Transform iptables into a TCP load balancer

Task requirement:

To create two new caddy LB or two nginx and after creating, it needs to forward the 50% of Load to another LB.

iptables: is a user-space utility program that allows a system administrator to configure the IP packet filter rules of the Linux kernel firewall.

Environment details:

```
manish@manish-user:~$ cat /etc/os-release /
PRETTY_NAME="Ubuntu 22.04.3 LTS"
NAME="Ubuntu"
VERSION_ID="22.04"
VERSION="22.04.3 LTS (Jammy Jellyfish)"
VERSION_CODENAME=jammy
ID=ubuntu
ID_LIKE=debian
HOME_URL="https://www.ubuntu.com/"
SUPPORT_URL="https://help.ubuntu.com/"
BUG_REPORT_URL="https://bugs.launchpad.net/ubuntu/"
PRIVACY_POLICY_URL="https://www.ubuntu.com/legal terms-and-policies/privacy-policy"
UBUNTU_CODENAME=jammy
```

List of tools and technologies:

- KVM
- Nginx

I have configre two vm and install nginx both vm:

```
vim1 >>>> 192.168.122.37
sudo apt install nginx
```

```
vim2 >>>> 192.168.122.85
sudo apt install nginx
```

Vm1 >>>>Change the index.html

```
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ cd /var/www/html/
```

```
vm1@vm1-Standard-PC-Q35-ICH9-2009:/var/www/html$ ls
index.html
```

After running this command:- sudo vim index.html

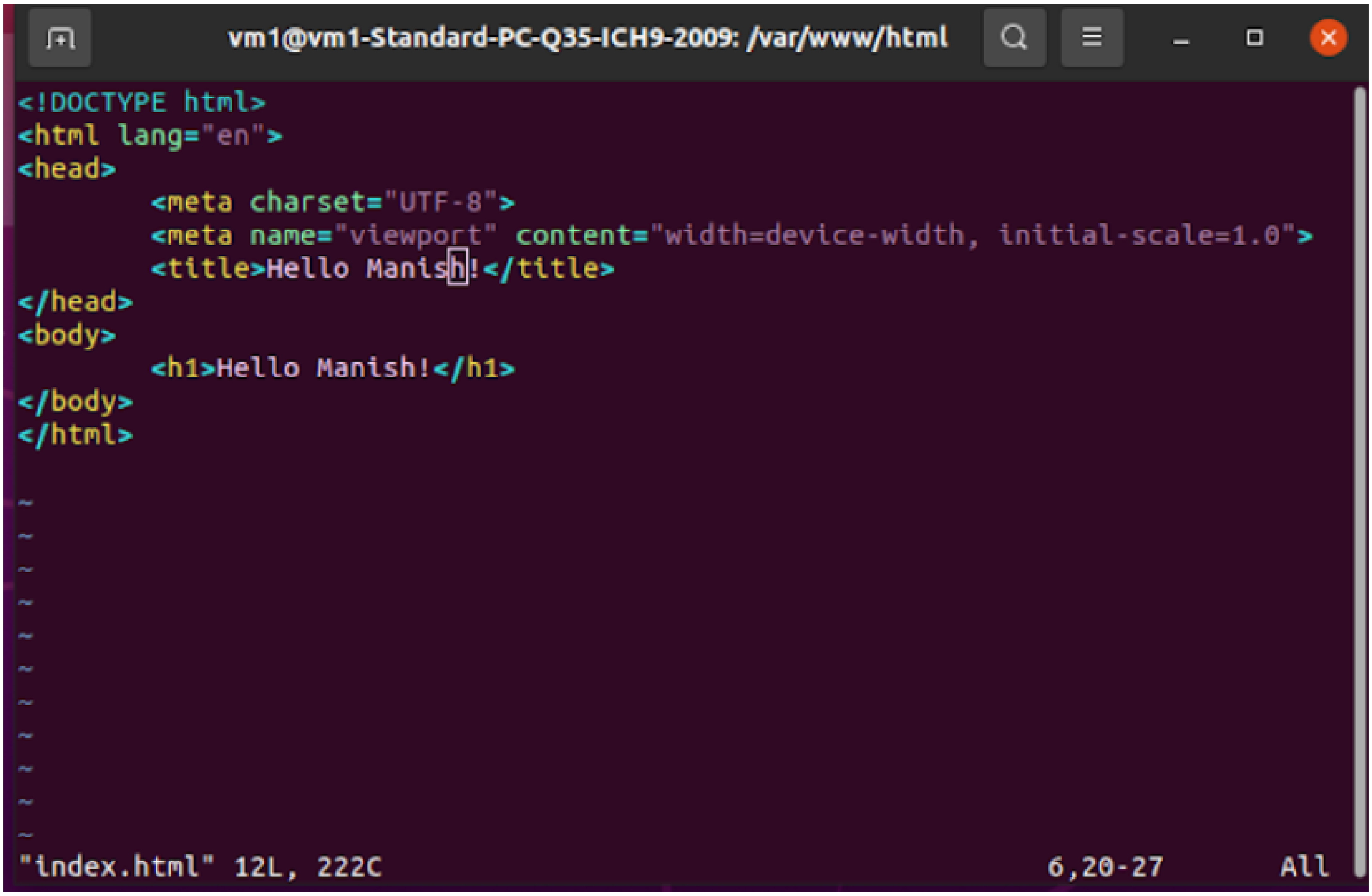
- Enter html file

```
vm1@vm1-Standard-PC-Q35-ICH9-2009:/var/www/html$ sudo vim index.html
```

Vm2 >>>> Change the index.html

```
vim2@vim2-Standard-PC-Q35-ICH9-2009:~$ cd /var/www/html/
```

```
vim2@vim2-Standard-PC-Q35-ICH9-2009:/var/www/html$ ls
index.nginx-debian.html
```

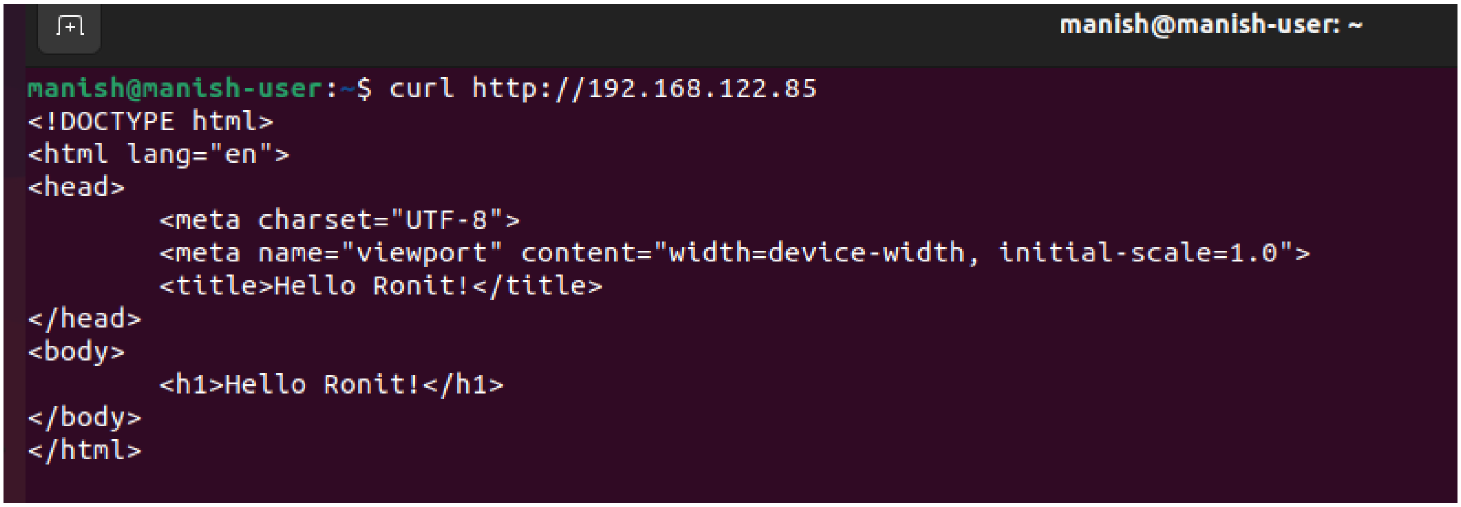


```
<!DOCTYPE html>
<html lang="en">
<head>
        <meta charset="UTF-8">
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
        <title>Hello Manish!</title>
</head>
<body>
        <h1>Hello Manish!</h1>
</body>
</html>

~
~
~
~
~
~
~
~
~
~
~
"index.html" 12L, 222C                                      6,20-27       All
```

I am able to curl Page from each other.

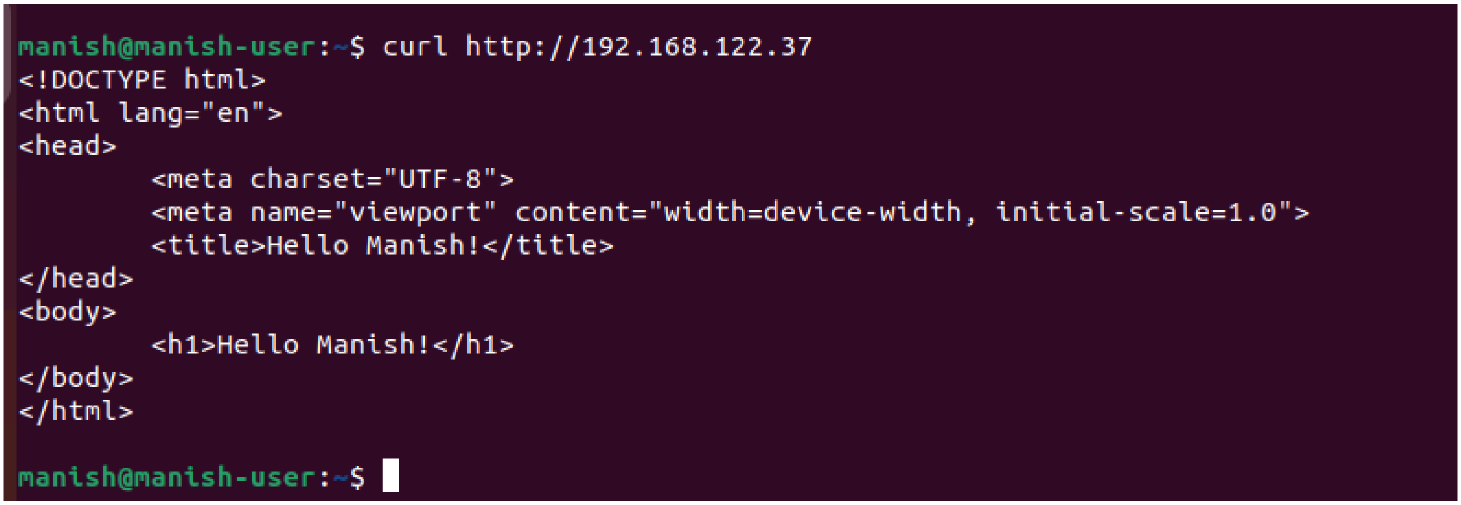
vm1@vm1-Standard-PC-Q35-ICH9-2009:/var/www/html$ curl http://192.168.122.37

manish@manish-user:~$ curl http://192.168.122.85



```
manish@manish-user:~$ curl http://192.168.122.85
<!DOCTYPE html>
<html lang="en">
<head>
        <meta charset="UTF-8">
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
        <title>Hello Ronit!</title>
</head>
<body>
        <h1>Hello Ronit!</h1>
</body>
</html>
```

manish@manish-user:~$ curl http://192.168.122.37



```
manish@manish-user:~$ curl http://192.168.122.37
<!DOCTYPE html>
<html lang="en">
<head>
        <meta charset="UTF-8">
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
        <title>Hello Manish!</title>
</head>
<body>
        <h1>Hello Manish!</h1>
</body>
</html>

manish@manish-user:~$ 
```

now work in Vm1 192.168.122.37

a) Enable IP Forwarding:

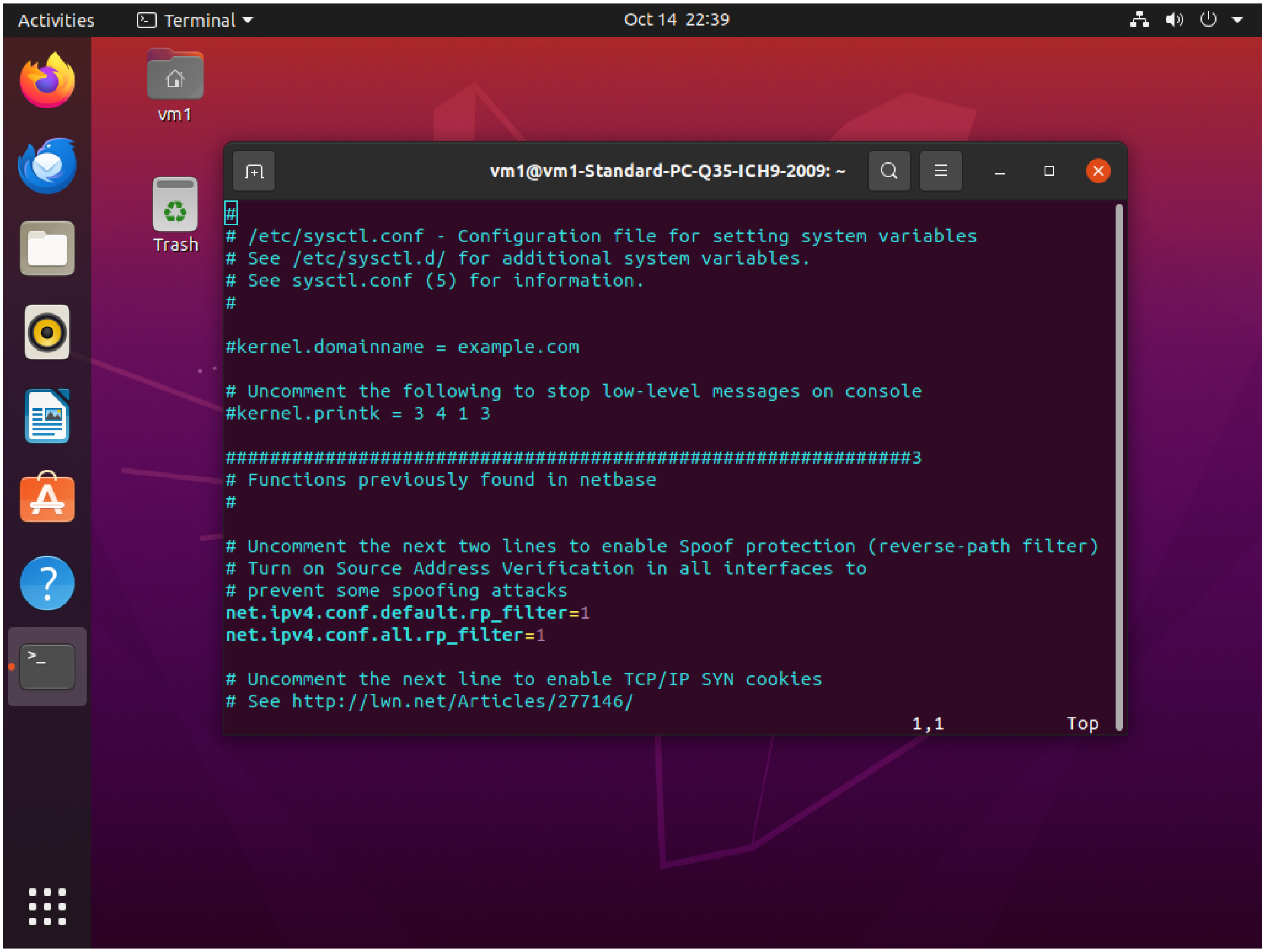
Activate IP forwarding to facilitate traffic routing between interfaces:

vm1 and vm2
Same process

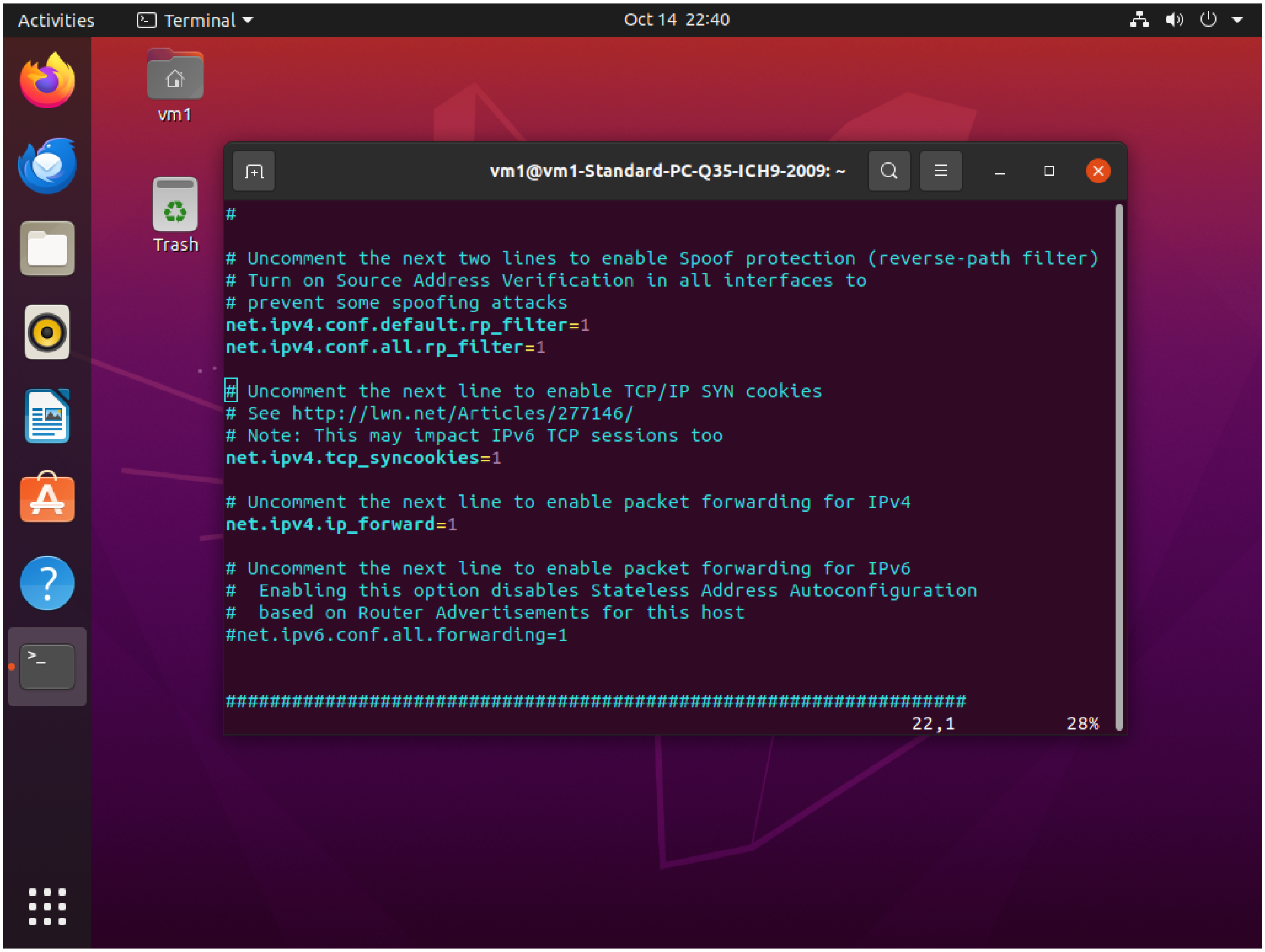
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo vim /etc/sysctl.conf
[sudo] password for vm1:

uncomment in the file below line.

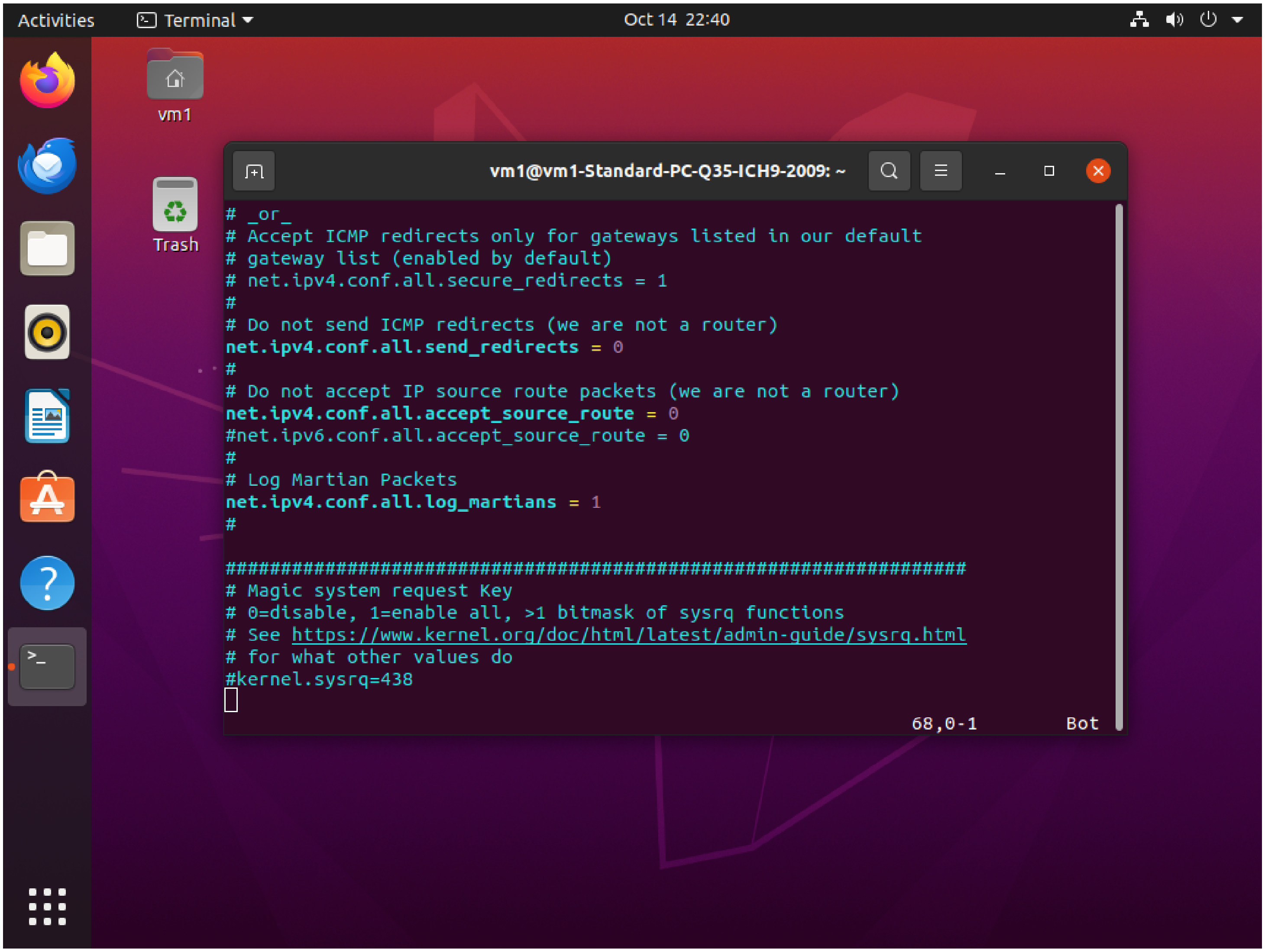
net.ipv4.conf.default.rp_filter = 1
net.ipv4.conf.all.rp_filter = 1
net.ipv4.tcp_syncookies = 1
net.ipv4.ip_forward = 1
net.ipv4.conf.all.accept_redirects = 0
net.ipv4.conf.all.send_redirects = 0
net.ipv4.conf.all.accept_source_route = 0
net.ipv4.conf.all.log_martians = 1



```
#
# /etc/sysctl.conf - Configuration file for setting system variables
# See /etc/sysctl.d/ for additional system variables.
# See sysctl.conf (5) for information.
#

#kernel.domainname = example.com

# Uncomment the following to stop low-level messages on console
#kernel.printk = 3 4 1 3

##############################################################3
# Functions previously found in netbase
#

# Uncomment the next two lines to enable Spoof protection (reverse-path filter)
# Turn on Source Address Verification in all interfaces to
# prevent some spoofing attacks
net.ipv4.conf.default.rp_filter=1
net.ipv4.conf.all.rp_filter=1

# Uncomment the next line to enable TCP/IP SYN cookies
# See http://lwn.net/Articles/277146/
                                                              1,1           Top
```

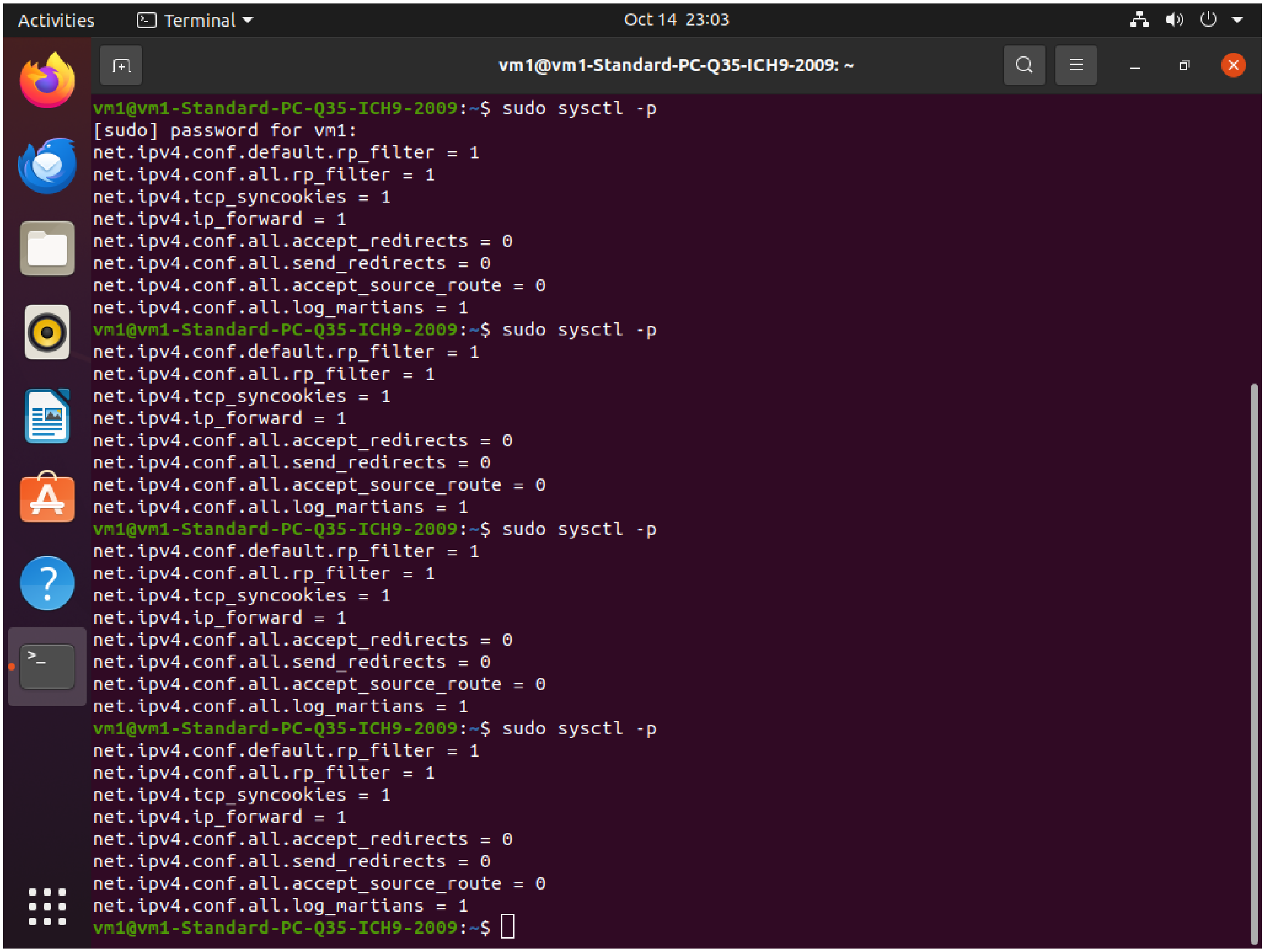


```
#

# Uncomment the next two lines to enable Spoof protection (reverse-path filter)
# Turn on Source Address Verification in all interfaces to
# prevent some spoofing attacks
net.ipv4.conf.default.rp_filter=1
net.ipv4.conf.all.rp_filter=1

# Uncomment the next line to enable TCP/IP SYN cookies
# See http://lwn.net/Articles/277146/
# Note: This may impact IPv6 TCP sessions too
net.ipv4.tcp_syncookies=1

# Uncomment the next line to enable packet forwarding for IPv4
net.ipv4.ip_forward=1

# Uncomment the next line to enable packet forwarding for IPv6
#  Enabling this option disables Stateless Address Autoconfiguration
#  based on Router Advertisements for this host
#net.ipv6.conf.all.forwarding=1


###################################################################
                                                              22,1          28%
```



```
# _or_
# Accept ICMP redirects only for gateways listed in our default
# gateway list (enabled by default)
# net.ipv4.conf.all.secure_redirects = 1
#
# Do not send ICMP redirects (we are not a router)
net.ipv4.conf.all.send_redirects = 0
#
# Do not accept IP source route packets (we are not a router)
net.ipv4.conf.all.accept_source_route = 0
#net.ipv6.conf.all.accept_source_route = 0
#
# Log Martian Packets
net.ipv4.conf.all.log_martians = 1
#

###################################################################
# Magic system request Key
# 0=disable, 1=enable all, >1 bitmask of sysrq functions
# See https://www.kernel.org/doc/html/latest/admin-guide/sysrq.html
# for what other values do
#kernel.sysrq=438

                                                              68,0-1        Bot
```

vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo sysctl -p



```
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo sysctl -p
[sudo] password for vm1:
net.ipv4.conf.default.rp_filter = 1
net.ipv4.conf.all.rp_filter = 1
net.ipv4.tcp_syncookies = 1
net.ipv4.ip_forward = 1
net.ipv4.conf.all.accept_redirects = 0
net.ipv4.conf.all.send_redirects = 0
net.ipv4.conf.all.accept_source_route = 0
net.ipv4.conf.all.log_martians = 1
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo sysctl -p
net.ipv4.conf.default.rp_filter = 1
net.ipv4.conf.all.rp_filter = 1
net.ipv4.tcp_syncookies = 1
net.ipv4.ip_forward = 1
net.ipv4.conf.all.accept_redirects = 0
net.ipv4.conf.all.send_redirects = 0
net.ipv4.conf.all.accept_source_route = 0
net.ipv4.conf.all.log_martians = 1
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo sysctl -p
net.ipv4.conf.default.rp_filter = 1
net.ipv4.conf.all.rp_filter = 1
net.ipv4.tcp_syncookies = 1
net.ipv4.ip_forward = 1
net.ipv4.conf.all.accept_redirects = 0
net.ipv4.conf.all.send_redirects = 0
net.ipv4.conf.all.accept_source_route = 0
net.ipv4.conf.all.log_martians = 1
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo sysctl -p
net.ipv4.conf.default.rp_filter = 1
net.ipv4.conf.all.rp_filter = 1
net.ipv4.tcp_syncookies = 1
net.ipv4.ip_forward = 1
net.ipv4.conf.all.accept_redirects = 0
net.ipv4.conf.all.send_redirects = 0
net.ipv4.conf.all.accept_source_route = 0
net.ipv4.conf.all.log_martians = 1
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$
```

Modify source IP for forwarding: this command run vm1 source

vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo iptables -A POSTROUTING -t nat -p tcp -d 192.168.122.85 --dport 80 -j SNAT --to-source 192.168.122.37

Set default connection drop vm1

This implies that by default, any incoming traffic that doesn't match specific predefined rules will be dropped or rejected. In other words, if the firewall doesn't have a rule that explicitly allows the traffic to pass through, it will block it as a security measure. This approach follows the principle of allowing only known and authorised traffic, enhancing the network's security.

vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo iptables -t filter -P FORWARD DROP

Accept Traffic to the Server:

This involves creating rules that explicitly allow certain types of traffic to reach a designated server. For instance, if you have a server at IP address 192.168.122.85 and it's listening on port 80, you can configure the firewall to accept incoming traffic destined for that server's IP and port. This is done using firewall rules that specify the source, destination, protocol, and port of the allowed traffic. Allow specific traffic from particular sources and to specific destinations (servers) on specific ports (--dport for destination port and --sport for source port). This creates a controlled and secure network environment where only the specified traffic is permitted to traverse the firewall.

This command on run vm1

```
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo iptables -t filter -A FORWARD -d 192.168.122.85 -p tcp --dport 80 -j ACCEPT
```

```
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo iptables -t filter -A FORWARD -s 192.168.122.85 -p tcp --sport 80 -j ACCEPT
```

This command run on vm2

```
vim2@vim2-Standard-PC-Q35-ICH9-2009:~$ sudo iptables -A INPUT -p tcp --dport 80 -j ACCEPT
[sudo] password for vim2:****
```

{}

A technique used in network environments to distribute incoming traffic across multiple servers in a random manner. This method is employed to optimize resource utilization, prevent overload on individual servers, and enhance the overall performance and reliability of a system.

In this case, incoming traffic destined for the IP address 192.168.122.37 on port 80 is subject to random distribution between one destination (192.168.122.85:80). The --mode random option ensures that the traffic is distributed based on a randomized algorithm, with different probabilities assigned to each destination (--probability 0.33 and --probability 0.5 in this case).

The goal of applying random load balancing is to distribute traffic unpredictably, achieving a fair distribution of incoming requests among the specified destinations. This way, the servers can collectively handle the load more efficiently, minimizing the risk of overloading any single server and contributing to improved performance and fault tolerance.

This command run Vm1 (source)

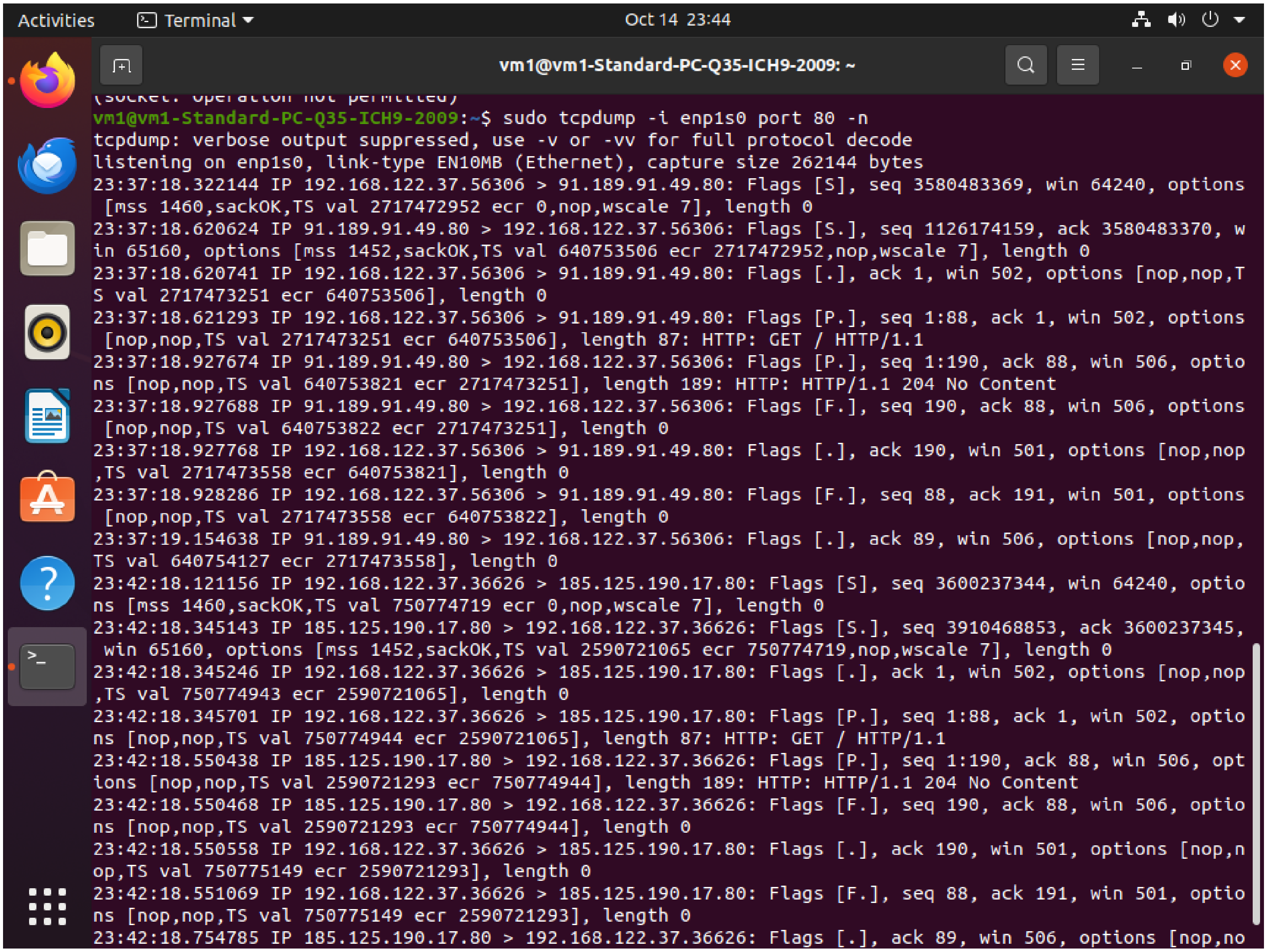
```
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo iptables -A PREROUTING -t nat -p tcp -d 192.168.122.37 --dport 80 -m statistic --mode random --probability 0.33 -j DNAT --to-destination 192.168.122.85:80
```

Capture Specific Port Traffic:

Use tcpdump to monitor network traffic on a specific port:-
tcpdump -i enp1s0 port 80 -n

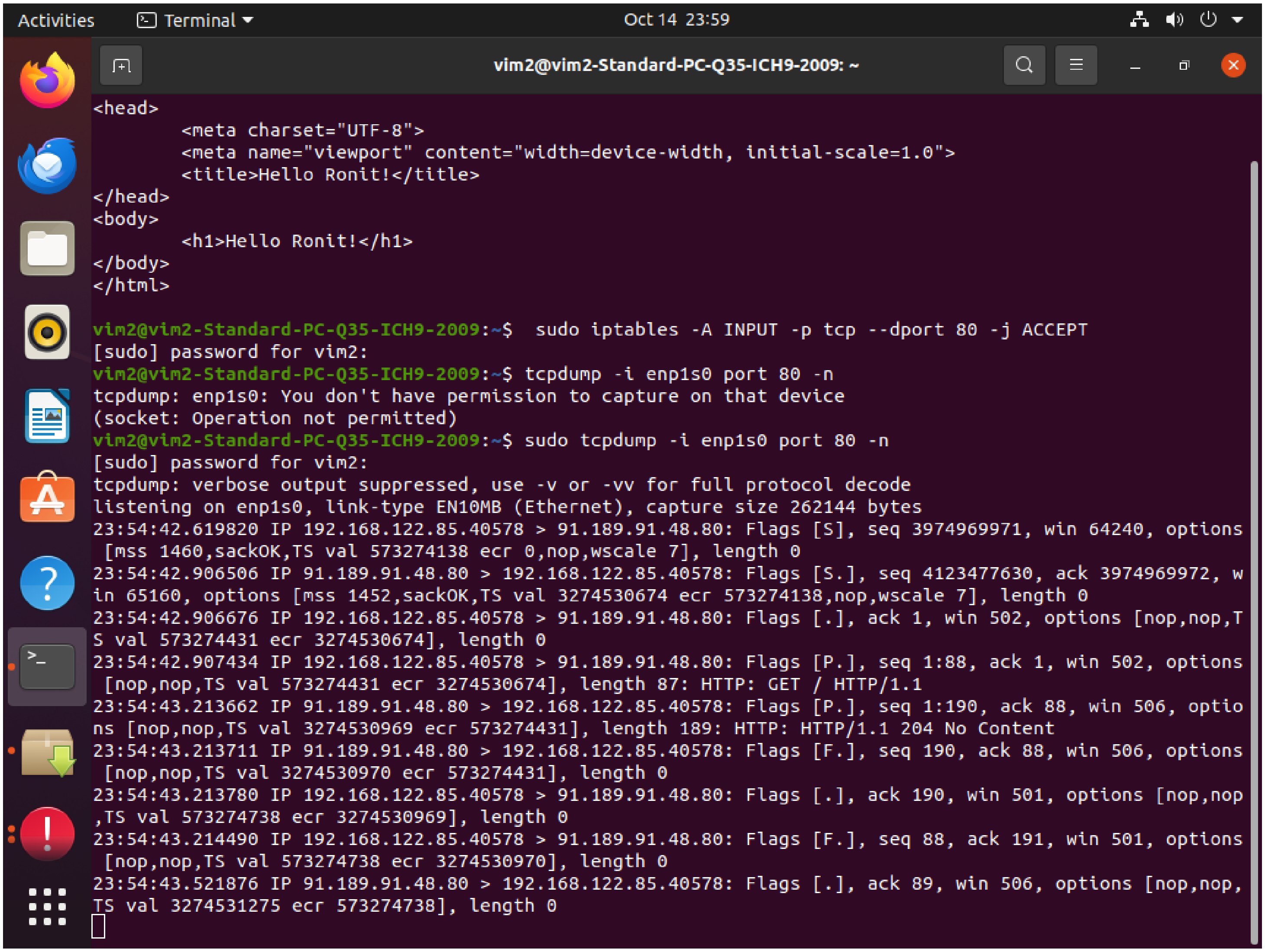
Output of TCP Dump

1st curl hit



```
(socket: operation not permitted)
vm1@vm1-Standard-PC-Q35-ICH9-2009:~$ sudo tcpdump -i enp1s0 port 80 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on enp1s0, link-type EN10MB (Ethernet), capture size 262144 bytes
23:37:18.322144 IP 192.168.122.37.56306 > 91.189.91.49.80: Flags [S], seq 3580483369, win 64240, options
 [mss 1460,sackOK,TS val 2717472952 ecr 0,nop,wscale 7], length 0
23:37:18.620624 IP 91.189.91.49.80 > 192.168.122.37.56306: Flags [S.], seq 1126174159, ack 3580483370, w
in 65160, options [mss 1452,sackOK,TS val 640753506 ecr 2717472952,nop,wscale 7], length 0
23:37:18.620741 IP 192.168.122.37.56306 > 91.189.91.49.80: Flags [.], ack 1, win 502, options [nop,nop,T
S val 2717473251 ecr 640753506], length 0
23:37:18.621293 IP 192.168.122.37.56306 > 91.189.91.49.80: Flags [P.], seq 1:88, ack 1, win 502, options
 [nop,nop,TS val 2717473251 ecr 640753506], length 87: HTTP: GET / HTTP/1.1
23:37:18.927674 IP 91.189.91.49.80 > 192.168.122.37.56306: Flags [P.], seq 1:190, ack 88, win 506, optio
ns [nop,nop,TS val 640753821 ecr 2717473251], length 189: HTTP: HTTP/1.1 204 No Content
23:37:18.927688 IP 91.189.91.49.80 > 192.168.122.37.56306: Flags [F.], seq 190, ack 88, win 506, options
 [nop,nop,TS val 640753822 ecr 2717473251], length 0
23:37:18.927768 IP 192.168.122.37.56306 > 91.189.91.49.80: Flags [.], ack 190, win 501, options [nop,nop
,TS val 2717473558 ecr 640753821], length 0
23:37:18.928286 IP 192.168.122.37.56306 > 91.189.91.49.80: Flags [F.], seq 88, ack 191, win 501, options
 [nop,nop,TS val 2717473558 ecr 640753822], length 0
23:37:19.154638 IP 91.189.91.49.80 > 192.168.122.37.56306: Flags [.], ack 89, win 506, options [nop,nop,
TS val 640754127 ecr 2717473558], length 0
23:42:18.121156 IP 192.168.122.37.36626 > 185.125.190.17.80: Flags [S], seq 3600237344, win 64240, optio
ns [mss 1460,sackOK,TS val 750774719 ecr 0,nop,wscale 7], length 0
23:42:18.345143 IP 185.125.190.17.80 > 192.168.122.37.36626: Flags [S.], seq 3910468853, ack 3600237345,
 win 65160, options [mss 1452,sackOK,TS val 2590721065 ecr 750774719,nop,wscale 7], length 0
23:42:18.345246 IP 192.168.122.37.36626 > 185.125.190.17.80: Flags [.], ack 1, win 502, options [nop,nop
,TS val 750774943 ecr 2590721065], length 0
23:42:18.345701 IP 192.168.122.37.36626 > 185.125.190.17.80: Flags [P.], seq 1:88, ack 1, win 502, optio
ns [nop,nop,TS val 750774944 ecr 2590721065], length 87: HTTP: GET / HTTP/1.1
23:42:18.550438 IP 185.125.190.17.80 > 192.168.122.37.36626: Flags [P.], seq 1:190, ack 88, win 506, opt
ions [nop,nop,TS val 2590721293 ecr 750774944], length 189: HTTP: HTTP/1.1 204 No Content
23:42:18.550468 IP 185.125.190.17.80 > 192.168.122.37.36626: Flags [F.], seq 190, ack 88, win 506, optio
ns [nop,nop,TS val 2590721293 ecr 750774944], length 0
23:42:18.550558 IP 192.168.122.37.36626 > 185.125.190.17.80: Flags [.], ack 190, win 501, options [nop,n
op,TS val 750775149 ecr 2590721293], length 0
23:42:18.551069 IP 192.168.122.37.36626 > 185.125.190.17.80: Flags [F.], seq 88, ack 191, win 501, optio
ns [nop,nop,TS val 750775149 ecr 2590721293], length 0
23:42:18.754785 IP 185.125.190.17.80 > 192.168.122.37.36626: Flags [.], ack 89, win 506, options [nop,no
```

2nd curl Hit



```
<head>
        <meta charset="UTF-8">
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
        <title>Hello Ronit!</title>
</head>
<body>
        <h1>Hello Ronit!</h1>
</body>
</html>

vim2@vim2-Standard-PC-Q35-ICH9-2009:~$  sudo iptables -A INPUT -p tcp --dport 80 -j ACCEPT
[sudo] password for vim2:
vim2@vim2-Standard-PC-Q35-ICH9-2009:~$ tcpdump -i enp1s0 port 80 -n
tcpdump: enp1s0: You don't have permission to capture on that device
(socket: Operation not permitted)
vim2@vim2-Standard-PC-Q35-ICH9-2009:~$ sudo tcpdump -i enp1s0 port 80 -n
[sudo] password for vim2:
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on enp1s0, link-type EN10MB (Ethernet), capture size 262144 bytes
23:54:42.619820 IP 192.168.122.85.40578 > 91.189.91.48.80: Flags [S], seq 3974969971, win 64240, options
 [mss 1460,sackOK,TS val 573274138 ecr 0,nop,wscale 7], length 0
23:54:42.906506 IP 91.189.91.48.80 > 192.168.122.85.40578: Flags [S.], seq 4123477630, ack 3974969972, w
in 65160, options [mss 1452,sackOK,TS val 3274530674 ecr 573274138,nop,wscale 7], length 0
23:54:42.906676 IP 192.168.122.85.40578 > 91.189.91.48.80: Flags [.], ack 1, win 502, options [nop,nop,T
S val 573274431 ecr 3274530674], length 0
23:54:42.907434 IP 192.168.122.85.40578 > 91.189.91.48.80: Flags [P.], seq 1:88, ack 1, win 502, options
 [nop,nop,TS val 573274431 ecr 3274530674], length 87: HTTP: GET / HTTP/1.1
23:54:43.213662 IP 91.189.91.48.80 > 192.168.122.85.40578: Flags [P.], seq 1:190, ack 88, win 506, optio
ns [nop,nop,TS val 3274530969 ecr 573274431], length 189: HTTP: HTTP/1.1 204 No Content
23:54:43.213711 IP 91.189.91.48.80 > 192.168.122.85.40578: Flags [F.], seq 190, ack 88, win 506, options
 [nop,nop,TS val 3274530970 ecr 573274431], length 0
23:54:43.213780 IP 192.168.122.85.40578 > 91.189.91.48.80: Flags [.], ack 190, win 501, options [nop,nop
,TS val 573274738 ecr 3274530969], length 0
23:54:43.214490 IP 192.168.122.85.40578 > 91.189.91.48.80: Flags [F.], seq 88, ack 191, win 501, options
 [nop,nop,TS val 573274738 ecr 3274530970], length 0
23:54:43.521876 IP 91.189.91.48.80 > 192.168.122.85.40578: Flags [.], ack 89, win 506, options [nop,nop,
TS val 3274531275 ecr 573274738], length 0
```

I have also done Load Testing:-

sudo apt install apache2-utils

Install ab command at local for load testing

install apache2-utils for ab command for Load Testing

run load test using ab command :-

ab -n 1000 -c 100 http://192.168.122.37:80/

jai@jai-Standard-PC-Q35-ICH9-2009:~$ab - n1000 - c100http : //192.168.122.37 : 80/ThisisApacheBench, Version2.3$ <Revision: 1843412 $>

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Benchmarking 192.168.122.37 (be patient)

Completed 100 requests

Completed 200 requests

```
Completed 300 requests
Completed 400 requests
Completed 500 requests
Completed 600 requests
Completed 700 requests
Completed 800 requests
Completed 900 requests
Completed 1000 requests
Finished 1000 requests

Server Software: nginx/1.18.0
Server Hostname: 192.168.122.37
Server Port: 80

Document Path: /
Document Length: 234 bytes

Concurrency Level: 100
Time taken for tests: 0.184 seconds
Complete requests: 1000
Failed requests: 0
Total transferred: 475000 bytes
HTML transferred: 234000 bytes
Requests per second: 5434.22 [#/sec] (mean)
Time per request: 18.402 [ms] (mean)
Time per request: 0.184 [ms] (mean, across all concurrent requests)
Transfer rate: 2520.76 [Kbytes/sec] received

Connection Times (ms)
min mean[+/-sd] median max
Connect: 1 8 4.1 7 28
Processing: 2 9 3.0 9 28
Waiting: 1 7 2.4 6 13
Total: 9 17 5.8 16 36

Percentage of the requests served within a certain time (ms)
50% 16
66% 17
75% 17
80% 18
```

90% 22

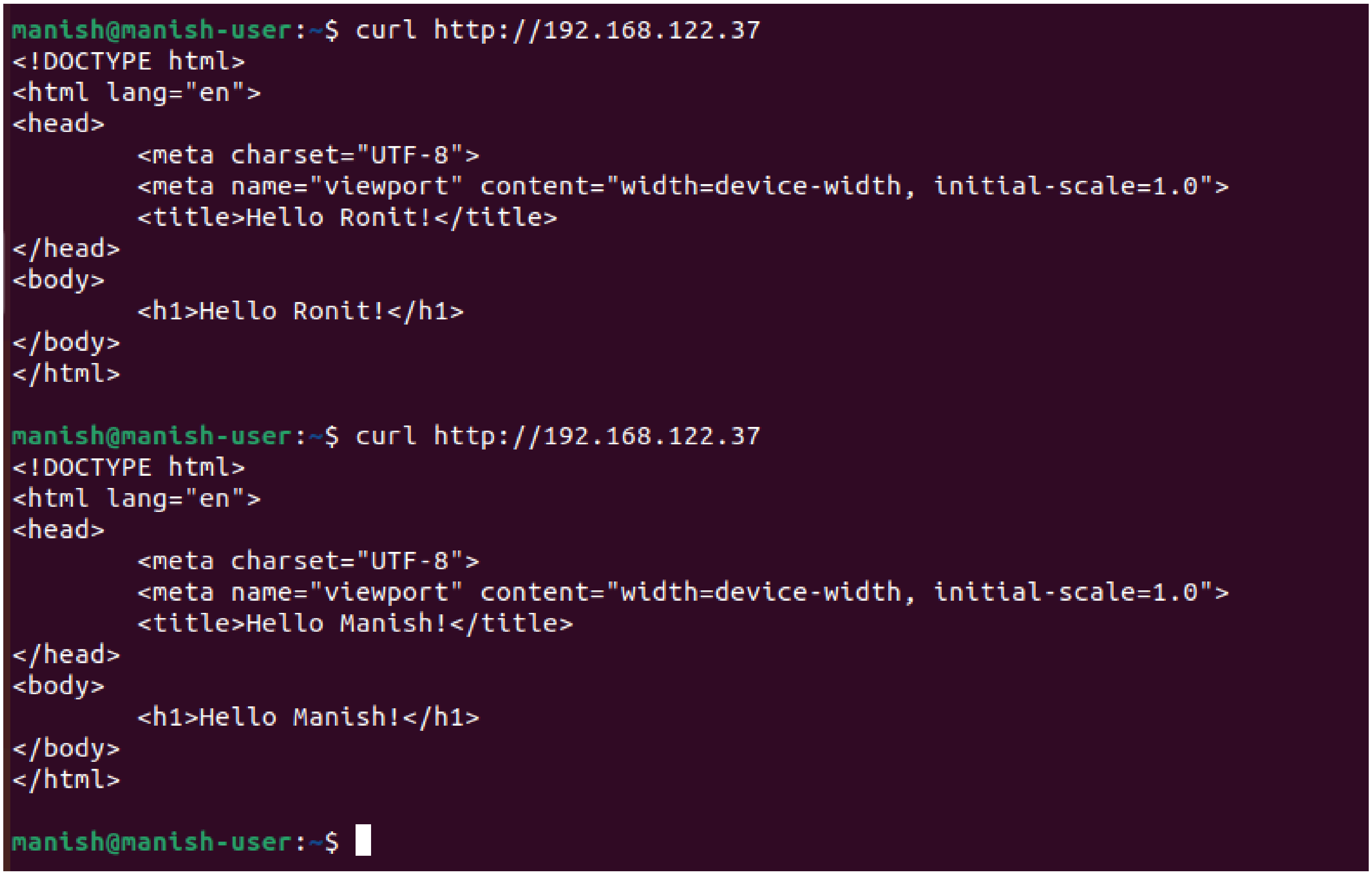
95% 33

98% 35

99% 35

100% 36 (longest request)

manish@manish-user:~$ curl http://192.168.122.37



```
manish@manish-user:~$ curl http://192.168.122.37
<!DOCTYPE html>
<html lang="en">
<head>
        <meta charset="UTF-8">
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
        <title>Hello Ronit!</title>
</head>
<body>
        <h1>Hello Ronit!</h1>
</body>
</html>

manish@manish-user:~$ curl http://192.168.122.37
<!DOCTYPE html>
<html lang="en">
<head>
        <meta charset="UTF-8">
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
        <title>Hello Manish!</title>
</head>
<body>
        <h1>Hello Manish!</h1>
</body>
</html>

manish@manish-user:~$
```