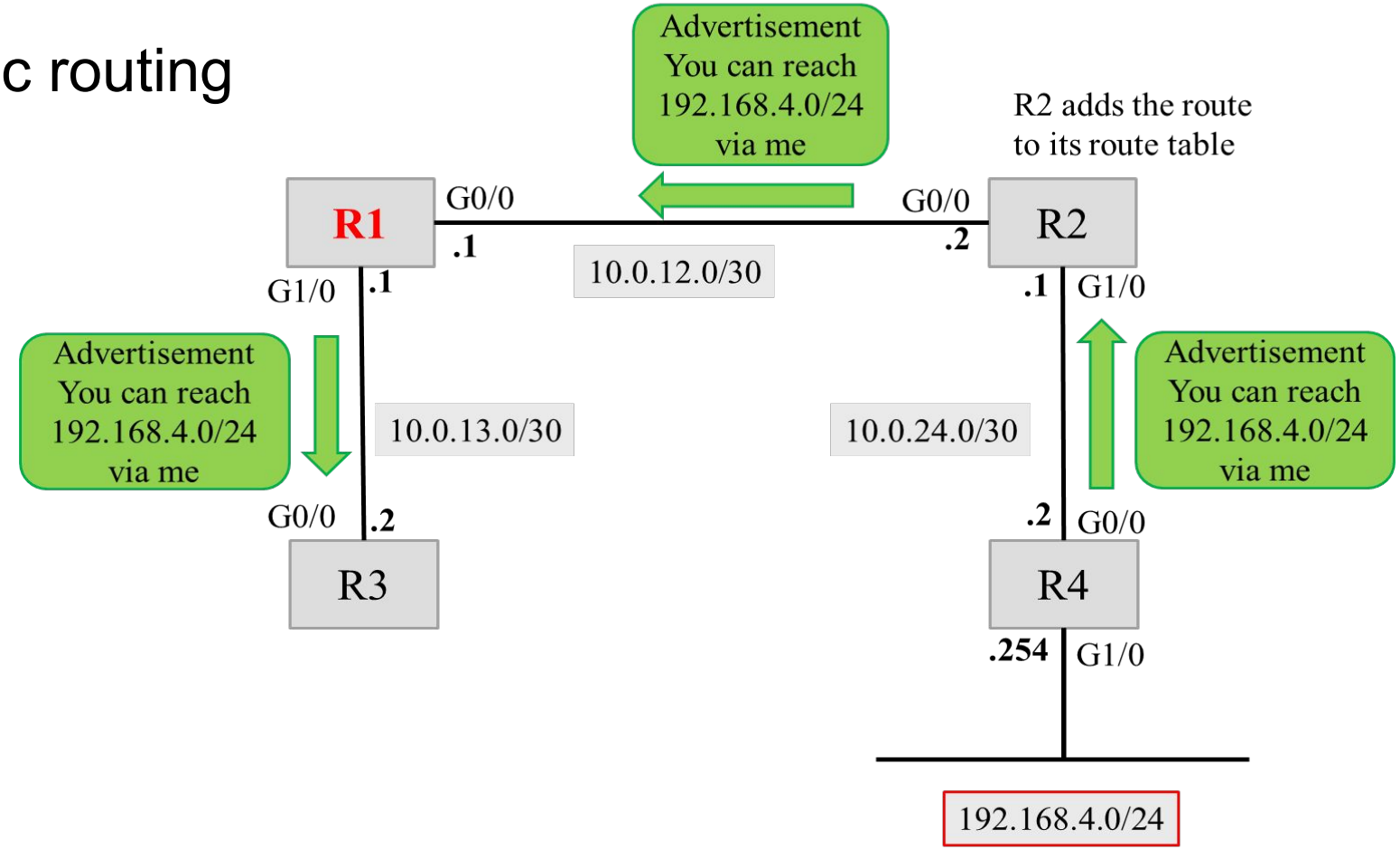
Lab03

CT106H - Computer network
Dynamic routing
RIP and OSPF

Dynamic routing

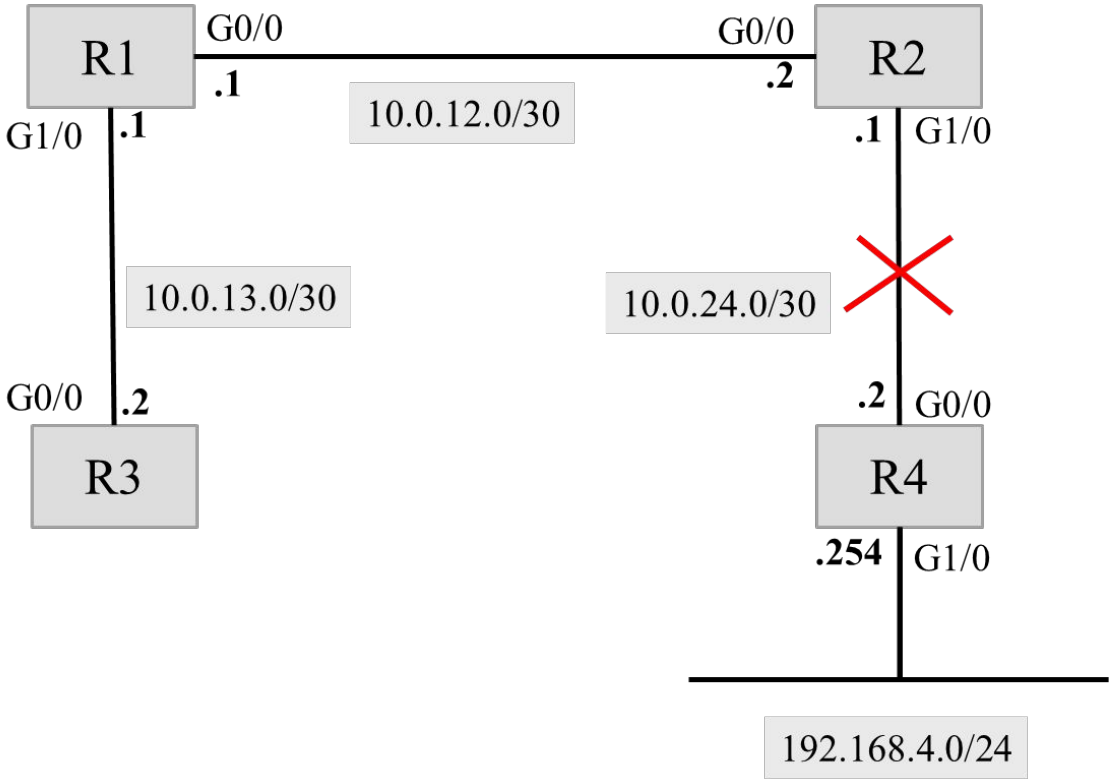


Dynamic routing

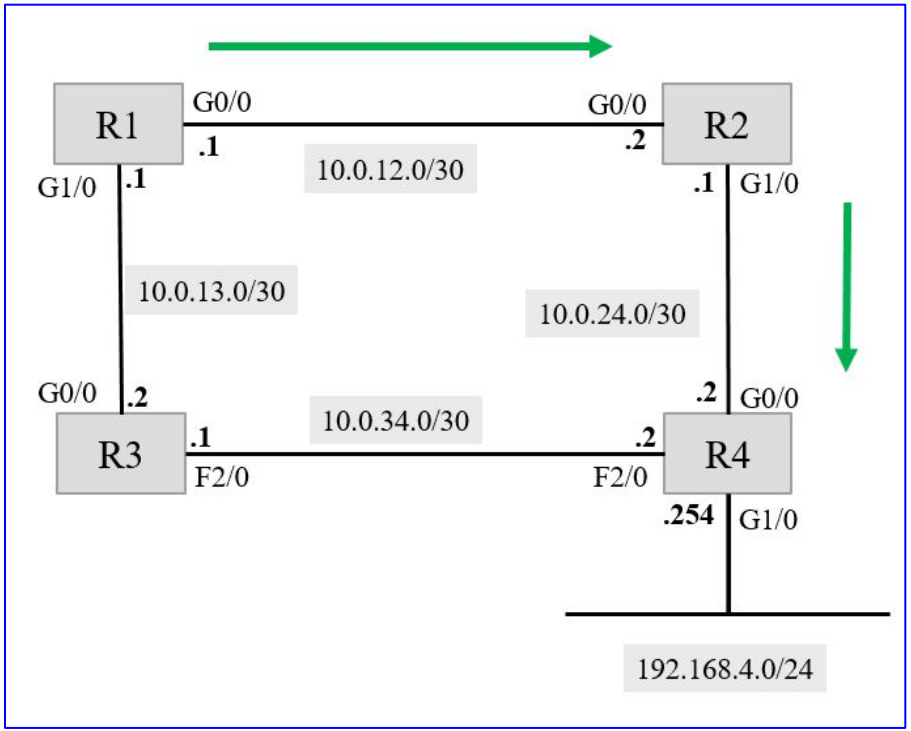
G0/0 on R4 goes down,

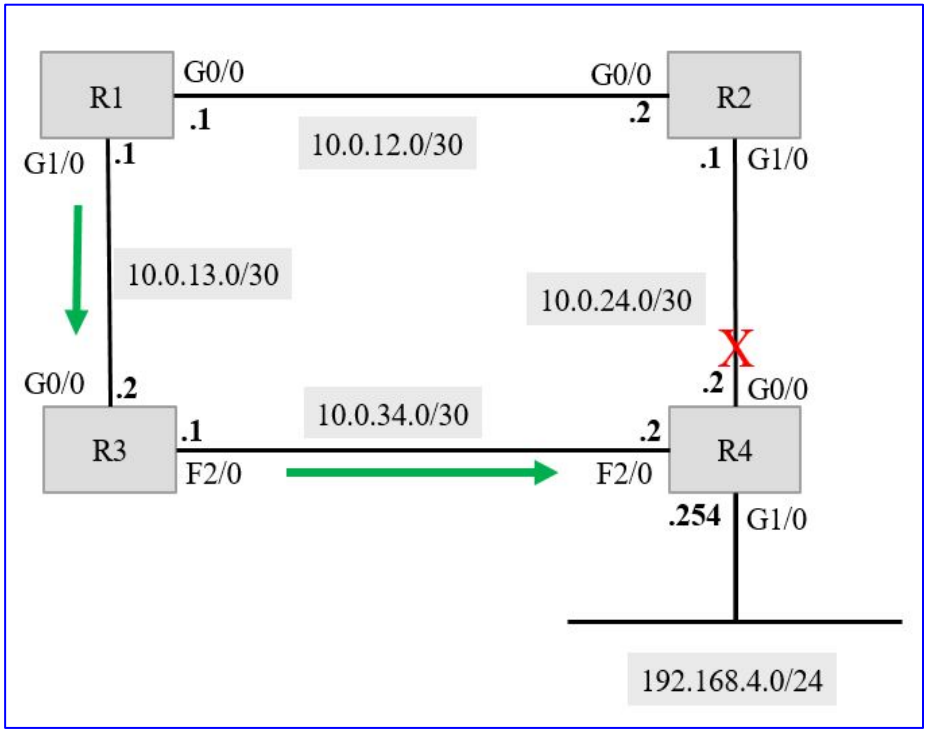
- **Dynamic routing:** other routers will automatically adapt and remove the route from their route tables

- **Static routing:** R1 is unaware that it can not longer reach the 192.168.4.0/24 → If R1 receives packets destined for 192.168.4.0/24, it will forward them to R2



Dynamic routing





Dynamic routing

- Routers can use dynamic routing protocols to advertise information about the route they know to other routers
- They form “*neighbor relationships*” with adjacent routers to exchange information
- If multiple routes to a destination are learned, the router determines which route is superior (based on the *metric*: *the lower the better*) and adds it to the routing table

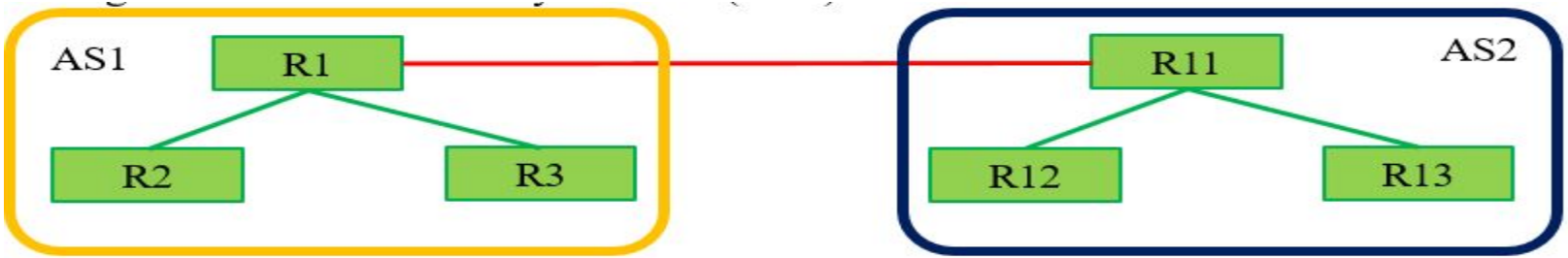
Dynamic routing protocols

An *Autonomous System* (AS) is a network under the administrative control of a single organization.

- Each AS can be assigned a number called an AS number (ASN) by the Internet Assigned Numbers Authority (IANA, www.iana.org)

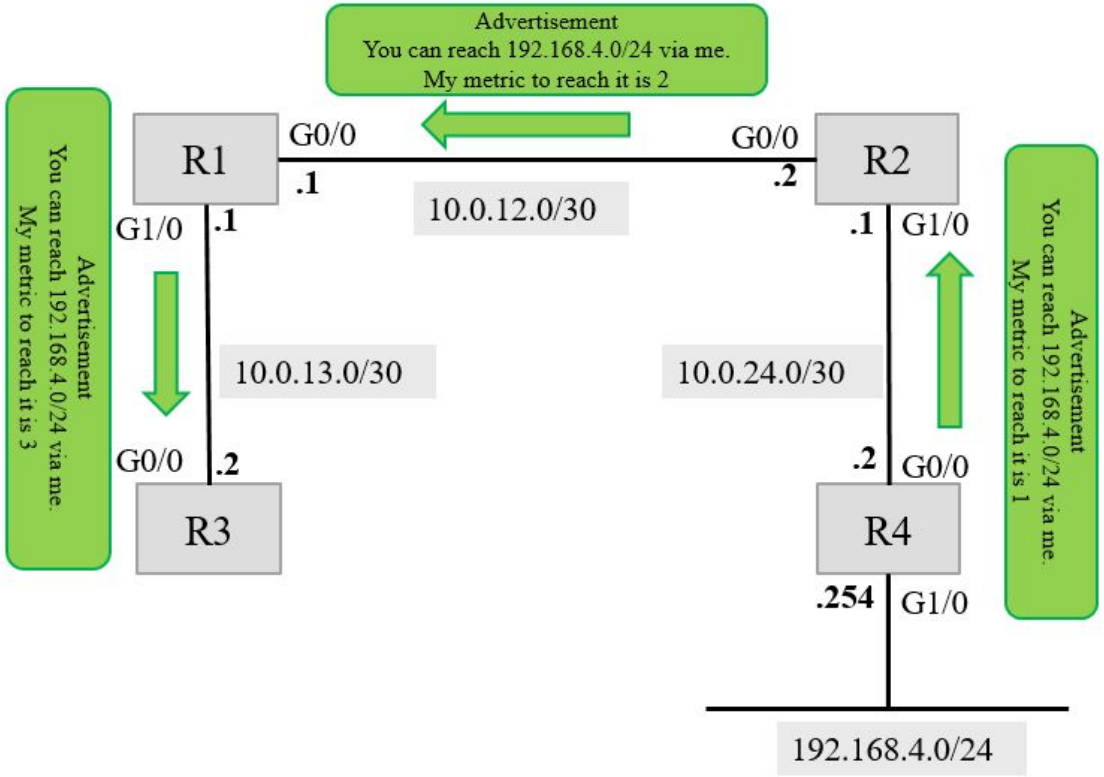
Dynamic routing protocols can be divided into 2 categories:

- Interior Gateway Protocol - IGP: used to share routes within a single AS
  - Distance vector algorithm (sometimes called Bellman-Ford): Routing Information Protocol (RIP)
  - Advanced distance vector (sometimes called “balanced hybrid”): Enhanced Interior Gateway Routing Protocol (EIGRP)
  - Link state algorithm: Open Shortest Path First (OSPF) and Intermediate System to Intermediate System (IS-IS)
- Exterior Gateway Protocol - EGP : used to share routes between different AS
  - Path Vector algorithm: Border Gateway Protocol (BGP)



Distance vector routing protocols

- Distance vector protocols operate by sending their *know destination networks* and the *metric* to reach their known destination networks
- Routers only share their routing tables with neighbors
- The routers do not know about the network beyond its neighbors (routing by "rumor")



Link state routing protocols

Every router creates a “connectivity map” of the network by advertises information about its interfaces to its neighbors

→ The *advertisements* are passed along to the routers until all routers in the network *develop* the *same network map*

→ Each router independently uses this map to *calculate the best routes* to each destination

- Link state protocols use more resources (CPU) on the router because more information is shared.
- Link state protocols tend to be faster in reacting to changes in the network than distance vector protocols.

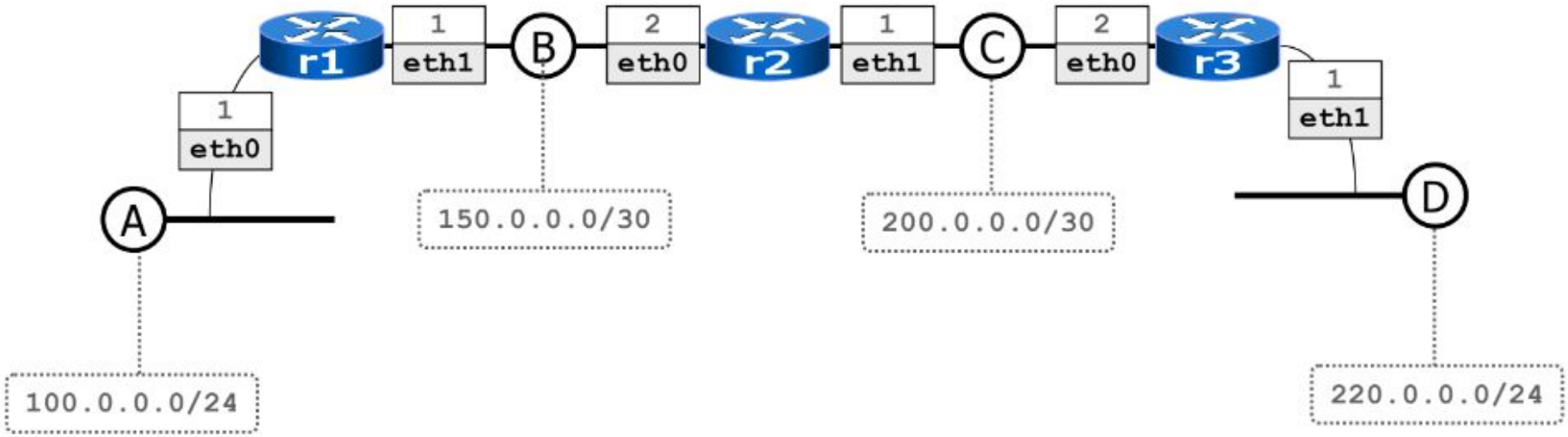
Dynamic Routing Protocol Metrics

IGP	Metric	Explanation
RIP	Hop count	Each router in the path counts as one hop. The total metric is the total number of hops to the destination. *Links of all speeds are equal*.
EIGRP	Based on bandwidth & delay (by default)	Complex formula that can take into account many values. By default, the bandwidth of the *slowest link in the route* and the total delay of all links in the route are used
OSPF	Cost	The cost of each link is calculated *based on bandwidth*. The total metric is the total cost of each link in the route
IS-IS	Cost	The total metric is the total cost of each link in the route. The cost of each link is *not automatically calculated* by default. All links have a cost of 10 by default.

Exercise 12

Exercise 12

Construct a simple topology



Exercise 12

```
lnk@NhutKhang:~/CT106H/exercise12$ tree
.
├── lab.conf
├── LICENSE
├── r1
│   └── etc
│       └── quagga
│           ├── daemons
│           ├── ripd.conf
│           └── zebra.conf
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10 directories, 14 files
lnk@NhutKhang:~/CT106H/exercise12$
```
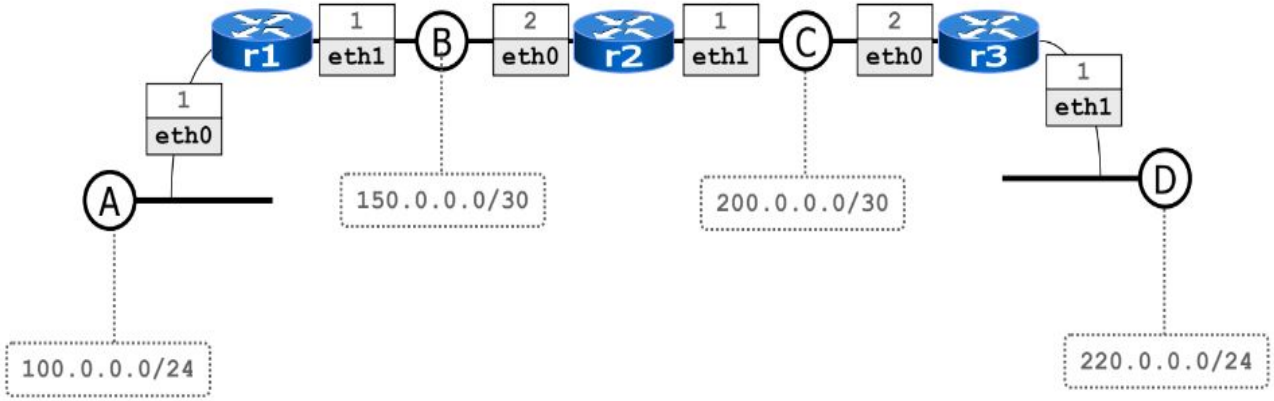
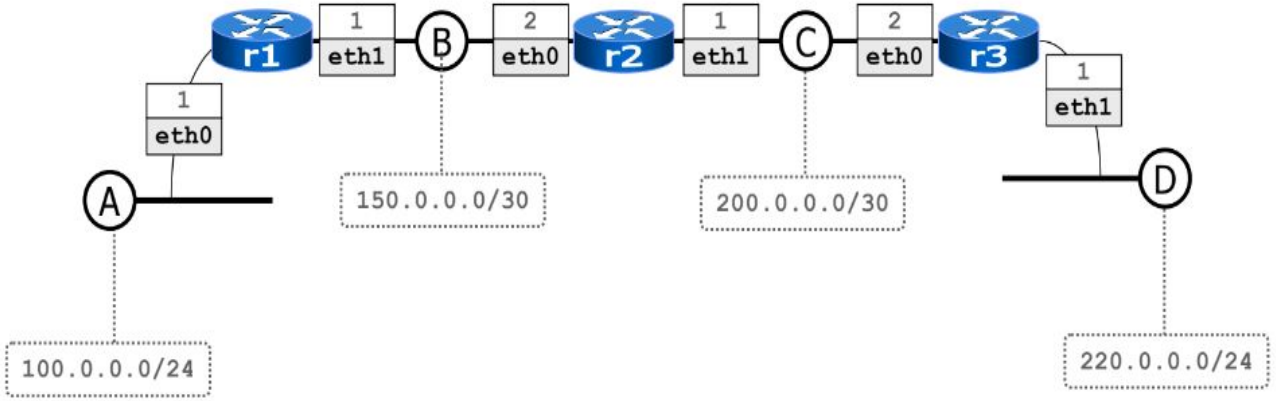




```
lnk@NhutKhang:~/CT106H/exercise12$ cat r1.startup
ifconfig eth0 100.0.0.1/24 up
ifconfig eth1 150.0.0.1/30 up
/etc/init.d/quagga start
lnk@NhutKhang:~/CT106H/exercise12$ cat r2.startup
ifconfig eth0 150.0.0.2/30 up
ifconfig eth1 200.0.0.1/30 up
/etc/init.d/quagga start
lnk@NhutKhang:~/CT106H/exercise12$ cat r3.startup
ifconfig eth0 200.0.0.2/30 up
ifconfig eth1 220.0.0.1/24 up
/etc/init.d/quagga start
```

Exercise 12

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10 directories, 14 files
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```

```
lnk@NhutKhang:~/CT106H/exercise12$ 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
```

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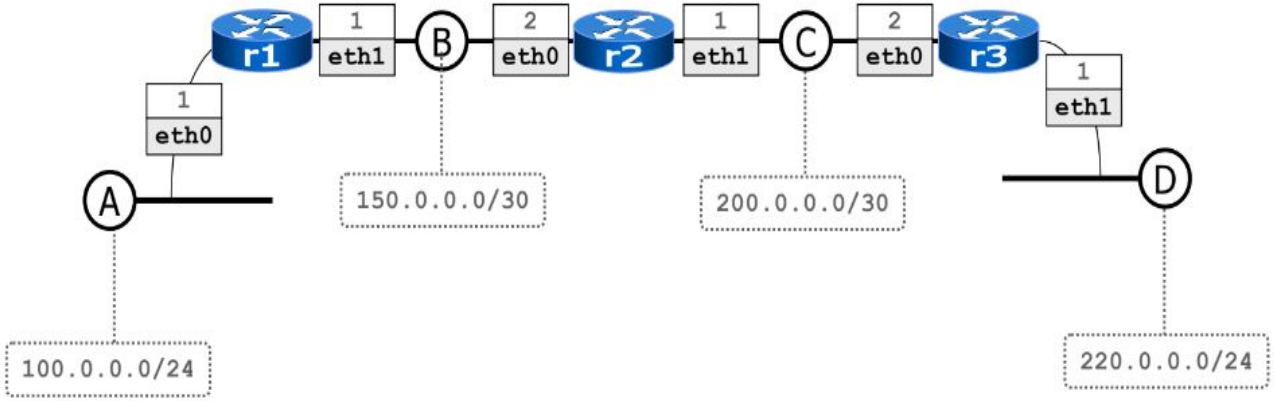


```
lnk@NhutKhang:~/CT106H/exercise12$ cat r1/etc/quagga/ripd.conf
!
hostname ripd
password zebra
enable password zebra
!
router rip
redistribute connected
network eth0
network eth1
!
log file /var/log/quagga/ripd.log
```

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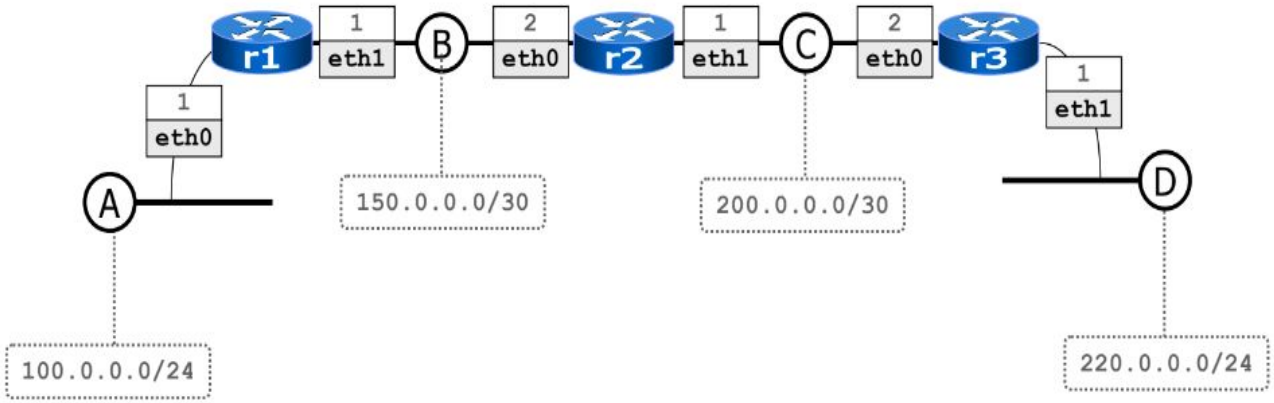


```
lnk@NhutKhang:~/CT106H/exercise12$ cat r1/etc/quagga/zebra.conf
! -*- zebra -*-
!
! zebra configuration file
!
hostname zebra
password zebra
enable password zebra
!
! Static default route sample.
!
!ip route 0.0.0.0/0 203.181.89.241
!
log file /var/log/quagga/zebra.log
```

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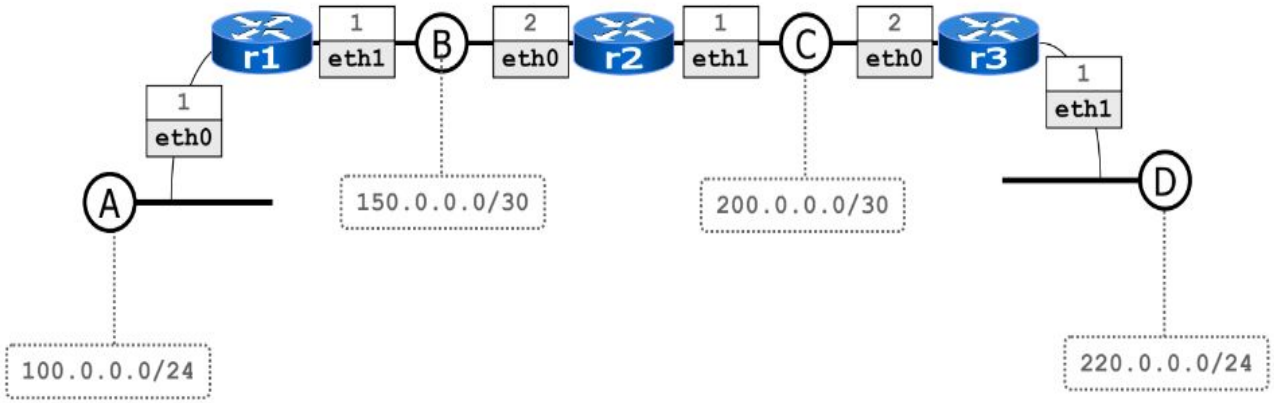


```
lnk@NhutKhang:~/CT106H/exercise12$ cat r2/etc/quagga/daemons
# This file tells the zebra package
# which daemons to start.
# Entries are in the format: <daemon>=(yes|no|priority)
# where 'yes' is equivalent to infinitely low priority, and
# lower numbers mean higher priority. Read
# /usr/doc/quagga/README.Debian for details.
# Daemons are: bgpd zebra ospfd ospf6d ripd ripngd
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
```

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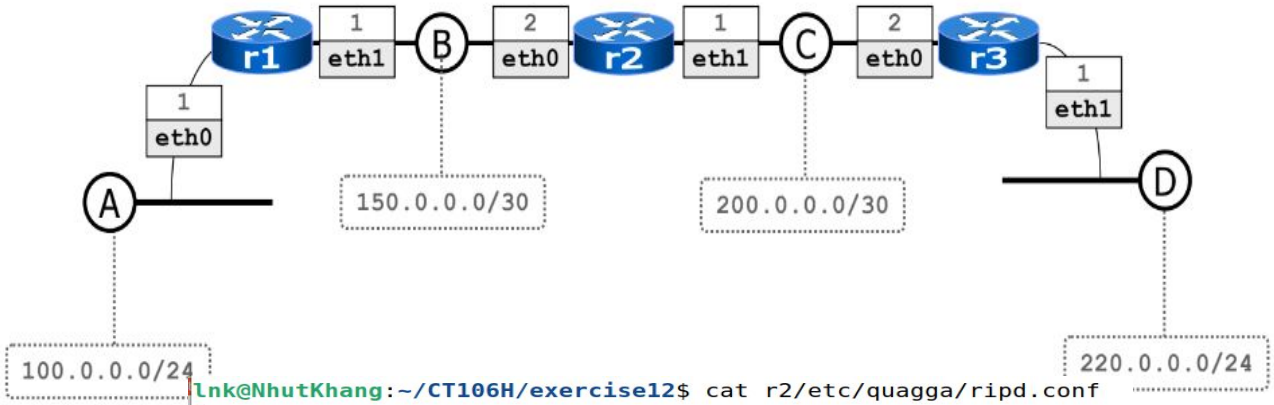


```
lnk@NhutKhang:~/CT106H/exercise12$ cat r2/etc/quagga/ripd.conf
!
hostname ripd
password zebra
enable password zebra
!
router rip
redistribute connected
network eth0
network eth1
!
log file /var/log/quagga/ripd.log

lnk@NhutKhang:~/CT106H/exercise12$ 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 _
```

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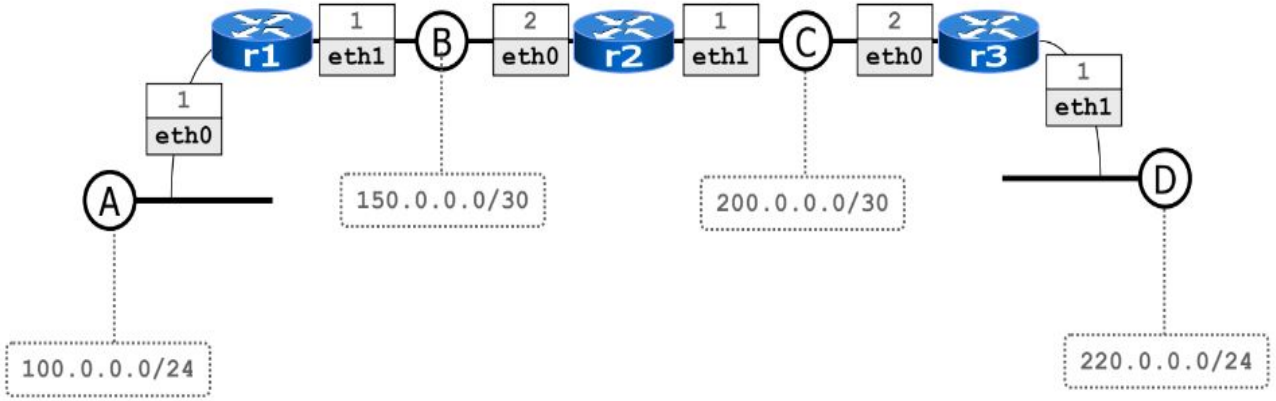


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# This file tells the zebra package
# which daemons to start.
# Entries are in the format: <daemon>=(yes|no|priority)
# where 'yes' is equivalent to infinitely low priority, and
# lower numbers mean higher priority. Read
# /usr/doc/quagga/README.Debian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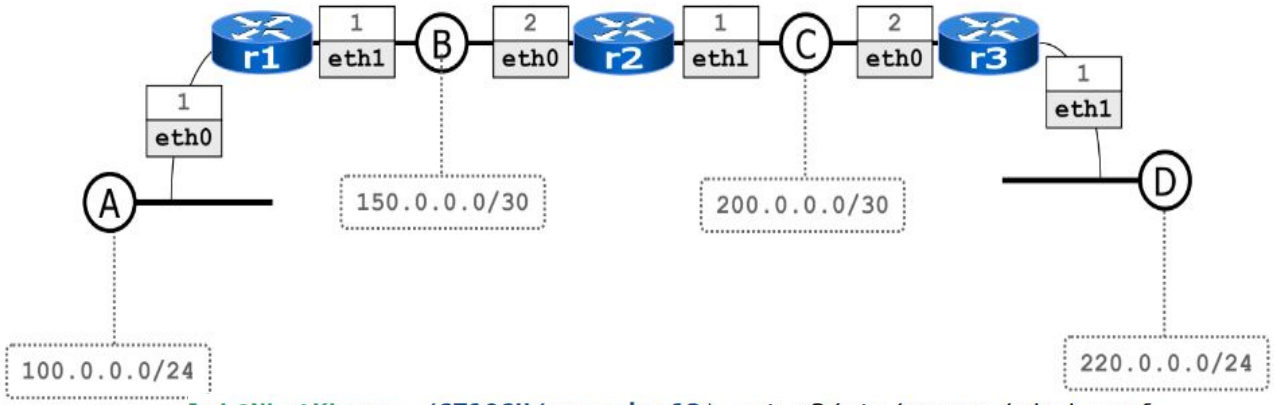


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enable password zebra
!
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redistribute connected
network eth0
network eth1
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log file /var/log/quagga/ripd.log

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! -*- 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 _
```
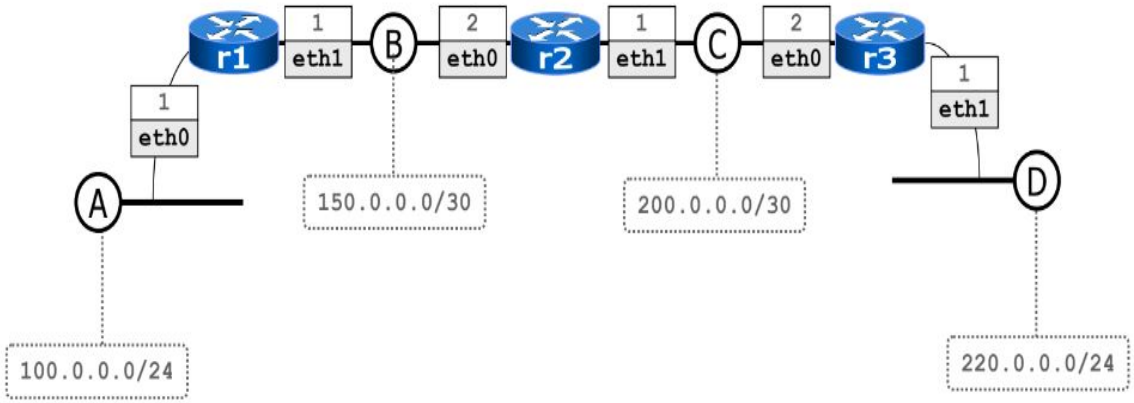

Exercise 12 (solution)



root@r1: /

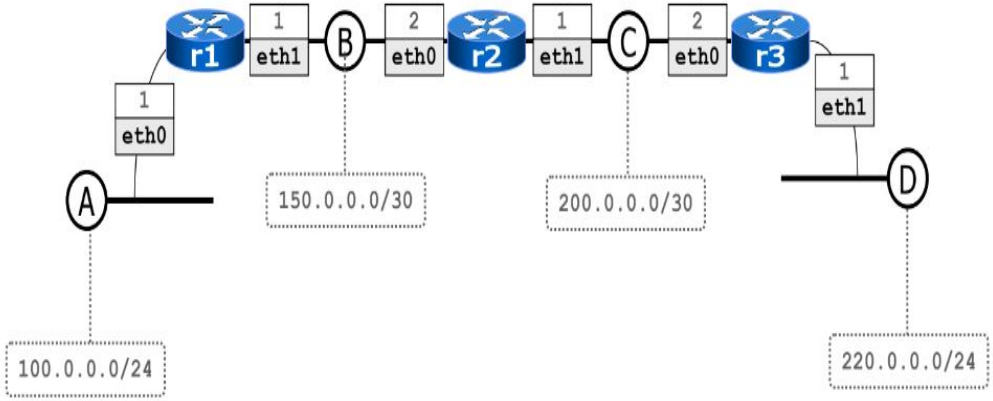
```
--- Startup Commands Log

++ 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@r1:/#
```

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@r2:/#
```

Exercise 12 (solution)

```
root@r3: /
--- 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 (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 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=0.137 ms
64 bytes from 100.0.0.1: icmp_seq=2 ttl=63 time=0.275 ms
^C
--- 100.0.0.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 4ms
rtt min/avg/max/mdev = 0.137/0.206/0.275/0.069 ms
root@r3:/#
```



Exercise 12

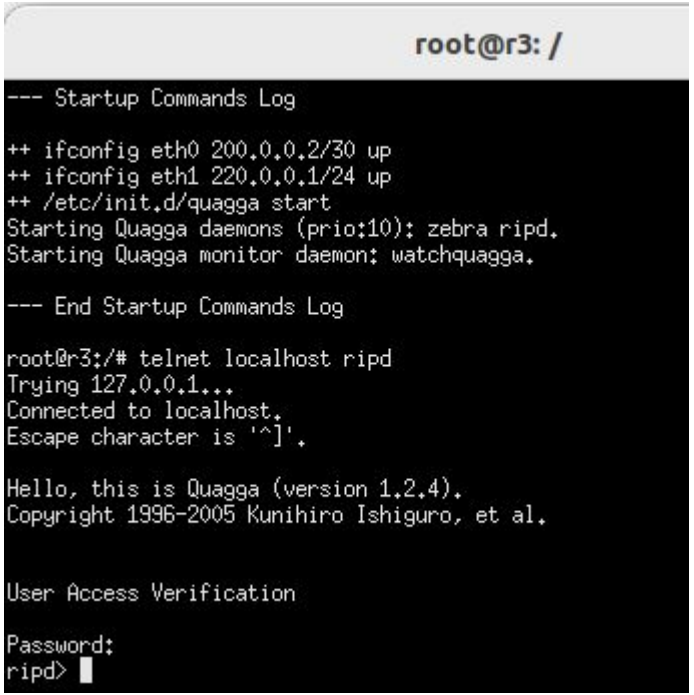
On a router, use the command `tcpdump` to capture the RIPv2 packet; then stop the command after about 20 seconds. For example, on r1 type:

```
tcpdump -i any -w
/hosthome/Ex12_r1.pcap
```

On a router, connecting to the main zebra daemon using the following command:

```
telnet localhost ripd
```

The password is zebra



Exercise 12

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:

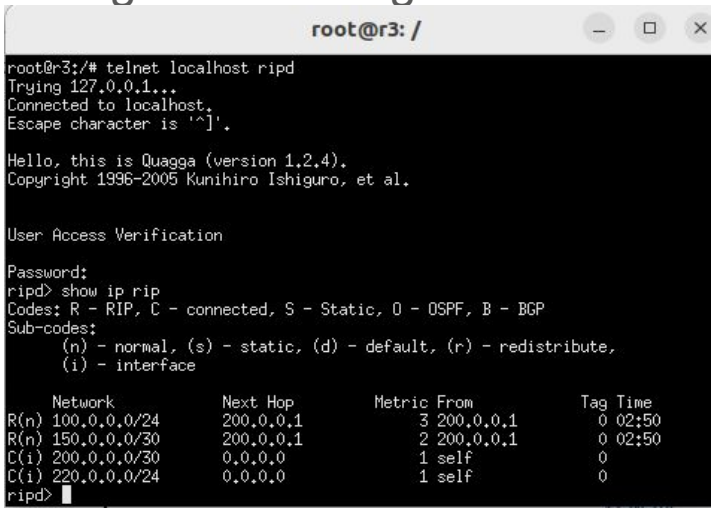
```
tcpdump -i any -w /hosthome/Ex12_r1.pcap
```

On a router, connecting to the main zebra daemon using the following command:

```
telnet localhost ripd
```

The password is zebra

Then type: `show ip rip`



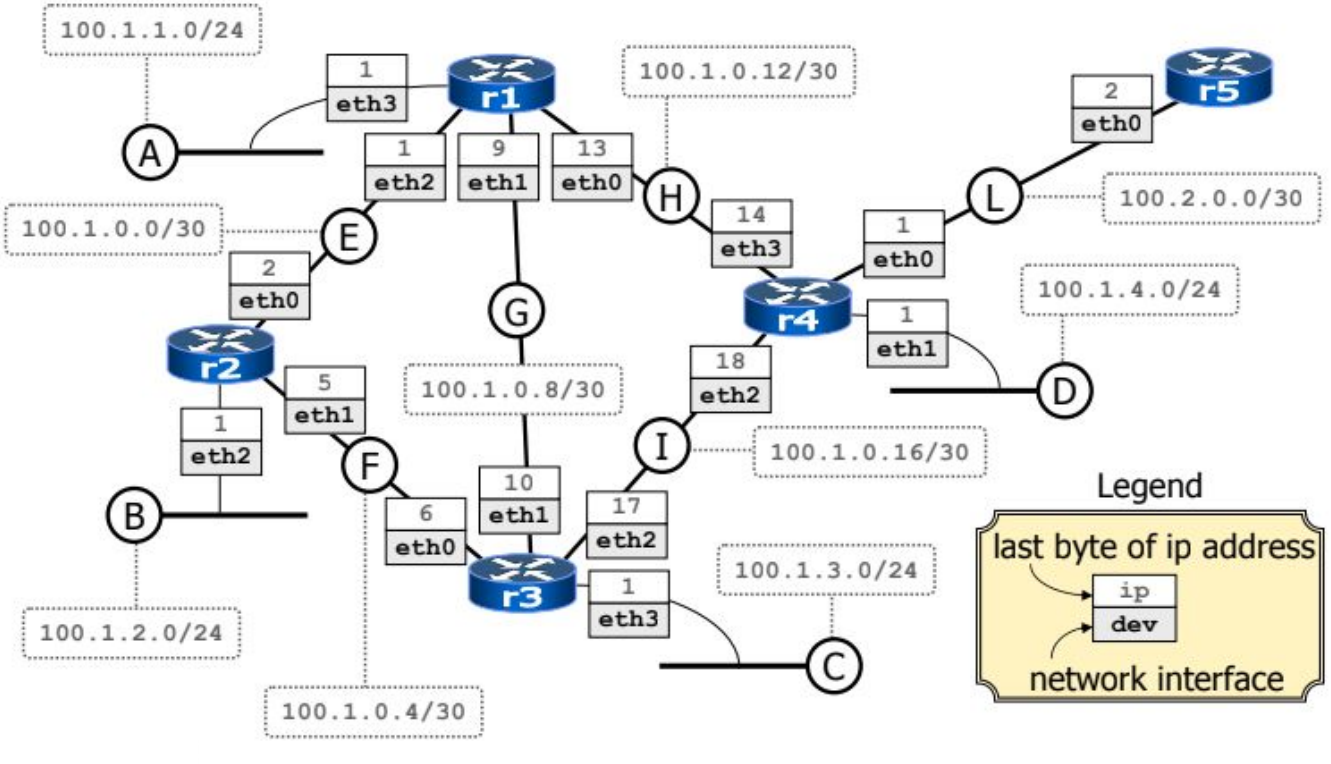
Exercise 12

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

Exercise 13 (RIP)

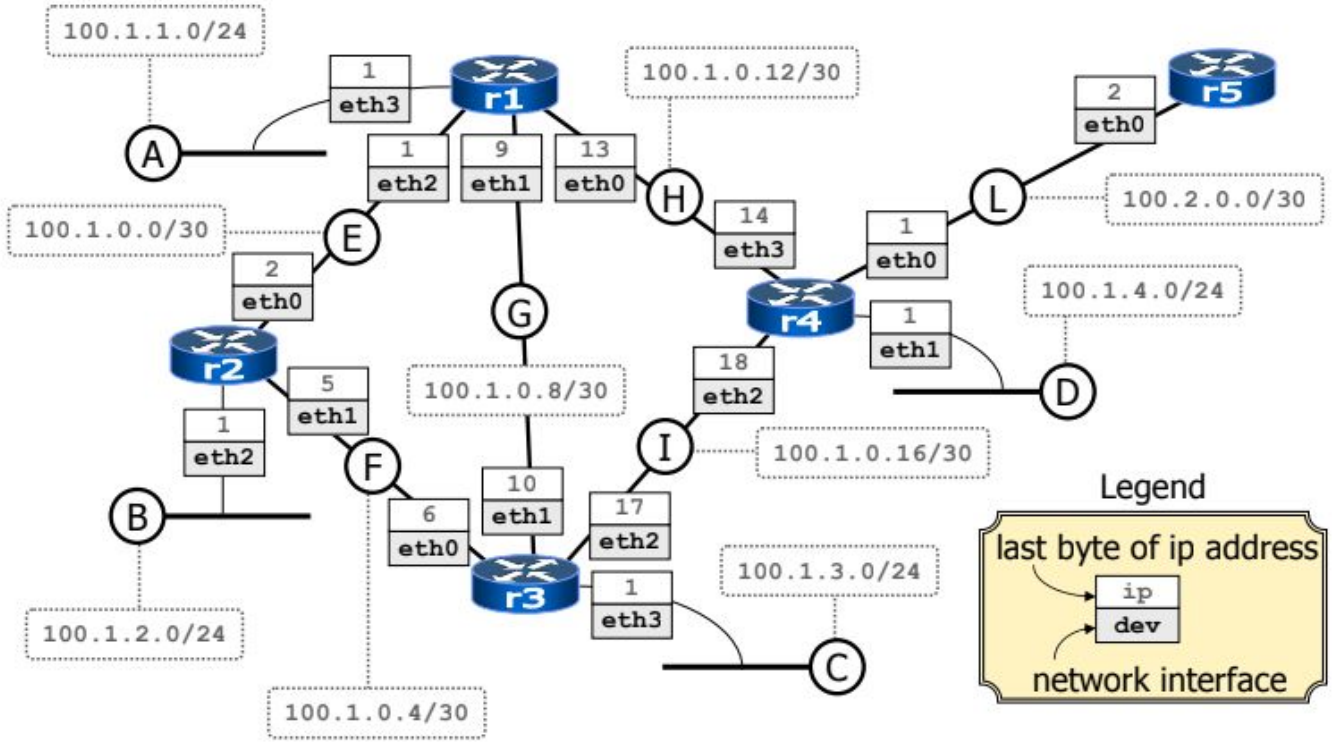
Exercise 13 (RIP)

Construct the following topology



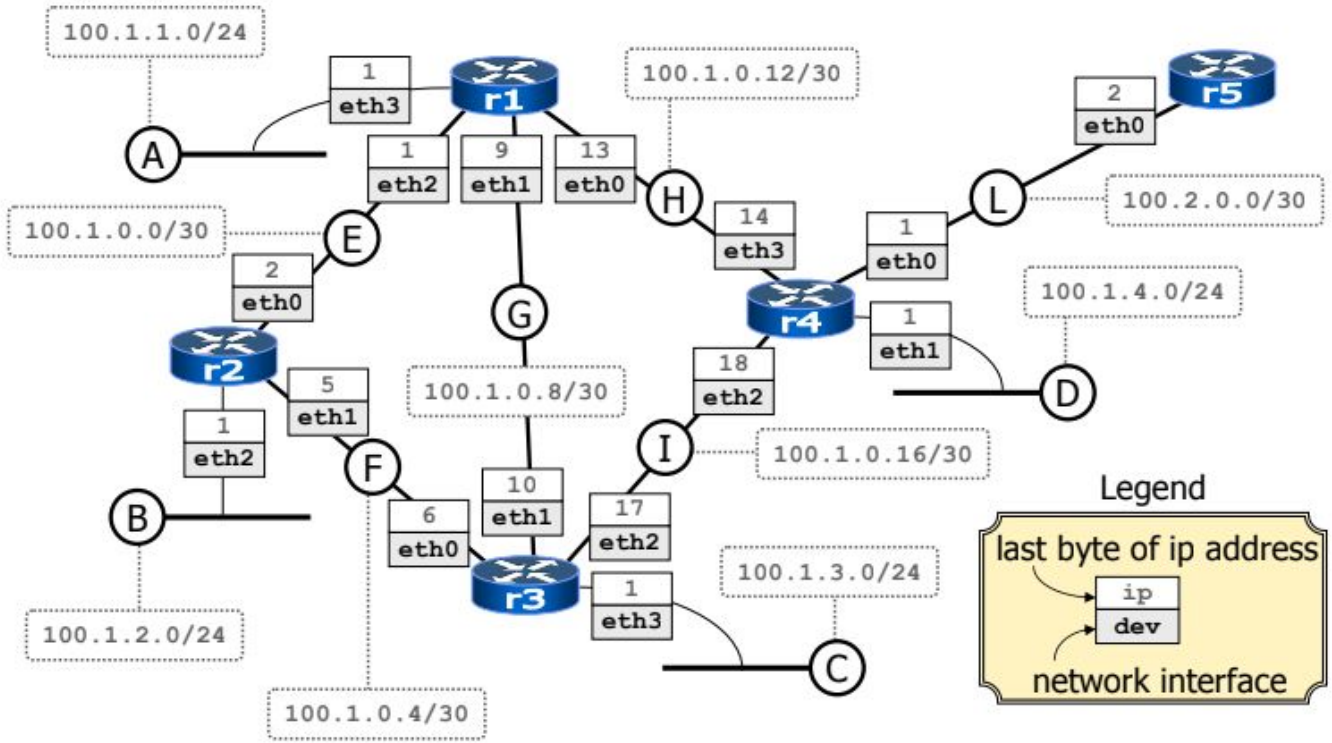
```
lnk@NhutKhang:~/CT106H/exercise13$ tree
.
├── lab.conf
├── r1
│   └── etc
│       └── quagga
│           ├── daemons
│           ├── ripd.conf
│           └── zebra.conf
├── r1.startup
├── r2
│   └── etc
│       └── quagga
│           ├── daemons
│           ├── ripd.conf
│           └── zebra.conf
├── 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
```

Exercise 13 (solution)



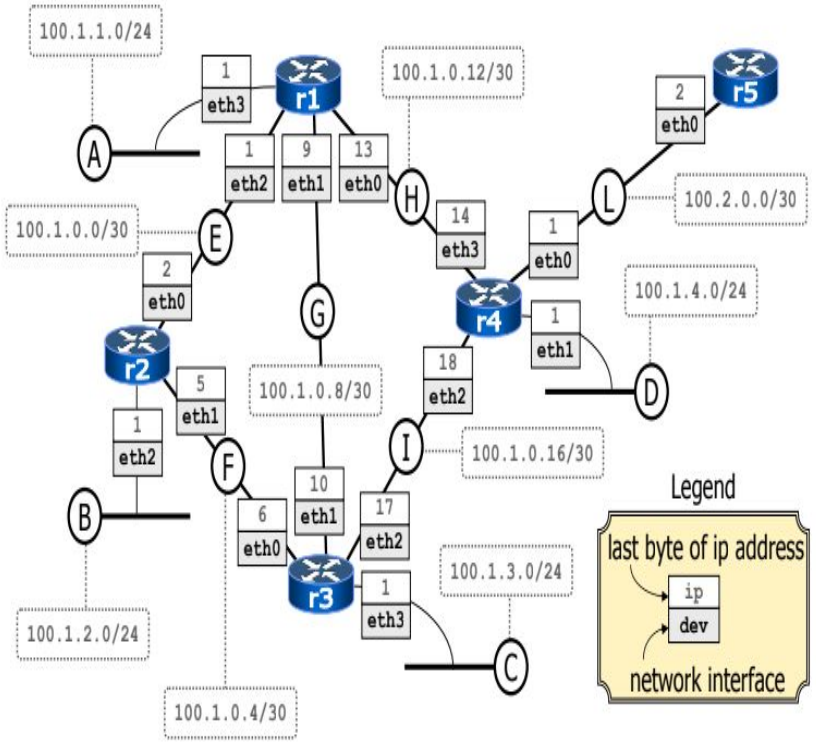
Exercise 13 (solution)

```
lnk@NhutKhang: ~/CT106H/exercise13
lnk@NhutKhang:~/CT106H/exercise13$ 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"
lnk@NhutKhang:~/CT106H
```



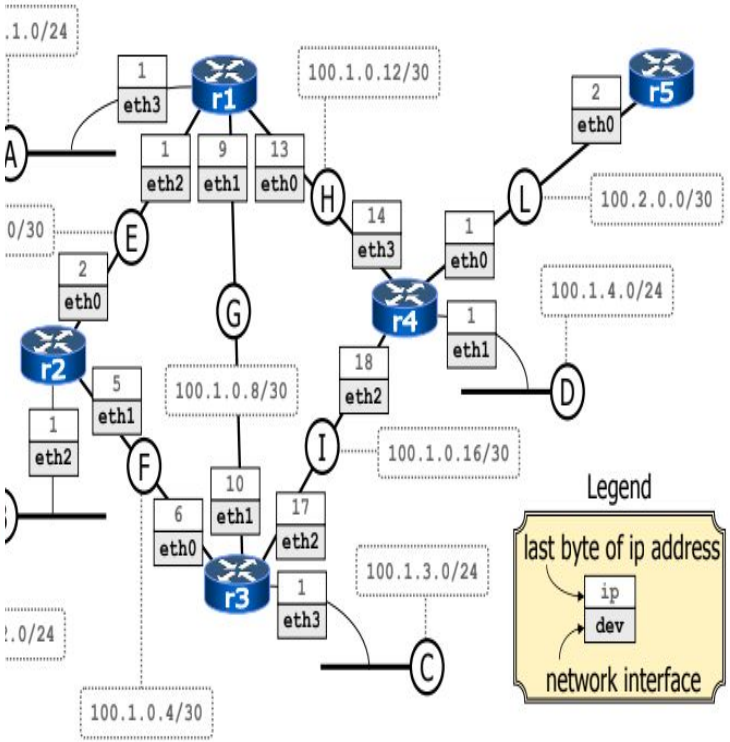
```
lnk@NhutKhang:~/CT106H/exercise13$ cat r1.startup
ifconfig eth0 100.1.0.13/30 up
ifconfig eth1 100.1.0.9/30  up
ifconfig eth2 100.1.0.1/30  up
ifconfig eth3 100.1.1.1/24  up
/etc/init.d/quagga start
lnk@NhutKhang:~/CT106H/exercise13$ cat r2.startup
ifconfig eth0 100.1.0.2/30 up
ifconfig eth1 100.1.0.5/30 up
ifconfig eth2 100.1.2.1/24 up
/etc/init.d/quagga start
lnk@NhutKhang:~/CT106H/exercise13$ 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
lnk@NhutKhang:~/CT106H/exercise13$ 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
lnk@NhutKhang:~/CT106H/exercise13$ cat r5.startup
ifconfig eth0 100.2.0.2/30 up
route add -net 100.1.0.0/16 gw 100.2.0.1
lnk@NhutKhang:~/CT106H/exercise13$
```

Exercise 13 (solution)



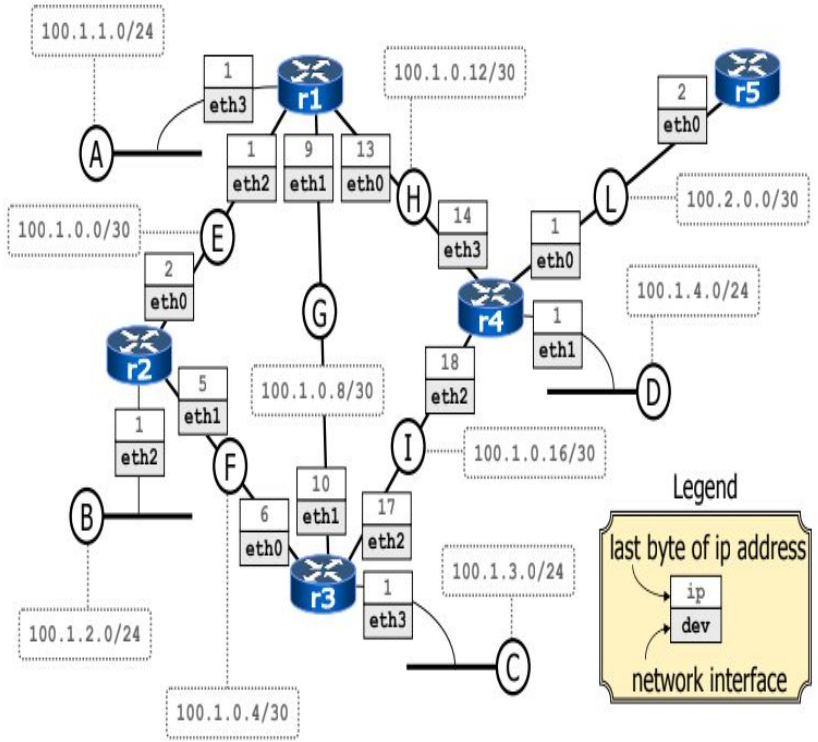
```
lnk@NhutKhang:~/CT106H/exercise13$ cat r1/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=no
ospf6d=no
ripd=yes
ripngd=no
lnk@NhutKhang:~/CT106H/exercise13$ cat r1/etc/quagga/ripd.conf
hostname ripd
password zebra
enable password zebra

router rip
redistribute connected
network 100.1.0.0/16

log file /var/log/quagga/ripd.log
lnk@NhutKhang:~/CT106H/exercise13$ cat r1/etc/quagga/zebra.conf
hostname r1
password zebra
enable password zebra
log file /var/log/quagga/zebra.log
lnk@NhutKhang:~/CT106H/exercise13$
```

Exercise 13 (solution)



Exercise 13

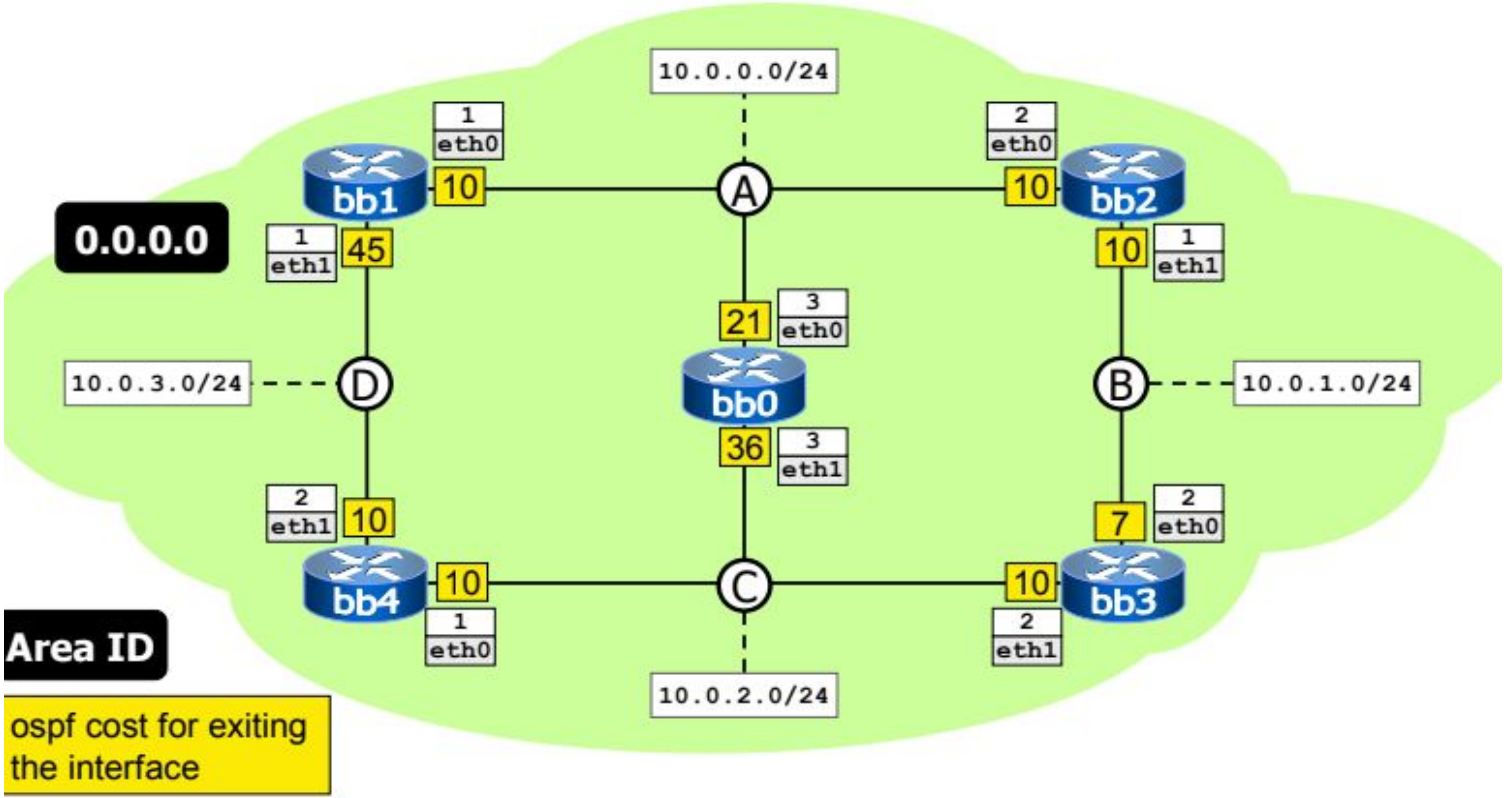
- Check the routing table using the `route` command
- Check connectivity using the `ping` command
- On R4, type `traceroute 100.1.2.1` command, and explain what happens?
- On R1, shutting down an interface using the command `ifconfig eth1 down`
- Examine the route using the command `traceroute 100.1.0.10`



Exercise 14 (OSPF)

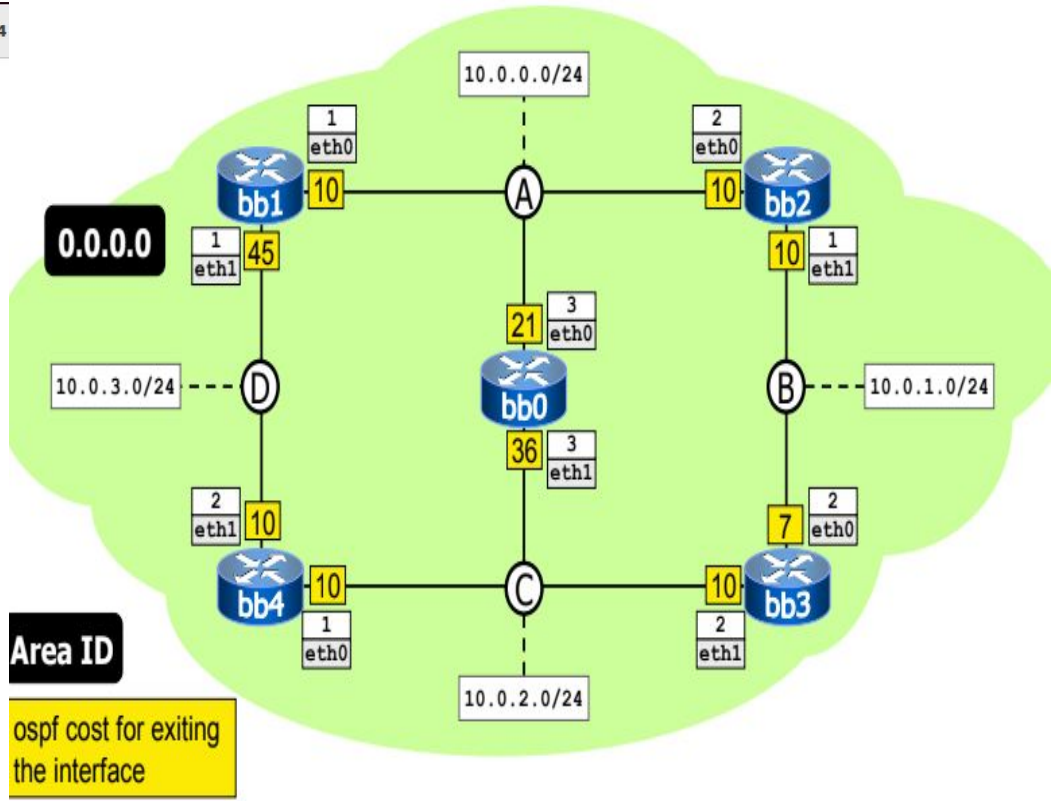
Exercise 14 (OSPF) - single area

Construct the following topology



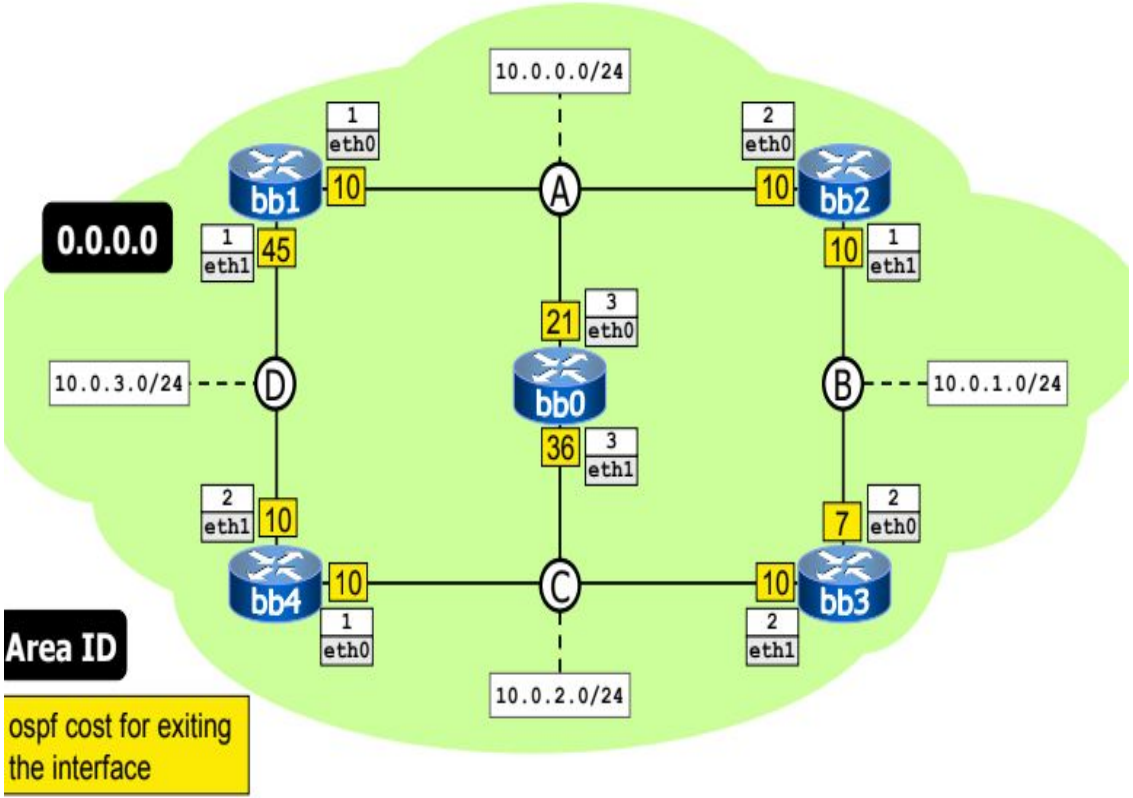
Exercise 14 (OSPF) - single area

```
lnk@NhutKhang: ~/CT106H/exercise14
lnk@NhutKhang:~/CT106H/exercise14$ 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
lnk@NhutKhang:~/CT106H/exercise14$
```



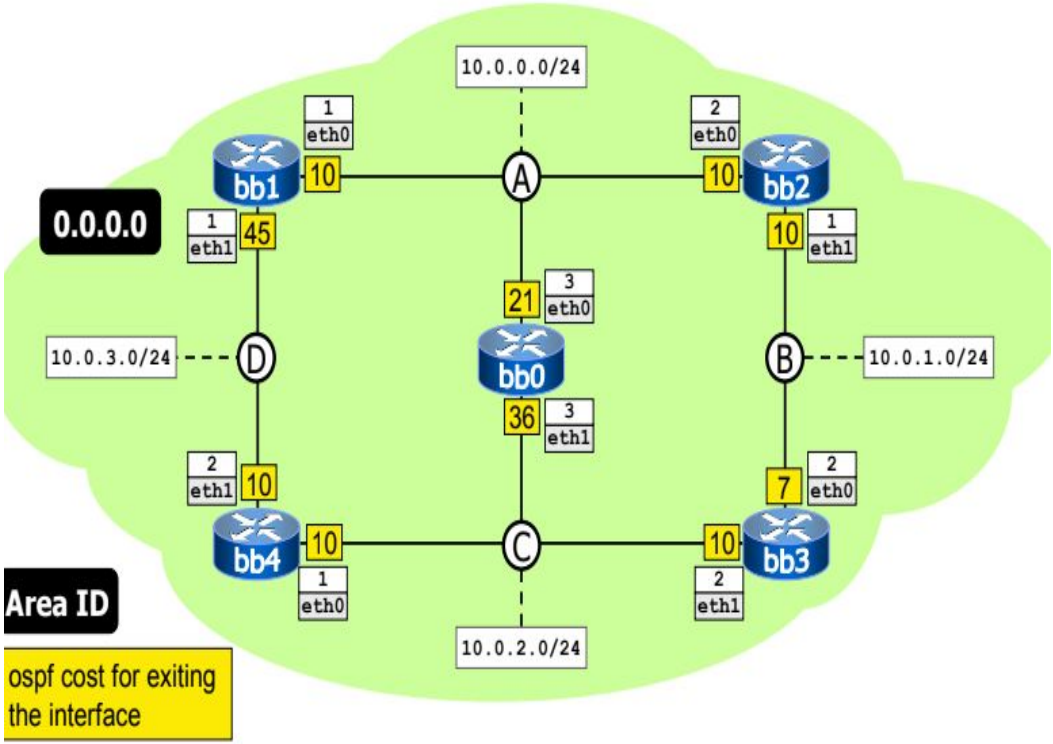
Exercise 14 (OSPF) - single area

```
lnk@NhutKhang:~/CT106H/exercise14$ 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
lnk@NhutKhang:~/CT106H/exercise14$
```



Exercise 14 (OSPF) - single area

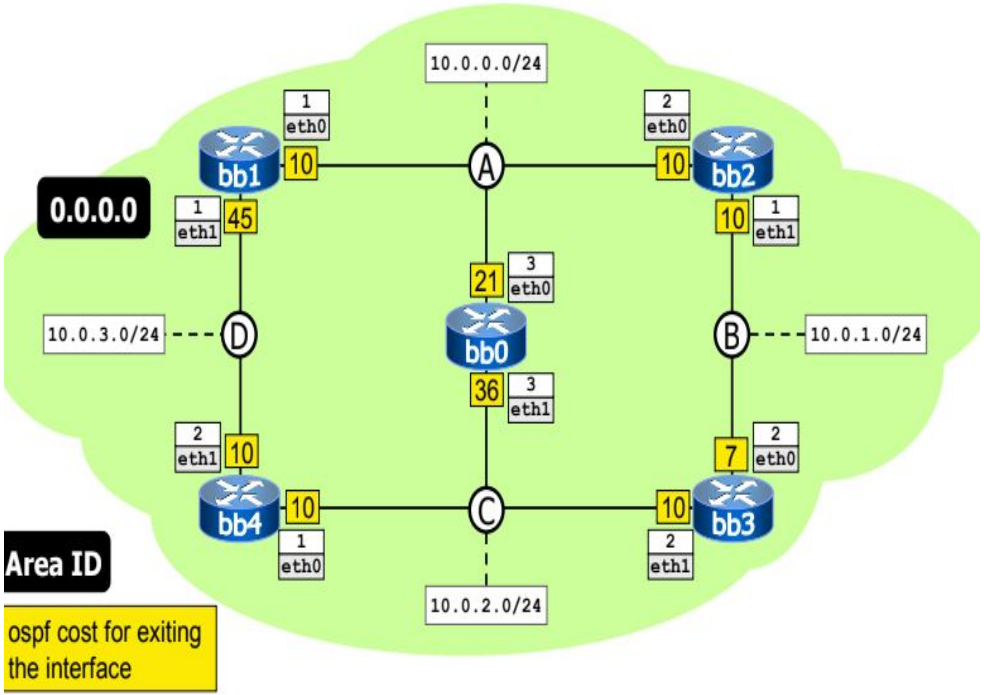
```
lnk@NhutKhang: ~/CT106H/exercise14
lnk@NhutKhang:~/CT106H/exercise14$ cat bb0.startup
ifconfig eth0 10.0.0.3/24 up
ifconfig eth1 10.0.2.3/24 up
/etc/init.d/quagga start
lnk@NhutKhang:~/CT106H/exercise14$ cat bb1.startup
ifconfig eth0 10.0.0.1/24 up
ifconfig eth1 10.0.3.1/24 up
/etc/init.d/quagga start
lnk@NhutKhang:~/CT106H/exercise14$ cat bb2.startup
ifconfig eth0 10.0.0.2/24 up
ifconfig eth1 10.0.1.1/24 up
/etc/init.d/quagga start
lnk@NhutKhang:~/CT106H/exercise14$ cat bb3.startup
ifconfig eth0 10.0.1.2/24 up
ifconfig eth1 10.0.2.2/24 up
/etc/init.d/quagga start
lnk@NhutKhang:~/CT106H/exercise14$ cat bb4.startup
ifconfig eth0 10.0.2.1/24 up
ifconfig eth1 10.0.3.2/24 up
/etc/init.d/quagga start
lnk@NhutKhang:~/CT106H/exercise14$
```



Exercise 14 (OSPF) - single area

lnk@NhutKhang: ~/CT106H/exercise14

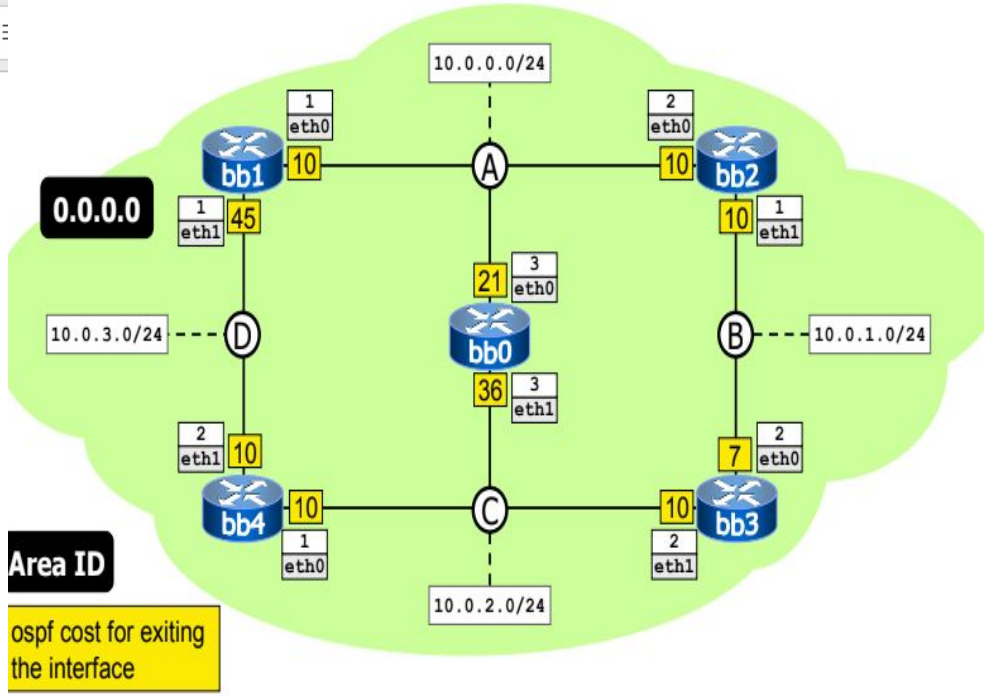
```
lnk@NhutKhang:~/CT106H/exercise14$ cat bb0/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
lnk@NhutKhang:~/CT106H/exercise14$ cat bb0/etc/quagga/ospfd.conf
hostname ospfd
password zebra
enable password zebra

! 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
```



Exercise 14 (OSPF) - single area

lnk@NhutKhang: ~/CT106H/exercise14

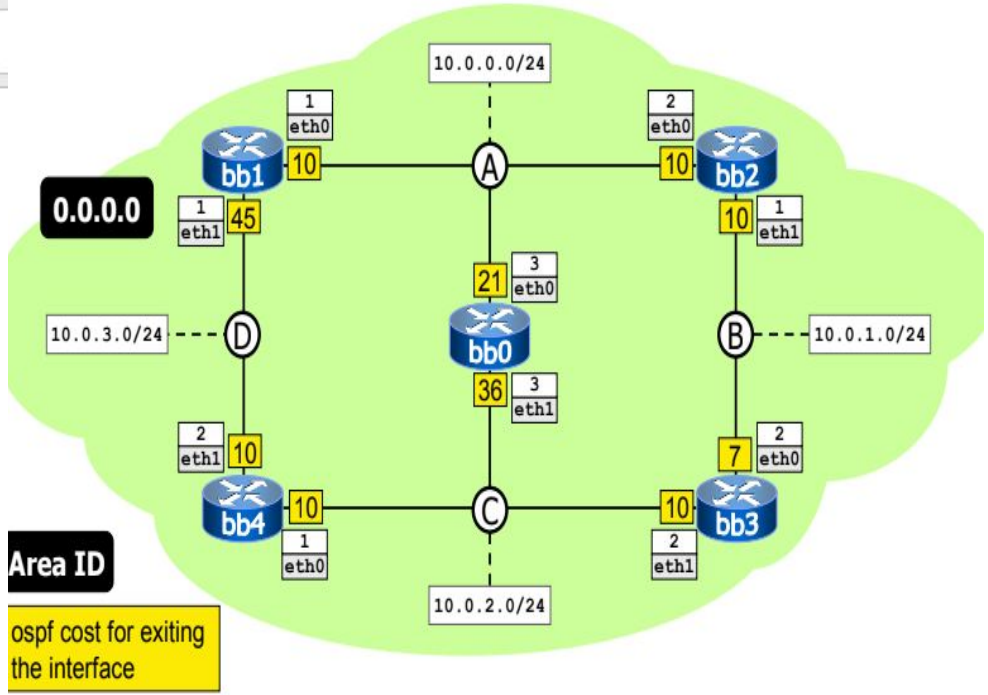
```
lnk@NhutKhang:~/CT106H/exercise14$ cat bb1/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
lnk@NhutKhang:~/CT106H/exercise14$ cat bb1/etc/quagga/ospfd.conf
hostname ospfd
password zebra
enable password zebra

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

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

log file /var/log/zebra/ospfd.log
```



Exercise 14 (OSPF) - single area

lnk@NhutKhang: ~/CT106H/exercise14

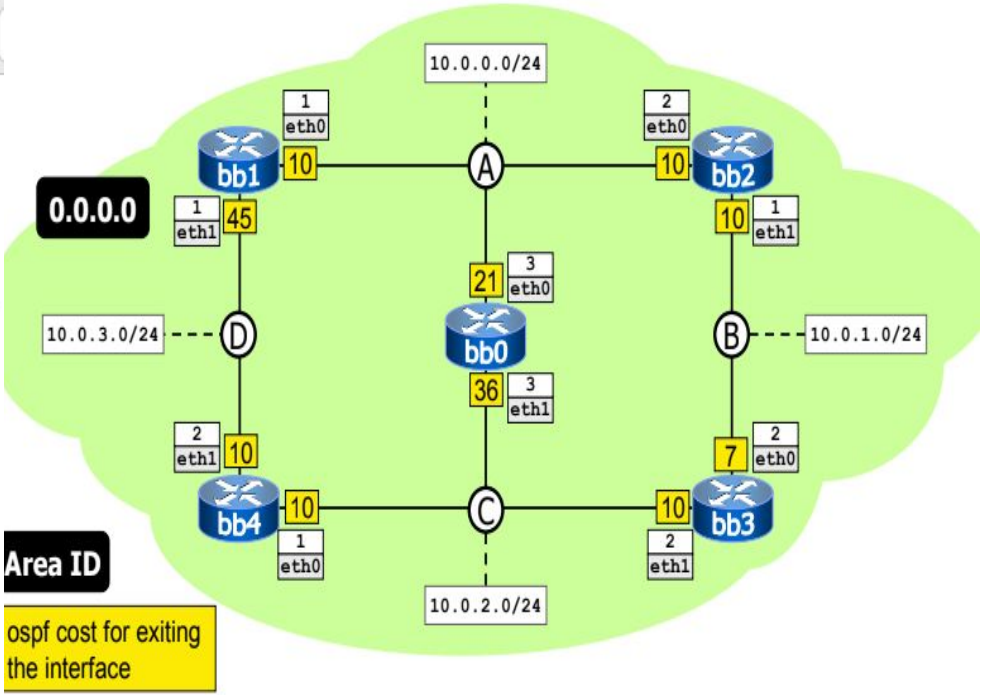
```
lnk@NhutKhang:~/CT106H/exercise14$ cat bb2/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
lnk@NhutKhang:~/CT106H/exercise14$ cat bb2/etc/quagga/ospfd.conf
hostname ospfd
password zebra
enable password zebra

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

log file /var/log/zebra/ospfd.log
```



Exercise 14 (OSPF) - single area

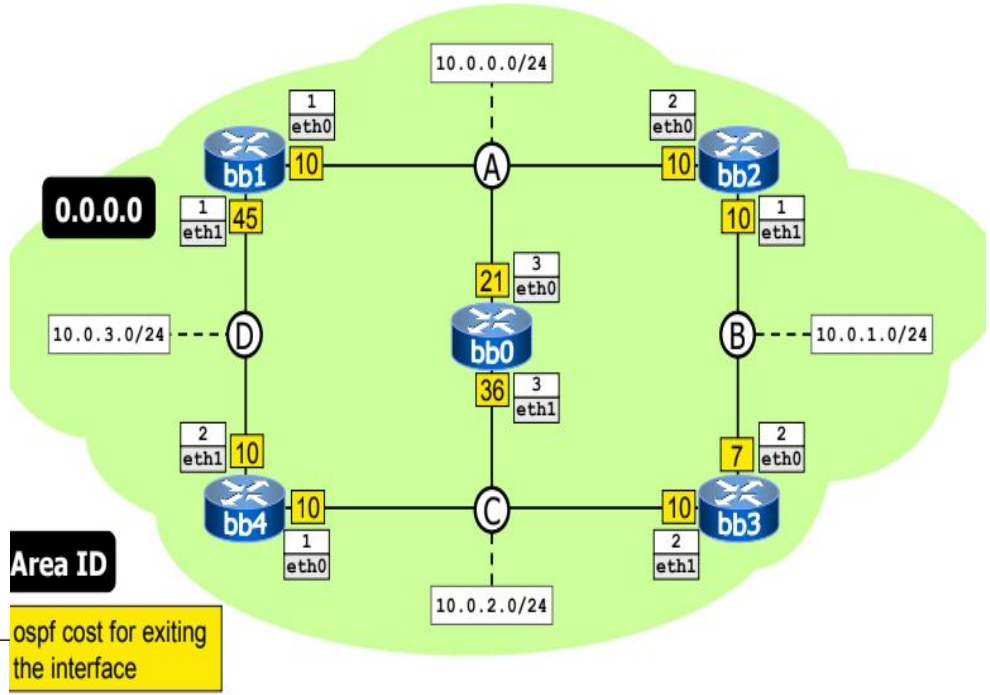
lnk@NhutKhang: ~/CT106H/exercise14

```
lnk@NhutKhang:~/CT106H/exercise14$ cat bb3/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
lnk@NhutKhang:~/CT106H/exercise14$ 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
```



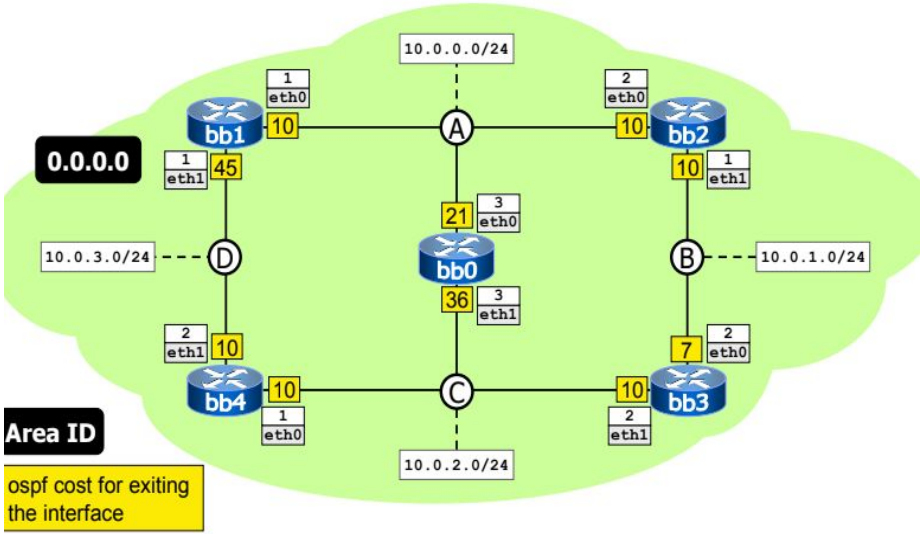
Exercise 14 (OSPF) - single area

```
lnk@NhutKhang:~/CT106H/exercise14$ cat bb4/etc/quagga/daemons
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
lnk@NhutKhang:~/CT106H/exercise14$ 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
lnk@NhutKhang:~/CT106H/exercise14$
```



Exercise 14 (OSPF) - single area

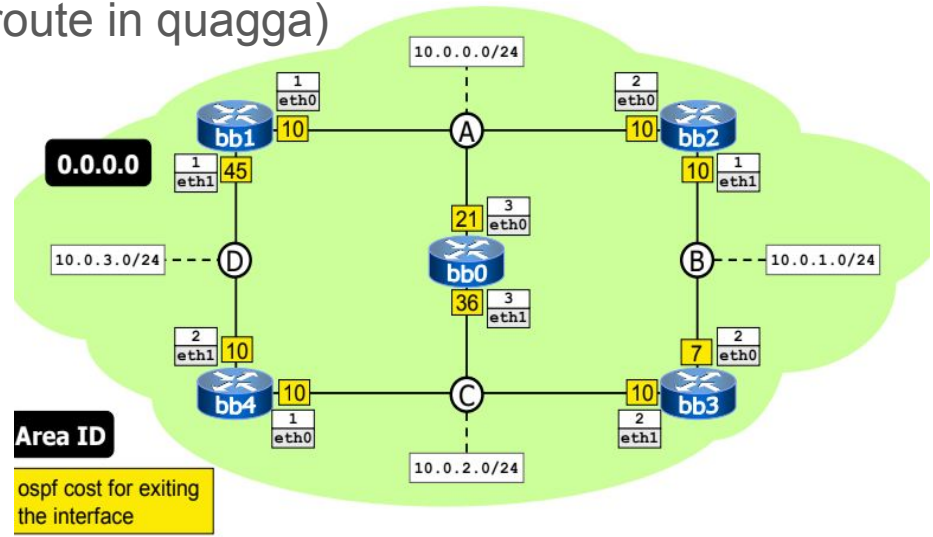
Perform traceroutes from/to different interfaces
*Perform a `traceroute -I` from bb1 to 10.0.2.1
- what path is the traceroute expected to take?
- what path are ICMP replies expected to take?




```
root@bb1: /
--- Startup Commands Log

++ ifconfig eth0 10.0.0.1/24 up
++ ifconfig eth1 10.0.3.1/24 up
++ /etc/init.d/quagga start
Starting Quagga daemons (prio:10): zebra ospfd.
Starting Quagga monitor daemon: watchquagga.

--- End Startup Commands Log

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 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=0.187 ms
64 bytes from 10.0.2.1: icmp_seq=2 ttl=64 time=0.312 ms
64 bytes from 10.0.2.1: icmp_seq=3 ttl=64 time=0.436 ms
^C
--- 10.0.2.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 9ms
rtt min/avg/max/mdev = 0.187/0.311/0.436/0.103 ms
```

Exercise 14 (OSPF) - single area

Perform traceroutes from/to different interfaces
*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)




```
root@bb1: /
--- 10.0.2.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 9ms
rtt min/avg/max/mdev = 0.187/0.311/0.436/0.103 ms
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)  0.104 ms  0.040 ms  0.038 ms
 2  10.0.1.2 (10.0.1.2)  0.078 ms  0.062 ms  0.061 ms
 3  10.0.2.1 (10.0.2.1)  0.081 ms  0.065 ms  0.074 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)  0.092 ms  0.030 ms  0.030 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:
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>
```

Exercise 14 (OSPF) - single area

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

- `show ip ospf database`
- `show ip ospf neighbor`

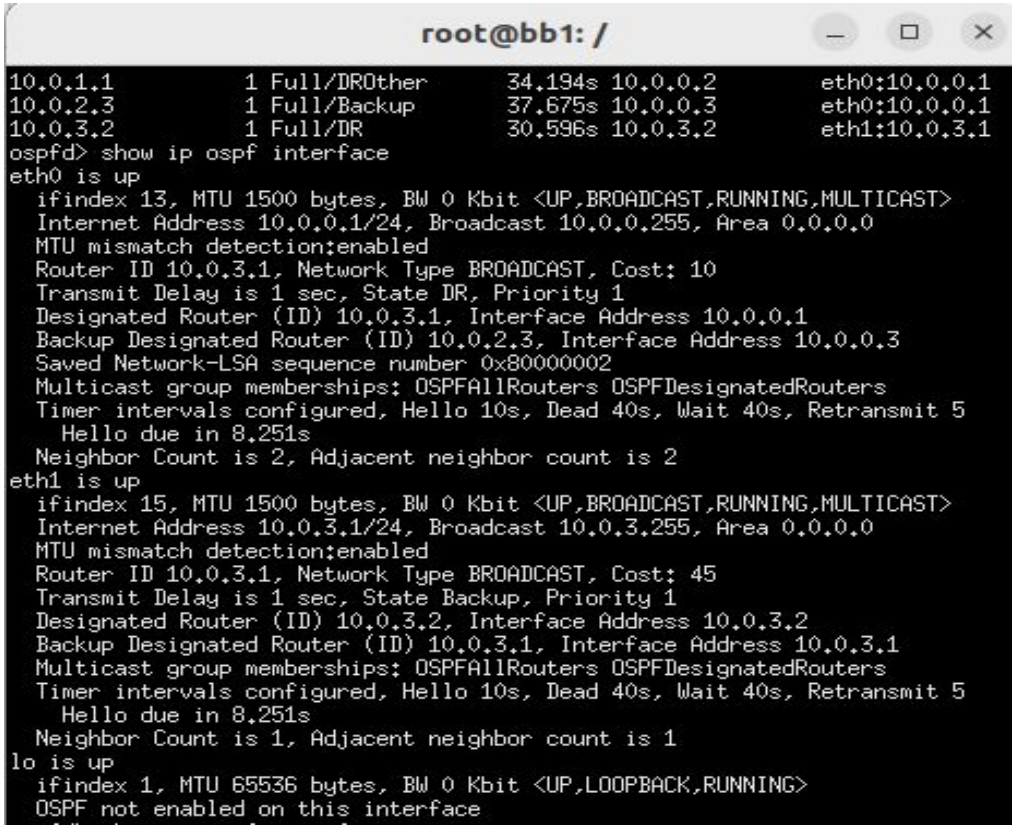
```
ospfd> show ip ospf database

       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        814 0x80000008 0xdfff 2
10.0.2.2        10.0.2.2        814 0x80000007 0xdbfe 2
10.0.2.3        10.0.2.3        814 0x8000000a 0xd9d4 2
10.0.3.1        10.0.3.1        813 0x80000008 0x288d 2
10.0.3.2        10.0.3.2        813 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        818 0x80000002 0x69a9
10.0.1.2        10.0.2.2        818 0x80000001 0x69bb
10.0.2.1        10.0.3.2        813 0x80000002 0x729a
10.0.3.2        10.0.3.2        814 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      34.194s 10.0.0.2        eth0:10.0.0.1            0     0     0
10.0.2.3          1 Full/Backup       37.675s 10.0.0.3        eth0:10.0.0.1            0     0     0
10.0.3.2          1 Full/DR           30.596s 10.0.3.2        eth1:10.0.3.1            0     0     0
ospfd>
```

Exercise 14 (OSPF) - single area

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

- `show ip ospf interface`

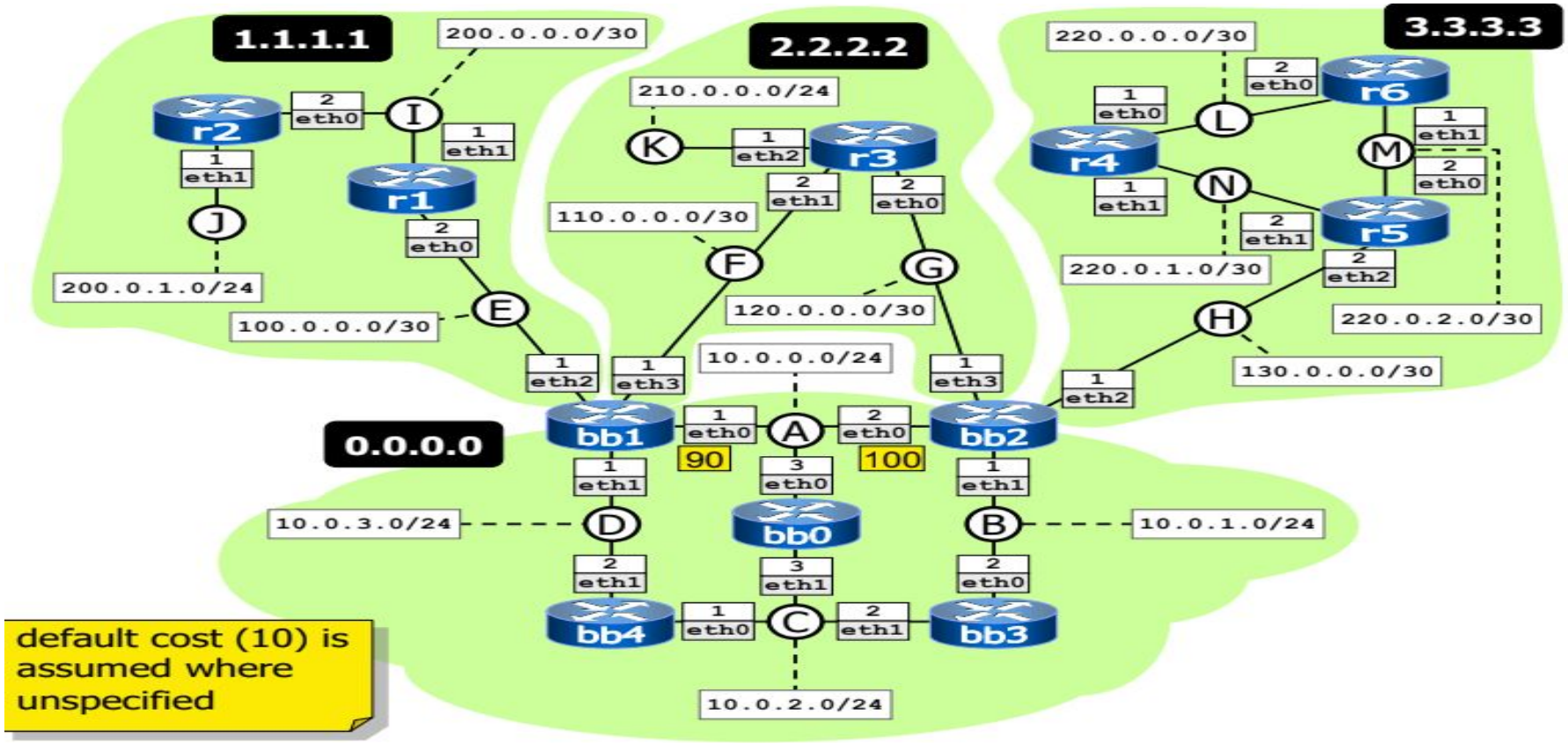


Exercise 14 (OSPF) - single area

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

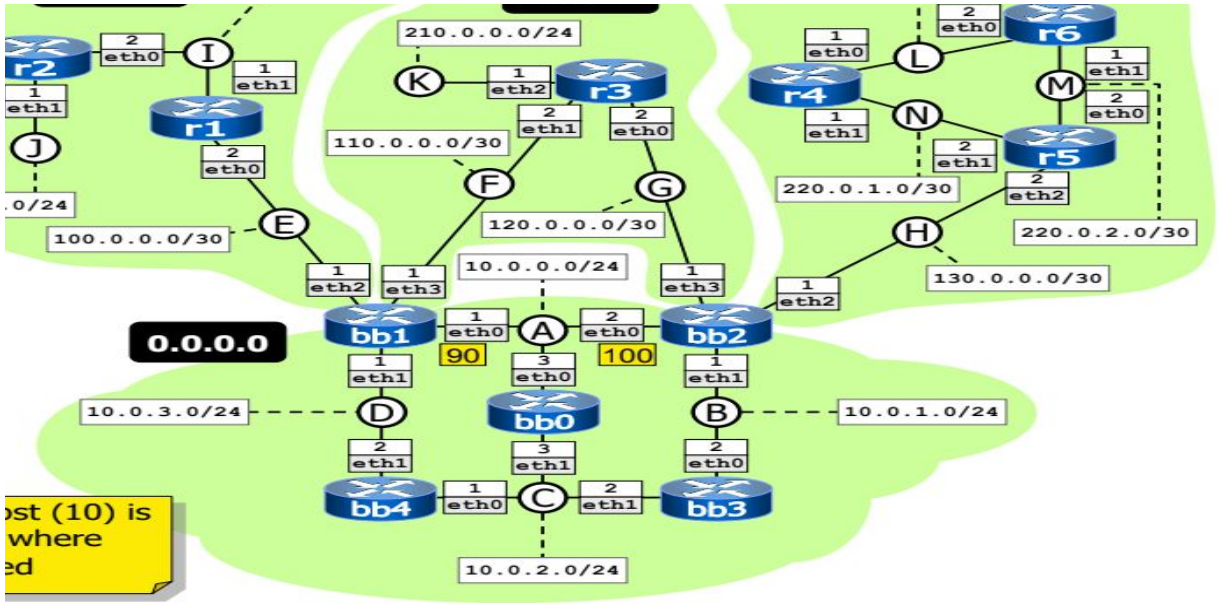
Exercise 15

Exercise 15 (ospf-multiarea)



Exercise 15 (solution)

Check the file 003-kathara-labs_ospf.zip → kathara-lab_ospf_multiarea



Exercise 16

Exercise 16

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