计算机网络实验报告

警示

1. 实验报告如有雷同，雷同各方当次实验成绩均以 0 分计。
2. 当次小组成员成绩只计学号、姓名登录在下表中的。
3. 在规定时间内未上交实验报告的，不得以其他方式补交，当次成绩按 0 分计。
4. 实验报告文件以 PDF 格式提交。

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【实验题目】**RIP 路由协议实验**

【实验目的】

掌握在路由器上配置 RIPv2

【实验内容】

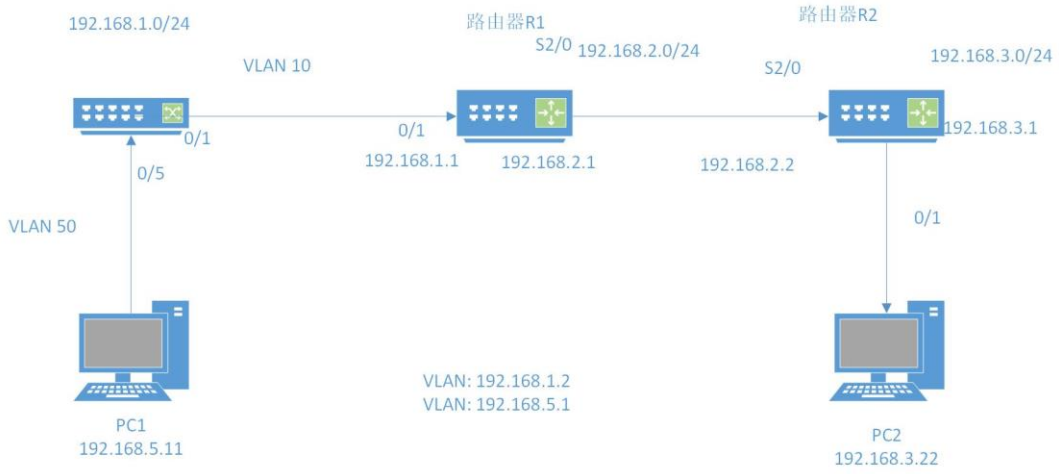
1. 在实验设备上完成 P243 实验 7-2 并测试实验网连通性。
2. 通过实验观察 RIP V1 和 V2 的区别（重点在 VLSM 上）给出分析过程与结果（实验 IP 采用 10.10.x.0 网段）
3. 学会使用 Debug ip packet 和 Debug ip rip 命令，并对 debug 信息做分析。
4. 观察试验拓扑中链路状态发生改变时路由表的前后信息对比及 debug 信息的变化。

【实验要求】

重要信息信息需给出截图，注意实验步骤的前后对比。

【实验记录】

1. 本实验的拓扑结构如下：



分析：本实验的预期目标是通过配置动态路由协议 RIP，自动学习网段的路由信息，实现网络的互联互通。

步骤 1:

(1) 按照拓扑图配置 PC1 和 PC2 的 IP 地址、子网掩码、网关，并测试它们的连通性。

可见此时两台 PC 并不连通。

(2) 在路由器 R1 上执行 show ip route 命令，记录路由表信息。

```
6-RSR20-2(config-router)#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
```

如图所示，此时路由表中还没有信息。

步骤 2：三层交换机的配置

```
6-S5750-1>enable 14

Password:
Password:
6-S5750-1#conf
Enter configuration commands, one per line.  End with CNTL/Z.
6-S5750-1(config)#hostname S5750
S5750(config)#show vlan
VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------------
   1 VLAN0001                         STATIC    Gi0/1, Gi0/2, Gi0/3, Gi0/4
                                                Gi0/5, Gi0/6, Gi0/7, Gi0/8
                                                Gi0/9, Gi0/10, Gi0/11, Gi0/12
                                                Gi0/13, Gi0/14, Gi0/15, Gi0/16
                                                Gi0/17, Gi0/18, Gi0/19, Gi0/20
                                                Gi0/21, Gi0/22, Gi0/23, Gi0/24
                                                Gi0/25, Gi0/26, Gi0/27, Gi0/28
S5750(config)#vlan 10
S5750(config-vlan)#exit
S5750(config)#vlan 50
S5750(config-vlan)#exit
S5750(config)#int gi 0/1
S5750(config-if-GigabitEthernet 0/1)#switchport access vlan 0
                                                             ^
% Invalid input detected at '^' marker.

S5750(config-if-GigabitEthernet 0/1)#switchport access vlan 10
S5750(config-if-GigabitEthernet 0/1)#exit
S5750(config)#int gi 0/5
S5750(config-if-GigabitEthernet 0/5)#switchgport access vlan 50
% Unknown command.

S5750(config-if-GigabitEthernet 0/5)#switchport access vlan 50
S5750(config-if-GigabitEthernet 0/5)#exit
S5750(config)#int vlan 10
S5750(config-if-VLAN 10)#ip address 192.168.1.2 255.255.255.0
S5750(config-if-VLAN 10)#no shut
S5750(config-if-VLAN 10)#exit
S5750(config)#int vlan 50
S5750(config-if-VLAN 50)#ip address 192.168.5.1 255.255.255.0
S5750(config-if-VLAN 50)#no shut
S5750(config-if-VLAN 50)#exit
```

步骤 3：路由器的配置

```
6-RSR20-2>enable 14

Password:
6-RSR20-2#conf
Enter configuration commands, one per line.  End with CNTL/Z.
6-RSR20-2(config)#int gi 0/1
6-RSR20-2(config-if-GigabitEthernet 0/1)#ip address 192.168.3.1 255.255.255.0
6-RSR20-2(config-if-GigabitEthernet 0/1)#not shut
% Unknown command.

6-RSR20-2(config-if-GigabitEthernet 0/1)#int serial 2/0
6-RSR20-2(config-if-Serial 2/0)#ip address 192.168.2.2 255.255.255.0
6-RSR20-2(config-if-Serial 2/0)#no shut
6-RSR20-2(config-if-Serial 2/0)#router rip
6-RSR20-2(config-router)#version 2
6-RSR20-2(config-router)#no auto-summary
6-RSR20-2(config-router)#network 192.168.2.0
6-RSR20-2(config-router)#network 192.168.3.0
```

此为路由器 2 的配置命令。路由器 1 与此类似。

步骤 3：验证 3 台路由设备的路由表，查看是否学习了其他网段的路由信息。

```
S5750(config-router)#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C    192.168.1.0/24 is directly connected, VLAN 10
C    192.168.1.2/32 is local host.
R    192.168.2.0/24 [120/1] via 192.168.1.1, 00:03:14, VLAN 10
R    192.168.3.0/24 [120/2] via 192.168.1.1, 00:02:39, VLAN 10
C    192.168.5.0/24 is directly connected, VLAN 50
C    192.168.5.1/32 is local host.
```

```
6-RSR20-1(config-router)#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C    192.168.1.0/24 is directly connected, GigabitEthernet 0/1
C    192.168.1.1/32 is local host.
C    192.168.2.0/24 is directly connected, Serial 2/0
C    192.168.2.1/32 is local host.
R    192.168.3.0/24 [120/1] via 192.168.2.2, 00:03:10, Serial 2/0
R    192.168.5.0/24 [120/1] via 192.168.1.2, 00:03:45, GigabitEthernet 0/1
```

```
6-RSR20-2(config-router)#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
R    192.168.1.0/24 [120/1] via 192.168.2.1, 00:03:29, Serial 2/0
C    192.168.2.0/24 is directly connected, Serial 2/0
C    192.168.2.2/32 is local host.
C    192.168.3.0/24 is directly connected, GigabitEthernet 0/1
C    192.168.3.1/32 is local host.
R    192.168.5.0/24 [120/2] via 192.168.2.1, 00:03:29, Serial 2/0
```

如图所示，为三台设备的路由表，已学习了其他网段的路由信息。

步骤 4：测试网络的连通性

(1) 将此时的路由表与步骤 1 的路由表进行比较，有什么结论？

步骤 1 的路由表为空，此时的路由表多了直连网段和 RIP 路由，说明设备已学习其他网点的路由信息。

(2) 分析 tracert PC1 的结果。

```
C:\Users\Administrator>tracert 192.168.5.11

通过最多 30 个跃点跟踪
到 DESKTOP-BVAQLT3 [192.168.5.11] 的路由:

  1    <1 毫秒    <1 毫秒    <1 毫秒 192.168.3.1
  2    44 ms     42 ms     42 ms  192.168.2.1
  3    49 ms     50 ms     49 ms  192.168.1.2
  4    47 ms     46 ms     46 ms  DESKTOP-BVAQLT3 [192.168.5.11]

跟踪完成。
```

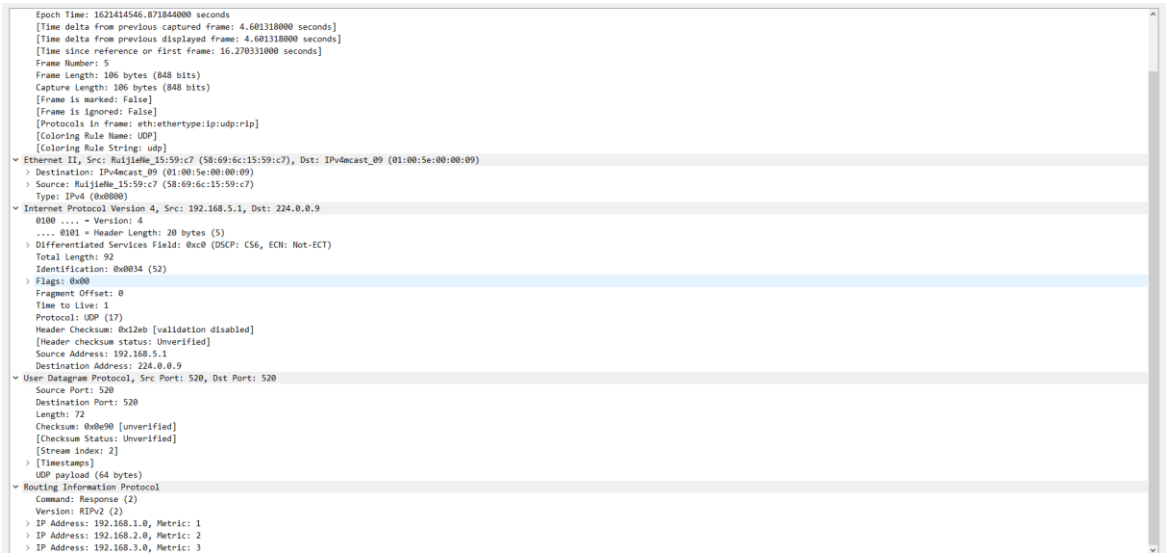
如图所示，tracert 经过的跃点为 PC1 和 PC2 间的路由器接口。

(3) 进行拔线实验，通过 Wireshark 测试报文变化的时间差，路由有没有出现毒性反转的现象？

```
▾ Routing Information Protocol
    Command: Response (2)
    Version: RIPv2 (2)
  › IP Address: 192.168.1.0, Metric: 16
  › IP Address: 192.168.2.0, Metric: 16
  › IP Address: 192.168.3.0, Metric: 16
```

变化的时间差大约为 5s，如图所示，路由出现了毒性反转的现象，Metric 变为 16。

(4) 捕获数据包，分析 RIP 封装结构。RIP 包在 PC1 或 PC2 上能捕获到吗？如果希望 2 台主机都能捕获到 RIP 包，请描述实现方法。



上图为 RIP 包的内容，RIP 包在 PC1 和 PC2 上都能捕获到。

2. RIPv1 和 RIPv2 是 RIP 的两个版本。

RIPv1 属于有类别路由协议，不支持 VLSM(可变长子网掩码)，RIP 以广播的形式进行路由信息的更新更新，更新周期为 30s。

RIPv2 属于无类别路由协议，支持 VLSM，RIPv2 以组播的形式进行路由信息的更新，组播地址是 224.0.0.9。RIPv2 还支持基于端口的认证，提高网络的安全性。

```
Internet Protocol Version 4, Src: 192.168.5.1, Dst: 255.255.255.255
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
    Total Length: 52
    Identification: 0x0093 (147)
  > Flags: 0x00
    Fragment Offset: 0
    Time to Live: 64
    Protocol: UDP (17)
    Header Checksum: 0xb3bd [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 192.168.5.1
    Destination Address: 255.255.255.255
User Datagram Protocol, Src Port: 520, Dst Port: 520
    Source Port: 520
    Destination Port: 520
    Length: 32
    Checksum: 0x34e4 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 1]
  > [Timestamps]
    UDP payload (24 bytes)
Routing Information Protocol
    Command: Request (1)
    Version: RIPv1 (1)
```

```
Internet Protocol Version 4, Src: 192.168.5.1, Dst: 224.0.0.9
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  > Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
    Total Length: 92
    Identification: 0x004f (79)
  > Flags: 0x00
    Fragment Offset: 0
    Time to Live: 1
    Protocol: UDP (17)
    Header Checksum: 0x12d0 [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 192.168.5.1
    Destination Address: 224.0.0.9
User Datagram Protocol, Src Port: 520, Dst Port: 520
    Source Port: 520
    Destination Port: 520
    Length: 72
    Checksum: 0x0e66 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 0]
  > [Timestamps]
    UDP payload (64 bytes)
Routing Information Protocol
    Command: Response (2)
    Version: RIPv2 (2)
```

上图分别为 RIPv1 和 RIPv2 的报文截图。从图中可见，RIPv1 采用广播的形式，目标地址为 255.255.255.255，RIPv2 采用组播的形式，目标地址为 224.0.0.9。

3. 学会使用 Debug ip packet 和 Debug ip rip 命令，并对 debug 信息做分析。

```
6-RSR20-2#debug ip packet
6-RSR20-2#debug ip rip
6-RSR20-2#*Jan 14 00:57:04: %7: IP: s=192.168.3.22 (GigabitEthernet 0/1), d=192.168.3.255,vrf=global(0),len=1468,received
*Jan 14 00:57:13: %7: IP: s=192.168.3.22 (GigabitEthernet 0/1), d=192.168.3.255,vrf=global(0),len=1468,received
*Jan 14 00:57:20: %7:  [RIP] Update timer expired via interface Serial 2/0[192.168.2.2/24]
*Jan 14 00:57:20: %7:  [RIP] Update timer schedule via interface Serial 2/0[192.168.2.2/24]
*Jan 14 00:57:20: %7:  [RIP] Prepare to send MULTICAST response...
*Jan 14 00:57:20: %7:  [RIP] Building update entries on Serial 2/0
*Jan 14 00:57:20: %7:        192.168.3.0/24 via 0.0.0.0 metric 1 tag 0
*Jan 14 00:57:20: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on Serial 2/0
*Jan 14 00:57:20: %7: IP: s=192.168.2.2 (local), d=224.0.0.9 (Serial 2/0),vrf=global(0), g=224.0.0.9,len=52,sent ip pkt to link_layer  222
*Jan 14 00:57:20: %7: IP: s=192.168.2.1 (Serial 2/0), d=224.0.0.9,vrf=global(0),len=72,received
*Jan 14 00:57:20: %7: [RIP] RIP recveived packet, sock=32979 src=192.168.2.1 len=44
*Jan 14 00:57:20: %7:  [RIP] Received version 2 response packet on Serial 2/0
*Jan 14 00:57:20: %7:  [RIP] Cancel peer[192.168.2.1] remove timer
*Jan 14 00:57:20: %7:  [RIP] Peer[192.168.2.1] remove timer shedule...
*Jan 14 00:57:20: %7:  [RIP] Both do not need auth, Auth ok
*Jan 14 00:57:20: %7:        route-entry: family 2 tag 0 ip 192.168.1.0 mask 255.255.255.0 nhop 0.0.0.0 metric 1
*Jan 14 00:57:20: %7:        route-entry: family 2 tag 0 ip 192.168.5.0 mask 255.255.255.0 nhop 0.0.0.0 metric 2
*Jan 14 00:57:20: %7:  [RIP] [192.168.1.0/24] RIP route update, protocol(4)
*Jan 14 00:57:20: %7:  [RIP] Old path is: nhop=192.168.2.1 routesrc=192.168.2.1 intf=2
*Jan 14 00:57:20: %7:  [RIP] New path is: nhop=192.168.2.1 routesrc=192.168.2.1 intf=2
*Jan 14 00:57:20: %7:  [RIP] [192.168.1.0/24] RIP distance apply from 192.168.2.1!
*Jan 14 00:57:20: %7:  [RIP] [192.168.1.0/24] cancel Route timer
*Jan 14 00:57:20: %7:  [RIP] [192.168.1.0/24] route timer schedule...
*Jan 14 00:57:20: %7:  [RIP] [192.168.5.0/24] RIP route update, protocol(4)
*Jan 14 00:57:20: %7:  [RIP] Old path is: nhop=192.168.2.1 routesrc=192.168.2.1 intf=2
*Jan 14 00:57:20: %7:  [RIP] New path is: nhop=192.168.2.1 routesrc=192.168.2.1 intf=2
*Jan 14 00:57:20: %7:  [RIP] [192.168.5.0/24] RIP distance apply from 192.168.2.1!
*Jan 14 00:57:20: %7:  [RIP] [192.168.5.0/24] cancel Route timer
*Jan 14 00:57:20: %7:  [RIP] [192.168.5.0/24] route timer schedule...
*Jan 14 00:57:21: %7:  [RIP] Update timer expired via interface GigabitEthernet 0/1[192.168.3.1/24]
*Jan 14 00:57:21: %7:  [RIP] Update timer schedule via interface GigabitEthernet 0/1[192.168.3.1/24]
*Jan 14 00:57:21: %7:  [RIP] Prepare to send MULTICAST response...
*Jan 14 00:57:21: %7:  [RIP] Building update entries on GigabitEthernet 0/1
*Jan 14 00:57:21: %7:        192.168.1.0/24 via 0.0.0.0 metric 2 tag 0
*Jan 14 00:57:21: %7:        192.168.2.0/24 via 0.0.0.0 metric 1 tag 0
*Jan 14 00:57:21: %7:        192.168.5.0/24 via 0.0.0.0 metric 3 tag 0
*Jan 14 00:57:21: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on GigabitEthernet 0/1
*Jan 14 00:57:21: %7: IP: s=192.168.3.1 (local), d=224.0.0.9 (GigabitEthernet 0/1),vrf=global(0), g=224.0.0.9,len=92,sent ip pkt to link_layer --> r
aw send
*Jan 14 00:57:21: %7: IP: s=192.168.3.22 (GigabitEthernet 0/1), d=192.168.3.255,vrf=global(0),len=1468,received
```

如图所示，使用 debug ip packet 和 debug ip rip 命令，可见 RIP 的组播地址 224.0.0.9，路由的距离，和 RIP 路由更新的过程。

4. 观察实验拓扑中链路状态发生改变时路由表的前后信息对比及 debug 信息的变化。

```
6-RSR20-2#conf
Enter configuration commands, one per line.  End with CNTL/Z.
6-RSR20-2(config)#show *Jan 14 01:03:03: %7: IP: s=192.168.3.22 (GigabitEthernet 0/1), d=192.168.3.255,vrf=global(0),len=1468,received
ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C    192.168.2.0/24 is directly connected, Serial 2/0
C    192.168.2.2/32 is local host.
C    192.168.3.0/24 is directly connected, GigabitEthernet 0/1
C    192.168.3.1/32 is local host.
```

上图为链路状态发生改变后的路由表，可见拓扑中链路断开时 R 类的路由会消失。

```
Password:*Jan 14 01:02:50: %7:  [RIP] Update timer expired via interface Serial 2/0[192.168.2.2/24]
*Jan 14 01:02:50: %7:  [RIP] Update timer schedule via interface Serial 2/0[192.168.2.2/24]
*Jan 14 01:02:50: %7:  [RIP] Prepare to send MULTICAST response...
*Jan 14 01:02:50: %7:  [RIP] Building update entries on Serial 2/0
*Jan 14 01:02:50: %7:        192.168.3.0/24 via 0.0.0.0 metric 1 tag 0
*Jan 14 01:02:50: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on Serial 2/0
*Jan 14 01:02:50: %7: IP: s=192.168.2.2 (local), d=224.0.0.9 (Serial 2/0),vrf=global(0), g=224.0.0.9,len=52,sent ip pkt to link_layer  222
*Jan 14 01:02:50: %7: IP: s=192.168.2.1 (Serial 2/0), d=224.0.0.9,vrf=global(0),len=52,received
*Jan 14 01:02:50: %7: [RIP] RIP received packet, sock=32979 src=192.168.2.1 len=24
*Jan 14 01:02:50: %7:  [RIP] Received version 2 response packet on Serial 2/0
*Jan 14 01:02:50: %7:  [RIP] Cancel peer[192.168.2.1] remove timer
*Jan 14 01:02:50: %7:  [RIP] Peer[192.168.2.1] remove timer shedule...
*Jan 14 01:02:50: %7:  [RIP] Both do not need auth, Auth ok
*Jan 14 01:02:50: %7:        route-entry: family 2 tag 0 ip 192.168.1.0 mask 255.255.255.0 nhop 0.0.0.0 metric 16
*Jan 14 01:02:51: %7:  [RIP] Update timer expired via interface GigabitEthernet 0/1[192.168.3.1/24]
*Jan 14 01:02:51: %7:  [RIP] Update timer schedule via interface GigabitEthernet 0/1[192.168.3.1/24]
*Jan 14 01:02:51: %7:  [RIP] Prepare to send MULTICAST response...
*Jan 14 01:02:51: %7:  [RIP] Building update entries on GigabitEthernet 0/1
*Jan 14 01:02:51: %7:        192.168.1.0/24 via 0.0.0.0 metric 16 tag 0
 01:02:51: %7:        192.168.2.0/24 via 0.0.0.0 metric 1 tag 0
*Jan 14 01:02:51: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on GigabitEthernet 0/1
*Jan 14 01:02:51: %7: IP: s=192.168.3.1 (local), d=224.0.0.9 (GigabitEthernet 0/1),vrf=global(0), g=224.0.0.9,len=72,sent ip pkt to link_layer --> r
aw send
```

上图为实验拓扑中链路状态发生改变后的 debug 信息。从图中可见，实验拓扑中出现了路由毒化，metric 变为 16。

【实验总结】

在本次实验中，我们成功地在交换机和路由器之间配置了动态路由协议 RIP，其中也遇到了不少困难，锻炼了在小组内与同学合作、分析问题、解决问题与请教他人的能力，将困难一一解决，体会到了团队协作的快乐和完成实验的成就感。

这次的实验也让我感受到了自己在计算机网络方面的知识在慢慢积累，我希望再接再厉，向老师请教，向同学学习，掌握好这门课程。