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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学号	21307347	21307350	21307100		
学生	陈欣宇	高宇	陈华清		
实验分工					
陈欣宇	配置交换机，PC2，完成部分实验报告	陈华清	完成路由器 R2 的配置，辅助完成实验任务和辅助编写报告		
高宇	配置路由器 R1、PC1，完成部分实验报告				

【实验题目】**RIP 路由协议实验**

【实验目的】（请思考后补齐）

1.学习如何在路由器上配置 RIPv2 和 RIPv1

2.比较和分析 RIPv1 和 RIPv2 之间的不同

3.学习使用 debug 相关指令

【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】(如有实验拓扑请自行画出)

一、 实验 7-2

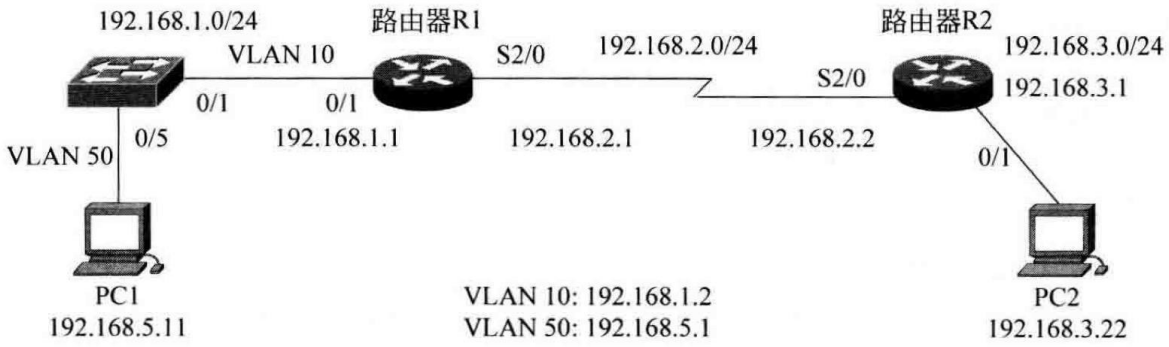

图 7-20 RIP 路由实验拓扑

步骤 1：

(1) 配置 PC1 和 PC2 的 IP 地址、子网掩码、网关，测试连通性

```
PS C:\Users\D502> ping 192.168.5.11

正在 Ping 192.168.5.11 具有 32 字节的数据:
请求超时。
请求超时。
请求超时。
请求超时。

192.168.5.11 的 Ping 统计信息:
    数据包: 已发送 = 4, 已接收 = 0, 丢失 = 4 (100% 丢失),
```

未配置 RIP 协议，故没有连通

(2) 在路由器 R1（或 R2）执行 show ip route

```
26-RSR20-2(config)#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
```

步骤 2：三层交换机的基本配置

```
S5750(config)#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.
C    192.168.5.0/24 is directly connected, VLAN 50
C    192.168.5.1/32 is local host.
```

步骤 3：路由器 R1 的基本配置

```
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.
```

步骤 4：路由器 R2 的基本配置

```
26-RSR20-2(config)#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    192.168.2.0/24 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.
```

步骤 5：交换机配置 RIPv2 路由协议

```
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, 00:00:17, VLAN 10
C    192.168.5.0/24 is directly connected, VLAN 50
C    192.168.5.1/32 is local host.
```

步骤 6：路由器 R1 配置 RIPv2 路由协议

```
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, 00:00:26, Serial 2/0
R    192.168.5.0/24 [120/1] via 192.168.1.2, 00:06:16, GigabitEthernet 0/1
```

步骤 7：路由器 R2 配置 RIPv2 路由协议

```
26-RSR20-2(config)#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, 00:00:12, 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, 00:00:12, Serial 2/0
```

分析交换机，路由器路由表，表中有无 R 条目，是怎样产生的?

show ip route 结果如上步骤截图

交换机有 R 条目，通过自动学习 R1 和 R2 的路由信息产生。

路由器 R1 有 R 条目，通过自动学习交换机和 R2 的路由信息产生。

路由器 R2 有 R 条目，通过自动学习交换机和 R1 的路由信息产生。

步骤 8：测试网络的连通性

(1) 将此时的路由表与步骤 1 的路由表对比，有什么结论？

此时的路由表存在 R 条目，可见 RIP 协议能实现自动更新路由信息

(2) 分析 traceroute PC1 的结果

```
PS C:\Users\D502> tracert 192.168.5.11

通过最多 30 个跃点跟踪
到 D52_76 [192.168.5.11] 的路由:

  1    <1 毫秒    <1 毫秒    <1 毫秒 192.168.3.1
  2    43 ms     42 ms     42 ms  192.168.2.1
  3    50 ms     52 ms     49 ms  192.168.1.2
  4    49 ms     46 ms     46 ms  D52_76 [192.168.5.11]

跟踪完成。
```

主机 ip 地址为 192.168.3.1，通过 IP 地址 192.168.2.1 和 192.168.1.2 到达 IP 地址为 192.168.5.11 的主机

(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现象？

12	4.222885	192.168.3.1	224.0.0.9	RIPv2	106 Response
123	34.223051	192.168.3.1	224.0.0.9	RIPv2	106 Response
138	47.781322	192.168.3.1	224.0.0.9	RIPv2	86 Response
142	54.051101	192.168.3.1	224.0.0.9	RIPv2	86 Response
166	64.220786	192.168.3.1	224.0.0.9	RIPv2	106 Response
250	94.219685	192.168.3.1	224.0.0.9	RIPv2	106 Response
359	124.220812	192.168.3.1	224.0.0.9	RIPv2	106 Response
491	154.217626	192.168.3.1	224.0.0.9	RIPv2	106 Response
592	184.216578	192.168.3.1	224.0.0.9	RIPv2	106 Response
770	214.215522	192.168.3.1	224.0.0.9	RIPv2	106 Response
938	244.214443	192.168.3.1	224.0.0.9	RIPv2	106 Response
1127	274.215140	192.168.3.1	224.0.0.9	RIPv2	106 Response
1425	304.212385	192.168.3.1	224.0.0.9	RIPv2	106 Response

拔线后报文时间间隔在 30s 之内，稳定后报文时间差重新变为 30s，因为 RIP 每隔 30s 向相邻路由器广播本地路由表，而在网络发生故障时会触发更新，缩短时间间隔。

通过检查报文段交换机路由器的跳数 metric，可看到拔线 metric 变化成 16，为最大限度，即不可达的度量值，发生毒性反转。

拔线后抓包：

```
Routing Information Protocol
    Command: Response (2)
    Version: RIPv2 (2)
  IP Address: 192.168.1.0, Metric: 16
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.168.1.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 16
  IP Address: 192.168.5.0, Metric: 16
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.168.5.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 16
```

(4) 捕获数据包，分析 RIP 封装结构。RIP 包在 PC1 和 PC2 上能捕获到吗？如希望两台主机都能捕获到 RIP 包，请描述实现方法。

RIP 包在 PC1 和 PC2 上都能捕获到

PC1 捕获的 RIP 包

85	16.552302	192.168.5.1	224.0.0.9	RIPv2	110 Response
249	46.552258	192.168.5.1	224.0.0.9	RIPv2	110 Response
419	76.552337	192.168.5.1	224.0.0.9	RIPv2	110 Response
574	106.552249	192.168.5.1	224.0.0.9	RIPv2	110 Response
698	136.552776	192.168.5.1	224.0.0.9	RIPv2	110 Response
832	166.552419	192.168.5.1	224.0.0.9	RIPv2	110 Response
951	196.552746	192.168.5.1	224.0.0.9	RIPv2	110 Response
1083	226.552661	192.168.5.1	224.0.0.9	RIPv2	110 Response
1209	256.552716	192.168.5.1	224.0.0.9	RIPv2	110 Response
1475	286.553256	192.168.5.1	224.0.0.9	RIPv2	110 Response
1802	316.552911	192.168.5.1	224.0.0.9	RIPv2	110 Response
1928	346.553029	192.168.5.1	224.0.0.9	RIPv2	110 Response

RIP 封装结构：

源 IP（32 位）和目的 IP（32 位）：

```
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: 0x00ae (174)
  > 000. .... = Flags: 0x0
    ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 1
    Protocol: UDP (17)
    Header Checksum: 0x1271 [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 192.168.5.1
    Destination Address: 224.0.0.9
```

源端口（16 位）、目的端口（16 位）、长度（16 位）和校验和（16 位）：

```
User Datagram Protocol, Src Port: 520, Dst Port: 520
    Source Port: 520
    Destination Port: 520
    Length: 72
    Checksum: 0x0e90 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 66]
  > [Timestamps]
    UDP payload (64 bytes)
```

命令（8 位）、版本（8 位）、0 域（16 位）和 RIP 报文内容

```
Routing Information Protocol
    Command: Response (2)
    Version: RIPv2 (2)
  > IP Address: 192.168.1.0, Metric: 1
  > IP Address: 192.168.2.0, Metric: 2
  > IP Address: 192.168.3.0, Metric: 3
```

【实验思考】

(1) 查看交换机端口 0/1 所属 VLAN 应使用哪条命令？

show vlan

```
S5750(config)#show vlan
VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
---
   1 VLAN0001                         STATIC    Gi0/1, Gi0/2, Gi0/3, Gi0/4
                                                Gi0/6, Gi0/7, Gi0/8, Gi0/9
                                                Gi0/10, Gi0/11, Gi0/12, 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
  10 VLAN0010                         STATIC    Gi0/13
  50 VLAN0050                         STATIC    Gi0/5
```

(2) 如何查看 RIP 的版本号和发布到的网段

show ip protocols

路由器 R2 上查看 RIP 的版本号和发布到的网段，版本号为 version 2，发布到得网段分别为 192.168.2.0　255.255.255.0 和 192.168.3.0　255.255.255.0

```
26-RSR20-2(config)#show ip protocols
Routing Protocol is "rip"
  Sending updates every 30 seconds
  Invalid after 180 seconds, flushed after 120 seconds
  Outgoing update filter list for all interface is: not set
  Incoming update filter list for all interface is: not set
  Redistribution default metric is 1
  Redistributing:
  Default version control: send version 2, receive version 2
    Interface                    Send  Recv
    GigabitEthernet 0/1          2     2
    Serial 2/0                   2     2
  Routing for Networks:
    192.168.2.0 255.255.255.0
    192.168.3.0 255.255.255.0
  Distance: (default is 120)
  Graceful-restart disabled
```

(3) RIPv1 的广播地址是什么？RIPv2 的组播地址是什么？

RIPv1 的广播地址：255.255.255.255

RIPv2 的组播地址：224.0.0.9

(4) 使用 10.10.X.0 的 IP 地址重做本次试验，注意网段间使用不同的子网掩码。当在 RIPv1 下设置不同网段时，配置后的端口实际上获得的子网掩码是什么？配合实验分析原因。

将路由器 R1 和路由器 R2 之间的子网掩码设置成 255.255.255.252，得到的结果如下

交换机：

```
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    10.10.1.0/24 is directly connected, VLAN 10
C    10.10.1.2/32 is local host.
R    10.10.2.0/24 [120/1] via 10.10.1.1, 00:00:33, VLAN 10
R    10.10.3.0/24 [120/2] via 10.10.1.1, 00:00:33, VLAN 10
C    10.10.5.0/24 is directly connected, VLAN 50
C    10.10.5.1/32 is local host.
```

路由器 R1：

```
Gateway of last resort is no set
C    10.10.1.0/24 is directly connected, GigabitEthernet 0/1
C    10.10.1.1/32 is local host.
C    10.10.2.0/30 is directly connected, Serial 2/0
C    10.10.2.1/32 is local host.
R    10.10.3.0/30 [120/1] via 10.10.2.2, 00:00:59, Serial 2/0
R    10.10.5.0/24 [120/1] via 10.10.1.2, 00:00:22, GigabitEthernet 0/1
```

路由器 R2：端口 gigabitethernet 0/1 的 ip address 的子网掩码设置为 255.255.255.0；端口 serial 2/0 的子网掩码设置为 255.255.255.252

```
26-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    10.10.1.0/30 [120/1] via 10.10.2.1, 00:02:01, Serial 2/0
C    10.10.2.0/30 is directly connected, Serial 2/0
C    10.10.2.2/32 is local host.
C    10.10.3.0/24 is directly connected, GigabitEthernet 0/1
C    10.10.3.1/32 is local host.
R    10.10.5.0/30 [120/2] via 10.10.2.1, 00:00:01, Serial 2/0
```

(5) RIPv1 必须使用自动汇总，不支持不连续网络，请实验验证。RIPv2 支持不连续网络吗？

ripv1

路由器 1

```
Gateway of last resort is no set
R    10.0.0.0/8 [120/1] via 192.168.2.2, 00:02:25, Serial 2/0
C    10.10.1.0/24 is directly connected, GigabitEthernet 0/1
C    10.10.1.1/32 is local host.
R    10.10.5.0/24 [120/1] via 10.10.1.2, 00:00:15, GigabitEthernet 0/1
C    192.168.2.0/24 is directly connected, Serial 2/0
C    192.168.2.1/32 is local host.
```

路由器 2

```
26-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    10.0.0.0/8 [120/1] via 192.168.2.1, 00:00:05, Serial 2/0
C    10.10.3.0/24 is directly connected, GigabitEthernet 0/1
C    10.10.3.1/32 is local host.
C    192.168.2.0/24 is directly connected, Serial 2/0
C    192.168.2.2/32 is local host.
```

交换机

```
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
R    10.0.0.0/24 [120/2] via 10.10.1.1, 00:00:16, VLAN 10
C    10.10.1.0/24 is directly connected, VLAN 10
C    10.10.1.2/32 is local host.
C    10.10.5.0/24 is directly connected, VLAN 50
C    10.10.5.1/32 is local host.
R    192.168.2.0/24 [120/1] via 10.10.1.1, 00:00:16, VLAN 10
```

```
PS C:\Users\D502> ping 10.10.5.2

正在 Ping 10.10.5.2 具有 32 字节的数据:
请求超时。
请求超时。
请求超时。
请求超时。

10.10.5.2 的 Ping 统计信息:
    数据包: 已发送 = 4, 已接收 = 0, 丢失 = 4 (100% 丢失),
```

在 ripv1 协议中，两台主机无法 ping 通，ripv1 不支持不连续网络

ripv2

路由器 1

```
Gateway of last resort is no set
C    10.10.1.0/24 is directly connected, GigabitEthernet 0/1
C    10.10.1.1/32 is local host.
R    10.10.3.0/24 [120/1] via 192.168.2.2, 00:00:39, Serial 2/0
R    10.10.5.0/24 [120/1] via 10.10.1.2, 00:54:18, GigabitEthernet 0/1
C    192.168.2.0/24 is directly connected, Serial 2/0
C    192.168.2.1/32 is local host.
```

路由器 2

```
26-RSR20-2(config)#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     10.10.1.0/24 [120/1] via 192.168.2.1, 00:01:49, Serial 2/0
C     10.10.3.0/24 is directly connected, GigabitEthernet 0/1
C     10.10.3.1/32 is local host.
R     10.10.5.0/24 [120/2] via 192.168.2.1, 00:01:49, Serial 2/0
C     192.168.2.0/24 is directly connected, Serial 2/0
C     192.168.2.2/32 is local host.
```

交换机

```
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     10.10.1.0/24 is directly connected, VLAN 10
C     10.10.1.2/32 is local host.
R     10.10.3.0/24 [120/2] via 10.10.1.1, 00:00:35, VLAN 10
C     10.10.5.0/24 is directly connected, VLAN 50
C     10.10.5.1/32 is local host.
R     192.168.2.0/24 [120/1] via 10.10.1.1, 00:04:29, VLAN 10
```

```
PS C:\Users\D502> ping 10.10.5.2

正在 Ping 10.10.5.2 具有 32 字节的数据:
来自 10.10.5.2 的回复: 字节=32 时间=38ms TTL=125
来自 10.10.5.2 的回复: 字节=32 时间=40ms TTL=125
来自 10.10.5.2 的回复: 字节=32 时间=38ms TTL=125
来自 10.10.5.2 的回复: 字节=32 时间=39ms TTL=125

10.10.5.2 的 Ping 统计信息:
    数据包: 已发送 = 4, 已接收 = 4, 丢失 = 0 (0% 丢失),
往返行程的估计时间(以毫秒为单位):
    最短 = 38ms, 最长 = 40ms, 平均 = 38ms
```

在 ripv2 协议中，两台主机可以 ping 通，ripv2 支持不连续网络

(6) RIPv1 对路由没有标记的功能，RIPv2 可以对路由打标记(tag)，用于过滤和做策略。请在实验中观察和分析。

在 RIPv2 的报文中，可以看到 Route Tag 为 0，这是 RIPv2 可以对路由打的标记(tag)，而在 RIP v1 的报文中，不存在 Route Tag 信息，对路由无标记功能

PIPv1 报文：

```
▾ Routing Information Protocol
    Command: Response (2)
    Version: RIPv1 (1)
  ▾ IP Address: 10.0.0.0, Metric: 3
      Address Family: IP (2)
      IP Address: 10.0.0.0
      Metric: 3
```

PIPv2 报文：

```
Routing Information Protocol
    Command: Response (2)
    Version: RIPv2 (2)
  IP Address: 192.168.1.0, Metric: 16
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.168.1.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 16
  IP Address: 192.168.5.0, Metric: 16
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.168.5.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 16
```

二、 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）

RIP v2 报文：

```
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: 0x00ae (174)
  > 000. .... = Flags: 0x0
    ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 1
    Protocol: UDP (17)
    Header Checksum: 0x1271 [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 192.168.5.1
    Destination Address: 224.0.0.9
```

```
Routing Information Protocol
    Command: Response (2)
    Version: RIPv2 (2)
  IP Address: 192.168.1.0, Metric: 16
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.168.1.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 16
  IP Address: 192.168.5.0, Metric: 16
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.168.5.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 16
```

RIP v1 报文

```
> Frame 291: 110 bytes on wire (880 bits), 110 bytes captured (880 bits) on interface \Device\NPF_{31DF8BDE-2496-4ED4-A
> Ethernet II, Src: RuijieNe_77:16:83 (14:14:4b:77:16:83), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
> Internet Protocol Version 4, Src: 10.10.5.1, Dst: 255.255.255.255
> User Datagram Protocol, Src Port: 520, Dst Port: 520
v Routing Information Protocol
    Command: Response (2)
    Version: RIPv1 (1)
  v IP Address: 10.0.0.0, Metric: 3
      Address Family: IP (2)
      IP Address: 10.0.0.0
      Metric: 3
  v IP Address: 10.10.1.0, Metric: 1
      Address Family: IP (2)
      IP Address: 10.10.1.0
      Metric: 1
  v IP Address: 192.168.2.0, Metric: 2
      Address Family: IP (2)
      IP Address: 192.168.2.0
      Metric: 2
```

RIPv1 不支持 VLSM，而 RIPv2 支持 VLSM，在上述实验中已验证

RIPv1 不支持不连续网络，而 RIPv2 支持不连续网络，在上述实验中已验证

RIPv1 广播地址为 255.255.255.255，而 RIPv2 组播地址为 224.0.0.9，在上述报文中的 Dst 中可看到报文的目的地址的不同。

RIPv1 对路由信息不打标记，而 RIPv2 对路由信息打上标记 tag，在上述报文中,RIPv1 没有 route tag 信息，而 RIPv2 存在 route tag 信息。

三、 使用 Debug ip packet 和 Debug ip rip 命令，并对 debug 信息做分析

在交换机

Debug ip packet

```
S5750#debug ip packet
S5750#*Nov 13 17:26:50: %7:  [RIP] Update timer expired via interface VLAN 10[192.168.1.2/24]
*Nov 13 17:26:50: %7:  [RIP] Update timer schedule via interface VLAN 10[192.168.1.2/24]
*Nov 13 17:26:50: %7:  [RIP] Prepare to send MULTICAST response ...
*Nov 13 17:26:50: %7:  [RIP] Building update entries on VLAN 10
*Nov 13 17:26:50: %7:        192.168.5.0/24 via 0.0.0.0 metric 1 tag 0
*Nov 13 17:26:50: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 10
*Nov 13 17:26:50: %7: IP: s=192.168.1.2 (local), d=224.0.0.9 (VLAN 10), g=224.0.0.9,len=52,sent ip pkt to link_layer --> raw send
*Nov 13 17:26:51: %7:  [RIP] Update timer expired via interface VLAN 50[192.168.5.1/24]
*Nov 13 17:26:51: %7:  [RIP] Update timer schedule via interface VLAN 50[192.168.5.1/24]
*Nov 13 17:26:51: %7:  [RIP] Prepare to send MULTICAST response ...
*Nov 13 17:26:51: %7:  [RIP] Building update entries on VLAN 50
*Nov 13 17:26:51: %7:        192.168.1.0/24 via 0.0.0.0 metric 1 tag 0
*Nov 13 17:26:51: %7:        192.168.2.0/24 via 0.0.0.0 metric 2 tag 0
*Nov 13 17:26:51: %7:        192.168.3.0/24 via 0.0.0.0 metric 3 tag 0
*Nov 13 17:26:51: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 50
*Nov 13 17:26:51: %7: IP: s=192.168.5.1 (local), d=224.0.0.9 (VLAN 50), g=224.0.0.9,len=92,sent ip pkt to link_layer --> raw send
*Nov 13 17:26:53: %7: IP: s=192.168.1.1 (VLAN 10), d=224.0.0.9,len=72,received
*Nov 13 17:26:53: %7: [RIP] RIP recveived packet, sock=32853 src=192.168.1.1 len=44
*Nov 13 17:26:53: %7:  [RIP] Received version 2 response packet
*Nov 13 17:26:53: %7:  [RIP] Cancel peer[192.168.1.1] remove timer
*Nov 13 17:26:53: %7:  [RIP] Peer[192.168.1.1] remove timer shedule ...
*Nov 13 17:26:53: %7:  [RIP] Both do not need auth, Auth ok
*Nov 13 17:26:53: %7:        route-entry: family 2 tag 0 ip 192.168.2.0 mask 255.255.255.0 nhop 0.0.0.0 metric 1
*Nov 13 17:26:53: %7:        route-entry: family 2 tag 0 ip 192.168.3.0 mask 255.255.255.0 nhop 0.0.0.0 metric 2
*Nov 13 17:26:53: %7:  [RIP] Old path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:26:53: %7:  [RIP] New path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:26:53: %7:  [RIP] [192.168.2.0/24] RIP route refresh!
*Nov 13 17:26:53: %7:  [RIP] [192.168.2.0/24] RIP distance apply from 192.168.1.1!
*Nov 13 17:26:53: %7:  [RIP] [192.168.2.0/24] cancel route timer
*Nov 13 17:26:53: %7:  [RIP] [192.168.2.0/24] route timer schedule ...
*Nov 13 17:26:53: %7:  [RIP] Old path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:26:53: %7:  [RIP] New path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:26:53: %7:  [RIP] [192.168.3.0/24] RIP route refresh!
*Nov 13 17:26:53: %7:  [RIP] [192.168.3.0/24] RIP distance apply from 192.168.1.1!
*Nov 13 17:26:53: %7:  [RIP] [192.168.3.0/24] cancel route timer
*Nov 13 17:26:53: %7:  [RIP] [192.168.3.0/24] route timer schedule ...
*Nov 13 17:27:20: %7:  [RIP] Update timer expired via interface VLAN 10[192.168.1.2/24]
*Nov 13 17:27:20: %7:  [RIP] Update timer schedule via interface VLAN 10[192.168.1.2/24]
*Nov 13 17:27:20: %7:  [RIP] Prepare to send MULTICAST response ...
*Nov 13 17:27:20: %7:  [RIP] Building update entries on VLAN 10
*Nov 13 17:27:20: %7:        192.168.5.0/24 via 0.0.0.0 metric 1 tag 0
*Nov 13 17:27:20: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 10
*Nov 13 17:27:20: %7: IP: s=192.168.1.2 (local), d=224.0.0.9 (VLAN 10), g=224.0.0.9,len=52,sent ip pkt to link_layer --> raw send
*Nov 13 17:27:21: %7:  [RIP] Update timer expired via interface VLAN 50[192.168.5.1/24]
*Nov 13 17:27:21: %7:  [RIP] Update timer schedule via interface VLAN 50[192.168.5.1/24]
*Nov 13 17:27:21: %7:  [RIP] Prepare to send MULTICAST response ...
*Nov 13 17:27:21: %7:  [RIP] Building update entries on VLAN 50
*Nov 13 17:27:21: %7:        192.168.1.0/24 via 0.0.0.0 metric 1 tag 0
*Nov 13 17:27:21: %7:        192.168.2.0/24 via 0.0.0.0 metric 2 tag 0
*Nov 13 17:27:21: %7:        192.168.3.0/24 via 0.0.0.0 metric 3 tag 0
*Nov 13 17:27:21: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 50
*Nov 13 17:27:21: %7: IP: s=192.168.5.1 (local), d=224.0.0.9 (VLAN 50), g=224.0.0.9,len=92,sent ip pkt to link_layer --> raw send
*Nov 13 17:27:23: %7: IP: s=192.168.1.1 (VLAN 10), d=224.0.0.9,len=72,received
*Nov 13 17:27:23: %7: [RIP] RIP recveived packet, sock=32853 src=192.168.1.1 len=44
```

使用 Debug ip packet 指令，可以观察到路由器获取和传出的路由表信息和一些 tag 信息等

Debug ip rip

```
S5750#debug ip rip
S5750#*Nov 13 17:28:20: %7:  [RIP] Update timer expired via interface VLAN 10[192.168.1.2/24]
*Nov 13 17:28:20: %7:  [RIP] Update timer schedule via interface VLAN 10[192.168.1.2/24]
*Nov 13 17:28:20: %7:  [RIP] Prepare to send MULTICAST response ...
*Nov 13 17:28:20: %7:  [RIP] Building update entries on VLAN 10
*Nov 13 17:28:20: %7:        192.168.5.0/24 via 0.0.0.0 metric 1 tag 0
*Nov 13 17:28:20: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 10
*Nov 13 17:28:20: %7: IP: s=192.168.1.2 (local), d=224.0.0.9 (VLAN 10), g=224.0.0.9,len=52,sent ip pkt to link_layer --> raw send
*Nov 13 17:28:21: %7:  [RIP] Update timer expired via interface VLAN 50[192.168.5.1/24]
*Nov 13 17:28:21: %7:  [RIP] Update timer schedule via interface VLAN 50[192.168.5.1/24]
*Nov 13 17:28:21: %7:  [RIP] Prepare to send MULTICAST response ...
*Nov 13 17:28:21: %7:  [RIP] Building update entries on VLAN 50
*Nov 13 17:28:21: %7:        192.168.1.0/24 via 0.0.0.0 metric 1 tag 0
*Nov 13 17:28:21: %7:        192.168.2.0/24 via 0.0.0.0 metric 2 tag 0
*Nov 13 17:28:21: %7:        192.168.3.0/24 via 0.0.0.0 metric 3 tag 0
*Nov 13 17:28:21: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 50
*Nov 13 17:28:21: %7: IP: s=192.168.5.1 (local), d=224.0.0.9 (VLAN 50), g=224.0.0.9,len=92,sent ip pkt to link_layer --> raw send
*Nov 13 17:28:23: %7: IP: s=192.168.1.1 (VLAN 10), d=224.0.0.9,len=72,received
*Nov 13 17:28:23: %7: [RIP] RIP recveived packet, sock=32853 src=192.168.1.1 len=44
*Nov 13 17:28:23: %7:  [RIP] Received version 2 response packet
*Nov 13 17:28:23: %7:  [RIP] Cancel peer[192.168.1.1] remove timer
*Nov 13 17:28:23: %7:  [RIP] Peer[192.168.1.1] remove timer shedule ...
*Nov 13 17:28:23: %7:  [RIP] Both do not need auth, Auth ok
*Nov 13 17:28:23: %7:        route-entry: family 2 tag 0 ip 192.168.2.0 mask 255.255.255.0 nhop 0.0.0.0 metric 1
*Nov 13 17:28:23: %7:        route-entry: family 2 tag 0 ip 192.168.3.0 mask 255.255.255.0 nhop 0.0.0.0 metric 2
*Nov 13 17:28:23: %7:  [RIP] Old path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:28:23: %7:  [RIP] New path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:28:23: %7:  [RIP] [192.168.2.0/24] RIP route refresh!
*Nov 13 17:28:23: %7:  [RIP] [192.168.2.0/24] RIP distance apply from 192.168.1.1!
*Nov 13 17:28:23: %7:  [RIP] [192.168.2.0/24] cancel route timer
*Nov 13 17:28:23: %7:  [RIP] [192.168.2.0/24] route timer schedule ...
*Nov 13 17:28:23: %7:  [RIP] Old path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:28:23: %7:  [RIP] New path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:28:23: %7:  [RIP] [192.168.3.0/24] RIP route refresh!
*Nov 13 17:28:23: %7:  [RIP] [192.168.3.0/24] RIP distance apply from 192.168.1.1!
*Nov 13 17:28:23: %7:  [RIP] [192.168.3.0/24] cancel route timer
*Nov 13 17:28:23: %7:  [RIP] [192.168.3.0/24] route timer schedule ...
*Nov 13 17:28:50: %7:  [RIP] Update timer expired via interface VLAN 10[192.168.1.2/24]
*Nov 13 17:28:50: %7:  [RIP] Update timer schedule via interface VLAN 10[192.168.1.2/24]
*Nov 13 17:28:50: %7:  [RIP] Prepare to send MULTICAST response ...
*Nov 13 17:28:50: %7:  [RIP] Building update entries on VLAN 10
*Nov 13 17:28:50: %7:        192.168.5.0/24 via 0.0.0.0 metric 1 tag 0
*Nov 13 17:28:50: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 10
*Nov 13 17:28:50: %7: IP: s=192.168.1.2 (local), d=224.0.0.9 (VLAN 10), g=224.0.0.9,len=52,sent ip pkt to link_layer --> raw send
*Nov 13 17:28:51: %7:  [RIP] Update timer expired via interface VLAN 50[192.168.5.1/24]
*Nov 13 17:28:51: %7:  [RIP] Update timer schedule via interface VLAN 50[192.168.5.1/24]
*Nov 13 17:28:51: %7:  [RIP] Prepare to send MULTICAST response ...
*Nov 13 17:28:51: %7:  [RIP] Building update entries on VLAN 50
*Nov 13 17:28:51: %7:        192.168.1.0/24 via 0.0.0.0 metric 1 tag 0
*Nov 13 17:28:51: %7:        192.168.2.0/24 via 0.0.0.0 metric 2 tag 0
*Nov 13 17:28:51: %7:        192.168.3.0/24 via 0.0.0.0 metric 3 tag 0
*Nov 13 17:28:51: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 50
*Nov 13 17:28:51: %7: IP: s=192.168.5.1 (local), d=224.0.0.9 (VLAN 50), g=224.0.0.9,len=92,sent ip pkt to link_layer --> raw send
*Nov 13 17:28:53: %7: IP: s=192.168.1.1 (VLAN 10), d=224.0.0.9,len=72,received
```

使用 Debug ip rip 指令可以观察到原有的路由信息和修改后的路由信息

四、 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。

```
*Nov 13 17:31:21: %7:        192.168.1.0/24 via 0.0.0.0 metric 1 tag 0
*Nov 13 17:31:21: %7:        192.168.2.0/24 via 0.0.0.0 metric 2 tag 0
*Nov 13 17:31:21: %7:        192.168.3.0/24 via 0.0.0.0 metric 3 tag 0
*Nov 13 17:31:21: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 50
*Nov 13 17:31:21: %7: IP: s=192.168.5.1 (local), d=224.0.0.9 (VLAN 50), g=224.0.0.9,len=92,sent ip pkt to link_layer --> raw send
*Nov 13 17:31:23: %7: IP: s=192.168.1.1 (VLAN 10), d=224.0.0.9,len=72,received
*Nov 13 17:31:23: %7: [RIP] RIP recveived packet, sock=32853 src=192.168.1.1 len=44
*Nov 13 17:31:23: %7:  [RIP] Received version 2 response packet
*Nov 13 17:31:23: %7:  [RIP] Cancel peer[192.168.1.1] remove timer
*Nov 13 17:31:23: %7:  [RIP] Peer[192.168.1.1] remove timer shedule ...
*Nov 13 17:31:23: %7:  [RIP] Both do not need auth, Auth ok
*Nov 13 17:31:23: %7:        route-entry: family 2 tag 0 ip 192.168.2.0 mask 255.255.255.0 nhop 0.0.0.0 metric 1
*Nov 13 17:31:23: %7:        route-entry: family 2 tag 0 ip 192.168.3.0 mask 255.255.255.0 nhop 0.0.0.0 metric 2
*Nov 13 17:31:23: %7:  [RIP] Old path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:31:23: %7:  [RIP] New path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:31:23: %7:  [RIP] [192.168.2.0/24] RIP route refresh!
*Nov 13 17:31:23: %7:  [RIP] [192.168.2.0/24] RIP distance apply from 192.168.1.1!
*Nov 13 17:31:23: %7:  [RIP] [192.168.2.0/24] cancel route timer
*Nov 13 17:31:23: %7:  [RIP] [192.168.2.0/24] route timer schedule ...
*Nov 13 17:31:23: %7:  [RIP] Old path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:31:23: %7:  [RIP] New path is: nhop=192.168.1.1 routesrc=192.168.1.1 intf=4106
*Nov 13 17:31:23: %7:  [RIP] [192.168.3.0/24] RIP route refresh!
*Nov 13 17:31:23: %7:  [RIP] [192.168.3.0/24] RIP distance apply from 192.168.1.1!
*Nov 13 17:31:23: %7:  [RIP] [192.168.3.0/24] cancel route timer
*Nov 13 17:31:23: %7:  [RIP] [192.168.3.0/24] route timer schedule ...
*Nov 13 17:31:30: %LINEPROTO-5-UPDOWN: Line protocol on Interface VLAN 50, changed state to down.
*Nov 13 17:31:30: %7: NSM Message Header
*Nov 13 17:31:30: %7:  VR ID: 0
*Nov 13 17:31:30: %7:  VRF ID: 0
*Nov 13 17:31:30: %7:  Message type: Link Down (30)
*Nov 13 17:31:30: %7:  Message length: 96
*Nov 13 17:31:30: %7:  Message ID: 0x00000000
*Nov 13 17:31:30: %7: NSM Interface
*Nov 13 17:31:30: %7:  Interface index: 4146
*Nov 13 17:31:30: %7:  Name: VLAN 50
*Nov 13 17:31:30: %7:  Flags: 0x00001042
*Nov 13 17:31:30: %7:  [RIP] Received interface[VLAN 50][vrf:0] DOWN event
*Nov 13 17:31:30: %7:  [RIP] Interface[VLAN 50] is downing
*Nov 13 17:31:30: %7:  [RIP] [192.168.5.0/24] RIP route disabling ...
*Nov 13 17:31:30: %7:  [RIP] [192.168.5.0/24] route timer schedule ...
*Nov 13 17:31:30: %7:  [RIP] Trigger timer Schedule, by instance 0
*Nov 13 17:31:30: %7:  [RIP] [192.168.5.0/24] ready to add into kernel ...
*Nov 13 17:31:30: %7:  [RIP] NSM delete: IPv4 Route 192.168.5.0/24
*Nov 13 17:31:30: %7:  [RIP] Cancel all timers of interface VLAN 50[192.168.5.1/24]
*Nov 13 17:31:30: %7:  [RIP] Interface[VLAN 50] is to be deleted
*Nov 13 17:31:30: %7:  [RIP] Cancel all timers of interface VLAN 50[192.168.5.1/24]
*Nov 13 17:31:30: %7:  [RIP] Setsockopt IP_LEAVE_MEMBERSHIP success: VLAN 50
*Nov 13 17:31:31: %LINK-3-UPDOWN: Interface GigabitEthernet 0/5, changed state to down.
*Nov 13 17:31:31: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet 0/5, changed state to down.
*Nov 13 17:31:35: %7:  [RIP] Trigger timer expired, by instance 0
*Nov 13 17:31:35: %7:  [RIP] Prepare to send MULTICAST response ...
*Nov 13 17:31:35: %7:  [RIP] Building update entries on VLAN 10
*Nov 13 17:31:35: %7:  [RIP] Skip route[192.168.1.0/24] in trigger
*Nov 13 17:31:35: %7:  [RIP] Skip route[192.168.2.0/24] in trigger
*Nov 13 17:31:35: %7:  [RIP] Skip route[192.168.3.0/24] in trigger
*Nov 13 17:31:35: %7:        192.168.5.0/24 via 0.0.0.0 metric 16 tag 0
*Nov 13 17:31:35: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on VLAN 10
*Nov 13 17:31:35: %7: IP: s=192.168.1.2 (local), d=224.0.0.9 (VLAN 10), g=224.0.0.9,len=52,sent ip pkt to link_layer --> raw send
```

链路断开前，链路状态稳定，路由器之间会相互发送路由信息，信息的最大条数 metric 分别为 1，2，3，即为可达的。链路断开后，链路发生毒性逆转了，路由器收到了最大跳数为 16 的信息，即为不可达的，并据此开始更新路由表，将更新结果发往邻居路由器。

本次实验完成后，请根据组员在实验中的贡献，请实事求是，自评在实验中应得的分数。（按百分制）

【交实验报告】

上传实验报告：ftp://222.200.180.109/　　截止日期（不迟于）：1 周之内

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