

LAB 3
CONSTRUCT A SIMPLE NETWORK



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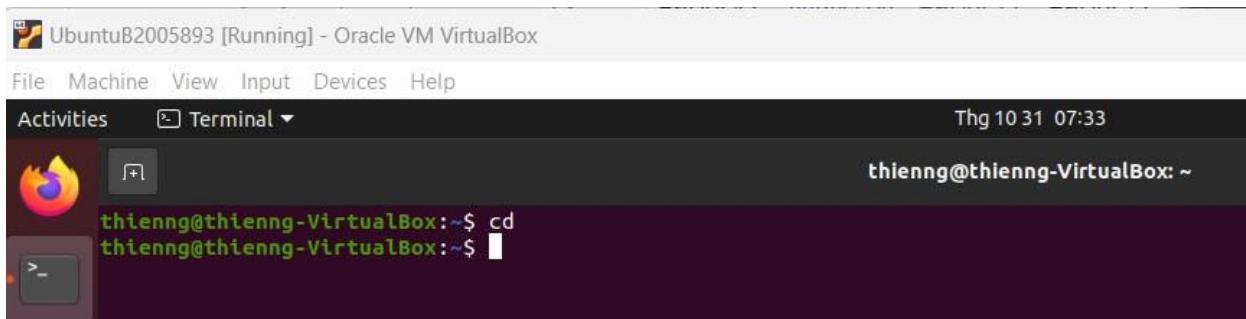
ID: B2005893

Group: M01

Submission: an ID_NAME_Lab03.pdf file describes clearly how did you solve the problem

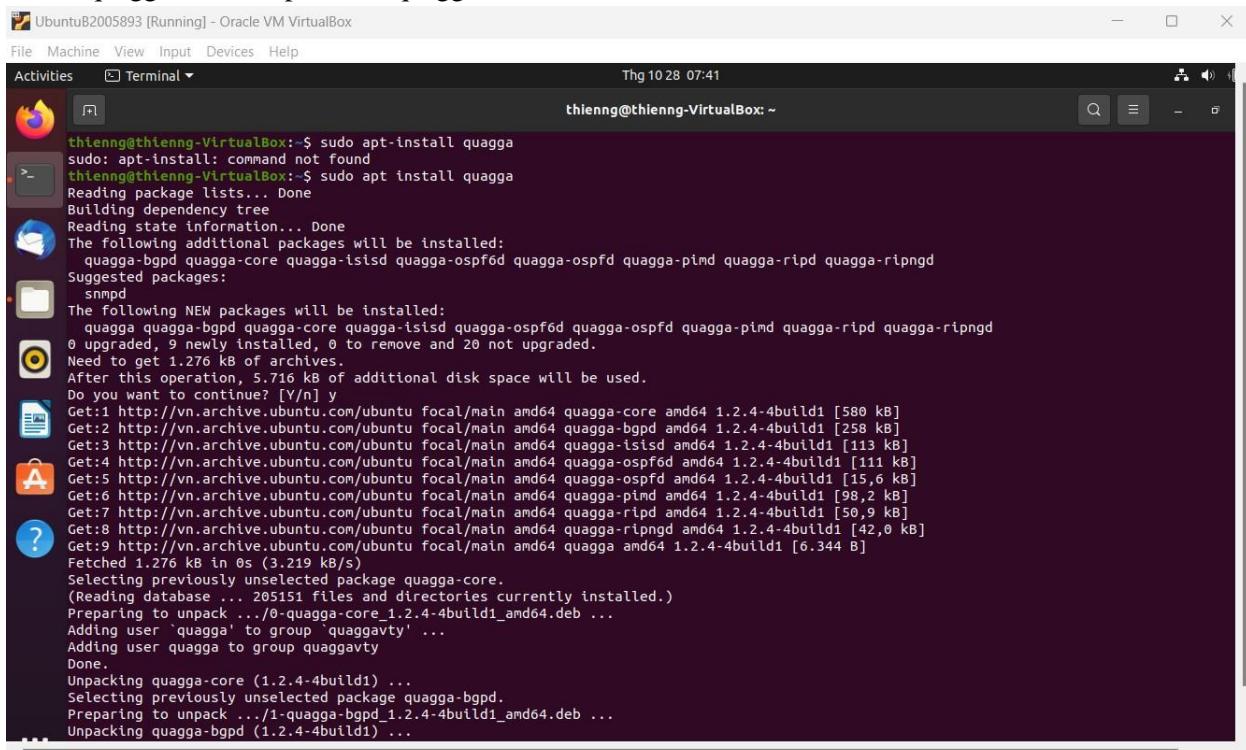
Exercise 0: change the directory to your home directory

Answer: \$cd



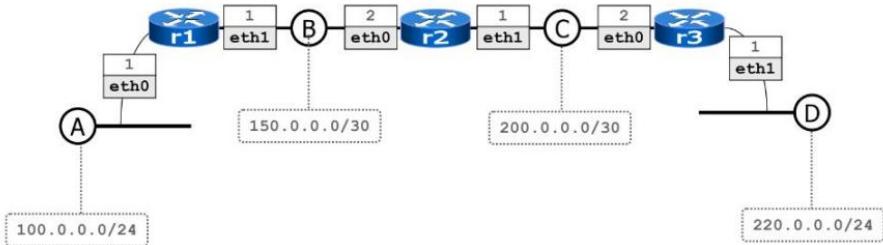
```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 10 31 07:33
thienng@thienng-VirtualBox:~$ cd
thienng@thienng-VirtualBox:~$
```

Install quagga: \$ sudo apt install quagga



```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 10 28 07:41
thienng@thienng-VirtualBox:~$ sudo apt-get install quagga
[sudo] password for thienng:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  quagga-bgpd quagga-core quagga-isisd quagga-ospfd quagga-pimd quagga-ripd quagga-ripngd
Suggested packages:
  snmpd
The following NEW packages will be installed:
  quagga quagga-bgpd quagga-core quagga-isisd quagga-ospfd quagga-pimd quagga-ripd quagga-ripngd
0 upgraded, 9 newly installed, 0 to remove and 20 not upgraded.
Need to get 1.276 kB of archives.
After this operation, 5.716 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://vn.archive.ubuntu.com/ubuntu focal/main amd64 quagga-core amd64 1.2.4-4build1 [580 kB]
Get:2 http://vn.archive.ubuntu.com/ubuntu focal/main amd64 quagga-bgpd amd64 1.2.4-4build1 [258 kB]
Get:3 http://vn.archive.ubuntu.com/ubuntu focal/main amd64 quagga-isisd amd64 1.2.4-4build1 [113 kB]
Get:4 http://vn.archive.ubuntu.com/ubuntu focal/main amd64 quagga-ospfd amd64 1.2.4-4build1 [111 kB]
Get:5 http://vn.archive.ubuntu.com/ubuntu focal/main amd64 quagga-pimd amd64 1.2.4-4build1 [15,6 kB]
Get:6 http://vn.archive.ubuntu.com/ubuntu focal/main amd64 quagga-ripd amd64 1.2.4-4build1 [98,2 kB]
Get:7 http://vn.archive.ubuntu.com/ubuntu focal/main amd64 quagga-ripngd amd64 1.2.4-4build1 [50,9 kB]
Get:8 http://vn.archive.ubuntu.com/ubuntu focal/main amd64 quagga-ripngd amd64 1.2.4-4build1 [42,0 kB]
Get:9 http://vn.archive.ubuntu.com/ubuntu focal/main amd64 quagga amd64 1.2.4-4build1 [6.344 B]
Fetched 1.276 kB in 0s (3.219 kB/s)
Selecting previously unselected package quagga-core.
(Reading database ... 205151 files and directories currently installed.)
Preparing to unpack .../0-quagga-core_1.2.4-4build1_amd64.deb ...
Adding user 'quagga' to group 'quaggavty' ...
Adding user quagga to group quaggavty
Done.
Unpacking quagga-core (1.2.4-4build1) ...
Selecting previously unselected package quagga-bgpd.
Preparing to unpack .../1-quagga-bgpd_1.2.4-4build1_amd64.deb ...
Unpacking quagga-bgpd (1.2.4-4build1) ...
```

Exercise 12: Construct a simple topology



1. Files and Folders

```
$ tree
```

```
thienng@thienng-VirtualBox:~/LAB3/EX12$ tree
.
+-- lab.conf
+-- LICENSE
+-- r1
|   +-- etc
|   |   +-- quagga
|   |   |   +-- daemons
|   |   |   +-- ripd.conf
|   |   |   +-- zebra.conf
|   +-- r1.startup
+-- r2
|   +-- etc
|   |   +-- quagga
|   |   |   +-- daemons
|   |   |   +-- ripd.conf
|   |   |   +-- zebra.conf
|   +-- r2.startup
+-- r3
|   +-- etc
|   |   +-- quagga
|   |   |   +-- daemons
|   |   |   +-- ripd.conf
|   |   |   +-- zebra.conf
|   +-- r3.startup
+-- shared

10 directories, 14 files
thienng@thienng-VirtualBox:~/LAB3/EX12$
```

2. File configurations

```
$ cat lab.conf
```

```
$ cat r1.startup
```

```
$ cat r2.startup
```

```
$ cat r3.startup
```

```
$ cat r1/etc/quagga/daemons
```

```
$ cat r1/etc/quagga/ripd.conf
```

```
$ cat r1/etc/quagga/zebra.conf
```

```
$ cat r2/etc/quagga/daemons  
$ cat r2/etc/quagga/ripd.conf  
$ cat r2/etc/quagga/zebra.conf
```

```
$ cat r3/etc/quagga/daemons  
$ cat r3/etc/quagga/ripd.conf  
$ cat r3/etc/quagga/zebra.conf
```

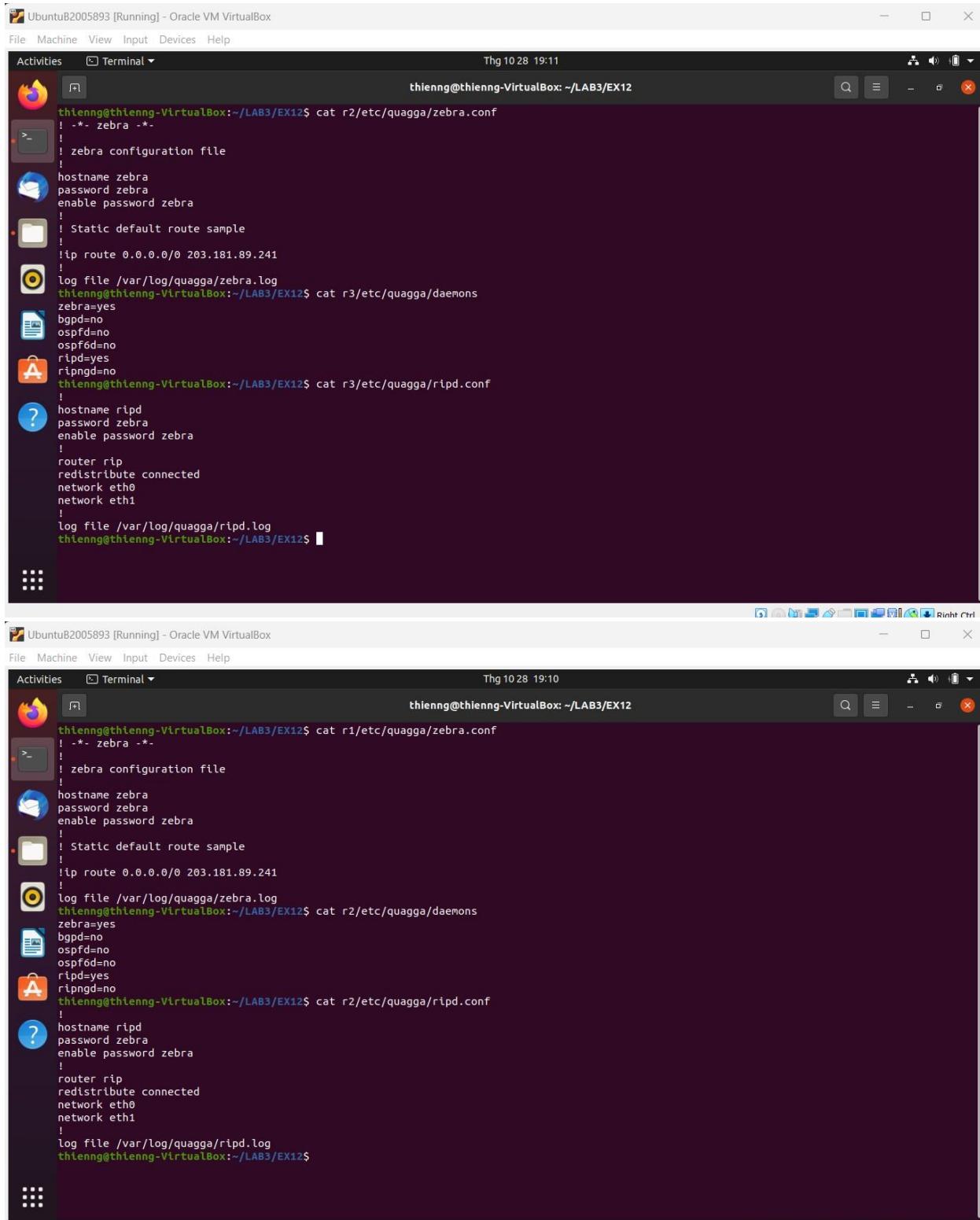
A screenshot of a terminal window titled "UbuntuB2005893 [Running] - Oracle VM VirtualBox". The terminal shows the following command and its output:

```
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat lab.conf  
r1[0]=A  
r1[1]=B  
r2[0]=B  
r2[1]=C  
r3[0]=C  
r3[1]=D  
thienng@thienng-VirtualBox:~/LAB3/EX12$
```

A screenshot of a terminal window titled "UbuntuB2005893 [Running] - Oracle VM VirtualBox". The terminal shows the following commands and their outputs:

```
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r1.startup  
ifconfig eth0 100.0.0.1/24 up  
ifconfig eth1 150.0.0.1/30 up  
/etc/init.d/quagga start  
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r2.startup  
ifconfig eth0 150.0.0.2/30 up  
ifconfig eth1 200.0.0.1/30 up  
/etc/init.d/quagga start  
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r3.startup  
ifconfig eth0 200.0.0.2/30 up  
ifconfig eth1 220.0.0.1/24 up  
/etc/init.d/quagga start  
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r1/etc/quagga/daemons  
zebra=yes  
bgpd=no  
ospf6d=no  
ospfd=no  
ripd=yes  
ripngd=no  
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r1/etc/quagga/ripd.conf  
!  
hostname ripd  
password zebra  
enable password zebra  
!  
router rip  
redistribute connected  
network eth0  
network eth1  
!  
log file /var/log/quagga/ripd.log  
thienng@thienng-VirtualBox:~/LAB3/EX12$
```

CT106H – Computer Network



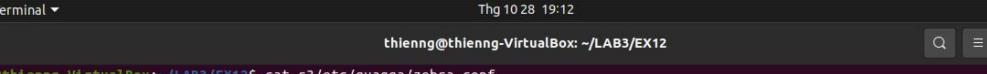
The image shows two side-by-side terminal windows from an Oracle VM VirtualBox running Ubuntu 20.04 LTS. Both terminals are titled "UbuntuB2005893 [Running] - Oracle VM VirtualBox". The top terminal window has the title bar "Thg 10 28 19:11" and the command prompt "thienng@thienng-VirtualBox: ~/LAB3/EX12\$". It displays the contents of three configuration files:

```
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r2/etc/quagga/zebra.conf
! -- zebra --
!
! zebra configuration file
!
hostname zebra
password zebra
enable password zebra
!
! Static default route sample
!
!ip route 0.0.0.0/0 203.181.89.241
!
log file /var/log/quagga/zebra.log
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r3/etc/quagga/daemons
zebra=yes
bgpd=no
ospf6=no
ospfd=no
ripd=yes
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r3/etc/quagga/ripd.conf
!
hostname ripd
password zebra
enable password zebra
!
router rip
redistribute connected
network eth0
network eth1
!
log file /var/log/quagga/ripd.log
thienng@thienng-VirtualBox:~/LAB3/EX12$
```

The bottom terminal window has the title bar "Thg 10 28 19:10" and the command prompt "thienng@thienng-VirtualBox: ~/LAB3/EX12\$". It also displays the same three configuration files:

```
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r1/etc/quagga/zebra.conf
! -- zebra --
!
! zebra configuration file
!
hostname zebra
password zebra
enable password zebra
!
! Static default route sample
!
!ip route 0.0.0.0/0 203.181.89.241
!
log file /var/log/quagga/zebra.log
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r2/etc/quagga/daemons
zebra=yes
bgpd=no
ospf6=no
ospfd=no
ripd=yes
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r2/etc/quagga/ripd.conf
!
hostname ripd
password zebra
enable password zebra
!
router rip
redistribute connected
network eth0
network eth1
!
log file /var/log/quagga/ripd.log
thienng@thienng-VirtualBox:~/LAB3/EX12$
```

CT106H – Computer Network



The screenshot shows a Linux desktop environment with a terminal window open. The terminal window title is "thienng@thienng-VirtualBox: ~/LAB3/EX12". The terminal content displays the configuration file for the Zebra daemon, which is part of the Quagga suite. The configuration includes basic authentication, static routes, and a log file path.

```
thienng@thienng-VirtualBox:~/LAB3/EX12$ cat r3/etc/quagga/zebra.conf
! _*. zebra -*-
!
! zebra configuration file
!
hostname zebra
password zebra
enable password zebra
!
! Static default route sample
!
!ip route 0.0.0.0/0 203.181.89.241
!
log file /var/log/quagga/zebra.log
thienng@thienng-VirtualBox:~/LAB3/EX12$
```

3. Start kathara

```
$ kathara lstart
```

A screenshot of a Linux desktop environment, likely Ubuntu, running in Oracle VM VirtualBox. The desktop has a dark theme. On the left, there's a dock with icons for a file manager, terminal, and other applications. In the center, there are several windows: a file manager window titled 'thien' showing a directory structure; a terminal window titled 'root@r3:/' displaying a log of system startup commands; another terminal window titled 'root@r1:/' showing a similar log; and a third terminal window titled 'root@r2:/' also showing a log. At the top, there's a menu bar with 'File', 'Machine', 'View', 'Input', 'Devices', and 'Help'. A system tray icon for 'Activities' is visible. The status bar at the bottom shows the date and time as 'Thg 10 28 19:13'.

4. Routing table on router 1 and router 2

```
$ route -n
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm -
root@r1: / Thg 10 28 19:17
root@r1: ~
--- Startup Commands Log
++ ifconfig eth0 100.0.0.1/24 up
++ ifconfig eth1 150.0.0.1/20 up
++ /etc/init.d/quagga start
Starting Quagga demons (priorities): zebra ripd,
Starting Quagga monitor daemon: watchquagga.
--- End Startup Commands Log
root@r1: # route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
100.0.0.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0
150.0.0.0 0.0.0.0 255.255.255.252 U 0 0 0 eth1
200.0.0.0 190.0.0.2 255.255.255.252 UG 20 0 0 eth1
220.0.0.0 190.0.0.2 255.255.255.0 UG 20 0 0 eth1
root@r1: #
root@r2: / Thg 10 28 19:17
root@r2: ~
--- Startup Commands Log
++ ifconfig eth0 150.0.0.2/20 up
++ ifconfig eth1 200.0.0.1/20 up
++ /etc/init.d/quagga start
Starting Quagga demons (priorities): zebra ripd,
Starting Quagga monitor daemon: watchquagga.
--- End Startup Commands Log
root@r2: # route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
100.0.0.0 150.0.0.1 255.255.255.0 UG 20 0 0 eth0
150.0.0.0 0.0.0.0 255.255.255.252 U 0 0 0 eth1
200.0.0.0 0.0.0.0 255.255.255.252 UG 20 0 0 eth1
220.0.0.0 200.0.0.2 255.255.255.0 UG 20 0 0 eth1
root@r2: #
```

5. Routing table on router 3 and ping to router 1

```
$ route -n
```

```
$ ping 100.0.0.1
```

```

--- Startup Commands Log
++ ifconfig eth0 200.0.0.2/30 up
++ ifconfig eth1 220.0.0.1/24 up
++ /etc/init.d/quagga start
Starting Quagga daemons (priorities): zebra ripd.
Starting Quagga monitor daemon: watchquagga.

--- End Startup Commands Log

root@r3:/# route -n
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref    Use Iface
100.0.0.0       200.0.0.1   255.255.255.0 UG        20      0        0 eth0
150.0.0.0       200.0.0.1   255.255.255.252 UG        20      0        0 eth0
200.0.0.0       0.0.0.0     255.255.255.252 U         0      0        0 eth0
220.0.0.0       0.0.0.0     255.255.255.0  U        0      0        0 eth1
root@r3:/# ping 100.0.0.1
PING 100.0.0.1 (100.0.0.1) 56(84) bytes of data.
64 bytes from 100.0.0.1: icmp_seq=1 ttl=63 time=0.074 ms
64 bytes from 100.0.0.1: icmp_seq=2 ttl=63 time=0.049 ms
^C
--- 100.0.0.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 24ms
rtt min/avg/max/mdev = 0.049/0.061/0.074/0.014 ms
root@r3:/#

```

- On a router, use the command `tcpdump` to capture the RIPv2 packet; then stop the command after about 20 seconds. On a router, connecting to the main zebra daemon. Then, show ip rip
`# tcpdump -i any -w /hosthome/Ex_r1.pcap`
`> telnet localhost ripd`
`> show ip rip`

```

root@r1:/# tcpdump -i any -w /hosthome/Ex2_r1.pcap
tcpdump: listening on any, link-type LINUX_SLL (Linux cooked), capture size 2621 bytes
44 bytes
^C3 packets captured
3 packets received by filter
0 packets dropped by kernel
root@r1:/#

```

```

Trying 127.0.0.1...
Connected to localhost.
Escape character is '^['.

Hello, this is Quagga (version 1.2.4),
Copyright 1996-2005 Kunihiro Ishiguro, et al.

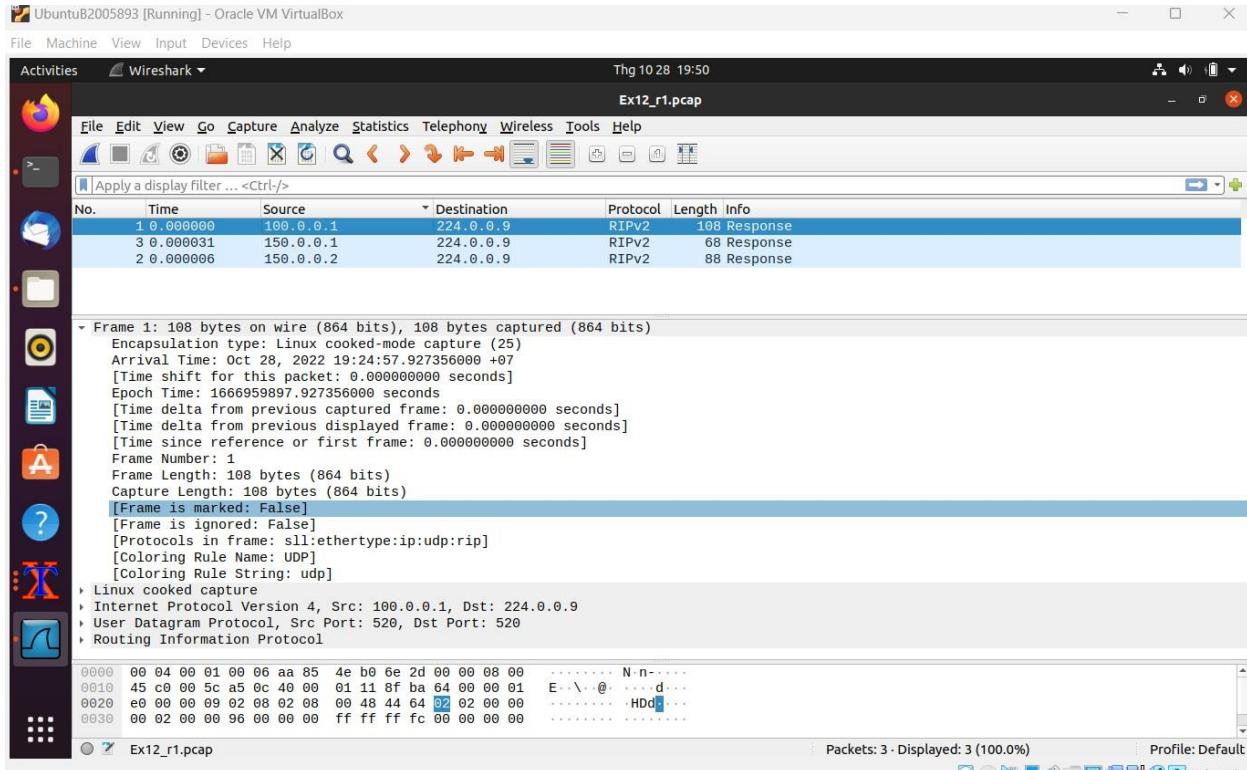
User Access Verification

Password:
ripd> show ip rip
Codes: R - RIP, C - connected, S - Static, O - OSPF, B - BGP
Sub-codes:
  (n) - normal, (s) - static, (d) - default, (r) - redistribute,
  (i) - interface

Network      Next Hop      Metric From          Tag Time
R(n) 100.0.0.0/24  200.0.0.1      3 200.0.0.1      0 02:31
R(n) 150.0.0.0/30  200.0.0.1      2 200.0.0.1      0 02:31
C(i) 200.0.0.0/30  0.0.0.0       1 self           0
C(i) 220.0.0.0/24  0.0.0.0       1 self           0
ripd>

```

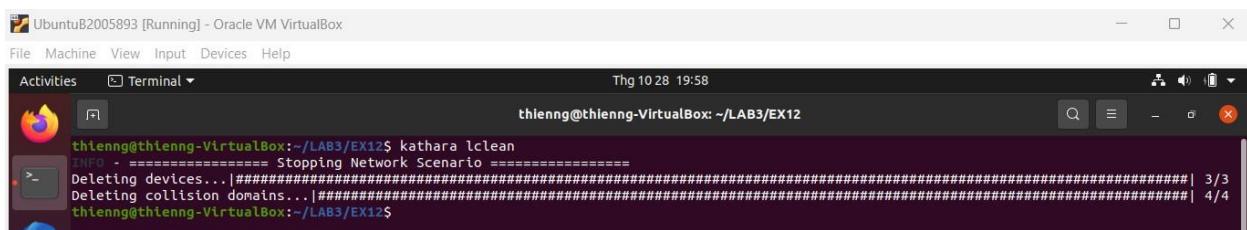
7. Open the file Ex12_r1.pcap using Wireshark, select the RIPv2 packet, explain information in that packet.



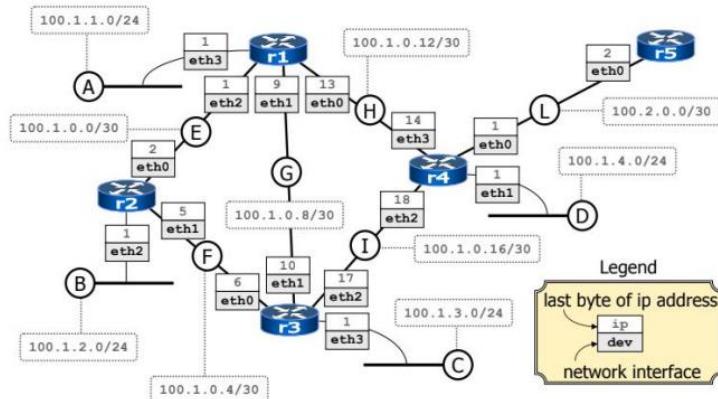
- The size of the frame is 108 bytes
- The source is 100.0.0.1, destination is 224.0.0.9
- Routing Information Protocol:
 - Command: the packet is a response message which contains route entries.
 - Version: the RIP version used (version 2)
 - Address Family: specifies the address family of entry. The AFI for IP is 2
 - Route tag: shows that the entry is from internal route which is the route learned from RIP protocol
 - IP address: the IP address of destination
 - Netmask: is the Subnetmask of mentioned IP address
 - Next hop: indicates the next hops that a packet needs to pass to reach the destination
 - Metric: is the amount of hops to reach the destination

8. Delete VMs

\$ kathara lclean



Exercise 13 (RIP): Construct a simple topology



1. Files and Folders

```
$ tree
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal ▾ Thg 10 31 08:48
thienng@thienng-VirtualBox: ~/LAB3/EX13$ tree
.
├── lab.conf
├── r1
│   └── etc
│       └── quagga
│           ├── daemons
│           ├── ripd.conf
│           └── zebra.conf
├── r1.startup
├── r2
│   └── etc
│       └── quagga
│           ├── daemons
│           ├── ripd.conf
│           └── zebra.conf
├── r2.startup
├── r3
│   └── etc
│       └── quagga
│           ├── daemons
│           ├── ripd.conf
│           └── zebra.conf
├── r3.startup
├── r4
│   └── etc
│       └── quagga
│           ├── daemons
│           ├── ripd.conf
│           └── zebra.conf
├── r4.startup
└── r5
    └── startup
        └── shared

14 directories, 18 files
thienng@thienng-VirtualBox: ~/LAB3/EX13$
```

2. File configurations

```
$ cat lab.conf
```

```
$ cat r1.startup
```

```
$ cat r2.startup
```

```
$ cat r3.startup
```

```
$ cat r4.startup
```

```
$ cat r5.startup
```

```
$ cat r1/etc/quagga/daemons
```

```
$ cat r1/etc/quagga/ripd.conf
```

```
$ cat r1/etc/quagga/zebra.conf
```

```
$ cat r2/etc/quagga/daemons
```

```
$ cat r2/etc/quagga/ripd.conf
```

```
$ cat r2/etc/quagga/zebra.conf
```

```
$ cat r3/etc/quagga/daemons
```

```
$ cat r3/etc/quagga/ripd.conf
```

```
$ cat r3/etc/quagga/zebra.conf
```

```
$ cat r4/etc/quagga/daemons
```

```
$ cat r4/etc/quagga/ripd.conf
```

```
$ cat r4/etc/quagga/zebra.conf
```

```
$ cat r5/etc/quagga/daemons
```

```
$ cat r5/etc/quagga/ripd.conf
```

```
$ cat r5/etc/quagga/zebra.conf
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal ▾
thienng@thienng-VirtualBox: ~/LAB3/EX13$ cat lab.conf
r1[0]=H
r1[1]=G
r1[2]=E
r1[3]=A
r2[0]=E
r2[1]=F
r2[2]=B
r3[0]=F
r3[1]=G
r3[2]=I
r3[3]=C
r4[0]=L
r4[1]=D
r4[2]=I
r4[3]=H
r5[0]=L
thienng@thienng-VirtualBox: ~/LAB3/EX13$
```

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UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal Thg 10 29 07:33

thienng@thienng-VirtualBox:~/LAB3/EX13\$ cat r1.startup

```
ifconfig eth0 100.1.0.13/30 up
ifconfig eth1 100.1.0.9/30 up
ifconfig eth2 100.1.0.1/30 up
ifconfig eth3 100.1.1.24 up
/etc/init.d/quagga start
```

thienng@thienng-VirtualBox:~/LAB3/EX13\$ cat r2.startup

```
ifconfig eth0 100.1.0.2/30 up
ifconfig eth1 100.1.0.5/30 up
ifconfig eth2 100.1.2.1/24 up
/etc/init.d/quagga start
```

thienng@thienng-VirtualBox:~/LAB3/EX13\$ cat r3.startup

```
ifconfig eth0 100.1.0.6/30 up
ifconfig eth1 100.1.0.10/30 up
ifconfig eth2 100.1.0.17/30 up
ifconfig eth3 100.1.3.1/24 up
/etc/init.d/quagga start
```

thienng@thienng-VirtualBox:~/LAB3/EX13\$ cat r4.startup

```
ifconfig eth0 100.2.0.1/30 up
ifconfig eth1 100.1.4.1/24 up
ifconfig eth2 100.1.0.18/30 up
ifconfig eth3 100.1.0.14/30 up
/etc/init.d/quagga start
```

thienng@thienng-VirtualBox:~/LAB3/EX13\$ cat r5.startup

```
ifconfig eth0 100.2.0.2/30 up
route add -net 100.1.0.0/16 gw 100.2.0.1
```

UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal Thg 10 29 07:36

thienng@thienng-VirtualBox:~/LAB3/EX13\$ cat r1/etc/quagga/daemons

```
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
```

thienng@thienng-VirtualBox:~/LAB3/EX13\$ cat r1/etc/quagga/ripd.conf

```
hostname ripd
password zebra
enable password zebra
```

router rip
redistribute connected
network 100.1.0.0/16

log file /var/log/quagga/ripd.log

thienng@thienng-VirtualBox:~/LAB3/EX13\$ cat r1/etc/quagga/zebra.conf

```
hostname zebra
password zebra
enable password zebra
```

log file /var/log/quagga/zebra.log

3. Start Kathara

```
$ kathara lstart
```

A screenshot of a Linux desktop environment, likely Ubuntu, running in Oracle VM VirtualBox. The desktop has a dark theme with icons for various applications like a browser, file manager, and system tools. There are four terminal windows open in the background:

- Terminal 1 (root@r5: /): Shows the root directory with several symbolic links to /dev/fd.
- Terminal 2 (root@r3: /): Shows the root directory with a large number of '#'.
- Terminal 3 (root@r2: /): Shows the root directory with a large number of '#'. This window has a search bar at the top with the text "thienng".
- Terminal 4 (root@r1: /): Shows the root directory with a large number of '#'. This window has a search bar at the top with the text "thienng".

A file manager window titled "thienng" is also visible, showing a list of files and folders. The status bar at the bottom of the screen shows "root@r4:/#".

4. Routing table on the routers

route -n

The screenshot shows two terminal windows side-by-side. The left window is titled 'root@r1:/' and the right window is titled 'root@r2:/'. Both windows show the output of the 'route -n' command.

```
root@r1:/# route -n
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref  Use Iface
100.1.0.0      0.0.0.0    255.255.255.252 U         0      0    0 eth2
100.1.0.4      100.1.0.10  255.255.255.252 UG        20     0    0 eth1
100.1.0.8      0.0.0.0    255.255.255.252 U         0      0    0 eth1
100.1.0.12     0.0.0.0    255.255.255.252 U         0      0    0 eth1
100.1.0.16     100.1.0.10  255.255.255.252 UG        20     0    0 eth1
100.1.1.0      0.0.0.0    255.255.255.255 U         0      0    0 eth3
100.1.2.0      100.1.0.2   255.255.255.0  UG        20     0    0 eth2
100.1.3.0      100.1.0.10  255.255.255.0  UG        20     0    0 eth1
100.1.4.0      100.1.0.14  255.255.255.0  UG        20     0    0 eth0
100.2.0.0      100.1.0.14  255.255.255.252 UG        20     0    0 eth0

root@r2:/# route -n
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref  Use Iface
100.1.0.0      0.0.0.0    255.255.255.252 U         0      0    0 eth0
100.1.0.4      0.0.0.0    255.255.255.252 U         0      0    0 eth1
100.1.0.8      100.1.0.6   255.255.255.252 UG        20     0    0 eth1
100.1.0.12     100.1.0.1   255.255.255.252 UG        20     0    0 eth0
100.1.0.16     100.1.0.6   255.255.255.252 UG        20     0    0 eth1
100.1.1.0      100.1.0.1   255.255.255.0  UG        20     0    0 eth0
100.1.2.0      0.0.0.0    255.255.255.0  UG        20     0    0 eth2
100.1.3.0      100.1.0.6   255.255.255.0  UG        20     0    0 eth1
100.1.4.0      100.1.0.1   255.255.255.0  UG        20     0    0 eth0
100.2.0.0      100.1.0.1   255.255.255.252 UG        20     0    0 eth0
```

The screenshot shows two terminal windows side-by-side. The left window is titled 'root@r3:/' and the right window is titled 'root@r4:/'. Both windows show the output of the 'route -n' command.

```
root@r3:/# route -n
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref  Use Iface
100.1.0.0      100.1.0.5   255.255.255.252 UG        20     0    0 eth0
100.1.0.4      0.0.0.0    255.255.255.252 U         0      0    0 eth0
100.1.0.8      0.0.0.0    255.255.255.252 U         0      0    0 eth1
100.1.0.12     100.1.0.9   255.255.255.252 UG        20     0    0 eth1
100.1.0.16     0.0.0.0    255.255.255.252 U         0      0    0 eth2
100.1.1.0      100.1.0.9   255.255.255.0  UG        20     0    0 eth1
100.1.2.0      100.1.0.5   255.255.255.0  UG        20     0    0 eth0
100.1.3.0      0.0.0.0    255.255.255.0  U         0      0    0 eth3
100.1.4.0      100.1.0.18  255.255.255.0  UG        20     0    0 eth2
100.2.0.0      100.1.0.18  255.255.255.252 UG        20     0    0 eth2

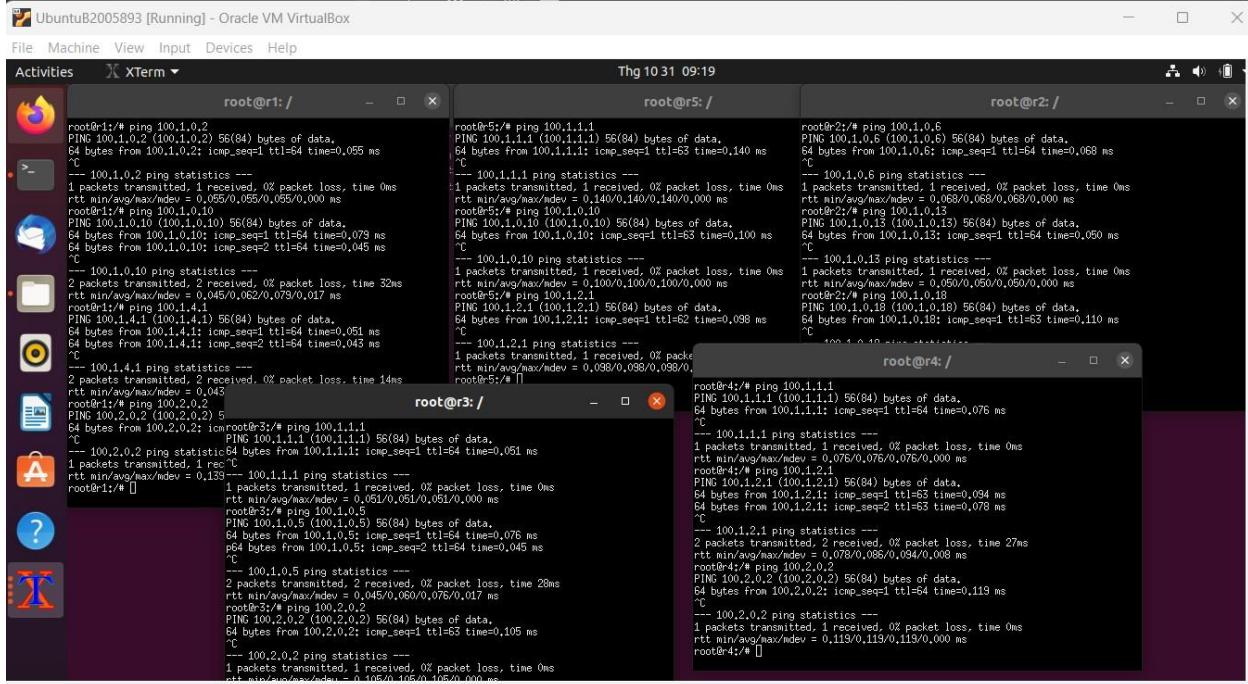
root@r4:/# route -n
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref  Use Iface
100.1.0.0      100.1.0.13  255.255.255.252 UG        20     0    0 eth3
100.1.0.4      100.1.0.17  255.255.255.252 UG        20     0    0 eth2
100.1.0.8      100.1.0.17  255.255.255.252 UG        20     0    0 eth2
100.1.0.12     0.0.0.0    255.255.255.252 U         0      0    0 eth3
100.1.0.16     0.0.0.0    255.255.255.252 U         0      0    0 eth2
100.1.1.0      100.1.0.13  255.255.255.0  UG        20     0    0 eth3
100.1.2.0      100.1.0.17  255.255.255.0  UG        20     0    0 eth2
100.1.3.0      100.1.0.17  255.255.255.0  UG        20     0    0 eth2
100.1.4.0      0.0.0.0    255.255.255.0  U         0      0    0 eth1
100.2.0.0      0.0.0.0    255.255.255.252 UG        20     0    0 eth0
```

The screenshot shows a single terminal window titled 'root@r5:/'. It displays the output of the 'route -n' command and shows the addition of a new route via the command '# route add -net 100.1.0.0/16 gw 100.2.0.1'.

```
root@r5:/# route -n
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref  Use Iface
100.1.0.0      100.2.0.1   255.255.0.0   UG         0      0    0 eth0
100.2.0.0      0.0.0.0    255.255.255.252 U         0      0    0 eth0

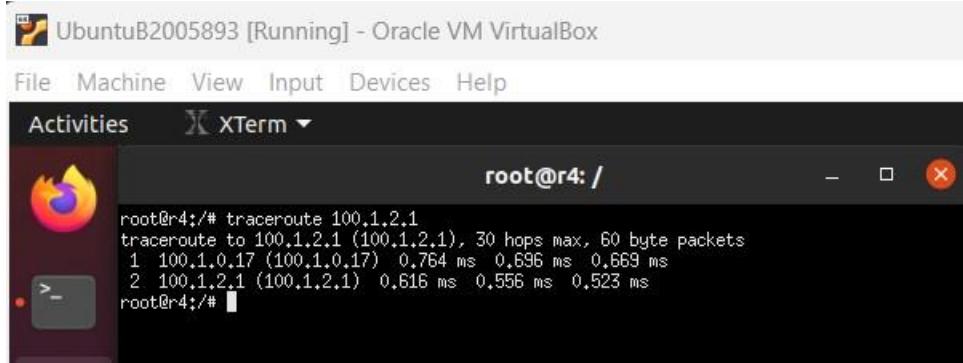
root@r5:/# route add -net 100.1.0.0/16 gw 100.2.0.1
```

5. Check connectivity using the ping command



6. On R4, type traceroute 100.1.2.1 command

traceroute 100.1.2.1

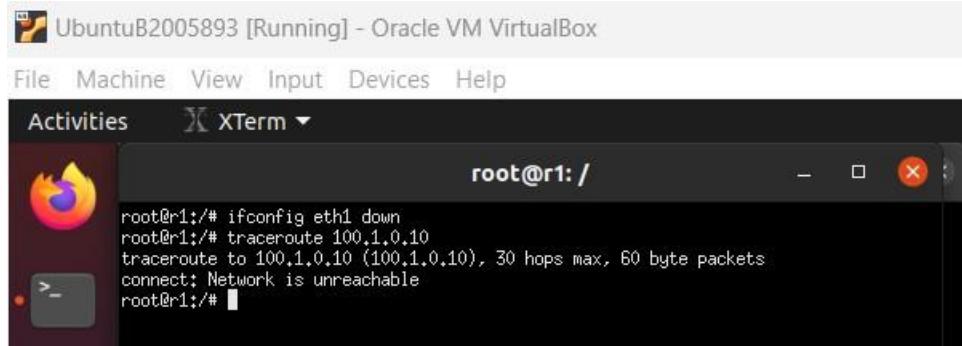


- displays the path that the signal took as it traveled around the router 4 to router 2. It also displays times which are the response times that occurred at each stop along the route.

7. On R1, shutting down an interface and Examine the route using the command

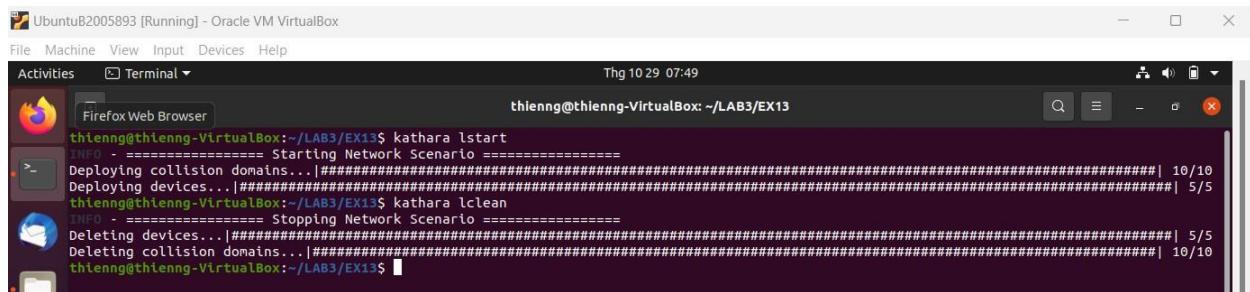
ifconfig eth1 down

traceroute 100.1.0.10

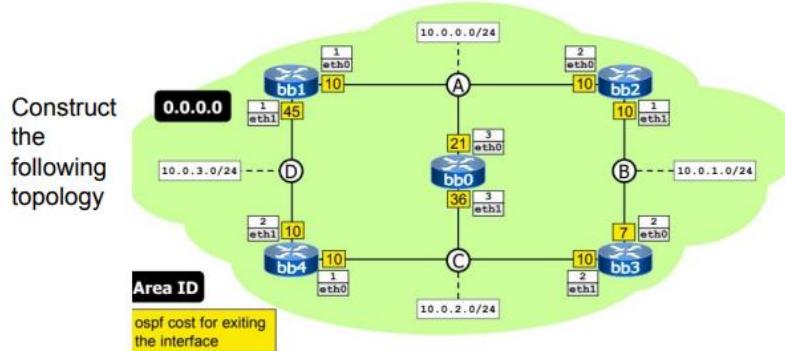


9. Delete VMs

\$ kathara lclean



Exercise 14 (OSPF) – single area



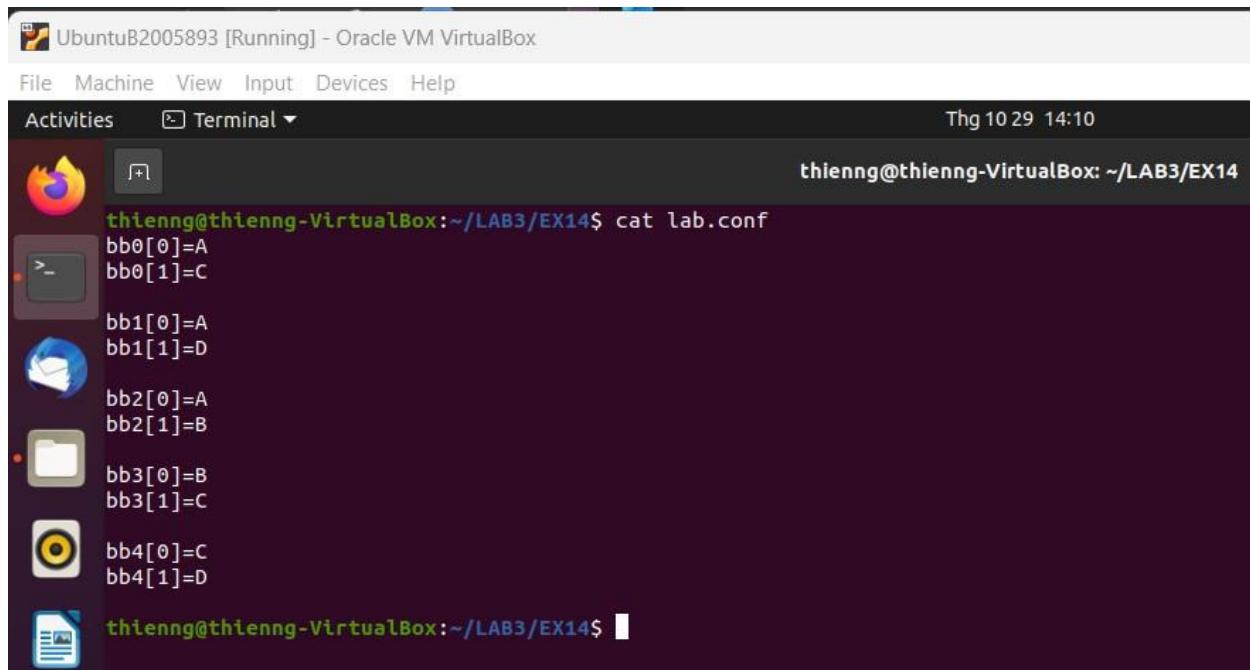
1. Files and folders

\$ tree

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 10 29 14:07
thienng@thienng-VirtualBox: ~/LAB3/EX14$ tree
.
+- bb0
|   +- etc
|   |   +- quagga
|   |   |   +- daemons
|   |   |   +- ospfd.conf
|   +- bb0.startup
+- bb1
|   +- etc
|   |   +- quagga
|   |   |   +- daemons
|   |   |   +- ospfd.conf
|   +- bb1.startup
+- bb2
|   +- etc
|   |   +- quagga
|   |   |   +- daemons
|   |   |   +- ospfd.conf
|   +- bb2.startup
+- bb3
|   +- etc
|   |   +- quagga
|   |   |   +- daemons
|   |   |   +- ospfd.conf
|   +- bb3.startup
+- bb4
|   +- etc
|   |   +- quagga
|   |   |   +- daemons
|   |   |   +- ospfd.conf
|   +- bb4.startup
+- lab.conf
.
15 directories, 16 files
thienng@thienng-VirtualBox: ~/LAB3/EX14$
```

2. File configurations

```
$ cat lab.conf  
$ cat bb0.startup  
$ cat bb1.startup  
$ cat bb2.startup  
$ cat bb3.startup  
$ cat bb4.startup  
  
$ cat bb0/etc/quagga/daemons  
$ cat bb0/etc/quagga/ospfd.conf  
$ cat bb1/etc/quagga/daemons  
$ cat bb1/etc/quagga/ospfd.conf  
$ cat bb2/etc/quagga/daemons  
$ cat bb2/etc/quagga/ospfd.conf  
$ cat bb3/etc/quagga/daemons  
$ cat bb3/etc/quagga/ospfd.conf  
$ cat bb4/etc/quagga/daemons  
$ cat bb4/etc/quagga/ospfd.conf
```



The screenshot shows a Linux desktop environment with a terminal window open. The terminal window title is "UbuntuB2005893 [Running] - Oracle VM VirtualBox". The terminal session shows the user running the command "cat lab.conf" which outputs configuration data for five interfaces (bb0 to bb4) across various paths under /etc/quagga. The desktop interface includes a dock with icons for the Dash, Home, Applications, and Help, and a top bar with "File Machine View Input Devices Help", "Activities Terminal", and the date/time "Thg 10 29 14:10".

```
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat lab.conf  
bb0[0]=A  
bb0[1]=C  
  
bb1[0]=A  
bb1[1]=D  
  
bb2[0]=A  
bb2[1]=B  
  
bb3[0]=B  
bb3[1]=C  
  
bb4[0]=C  
bb4[1]=D  
  
thienng@thienng-VirtualBox:~/LAB3/EX14$
```

```
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb0.startup
ifconfig eth0 10.0.0.3/24 up
ifconfig eth1 10.0.2.3/24 up
/etc/init.d/quagga start
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb1.startup
ifconfig eth0 10.0.0.1/24 up
ifconfig eth1 10.0.3.1/24 up
/etc/init.d/quagga start
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb2.startup
ifconfig eth0 10.0.0.2/24 up
ifconfig eth1 10.0.1.1/24 up
/etc/init.d/quagga start
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb3.startup
ifconfig eth0 10.0.1.2/24 up
ifconfig eth1 10.0.2.2/24 up
/etc/init.d/quagga start
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb4.startup
ifconfig eth0 10.0.2.1/24 up
ifconfig eth1 10.0.3.2/24 up
/etc/init.d/quagga start
thienng@thienng-VirtualBox:~/LAB3/EX14$ 

thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb0/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb0/etc/quagga/ospfd.conf
hostname ospf0
password zebra
enable password zebra

! Default cost for exiting an interface is 10
interface eth0
ospf cost 21
interface eth1
ospf cost 36

router ospf
! Speak OSPF on all interfaces falling in 10.0.0.0/16
network 10.0.0.0/16 area 0.0.0.0
redistribute connected

? log file /var/log/zebra/ospfd.log
thienng@thienng-VirtualBox:~/LAB3/EX14$ 
```

UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal ▾

Thg 10 29 14:15

```
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb1/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb1/etc/quagga/ospfd.conf
hostname ospfd
password zebra
enable password zebra

! Default cost for exiting an interface is 10
interface eth1
ospf cost 45

router ospf
! Speak OSPF on all interfaces falling in 10.0.0.0/16
network 10.0.0.0/16 area 0.0.0.0
redistribute connected

A
log file /var/log/zebra/ospfd.log
thienng@thienng-VirtualBox:~/LAB3/EX14$
```

UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

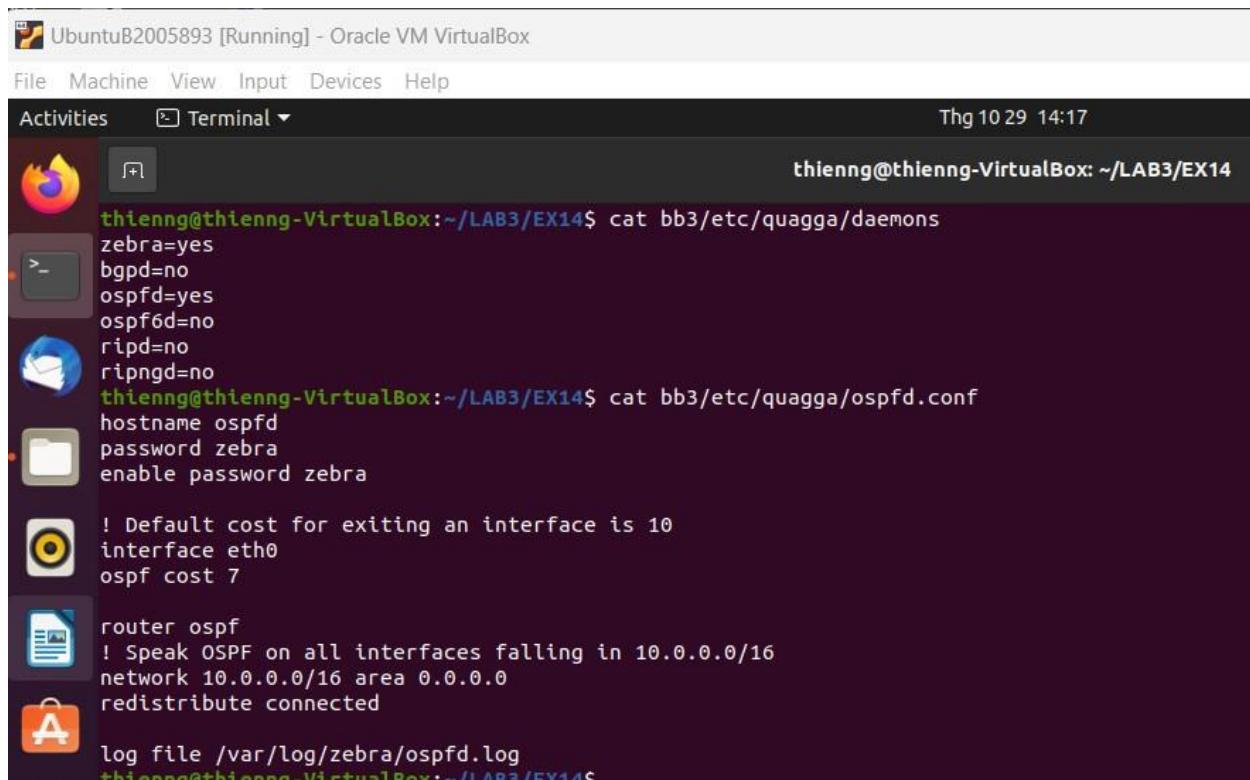
Activities Terminal ▾

Thg 10 29 14:16

```
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb2/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb2/etc/quagga/ospfd.conf
hostname ospfd
password zebra
enable password zebra

router ospf
! Speak OSPF on all interfaces falling in 10.0.0.0/16
network 10.0.0.0/16 area 0.0.0.0
redistribute connected

A
log file /var/log/zebra/ospfd.log
thienng@thienng-VirtualBox:~/LAB3/EX14$
```



UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal ▾

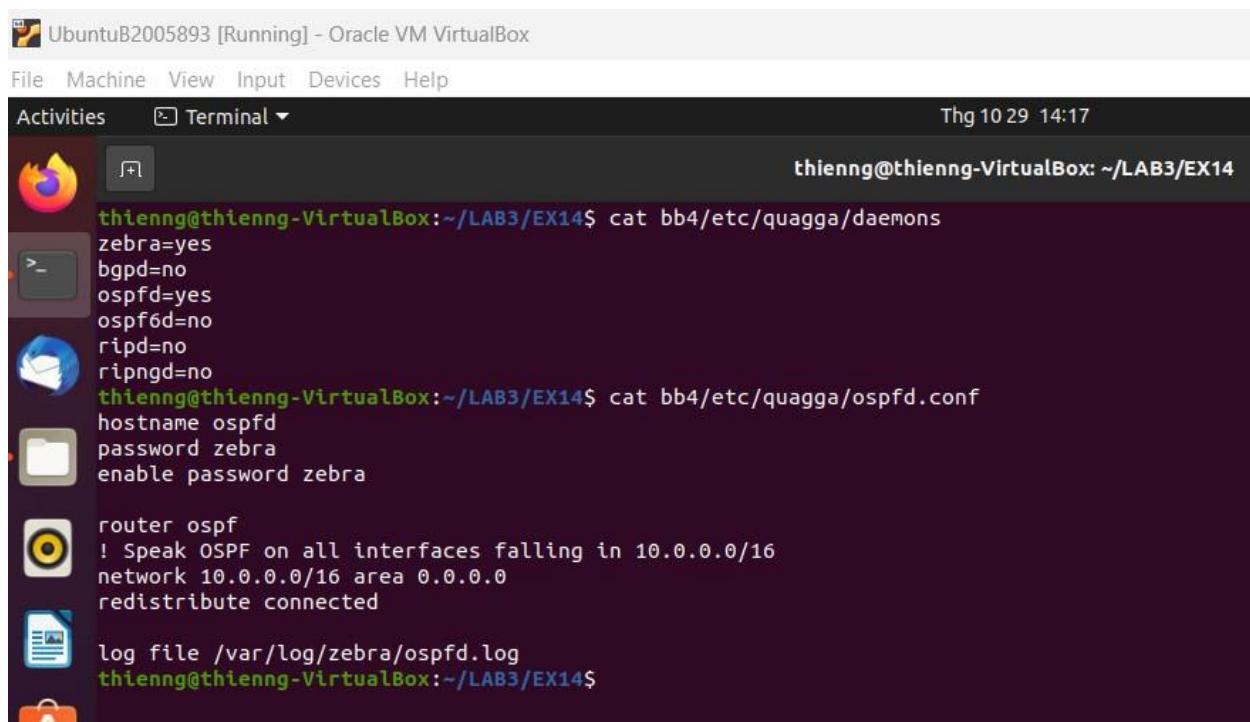
Thg 10 29 14:17

```
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb3/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb3/etc/quagga/ospfd.conf
hostname ospfd
password zebra
enable password zebra

! Default cost for exiting an interface is 10
interface eth0
ospf cost 7

router ospf
! Speak OSPF on all interfaces falling in 10.0.0.0/16
network 10.0.0.0/16 area 0.0.0.0
redistribute connected

log file /var/log/zebra/ospfd.log
thienng@thienng-VirtualBox:~/LAB3/EX14$
```



UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal ▾

Thg 10 29 14:17

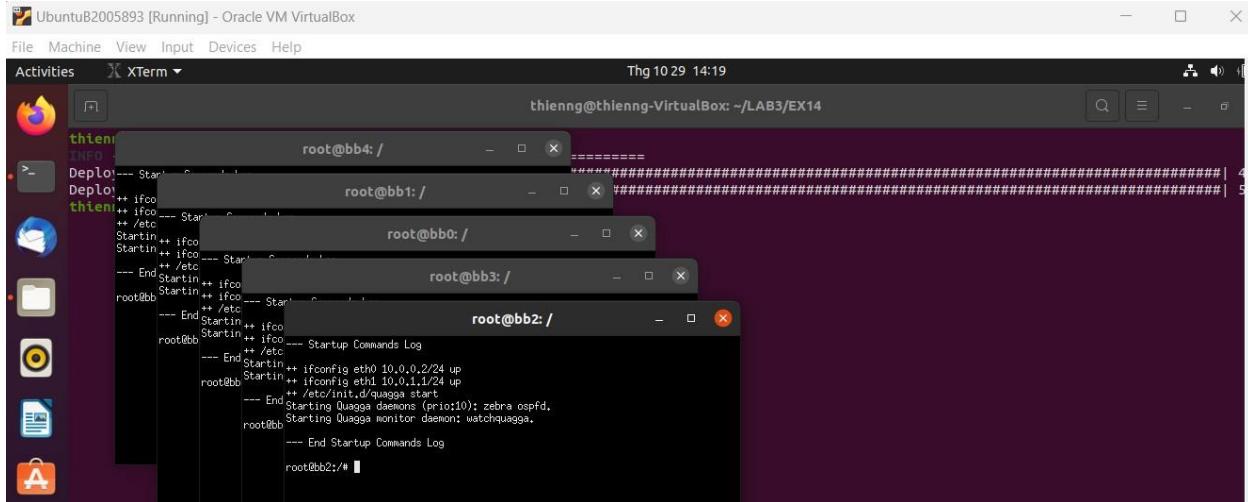
```
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb4/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX14$ cat bb4/etc/quagga/ospfd.conf
hostname ospfd
password zebra
enable password zebra

router ospf
! Speak OSPF on all interfaces falling in 10.0.0.0/16
network 10.0.0.0/16 area 0.0.0.0
redistribute connected

log file /var/log/zebra/ospfd.log
thienng@thienng-VirtualBox:~/LAB3/EX14$
```

3. Start Kathara

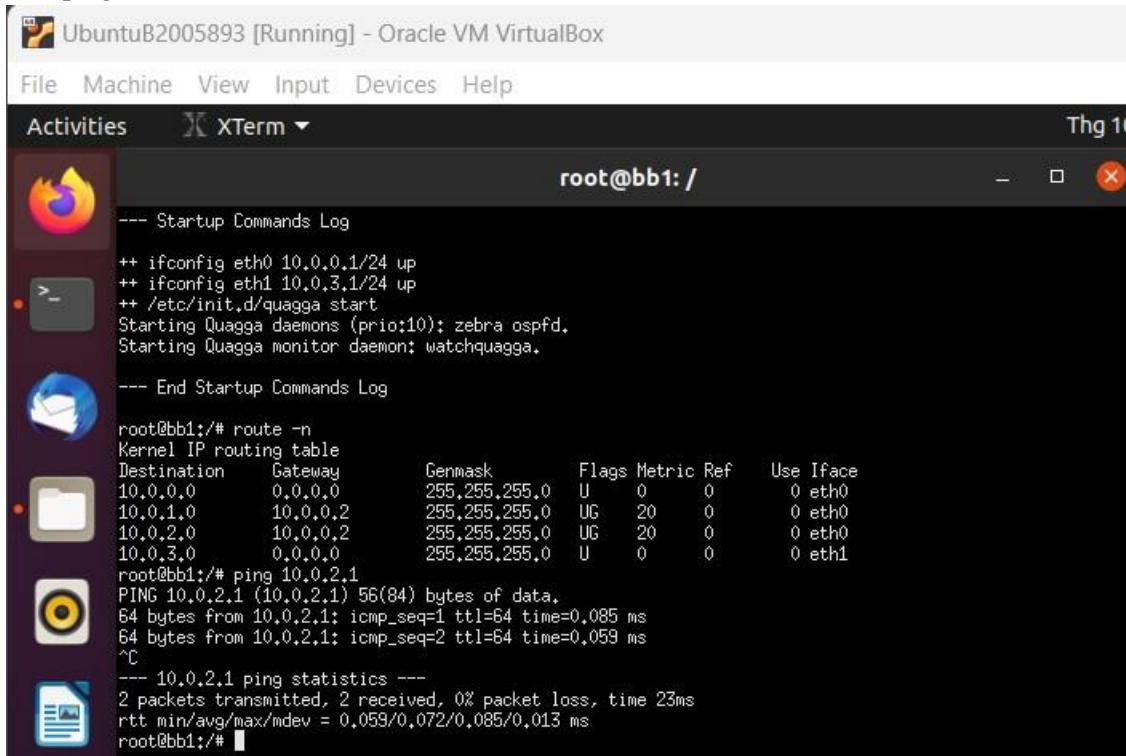
```
$ kathara lstart
```



4. Route on bb1 and ping to bb4

```
# route -n
```

```
# ping 10.0.2.1
```



5. Perform a traceroute -I from bb1 to 10.0.2.1 and 10.0.3.2

```
# traceroute -I 10.0.2.1
```

```
# traceroute -I 10.0.3.2
```

```
# show ip ospf route
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm Thg 10 29 14:49
root@bb1: /
```

```
root@bb1:/# traceroute -I 10.0.2.1
traceroute to 10.0.2.1 (10.0.2.1), 30 hops max, 60 byte packets
 1  10.0.0.2 (10.0.0.2)  0.163 ms  0.082 ms  0.912 ms
 2  10.0.1.2 (10.0.1.2)  0.911 ms  0.910 ms  0.909 ms
 3  10.0.2.1 (10.0.2.1)  0.923 ms  0.922 ms  0.921 ms
root@bb1:/# traceroute -I 10.0.3.2
traceroute to 10.0.3.2 (10.0.3.2), 30 hops max, 60 byte packets
 1  10.0.3.2 (10.0.3.2)  0.197 ms  0.133 ms  0.125 ms
root@bb1:/# telnet localhost ospfd
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Hello, this is Quagga (version 1.2.4).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

User Access Verification

Password:
Password:
ospfd> show ip ospf route
===== OSPF network routing table =====
N  10.0.0.0/24      [10] area: 0.0.0.0
                           directly attached to eth0
N  10.0.1.0/24      [20] area: 0.0.0.0
                           via 10.0.0.2, eth0
N  10.0.2.0/24      [30] area: 0.0.0.0
                           via 10.0.0.2, eth0
N  10.0.3.0/24      [40] area: 0.0.0.0
                           via 10.0.0.2, eth0

===== OSPF router routing table =====
R  10.0.1.1      [10] area: 0.0.0.0, ASBR
                           via 10.0.0.2, eth0
R  10.0.2.2      [20] area: 0.0.0.0, ASBR
                           via 10.0.0.2, eth0
R  10.0.2.3      [10] area: 0.0.0.0, ASBR
                           via 10.0.0.3, eth0
R  10.0.3.2      [30] area: 0.0.0.0, ASBR
                           via 10.0.0.2, eth0

===== OSPF external routing table =====
```

6. Access the ospfd cli on the various routers and issue the following commands:

```
# show ip ospf database
```

```
root@bb1: /  
R 10.0.2.3      via 10.0.0.2, eth0  
          [10] area: 0.0.0.0, ASBR  
R 10.0.3.2      via 10.0.0.3, eth0  
          [30] area: 0.0.0.0, ASBR  
via 10.0.0.2, eth0  
===== OSPF external routing table =====  
ospfd> show ip ospf database  
OSPF Router with ID (10.0.3.1)  
      Router Link States (Area 0.0.0.0)  
      Link ID      ADV Router      Age Seq#      CkSum Link count  
10.0.1.1      10.0.1.1      28 0x80000009 0xdd01 2  
10.0.2.2      10.0.2.2      1834 0x80000007 0xdbfe 2  
10.0.2.3      10.0.2.3      28 0x8000000b 0xd7d5 2  
10.0.3.1      10.0.3.1      7 0x80000008 0x288d 2  
10.0.3.2      10.0.3.2      8 0x80000008 0x4091 2  
      Net Link States (Area 0.0.0.0)  
      Link ID      ADV Router      Age Seq#      CkSum  
10.0.0.1      10.0.3.1      27 0x80000003 0xb7aa  
10.0.1.2      10.0.2.2      1834 0x80000001 0x69bb  
10.0.2.1      10.0.3.2      28 0x80000003 0x709b  
10.0.3.2      10.0.3.2      28 0x80000002 0x69b4
```

```
# show ip ospf neighbor
```

```
root@bb1: /  
      Link ID      ADV Router      Age Seq#      CkSum Link count  
10.0.1.1      10.0.1.1      28 0x80000009 0xdd01 2  
10.0.2.2      10.0.2.2      1834 0x80000007 0xdbfe 2  
10.0.2.3      10.0.2.3      28 0x8000000b 0xd7d5 2  
10.0.3.1      10.0.3.1      7 0x80000008 0x288d 2  
10.0.3.2      10.0.3.2      8 0x80000008 0x4091 2  
      Net Link States (Area 0.0.0.0)  
      Link ID      ADV Router      Age Seq#      CkSum  
10.0.0.1      10.0.3.1      27 0x80000003 0xb7aa  
10.0.1.2      10.0.2.2      1834 0x80000001 0x69bb  
10.0.2.1      10.0.3.2      28 0x80000003 0x709b  
10.0.3.2      10.0.3.2      28 0x80000002 0x69b4  
ospfd> show ip ospf neighbor  
      Neighbor ID      Pri State      Dead Time Address      Interface      RXmtL RqstL DBsmL  
10.0.1.1      1 Full/DROther      33.251s 10.0.0.2      eth0:10.0.0.1      0 0 0  
10.0.2.3      1 Full/Backup      33.251s 10.0.0.3      eth0:10.0.0.1      0 0 0  
10.0.3.2      1 Full/DR      33.251s 10.0.3.2      eth1:10.0.3.1      0 0 0  
ospfd> clear  
% [OSPF] Unknown command: clear  
ospfd> show ip ospf neighbor
```

```
# show ip ospf interface
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm ▾ Thg 10
root@bb1: ~
10.0.3.2      1 Full/DR      31.404s 10.0.3.2      eth1:10.0.3.1      0 0 0
ospf> show ip ospf interface
eth0 is up
    ifindex 13, MTU 1500 bytes, BW 0 Kbit <UP,BROADCAST,RUNNING,MULTICAST>
    Internet Address 10.0.0.1/24, Broadcast 10.0.0.255, Area 0.0.0.0
    MTU mismatch detection:enabled
    Router ID 10.0.3.1, Network Type BROADCAST, Cost: 10
    Transmit Delay is 1 sec, State DR, Priority 1
    Designated Router (ID) 10.0.3.1, Interface Address 10.0.0.1
    Backup Designated Router (ID) 10.0.2.3, Interface Address 10.0.0.3
    Saved Network-LSA sequence number 0x80000003
    Multicast group memberships: OSPFAllRouters OSPFDesignatedRouters
    Timer intervals configured, Hello 10s, Dead 40s, Wait 40s, Retransmit 5
        Hello due in 0.038s
    Neighbor Count is 2, Adjacent neighbor count is 2
eth1 is up
    ifindex 27, MTU 1500 bytes, BW 0 Kbit <UP,BROADCAST,RUNNING,MULTICAST>
    Internet Address 10.0.3.1/24, Broadcast 10.0.3.255, Area 0.0.0.0
    MTU mismatch detection:enabled
    Router ID 10.0.3.1, Network Type BROADCAST, Cost: 45
    Transmit Delay is 1 sec, State Backup, Priority 1
    Designated Router (ID) 10.0.3.2, Interface Address 10.0.3.2
    Backup Designated Router (ID) 10.0.3.1, Interface Address 10.0.3.1
    Multicast group memberships: OSPFAllRouters OSPFDesignatedRouters
    Timer intervals configured, Hello 10s, Dead 40s, Wait 40s, Retransmit 5
        Hello due in 0.038s
    Neighbor Count is 1, Adjacent neighbor count is 1
lo is up
    ifindex 1, MTU 65536 bytes, BW 0 Kbit <UP,LOOPBACK,RUNNING>
    OSPF not enabled on this interface
ospf>
```

7. On a router, use tcpdump command to capture packets transmitted between routers and discover them

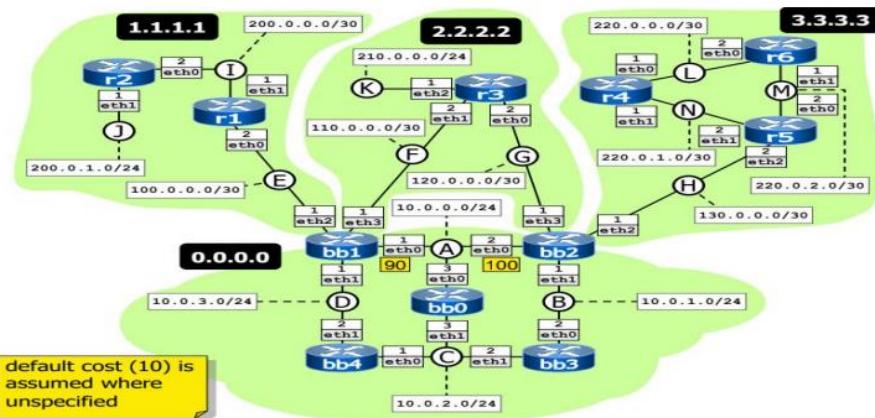
```
# tcpdump -i any -w /hosthome/Ex14_bb1.pcap
```

```
root@bb1:/# tcpdump -i any -w /hosthome/Ex14_bb1.pcap
tcpdump: listening on any, link-type LINUX_SLL (Linux cooked), capture size 262144 bytes
25 packets captured
0 packets dropped by kernel
root@bb1:/# telnet localhost rpid
Trying 127.0.0.1...
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.
Quagga (version 1.2.4).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

User Access Verification
Password:
ospfd: show ip ospf
OSPF Routing Process, Router ID: 10.0.3.1
Supports only single TOS (TOS0) routes
This implementation conforms to RFC2328
Maximum path cost is 1500000000
Queueingdiscipline is disabled
Initial SPF scheduling delay 0 millisecond(s)
Minimum hold time between consecutive SPFs: 50 millisecond(s)
Maximum hold time between consecutive SPFs: 5000 millisecond(s)
Hold time multiplier is currently 1
Hold time multiplier was last executed 4ms ago
Last SPF algorithm execution uses
SPF timer is inactive
Refresh timer 10 secs
This router is an ASBR (injecting external routing information)
Number of external LSA 0, Checksum Sum 0x00000000
Number of opaque AS LSA 0, Checksum Sum 0x00000000
Number of areas attached to this router: 1

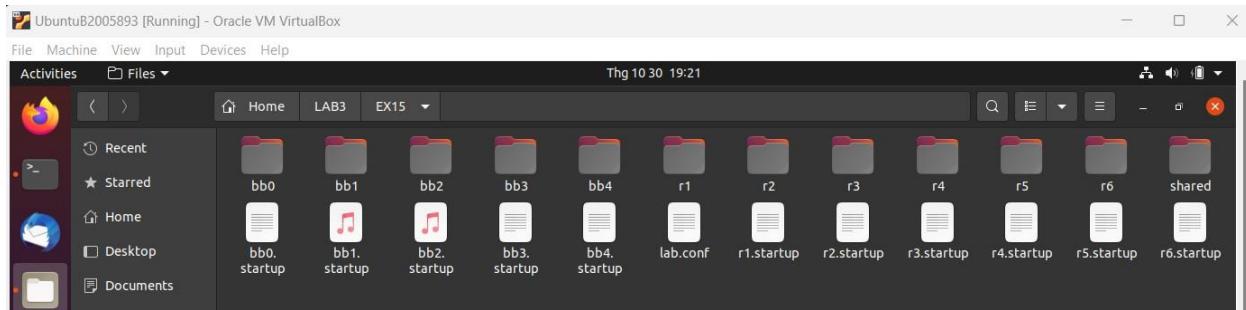
Area ID: 0,0,0 (Backbone)
Number of interfaces in this area; Total: 2, Active: 2
Number of fully adjacent neighbors in this area: 3
Area has no authentication
SPF algorithm was executed 8 times
Number of LSA 5
Number of router LSA 5, Checksum Sum 0x0002f7f3
Number of network LSA 4, Checksum Sum 0x0001ab95
Number of summary LSA 0, Checksum Sum 0x00000000
Number of ASBR summary LSA 0, Checksum Sum 0x00000000
Number of NLSA 0, Checksum Sum 0x00000000
Number of opaque link LSA 0, Checksum Sum 0x00000000
Number of opaque area LSA 0, Checksum Sum 0x00000000
```

Exercise 15 (OSPF - multiarea)



1. File and folders

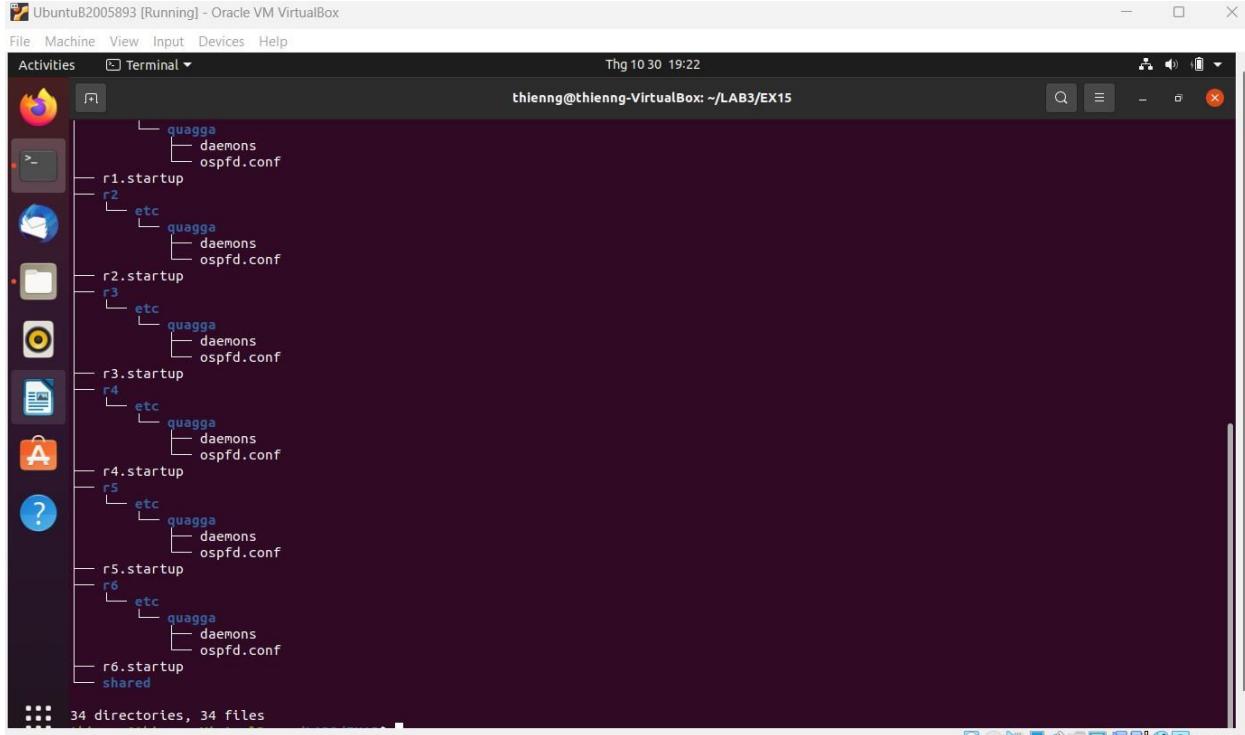
\$ tree



```

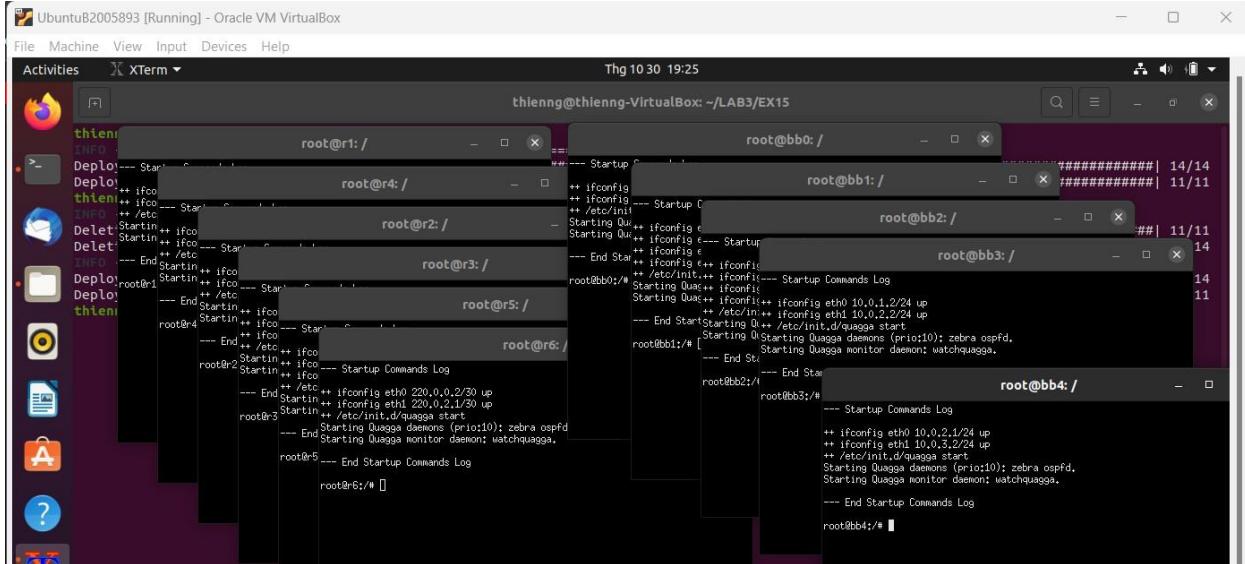
thienng@thienng-VirtualBox:~/LAB3/EX15$ tree
.
├── bb0
│   └── etc
│       └── quagga
│           ├── daemons
│           └── ospfd.conf
├── bb1
│   └── etc
│       └── quagga
│           ├── daemons
│           └── ospfd.conf
├── bb2
│   └── etc
│       └── quagga
│           ├── daemons
│           └── ospfd.conf
├── bb3
│   └── etc
│       └── quagga
│           ├── daemons
│           └── ospfd.conf
├── bb4
│   └── etc
│       └── quagga
│           ├── daemons
│           └── ospfd.conf
├── bb0.startup
├── bb1.startup
├── bb2.startup
├── bb3.startup
├── bb4.startup
└── lab.conf

```



2. Start Kathara

```
$ kathara lstart
```



3. EXPERIMENTS

a. check that routers know detailed topology information only about their own area

```
# show ip ospf neighbor
# show ip ospf database network
```

On r1:

```
root@r1:~# telnet localhost ospfd
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^J'.
Hello, this is Quagga (version 1.2.4).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

User Access Verification

Password:
ospfd> show ip ospf neighbor

Neighbor ID      Pri State        Dead Time Address      Interface      RxMtu RmtL RspLl IBsMl
110.0.0.1        1 Full/Backup   35.721s 100.0.0.1    eth0:100.0.0.2    0     0     0
200.0.1.1        1 Full/DR      31.582s 200.0.0.2    eth1:200.0.0.1    0     0     0
ospfd> show ip ospf database router

OSPF Router with ID (200.0.0.1)

Router Link States (Area 1.1.1.1 [Stub])

LS age: 899
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
Flags: 0x1 : LBR
LS Type: router-LSR
Link State ID: 100.0.0.1
Advertising Router: 110.0.0.1
LS Seq Number: 80000005
Checksum: 0x2d6f
Length: 36
Number of Links: 1

Link connected to: a Transit Network
(Link ID) Designated Router address: 100.0.0.2
(Link Data) Router Interface address: 100.0.0.1
Number of TOS metrics: 0
TOS 0 Metric: 10

LS age: 899
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x3
Flags: 0x0
LS Type: network-LSR
Link State ID: 200.0.0.1
Advertising Router: 200.0.0.1
LS Seq Number: 80000008
Checksum: 0x2710
Length: 48
```

On r2:

```
root@r2:~# telnet localhost ospfd
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^J'.
Hello, this is Quagga (version 1.2.4).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

User Access Verification

Password:
ospfd> show ip ospf neighbor

Neighbor ID      Pri State        Dead Time Address      Interface      RxMtu RmtL RspLl IBsMl
200.0.0.1        1 Full/Backup   31.509s 200.0.0.1    eth0:200.0.0.2    0     0     0
ospfd> show ip ospf database network

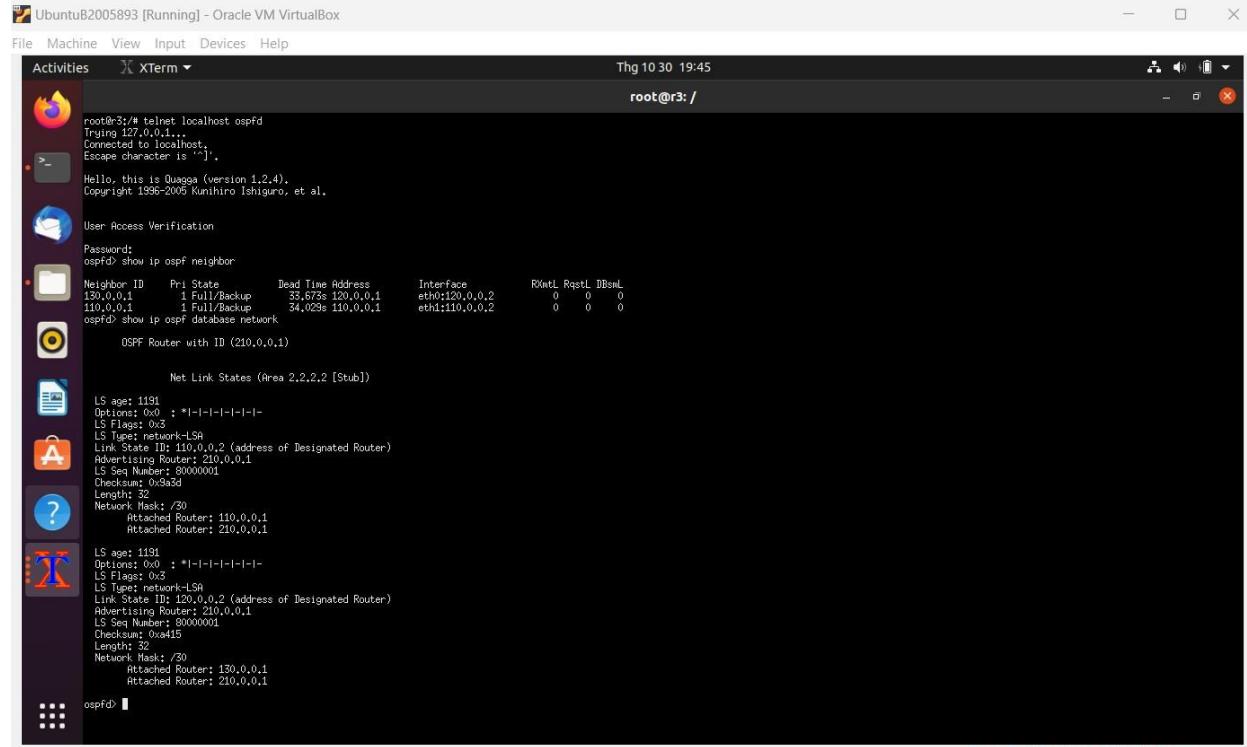
OSPF Router with ID (200.0.0.1)

Net Link States (Area 1.1.1.1 [Stub])

LS age: 1100
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x3
LS Type: network-LSR
Link State ID: 100.0.0.2 (address of Designated Router)
Advertising Router: 200.0.0.1
LS Seq Number: 80000001
Checksum: 0x0dec
Length: 32
Network Mask: /30
Attached Router: 110.0.0.1
Attached Router: 200.0.0.1

LS age: 163
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x3
LS Type: network-LSR
Link State ID: 200.0.0.2 (address of Designated Router)
Advertising Router: 200.0.0.1
LS Seq Number: 80000002
Checksum: 0x6cc7
Length: 32
Network Mask: /30
Attached Router: 200.0.0.1
Attached Router: 200.0.1.1
```

On r3:



```

root@r3:/# telnet localhost ospfd
Trying 127.0.0.1...
Connected to localhost.
Escape character is ']'.

Hello, this is Quagga (version 1.2.4).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

User Access Verification

Password:
ospfd> show ip ospf neighbor

Neighbor ID      Pri State        Dead Time Address      Interface      RxMtu Rgstd DBSnl
130.0.0.1        1 Full/Backup   33.673s 120.0.0.1    eth0:120.0.0.2    0     0     0
110.0.0.1        1 Full/Backup   34.029s 110.0.0.1    eth1:110.0.0.2    0     0     0
ospfd> show ip ospf database network

OSPF Router with ID (210.0.0.1)

Net Link States (Area 2.2.2.2 [Stub])

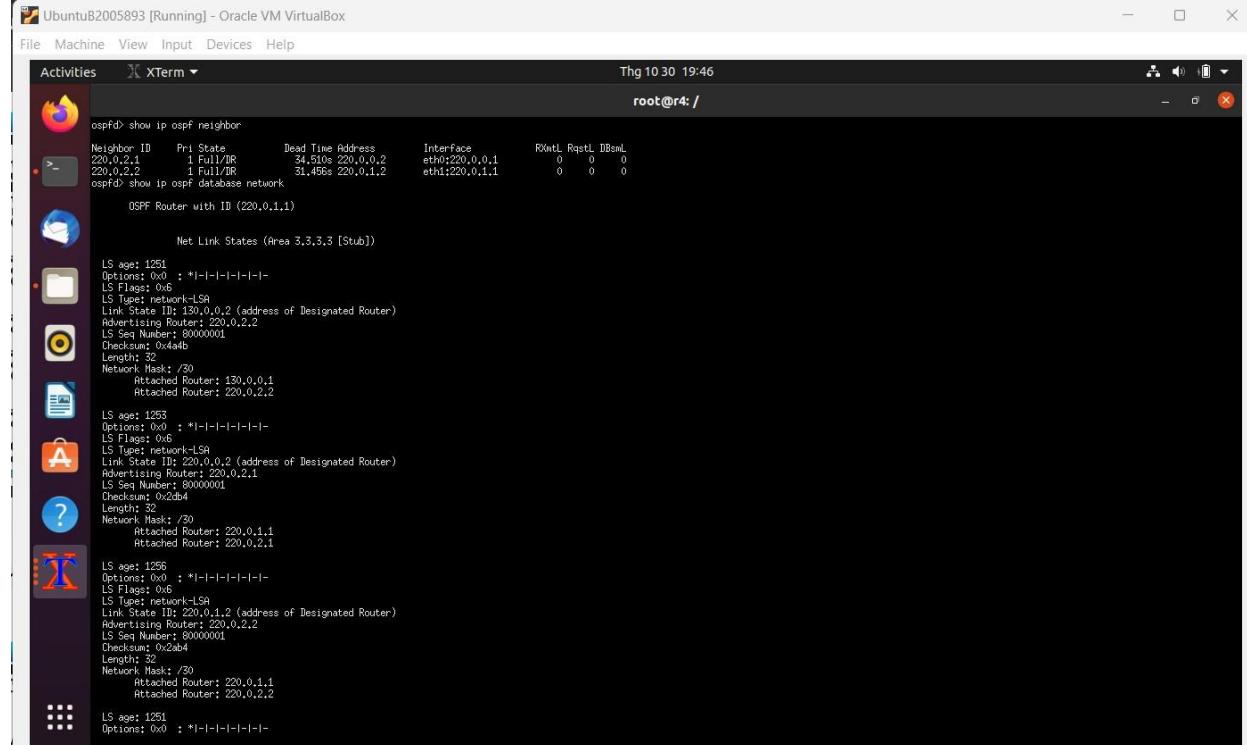
LS age: 1191
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x3
LS Type: network-LSA
Link State ID: 110.0.0.2 (address of Designated Router)
Advertising Router: 210.0.0.1
LS Seq Number: 80000001
Checksum: 0x9ad3
Length: 32
Network Mask: /30
Attached Router: 110.0.0.1
Attached Router: 210.0.0.1

LS age: 1191
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x3
LS Type: network-LSA
Link State ID: 120.0.0.2 (address of Designated Router)
Advertising Router: 210.0.0.1
LS Seq Number: 80000001
Checksum: 0x9ad3
Length: 32
Network Mask: /30
Attached Router: 130.0.0.1
Attached Router: 210.0.0.1

ospfd>

```

On r4:



```

root@r4:/# Activities XTerm Thg 10 30 19:46 root@r4:/
ospfd> show ip ospf neighbor

Neighbor ID      Pri State        Dead Time Address      Interface      RxMtu Rgstd DBSnl
220.0.2.1        1 Full/DR      34.510s 220.0.0.2    eth0:220.0.0.1    0     0     0
220.0.2.2        1 Full/DR      31.456s 220.0.1.2    eth1:220.0.1.1    0     0     0
ospfd> show ip ospf database network

OSPF Router with ID (220.0.1.1)

Net Link States (Area 3.3.3.3 [Stub])

LS age: 1251
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x3
LS Type: network-LSA
Link State ID: 130.0.0.2 (address of Designated Router)
Advertising Router: 220.0.2.2
LS Seq Number: 80000001
Checksum: 0x4ab6
Length: 32
Network Mask: /30
Attached Router: 130.0.0.1
Attached Router: 220.0.2.2

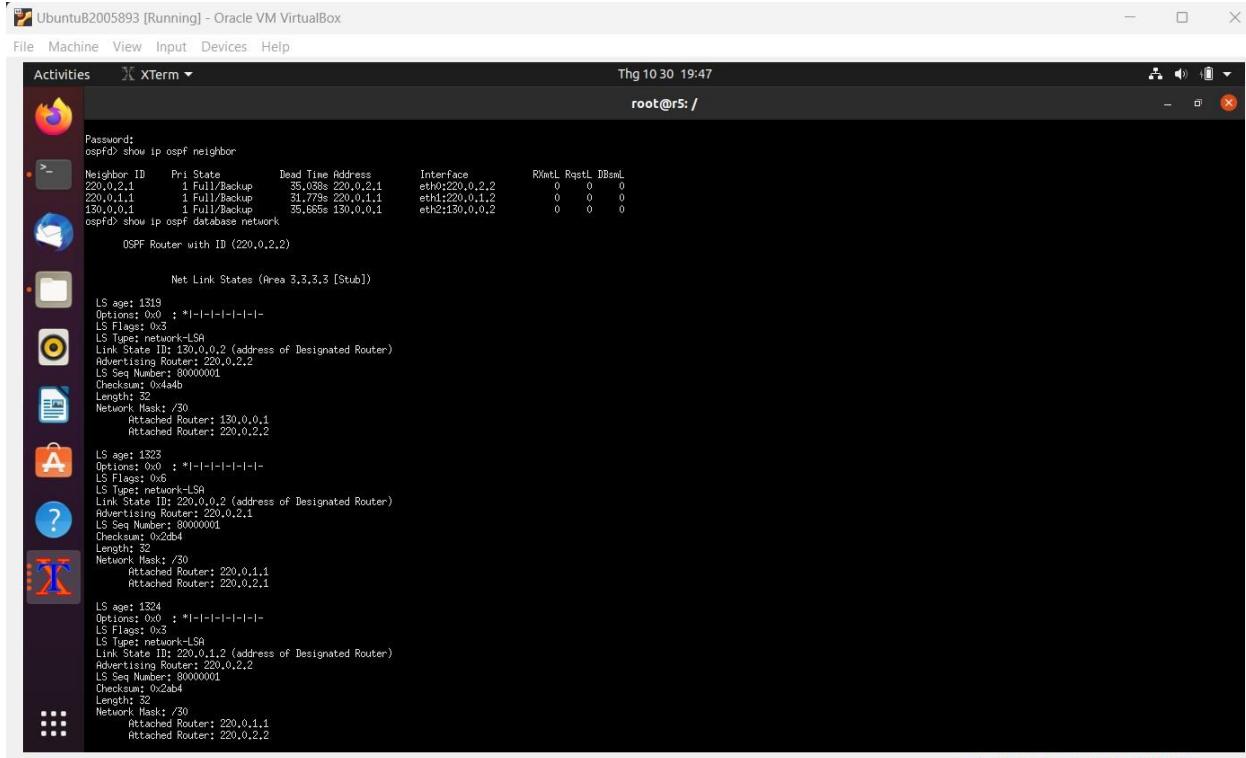
LS age: 1253
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 220.0.1.2 (address of Designated Router)
Advertising Router: 220.0.2.1
LS Seq Number: 80000001
Checksum: 0x2ab4
Length: 32
Network Mask: /30
Attached Router: 220.0.1.1
Attached Router: 220.0.2.1

LS age: 1256
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 220.0.1.2 (address of Designated Router)
Advertising Router: 220.0.2.2
LS Seq Number: 80000001
Checksum: 0x2ab4
Length: 32
Network Mask: /30
Attached Router: 220.0.1.1
Attached Router: 220.0.2.2

LS age: 1251
Options: 0x0 : *|-|-|-|-|-|-|

```

On r5:



```

Activities XTerm
Thg 10 30 19:47
root@r5: /root@r5: ~

Password:
ospfd> show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface RxMtu RstL DBsmL
220.0.2.1 1 Full/Backup 35.038s 220.0.2.1 eth0:220.0.2.2 0 0 0
220.0.1.1 1 Full/Backup 31.779s 220.0.1.1 eth1:220.0.1.2 0 0 0
120.0.1.1 1 Full/Backup 35.665s 120.0.0.1 eth2:120.0.0.2 0 0 0

ospfd> show ip ospf database network

OSPF Router with ID (220.0.2.2)

Net Link States (Area 3.3.3.3 [Stub])

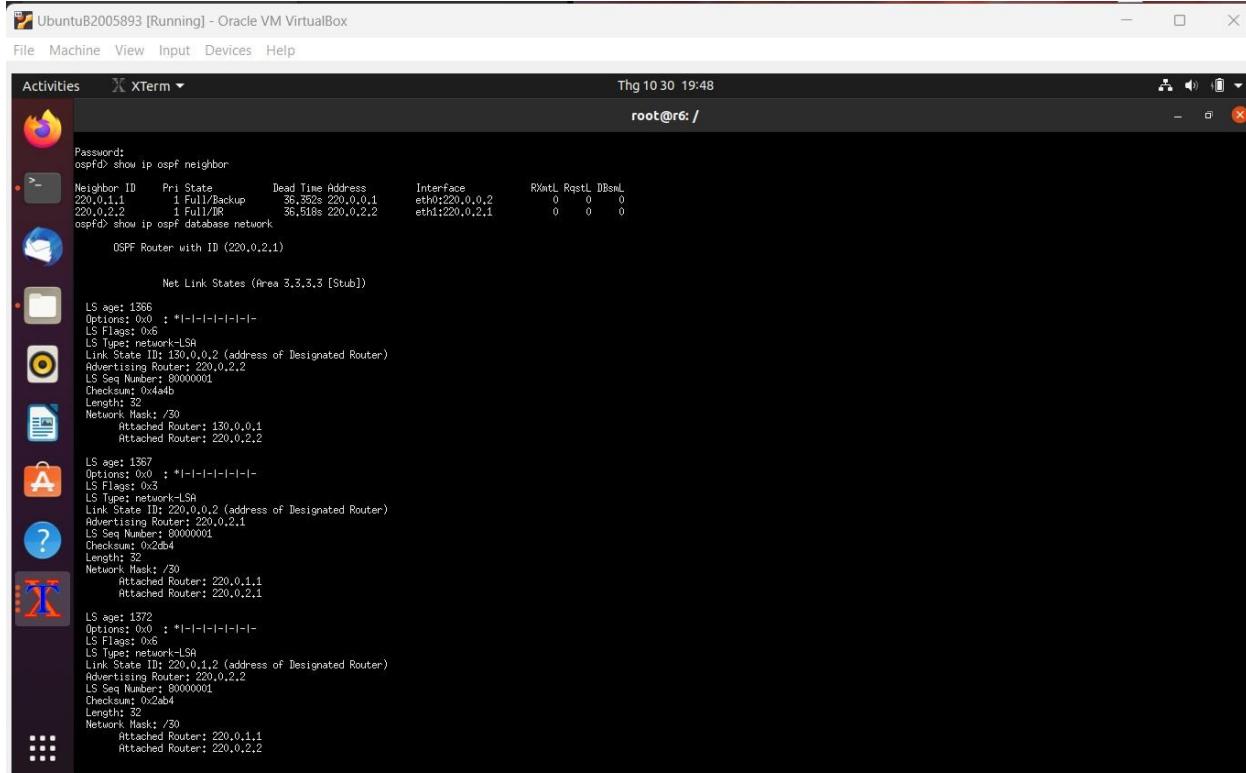
LS age: 1319
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x3
LS Type: network-LSA
Link State ID: 120.0.0.2 (address of Designated Router)
Advertising Router: 220.0.2.2
LS Seq Number: 80000001
Checksum: 0xae4b
Length: 32
Network Mask: /30
Attached Router: 120.0.0.1
Attached Router: 220.0.2.2

LS age: 1323
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x3
LS Type: network-LSA
Link State ID: 220.0.0.2 (address of Designated Router)
Advertising Router: 220.0.2.1
LS Seq Number: 80000001
Checksum: 0xbdb4
Length: 32
Network Mask: /30
Attached Router: 220.0.1.1
Attached Router: 220.0.2.1

LS age: 1324
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x3
LS Type: network-LSA
Link State ID: 220.0.1.2 (address of Designated Router)
Advertising Router: 220.0.2.2
LS Seq Number: 80000001
Checksum: 0x2ab4
Length: 32
Network Mask: /30
Attached Router: 220.0.1.1
Attached Router: 220.0.2.2

```

On r6:



```

Activities XTerm
Thg 10 30 19:48
root@r6: /root@r6: ~

Password:
ospfd> show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface RxMtu RstL DBsmL
220.0.1.1 1 Full/Backup 36.352s 220.0.0.1 eth0:220.0.0.2 0 0 0
220.0.2.2 1 Full/IR 36.518s 220.0.2.2 eth1:220.0.2.1 0 0 0

ospfd> show ip ospf database network

OSPF Router with ID (220.0.2.1)

Net Link States (Area 3.3.3.3 [Stub])

LS age: 1366
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 130.0.0.2 (address of Designated Router)
Advertising Router: 220.0.2.2
LS Seq Number: 80000001
Checksum: 0x4abb
Length: 32
Network Mask: /30
Attached Router: 130.0.0.1
Attached Router: 220.0.2.2

LS age: 1372
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 220.0.0.2 (address of Designated Router)
Advertising Router: 220.0.2.1
LS Seq Number: 80000001
Checksum: 0x2ab4
Length: 32
Network Mask: /30
Attached Router: 220.0.1.1
Attached Router: 220.0.2.2

LS age: 1372
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 220.0.1.2 (address of Designated Router)
Advertising Router: 220.0.2.2
LS Seq Number: 80000001
Checksum: 0x2ab4
Length: 32
Network Mask: /30
Attached Router: 220.0.1.1
Attached Router: 220.0.2.2

```

- b. *check what routers know about the outside of the area, using the show ip ospf database summary command*

```
# show ip ospf database
```

On r1:

```
ospfd> clear
% [OSPF] Unknown command: clear
ospfd> show ip ospf database summary
OSPF Router with ID (200.0.0.1)

Summary Link States (Area 1.1.1.1 [Stub])
LS age: 840
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 0.0.0.0 (summary Network Number)
Advertising Router: 110.0.0.1
LS Seq Number: 80000002
Checksum: 0x944
Length: 28
Network Mask: /0
TOS: 0 Metric: 1

LS age: 1515
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 10.0.0.0 (summary Network Number)
Advertising Router: 110.0.0.1
LS Seq Number: 80000003
Checksum: 0x87d
Length: 28
Network Mask: /24
TOS: 0 Metric: 30

LS age: 1515
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 10.0.1.0 (summary Network Number)
Advertising Router: 110.0.0.1
LS Seq Number: 80000002
Checksum: 0x8f8
Length: 28
Network Mask: /24
TOS: 0 Metric: 30

LS age: 1515
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 10.0.1.0 (summary Network Number)
Advertising Router: 110.0.0.1
LS Seq Number: 80000003
Checksum: 0xcdf
Length: 28
```

On r2:

```
ospfd> show ip ospf database summary
OSPF Router with ID (200.0.1.1)

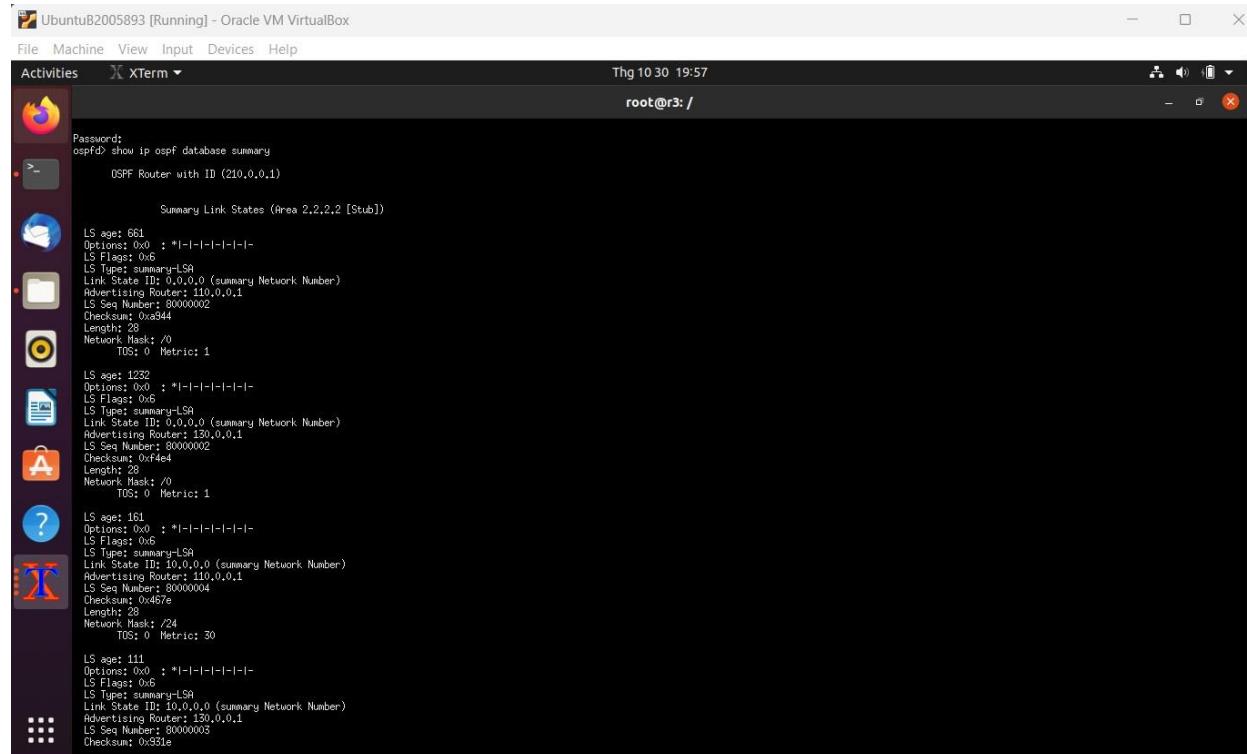
Summary Link States (Area 1.1.1.1 [Stub])
LS age: 83
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 0.0.0.0 (summary Network Number)
Advertising Router: 110.0.0.1
LS Seq Number: 90000001
Checksum: 0xa43
Length: 28
Network Mask: /0
TOS: 0 Metric: 1

LS age: 33
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 10.0.0.0 (summary Network Number)
Advertising Router: 110.0.0.1
LS Seq Number: 80000003
Checksum: 0x45d
Length: 28
Network Mask: /24
TOS: 0 Metric: 30

LS age: 33
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 10.0.1.0 (summary Network Number)
Advertising Router: 110.0.0.1
LS Seq Number: 80000002
Checksum: 0x3f8
Length: 28
Network Mask: /24
TOS: 0 Metric: 30

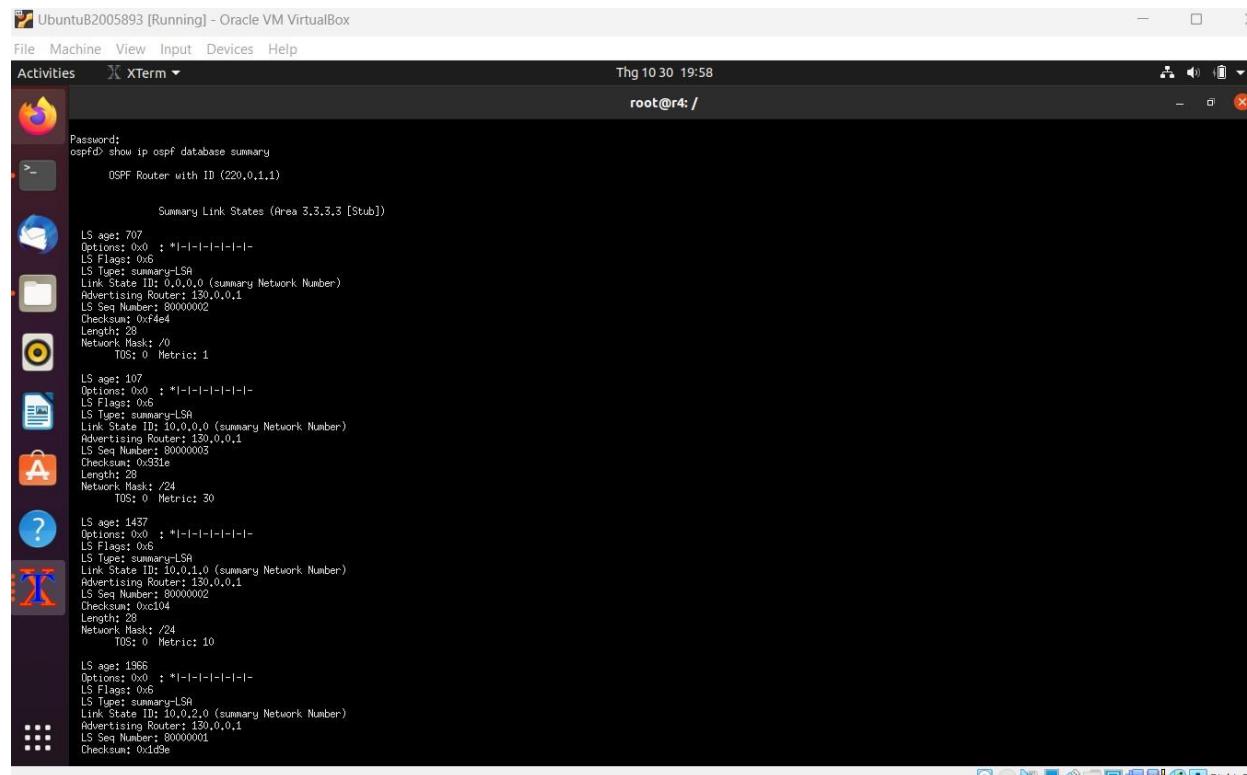
LS age: 33
Options: 0x0 : *|-|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 10.0.1.0 (summary Network Number)
Advertising Router: 110.0.0.1
LS Seq Number: 80000003
Checksum: 0xcfe
Length: 28
```

On r3:



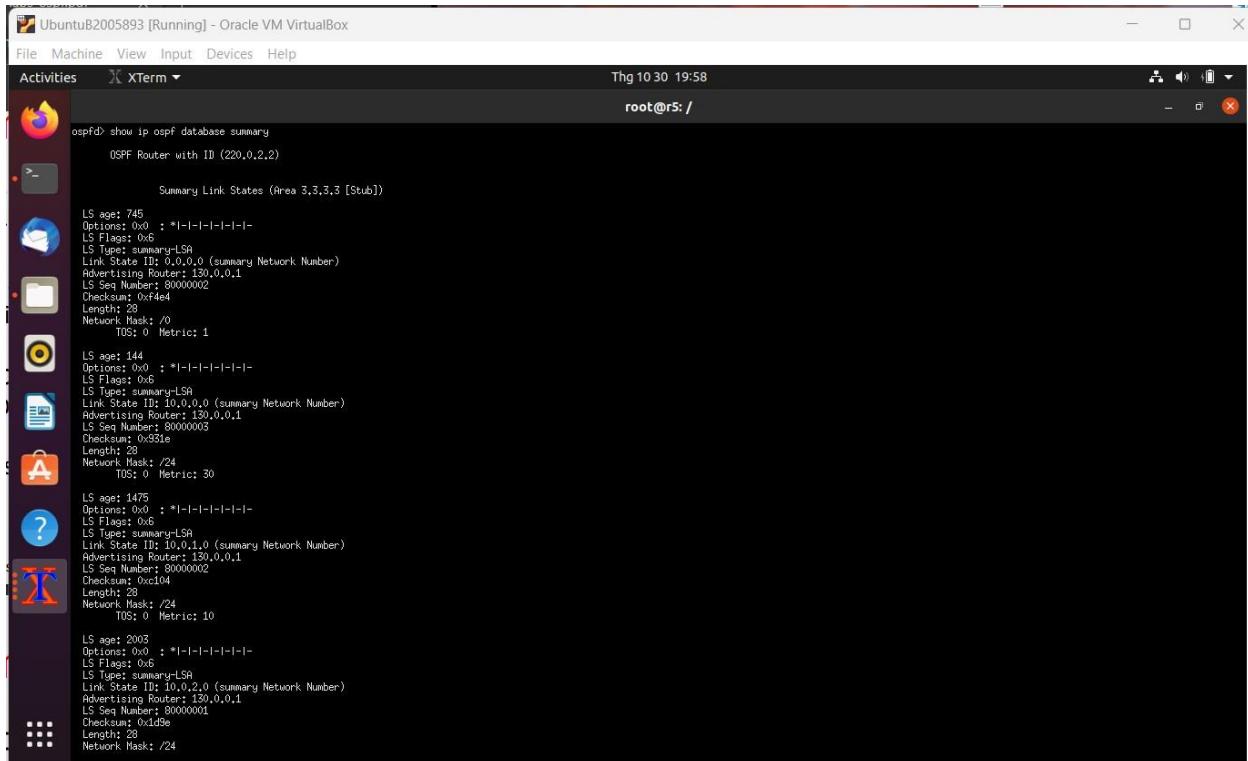
```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities X XTerm Thg 10 30 19:57
root@r3: /  
Password:  
ospfd> show ip ospf database summary  
OSPF Router with ID (210.0.0.1)  
  
Summary Link States (Area 2.2.2.2 [Stub])  
  
LS age: 661  
Options: 0x0 : *|-|-|-|-|-|-|  
LS Flags: 0x6  
LS Type: summary-LSA  
Link State ID: 0.0.0.0 (summary Network Number)  
Advertising Router: 110.0.0.1  
LS Seq Number: 80000002  
Checksum: 0xa944  
Length: 28  
Network Mask: /0  
TOS: 0 Metric: 1  
  
LS age: 1232  
Options: 0x0 : *|-|-|-|-|-|-|  
LS Flags: 0x6  
LS Type: summary-LSA  
Link State ID: 0.0.0.0 (summary Network Number)  
Advertising Router: 130.0.0.1  
LS Seq Number: 80000002  
Checksum: 0xfed4  
Length: 28  
Network Mask: /0  
TOS: 0 Metric: 1  
  
LS age: 161  
Options: 0x0 : *|-|-|-|-|-|-|  
LS Flags: 0x6  
LS Type: summary-LSA  
Link State ID: 10.0.0.0 (summary Network Number)  
Advertising Router: 110.0.0.1  
LS Seq Number: 80000004  
Checksum: 0x457e  
Length: 28  
Network Mask: /24  
TOS: 0 Metric: 30  
  
LS age: 111  
Options: 0x0 : *|-|-|-|-|-|-|  
LS Flags: 0x6  
LS Type: summary-LSA  
Link State ID: 10.0.0.0 (summary Network Number)  
Advertising Router: 130.0.0.1  
LS Seq Number: 80000003  
Checksum: 0x951e
```

On r4:



```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities X XTerm Thg 10 30 19:58
root@r4: /  
Password:  
ospfd> show ip ospf database summary  
OSPF Router with ID (220.0.1.1)  
  
Summary Link States (Area 3.3.3.3 [Stub])  
  
LS age: 707  
Options: 0x0 : *|-|-|-|-|-|-|  
LS Flags: 0x6  
LS Type: summary-LSA  
Link State ID: 0.0.0.0 (summary Network Number)  
Advertising Router: 130.0.0.1  
LS Seq Number: 80000002  
Checksum: 0xfed4  
Length: 28  
Network Mask: /0  
TOS: 0 Metric: 1  
  
LS age: 107  
Options: 0x0 : *|-|-|-|-|-|-|  
LS Flags: 0x6  
LS Type: summary-LSA  
Link State ID: 10.0.0.0 (summary Network Number)  
Advertising Router: 130.0.0.1  
LS Seq Number: 80000003  
Checksum: 0x931e  
Length: 28  
Network Mask: /24  
TOS: 0 Metric: 30  
  
LS age: 1437  
Options: 0x0 : *|-|-|-|-|-|-|  
LS Flags: 0x6  
LS Type: summary-LSA  
Link State ID: 10.0.1.0 (summary Network Number)  
Advertising Router: 130.0.0.1  
LS Seq Number: 80000002  
Checksum: 0x1c04  
Length: 28  
Network Mask: /24  
TOS: 0 Metric: 10  
  
LS age: 1965  
Options: 0x0 : *|-|-|-|-|-|-|  
LS Flags: 0x6  
LS Type: summary-LSA  
Link State ID: 10.0.2.0 (summary Network Number)  
Advertising Router: 130.0.0.1  
LS Seq Number: 80000001  
Checksum: 0x1d9e
```

On r5:



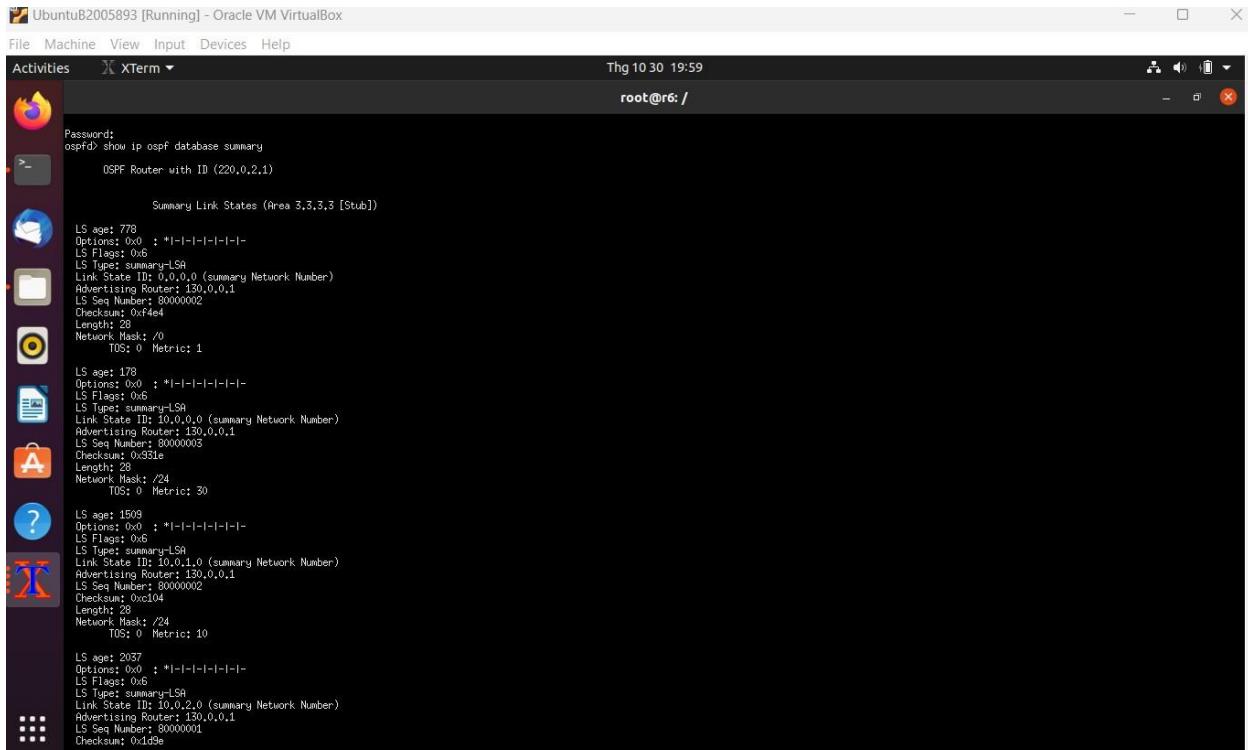
```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities X Term Thg 10 30 19:58
root@r5:/
ospf6d> show ip ospf database summary
OSPF Router with ID (220.0.2.2)
Summary Link States (Area 3.3.3.3 [Stub])
LS age: 745
Options: 0x0 : *|-|-|-|-|-|
LS Flags: 0x0
LS Type: summary-LSA
Link State ID: 0.0.0.0 (summary Network Number)
Advertising Router: 130.0.0.1
LS Seq Number: 90000002
Checksum: 0x4e4
Length: 28
Network Mask: /0
TOS: 0 Metric: 1

LS age: 144
Options: 0x0 : *|-|-|-|-|-|
LS Flags: 0x0
LS Type: summary-LSA
Link State ID: 10.0.0.0 (summary Network Number)
Advertising Router: 130.0.0.1
LS Seq Number: 80000003
Checksum: 0x93le
Length: 28
Network Mask: /24
TOS: 0 Metric: 30

LS age: 1475
Options: 0x0 : *|-|-|-|-|-|
LS Flags: 0x0
LS Type: summary-LSA
Link State ID: 10.0.1.0 (summary Network Number)
Advertising Router: 130.0.0.1
LS Seq Number: 80000002
Checksum: 0x104
Length: 28
Network Mask: /24
TOS: 0 Metric: 10

LS age: 2003
Options: 0x0 : *|-|-|-|-|-|
LS Flags: 0x0
LS Type: summary-LSA
Link State ID: 10.0.2.0 (summary Network Number)
Advertising Router: 130.0.0.1
LS Seq Number: 80000001
Checksum: 0xd9e
Length: 28
Network Mask: /24
TOS: 0 Metric: 10
```

On r6:



```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities X Term Thg 10 30 19:59
root@r6:/
Password:
ospf6d> show ip ospf database summary
OSPF Router with ID (220.0.2.1)
Summary Link States (Area 3.3.3.3 [Stub])
LS age: 770
Options: 0x0 : *|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 0.0.0.0 (summary Network Number)
Advertising Router: 130.0.0.1
LS Seq Number: 80000002
Checksum: 0xf4e4
Length: 28
Network Mask: /0
TOS: 0 Metric: 1

LS age: 178
Options: 0x0 : *|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 10.0.0.0 (summary Network Number)
Advertising Router: 130.0.0.1
LS Seq Number: 80000003
Checksum: 0x93le
Length: 28
Network Mask: /24
TOS: 0 Metric: 30

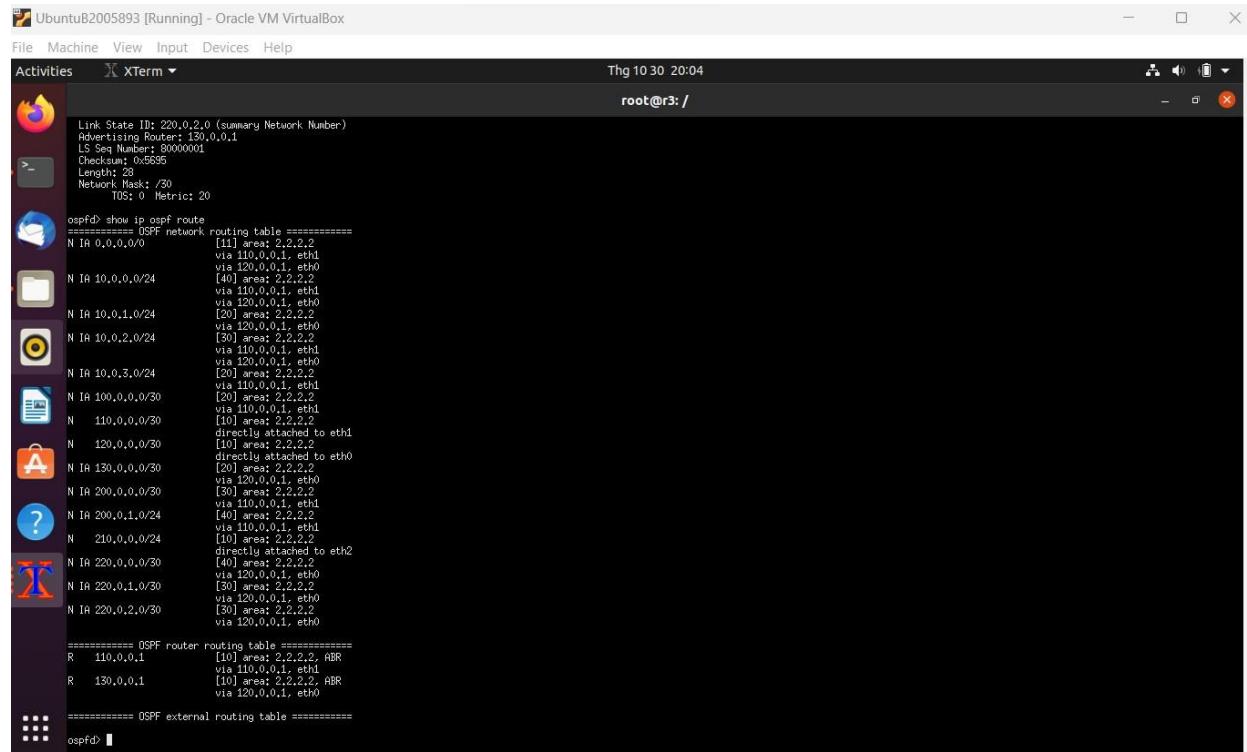
LS age: 1509
Options: 0x0 : *|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 10.0.1.0 (summary Network Number)
Advertising Router: 130.0.0.1
LS Seq Number: 80000002
Checksum: 0xc104
Length: 28
Network Mask: /24
TOS: 0 Metric: 10

LS age: 2037
Options: 0x0 : *|-|-|-|-|-|
LS Flags: 0x6
LS Type: summary-LSA
Link State ID: 10.0.2.0 (summary Network Number)
Advertising Router: 130.0.0.1
LS Seq Number: 80000001
Checksum: 0xd9e
```

c. experiment ospf's recovery capabilities

show ip ospf route

On r3



```
Link State ID: 220.0.2.0 (summary Network Number)
Advertising Router: 130.0.0.1
LS Sequence: 80000001
Checksum: 0x3635
Length: 28
Network Mask: /30
TOS: 0 Metric: 20

ospfd> show ip ospf route
=====
OSPF network routing table =====
N 0.0.0.0/0      [11] area: 2.2.2.2
                           via 120.0.0.1, eth0
N 10.0.0.0/24    [40] area: 2.2.2.2
                           via 110.0.0.1, eth1
                           via 120.0.0.1, eth0
N 10.0.1.0/24    [20] area: 2.2.2.2
                           via 120.0.0.1, eth0
N 10.0.2.0/24    [30] area: 2.2.2.2
                           via 110.0.0.1, eth1
                           via 120.0.0.1, eth0
N 10.0.3.0/24    [20] area: 2.2.2.2
                           via 110.0.0.1, eth1
N 100.0.0.0/30   [20] area: 2.2.2.2
                           via 110.0.0.1, eth1
N 110.0.0.0/30   [10] area: 2.2.2.2
                           directly attached to eth1
N 120.0.0.0/30   [10] area: 2.2.2.2
                           directly attached to eth0
N 130.0.0.0/30   [20] area: 2.2.2.2
                           via 120.0.0.1, eth0
N 200.0.0.0/30   [30] area: 2.2.2.2
                           via 110.0.0.1, eth1
N 200.0.1.0/24   [40] area: 2.2.2.2
                           via 120.0.0.1, eth0
N 210.0.0.0/24   [10] area: 2.2.2.2
                           directly attached to eth2
N 220.0.0.0/30   [40] area: 2.2.2.2
                           via 120.0.0.1, eth0
N 220.0.1.0/30   [30] area: 2.2.2.2
                           via 120.0.0.1, eth0
N 220.0.2.0/30   [30] area: 2.2.2.2
                           via 120.0.0.1, eth0

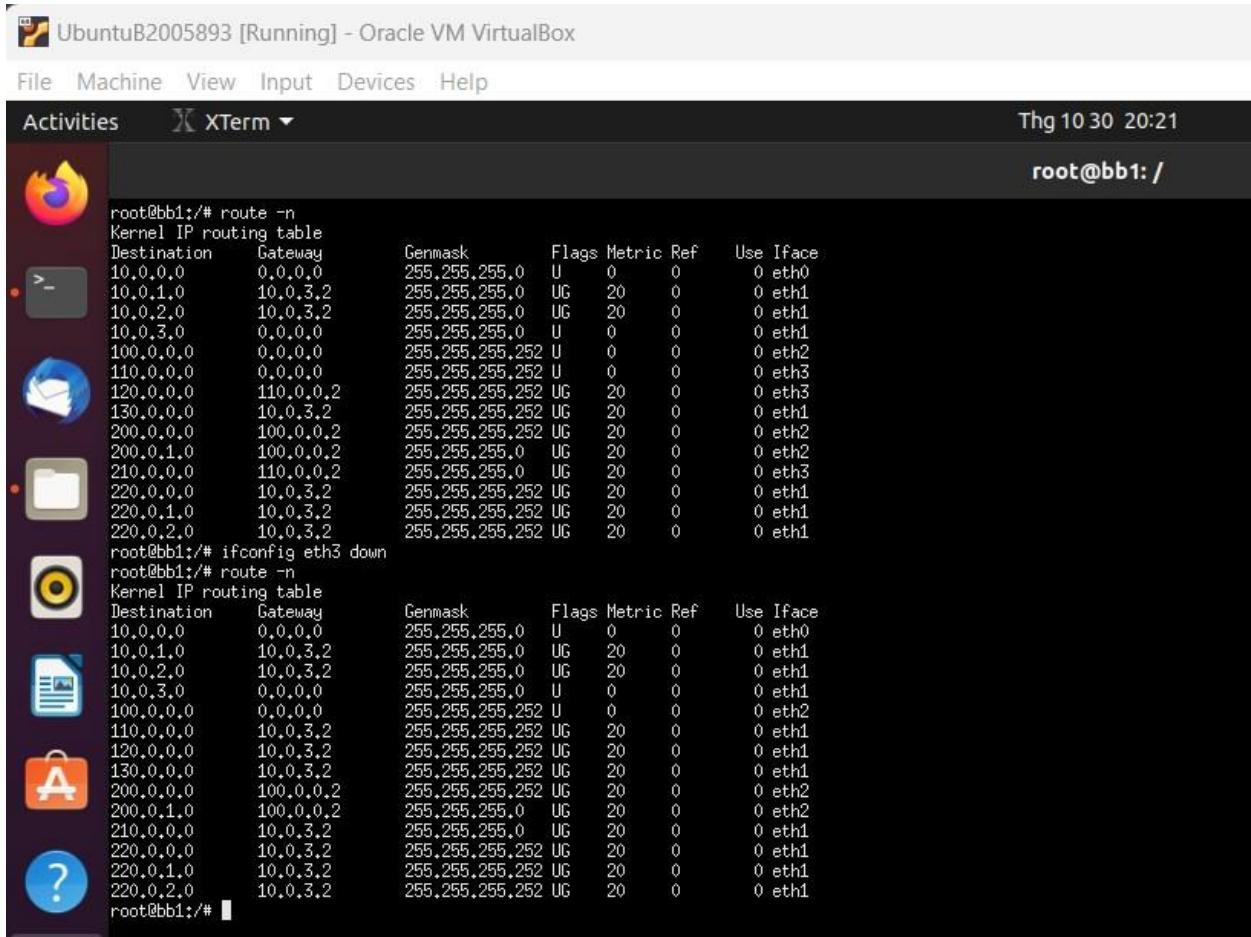
=====
OSPF router routing table =====
R  110.0.0.1      [10] area: 2.2.2.2, ABR
                           via 110.0.0.1, eth1
R  130.0.0.1      [10] area: 2.2.2.2, ABR
                           via 120.0.0.1, eth0

=====
OSPF external routing table =====
ospfd>
```

4. Bring bb1's eth3 down using ifconfig, wait a few seconds and check how the routing is changed

```
# route -n
```

```
# ifconfig eth3 down
```



The screenshot shows a terminal window titled "XTerm" running on an Ubuntu system. The window title bar includes "UbuntuB2005893 [Running] - Oracle VM VirtualBox". The terminal shows the following command history:

```
root@bb1:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref    Use Iface
10.0.0.0        0.0.0.0        255.255.255.0 U   0      0      0 eth0
10.0.1.0        10.0.3.2       255.255.255.0 UG  20     0      0 eth1
10.0.2.0        10.0.3.2       255.255.255.0 UG  20     0      0 eth1
10.0.3.0        0.0.0.0        255.255.255.0 U   0      0      0 eth1
100.0.0.0       0.0.0.0        255.255.255.252 U  0      0      0 eth2
110.0.0.0       0.0.0.0        255.255.255.252 U  0      0      0 eth3
120.0.0.0       110.0.0.2      255.255.255.252 UG  20     0      0 eth3
130.0.0.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
200.0.0.0       100.0.0.2      255.255.255.252 UG  20     0      0 eth2
200.0.1.0       100.0.0.2      255.255.255.0   UG  20     0      0 eth2
210.0.0.0       110.0.0.2      255.255.255.0   UG  20     0      0 eth3
220.0.0.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
220.0.1.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
220.0.2.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
root@bb1:/# ifconfig eth3 down
root@bb1:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref    Use Iface
10.0.0.0        0.0.0.0        255.255.255.0 U   0      0      0 eth0
10.0.1.0        10.0.3.2       255.255.255.0 UG  20     0      0 eth1
10.0.2.0        10.0.3.2       255.255.255.0 UG  20     0      0 eth1
10.0.3.0        0.0.0.0        255.255.255.0 U   0      0      0 eth1
100.0.0.0       0.0.0.0        255.255.255.252 U  0      0      0 eth2
110.0.0.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
120.0.0.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
130.0.0.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
200.0.0.0       100.0.0.2      255.255.255.252 UG  20     0      0 eth2
200.0.1.0       100.0.0.2      255.255.255.0   UG  20     0      0 eth2
210.0.0.0       10.0.3.2       255.255.255.0   UG  20     0      0 eth1
220.0.0.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
220.0.1.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
220.0.2.0       10.0.3.2       255.255.255.252 UG  20     0      0 eth1
root@bb1:/#
```

- We can see that after bring interface 3 down, it completely gone on the routing table

5. Bring bb1's eth3 back up and check again how the routing is changed

```
# ifconfig eth3 up
# route -n
```

```
root@bb1:/# ifconfig eth3 up
root@bb1:/# route -n
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref    Use Iface
10.0.0.0        0.0.0.0    255.255.255.0 U     0      0        0 eth0
10.0.1.0        10.0.3.2   255.255.255.0 UG    20     0        0 eth1
10.0.2.0        10.0.3.2   255.255.255.0 UG    20     0        0 eth1
10.0.3.0        0.0.0.0    255.255.255.0 U     0      0        0 eth1
100.0.0.0       0.0.0.0    255.255.255.252 U    0      0        0 eth2
110.0.0.0       0.0.0.0    255.255.255.252 U    0      0        0 eth3
120.0.0.0       110.0.0.2   255.255.255.252 UG   20     0        0 eth3
130.0.0.0       10.0.3.2   255.255.255.252 UG   20     0        0 eth1
200.0.0.0       100.0.0.2   255.255.255.252 UG   20     0        0 eth2
200.0.1.0       100.0.0.2   255.255.255.0 UG   20     0        0 eth2
210.0.0.0       110.0.0.2   255.255.255.0 UG   20     0        0 eth3
220.0.0.0       10.0.3.2   255.255.255.252 UG   20     0        0 eth1
220.0.1.0       10.0.3.2   255.255.255.252 UG   20     0        0 eth1
220.0.2.0       10.0.3.2   255.255.255.252 UG   20     0        0 eth1
root@bb1:/#
```

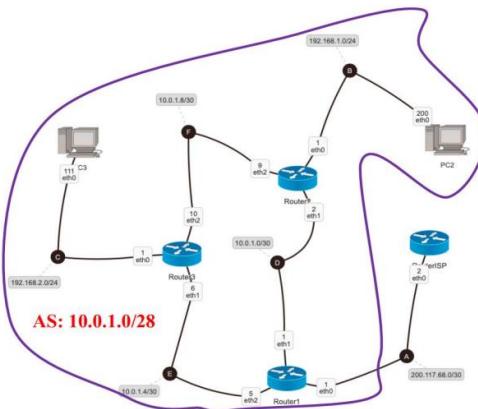
→ Interface 3 is now online again

6. Delete VMs

```
$ kathara lclean
```

```
thienng@thienng-VirtualBox:~/LAB3/EX15$ kathara lrestart
INFO - ===== Stopping Network Scenario =====
INFO - Deleting devices...|#####
INFO - Deleting collision domains...|#####
INFO - ===== Starting Network Scenario =====
INFO - Deploying collision domains...|#####
INFO - Deploying devices...|#####
thienng@thienng-VirtualBox:~/LAB3/EX15$ kathara lclean
INFO - ===== Stopping Network Scenario =====
INFO - Deleting devices...|#####
INFO - Deleting collision domains...|#####
thienng@thienng-VirtualBox:~/LAB3/EX15$
```

Exercise 16: Construct the following network using the RIPv2 protocol. We note that the RouterISP won't run the RIPv2 protocol



1. Files and folders

\$ tree

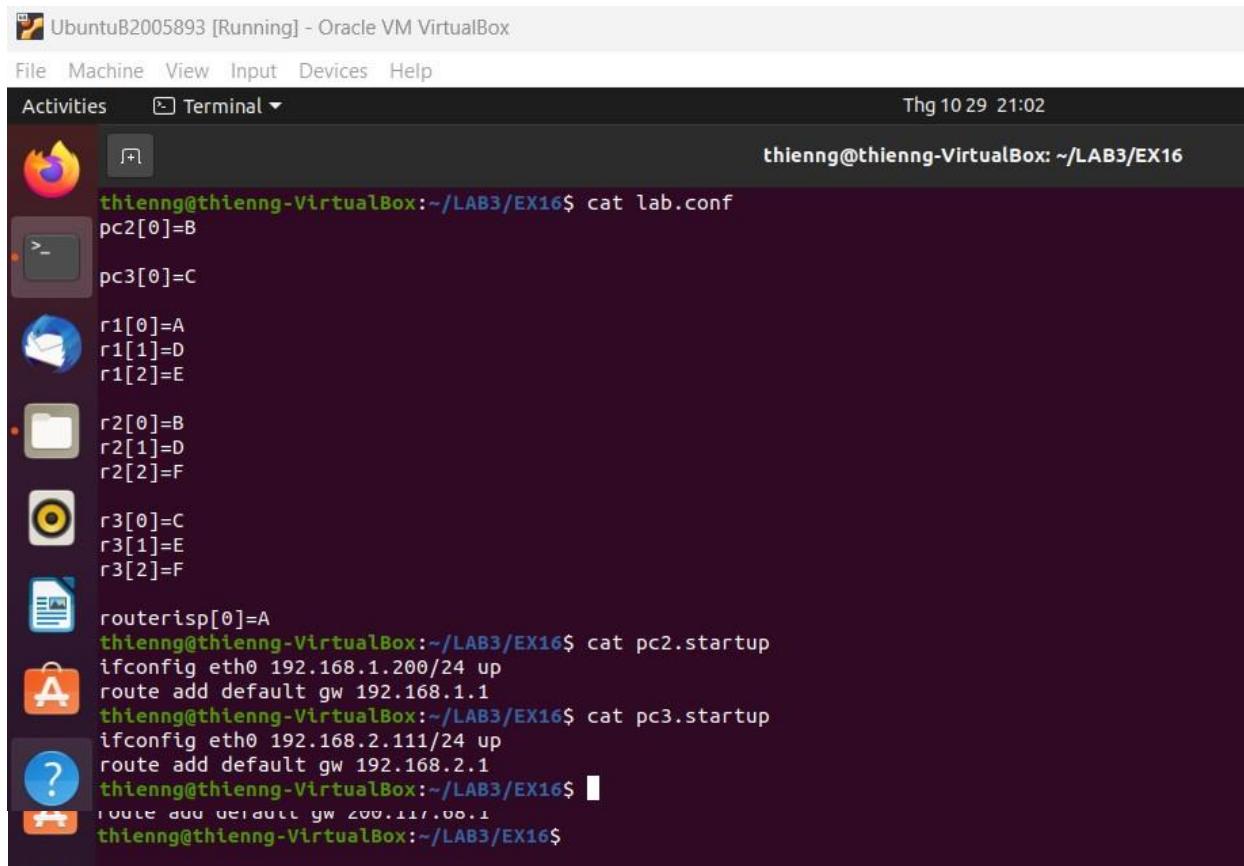
```

UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal ▾ Thg 10 29 21:01
thienng@thienng-VirtualBox: ~/LAB3/EX16$ tree
.
├── lab.conf
├── pc2
├── pc2.startup
├── pc3
├── pc3.startup
├── r1
│   └── etc
│       └── quagga
│           ├── daemons
│           │   └── ripd.conf
│           └── zebra.conf
├── r1.startup
├── r2
│   └── etc
│       └── quagga
│           ├── daemons
│           │   └── ripd.conf
│           └── zebra.conf
├── r2.startup
├── r3
│   └── etc
│       └── quagga
│           ├── daemons
│           │   └── ripd.conf
│           └── zebra.conf
└── r3.startup
    └── routerISP
        └── routerisp.startup
    └── shared

13 directories, 16 files
thienng@thienng-VirtualBox: ~/LAB3/EX16$ 
```

2. Lab configurations

```
$ cat lab.conf  
$ cat pc2.startup  
$ cat pc3.startup  
$ cat r1.startup  
$ cat r2.startup  
$ cat r3.startup  
$ cat routerisp.startup  
  
$ cat r1/etc/quagga/daemons  
$ cat r1/etc/quagga/ripd.conf  
$ cat r1/etc/quagga/zebra.conf  
  
$ cat r2/etc/quagga/daemons  
$ cat r2/etc/quagga/ripd.conf  
$ cat r2/etc/quagga/zebra.conf  
  
$ cat r3/etc/quagga/daemons  
$ cat r3/etc/quagga/ripd.conf  
$ cat r3/etc/quagga/zebra.conf
```



The screenshot shows a Linux desktop environment with a dark theme. A terminal window is open, displaying the command-line interface of a virtual machine named "UbuntuB2005893 [Running] - Oracle VM VirtualBox". The terminal window title bar says "UbuntuB2005893 [Running] - Oracle VM VirtualBox". The desktop background is light grey. On the left, there's a dock with icons for a browser, file manager, terminal, and system settings. The terminal window has a dark background and white text. It shows the user "thienng" at the prompt "thienng@thienng-VirtualBox: ~/LAB3/EX16\$". The user runs several commands to display configuration files:

```
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat lab.conf  
pc2[0]=B  
pc3[0]=C  
  
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat pc2.startup  
ifconfig eth0 192.168.1.200/24 up  
route add default gw 192.168.1.1  
  
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat pc3.startup  
ifconfig eth0 192.168.2.111/24 up  
route add default gw 192.168.2.1  
  
thienng@thienng-VirtualBox:~/LAB3/EX16$
```

The image shows two terminal windows running on a Linux desktop within an Oracle VM VirtualBox environment. The desktop interface includes a top bar with icons for File, Machine, View, Input, Devices, Help, Activities, and Terminal. The desktop background is dark.

Terminal Window 1 (Top):

```
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r1.startup
ifconfig eth0 200.117.68.1/30 up
ifconfig eth1 10.0.1.1/30 up
ifconfig eth2 10.0.1.5/30 up

/etc/init.d/quagga start
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r2.startup
ifconfig eth0 192.168.1.1/24 up
ifconfig eth1 10.0.1.2/30 up
ifconfig eth2 10.0.1.9/30 up

/etc/init.d/quagga start
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r3.startup
ifconfig eth0 192.168.2.1/24 up
ifconfig eth1 10.0.1.6/30 up
ifconfig eth2 10.0.1.10/30 up

/etc/init.d/quagga start
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat routerisp.startup
ifconfig eth0 200.117.68.2/30 up
route add default gw 200.117.68.1
thienng@thienng-VirtualBox:~/LAB3/EX16$
```

Terminal Window 2 (Bottom):

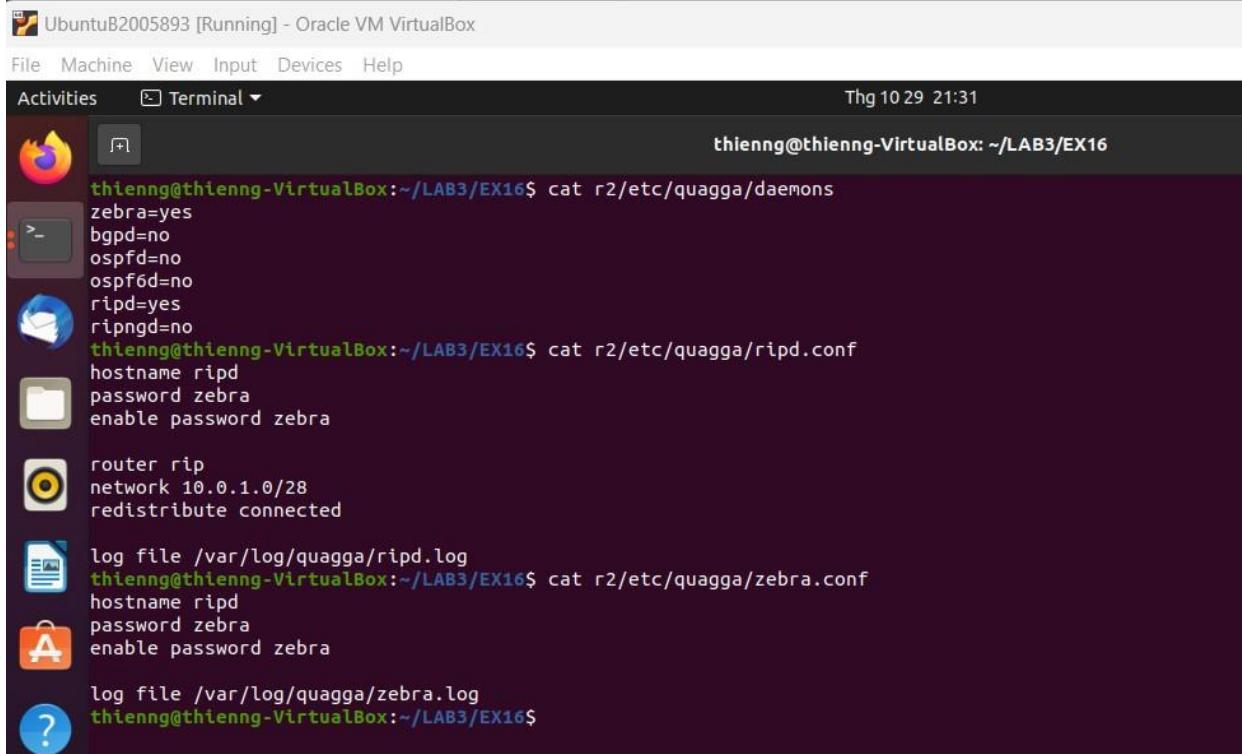
```
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r1/etc/quagga/daemons
zebra=yes
ripd=yes

bgpd=no
ospfd=no
ospf6d=no
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r1/etc/quagga/ripd.conf
hostname ripd
password zebra
enable password zebra

router rip
network 10.0.1.0/28
redistribute connected

log file /var/log/quagga/ripd.log
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r1/etc/quagga/zebra.conf
hostname zebra
password zebra
enable password zebra

log file /var/log/quagga/zebra.log
thienng@thienng-VirtualBox:~/LAB3/EX16$
```



UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

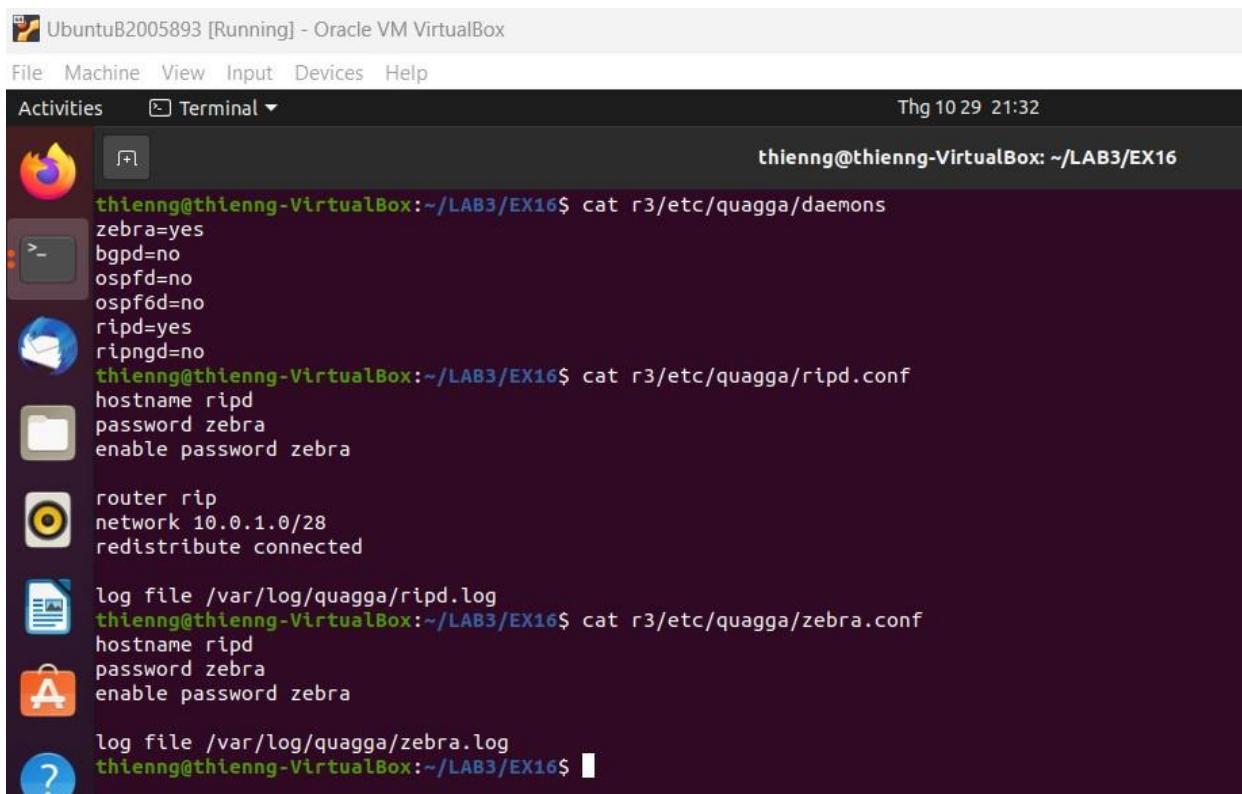
Activities Terminal Thg 10 29 21:31

```
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r2/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r2/etc/quagga/ripd.conf
hostname ripd
password zebra
enable password zebra

router rip
network 10.0.1.0/28
redistribute connected

log file /var/log/quagga/ripd.log
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r2/etc/quagga/zebra.conf
hostname ripd
password zebra
enable password zebra

log file /var/log/quagga/zebra.log
thienng@thienng-VirtualBox:~/LAB3/EX16$
```



UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal Thg 10 29 21:32

```
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r3/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r3/etc/quagga/ripd.conf
hostname ripd
password zebra
enable password zebra

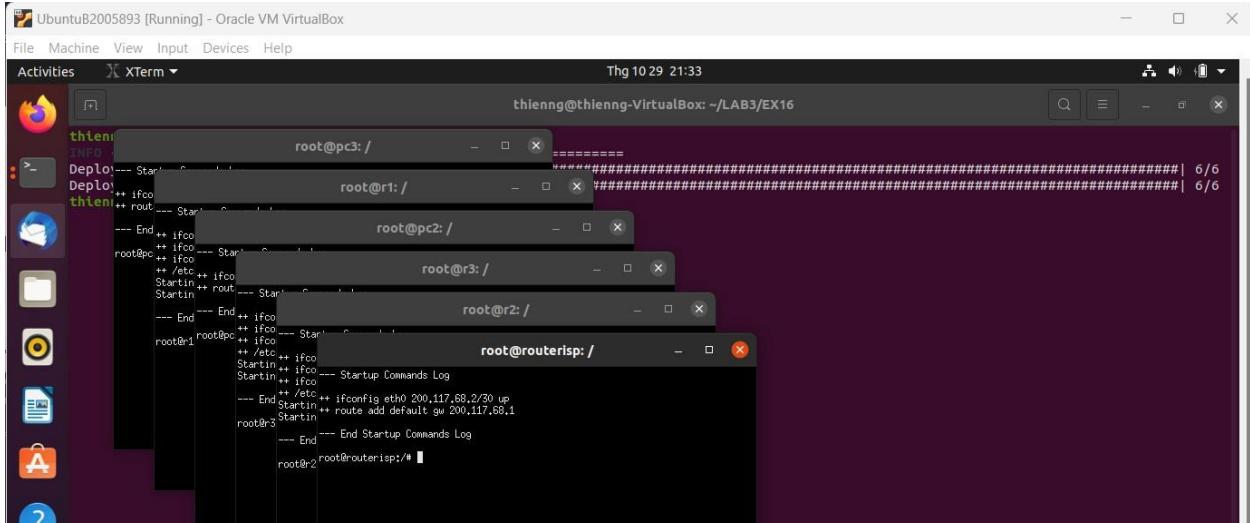
router rip
network 10.0.1.0/28
redistribute connected

log file /var/log/quagga/ripd.log
thienng@thienng-VirtualBox:~/LAB3/EX16$ cat r3/etc/quagga/zebra.conf
hostname ripd
password zebra
enable password zebra

log file /var/log/quagga/zebra.log
thienng@thienng-VirtualBox:~/LAB3/EX16$
```

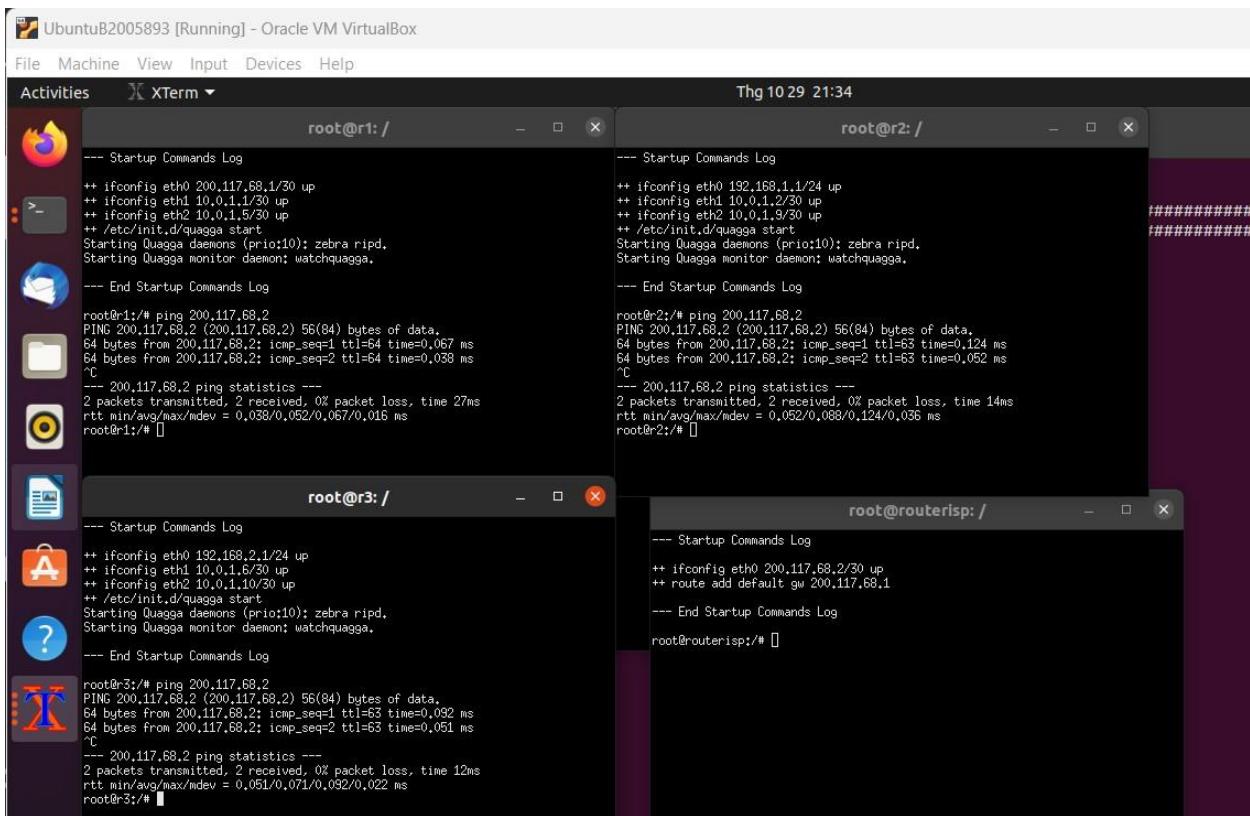
3. Start Kathara

```
$ kathara lstart
```



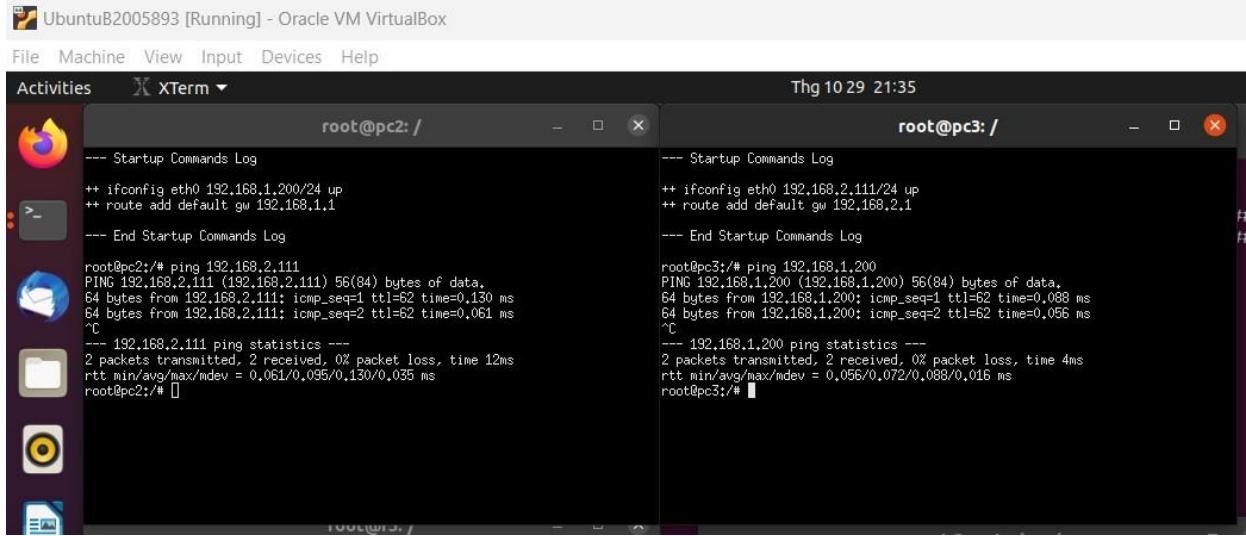
4. Ping from other routers to router isp

```
# ping 200.117.68.2
```



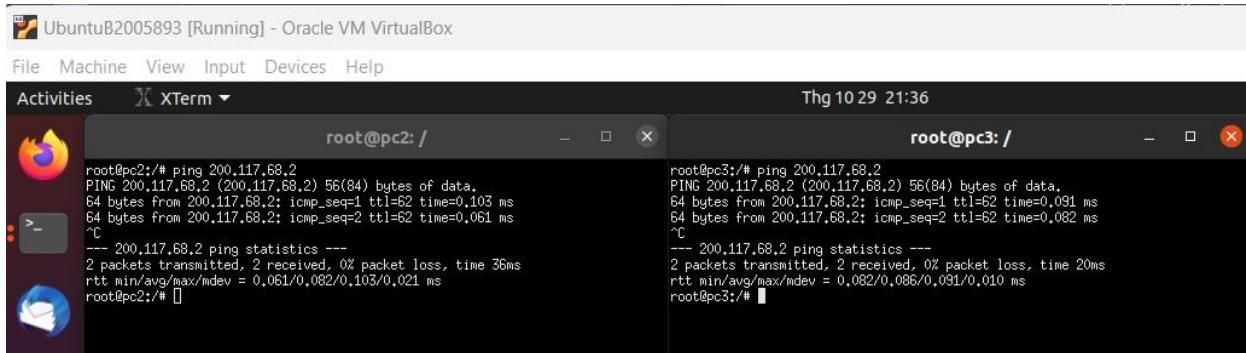
5. Ping from pc to each other

```
# ping 192.168.2.111  
# ping 192.168.1.200
```



6. Ping pc to routerisp

```
# ping 200.117.68.2
```



7. Delete VMs

```
$ kathara lclean
```

