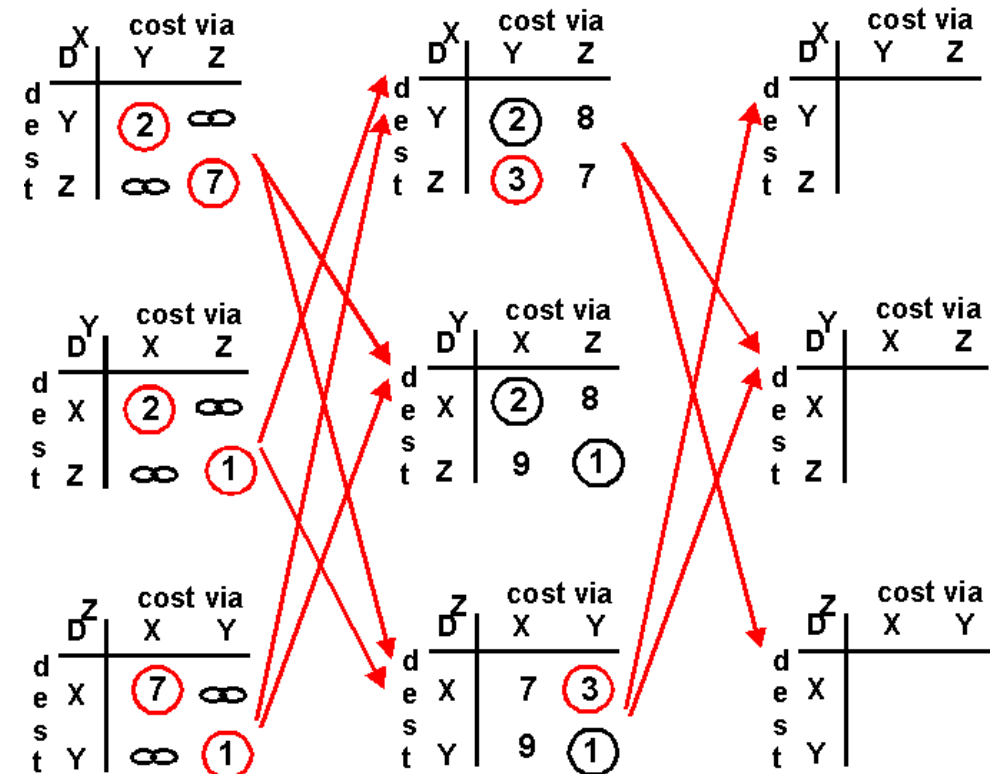
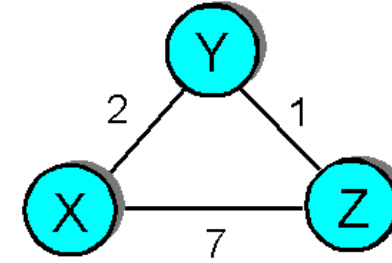


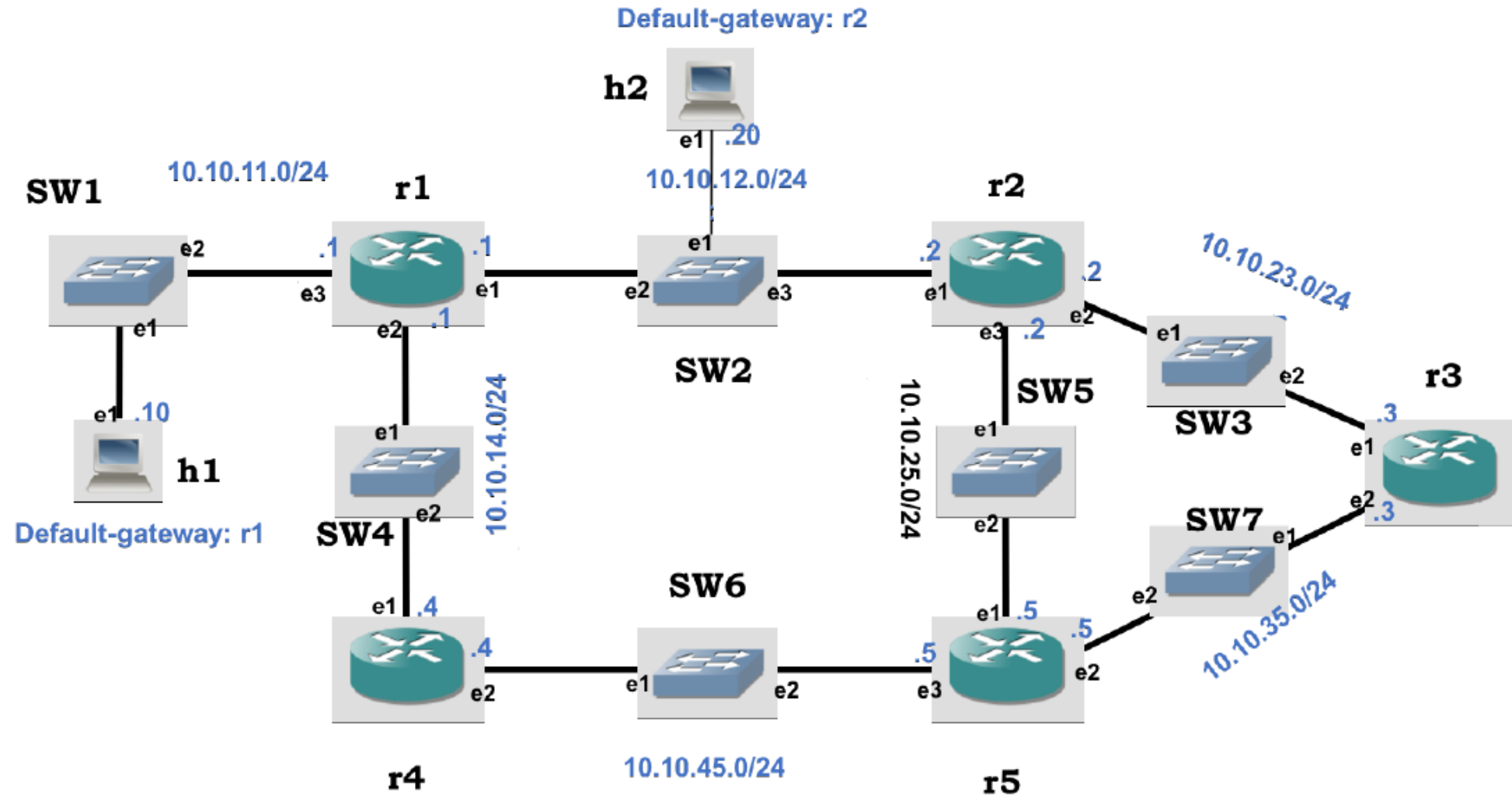
RIPv2

Routing Information Protocol (RIP)

- Distance-vector routing protocols:
 - typically run inside the network of an autonomous system (AS).
 - set up automatically network routes that ensure shortest path between two points in the network with respect to a predefined metric (such as number of hops).



Network topology



Settings for all routers

- daemons:

zebra=yes

bgpd=no

ospfd=no

ospf6d=no

ripd=yes

ripngd=no

isisd=no

lab8.py

```
58 info '** Executing custom commands\n')
59 #####
60 # Space to add any customize command before prompting command line
61
62 # We gather only the hosts created in the topology (no switches nor controller)
63 hosts = [ net.getNodeByName( h ) for h in topo.hosts() ]
64
65 info '** Starting the Quagga Service on Virtual Routers\n')
66
67 for r in ['r3', 'r4', 'r5', 'r1']:
68     net.getNodeByName(r).cmd( "echo 1 > /proc/sys/net/ipv4/ip_forward" )
69     net.getNodeByName(r).cmd( "/etc/init.d/quagga start" )
70
71 import time
72 time.sleep(10)
73 net.getNodeByName('r2').cmd( "echo 1 > /proc/sys/net/ipv4/ip_forward" )
74 net.getNodeByName('r2').cmd( "/etc/init.d/quagga start" )
75
76 info '** Enabling xterm for all hosts\n')
77 makeTerms( hosts, 'node' )
78
79 #####
80 # Enable the minixterm prompt
81 info '** Running CLI\n')
82 CLI(net)
```

Capture r1-eth1 traffic

- root@r1:/# wireshark

Capturing from r1-eth1 [Wireshark 1.10.6 (v1.10.6 from master-1.10)] (r1)

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
2	0.003034000	10.10.12.1	224.0.0.22	IGMPv3	54	Membership Report / Join group 224.0.0.9 for any sources
3	0.032307000	10.10.12.1	224.0.0.22	IGMPv3	54	Membership Report / Join group 224.0.0.9 for any sources
4	0.036762000	10.10.12.2	10.10.12.1	RIPv2	126	Response
5	5.048274000	72:60:05:87:fe:c7	36:f2:d6:b2:aa:83	ARP	42	Who has 10.10.12.1? Tell 10.10.12.2
6	5.048320000	36:f2:d6:b2:aa:83	72:60:05:87:fe:c7	ARP	42	10.10.12.1 is at 36:f2:d6:b2:aa:83
7	11.134552000	10.10.12.1	224.0.0.9	RIPv2	126	Response
8	26.287405000	10.10.12.2	224.0.0.9	RIPv2	126	Response
9	42.186035000	10.10.12.1	224.0.0.9	RIPv2	126	Response
10	61.290491000	10.10.12.2	224.0.0.9	RIPv2	126	Response

► Frame 7: 126 bytes on wire (1008 bits), 126 bytes captured (1008 bits) on interface 0

▼ Ethernet II, Src: 36:f2:d6:b2:aa:83 (36:f2:d6:b2:aa:83), Dst: IPv4mcast_00:00:09 (01:00:5e:00:00:09)

▼ Destination: IPv4mcast_00:00:09 (01:00:5e:00:00:09)

Address: IPv4mcast_00:00:09 (01:00:5e:00:00:09)

.... ..0. = LG bit: Globally unique address (factory default)

.... ..1. = IG bit: Group address (multicast/broadcast)

▼ Source: 36:f2:d6:b2:aa:83 (36:f2:d6:b2:aa:83)

Address: 36:f2:d6:b2:aa:83 (36:f2:d6:b2:aa:83)

.... ..1. = LG bit: Locally administered address (this is NOT the factory default)

.... ..0. = IG bit: Individual address (unicast)

Type: IP (0x0800)

0000 01 00 5e 00 00 09 36 f2 d6 b2 aa 83 08 00 45 c0 ..^...6.E.

0010 00 70 3b 44 40 00 01 11 47 65 0a 0a 0c 01 e0 00 .p;D@... Ge.....

0020 00 09 02 08 02 08 00 5c f6 81 02 02 00 00 00 02 \

0030 00 00 0a 0a 0b 00 ff ff ff 00 00 00 00 00 00 00

Destination Hardware Address... Packets: 10 · Displayed: 10 (100.0%) Profile: Default

configs/r1/logs/ripd.log

```
22 2022/06/22 13:04:39 RIP: ignore packet comes from myself
23 2022/06/22 13:04:39 RIP: ignore packet comes from myself
24 2022/06/22 13:04:39 RIP: RECV packet from 10.10.14.4 port 520 on r1-eth2
25 2022/06/22 13:04:39 RIP: RECV RESPONSE version 2 packet size 24
26 2022/06/22 13:04:39 RIP: 10.10.45.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
27 2022/06/22 13:04:39 RIP: RECV packet from 10.10.14.4 port 520 on r1-eth2
28 2022/06/22 13:04:39 RIP: RECV RESPONSE version 2 packet size 24
29 2022/06/22 13:04:39 RIP: 10.10.45.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
30 2022/06/22 13:04:40 RIP: RECV packet from 10.10.14.4 port 520 on r1-eth2
31 2022/06/22 13:04:40 RIP: RECV RESPONSE version 2 packet size 84
32 2022/06/22 13:04:40 RIP: 10.10.23.0/24 -> 0.0.0.0 family 2 tag 0 metric 3
33 2022/06/22 13:04:40 RIP: 10.10.25.0/24 -> 0.0.0.0 family 2 tag 0 metric 2
34 2022/06/22 13:04:40 RIP: 10.10.35.0/24 -> 0.0.0.0 family 2 tag 0 metric 2
35 2022/06/22 13:04:40 RIP: 10.10.45.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
36 2022/06/22 13:04:40 RIP: update timer fire!
37 2022/06/22 13:04:40 RIP: SEND UPDATE to r1-eth1 ifindex 1718
38 2022/06/22 13:04:40 RIP: multicast announce on r1-eth1
39 2022/06/22 13:04:40 RIP: update routes on interface r1-eth1 ifindex 1718
40 2022/06/22 13:04:40 RIP: rip_send_packet 10.10.12.1 > 224.0.0.9 (r1-eth1)
41 2022/06/22 13:04:40 RIP: SEND to 224.0.0.9.520
42 2022/06/22 13:04:40 RIP: SEND RESPONSE version 2 packet size 124
43 2022/06/22 13:04:40 RIP: 10.10.11.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
44 2022/06/22 13:04:40 RIP: 10.10.14.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
45 2022/06/22 13:04:40 RIP: 10.10.23.0/24 -> 0.0.0.0 family 2 tag 0 metric 4
46 2022/06/22 13:04:40 RIP: 10.10.25.0/24 -> 0.0.0.0 family 2 tag 0 metric 3
```


configs/r1/logs/ripd.log

```
75 2022/06/22 13:04:49 RIP: update routes to neighbor 10.10.12.2
76 2022/06/22 13:04:49 RIP: rip_send_packet 10.10.12.1 > 10.10.12.2 (r1-eth1)
77 2022/06/22 13:04:49 RIP: SEND to 10.10.12.2.520
78 2022/06/22 13:04:49 RIP: SEND RESPONSE version 2 packet size 124
79 2022/06/22 13:04:49 RIP: 10.10.11.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
80 2022/06/22 13:04:49 RIP: 10.10.14.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
81 2022/06/22 13:04:49 RIP: 10.10.23.0/24 -> 0.0.0.0 family 2 tag 0 metric 4
82 2022/06/22 13:04:49 RIP: 10.10.25.0/24 -> 0.0.0.0 family 2 tag 0 metric 3
83 2022/06/22 13:04:49 RIP: 10.10.35.0/24 -> 0.0.0.0 family 2 tag 0 metric 3
84 2022/06/22 13:04:49 RIP: 10.10.45.0/24 -> 0.0.0.0 family 2 tag 0 metric 2
85 2022/06/22 13:04:50 RIP: RECV packet from 10.10.12.2 port 520 on r1-eth1
86 2022/06/22 13:04:50 RIP: RECV RESPONSE version 2 packet size 84
87 2022/06/22 13:04:50 RIP: 10.10.23.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
88 2022/06/22 13:04:50 RIP: 10.10.25.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
89 2022/06/22 13:04:50 RIP: 10.10.35.0/24 -> 0.0.0.0 family 2 tag 0 metric 2
90 2022/06/22 13:04:50 RIP: 10.10.45.0/24 -> 0.0.0.0 family 2 tag 0 metric 2
91 2022/06/22 13:04:50 RIP: triggered update!
92 2022/06/22 13:04:50 RIP: SEND UPDATE to r1-eth1 ifindex 1718
93 2022/06/22 13:04:50 RIP: multicast announce on r1-eth1
94 2022/06/22 13:04:50 RIP: update routes on interface r1-eth1 ifindex 1718
95 2022/06/22 13:04:50 RIP: rip_send_packet 10.10.12.1 > 224.0.0.9 (r1-eth1)
96 2022/06/22 13:04:50 RIP: SEND to 224.0.0.9.520
97 2022/06/22 13:04:50 RIP: SEND RESPONSE version 2 packet size 84
98 2022/06/22 13:04:50 RIP: 10.10.11.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
99 2022/06/22 13:04:50 RIP: 10.10.14.0/24 -> 0.0.0.0 family 2 tag 0 metric 1
100 2022/06/22 13:04:50 RIP: 10.10.35.0/24 -> 0.0.0.0 family 2 tag 0 metric 3
101 2022/06/22 13:04:50 RIP: 10.10.45.0/24 -> 0.0.0.0 family 2 tag 0 metric 2
```


configs/r1/logs/zebra.log

```
1 2022/06/22 13:04:38 ZEBRA: Zebra 0.99.22.4 starting: vty@2601
2 2022/06/22 13:04:38 ZEBRA: zebra message received [ZEBRA_HELLO] 1
3 2022/06/22 13:04:38 ZEBRA: client 12 says hello and bids fair to announce only rip routes
4 2022/06/22 13:04:38 ZEBRA: zebra message received [ZEBRA_ROUTER_ID_ADD] 0
5 2022/06/22 13:04:38 ZEBRA: zebra message received [ZEBRA_INTERFACE_ADD] 0
6 2022/06/22 13:04:38 ZEBRA: zebra message received [ZEBRA_REDISTRIBUTE_ADD] 1
7 2022/06/22 13:04:39 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
8 2022/06/22 13:04:40 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
9 2022/06/22 13:04:40 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
10 2022/06/22 13:04:40 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
11 2022/06/22 13:04:50 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_DELETE] 19
12 2022/06/22 13:04:50 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
13 2022/06/22 13:04:50 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_DELETE] 19
14 2022/06/22 13:04:50 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
15
```

- Given that r1 has no better routes for these networks all of them will be accepted.

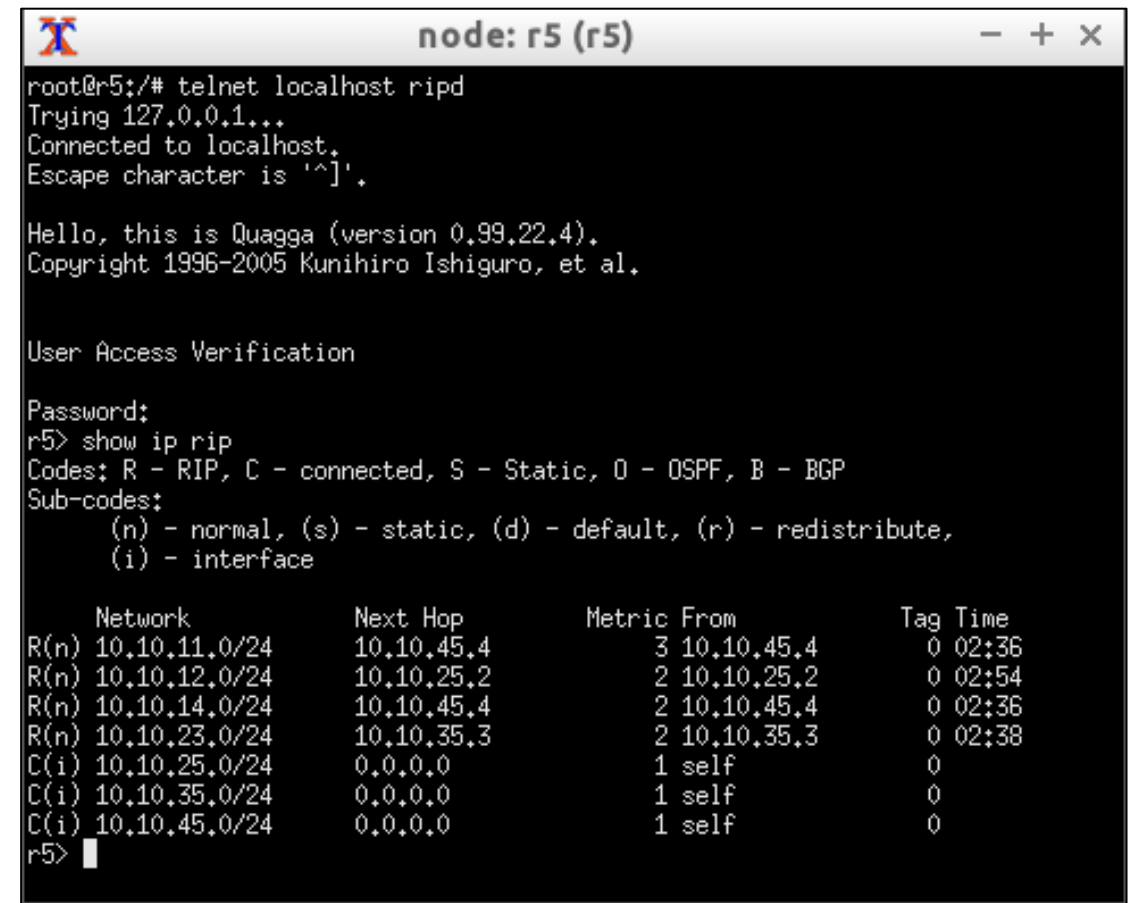
configs/r1/logs/zebra.log

```
1 2022/06/22 13:04:38 ZEBRA: Zebra 0.99.22.4 starting: vty@2601
2 2022/06/22 13:04:38 ZEBRA: zebra message received [ZEBRA_HELLO] 1
3 2022/06/22 13:04:38 ZEBRA: client 12 says hello and bids fair to announce only rip routes
4 2022/06/22 13:04:38 ZEBRA: zebra message received [ZEBRA_ROUTER_ID_ADD] 0
5 2022/06/22 13:04:38 ZEBRA: zebra message received [ZEBRA_INTERFACE_ADD] 0
6 2022/06/22 13:04:38 ZEBRA: zebra message received [ZEBRA_REDISTRIBUTE_ADD] 1
7 2022/06/22 13:04:39 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
8 2022/06/22 13:04:40 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
9 2022/06/22 13:04:40 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
10 2022/06/22 13:04:40 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
11 2022/06/22 13:04:50 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_DELETE] 19
12 2022/06/22 13:04:50 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
13 2022/06/22 13:04:50 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_DELETE] 19
14 2022/06/22 13:04:50 ZEBRA: zebra message received [ZEBRA_IPV4_ROUTE_ADD] 19
15
```

- Given that r2 offers fewer hops to 10.10.23.0/24, the previous entry through r4 will be deleted and the new entry through r2 will be added.

Monitoring Commands

- RIP database
- Enter to Quagga configuration mode
- (password: quagga)



```
node: r5 (r5)
root@r5:/# telnet localhost ripd
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Hello, this is Quagga (version 0.99.22.4).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

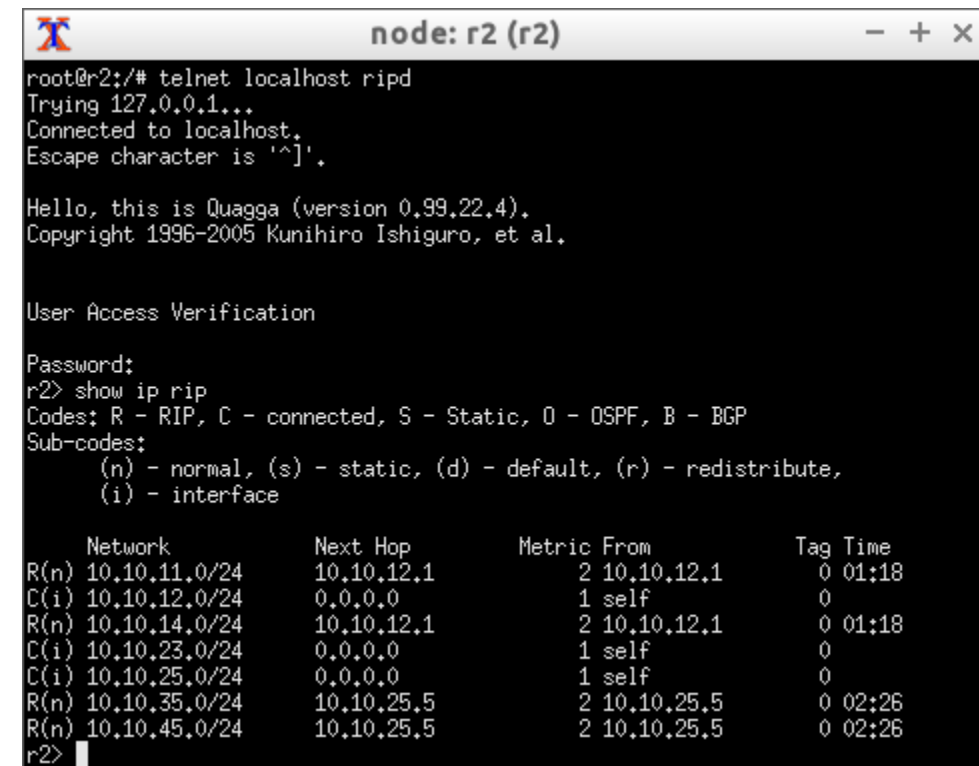
User Access Verification

Password:
r5> show ip rip
Codes: R - RIP, C - connected, S - Static, O - OSPF, B - BGP
Sub-codes:
      (n) - normal, (s) - static, (d) - default, (r) - redistribute,
      (i) - interface

      Network        Next Hop        Metric From      Tag Time
R(n) 10.10.11.0/24    10.10.45.4       3 10.10.45.4      0 02:36
R(n) 10.10.12.0/24    10.10.25.2       2 10.10.25.2      0 02:54
R(n) 10.10.14.0/24    10.10.45.4       2 10.10.45.4      0 02:36
R(n) 10.10.23.0/24    10.10.35.3       2 10.10.35.3      0 02:38
C(i) 10.10.25.0/24    0.0.0.0          1 self            0
C(i) 10.10.35.0/24    0.0.0.0          1 self            0
C(i) 10.10.45.0/24    0.0.0.0          1 self            0
r5>
```

Understanding Neighbors in RIP

- The command `network 10.10.11.0/24` would enable r1-eth3 interface for sending/receiving RIP database updates, which would be disregarded by h1 as it is not running RIP, h1 is only a host.
- From `configs/r1/ripd.conf`:
 - `! network 10.10.12.0/24`
- Restart the Quagga service:
 - `root@r1:/# /etc/init.d/quagga stop`
 - `root@r1:/# /etc/init.d/quagga start`
- From Wireshark, we cannot see any RIPv2 packet coming from r1.



```
node: r2 (r2)
root@r2:/# telnet localhost ripd
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^'.

Hello, this is Quagga (version 0.99.22.4).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

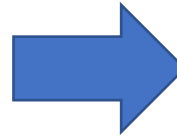
User Access Verification

Password:
r2> show ip rip
Codes: R - RIP, C - connected, S - Static, O - OSPF, B - BGP
Sub-codes:
        (n) - normal, (s) - static, (d) - default, (r) - redistribute,
        (i) - interface

   Network      Next Hop      Metric From      Tag Time
R(n) 10.10.11.0/24 10.10.12.1      2 10.10.12.1      0 01:18
C(i) 10.10.12.0/24 0.0.0.0         1 self           0
R(n) 10.10.14.0/24 10.10.12.1      2 10.10.12.1      0 01:18
C(i) 10.10.23.0/24 0.0.0.0         1 self           0
C(i) 10.10.25.0/24 0.0.0.0         1 self           0
R(n) 10.10.35.0/24 10.10.25.5      2 10.10.25.5      0 02:26
R(n) 10.10.45.0/24 10.10.25.5      2 10.10.25.5      0 02:26
r2>
```

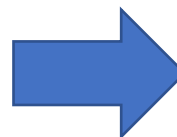
The difference

```
node: h1 (h1)
root@h1:/# traceroute 10.10.12.2
traceroute to 10.10.12.2 (10.10.12.2), 64 hops max
 1  10.10.11.1  4.059ms  1.567ms  1.500ms
 2  10.10.12.2  5.391ms  2.496ms  2.248ms
root@h1:/# ping 10.10.12.2
PING 10.10.12.2 (10.10.12.2) 56(84) bytes of data.
64 bytes from 10.10.12.2: icmp_seq=1 ttl=63 time=7.14 ms
64 bytes from 10.10.12.2: icmp_seq=2 ttl=63 time=0.959 ms
64 bytes from 10.10.12.2: icmp_seq=3 ttl=63 time=0.336 ms
64 bytes from 10.10.12.2: icmp_seq=4 ttl=63 time=0.263 ms
^C
--- 10.10.12.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.263/2.176/7.149/2.884 ms
root@h1:/#
```



```
node: h1 (h1)
root@h1:/# traceroute 10.10.12.2
traceroute to 10.10.12.2 (10.10.12.2), 64 hops max
 1  10.10.11.1  3.952ms  1.589ms  9.822ms
 2  10.10.12.2  8.945ms  5.386ms  18.889ms
root@h1:/# ping 10.10.12.2
PING 10.10.12.2 (10.10.12.2) 56(84) bytes of data.
64 bytes from 10.10.12.2: icmp_seq=1 ttl=61 time=8.70 ms
64 bytes from 10.10.12.2: icmp_seq=2 ttl=61 time=2.51 ms
64 bytes from 10.10.12.2: icmp_seq=3 ttl=61 time=0.373 ms
64 bytes from 10.10.12.2: icmp_seq=4 ttl=61 time=0.364 ms
^C
--- 10.10.12.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3003ms
rtt min/avg/max/mdev = 0.364/2.988/8.705/3.415 ms
root@h1:/#
```

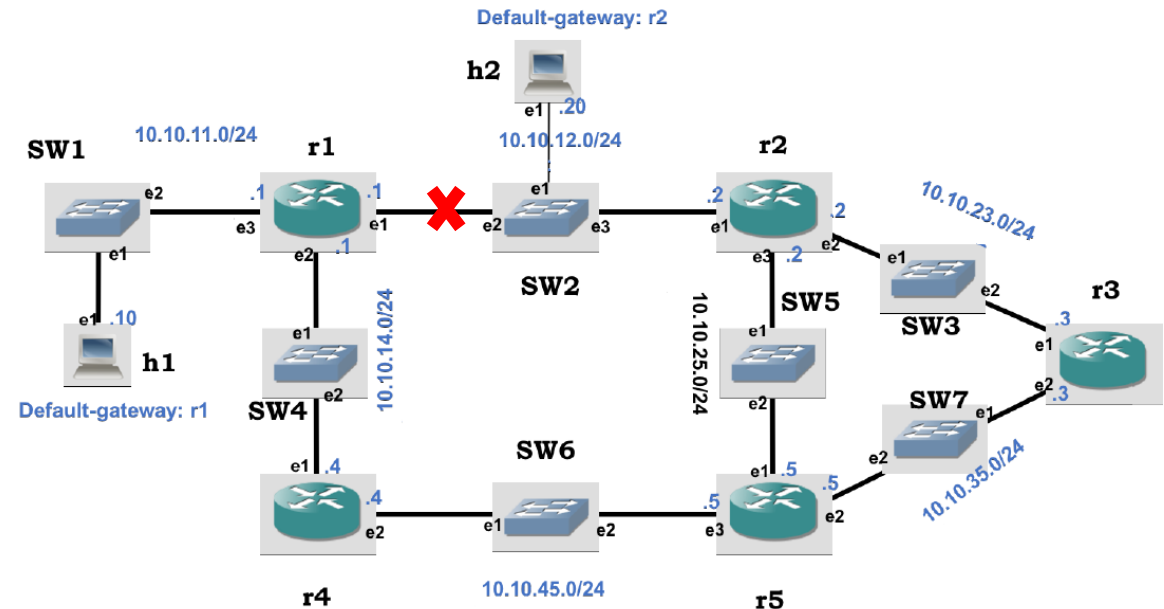
```
node: h1 (h1)
root@h1:/# traceroute 10.10.23.2
traceroute to 10.10.23.2 (10.10.23.2), 64 hops max
 1  10.10.11.1  3.792ms  1.785ms  1.802ms
 2  10.10.23.2  5.162ms  2.409ms  2.435ms
root@h1:/# ping 10.10.23.2
PING 10.10.23.2 (10.10.23.2) 56(84) bytes of data.
64 bytes from 10.10.23.2: icmp_seq=1 ttl=63 time=5.67 ms
64 bytes from 10.10.23.2: icmp_seq=2 ttl=63 time=1.74 ms
64 bytes from 10.10.23.2: icmp_seq=3 ttl=63 time=0.266 ms
64 bytes from 10.10.23.2: icmp_seq=4 ttl=63 time=0.270 ms
^C
--- 10.10.23.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3005ms
rtt min/avg/max/mdev = 0.266/1.990/5.676/2.212 ms
root@h1:/#
```



```
node: h1 (h1)
root@h1:/# traceroute 10.10.23.2
traceroute to 10.10.23.2 (10.10.23.2), 64 hops max
 1  10.10.11.1  4.660ms  1.528ms  1.428ms
 2  10.10.14.4  5.073ms  2.636ms  2.689ms
 3  10.10.45.5  7.221ms  3.902ms  3.791ms
 4  10.10.35.3  10.463ms  5.405ms  5.821ms
 5  10.10.23.2  10.149ms  5.437ms  4.681ms
root@h1:/# ping 10.10.23.2
PING 10.10.23.2 (10.10.23.2) 56(84) bytes of data.
64 bytes from 10.10.23.2: icmp_seq=1 ttl=61 time=11.2 ms
64 bytes from 10.10.23.2: icmp_seq=2 ttl=61 time=3.83 ms
64 bytes from 10.10.23.2: icmp_seq=3 ttl=61 time=0.519 ms
64 bytes from 10.10.23.2: icmp_seq=4 ttl=61 time=0.500 ms
^C
--- 10.10.23.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3002ms
rtt min/avg/max/mdev = 0.500/4.030/11.266/4.393 ms
root@h1:/#
```

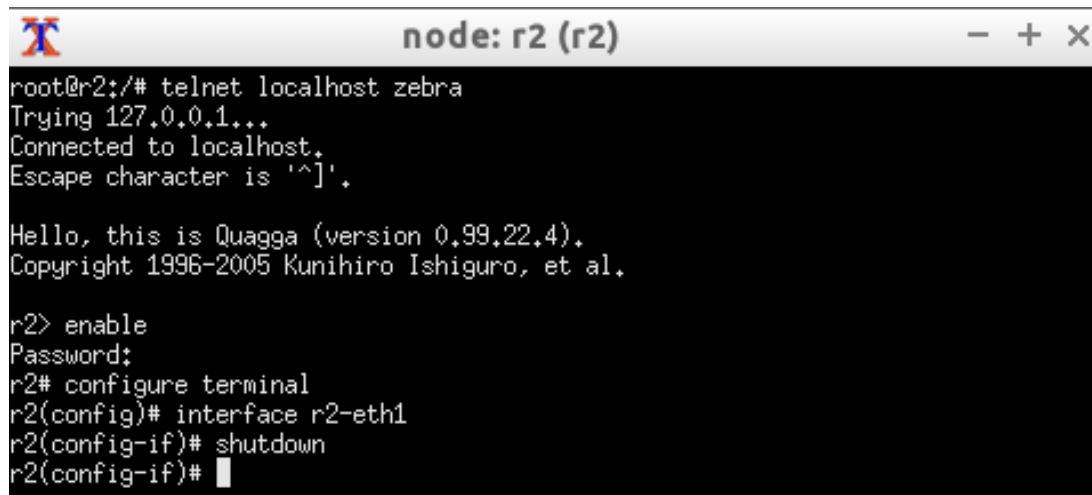
The difference

- RIP sees two different routers with a common prefix (10.10.12.0/24), and these two routers have no communication between each other. Therefore, r2 has to take the route announced by r5 as the only choice to go to any of r1's networks (other than 10.10.12.0/24, as r2 has it directly connected) and installs the networks to 10.10.11.0/24 and 10.10.14.0/24 through r5.



Broken Link

- `$ sudo python lab8_v2.py`
- Restart the Quagga service in r1, r2 and r4 respectively:
 - `# /etc/init.d/quagga stop`
 - `# /etc/init.d/quagga start`
- Shutdown the r2-eth1 interface on r2:

A terminal window titled "node: r2 (r2)" with standard window controls. The terminal shows a sequence of commands and outputs: a telnet connection to localhost, enabling privileged mode, configuring the terminal, and shutting down the r2-eth1 interface.

```
node: r2 (r2)
root@r2:/# telnet localhost zebra
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Hello, this is Quagga (version 0.99.22.4).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

r2> enable
Password:
r2# configure terminal
r2(config)# interface r2-eth1
r2(config-if)# shutdown
r2(config-if)#
```


Broken Link

- After the expiration of the Invalid timer of 180s, the routes via r2 will be removed from the routing table of r1 and replaced with the routes via r4. This will happen after the reception of the first hello packet from r4 following the expiration of Invalid timer.

```
node: r1 (r1)
root@r1:/# telnet localhost ripd
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Hello, this is Quagga (version 0.99.22.4).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

User Access Verification

Password:
r1> 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) 10.10.11.0/24    0.0.0.0          1 self             0
C(i) 10.10.12.0/24    0.0.0.0          1 self             0
C(i) 10.10.14.0/24    0.0.0.0          1 self             0
R(n) 10.10.23.0/24    10.10.12.2        2 10.10.12.2        0 02:28
R(n) 10.10.25.0/24    10.10.12.2        2 10.10.12.2        0 02:28
R(n) 10.10.35.0/24    10.10.12.2        3 10.10.12.2        0 02:28
R(n) 10.10.45.0/24    10.10.14.4        2 10.10.14.4        0 02:56
r1> 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) 10.10.11.0/24    0.0.0.0          1 self             0
C(i) 10.10.12.0/24    0.0.0.0          1 self             0
C(i) 10.10.14.0/24    0.0.0.0          1 self             0
R(n) 10.10.23.0/24    10.10.14.4        4 10.10.14.4        0 02:49
R(n) 10.10.25.0/24    10.10.14.4        3 10.10.14.4        0 02:49
R(n) 10.10.35.0/24    10.10.14.4        3 10.10.14.4        0 02:49
R(n) 10.10.45.0/24    10.10.14.4        2 10.10.14.4        0 02:49
r1>
```

Broken Link

- After bringing up the r2-eth1 interface on r2 again, the routing table of r1 will take some time to converge. Its content will not be the same as in the beginning. The equal cost routes via r4 will be kept (only better routes are chosen).

```
node: r1 (r1)
r1> 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) 10.10.11.0/24 0.0.0.0         1 self           0
C(i) 10.10.12.0/24 0.0.0.0         1 self           0
C(i) 10.10.14.0/24 0.0.0.0         1 self           0
R(n) 10.10.23.0/24 10.10.12.2      2 10.10.12.2     0 02:28
R(n) 10.10.25.0/24 10.10.12.2      2 10.10.12.2     0 02:28
R(n) 10.10.35.0/24 10.10.12.2      3 10.10.12.2     0 02:28
R(n) 10.10.45.0/24 10.10.14.4      2 10.10.14.4     0 02:56
r1> 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) 10.10.11.0/24 0.0.0.0         1 self           0
C(i) 10.10.12.0/24 0.0.0.0         1 self           0
C(i) 10.10.14.0/24 0.0.0.0         1 self           0
R(n) 10.10.23.0/24 10.10.14.4      4 10.10.14.4     0 02:49
R(n) 10.10.25.0/24 10.10.14.4      3 10.10.14.4     0 02:49
R(n) 10.10.35.0/24 10.10.14.4      3 10.10.14.4     0 02:49
R(n) 10.10.45.0/24 10.10.14.4      2 10.10.14.4     0 02:49
r1> 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) 10.10.11.0/24 0.0.0.0         1 self           0
C(i) 10.10.12.0/24 0.0.0.0         1 self           0
C(i) 10.10.14.0/24 0.0.0.0         1 self           0
R(n) 10.10.23.0/24 10.10.12.2      2 10.10.12.2     0 02:45
R(n) 10.10.25.0/24 10.10.12.2      2 10.10.12.2     0 02:45
R(n) 10.10.35.0/24 10.10.14.4      3 10.10.14.4     0 02:56
R(n) 10.10.45.0/24 10.10.14.4      2 10.10.14.4     0 02:56
r1>
```

Modified Link Metric

- From r2, we can directly inject an offset in r2's computation of the cost.
- In this case, r2 will receive the updates from r1, and it will add the desired offset in order to calculate the shortest-path tree.

```
node: r2 (r2)
r2> show ip rip
Codes: R - RIP, C - connected, S - Static, O - OSPF, B - BGP
Sub-codes:
      (n) - normal, (s) - static, (d) - default, (r) - redistribute,
      (i) - interface

      Network        Next Hop        Metric From        Tag Time
R(n) 10.10.11.0/24    10.10.12.1        2 10.10.12.1        0 02:42
C(i) 10.10.12.0/24    0.0.0.0           1 self              0
R(n) 10.10.14.0/24    10.10.12.1        2 10.10.12.1        0 02:42
C(i) 10.10.23.0/24    0.0.0.0           1 self              0
C(i) 10.10.25.0/24    0.0.0.0           1 self              0
R(n) 10.10.35.0/24    10.10.23.3        2 10.10.23.3        0 02:34
R(n) 10.10.45.0/24    10.10.25.5        2 10.10.25.5        0 02:41
r2> enable
Password:
r2# configure terminal
r2(config)# router rip
r2(config-router)# offset-list addExtraMetric in 4 r2-eth1
r2(config-router)# access-list addExtraMetric permit any
r2(config)# exit
r2# show ip rip
Codes: R - RIP, C - connected, S - Static, O - OSPF, B - BGP
Sub-codes:
      (n) - normal, (s) - static, (d) - default, (r) - redistribute,
      (i) - interface

      Network        Next Hop        Metric From        Tag Time
R(n) 10.10.11.0/24    10.10.25.5        4 10.10.25.5        0 02:45
C(i) 10.10.12.0/24    0.0.0.0           1 self              0
R(n) 10.10.14.0/24    10.10.25.5        3 10.10.25.5        0 02:45
C(i) 10.10.23.0/24    0.0.0.0           1 self              0
C(i) 10.10.25.0/24    0.0.0.0           1 self              0
R(n) 10.10.35.0/24    10.10.23.3        2 10.10.23.3        0 02:28
R(n) 10.10.45.0/24    10.10.25.5        2 10.10.25.5        0 02:45
r2#
```

Process Crash

```
node: r2 (r2)
root@r2:/# pidof ripd
43
root@r2:/# kill 43
root@r2:/#
```

```
node: r5 (r5)
root@r5:/# pidof ripd
43
root@r5:/# kill 43
root@r5:/#
```

```
node: r1 (r1)
root@r1:/# telnet localhost ripd
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Hello, this is Quagga (version 0.99.22.4).
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User Access Verification

Password:
r1> 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) 10.10.11.0/24  0.0.0.0        1 self           0
C(i) 10.10.12.0/24  0.0.0.0        1 self           0
C(i) 10.10.14.0/24  0.0.0.0        1 self           0
R(n) 10.10.23.0/24  10.10.12.2     2 10.10.12.2     0 02:38
R(n) 10.10.25.0/24  10.10.12.2     2 10.10.12.2     0 02:38
R(n) 10.10.35.0/24  10.10.12.2     3 10.10.12.2     0 02:38
R(n) 10.10.45.0/24  10.10.14.4     2 10.10.14.4     0 02:38
r1> 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) 10.10.11.0/24  0.0.0.0        1 self           0
C(i) 10.10.12.0/24  0.0.0.0        1 self           0
C(i) 10.10.14.0/24  0.0.0.0        1 self           0
R(n) 10.10.23.0/24  10.10.12.2    16 10.10.12.2     0 01:45
R(n) 10.10.25.0/24  10.10.12.2    16 10.10.12.2     0 01:45
R(n) 10.10.35.0/24  10.10.12.2    16 10.10.12.2     0 01:45
R(n) 10.10.45.0/24  10.10.14.4     2 10.10.14.4     0 02:40
r1>
```

```
node: r4 (r4)
root@r4:/# telnet localhost ripd
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Hello, this is Quagga (version 0.99.22.4).
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User Access Verification

Password:
r4> show ip rip
Codes: R - RIP, C - connected, S - Static, O - OSPF, B - BGP
Sub-codes:
      (n) - normal, (s) - static, (d) - default, (r) - redistribute,
      (i) - interface

      Network      Next Hop      Metric From      Tag Time
R(n) 10.10.11.0/24  10.10.14.1     2 10.10.14.1     0 02:46
R(n) 10.10.12.0/24  10.10.14.1     2 10.10.14.1     0 02:46
C(i) 10.10.14.0/24  0.0.0.0        1 self           0
R(n) 10.10.23.0/24  10.10.14.1     3 10.10.14.1     0 02:46
R(n) 10.10.25.0/24  10.10.45.5     2 10.10.45.5     0 02:46
R(n) 10.10.35.0/24  10.10.45.5     2 10.10.45.5     0 02:46
C(i) 10.10.45.0/24  0.0.0.0        1 self           0
r4> show ip rip
Codes: R - RIP, C - connected, S - Static, O - OSPF, B - BGP
Sub-codes:
      (n) - normal, (s) - static, (d) - default, (r) - redistribute,
      (i) - interface

      Network      Next Hop      Metric From      Tag Time
R(n) 10.10.11.0/24  10.10.14.1     2 10.10.14.1     0 02:50
R(n) 10.10.12.0/24  10.10.14.1     2 10.10.14.1     0 02:50
C(i) 10.10.14.0/24  0.0.0.0        1 self           0
R(n) 10.10.23.0/24  10.10.14.1    16 10.10.14.1     0 01:19
R(n) 10.10.25.0/24  10.10.45.5    16 10.10.45.5     0 01:25
R(n) 10.10.35.0/24  10.10.45.5    16 10.10.45.5     0 01:25
C(i) 10.10.45.0/24  0.0.0.0        1 self           0
r4>
```