

LAB 3
CONSTRUCT A SIMPLE NETWORK



Name: **Đặng Nhật Tường**

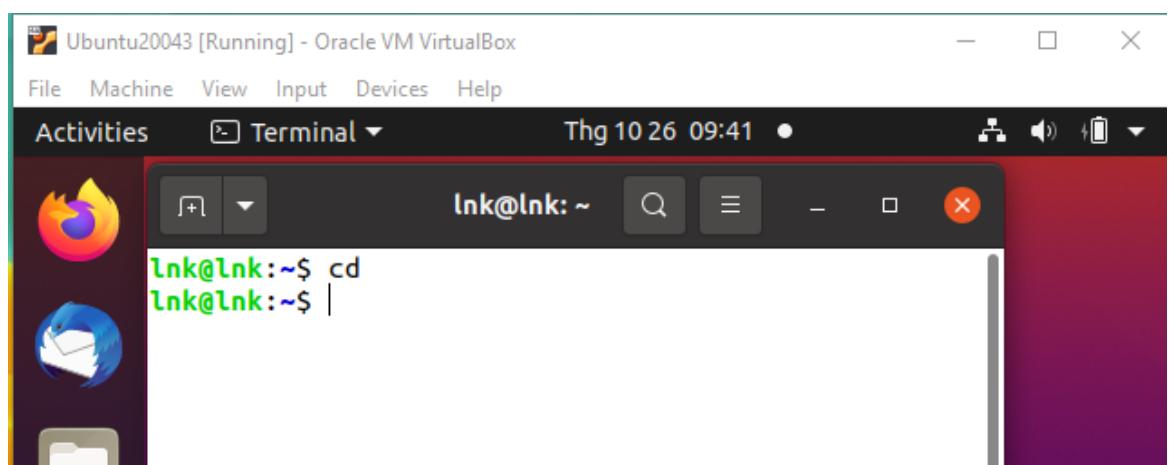
ID: **B2206021**

Group: **M02**

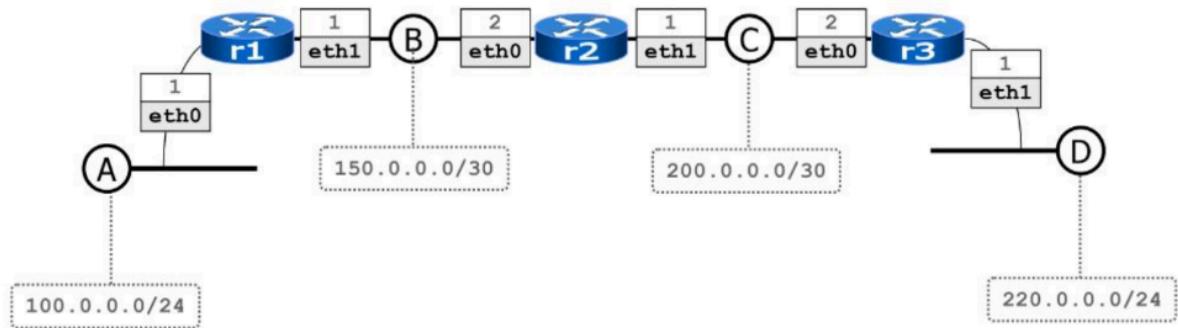
*Submission: an **ID_NAME_Lab03.pdf** file describes clearly how did you solve the problem*

Exercise 0: change the directory to your home directory

Answer: \$cd



Exercise 12: Construct a simple topology



Answer:

Create exercises12 directory

```
$ mkdir -p ~/CT106H/lab3/exercises12
```

```
$ cd ~/CT106H/lab3/exercises12
```

```
TuongB2206021 [Running] - Oracle VM VirtualBox
Activities Terminal
b2206021@TuongB2206021: ~/CT106H/lab3/exercises12
b2206021@TuongB2206021:~$ mkdir -p ~/CT106H/lab3/exercises12
b2206021@TuongB2206021:~$ cd ~/CT106H/lab3/exercises12
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$
```

Prepare the lab

```
$ mkdir -p r1/etc/quagga r2/etc/quagga r3/etc/quagga shared
$ gedit lab.conf
$ gedit LICENSE
$ gedit r1.startup
$ gedit r2.startup
$ gedit r3.startup
$ gedit r1/etc/quagga/daemons
$ gedit r1/etc/quagga/ripd.conf
$ gedit r1/etc/quagga/zebra.conf
$ gedit r2/etc/quagga/daemons
$ gedit r2/etc/quagga/ripd.conf
$ gedit r2/etc/quagga/zebra.conf
$ gedit r3/etc/quagga/daemons
$ gedit r3/etc/quagga/ripd.conf
$ gedit r3/etc/quagga/zebra.conf
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises12$ tree
.
├── lab.conf
├── LICENSE
└── r1
    ├── etc
    │   └── quagga
    │       ├── daemons
    │       └── ripd.conf
    ├── r1.startup
    └── r2
        └── etc
            └── quagga
                ├── daemons
                └── ripd.conf
    └── r2.startup
    └── r3
        └── etc
            └── quagga
                ├── daemons
                └── ripd.conf
    └── r3.startup
    └── shared
10 directories, 14 files
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises12$ cat lab.conf
r1[0]=A
r1[1]=B

r2[0]=B
r2[1]=C

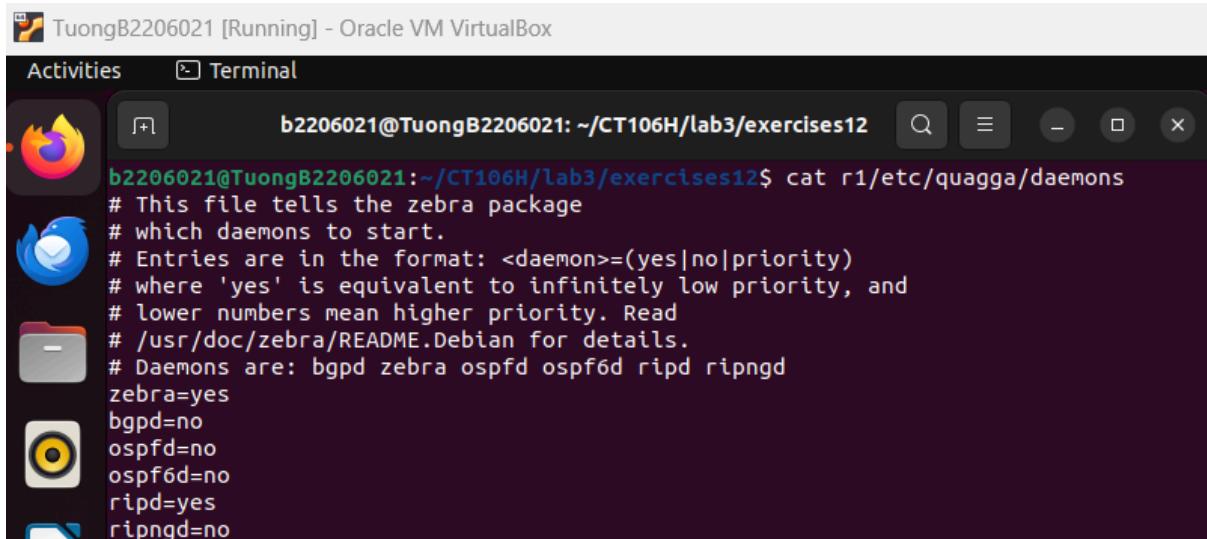
r3[0]=C
r3[1]=D
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises12$ cat r1.startup
ifconfig eth0 100.0.0.1/24 up
ifconfig eth1 150.0.0.1/30 up
/etc/init.d/quagga start
b2206021@TuongB2206021: ~/CT106H/lab3/exercises12$ cat r2.startup
ifconfig eth0 150.0.0.2/30 up
ifconfig eth1 200.0.0.1/30 up
/etc/init.d/quagga start
b2206021@TuongB2206021: ~/CT106H/lab3/exercises12$ cat r3.startup
ifconfig eth0 200.0.0.2/30 up
ifconfig eth1 220.0.0.1/24 up
/etc/init.d/quagga start
```

/etc/init.d/quagga start: the command will start the quagga routing services after setting up the appropriate configuration files for each router.



```
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ cat r1/etc/quagga/daemons
# This file tells the zebra package
# which daemons to start.
# Entries are in the format: <daemon>=(yes|no|priority)
# where 'yes' is equivalent to infinitely low priority, and
# lower numbers mean higher priority. Read
# /usr/doc/zebra/README.Debian for details.
# Daemons are: bgpd zebra ospfd ospf6d ripd ripngd
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
```

zebra=yes: The Zebra daemon is activated. It manages the system's routing table and facilitates communication between the other routing daemons and the kernel

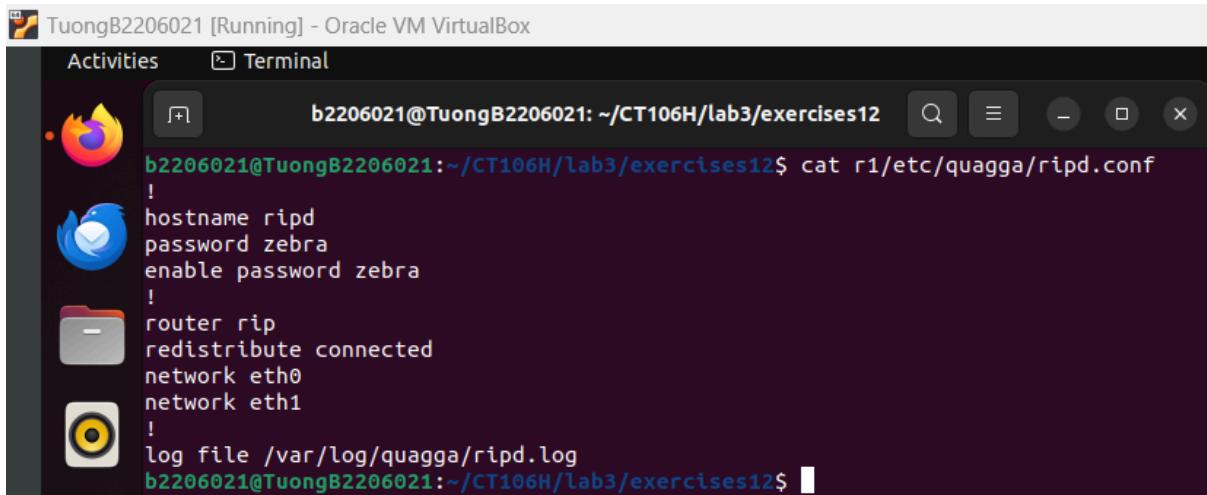
bgpd=no: The Border Gateway Protocol daemon is turned off

ospfd=no: The OSPF (Open Shortest Path First) daemon is turned off

ospf6d=no: The IPv6 version of the OSPF daemon is turned off

ripd=yes: The Routing Information Protocol daemon is enabled, allowing the system to route using the RIP protocol

ripngd=no: The IPv6 version of the RIP daemon (RIPng) is turned off



```
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ 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
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$
```

!

hostname ripd

password zebra

enable password zebra

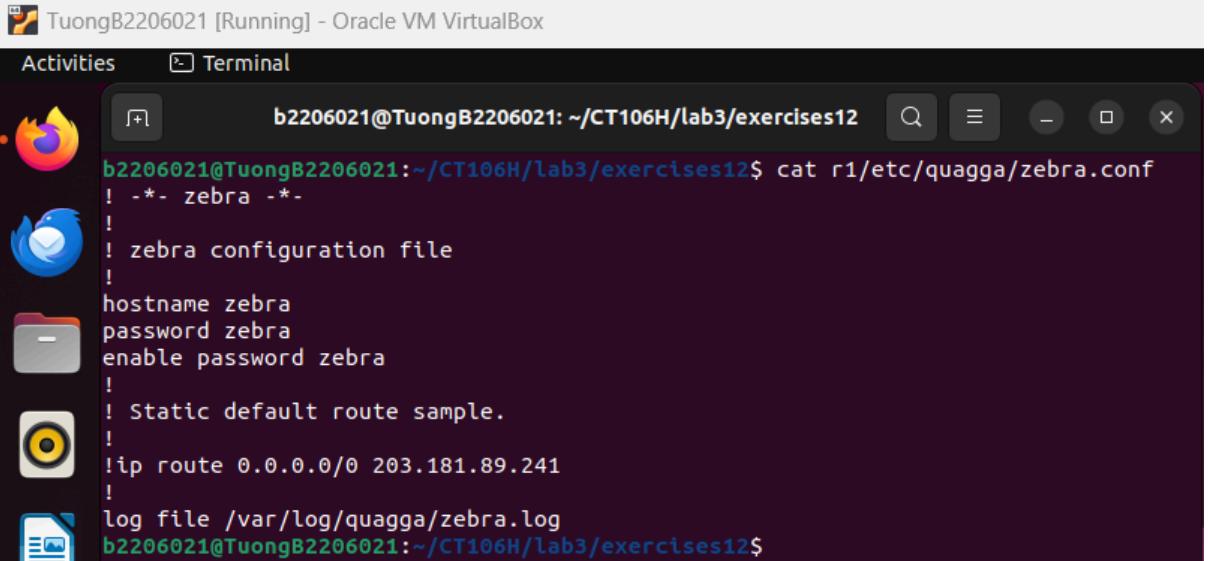
!

This section handles the identification of the RIP daemon and basic security through password protection, ensuring that only authenticated users can configure the RIP service

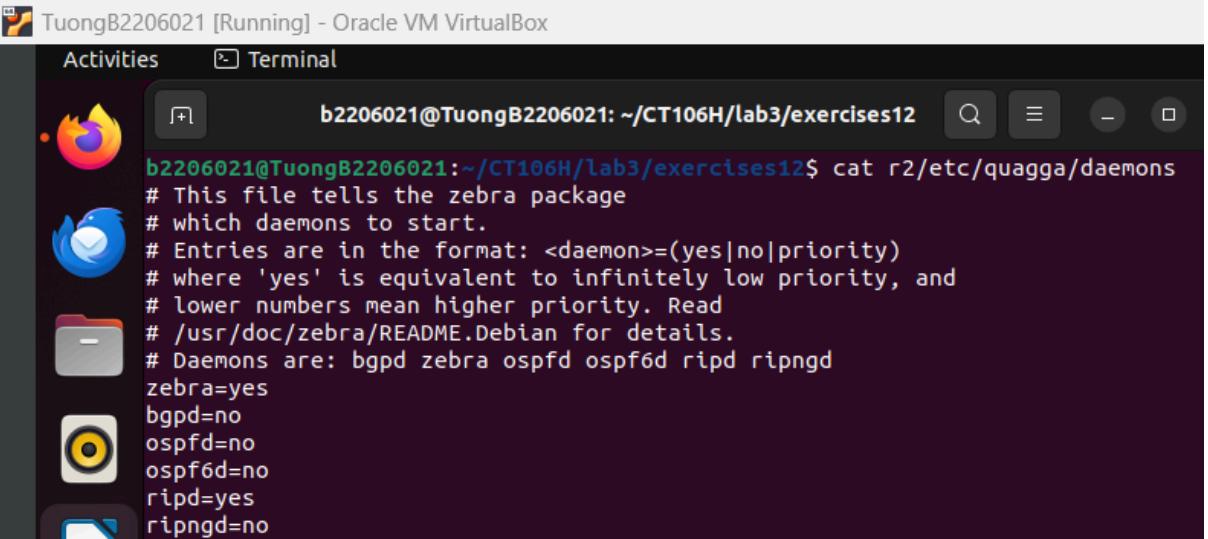
```
!
router rip
redistribute connected
network eth0
network eth1
!
```

This section defines how the router interacts with other devices using the RIP protocol, including which interfaces participate in routing and what information (connected routes) should be shared

log file /var/log/quagga/ripd.log: this command sets the location where the RIP daemon will logs its events and activities



```
Activities Terminal
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ 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
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$
```



```
Activities Terminal
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ cat r2/etc/quagga/daemons
# This file tells the zebra package
# which daemons to start.
# Entries are in the format: <daemon>=(yes|no|priority)
# where 'yes' is equivalent to infinitely low priority, and
# lower numbers mean higher priority. Read
# /usr/doc/zebra/README.Debian for details.
# Daemons are: bgpd zebra ospfd ospf6d ripd ripngd
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ 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
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ 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
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ cat r3/etc/quagga/daemons
# This file tells the zebra package
# which daemons to start.
# Entries are in the format: <daemon>=(yes|no|priority)
# where 'yes' is equivalent to infinitely low priority, and
# lower numbers mean higher priority. Read
# /usr/doc/zebra/README.Debian for details.
# Daemons are: bgpd zebra ospfd ospf6d ripd ripngd
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ 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
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ 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
```

Start the lab

\$ kathara lstart

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ kathara lstart
Starting Network Scenario
root@r2: /           - 4/4
[--- Startup Commands Log
++ ifconfig eth0
++ ifconfig eth1
++ /etc/init.d/quagga start
Starting Quagga daemons (priorities: zebra ripd,
Starting Quagga monitor daemon: watchquagga.
--- End Startup Commands Log
root@r2:/# Starting Quagga daemon: ifconfig eth0 100.0.0.1/24 up
Starting Quagga monitor daemon: ifconfig eth1 150.0.0.1/30 up
--- End Startup Commands Log
root@r3:/# Starting Quagga daemons (priorities: zebra ripd,
Starting Quagga monitor daemon: watchquagga.
--- End Startup Commands Log
```

Testing connectivity

\$ route -n (On r1 r2 r3)

\$ ping -c 2 100.0.0.1 (r3 ping to eth0 r1)

```
root@r1: /  
--- Startup Commands Log  
++ ifconfig eth0 100.0.0.1/24 up  
++ ifconfig eth1 150.0.0.1/30 up  
++ /etc/init.d/quagga start  
Starting Quagga daemons (prio:10): 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  
200.0.0.0 150.0.0.2 255.255.255.252 UG 20 0 0 eth1  
220.0.0.0 150.0.0.2 255.255.255.0 UG 20 0 0 eth1  
root@r2: /  
--- Startup Commands Log  
++ ifconfig eth0 150.0.0.2/30 up  
++ ifconfig eth1 200.0.0.1/30 up  
++ /etc/init.d/quagga start  
Starting Quagga daemons (prio:10): 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 eth0  
200.0.0.0 0.0.0.0 255.255.255.252 U 0 0 0 eth1  
220.0.0.0 200.0.0.2 255.255.255.0 UG 20 0 0 eth1
```

```
root@r3: /  
++ ifconfig eth0 200.0.0.2/30 up  
++ ifconfig eth1 220.0.0.1/24 up  
++ /etc/init.d/quagga start  
Starting Quagga daemons (prio:10): 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 -c 2 100.0.0.1  
Ping: invalid argument: '2100.0.0.1'  
root@r3:/# ping -c 2 100.0.0.1  
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=19.4 ms  
64 bytes from 100.0.0.1: icmp_seq=2 ttl=63 time=0.973 ms  
--- 100.0.0.1 ping statistics ---  
2 packets transmitted, 2 received, 0% packet loss, time 1002ms  
rtt min/avg/max/mdev = 0.973/10.182/19.391/9.209 ms
```

⇒ Routing protocols (RIP, OSPF) can detect and update route in the routing table automatically

On a router, use the command `tcpdump` to capture the RIPv2 packet; then stop the command after about 20 seconds. For example, on `r1` type: `tcpdump -i any -w /shared/Ex12_r1.pcap`

On a router, connecting to the main zebra daemon using the following command:
`telnet localhost ripd`

The password is `zebra`

```
root@r1:~/# tcpdump -i any -w /shared/Ex12_r1.pcap
tcpdump: data link type LINUX_SLL2
tcpdump: listening on any, link-type LINUX_SLL2 (Linux cooked v2), snapshot length 262144 bytes
^C3 packets captured
3 packets received by filter
0 packets dropped by kernel
root@r1:~/# telnet localhost ripd
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>
```

Then type: `show ip rip`

```
root@r1:~/# telnet localhost ripd
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
C(i) 100.0.0.0/24    0.0.0.0          1 self           0
C(i) 150.0.0.0/30    0.0.0.0          1 self           0
R(n) 200.0.0.0/30    150.0.0.2        2 150.0.0.2     0 02:52
R(n) 220.0.0.0/24    150.0.0.2        3 150.0.0.2     0 02:52
```

The command **shows ip rip**, which displays the RIP routing table. The output provides a detailed view of the routes learned or advertised via RIP:

- **Codes** section indicates the source of the routing information and helps distinguish between dynamically learned routes (e.g., RIP or OSPF) and manually configured routes (static)
- **Subcodes** section provides more specific details about the type of route, such as whether it's a default route, a redistributed route, or a direct connection. This helps in route classification and decision-making when forwarding packets
- **Network**: This shows the network addresses for the routes in the table.
- **Next Hop**: The next hop IP address (the router where packets will be forwarded)
- **Metric**: RIP uses a hop count as the metric, where the lower the number, the better the route
- **From**: The source IP address from which the route was learned
- **Tag**: A field used for route identification or filtering
- **Time**: How long the route has been in the table since it was last updated

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

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	150.0.0.2	224.0.0.9	RIPv2	92	Response
2	18.991801	100.0.0.1	224.0.0.9	RIPv2	112	Response
3	18.991896	150.0.0.1	224.0.0.9	RIPv2	72	Response

Frame 2: 112 bytes on wire (896 bits), 112 bytes captured (896 bits)
 ↳ Linux cooked capture v2
 ↳ Internet Protocol Version 4, Src: 100.0.0.1, Dst: 224.0.0.9
 ↳ User Datagram Protocol, Src Port: 520, Dst Port: 520
 ↳ Routing Information Protocol
 Command: Response (2)
 Version: RIPv2 (2)
 IP Address: 150.0.0.0, Metric: 1
 IP Address: 200.0.0.0, Metric: 2
 IP Address: 220.0.0.0, Metric: 3

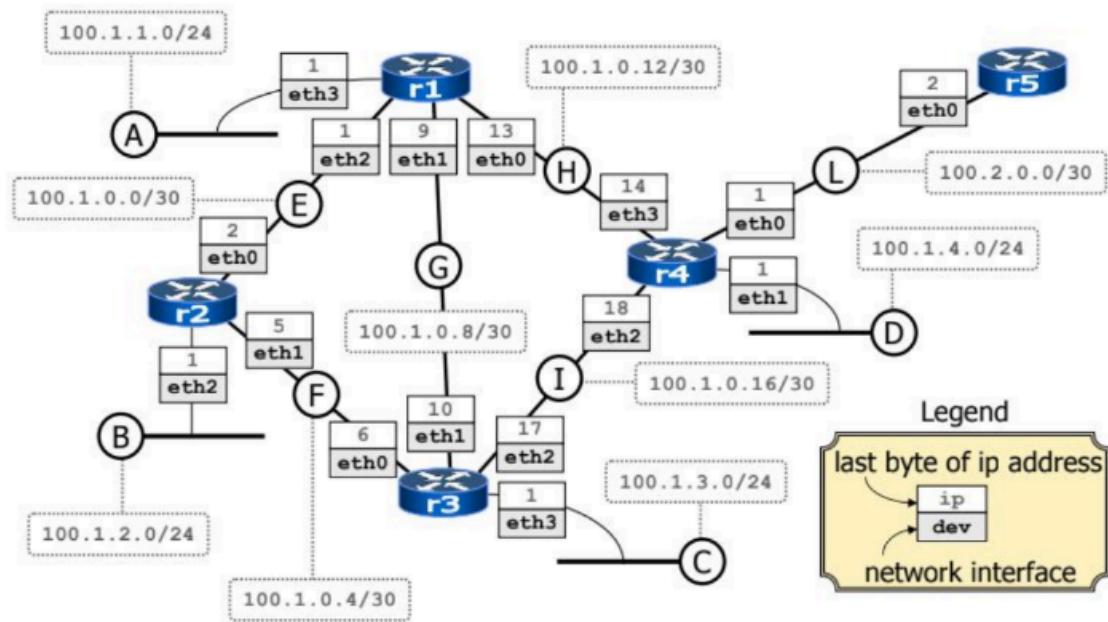
- **Frame 1 captured (92 bytes in length). The source IP is 150.0.0.2 and the destination is the multicast 224.0.0.9.**
- **The protocol is UDP (User Datagram Protocol) with source and destination ports set to 520, which is the port used for RIP messages.**
- **RIPv2 (Routing Information Protocol version 2) is a distance-vector routing protocol used in IP networks to facilitate the exchange of routing information between routers. It is an enhancement of the original RIP with several improvements while maintaining simplicity and ease of use.**
- **The route of packet: 100.0.0.1 ⇒ 150.0.0.0 ⇒ 200.0.0.0 ⇒ 220.0.0.0 ⇒ 224.0.0.9**

Clean the lab

\$ kathara lclean

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$ kathara lclean
Stopping Network Scenario
[Deleting devices] 3/3
[Deleting collision domains] 4/4
b2206021@TuongB2206021:~/CT106H/lab3/exercises12$
```

Exercise 13 (RIP): Construct the following topology



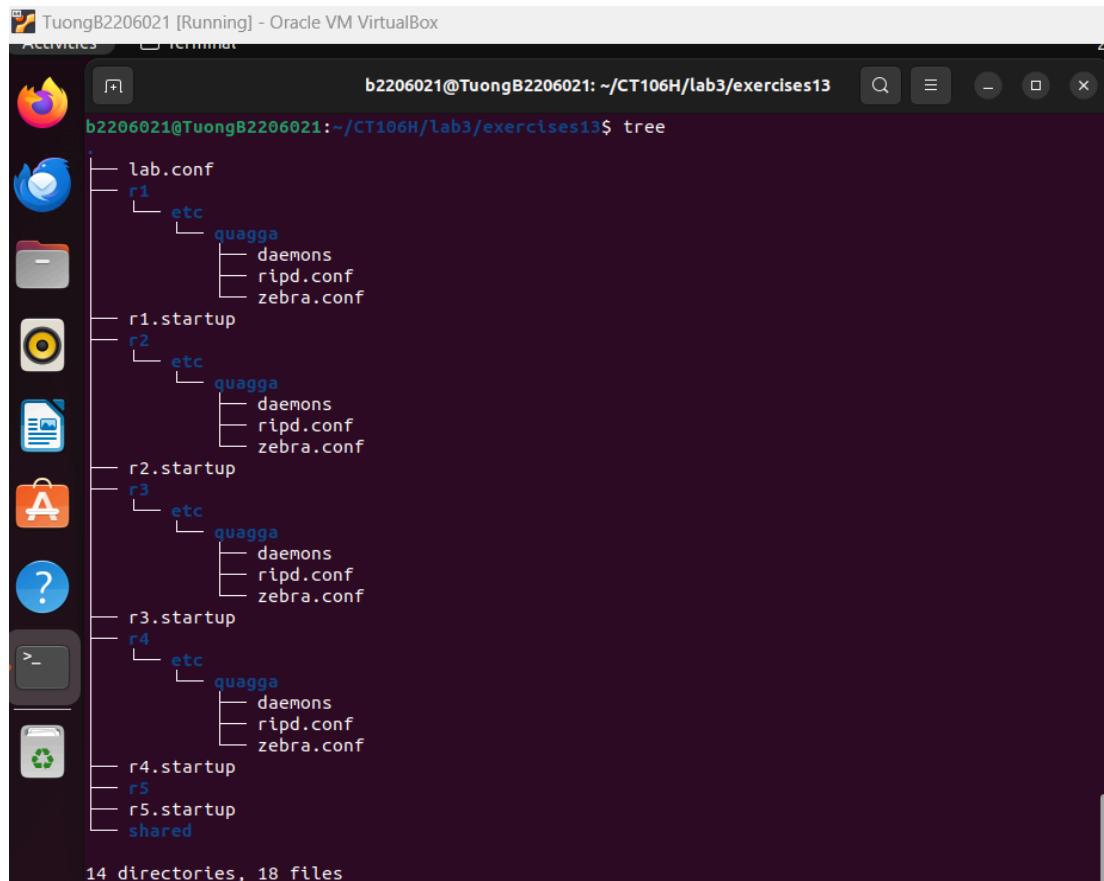
\$ mkdir -p ~/CT106H/lab3/exercises13

\$ cd ~/CT106H/lab3/exercises13

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises13$ mkdir -p ~/CT106H/lab3/exercises13
b2206021@TuongB2206021:~/CT106H/lab3/exercises13$ cd ~/CT106H/lab3/exercises13
b2206021@TuongB2206021:~/CT106H/lab3/exercises13$
```

Prepare the lab

```
$ mkdir -p r1/etc/quagga r2/etc/quagga r3/etc/quagga r4/etc/quagga r5 shared  
$ gedit lab.conf  
$ gedit LICENSE  
$ gedit r1.startup  
$ gedit r2.startup  
$ gedit r3.startup  
$ gedit r4.startup  
$ gedit r5.startup  
$ gedit r1/etc/quagga/daemons  
$ gedit r1/etc/quagga/ripd.conf  
$ gedit r1/etc/quagga/zebra.conf  
$ gedit r2/etc/quagga/daemons  
$ gedit r2/etc/quagga/ripd.conf  
$ gedit r2/etc/quagga/zebra.conf  
$ gedit r3/etc/quagga/daemons  
$ gedit r3/etc/quagga/ripd.conf  
$ gedit r3/etc/quagga/zebra.conf  
$ gedit r4/etc/quagga/daemons  
$ gedit r4/etc/quagga/ripd.conf  
$ gedit r4/etc/quagga/zebra.conf
```



```
b2206021@TuongB2206021:~/CT106H/lab3/exercises13$ 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  
    └── r5.startup  
        └── shared  
14 directories, 18 files
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises13$ 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"
b2206021@TuongB2206021: ~/CT106H/lab3/exercises13$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises13$ 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 100.1.1.1/24 up
/etc/init.d/quagga start
b2206021@TuongB2206021: ~/CT106H/lab3/exercises13$ 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
b2206021@TuongB2206021: ~/CT106H/lab3/exercises13$ 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
b2206021@TuongB2206021: ~/CT106H/lab3/exercises13$ 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
b2206021@TuongB2206021: ~/CT106H/lab3/exercises13$ cat r5.startup
ifconfig eth0 100.2.0.2/30 up
route add -net 100.1.0.0/16 gw 100.2.0.1
b2206021@TuongB2206021: ~/CT106H/lab3/exercises13$
```

```

TuongB2206021 [Running] - Oracle VM VirtualBox
Activities Terminal

b2206021@TuongB2206021:~/CT106H/lab3/exercises13$ cat r1/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
b2206021@TuongB2206021:~/CT106H/lab3/exercises13$ 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
b2206021@TuongB2206021:~/CT106H/lab3/exercises13$ cat r1/etc/quagga/zebra.conf
hostname r1
password zebra
enable password zebra
log file /var/log/quagga/zebra.log
b2206021@TuongB2206021:~/CT106H/lab3/exercises13$

```

Start the lab

\$ kathara lstart

```

TuongB2206021 [Running] - Oracle VM VirtualBox
Activities Terminal

b2206021@TuongB2206021:~/CT106H/lab3/exercises13$ kathara lstart
Starting Network Scenario
root@r1: / 10/10
root@r2: / 5/5
root@r3: /
root@r4: /
root@r5: /

```

Output from hosts:

```

--- Startup Commands
++ ifconfig eth0 1
++ ifconfig eth1 1
++ ifconfig eth2 1--- Startup Commands
++ ifconfig eth3 1++ ifconfig e
++ /etc/init.d/quagga ifconfig e --- Startup Commands
Starting Quagga d++ ifconfig e --- Startup Commands
Starting Quagga m++ /etc/init.d/quagga ++ ifconfig eth0 100.1.0.1
--- End Startup Commands
Quagga d++ ifconfig eth1 100.1.0.2
--- End Startup Commands
++ ifconfig eth2 100.1.0.3++ ifconfig eth0 100.2.0.1
--- End Startup Commands
++ ifconfig eth3 100.1.0.4++ ifconfig eth1 100.2.0.2
--- End Startup Commands
Starting Quagga daemon++ ifconfig eth2 --- Startup Commands Log
Starting Quagga monitor++ ifconfig eth3 ++ ifconfig eth0 100.2.0.2/30 up
--- End Startup Commands
++ /etc/init.d/quagga ++ ifconfig eth1 100.2.0.1
--- End Startup Commands
Starting Quagga --- End Startup Commands Log
root@r3: / Starting Quagga --- End Startup Commands Log
root@r4: / Starting Quagga root@r5: /

```

Check the routing table using the route command

route -n (On r1 r2 r3 r4 r5)

TuongB2206021 [Running] - Oracle VM VirtualBox

```
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       100.1.0.2      255.255.255.252 UG    20     0      0 eth2
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 eth0
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        255.255.255.0   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
```

TuongB2206021 [Running] - Oracle VM VirtualBox

```
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       100.1.0.1      255.255.255.252 UG    20     0      0 eth0
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   U     0      0      0 eth2
100.1.3.0       100.1.0.6      255.255.255.0   UG    20     0      0 eth1
100.1.4.0       100.1.0.6      255.255.255.0   UG    20     0      0 eth1
100.2.0.0       100.1.0.6      255.255.255.252 UG    20     0      0 eth1
```

TuongB2206021 [Running] - Oracle VM VirtualBox

```
root@r3:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref  Use Iface
100.1.0.0       100.1.0.9      255.255.255.252 UG    20     0      0 eth1
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
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

```
root@r4: /
```

```
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       100.1.0.13    255.255.255.252 UG        20      0      0 eth3
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       100.1.0.13    255.255.255.0   UG        20      0      0 eth3
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 U          0      0      0 eth0
root@r4:/#
```

Using RIP dynamic routing protocol, r1 - r2 - r3 - r4 will have all information in the local network

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

```
root@r5: /
```

```
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:/#
```

Otherwise, r5 is just an external router (configured as static routing)

Check connectivity using the ping command

\$ ping -c 2 100.1.3.1 (r1 ping to eth3 r3)

TuongB2206021 [Running] - Oracle VM VirtualBox

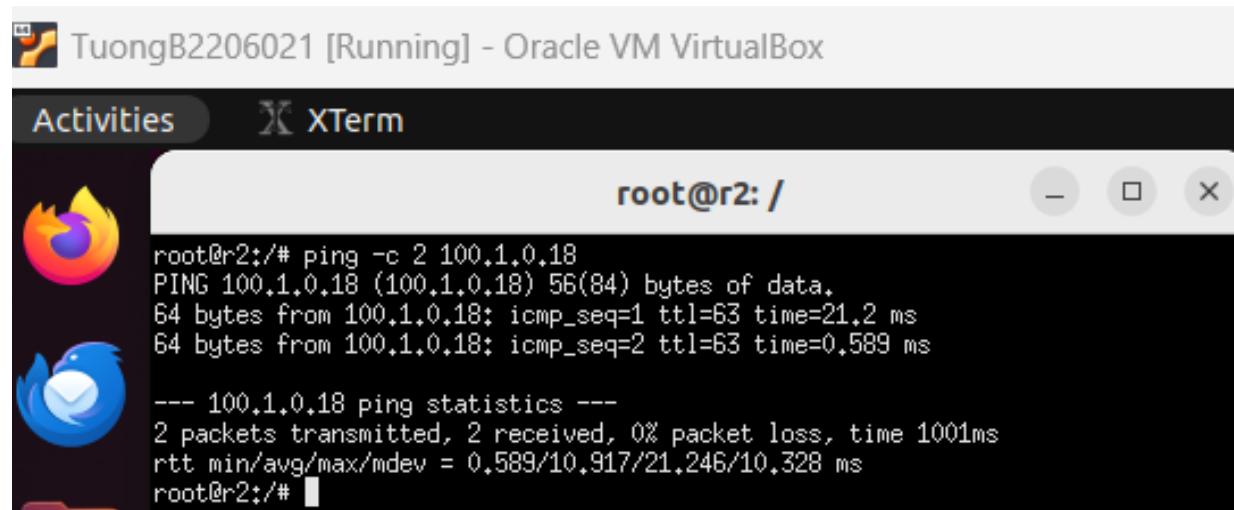
Activities XTerm

```
root@r1: /
```

```
root@r1:/# ping -c 2 100.1.3.1
PING 100.1.3.1 (100.1.3.1) 56(84) bytes of data.
64 bytes from 100.1.3.1: icmp_seq=1 ttl=64 time=2.10 ms
64 bytes from 100.1.3.1: icmp_seq=2 ttl=64 time=0.648 ms

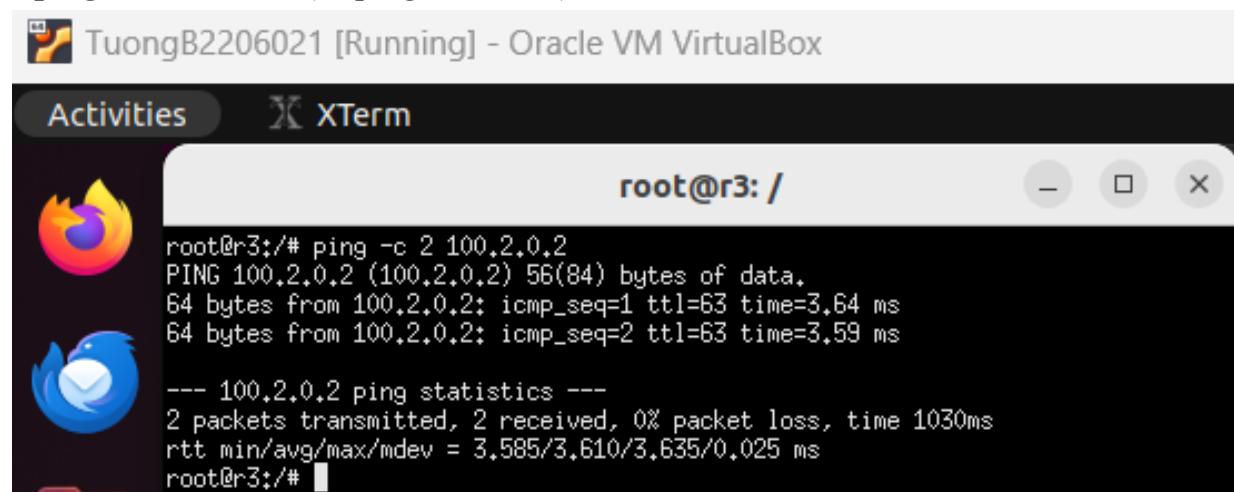
--- 100.1.3.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1000ms
rtt min/avg/max/mdev = 0.648/1.375/2.102/0.727 ms
root@r1:/#
```

\$ ping -c 2 100.1.0.8 (*r2 ping to eth2 r4*)



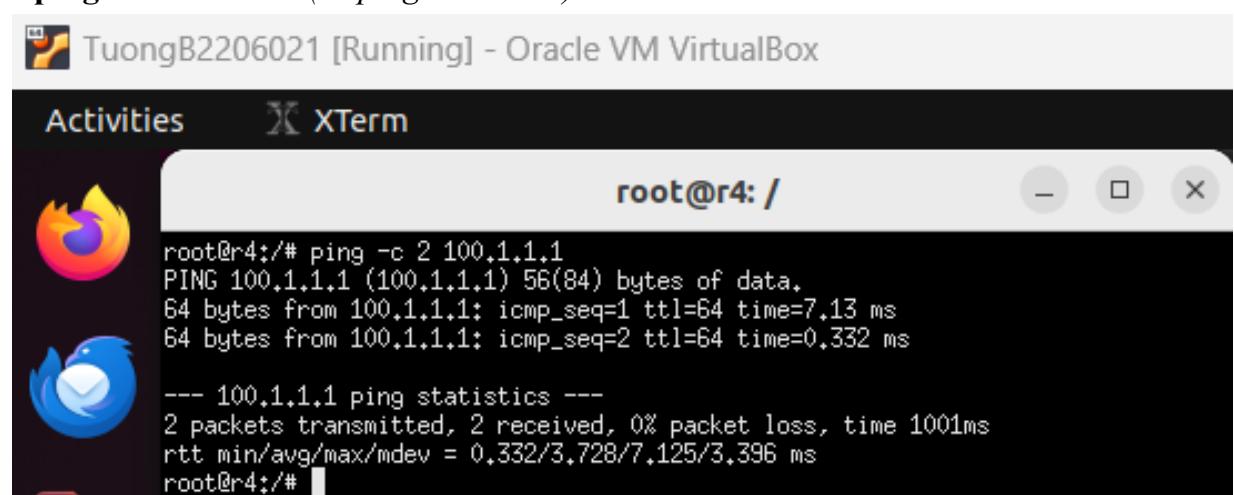
```
root@r2:/# ping -c 2 100.1.0.18
PING 100.1.0.18 (100.1.0.18) 56(84) bytes of data.
64 bytes from 100.1.0.18: icmp_seq=1 ttl=63 time=21.2 ms
64 bytes from 100.1.0.18: icmp_seq=2 ttl=63 time=0.589 ms
--- 100.1.0.18 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.589/10.917/21.246/10.328 ms
root@r2:/#
```

\$ ping -c 2 100.2.0.2 (*r3 ping to eth0 r5*)



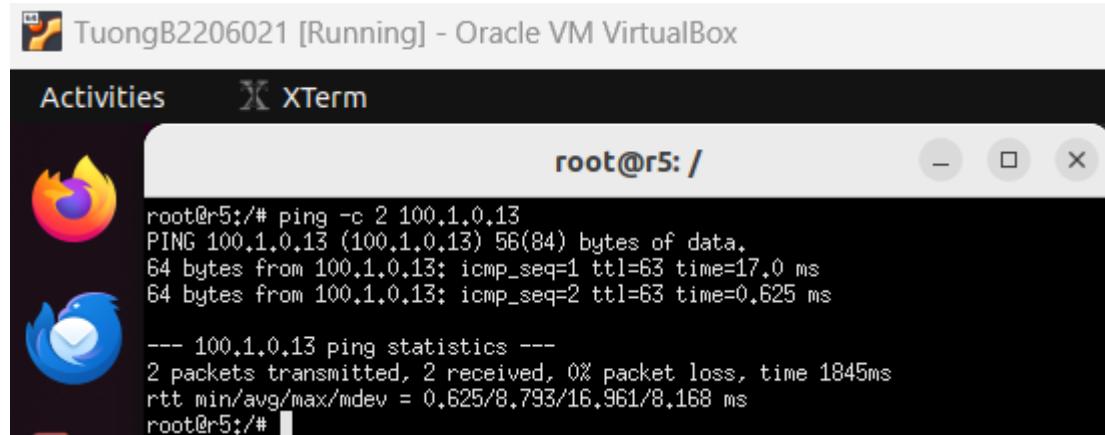
```
root@r3:/# ping -c 2 100.2.0.2
PING 100.2.0.2 (100.2.0.2) 56(84) bytes of data.
64 bytes from 100.2.0.2: icmp_seq=1 ttl=63 time=3.64 ms
64 bytes from 100.2.0.2: icmp_seq=2 ttl=63 time=3.59 ms
--- 100.2.0.2 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1030ms
rtt min/avg/max/mdev = 3.585/3.610/3.635/0.025 ms
root@r3:/#
```

\$ ping -c 2 100.1.1.1 (*r4 ping to eth3 r1*)



```
root@r4:/# ping -c 2 100.1.1.1
PING 100.1.1.1 (100.1.1.1) 56(84) bytes of data.
64 bytes from 100.1.1.1: icmp_seq=1 ttl=64 time=7.13 ms
64 bytes from 100.1.1.1: icmp_seq=2 ttl=64 time=0.332 ms
--- 100.1.1.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.332/3.728/7.125/3.396 ms
root@r4:/#
```

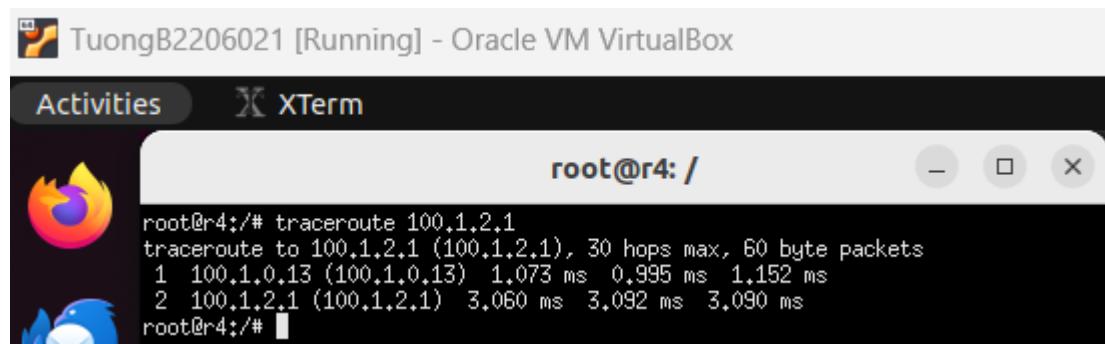
\$ ping -c 2 100.1.0.13 (*r5 ping to eth0 r1*)



```
root@r5:/# ping -c 2 100.1.0.13
PING 100.1.0.13 (100.1.0.13) 56(84) bytes of data.
64 bytes from 100.1.0.13: icmp_seq=1 ttl=63 time=17.0 ms
64 bytes from 100.1.0.13: icmp_seq=2 ttl=63 time=0.625 ms
--- 100.1.0.13 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1845ms
rtt min/avg/max/mdev = 0.625/8.793/16.961/8.168 ms
root@r5:/#
```

On R4, type traceroute 100.1.2.1 command, and explain what happens?

traceroute 100.1.2.1 (*On r4*)



```
root@r4:/# traceroute 100.1.2.1
traceroute to 100.1.2.1 (100.1.2.1), 30 hops max, 60 byte packets
 1  100.1.0.13 (100.1.0.13)  1.073 ms  0.995 ms  1.152 ms
 2  100.1.2.1 (100.1.2.1)  3.060 ms  3.092 ms  3.090 ms
root@r4:/#
```

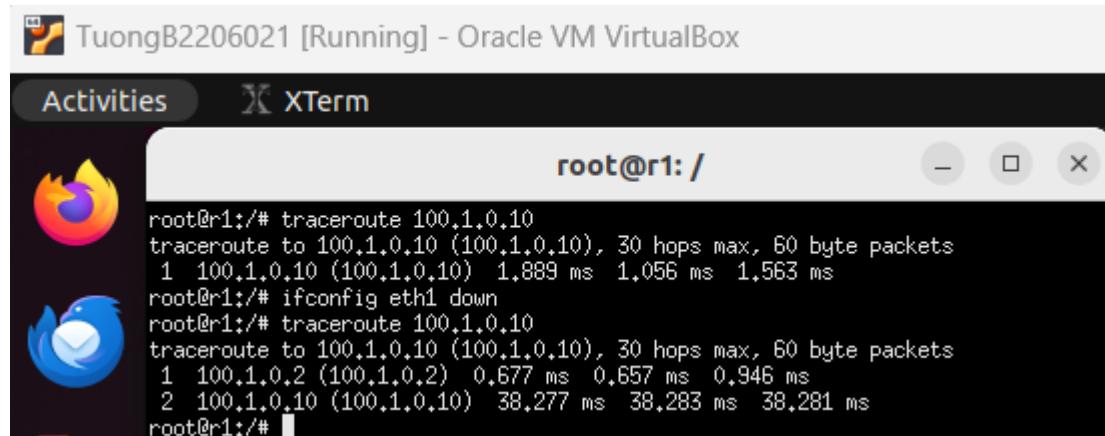
traceroute 100.1.2.1 command trace the path that data packets take from your computer to the destination IP address 100.1.2.1. In this process, **100.1.0.13** represents the next hop from R4 on the way to the final destination, which is **100.1.2.1**.

On R1, shutting down an interface using the command ifconfig eth1 down and Examine the route using the command traceroute 100.1.0.10

traceroute 100.1.0.10 (**before**)

ifconfig eth1 down

traceroute 100.1.0.10 (**after**)



```
root@r1:/# traceroute 100.1.0.10
traceroute to 100.1.0.10 (100.1.0.10), 30 hops max, 60 byte packets
 1  100.1.0.10 (100.1.0.10)  1.889 ms  1.056 ms  1.563 ms
root@r1:/# ifconfig eth1 down
root@r1:/# traceroute 100.1.0.10
traceroute to 100.1.0.10 (100.1.0.10), 30 hops max, 60 byte packets
 1  100.1.0.2 (100.1.0.2)  0.677 ms  0.657 ms  0.946 ms
 2  100.1.0.10 (100.1.0.10)  38.277 ms  38.283 ms  38.281 ms
root@r1:/#
```

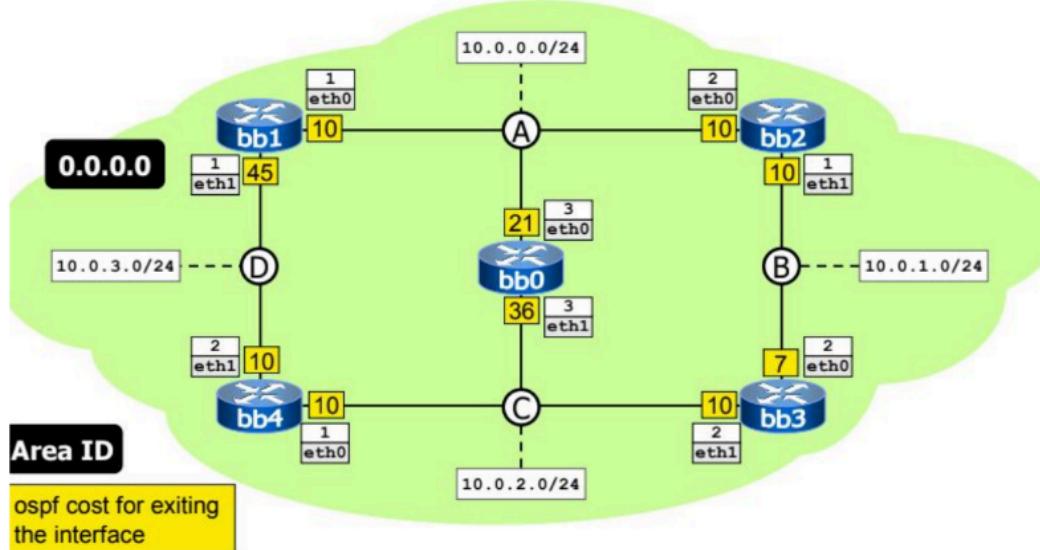
Before the shutdown, the traceroute shows that the track from *r1* to the IP address 100.1.0.10 is just only 1 hop. After shutting down the interface, the destination was still reachable but in two hops, also the latency values changed, indicating a different route or path was used after *eth1* went down.

Clean the lab

\$ kathara lclean

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises13$ kathara lclean
Stopping Network Scenario
[Deleting devices] 5/5
[Deleting collision domains] 10/10
b2206021@TuongB2206021:~/CT106H/lab3/exercises13$
```

Exercise 14 (OSPF) - single area: Construct the following topology



Answer:

Create exercises14 directory

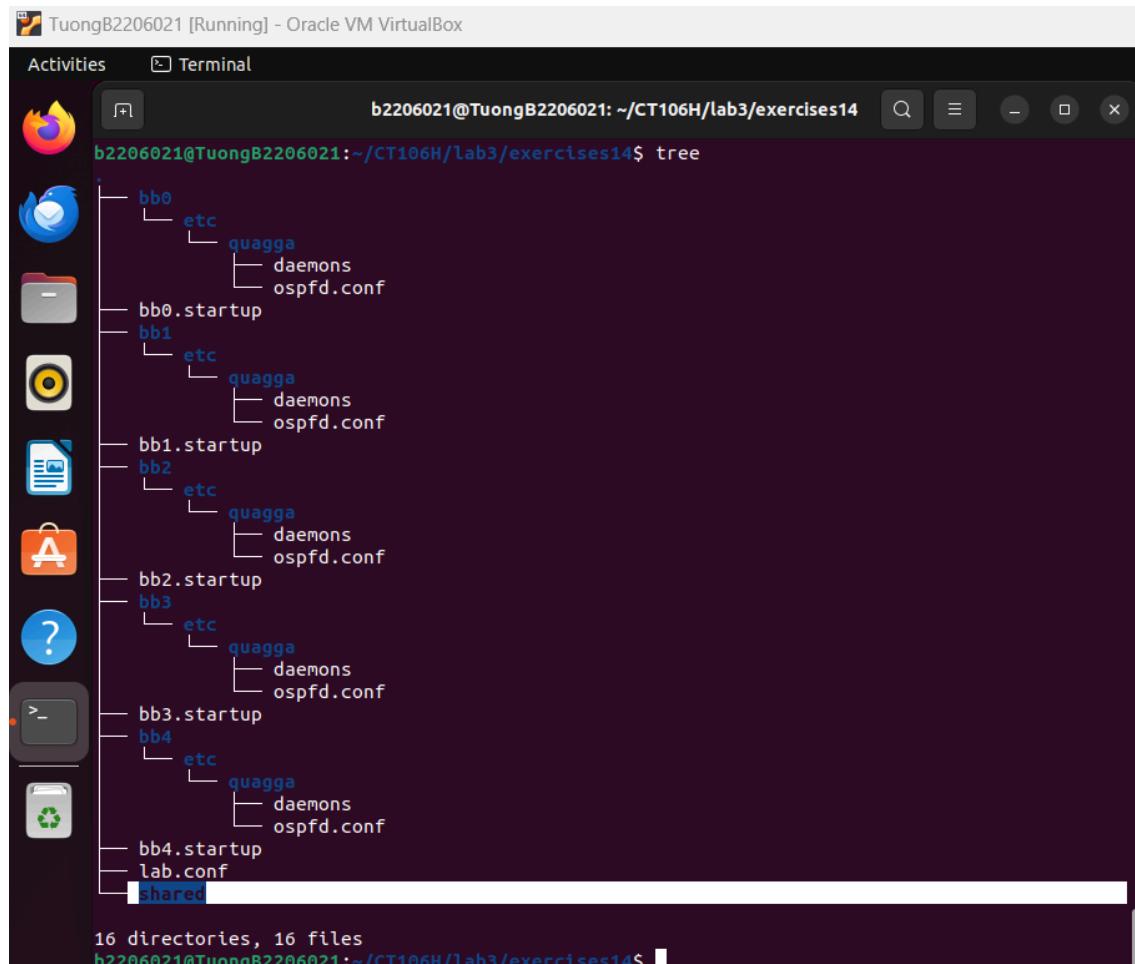
\$ mkdir -p ~/CT106H/lab3/exercises14

\$ cd ~/CT106H/lab3/exercises14

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$ mkdir -p ~/CT106H/lab3/exercises14
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$ cd ~/CT106H/lab3/exercises14
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$
```

Prepare the lab

```
$ mkdir bb0/etc/quagga bb1/etc/quagga bb2/etc/quagga bb3/etc/quagga  
bb5/etc/quagga shared  
$ gedit lab.conf  
$ gedit bb0.startup  
$ gedit bb1.startup  
$ gedit bb2.startup  
$ gedit bb3.startup  
$ gedit bb4.startup  
$ gedit bb0/etc/quagga/daemons  
$ gedit bb0/etc/quagga/ospfd.conf  
$ gedit bb1/etc/quagga/daemons  
$ gedit bb1/etc/quagga/ospfd.conf  
$ gedit bb2/etc/quagga/daemons  
$ gedit bb2/etc/quagga/ospfd.conf  
$ gedit bb3/etc/quagga/daemons  
$ gedit bb3/etc/quagga/ospfd.conf  
$ gedit bb4/etc/quagga/daemons  
$ gedit bb4/etc/quagga/ospfd.conf
```



The screenshot shows a Linux desktop environment with a terminal window open. The terminal window title is "TuongB2206021 [Running] - Oracle VM VirtualBox". The terminal command is "tree" and the output shows a directory structure:

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$ 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  
+-- Shared
```

The terminal also displays the message "16 directories, 16 files".

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ 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
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb0.startup
ifconfig eth0 10.0.0.3/24 up
ifconfig eth1 10.0.2.3/24 up
/etc/init.d/quagga start
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb1.startup
ifconfig eth0 10.0.0.1/24 up
ifconfig eth1 10.0.3.1/24 up
/etc/init.d/quagga start
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb2.startup
ifconfig eth0 10.0.0.2/24 up
ifconfig eth1 10.0.1.1/24 up
/etc/init.d/quagga start
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb3.startup
ifconfig eth0 10.0.1.2/24 up
ifconfig eth1 10.0.2.2/24 up
/etc/init.d/quagga start
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb4.startup
ifconfig eth0 10.0.2.1/24 up
ifconfig eth1 10.0.3.2/24 up
/etc/init.d/quagga start
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb0/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb0/etc/quagga/ospfd.conf
hostname ospfd
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
```

The file represents the configuration of the OSPF (Open Shortest Path First) routing protocol on a router

interface eth1: Refers to the Ethernet interface `eth1`.

ospf cost 45: Sets the OSPF cost for this interface to 45. This cost determines the metric for routing decisions—lower cost paths are preferred.

router ospf: Starts the OSPF routing process.

network 10.0.0.0/16 area 0.0.0.0: This command tells OSPF to include all interfaces within the `10.0.0.0/16` network in Area 0, which is the backbone area in OSPF.

redistribute connected: Redistributions directly connected routes into OSPF, meaning any networks directly connected to this router will be advertised in OSPF.

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$ cat bb1/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$ 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
log file /var/log/zebra/ospfd.log
```

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$ cat bb2/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$ 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
log file /var/log/zebra/ospfd.log
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb3/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ 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
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

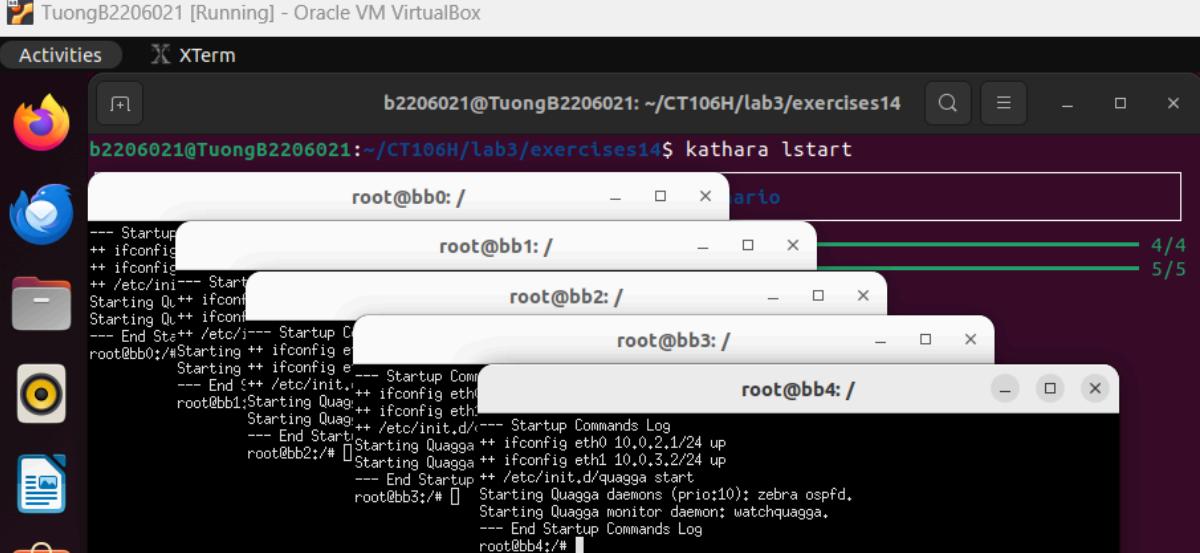
```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb4/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$ cat bb4/etc/quagga/ospfd.conf
hostname ospfd
password zebra
enable password zebra

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
b2206021@TuongB2206021: ~/CT106H/lab3/exercises14$
```

Start the lab

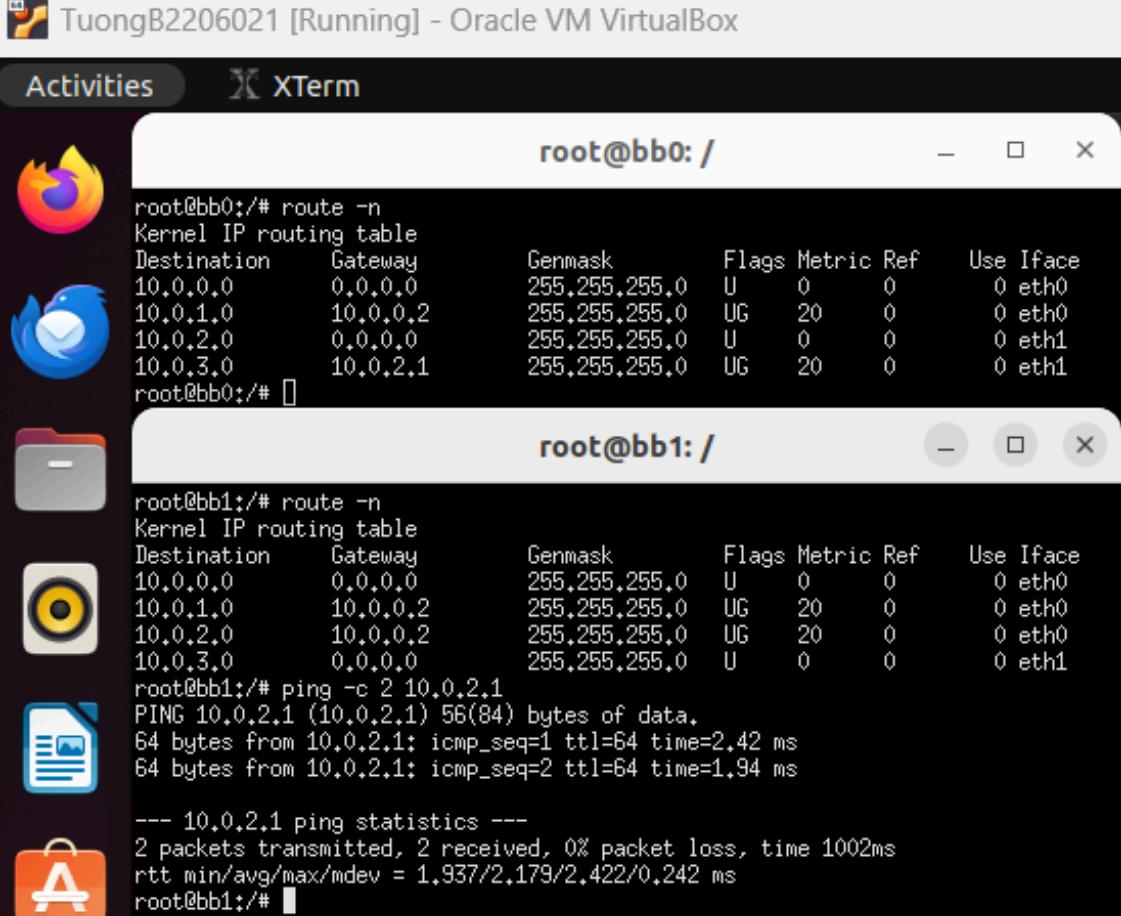
\$ kathara lstart



```
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$ kathara lstart
root@bb0: /root@bb1: /root@bb2: /root@bb3: /root@bb4: /
--- Startup Log ---  
++ ifconfig  
++ ifconfig  
++ /etc/init--- Startup Commands Log  
Starting Quagga++ ifconfig eth0  
Starting Quagga++ ifconfig eth1  
--- End Startup Commands Log  
root@bb0:/# Starting Quagga++ ifconfig eth0  
Starting Quagga++ ifconfig eth1  
--- Startup Commands Log  
--- End Startup Commands Log  
root@bb1:/# Starting Quagga++ ifconfig eth0  
Starting Quagga++ ifconfig eth1  
--- End Startup Commands Log  
root@bb2:/# Starting Quagga++ ifconfig eth0  
Starting Quagga++ ifconfig eth1  
--- End Startup Commands Log  
root@bb3:/# Starting Quagga daemons (priorities: zebra ospfd, watchquagga)  
Starting Quagga monitor daemon: watchquagga.  
--- End Startup Commands Log  
root@bb4:/#
```

Testing connectivity

```
# route -n ( On bb0 bb1 bb2 bb3 bb4)
# ping -c 2 10.0.2.1 ( bb1 ping to eth0 bb4)
# ping -c 2 10.0.0.3 ( bb2 ping to eth0 bb0)
```



```
root@bb0:/# 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         10.0.0.2      255.255.255.0   UG     20     0      0 eth0
10.0.2.0         0.0.0.0       255.255.255.0   U      0      0      0 eth1
10.0.3.0         10.0.2.1      255.255.255.0   UG     20     0      0 eth1
root@bb0:/#  
  
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         10.0.0.2      255.255.255.0   UG     20     0      0 eth0
10.0.2.0         10.0.0.2      255.255.255.0   UG     20     0      0 eth0
10.0.3.0         0.0.0.0       255.255.255.0   U      0      0      0 eth1
root@bb1:/# ping -c 2 10.0.2.1
PING 10.0.2.1 (10.0.2.1) 56(84) bytes of data.
64 bytes from 10.0.2.1: icmp_seq=1 ttl=64 time=2.42 ms
64 bytes from 10.0.2.1: icmp_seq=2 ttl=64 time=1.94 ms
--- 10.0.2.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 1.937/2.179/2.422/0.242 ms
root@bb1:/#
```



TuongB2206021 [Running] - Oracle VM VirtualBox

Activities

X XTerm



```
root@bb2:/# 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        0.0.0.0        255.255.255.0  U     0      0    0 eth1
10.0.2.0        10.0.1.2       255.255.255.0  UG    20      0    0 eth1
10.0.3.0        10.0.1.2       255.255.255.0  UG    20      0    0 eth1
root@bb2:/# ping -c 2 10.0.0.3
PING 10.0.0.3 (10.0.0.3) 56(84) bytes of data.
64 bytes from 10.0.0.3: icmp_seq=1 ttl=64 time=9.84 ms
64 bytes from 10.0.0.3: icmp_seq=2 ttl=64 time=0.364 ms

--- 10.0.0.3 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.364/5.101/9.838/4.737 ms
root@bb2:/#
```



TuongB2206021 [Running] - Oracle VM VirtualBox

Activities

X XTerm



```
root@bb3:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref  Use Iface
10.0.0.0        10.0.1.1       255.255.255.0  UG    20      0    0 eth0
10.0.1.0        0.0.0.0        255.255.255.0  U     0      0    0 eth0
10.0.2.0        0.0.0.0        255.255.255.0  U     0      0    0 eth1
10.0.3.0        10.0.2.1       255.255.255.0  UG    20      0    0 eth1
```

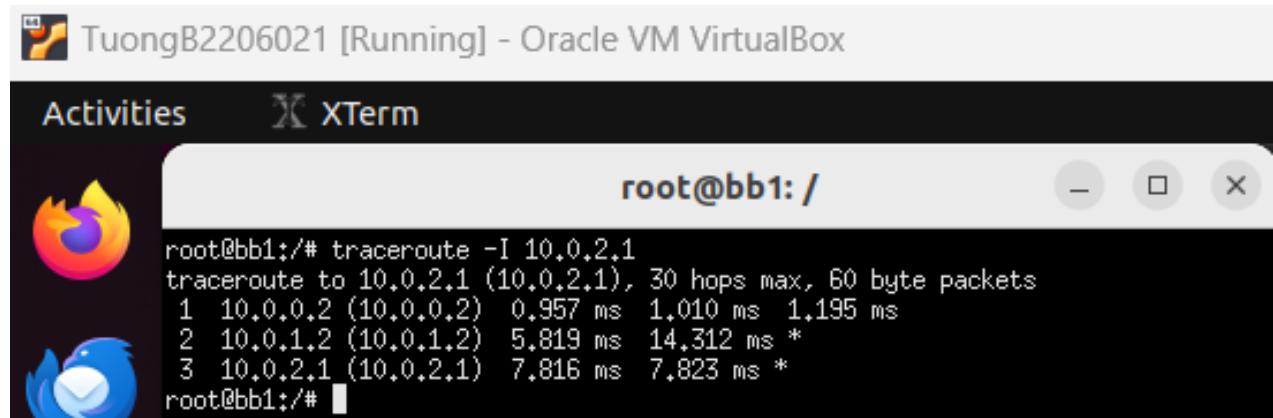


```
root@bb4:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref  Use Iface
10.0.0.0        10.0.3.1       255.255.255.0  UG    20      0    0 eth1
10.0.1.0        10.0.2.2       255.255.255.0  UG    20      0    0 eth0
10.0.2.0        0.0.0.0        255.255.255.0  U     0      0    0 eth0
10.0.3.0        0.0.0.0        255.255.255.0  U     0      0    0 eth1
root@bb4:/#
```

Perform a traceroute -I from bb1 to 10.0.2.1

- what path is the traceroute expected to take?
- what path are ICMP replies expected to take?

traceroute -I 10.0.2.1 (the -I option specifies that the traceroute should use ICMP (Internet Control Message Protocol) echo requests instead of the default UDP (User Datagram Protocol) packets)



```
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)  0.957 ms  1.010 ms  1.195 ms
 2  10.0.1.2 (10.0.1.2)  5.819 ms  14.312 ms *
 3  10.0.2.1 (10.0.2.1)  7.816 ms  7.823 ms *
```

The path is bb1 ⇒ 10.0.0.2 ⇒ 10.0.1.2 ⇒ 10.0.2.1

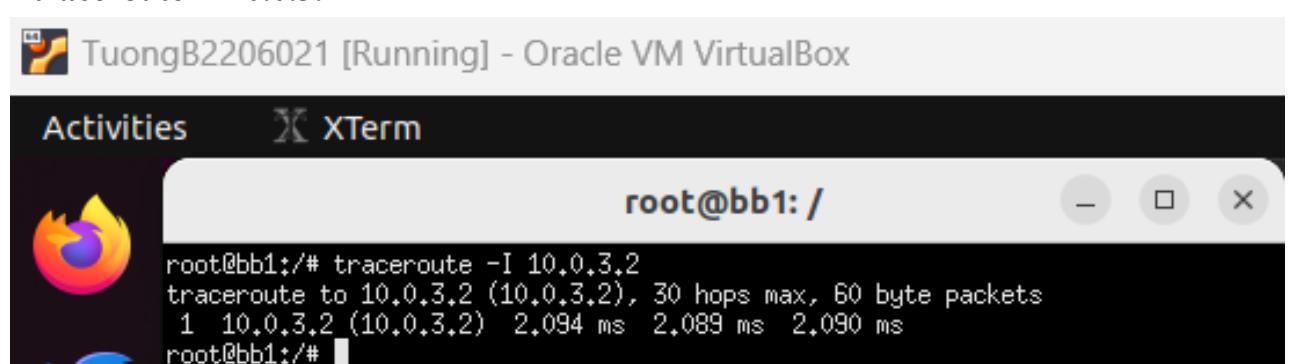
The path ICMP replies expected to take is bb1 ⇒ 10.0.0.2 ⇒ 10.0.1.2 ⇒ 10.0.2.1

⇒ The path is the same as traceroute expected

**Perform a traceroute -I from bb1 to 10.0.3.2*

- what path is the traceroute expected to take?
- observe the interplay between ospf routes and directly connected networks (i.e., perform a show ip route in quagga)

traceroute -I 10.0.3.2



```
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)  2.094 ms  2.089 ms  2.090 ms
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

root@bb1: /

```
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:
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

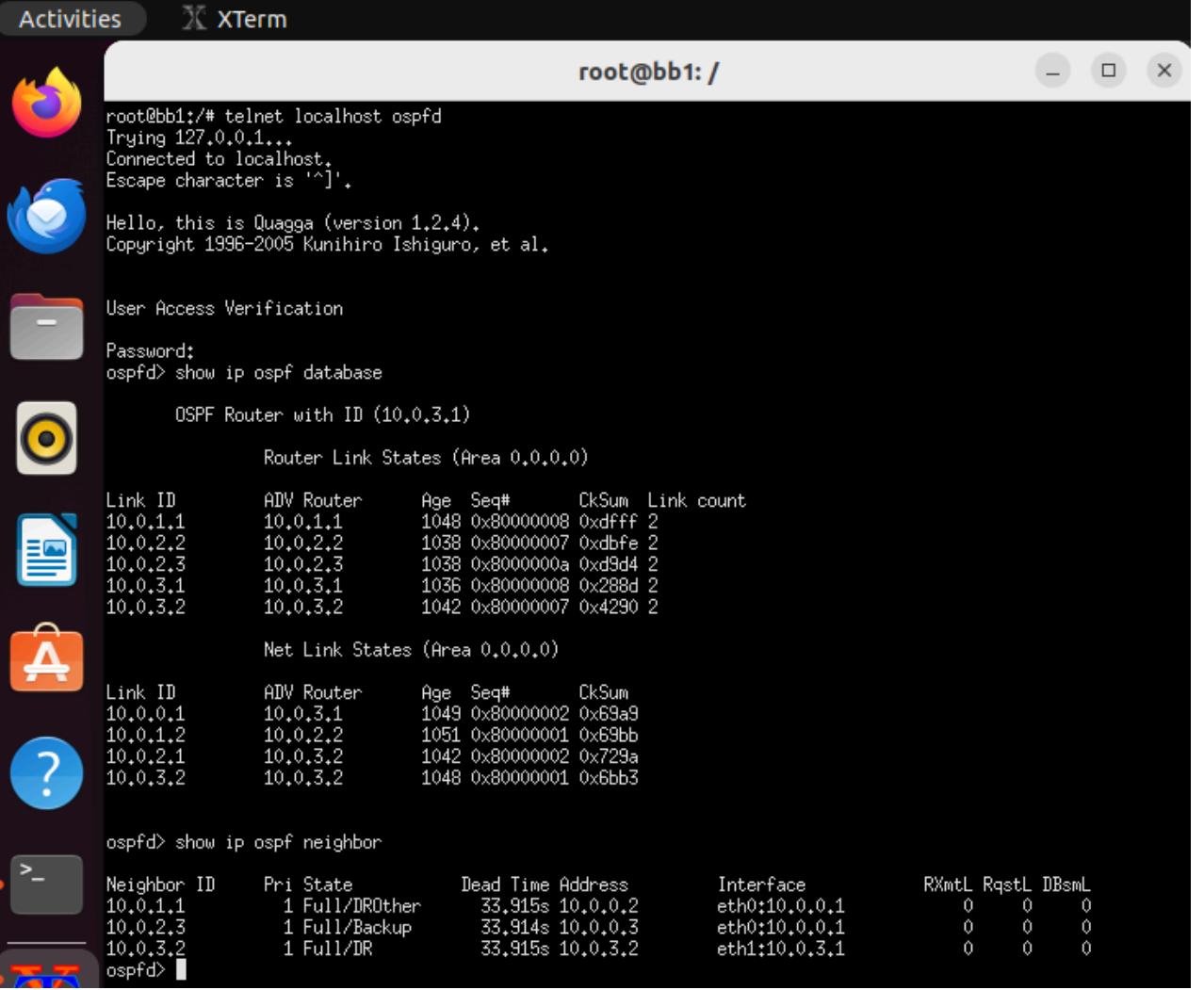
=====
OSPF external routing table =====
ospfd>
```

In OSPF network routing table, the path is: 10.0.1.1 \Rightarrow 10.0.2.2 \Rightarrow 10.0.2.3 \Rightarrow 10.0.3.2

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

- **show ip ospf database**
- **show ip ospf neighbor**

 TuongB2206021 [Running] - Oracle VM VirtualBox



The screenshot shows an XTerm window running on a Linux system (root@bb1: /). The terminal session starts with a telnet connection to localhost ospfd, followed by a greeting from Quagga (version 1.2.4) with copyright information. It then prompts for User Access Verification and displays the OSPF Router ID (10.0.3.1). The Router Link States (Area 0.0.0.0) table lists five entries with columns: Link ID, ADV Router, Age, Seq#, CkSum, and Link count. The Net Link States (Area 0.0.0.0) table lists five entries with the same columns. Finally, the show ip ospf neighbor command is run, displaying a table of neighbors with columns: Neighbor ID, Pri, State, Dead Time, Address, Interface, RXmtL, RqstL, DBsmL, and DROther.

```
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:
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      1048 0x80000008 0xdfff 2
10.0.2.2      10.0.2.2      1038 0x80000007 0xdbfe 2
10.0.2.3      10.0.2.3      1038 0x8000000a 0xd9d4 2
10.0.3.1      10.0.3.1      1036 0x80000008 0x288d 2
10.0.3.2      10.0.3.2      1042 0x80000007 0x4290 2

      Net Link States (Area 0.0.0.0)

      Link ID      ADV Router      Age  Seq#      CkSum
10.0.0.1      10.0.3.1      1049 0x80000002 0x69a9
10.0.1.2      10.0.2.2      1051 0x80000001 0x69bb
10.0.2.1      10.0.3.2      1042 0x80000002 0x729a
10.0.3.2      10.0.3.2      1048 0x80000001 0x6bb3

ospfd> show ip ospf neighbor

      Neighbor ID      Pri  State      Dead Time  Address      Interface      RXmtL  RqstL  DBsmL
10.0.1.1          1  Full/DROther  33.915s 10.0.0.2      eth0:10.0.0.1          0      0      0
10.0.2.3          1  Full/Backup   33.914s 10.0.0.3      eth0:10.0.0.1          0      0      0
10.0.3.2          1  Full/DR       33.915s 10.0.3.2      eth1:10.0.3.1          0      0      0

ospfd>
```

show ip ospf database: Displays information about the OSPF link-state database (LSDB), which contains all the link-state advertisements (LSAs) used by OSPF to create the network routing topology.

show ip ospf neighbor: Displays information about the OSPF neighbors with which the router has formed adjacencies.

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

root@bb2: /

```
>Password:  
ospfd> show ip ospf database  
  
OSPF Router with ID (10.0.1.1)  
  
        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      1426 0x80000007 0xe1fe 2  
10.0.2.2    10.0.2.2      1427 0x80000007 0xdbfe 2  
10.0.2.3    10.0.2.3      1429 0x8000000a 0xd9d4 2  
10.0.3.1    10.0.3.1      1434 0x80000008 0x288d 2  
10.0.3.2    10.0.3.2      1432 0x80000007 0x4290 2  
  
        Net Link States (Area 0.0.0.0)  
  
Link ID      ADV Router      Age  Seq#      CkSum  
10.0.0.1    10.0.3.1      1432 0x80000002 0x69a9  
10.0.1.2    10.0.2.2      137   0x80000002 0x67bc  
10.0.2.1    10.0.3.2      1434 0x80000002 0x729a  
10.0.3.2    10.0.3.2      1434 0x80000001 0x6bb3  
  
ospfd>
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

root@bb2: /

```
ospfd> show ip ospf neighbor  
  
Neighbor ID      Pri State          Dead Time Ad  
                  RXmtL RqstL DBsmL  
10.0.3.1          1 Full/DR        33.298s 10  
                  0     0     0  
10.0.2.3          1 Full/Backup     33.299s 10  
                  0     0     0  
10.0.2.2          1 Full/DR        33.299s 10  
                  0     0     0  
ospfd>
```

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

- **show ip ospf interface:** Displays information about OSPF settings for different interfaces on the router.

```
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:
ospfd> show ip ospf interface
eth0 is up
    ifindex 49, 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 0x80000002
    Multicast group memberships: OSPFAllRouters OSPFDesignatedRouters
    Timer intervals configured, Hello 10s, Dead 40s, Wait 40s, Retransmit 5
        Hello due in 2.668s
    Neighbor Count is 2, Adjacent neighbor count is 2
eth1 is up
    ifindex 52, 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 2.668s
    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
ospfd>
```

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

tcpdump (On bb1)

```
root@bb1:/# tcpdump -v
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), snapshot length 262144 bytes
07:50:07.914933 IP 10.0.0.1 > 224.0.0.5: OSPFv2, Hello, length 52
07:50:07.916206 IP 10.0.0.2 > 224.0.0.5: OSPFv2, Hello, length 52
07:50:07.919480 IP 10.0.0.3 > 224.0.0.5: OSPFv2, Hello, length 52
07:50:17.921636 IP 10.0.0.1 > 224.0.0.5: OSPFv2, Hello, length 52
07:50:17.922405 IP 10.0.0.2 > 224.0.0.5: OSPFv2, Hello, length 52
07:50:17.922996 IP 10.0.0.3 > 224.0.0.5: OSPFv2, Hello, length 52
07:50:27.922610 IP 10.0.0.1 > 224.0.0.5: OSPFv2, Hello, length 52
07:50:27.922579 IP 10.0.0.2 > 224.0.0.5: OSPFv2, Hello, length 52
07:50:27.923159 IP 10.0.0.3 > 224.0.0.5: OSPFv2, Hello, length 52
tcpdump>
```

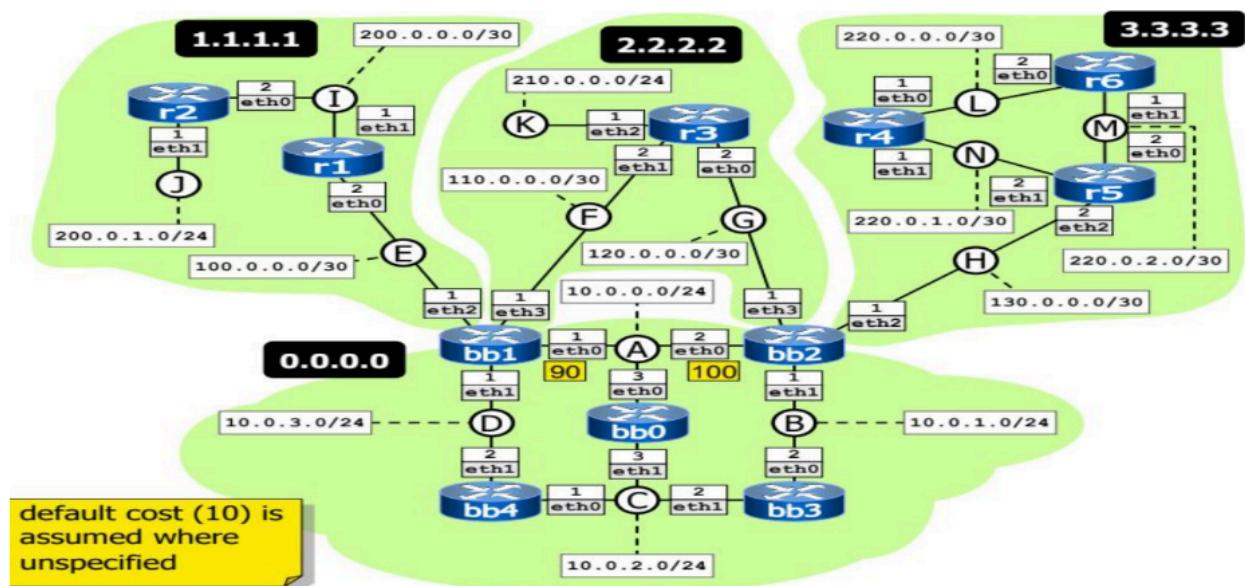
Routers send "Hello" packets to each other automatically, so there's no need for manual ping commands. This is the key part of how OSPF works as a dynamic routing protocol. These Hello packets help routers find one another, check that they're connected, and keep their routing information up to date

Clean the lab

\$ kathara clean

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$ kathara lclean
Stopping Network Scenario
[Deleting devices] 5/5
[Deleting collision domains] 4/4
b2206021@TuongB2206021:~/CT106H/lab3/exercises14$
```

Exercise 15 (ospf-multiarea)



Answer:

Create exercises15 directory

\$ mkdir -p ~/CT106H/lab3/exercises15

\$ cd ~/CT106H/lab3/exercises15

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ mkdir -p CT106H/lab3/exercises15
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cd CT106H/lab3/exercises15
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$
```

Prepare the lab

```
$ mkdir -p bb0/etc/zebra bb1/etc/zebra bb2/etc/zebra bb3/etc/zebra bb4/etc/zebra  
r1/etc/zebra  r2/etc/zebra  r3/etc/zebra  r4/etc/zebra  r5/etc/zebra  r6/etc/zebra  
shared  
$ gedit lab.conf  
$ gedit bb0.startup  
$ gedit bb1.startup  
$ gedit bb2.startup  
$ gedit bb3.startup  
$ gedit bb4.startup  
$ gedit r1.startup  
$ gedit r2.startup  
$ gedit r3.startup  
$ gedit r4.startup  
$ gedit r5.startup  
$ gedit r6.startup  
$ gedit bb0/etc/zebra/daemons  
$ gedit bb0/etc/zebra/ospfd.conf  
$ gedit bb1/etc/zebra/daemons  
$ gedit bb1/etc/zebra/ospfd.conf  
$ gedit bb2/etc/zebra/daemons  
$ gedit bb2/etc/zebra/ospfd.conf  
$ gedit bb3/etc/zebra/daemons  
$ gedit bb3/etc/zebra/ospfd.conf  
$ gedit bb4/etc/zebra/daemons  
$ gedit bb4/etc/zebra/ospfd.conf  
$ gedit r1/etc/zebra/daemons  
$ gedit r1/etc/zebra/ospfd.conf  
$ gedit r2/etc/zebra/daemons  
$ gedit r2/etc/zebra/ospfd.conf  
$ gedit r3/etc/zebra/daemons  
$ gedit r3/etc/zebra/ospfd.conf  
$ gedit r4/etc/zebra/daemons  
$ gedit r4/etc/zebra/ospfd.conf  
$ gedit r5/etc/zebra/daemons  
$ gedit r5/etc/zebra/ospfd.conf  
$ gedit r6/etc/zebra/daemons  
$ gedit r6/etc/zebra/ospfd.conf
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal 23

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises15$ tree
.
├── bb0
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── bb0.startup
├── bb1
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── bb1.startup
├── bb2
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── bb2.startup
├── bb3
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── bb3.startup
├── bb4
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── bb4.startup
└── lab.conf
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal 23 ຕ.ອ. 15:07

```
b2206021@TuongB2206021: ~/CT106H/lab3/exercises15$ tree
.
└── etc
    └── zebra
        ├── daemons
        └── ospfd.conf
├── r1.startup
├── r2
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── r2.startup
├── r3
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── r3.startup
├── r4
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── r4.startup
├── r5
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── r5.startup
├── r6
│   └── etc
│       └── zebra
│           ├── daemons
│           └── ospfd.conf
├── r6.startup
└── shared
```

34 directories, 34 files

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat lab.conf
bb0[0]=A
bb0[1]=C

bb1[0]=A
bb1[1]=D
bb1[2]=E
bb1[3]=F

bb2[0]=A
bb2[1]=B
bb2[2]=H
bb2[3]=G

bb3[0]=B
bb3[1]=C

bb4[0]=C
bb4[1]=D

r1[0]=E
r1[1]=I
r2[0]=I
r2[1]=J
r3[0]=G
r3[1]=F
r3[2]=K
r4[0]=L
r4[1]=N
r5[0]=M
r5[1]=N
r5[2]=H
r6[0]=L
r6[1]=M

b2206021@TuongB2206021:~/CT106H/lab3/exercises15$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb0.startup
ifconfig eth0 10.0.0.3 netmask 255.255.255.0 up
ifconfig eth1 10.0.2.3 netmask 255.255.255.0 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb1.startup
ifconfig eth0 10.0.0.1 netmask 255.255.255.0 up
ifconfig eth1 10.0.3.1 netmask 255.255.255.0 up
ifconfig eth2 100.0.0.1 netmask 255.255.255.252 up
ifconfig eth3 110.0.0.1 netmask 255.255.255.252 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb2.startup
ifconfig eth0 10.0.0.2 netmask 255.255.255.0 up
ifconfig eth1 10.0.1.1 netmask 255.255.255.0 up
ifconfig eth2 130.0.0.1 netmask 255.255.255.252 up
ifconfig eth3 120.0.0.1 netmask 255.255.255.252 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb3.startup
ifconfig eth0 10.0.1.2 netmask 255.255.255.0 up
UbuntuSoftware 3.0.2.2 netmask 255.255.255.0 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb4.startup
ifconfig eth0 10.0.2.1 netmask 255.255.255.0 up
ifconfig eth1 10.0.3.2 netmask 255.255.255.0 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r1.startup
ifconfig eth0 100.0.0.2 netmask 255.255.255.252 up
ifconfig eth1 200.0.0.1 netmask 255.255.255.252 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r2.startup
ifconfig eth0 200.0.0.2 netmask 255.255.255.252 up
ifconfig eth1 200.0.1.1 netmask 255.255.255.0 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r3.startup
ifconfig eth0 120.0.0.2 netmask 255.255.255.252 up
ifconfig eth1 110.0.0.2 netmask 255.255.255.252 up
ifconfig eth2 210.0.0.1 netmask 255.255.255.0 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r4.startup
ifconfig eth0 220.0.0.1 netmask 255.255.255.252 up
ifconfig eth1 220.0.1.1 netmask 255.255.255.252 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r5.startup
ifconfig eth0 220.0.2.2 netmask 255.255.255.252 up
ifconfig eth1 220.0.1.2 netmask 255.255.255.252 up
ifconfig eth2 130.0.0.2 netmask 255.255.255.252 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r6.startup
ifconfig eth0 220.0.0.2 netmask 255.255.255.252 up
ifconfig eth1 220.0.2.1 netmask 255.255.255.252 up
/etc/init.d/zebra start
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r1/etc/zebra/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r1/etc/zebra/ospfd.conf
!
hostname ospfd
password zebra
enable password zebra
!
router ospf
! Speak OSPF on all interfaces falling in the listed subnets
network 100.0.0.0/30 area 1.1.1.1
network 200.0.0.0/16 area 1.1.1.1
area 1.1.1.1 stub
redistribute connected
!
log file /var/log/zebra/ospfd.log
!
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r2/etc/zebra/ospfd.conf
!
hostname ospfd
password zebra
enable password zebra
!
router ospf
! Speak OSPF on all interfaces falling in the listed subnets
network 200.0.0.0/16 area 1.1.1.1
area 1.1.1.1 stub
redistribute connected
!
log file /var/log/zebra/ospfd.log
!
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r3/etc/zebra/ospfd.conf
!
hostname ospfd
password zebra
enable password zebra
!
router ospf
! Speak OSPF on all interfaces falling in the listed subnets
network 210.0.0.0/16 area 2.2.2.2
network 110.0.0.0/30 area 2.2.2.2
network 120.0.0.0/30 area 2.2.2.2
area 2.2.2.2 stub
redistribute connected
!
log file /var/log/zebra/ospfd.log
!
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r4/etc/zebra/ospfd.conf
!
hostname ospfd
password zebra
enable password zebra
!
router ospf
! Speak OSPF on all interfaces falling in the listed subnets
network 220.0.0.0/16 area 3.3.3.3
area 3.3.3.3 stub
redistribute connected
!
log file /var/log/zebra/ospfd.log
!
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r5/etc/zebra/ospfd.conf
!
hostname ospfd
password zebra
enable password zebra
!
router ospf
! Speak OSPF on all interfaces falling in the listed subnets
network 220.0.0.0/16 area 3.3.3.3
network 130.0.0.0/30 area 3.3.3.3
area 3.3.3.3 stub
redistribute connected
!
log file /var/log/zebra/ospfd.log
!
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat r6/etc/zebra/ospfd.conf
!
hostname ospfd
password zebra
enable password zebra
!
router ospf
! Speak OSPF on all interfaces falling in the listed subnets
network 220.0.0.0/16 area 3.3.3.3
area 3.3.3.3 stub
redistribute connected
!
log file /var/log/zebra/ospfd.log
!
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb0/etc/zebra/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb0/etc/zebra/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
!
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb1/etc/zebra/ospfd.conf
!
hostname ospfd
password zebra
enable password zebra
!
interface eth0
ospf cost 90
!
router ospf
! Speak OSPF on all interfaces falling in the listed subnets
network 10.0.0.0/16 area 0.0.0.0
network 100.0.0.0/30 area 1.1.1.1
network 110.0.0.0/30 area 2.2.2.2
area 1.1.1.1 stub
area 2.2.2.2 stub
redistribute connected
!
log file /var/log/zebra/ospfd.log
!
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb2/etc/zebra/ospfd.conf
!
hostname ospfd
password zebra
enable password zebra
!
interface eth0
ospf cost 100
!
router ospf
! Speak OSPF on all interfaces falling in the listed subnets
network 10.0.0.0/16 area 0.0.0.0
network 120.0.0.0/30 area 2.2.2.2
network 130.0.0.0/30 area 3.3.3.3
area 2.2.2.2 stub
area 3.3.3.3 stub
redistribute connected
!
log file /var/log/zebra/ospfd.log
!
```

TuongB2206021 [Running] - Oracle VM VirtualBox

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb3/etc/zebra/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
!
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ cat bb4/etc/zebra/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
!
```

Start the lab

\$ kathara lstart

TuongB2206021 [Running] - Oracle VM VirtualBox

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ kathara lstart
root@bb2: / - X - 1/14
root@bb3: / - X - 2/14
root@r2: / - X - 3/14
root@r1: / - X - 4/14
root@r3: / - X - 5/14
root@r4: / - X - 6/14
root@r6: / - X - 7/14
root@bb1: / - X - 8/14
root@bb4: / - X - 9/14
root@bb0: / - X - 10/14
root@r5: / - X - 11/14
root@r0: / - X - 12/14
root@r7: / - X - 13/14
root@r8: / - X - 14/14

root@bb0: / --- Startup Commands Log
++ ifconfig eth0 10.0.0.3 netmask 255.255.255.0 up
++ ifconfig eth1 10.0.0.23 netmask 255.255.255.0 up
++ /etc/init.d/zebra start
Starting Quagga daemons (priorities: zebra ospfd).
Starting Quagga monitor daemon: watchquagga.
--- End Startup Commands Log
root@bb0:/#
```

Testing connectivity

route -n (On r1 r6 bb2 bb4)

The screenshot shows two terminal windows side-by-side. The left window is titled "root@r1: /" and the right window is titled "root@r6: /". Both windows display the output of the "route -n" command, showing the Kernel IP routing table.

root@r1: /

```
root@r1:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref    Use Iface
0.0.0.0         100.0.0.1      0.0.0.0       UG    20      0        0 eth0
10.0.0.0        100.0.0.1      255.255.255.0 UG    20      0        0 eth0
10.0.1.0        100.0.0.1      255.255.255.0 UG    20      0        0 eth0
10.0.2.0        100.0.0.1      255.255.255.0 UG    20      0        0 eth0
10.0.3.0        100.0.0.1      255.255.255.0 UG    20      0        0 eth0
100.0.0.0       0.0.0.0        255.255.255.252 U   0      0        0 eth0
110.0.0.0       100.0.0.1      255.255.255.252 UG   20      0        0 eth0
120.0.0.0       100.0.0.1      255.255.255.252 UG   20      0        0 eth0
130.0.0.0       100.0.0.1      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 eth1
200.0.1.0       200.0.0.2      255.255.255.0  UG   20      0        0 eth1
210.0.0.0       100.0.0.1      255.255.255.0  UG   20      0        0 eth0
220.0.0.0       100.0.0.1      255.255.255.252 UG   20      0        0 eth0
220.0.1.0       100.0.0.1      255.255.255.252 UG   20      0        0 eth0
220.0.2.0       100.0.0.1      255.255.255.252 UG   20      0        0 eth0
```

root@r6: /

```
root@r6:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref    Use Iface
0.0.0.0         220.0.2.2      0.0.0.0       UG    20      0        0 eth1
10.0.0.0        220.0.2.2      255.255.255.0 UG    20      0        0 eth1
10.0.1.0        220.0.2.2      255.255.255.0 UG    20      0        0 eth1
10.0.2.0        220.0.2.2      255.255.255.0 UG    20      0        0 eth1
10.0.3.0        220.0.2.2      255.255.255.0 UG    20      0        0 eth1
100.0.0.0       220.0.2.2      255.255.255.252 UG   20      0        0 eth1
110.0.0.0       220.0.2.2      255.255.255.252 UG   20      0        0 eth1
120.0.0.0       220.0.2.2      255.255.255.252 UG   20      0        0 eth1
130.0.0.0       220.0.2.2      255.255.255.252 UG   20      0        0 eth1
200.0.0.0       220.0.2.2      255.255.255.252 UG   20      0        0 eth1
200.0.1.0       220.0.2.2      255.255.255.0  UG   20      0        0 eth1
210.0.0.0       220.0.2.2      255.255.255.0  UG   20      0        0 eth1
220.0.0.0       0.0.0.0        255.255.255.252 U   0      0        0 eth0
220.0.1.0       220.0.0.1      255.255.255.252 UG   20      0        0 eth0
220.0.2.0       0.0.0.0        255.255.255.252 U   0      0        0 eth1
```

TuongB2206021 [Running] - Oracle VM VirtualBox

```
root@bb2: # 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        0.0.0.0        255.255.255.0 U     0      0        0 eth1
10.0.2.0        10.0.1.2       255.255.255.0 UG    20     0        0 eth1
10.0.3.0        10.0.1.2       255.255.255.0 UG    20     0        0 eth1
100.0.0.0       10.0.1.2       255.255.255.252 UG   20     0        0 eth1
110.0.0.0       120.0.0.2      255.255.255.252 UG   20     0        0 eth3
120.0.0.0       0.0.0.0        255.255.255.252 U     0      0        0 eth3
130.0.0.0       0.0.0.0        255.255.255.252 U     0      0        0 eth2
200.0.0.0       10.0.1.2       255.255.255.252 UG   20     0        0 eth1
200.0.1.0       10.0.1.2       255.255.255.0 UG    20     0        0 eth1
210.0.0.0       120.0.0.2      255.255.255.0 UG    20     0        0 eth3
220.0.0.0       130.0.0.2      255.255.255.252 UG   20     0        0 eth2
220.0.1.0       130.0.0.2      255.255.255.252 UG   20     0        0 eth2
220.0.2.0       130.0.0.2      255.255.255.252 UG   20     0        0 eth2

root@bb4: # route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref    Use Iface
10.0.0.0        10.0.2.3       255.255.255.0 UG    20     0        0 eth0
10.0.1.0        10.0.2.2       255.255.255.0 UG    20     0        0 eth0
10.0.2.0        0.0.0.0        255.255.255.0 U     0      0        0 eth0
10.0.3.0        0.0.0.0        255.255.255.0 U     0      0        0 eth1
100.0.0.0       10.0.3.1       255.255.255.252 UG   20     0        0 eth1
110.0.0.0       10.0.3.1       255.255.255.252 UG   20     0        0 eth1
120.0.0.0       10.0.3.1       255.255.255.252 UG   20     0        0 eth1
130.0.0.0       10.0.2.2       255.255.255.252 UG   20     0        0 eth0
200.0.0.0       10.0.3.1       255.255.255.0 UG    20     0        0 eth1
200.0.1.0       10.0.3.1       255.255.255.0 UG    20     0        0 eth1
210.0.0.0       10.0.3.1       255.255.255.0 UG    20     0        0 eth1
220.0.0.0       10.0.2.2       255.255.255.252 UG   20     0        0 eth0
220.0.1.0       10.0.2.2       255.255.255.252 UG   20     0        0 eth0
220.0.2.0       10.0.2.2       255.255.255.252 UG   20     0        0 eth0
```

ping -c 2 220.0.1.1 (r2 ping to eth1 r4)

ping -c 2 10.0.1.2 (r3 ping to eth0 bb3)

TuongB2206021 [Running] - Oracle VM VirtualBox

```
root@r2: # ping -c 2 220.0.1.1
PING 220.0.1.1 (220.0.1.1) 56(84) bytes of data.
64 bytes from 220.0.1.1: icmp_seq=1 ttl=58 time=53.9 ms
64 bytes from 220.0.1.1: icmp_seq=2 ttl=58 time=4.10 ms

--- 220.0.1.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 4.100/28.994/53.889/24.894 ms

root@r3: # ping -c 2 10.0.1.2
PING 10.0.1.2 (10.0.1.2) 56(84) bytes of data.
64 bytes from 10.0.1.2: icmp_seq=1 ttl=63 time=2.91 ms
64 bytes from 10.0.1.2: icmp_seq=2 ttl=63 time=1.61 ms

--- 10.0.1.2 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 1.612/2.260/2.908/0.648 ms
```

```
# ping -c 2 10.0.1.2 (r4 ping to eth1 bb4)
# ping -c 2 210.0.0.1 (bb2 ping to eth2 r3)
```

```
root@r4:/# ping -c 2 10.0.3.2
PING 10.0.3.2 (10.0.3.2) 56(84) bytes of data.
64 bytes from 10.0.3.2: icmp_seq=1 ttl=61 time=42.4 ms
64 bytes from 10.0.3.2: icmp_seq=2 ttl=61 time=4.19 ms

--- 10.0.3.2 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 4.185/23.276/42.368/19.091 ms

root@bb2:/# ping -c 2 210.0.0.1
PING 210.0.0.1 (210.0.0.1) 56(84) bytes of data.
64 bytes from 210.0.0.1: icmp_seq=1 ttl=64 time=0.779 ms
64 bytes from 210.0.0.1: icmp_seq=2 ttl=64 time=0.554 ms

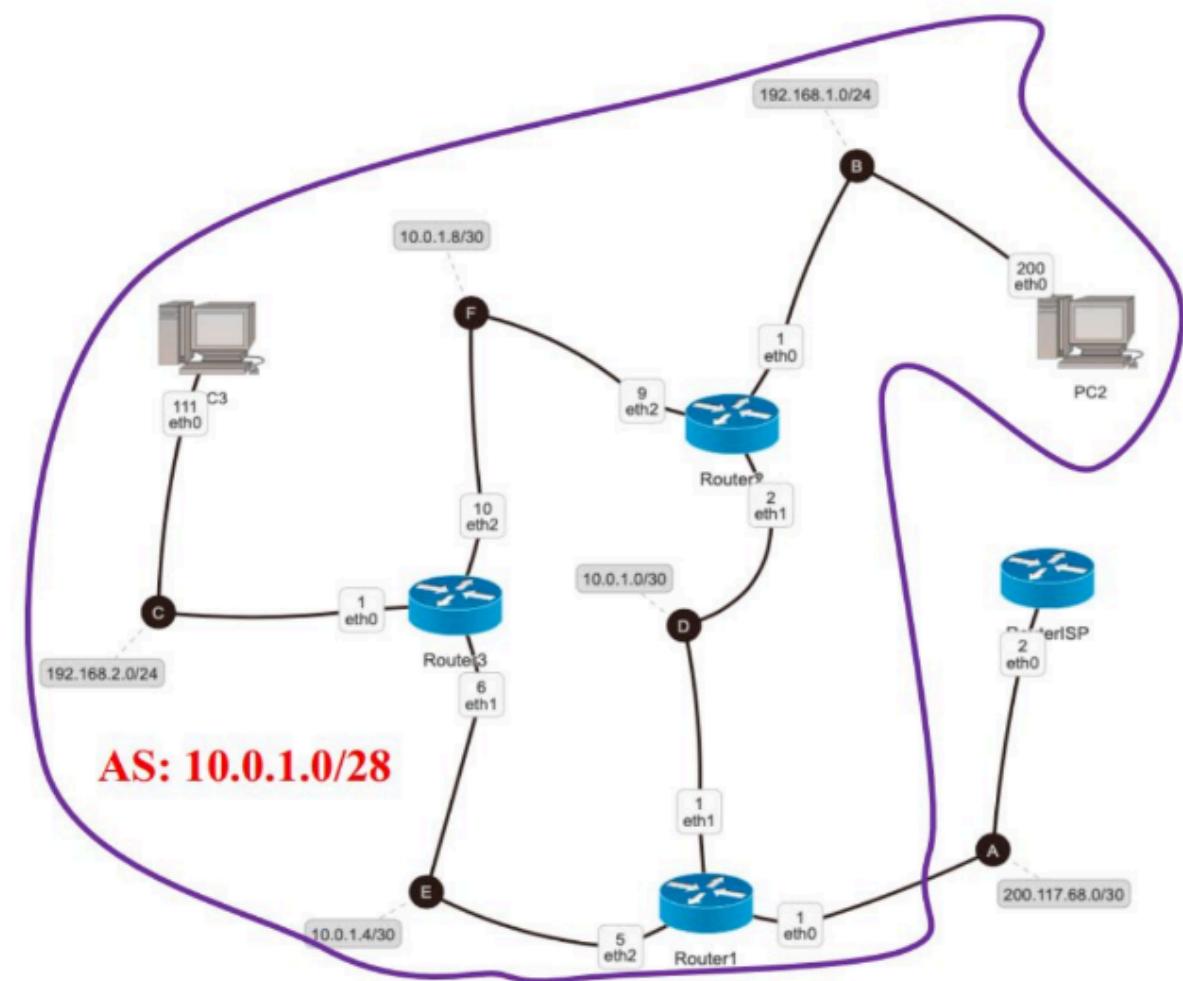
--- 210.0.0.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1029ms
rtt min/avg/max/mdev = 0.554/0.666/0.779/0.112 ms
```

Clean the lab

\$ kathara lclean

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$ kathara lclean
Stopping Network Scenario
[Deleting devices] 11/11
[Deleting collision domains] 14/14
b2206021@TuongB2206021:~/CT106H/lab3/exercises15$
```

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



Answer:

Create exercises16 directory

```
$ mkdir -p ~/CT106H/lab3/exercises16
```

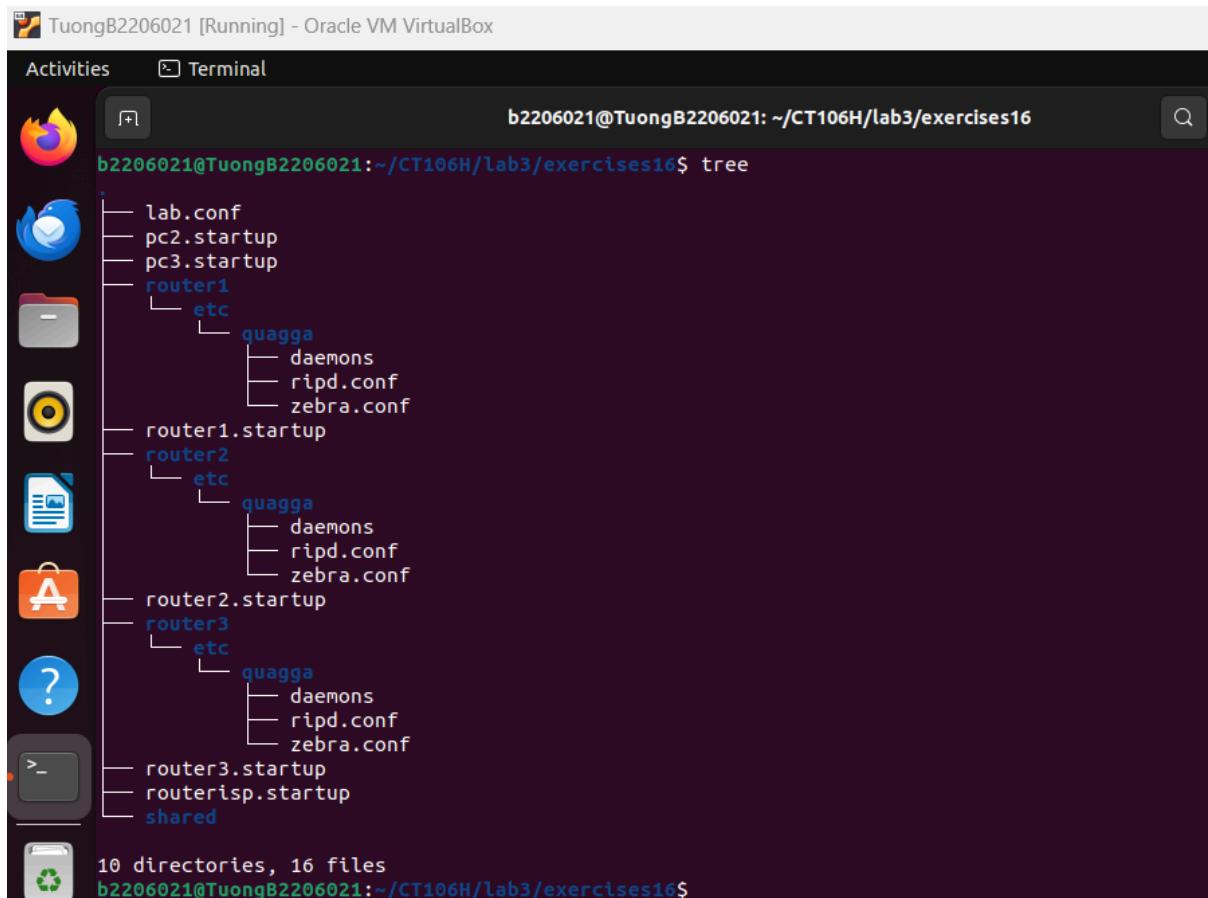
```
$ cd ~/CT106H/lab3/exercises16
```

```
TuongB2206021 [Running] - Oracle VM VirtualBox
```

```
Activities Terminal
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ b2206021@TuongB2206021:~$ mkdir -p ~/CT106H/lab3/exercises16
b2206021@TuongB2206021:~$ cd ~/CT106H/lab3/exercises16
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$
```

Prepare the lab

```
$ mkdir router1/etc/quagga router2/etc/quagga router3/etc/quagga shared  
$ gedit lab.conf  
$ gedit pc2.startup  
$ gedit pc3.startup  
$ gedit router1.startup  
$ gedit router2.startup  
$ gedit router3.startup  
$ gedit routerisp.startup  
$ gedit router1/etc/quagga/daemons  
$ gedit router1/etc/quagga/ripd.conf  
$ gedit router1/etc/quagga/zebra.conf  
$ gedit router2/etc/quagga/daemons  
$ gedit router2/etc/quagga/ripd.conf  
$ gedit router2/etc/quagga/zebra.conf  
$ gedit router3/etc/quagga/daemons  
$ gedit router3/etc/quagga/ripd.conf  
$ gedit router3/etc/quagga/zebra.conf
```



```
Activities Terminal b2206021@TuongB2206021: ~/CT106H/lab3/exercises16$ tree  
.  
├── lab.conf  
├── pc2.startup  
├── pc3.startup  
└── router1  
    └── etc  
        └── quagga  
            ├── daemons  
            ├── ripd.conf  
            └── zebra.conf  
├── router1.startup  
└── router2  
    └── etc  
        └── quagga  
            ├── daemons  
            ├── ripd.conf  
            └── zebra.conf  
├── router2.startup  
└── router3  
    └── etc  
        └── quagga  
            ├── daemons  
            ├── ripd.conf  
            └── zebra.conf  
├── router3.startup  
└── routerisp.startup  
└── shared  
  
10 directories, 16 files  
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat lab.conf
pc2[0]=B
pc3[0]=C

router1[0]=A
router1[1]=D
router1[2]=E

router2[0]=B
router2[1]=D
router2[2]=F

router3[0]=C
router3[1]=E
router3[2]=F

routerisp[0]=A
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat pc2.startup
ifconfig eth0 192.168.1.200/24
route add default gw 192.168.1.1
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat pc3.startup
ifconfig eth0 192.168.2.111/24 up
route add default gw 192.168.2.1
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat router1.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
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat router2.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
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat router3.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
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat routerisp.startup
ifconfig eth0 200.117.68.2/30 up
route add default gw 200.117.68.1
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities Terminal

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat router1/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat router1/etc/quagga/ripd.conf
hostname ripd
password zebra
enable password zebra
router rip
redistribute connected
network 10.0.1.0/28
log file /var/log/quagga/ripd.log
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat router1/etc/quagga/zebra.conf
hostname router1
password zebra
enable password zebra
log file /var/log/quagga/zebra.log
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat router2/etc/quagga/zebra.conf
hostname router2
password zebra
enable password zebra
log file /var/log/quagga/zebra.log
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ cat router3/etc/quagga/zebra.conf
hostname router3
password zebra
enable password zebra
log file /var/log/quagga/zebra.log
```

Start the lab

\$ kathara lstart

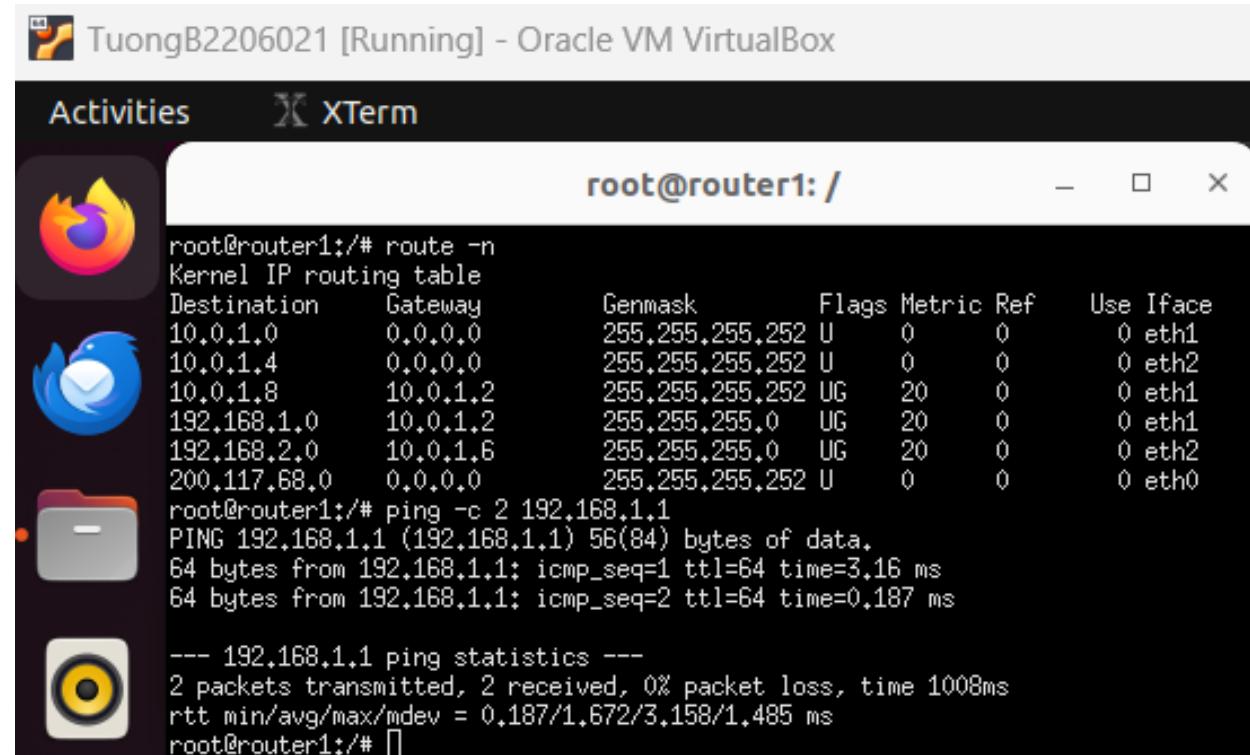
TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ kathara lstart
Starting Network...
root@router1: / root@pc2: /
root@router2: / root@pc3: /
root@router3: / root@routerisp: /
--- Startup Commands Log
++ 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
Starting Quagga daemons (prior:10); zebra ripd.
Starting Quagga monitor daemon; watchquagga.
--- End Startup Commands Log
root@router3:/#
```

Testing connectivity

route -n (On router1 router2 router3)

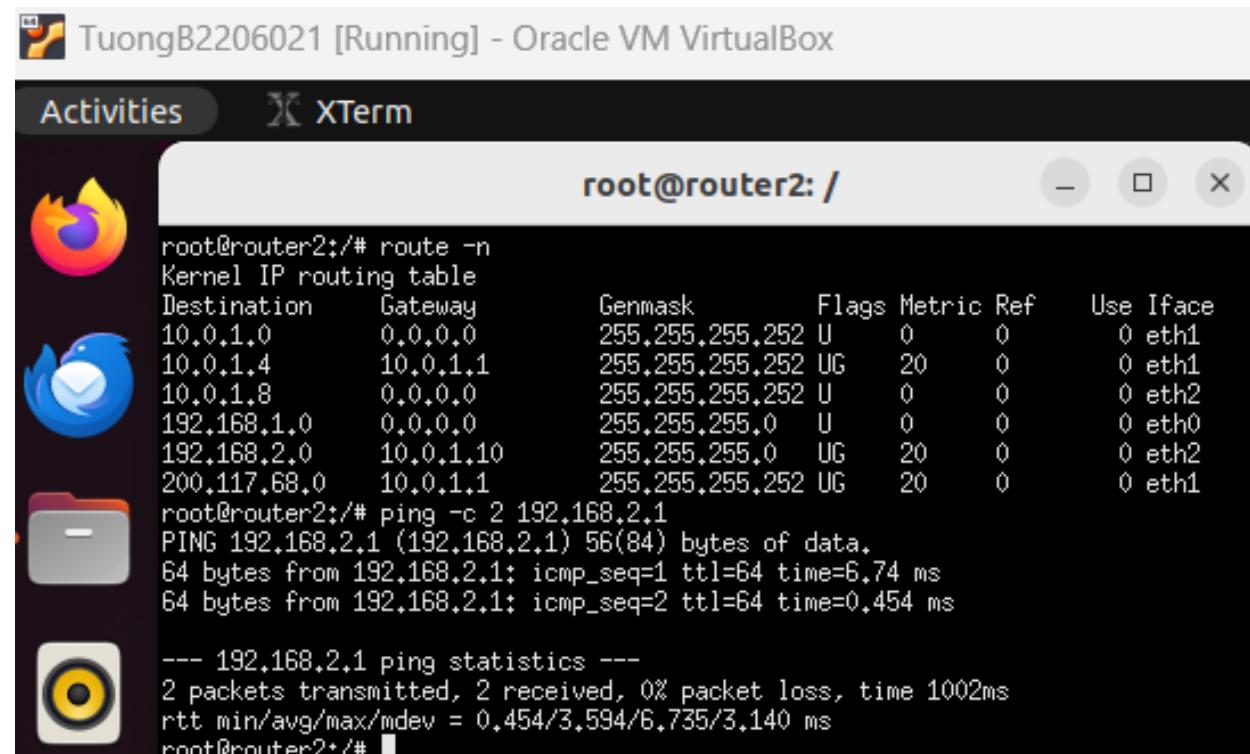


TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

root@router1: /

```
root@router1:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref Use Iface
10.0.1.0        0.0.0.0        255.255.255.252 U     0      0      0 eth1
10.0.1.4        0.0.0.0        255.255.255.252 U     0      0      0 eth2
10.0.1.8        10.0.1.2       255.255.255.252 UG    20      0      0 eth1
192.168.1.0     10.0.1.2       255.255.255.0   UG    20      0      0 eth1
192.168.2.0     10.0.1.6       255.255.255.0   UG    20      0      0 eth2
200.117.68.0    0.0.0.0        255.255.255.252 U     0      0      0 eth0
root@router1:/# ping -c 2 192.168.1.1
PING 192.168.1.1 (192.168.1.1) 56(84) bytes of data,
64 bytes from 192.168.1.1: icmp_seq=1 ttl=64 time=3.16 ms
64 bytes from 192.168.1.1: icmp_seq=2 ttl=64 time=0.187 ms
--- 192.168.1.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1008ms
rtt min/avg/max/mdev = 0.187/1.672/3.158/1.485 ms
root@router1:/#
```



TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

root@router2: /

```
root@router2:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref Use Iface
10.0.1.0        0.0.0.0        255.255.255.252 U     0      0      0 eth1
10.0.1.4        10.0.1.1       255.255.255.252 UG    20      0      0 eth1
10.0.1.8        0.0.0.0        255.255.255.252 U     0      0      0 eth2
192.168.1.0     0.0.0.0        255.255.255.0   U     0      0      0 eth0
192.168.2.0     10.0.1.10      255.255.255.0   UG    20      0      0 eth2
200.117.68.0    10.0.1.1       255.255.255.252 UG    20      0      0 eth1
root@router2:/# ping -c 2 192.168.2.1
PING 192.168.2.1 (192.168.2.1) 56(84) bytes of data,
64 bytes from 192.168.2.1: icmp_seq=1 ttl=64 time=6.74 ms
64 bytes from 192.168.2.1: icmp_seq=2 ttl=64 time=0.454 ms
--- 192.168.2.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 0.454/3.594/6.735/3.140 ms
root@router2:/#
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

```
root@router3: /  
root@router3:/# route -n  
Kernel IP routing table  
Destination     Gateway      Genmask      Flags Metric Ref Use Iface  
10.0.1.0        10.0.1.5    255.255.255.252 UG    20      0      0 eth1  
10.0.1.4        0.0.0.0     255.255.255.252 U      0      0      0 eth1  
10.0.1.8        0.0.0.0     255.255.255.252 U      0      0      0 eth2  
192.168.1.0    10.0.1.9    255.255.255.0   UG    20      0      0 eth2  
192.168.2.0    0.0.0.0     255.255.255.0   U      0      0      0 eth0  
200.117.68.0   10.0.1.5    255.255.255.252 UG    20      0      0 eth1  
root@router3:/# ping -c 2 200.117.68.1  
PING 200.117.68.1 (200.117.68.1) 56(84) bytes of data.  
64 bytes from 200.117.68.1: icmp_seq=1 ttl=64 time=0.532 ms  
64 bytes from 200.117.68.1: icmp_seq=2 ttl=64 time=0.306 ms  
--- 200.117.68.1 ping statistics ---  
2 packets transmitted, 2 received, 0% packet loss, time 1047ms  
rtt min/avg/max/mdev = 0.306/0.419/0.532/0.113 ms  
root@router3: #
```

```
# ping -c 2 192.168.2.111 (pc2 ping to eth0 pc3)  
# ping -c 2 10.0.1.5 (pc2 ping to eth2 router1)
```

TuongB2206021 [Running] - Oracle VM VirtualBox

Activities XTerm

```
root@pc2: /  
root@pc2:/# ping -c 2 192.168.2.111  
PING 192.168.2.111 (192.168.2.111) 56(84) bytes of data.  
64 bytes from 192.168.2.111: icmp_seq=1 ttl=62 time=3.16 ms  
64 bytes from 192.168.2.111: icmp_seq=2 ttl=62 time=2.19 ms  
--- 192.168.2.111 ping statistics ---  
2 packets transmitted, 2 received, 0% packet loss, time 1015ms  
rtt min/avg/max/mdev = 2.194/2.675/3.156/0.481 ms  
root@pc2:/# ping -c 2 10.0.1.5  
PING 10.0.1.5 (10.0.1.5) 56(84) bytes of data.  
64 bytes from 10.0.1.5: icmp_seq=1 ttl=63 time=2.19 ms  
64 bytes from 10.0.1.5: icmp_seq=2 ttl=63 time=1.25 ms  
--- 10.0.1.5 ping statistics ---  
2 packets transmitted, 2 received, 0% packet loss, time 1038ms  
rtt min/avg/max/mdev = 1.246/1.718/2.191/0.472 ms  
root@pc2: #
```

```
# ping -c 2 192.168.1.200 (pc3 ping to eth0 pc2)
# ping -c 2 10.0.1.9 (pc3 ping to eth2 router2)
```

```
root@pc3:/# ping -c 2 192.168.1.200
PING 192.168.1.200 (192.168.1.200) 56(84) bytes of data,
64 bytes from 192.168.1.200: icmp_seq=1 ttl=62 time=2.20 ms
64 bytes from 192.168.1.200: icmp_seq=2 ttl=62 time=2.14 ms

--- 192.168.1.200 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1040ms
rtt min/avg/max/mdev = 2.137/2.166/2.195/0.029 ms
root@pc3:/# ping -c 2 10.0.1.9
PING 10.0.1.9 (10.0.1.9) 56(84) bytes of data.
64 bytes from 10.0.1.9: icmp_seq=1 ttl=63 time=1.74 ms
64 bytes from 10.0.1.9: icmp_seq=2 ttl=63 time=1.01 ms

--- 10.0.1.9 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1007ms
rtt min/avg/max/mdev = 1.010/1.373/1.737/0.363 ms
root@pc3:/#
```

route -n (On routerisp)

ping -c 2 192.168.2.1 (routerisp ping to eth0 router3)

RouterISP doesn't run the RIPv2 protocol so it just connect to only router1

```
root@routerisp:/# route -n
Kernel IP routing table
Destination      Gateway         Genmask        Flags Metric Ref  Use Iface
0.0.0.0          200.117.68.1   0.0.0.0        UG    0      0      0 eth0
200.117.68.0     0.0.0.0        255.255.255.252 U      0      0      0 eth0
root@routerisp:/# ping -c 2 192.168.2.1
PING 192.168.2.1 (192.168.2.1) 56(84) bytes of data.
64 bytes from 192.168.2.1: icmp_seq=1 ttl=63 time=1.33 ms
64 bytes from 192.168.2.1: icmp_seq=2 ttl=63 time=0.734 ms

--- 192.168.2.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 0.734/1.033/1.333/0.299 ms
root@routerisp:/#
```

Clean the lab

\$ kathara clean

```
b2206021@TuongB2206021:~/CT106H/lab3/exercises16$ kathara lclean
Stopping Network Scenario
[Deleting devices] 6/6
[Deleting collision domains] 6/6
```

