.39 ms
64 bytes from 40.1.1.1: icmp_seq=10 ttl=63 time=1.22 ms

--- 40.1.1.1 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 15472ms
rtt min/avg/max/mdev = 1.216/1.381/1.789/0.157 ms
vboxuser@User1:~$
```


ii)



The screenshot shows a terminal window titled "User1 [Running] - Oracle VirtualBox" with a date and time of "Oct 27 08:05". The prompt is "vboxuser@User1: ~". The terminal output shows the results of a ping command to 40.1.1.3. It indicates that 10 packets were transmitted and received with 0% packet loss and a total time of 15472ms. The round-trip times (RTT) for each packet are listed, ranging from 1.17ms to 1.51ms. A summary of the ping statistics is also provided, showing a total time of 9584ms and an average RTT of 1.320ms.

```
10 packets transmitted, 10 received, 0% packet loss, time 15472ms
rtt min/avg/max/mdev = 1.216/1.381/1.789/0.157 ms
vboxuser@User1:~$ ping -c 10 40.1.1.3
PING 40.1.1.3 (40.1.1.3) 56(84) bytes of data.
64 bytes from 40.1.1.3: icmp_seq=1 ttl=63 time=1.51 ms
64 bytes from 40.1.1.3: icmp_seq=2 ttl=63 time=1.50 ms
64 bytes from 40.1.1.3: icmp_seq=3 ttl=63 time=1.18 ms
64 bytes from 40.1.1.3: icmp_seq=4 ttl=63 time=1.42 ms
64 bytes from 40.1.1.3: icmp_seq=5 ttl=63 time=1.23 ms
64 bytes from 40.1.1.3: icmp_seq=6 ttl=63 time=1.25 ms
64 bytes from 40.1.1.3: icmp_seq=7 ttl=63 time=1.43 ms
64 bytes from 40.1.1.3: icmp_seq=8 ttl=63 time=1.17 ms
64 bytes from 40.1.1.3: icmp_seq=9 ttl=63 time=1.23 ms
64 bytes from 40.1.1.3: icmp_seq=10 ttl=63 time=1.29 ms

--- 40.1.1.3 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9584ms
rtt min/avg/max/mdev = 1.170/1.320/1.509/0.122 ms
vboxuser@User1:~$
```

Output Reference: Screenshots captured minimum, average, and maximum RTT for both 40.1.1.1 and 40.1.1.3, indicating the observed differences.

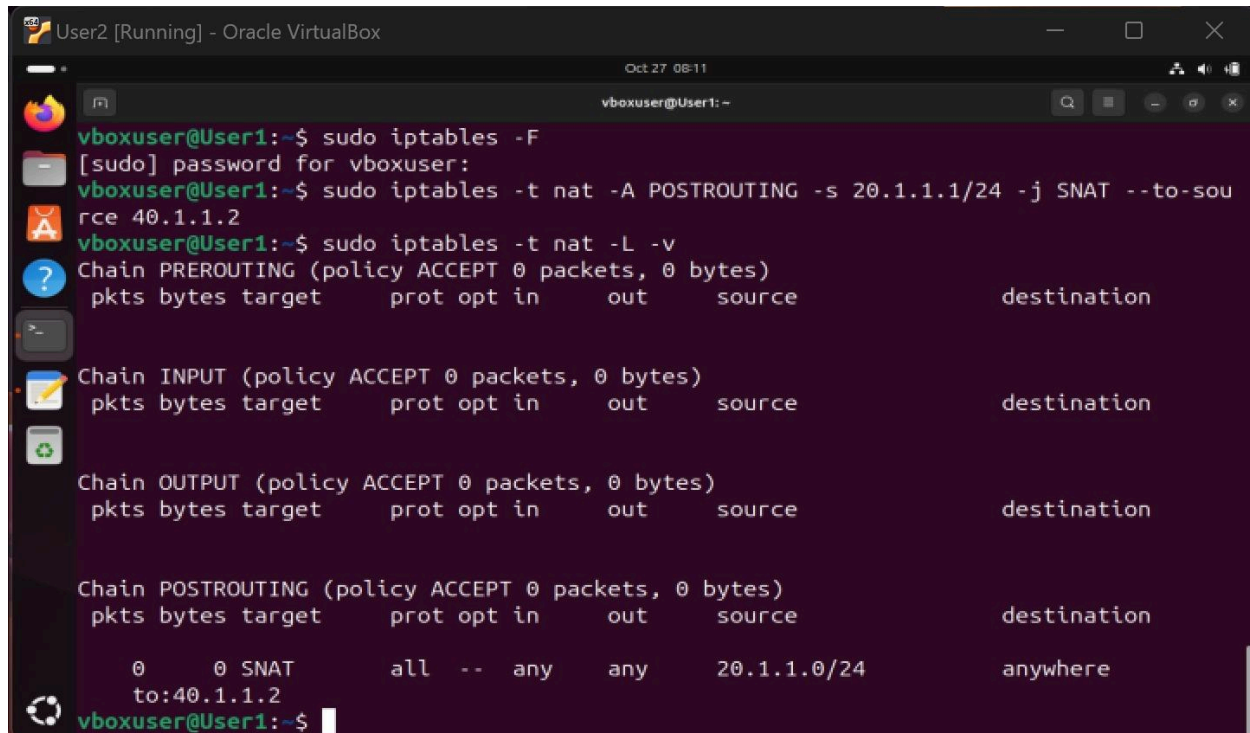
iii) Much difference was not observed between 40.1.1.1 and 40.1.1.3 but 40.1.1.3 was seen to have slightly lower RRT than 40.1.1.1.

Q4. Network Address Translation (NAT) Configuration

Objective: Implement source and destination NAT on VM2 to rewrite packet headers.

a) **Source NAT (SNAT):** A rule was configured on VM2 to change the source IP of packets from 20.1.1.1/24 to 40.1.1.2/24:

```
sudo iptables -t nat -A POSTROUTING -s 20.1.1.1 -j SNAT --to-source 40.1.1.2
```



```
vboxuser@User1:~$ sudo iptables -F
[sudo] password for vboxuser:
vboxuser@User1:~$ sudo iptables -t nat -A POSTROUTING -s 20.1.1.1/24 -j SNAT --to-source 40.1.1.2
vboxuser@User1:~$ sudo iptables -t nat -L -v
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target      prot opt in      out     source      destination

Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target      prot opt in      out     source      destination

Chain OUTPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target      prot opt in      out     source      destination

Chain POSTROUTING (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target      prot opt in      out     source      destination
    0      0 SNAT        all  --  any     any     20.1.1.0/24  anywhere
    to:40.1.1.2
vboxuser@User1:~$
```

b) **Destination NAT (DNAT):** Incoming packets addressed to 40.1.1.2 were modified back to the original source IP (20.1.1.1):

```
sudo iptables -t nat -A PREROUTING -d 40.1.1.2 -j DNAT
--to-destination 20.1.1.1
```

```
User2 [Running] - Oracle VirtualBox
Oct 27 08:15
vboxuser@User1: ~$ sudo iptables -t nat -A PREROUTING -d 40.1.1.2 -j DNAT --to-destination 20.1.1.1
vboxuser@User1: ~$ sudo iptables -t nat -L -v
Chain PREROUTING (policy ACCEPT 5 packets, 535 bytes)
pkts bytes target      prot opt in     out    source    destination
    0     0 DNAT       all  --  any    any     anywhere  User1
    0     0 to:20.1.1.1

Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target      prot opt in     out    source    destination

Chain OUTPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target      prot opt in     out    source    destination

Chain POSTROUTING (policy ACCEPT 8 packets, 594 bytes)
pkts bytes target      prot opt in     out    source    destination
    0     0 SNAT       all  --  any    any     20.1.1.0/24  anywhere
    0     0 to:40.1.1.2
vboxuser@User1: ~$
```

Validation with tcpdump: Traffic was observed at each VM using tcpdump to confirm IP changes:

Command: `sudo tcpdump -i [interface] host [destination IP]`

```
User1 [Running] - Oracle VirtualBox
Oct 27 08:30
vboxuser@User1: ~
tcpdump: 40.1.1.1: No such device exists
(No such device exists)
vboxuser@User1:~$ sudo tcpdump -i enp0s8 tcp -w client_capture.pcap &
[1] 4981
vboxuser@User1:~$ tcpdump: listening on enp0s8, link-type EN10MB (Ethernet), snapshot length 262144 bytes
vboxuser@User1:~$ echo "hi" | nc 40.1.1.1 8080
^C
vboxuser@User1:~$ sudo killall tcpdump
8 packets captured
8 packets received by filter
0 packets dropped by kernel
vboxuser@User1:~$ tcpdump -r client_capture.pcap
reading from file client_capture.pcap, link-type EN10MB (Ethernet), snapshot length 262144
08:25:20.452660 IP User1.40538 > 40.1.1.1.http-alt: Flags [S], seq 2643662366, win 64240, options [mss 1460,sackOK,TS val 4139203824 ecr 0,nop,wscale 7], length 0
08:25:20.454168 IP 40.1.1.1.http-alt > User1.40538: Flags [S.], seq 3554351252, ack 2643662367, win 65160, options [mss 1460,sackOK,TS val 854134130 ecr 4139203824,nop,wscale 7], length 0
08:25:20.454225 IP User1.40538 > 40.1.1.1.http-alt: Flags [.], ack 1, win 502, options [nop,nop,TS val 4139203826 ecr 854134130], length 0
08:25:20.454364 IP User1.40538 > 40.1.1.1.http-alt: Flags [P.], seq 1:4, ack 1, win 502, options [nop,nop,TS val 4139203826 ecr 854134130], length 3: HTTP
08:25:20.457089 IP 40.1.1.1.http-alt > User1.40538: Flags [.], ack 4, win 510, options [nop,nop,TS val 854134131 ecr 4139203826], length 0
08:25:33.599367 IP User1.40538 > 40.1.1.1.http-alt: Flags [F.], seq 4, ack 1, win 502, options [nop,nop,TS val 4139216971 ecr 854134131], length 0
08:25:33.600735 IP 40.1.1.1.http-alt > User1.40538: Flags [F.], seq 1, ack 5, win 510, options [nop,nop,TS val 854147276 ecr 4139216971], length 0
08:25:33.600771 IP User1.40538 > 40.1.1.1.http-alt: Flags [.], ack 2, win 502, options [nop,nop,TS val 4139216973 ecr 854147276], length 0
[1]+ Done
vboxuser@User1:~$ sudo tcpdump -i enp0s8 tcp -w client_capture.pcap
vboxuser@User1:~$

User3 [Running] - Oracle VirtualBox
Oct 27 08:29
vboxuser@User1: ~
vboxuser@User1:~$ sudo tcpdump -i enp0s9 tcp -w server1_capture.pcap &
[1] 4370
vboxuser@User1:~$ tcpdump: listening on enp0s9, link-type EN10MB (Ethernet), snapshot length 262144 bytes
vboxuser@User1:~$ nc -l -p 8080
hi
vboxuser@User1:~$ sudo killall tcpdump
17 packets captured
17 packets received by filter
0 packets dropped by kernel
vboxuser@User1:~$ tcpdump -r server1_capture.pcap
reading from file server1_capture.pcap, link-type EN10MB (Ethernet), snapshot length 262144
08:24:23.595622 IP User1.47310 > is-content-cache-2.ps5.canonical.com.http: Flags [S], seq 1579285727, win 64240, option s [mss 1460,sackOK,TS val 951223918 ecr 0,nop,wscale 7], length 0
08:24:24.639835 IP User1.47310 > is-content-cache-2.ps5.canonical.com.http: Flags [S], seq 1579285727, win 64240, option s [mss 1460,sackOK,TS val 951224963 ecr 0,nop,wscale 7], length 0
08:24:25.673450 IP User1.47310 > is-content-cache-2.ps5.canonical.com.http: Flags [S], seq 1579285727, win 64240, option s [mss 1460,sackOK,TS val 951225996 ecr 0,nop,wscale 7], length 0
08:24:26.723984 IP User1.47310 > is-content-cache-2.ps5.canonical.com.http: Flags [S], seq 1579285727, win 64240, option s [mss 1460,sackOK,TS val 951227047 ecr 0,nop,wscale 7], length 0
08:24:27.773488 IP User1.47310 > is-content-cache-2.ps5.canonical.com.http: Flags [S], seq 1579285727, win 64240, option s [mss 1460,sackOK,TS val 951228096 ecr 0,nop,wscale 7], length 0
08:24:28.798593 IP User1.47310 > is-content-cache-2.ps5.canonical.com.http: Flags [S], seq 1579285727, win 64240, option s [mss 1460,sackOK,TS val 951229121 ecr 0,nop,wscale 7], length 0
08:24:30.845575 IP User1.47310 > is-content-cache-2.ps5.canonical.com.http: Flags [S], seq 1579285727, win 64240, option s [mss 1460,sackOK,TS val 951231168 ecr 0,nop,wscale 7], length 0
08:24:34.884792 IP User1.47310 > is-content-cache-2.ps5.canonical.com.http: Flags [S], seq 1579285727, win 64240, option s [mss 1460,sackOK,TS val 951235208 ecr 0,nop,wscale 7], length 0
08:24:43.198511 IP User1.47310 > is-content-cache-2.ps5.canonical.com.http: Flags [S], seq 1579285727, win 64240, option s [mss 1460,sackOK,TS val 951243521 ecr 0,nop,wscale 7], length 0
08:25:20.459649 IP _gateway.40538 > User1.http-alt: Flags [S], seq 2643662366, win 64240, options [mss 1460,sackOK,TS val 4139203824 ecr 0,nop,wscale 7], length 0
08:25:20.459701 IP User1.http-alt > _gateway.40538: Flags [S.], seq 3554351252, ack 2643662367, win 65160, options [mss 1460,sackOK,TS val 854134130 ecr 4139203824,nop,wscale 7], length 0
```

Output Reference: Screenshots from tcpdump on VMs confirmed that NAT was functioning correctly, showing translated source and destination addresses.

Q5. Load Balancing at the Gateway

Objective: Distribute traffic from 20.1.1.1/24 to servers 40.1.1.1/24 and 40.1.1.3/24 with a probability-based load balancing.

Setting up Probability-based DNAT: The following iptables rules were set to direct 80% of traffic to 40.1.1.3 and 20% to 40.1.1.1, based on RTT results showing 40.1.1.3 had lower latency:

```
sudo iptables -t nat -A PREROUTING -d 20.1.1.2 -m statistic --mode random --probability 0.2 -j DNAT --to-destination 40.1.1.1
```

```
sudo iptables -t nat -A PREROUTING -d 20.1.1.2 -j DNAT --to-destination 40.1.1.3
```

Testing with Ping Packets: From VM1, multiple ping requests were sent to validate traffic distribution. tcpdump on the servers confirmed the 80-20 split:

```
rtt min/avg/max/mdev = 1.404/1.404/1.404/0.000 ms
vboxuser@User1:~$ ping -c 1 40.1.1.2
PING 40.1.1.2 (40.1.1.2) 56(84) bytes of data:
64 bytes from 40.1.1.2: icmp_seq=1 ttl=63 time=1.29 ms

--- 40.1.1.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.294/1.294/1.294/0.000 ms
vboxuser@User1:~$ ping -c 1 40.1.1.1
PING 40.1.1.1 (40.1.1.1) 56(84) bytes of data:
64 bytes from 40.1.1.1: icmp_seq=1 ttl=63 time=1.20 ms

--- 40.1.1.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.195/1.195/1.195/0.000 ms
vboxuser@User1:~$ ping -c 1 40.1.1.2
PING 40.1.1.2 (40.1.1.2) 56(84) bytes of data:
64 bytes from 40.1.1.2: icmp_seq=1 ttl=63 time=1.38 ms

--- 40.1.1.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.375/1.375/1.375/0.000 ms
vboxuser@User1:~$
```

```
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target prot opt in out source destination

Chain OUTPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target prot opt in out source destination

Chain POSTROUTING (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target prot opt in out source destination

vboxuser@User1:~$ sudo iptables -t nat -A PREROUTING -s 20.1.1.1/24 -m statistic --mode random --probability 0.2 -j DNAT --to-destination 40.1.1.1
vboxuser@User1:~$ sudo iptables -t nat -A PREROUTING -s 20.1.1.1/24 -j DNAT --to-destination 40.1.1.3
vboxuser@User1:~$ sudo iptables -t nat -A POSTROUTING -d 40.1.1.1 -j SNAT --to-source 40.1.1.2
vboxuser@User1:~$ sudo iptables -t nat -A POSTROUTING -d 40.1.1.3 -j SNAT --to-source 40.1.1.2
vboxuser@User1:~$
```

```
vboxuser@User1:~$ sudo ip route add 20.1.1.0/24 via 40.1.1.2
[sudo] password for vboxuser:
vboxuser@User1:~$ sudo tcpdump -i enp0s9 icmp &
[1] 3156
vboxuser@User1:~$ tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on enp0s9, link-type EN10MB (Ethernet), snapshot length 262144 bytes
14:32:37.417851 IP _gateway > User1: ICMP echo request, id 3093, seq 1, length 64
14:32:37.417924 IP User1 > _gateway: ICMP echo reply, id 3093, seq 1, length 64
14:32:38.314506 IP _gateway > User1: ICMP echo request, id 3094, seq 1, length 64
14:32:38.314537 IP User1 > _gateway: ICMP echo reply, id 3094, seq 1, length 64
```

```
[1] 3383
vboxuser@User1:~$ tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on enp0s9, link-type EN10MB (Ethernet), snapshot length 262144 bytes
14:32:20.477957 IP _gateway > User1: ICMP echo request, id 3084, seq 1, length 64
14:32:20.477987 IP User1 > _gateway: ICMP echo reply, id 3084, seq 1, length 64
14:32:29.265856 IP _gateway > User1: ICMP echo request, id 3085, seq 1, length 64
14:32:29.265898 IP User1 > _gateway: ICMP echo reply, id 3085, seq 1, length 64
14:32:30.952191 IP _gateway > User1: ICMP echo request, id 3086, seq 1, length 64
14:32:30.952217 IP User1 > _gateway: ICMP echo reply, id 3086, seq 1, length 64
14:32:32.016267 IP _gateway > User1: ICMP echo request, id 3087, seq 1, length 64
14:32:32.016292 IP User1 > _gateway: ICMP echo reply, id 3087, seq 1, length 64
14:32:32.984715 IP _gateway > User1: ICMP echo request, id 3088, seq 1, length 64
14:32:32.984739 IP User1 > _gateway: ICMP echo reply, id 3088, seq 1, length 64
14:32:33.864071 IP _gateway > User1: ICMP echo request, id 3089, seq 1, length 64
14:32:33.864100 IP User1 > _gateway: ICMP echo reply, id 3089, seq 1, length 64
14:32:34.780930 IP _gateway > User1: ICMP echo request, id 3090, seq 1, length 64
14:32:34.780957 IP User1 > _gateway: ICMP echo reply, id 3090, seq 1, length 64
14:32:35.655804 IP _gateway > User1: ICMP echo request, id 3091, seq 1, length 64
14:32:35.655842 IP User1 > _gateway: ICMP echo reply, id 3091, seq 1, length 64
14:32:36.572299 IP _gateway > User1: ICMP echo request, id 3092, seq 1, length 64
14:32:36.572327 IP User1 > _gateway: ICMP echo reply, id 3092, seq 1, length 64
```

Output Reference: tcpdump results indicated that approximately 80% of packets reached 40.1.1.3, and 20% reached 40.1.1.1, confirming the load balancing configuration.