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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RIP 实验

【实验题目】RIP 路由协议实验

【实验目的】

1. 掌握 RIP 路由协议基本概念
2. 掌握 RIP 数据包类型和工作过程
3. 了解 RIP 基本配置命令
4. 通过在路由器上配置 RIP，实现不同网络的互联

【实验内容】

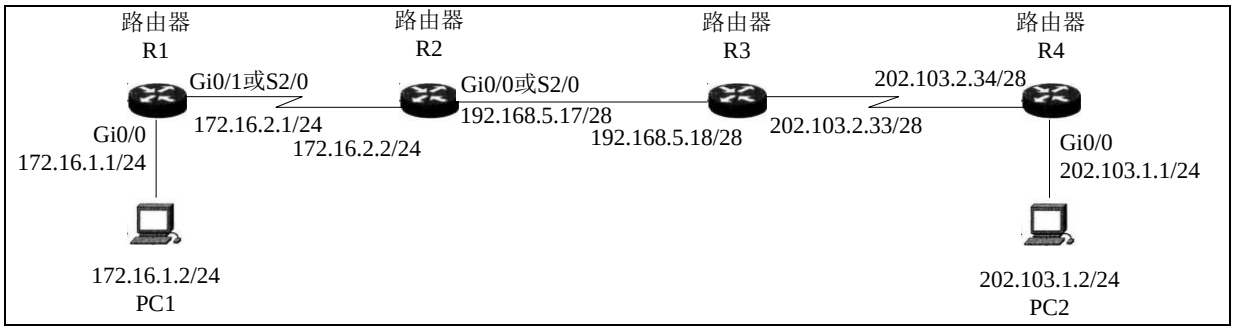

图 1 实验拓扑图

1. 阅读实验教程 P235-241, 7.3 RIP 路由，掌握 RIP 路由协议基本概念和工作过程。
2. 阅读实验教程 P242,了解 RIP 基本配置命令。
3. 按图 1（两组组队）完成 RIP 路由协议实验。具体实验配置请参考(但不完全一致)教材 P244 的 实验 7-2 步骤(2)、步骤(3)-(4)和步骤(6)-(7) 。

【实验步骤】

1. 使用 show ip route 命令，查看 R3 与 R4 在未配置 RIP 时的路由表，并记录。

```
RSR20-1#show ip route

es:  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

eway of last resort is no set
  192.168.5.16/28 is directly connected, GigabitEthernet 0/0
  192.168.5.18/32 is local host.
  202.103.2.32/28 is directly connected, Serial 2/0
  202.103.2.33/32 is local host.
RSR20-1#
```

图 1 R3 未配置 RIP 时的路由表（此时已经配置了实验拓扑与路由器端口）

```
2-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     202.103.1.0/24 is directly connected, GigabitEthernet 0/0
C     202.103.1.1/32 is local host.
C     202.103.2.32/28 is directly connected, Serial 2/0
C     202.103.2.34/32 is local host.
2-RSR20-2(config)#
```

图 2 R4 未配置 RIP 时的路由表（此时已经配置了实验拓扑与路由器端口）

2. 按照图 1 配置所有设备，并在路由器上配置 RIP v2 协议。

（1） 配置路由器 R1

```
Password:
03-RSR20-1#conf ter
Enter configuration commands, one per line.  End with CNTL/Z.
03-RSR20-1(config)#
03-RSR20-1(config)#int giga 0/0
03-RSR20-1(config-if-GigabitEthernet 0/0)#ip addr 172.16.1.1 255.255.255.0
03-RSR20-1(config-if-GigabitEthernet 0/0)#no shutdown
03-RSR20-1(config-if-GigabitEthernet 0/0)#exit
03-RSR20-1(config)# int ser 2/0
03-RSR20-1(config-if-Serial 2/0)#ip addr 172.16.2.1 255.255.255.0
03-RSR20-1(config-if-Serial 2/0)#no shut
03-RSR20-1(config-if-Serial 2/0)#exit
03-RSR20-1(config)#show ip int b
Interface                  IP-Address(Pri)      IP-Address(Sec)      Status               Protocol
Serial 2/0                 172.16.2.1/24        no address           up                   up
SIC-3G-WCDMA 3/0           no address           no address           up                   down
GigabitEthernet 0/0        172.16.1.1/24        no address           down                 down
GigabitEthernet 0/1        no address           no address           down                 down
VLAN 1                     no address           no address           up                   down
03-RSR20-1(config)#
```

图 3 配置路由器 R1 端口

```
03-RSR20-1(config)#router rip
03-RSR20-1(config-router)#version 2
03-RSR20-1(config-router)#no auto-summary
03-RSR20-1(config-router)#network 172.16.1.0 255.255.255.0
03-RSR20-1(config-router)#network 172.16.2.0 255.255.255.0
03-RSR20-1(config-router)#exit
03-RSR20-1(config)#
```

图 4 在 R1 上配置 RIPv2 协议

（2） 配置路由器 R2

```
% Invalid input detected at '^' marker.

3-RSR20-2(config-if-Serial 2/0)#no shut
3-RSR20-2(config-if-Serial 2/0)#exit
3-RSR20-2(config)#int giga 0/0
3-RSR20-2(config-if-GigabitEthernet 0/0)#ip addr 192.168.5.17 255.255.255.240
3-RSR20-2(config-if-GigabitEthernet 0/0)#no shut
3-RSR20-2(config-if-GigabitEthernet 0/0)#exti
% Unknown command.

3-RSR20-2(config-if-GigabitEthernet 0/0)#exit
3-RSR20-2(config)#show ip int b
Interface                  IP-Address(Pri)      IP-Address(Sec)      Status               Protocol
Serial 2/0                 172.16.2.2/24        no address           up                   up
Serial 3/0                 no address           no address           down                 down
GigabitEthernet 0/0        192.168.5.17/28      no address           down                 down
GigabitEthernet 0/1        no address           no address           down                 down
VLAN 1                     no address           no address           up                   down
3-RSR20-2(config)#
```

图 5 配置路由器 R2 端口

```
3-RSR20-2(config)#router rip
3-RSR20-2(config-router)#version 2
3-RSR20-2(config-router)#no auto-summary
3-RSR20-2(config-router)#network 172.16.2.0 255.255.255.0
3-RSR20-2(config-router)#network 192.168.5.16 255.255.255.240
3-RSR20-2(config-router)#exit
3-RSR20-2(config)#
```

图 6 在 R2 上配置 RIPv2 协议

（3） 配置路由器 R3

```
12-RSR20-1>en 14

Password:
12-RSR20-1#conf ter
Enter configuration commands, one per line.  End with CNTL/Z.
12-RSR20-1(config)#int giga 0/0
12-RSR20-1(config-if-GigabitEthernet 0/0)#$68.5.18 255.255.255.240
12-RSR20-1(config-if-GigabitEthernet 0/0)#no shut
12-RSR20-1(config-if-GigabitEthernet 0/0)#exit
12-RSR20-1(config)#int s 2/0
12-RSR20-1(config-if-Serial 2/0)#ip addr 202.2.33.255.255.255.240
                                         ^
% Invalid input detected at '^' marker.

12-RSR20-1(config-if-Serial 2/0)#ip addr 202.103.2.33 255.255.255.240
12-RSR20-1(config-if-Serial 2/0)#no shut
12-RSR20-1(config-if-Serial 2/0)#exit
12-RSR20-1(config)#show ip int b
Interface                  IP-Address(Pri)    IP-Address(Sec)    Status             Protocol
Serial 2/0                 202.103.2.33/28    no address         up                 up
SIC-3G-WCDMA 3/0           no address         no address         up                 down
GigabitEthernet 0/0        192.168.5.18/28    no address         down               down
GigabitEthernet 0/1        no address         no address         down               down
VLAN 1                     no address         no address         up                 down
12-RSR20-1(config)#
```

图 7 配置路由器 R3 端口

```
Router3(config)#router rip
Router3(config-router)#version 2
Router2(config-router)#poison-reverse
Router3(config-router)#no auto-summary
Router3(config-router)#network 192.168.5.16 255.255.255.240
Router3(config-router)#network 202.103.2.32 255.255.255.240
```

图 8 在 R3 上配置 RIPv2 协议

（4） 配置路由器 R4

```
2-RSR20-2(config)#int s 2/0
2-RSR20-2(config-if-Serial 2/0)#ip add 202.103.2.34 255.255.255.240
2-RSR20-2(config-if-Serial 2/0)#no shut
2-RSR20-2(config-if-Serial 2/0)#exit
2-RSR20-2(config)#int giga 0/0
2-RSR20-2(config-if-GigabitEthernet 0/0)#ip add 202.103.1.1 255.255.255.0
2-RSR20-2(config-if-GigabitEthernet 0/0)#no shut
2-RSR20-2(config-if-GigabitEthernet 0/0)#exit
2-RSR20-2(config)#show ip int b
Interface                  IP-Address(Pri)    IP-Address(Sec)    Status             Protocol
Serial 2/0                 202.103.2.34/28    no address         up                 up
Serial 3/0                 no address         no address         down               down
GigabitEthernet 0/0        202.103.1.1/24     no address         down               down
GigabitEthernet 0/1        no address         no address         down               down
VLAN 1                     no address         no address         up                 down
2-RSR20-2(config)#
```

图 9 配置路由器 R4 端口

```
2-RSR20-2(config)#router rip
2-RSR20-2(config-router)#version
% Incomplete command.

2-RSR20-2(config-router)#version 2
2-RSR20-2(config-router)#poison-reverse
% Unknown command.

2-RSR20-2(config-router)#no auto-summary
2-RSR20-2(config-router)#network 202.103.2.32 255.255.255.240
2-RSR20-2(config-router)#network 202.103.1.0 255.255.255.0
```

图 10 在 R4 上配置 RIPv2 协议

3. 配置 RIP 后，在路由器上，学会使用 debug ip rip 命令，对该命令的输出信息做分析。

debug ip rip 命令会输出 RIP 的详细运行信息，命令的使用方法如下：

```
Router#debug ip rip          # 开启调试
Router#undebug ip rip        # 关闭调试
Router#debug ip rip events    # 查看 RIP 事件
```

在路由器 R2 上使用 debug ip rip 命令后，输出信息如下：

```
3-RSR20-2#*Jan  1 04:20:52: %7: [RIP] RIP recveived packet, sock=32979 src=192.168.5.18 len=44
*Jan  1 04:20:52: %7:  [RIP] Received version 2 response packet on GigabitEthernet 0/0
*Jan  1 04:20:52: %7:  [RIP] Cancel peer[192.168.5.18] remove timer
*Jan  1 04:20:52: %7:  [RIP] Peer[192.168.5.18] remove timer shedule...
*Jan  1 04:20:52: %7:  [RIP] Both do not need auth, Auth ok
*Jan  1 04:20:52: %7:        route-entry: family 2 tag 0 ip 202.103.1.0 mask 255.255.255.0 nhop 0.0.0.0 metric 2
*Jan  1 04:20:52: %7:        route-entry: family 2 tag 0 ip 202.103.2.32 mask 255.255.255.240 nhop 0.0.0.0 metric 1
*Jan  1 04:20:52: %7:  [RIP] [202.103.1.0/24] RIP route update, protocol(4)
*Jan  1 04:20:52: %7:  [RIP] Old path is: nhop=192.168.5.18 routesrc=192.168.5.18 intf=4
*Jan  1 04:20:52: %7:  [RIP] New path is: nhop=192.168.5.18 routesrc=192.168.5.18 intf=4
*Jan  1 04:20:52: %7:  [RIP] [202.103.1.0/24] RIP distance apply from 192.168.5.18!
*Jan  1 04:20:52: %7:  [RIP] [202.103.1.0/24] cancel Route timer
*Jan  1 04:20:52: %7:  [RIP] [202.103.1.0/24] route timer schedule...
*Jan  1 04:20:52: %7:  [RIP] [202.103.2.32/28] RIP route update, protocol(4)
*Jan  1 04:20:52: %7:  [RIP] Old path is: nhop=192.168.5.18 routesrc=192.168.5.18 intf=4
*Jan  1 04:20:52: %7:  [RIP] New path is: nhop=192.168.5.18 routesrc=192.168.5.18 intf=4
*Jan  1 04:20:52: %7:  [RIP] [202.103.2.32/28] RIP distance apply from 192.168.5.18!
*Jan  1 04:20:52: %7:  [RIP] [202.103.2.32/28] cancel Route timer
*Jan  1 04:20:52: %7:  [RIP] [202.103.2.32/28] route timer schedule...
*Jan  1 04:20:59: %7: [RIP] RIP recveived packet, sock=32979 src=172.16.2.1 len=24
*Jan  1 04:20:59: %7:  [RIP] Received version 2 response packet on Serial 2/0
*Jan  1 04:20:59: %7:  [RIP] Cancel peer[172.16.2.1] remove timer
*Jan  1 04:20:59: %7:  [RIP] Peer[172.16.2.1] remove timer shedule...
*Jan  1 04:20:59: %7:  [RIP] Both do not need auth, Auth ok
*Jan  1 04:20:59: %7:        route-entry: family 2 tag 0 ip 172.16.1.0 mask 255.255.255.0 nhop 0.0.0.0 metric 1
*Jan  1 04:20:59: %7:  [RIP] [172.16.1.0/24] RIP route update, protocol(4)
*Jan  1 04:20:59: %7:  [RIP] Old path is: nhop=172.16.2.1 routesrc=172.16.2.1 intf=2
*Jan  1 04:20:59: %7:  [RIP] New path is: nhop=172.16.2.1 routesrc=172.16.2.1 intf=2
*Jan  1 04:20:59: %7:  [RIP] [172.16.1.0/24] RIP distance apply from 172.16.2.1!
*Jan  1 04:20:59: %7:  [RIP] [172.16.1.0/24] cancel Route timer
*Jan  1 04:20:59: %7:  [RIP] [172.16.1.0/24] route timer schedule...
*Jan  1 04:21:02: %7:  [RIP] Update timer expired via interface Serial 2/0[172.16.2.2/24]
*Jan  1 04:21:02: %7:  [RIP] Update timer schedule via interface Serial 2/0[172.16.2.2/24]
*Jan  1 04:21:02: %7:  [RIP] Prepare to send MULTICAST response...
*Jan  1 04:21:02: %7:  [RIP] Building update entries on Serial 2/0
*Jan  1 04:21:02: %7:        192.168.5.16/28 via 0.0.0.0 metric 1 tag 0
*Jan  1 04:21:02: %7:        202.103.1.0/24 via 0.0.0.0 metric 3 tag 0
*Jan  1 04:21:02: %7:        202.103.2.32/28 via 0.0.0.0 metric 2 tag 0
*Jan  1 04:21:02: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on Serial 2/0
*Jan  1 04:21:18: %7:  [RIP] Update timer expired via interface GigabitEthernet 0/0[192.168.5.17/28]
*Jan  1 04:21:18: %7:  [RIP] Update timer schedule via interface GigabitEthernet 0/0[192.168.5.17/28]
*Jan  1 04:21:18: %7:  [RIP] Prepare to send MULTICAST response...
*Jan  1 04:21:18: %7:  [RIP] Building update entries on GigabitEthernet 0/0
*Jan  1 04:21:18: %7:        172.16.1.0/24 via 0.0.0.0 metric 2 tag 0
*Jan  1 04:21:18: %7:        172.16.2.0/24 via 0.0.0.0 metric 1 tag 0
*Jan  1 04:21:18: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on GigabitEthernet 0/0
*Jan  1 04:21:22: %7: [RIP] RIP recveived packet, sock=32979 src=192.168.5.18 len=44
*Jan  1 04:21:22: %7:  [RIP] Received version 2 response packet on GigabitEthernet 0/0
*Jan  1 04:21:22: %7:  [RIP] Cancel peer[192.168.5.18] remove timer
*Jan  1 04:21:22: %7:  [RIP] Peer[192.168.5.18] remove timer shedule...
*Jan  1 04:21:22: %7:  [RIP] Both do not need auth, Auth ok
*Jan  1 04:21:22: %7:        route-entry: family 2 tag 0 ip 202.103.1.0 mask 255.255.255.0 nhop 0.0.0.0 metric 2
*Jan  1 04:21:22: %7:        route-entry: family 2 tag 0 ip 202.103.2.32 mask 255.255.255.240 nhop 0.0.0.0 metric 1
*Jan  1 04:21:22: %7:  [RIP] [202.103.1.0/24] RIP route update, protocol(4)
*Jan  1 04:21:22: %7:  [RIP] Old path is: nhop=192.168.5.18 routesrc=192.168.5.18 intf=4
*Jan  1 04:21:22: %7:  [RIP] New path is: nhop=192.168.5.18 routesrc=192.168.5.18 intf=4
*Jan  1 04:21:22: %7:  [RIP] [202.103.1.0/24] RIP distance apply from 192.168.5.18!
*Jan  1 04:21:22: %7:  [RIP] [202.103.1.0/24] cancel Route timer
*Jan  1 04:21:22: %7:  [RIP] [202.103.1.0/24] route timer schedule...
```

图 11 debug ip rip 命令输出信息

分析如下：

1） 数据包接收信息：

- "RIP received packet from 192.168.5.18 len=44"含义：R2 从 IP 地址 192.168.5.18 接收到一个 RIP 数据包，长度为 44 字节。
- "Received version 2 response packet on GigabitEthernet 0/0"含义：在 GigabitEthernet 0/0 接口上接收到 RIPv2 的响应数据包。

2）路由更新处理：

- "RIP route update, protocol(4)"含义：RIP 正在处理路由更新，协议号为 4（表示 RIP）。
- "Old path is: nhop=192.168.5.18 routerc=192.168.5.18 intf=4"含义：显示更新前的路由信息。
- "New path is: nhop=192.168.5.18 routerc=192.168.5.18 intf=4"含义：显示更新后的路由信息。
- "Update timer schedule via interface Serial 2/0"含义：通过 Serial 2/0 接口调度了一个更新定时器。

2） 定时器操作：

- "cancel Route timer"含义：取消当前路由的定时器。
- "route timer schedule..."含义：为路由设置新的定时器。
- "Update timer expired via interface Serial 2/0"含义：Serial 2/0 接口的更新定时器到期。

4）认证信息：

- "Both do not need auth, Auth ok"含义：双方都不需要认证，认证状态正常。

5）路由通告准备：

- "Prepare to send MULTICAST response"含义：准备发送多播响应包。
- "Send packet to 224.0.0.9 Port 520 on GigabitEthernet 0/0"含义：通过 GigabitEthernet 0/0 接口向 RIP 多播地址 224.0.0.9 的 520 端口发送数据包。

6）路由条目详情：

- "route-entry: 2 tag 0 ip 202.103.1.0 mask 255.255.255.0 nhop 0.0.0.0 metric 2"含义：显示一个路由条目的详细信息，包括标签、IP 地址、掩码、下一跳和度量值。（nhop 指的是 next hop）

7）对等体操作：

- "Peer[192.168.5.18] remove timer schedule..."含义：移除与 192.168.5.18 对等体相关的定时器。

调试信息的含义大致如上，不难看出 RIP 在路由器上正常运行。

4. 查看 4 台路由器的路由表，验证是否学习到了其他网段的路由信息。

```
03-RSR20-1#sho 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    172.16.1.0/24 is directly connected, GigabitEthernet 0/0
C    172.16.1.1/32 is local host.
C    172.16.2.0/24 is directly connected, Serial 2/0
C    172.16.2.1/32 is local host.
R    192.168.5.16/28 [120/1] via 172.16.2.2, 00:24:02, Serial 2/0
R    202.103.1.0/24 [120/3] via 172.16.2.2, 00:14:47, Serial 2/0
R    202.103.2.32/28 [120/2] via 172.16.2.2, 00:18:40, Serial 2/0
03-RSR20-1#
```

图 12 路由器 R1 的路由表

```
3-RSR20-2#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    172.16.1.0/24 [120/1] via 172.16.2.1, 00:24:43, Serial 2/0
C    172.16.2.0/24 is directly connected, Serial 2/0
C    172.16.2.2/32 is local host.
C    192.168.5.16/28 is directly connected, GigabitEthernet 0/0
C    192.168.5.17/32 is local host.
R    202.103.1.0/24 [120/2] via 192.168.5.18, 00:15:13, GigabitEthernet 0/0
R    202.103.2.32/28 [120/1] via 192.168.5.18, 00:19:06, GigabitEthernet 0/0
3-RSR20-2#
```

图 13 路由器 R2 的路由表

```
12-RSR20-1(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    172.16.1.0/24 [120/2] via 192.168.5.17, 00:19:49, GigabitEthernet 0/0
R    172.16.2.0/24 [120/1] via 192.168.5.17, 00:19:49, GigabitEthernet 0/0
C    192.168.5.16/28 is directly connected, GigabitEthernet 0/0
C    192.168.5.18/32 is local host.
R    202.103.1.0/24 [120/1] via 202.103.2.34, 00:15:45, Serial 2/0
C    202.103.2.32/28 is directly connected, Serial 2/0
C    202.103.2.33/32 is local host.
12-RSR20-1(config)#
```

图 14 路由器 R3 的路由表

```
2-RSR20-2#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    172.16.1.0/24 [120/3] via 202.103.2.33, 00:21:01, Serial 2/0
R    172.16.2.0/24 [120/2] via 202.103.2.33, 00:21:01, Serial 2/0
R    192.168.5.16/28 [120/1] via 202.103.2.33, 00:21:01, Serial 2/0
C    202.103.1.0/24 is directly connected, GigabitEthernet 0/0
C    202.103.1.1/32 is local host.
C    202.103.2.32/28 is directly connected, Serial 2/0
C    202.103.2.34/32 is local host.
2-RSR20-2#
```

图 15 路由器 R4 的路由表

分析如下：

可以观察到四个路由其中均出现了带有其它网段信息的 R 类型的路由条目，说明了 4 台路由表均学习到了其它网段的路由信息。

5. 对比步骤 1 中路由器 R3 和 R4 的路由表，分析此时路由器 R3 和 R4 的路由表中的 R 条目是怎样产生的？

R3 中新增了三条 R 类型路由：

1）172.16.1.0/24 [120/2] via 192.168.5.17, GigabitEthernet 0/0

2）172.16.2.0/24 [120/1] via 192.168.5.17, GigabitEthernet 0/0

3）202.103.1.0/24 [120/1] via 202.103.2.34, Serial 2/0

其中前两条来自 R1 和 R2，在 R2 通过 GigabitEthernet 0/0 发送到了 R3。R3 将这些路由添加到路由表，下一跳为 R2 的接口 IP (192.168.5.17)。

第三条来自 R4，在 R4 通过 Serial 2/0 接口传播给 R3。R3 将此路由添加到路由表，下一跳为 R4 的接口 IP (202.103.2.34)。

6. 测试网络的连通性，分析 tracerout PC1（或 PC2）的结果。

PC2 ping PC1 的结果如下：

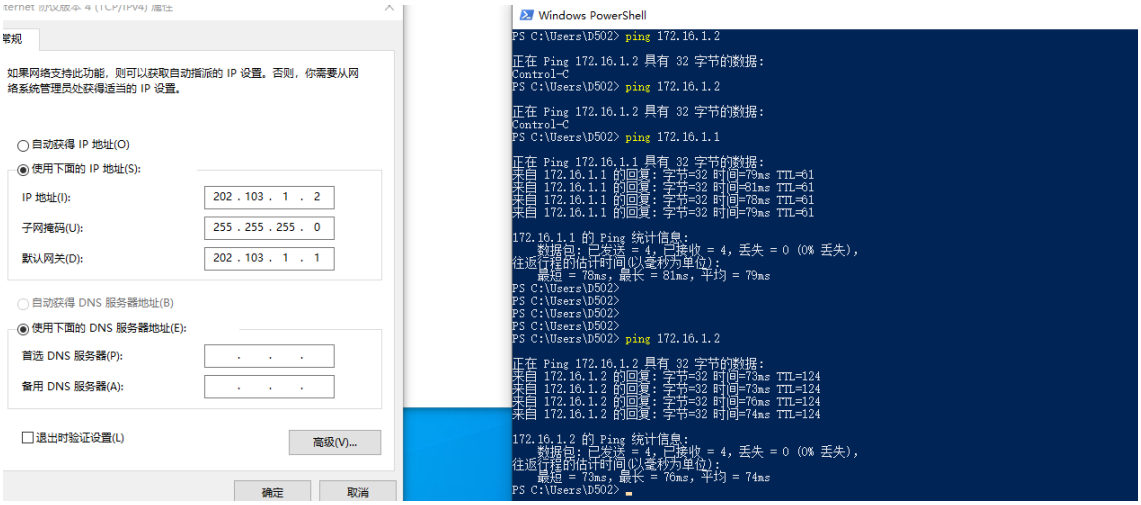

图 16 测试 PC1 与 PC2 的连通性

从 ping 的结果可以看出，PC1 与 PC2 正常连通。tracert 命令执行结果的图片丢失，其输出为从 PC2 一级级通过端口路由到 PC1，结果符合预期。

7. 捕获数据包，分析 RIP 封装结构，并给出从捕获的数据包中哪里可以查看到 RIP 版本号和发布到的网段？ RIP 包在 PC1 或 PC2 上能捕获到吗？

RIP 封装结构如下：

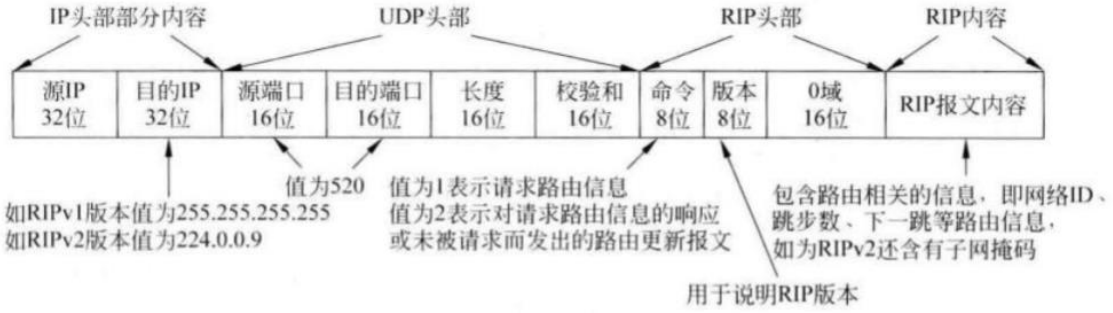

图 17 RIP 封装结构

在 wireshark 中可以看到 RIP 的数据包结构如下：

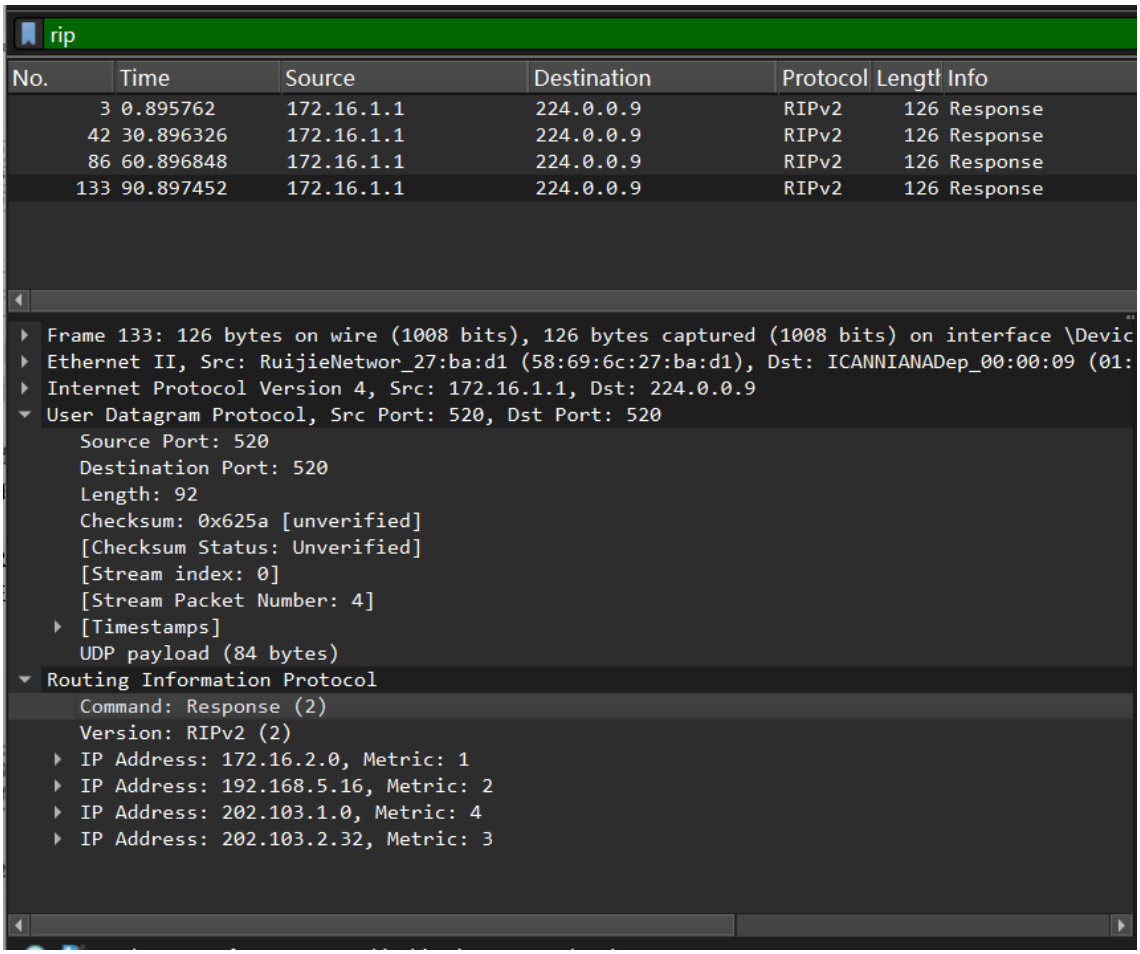

图 18 wireshark RIP 数据包结构

可以在 Routing Information Protocol 中看到 RIP 版本号和发布到的网段。

RIP 包在 PC1 与 PC2 上都能够捕获到。

8. 进行拔线实验，拔掉任一根网线，在相关路由器上使用 debug ip rip 命令，查看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，查看是否出现毒性反转？

拔掉路由器 R4 与 PC2 之间的连线，通过 debug ip rip 命令得到的信息如下：

172.16.2.5

```
*Oct 21 12:05:33: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on GigabitEthernet 0/0
*Oct 21 12:05:35: %7:  [RIP] Update timer expired via interface Serial 2/0[202.103.2.34/28]
*Oct 21 12:05:35: %7:  [RIP] Update timer schedule via interface Serial 2/0[202.103.2.34/28]
*Oct 21 12:05:35: %7:  [RIP] Prepare to send MULTICAST response...
*Oct 21 12:05:35: %7:  [RIP] Building update entries on Serial 2/0
*Oct 21 12:05:35: %7:        202.103.1.0/24 via 0.0.0.0 metric 1 tag 0
*Oct 21 12:05:35: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on Serial 2/0
*Oct 21 12:05:37: %LINK-3-UPDOWN: Interface GigabitEthernet 0/0, changed state to down.
*Oct 21 12:05:37: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet 0/0, changed state to down.
*Oct 21 12:05:37: %7: NSM Message Header
*Oct 21 12:05:37: %7:  VR ID: 0
*Oct 21 12:05:37: %7:  VRF ID: 0
*Oct 21 12:05:37: %7:  Message type: Link Down (30)
*Oct 21 12:05:37: %7:  Message length: 96
*Oct 21 12:05:37: %7:  Message ID: 0x00000000
*Oct 21 12:05:37: %7: NSM Interface
*Oct 21 12:05:37: %7:  Interface index: 4
*Oct 21 12:05:37: %7:  Name: GigabitEthernet 0/0
*Oct 21 12:05:37: %7:  Flags: 0x00001042
*Oct 21 12:05:37: %7:  [RIP] Received interface[GigabitEthernet 0/0][vrf:0] DOWN event
*Oct 21 12:05:37: %7:  [RIP] Interface[GigabitEthernet 0/0] is downing
*Oct 21 12:05:37: %7:  [RIP] [202.103.1.0/24] RIP route disabling...
*Oct 21 12:05:37: %7:  [RIP] [202.103.1.0/24] route timer schedule...
*Oct 21 12:05:37: %7:  [RIP] Trigger timer Schedule, by instance 0
*Oct 21 12:05:37: %7:  [RIP] [202.103.1.0/24] ready to add into kernel...
*Oct 21 12:05:37: %7:  [RIP] NSM delete: IPv4 Route 202.103.1.0/24
*Oct 21 12:05:37: %7:  [RIP] Cancel all timers of interface GigabitEthernet 0/0[202.103.1.1/24]
*Oct 21 12:05:37: %7:  [RIP] Interface[GigabitEthernet 0/0] is to be deleted
*Oct 21 12:05:37: %7:  [RIP] GR: Remove graceful restart data of Interface GigabitEthernet 0/0, ifindex:4.
*Oct 21 12:05:37: %7:  [RIP] Setsockopt IP_LEAVE_MEMBERSHIP success: GigabitEthernet 0/0
*Oct 21 12:05:39: %7:  [RIP] Trigger timer expired, by instance 0
*Oct 21 12:05:39: %7:  [RIP] Prepare to send MULTICAST response...
*Oct 21 12:05:39: %7:  [RIP] Building update entries on Serial 2/0
*Oct 21 12:05:39: %7:  [RIP] Skip route[172.16.1.0/24] in trigger
*Oct 21 12:05:39: %7:  [RIP] Skip route[172.16.2.0/24] in trigger
*Oct 21 12:05:39: %7:  [RIP] Skip route[192.168.5.16/28] in trigger
*Oct 21 12:05:39: %7:        202.103.1.0/24 via 0.0.0.0 metric 16 tag 0
*Oct 21 12:05:39: %7:  [RIP] Skip route[202.103.2.32/28] in trigger
*Oct 21 12:05:39: %7:  [RIP] Send packet to 224.0.0.9 Port 520 on Serial 2/0
*Oct 21 12:05:58: %7: [RIP] RIP recveived packet, sock=32979 src=202.103.2.33 len=64
*Oct 21 12:05:58: %7:  [RIP] Received version 2 response packet on Serial 2/0
*Oct 21 12:05:58: %7:  [RIP] Cancel peer[202.103.2.33] remove timer
*Oct 21 12:05:58: %7:  [RIP] Peer[202.103.2.33] remove timer shedule...
*Oct 21 12:05:58: %7:  [RIP] Both do not need auth, Auth ok
*Oct 21 12:05:58: %7:        route-entry: family 2 tag 0 ip 172.16.1.0 mask 255.255.255.0 nhop 0.0.0.0 metric 3
*Oct 21 12:05:58: %7:        route-entry: family 2 tag 0 ip 172.16.2.0 mask 255.255.255.0 nhop 0.0.0.0 metric 2
*Oct 21 12:05:58: %7:        route-entry: family 2 tag 0 ip 192.168.5.16 mask 255.255.255.240 nhop 0.0.0.0 metric 1
*Oct 21 12:05:58: %7:  [RIP] [172.16.1.0/24] RIP route update, protocol(4)
*Oct 21 12:05:58: %7:  [RIP] Old path is: nhop=202.103.2.33 routesrc=202.103.2.33 intf=2
*Oct 21 12:05:58: %7:  [RIP] New path is: nhop=202.103.2.33 routesrc=202.103.2.33 intf=2
*Oct 21 12:05:58: %7:  [RIP] [172.16.1.0/24] RIP distance apply from 202.103.2.33!
*Oct 21 12:05:58: %7:  [RIP] [172.16.1.0/24] cancel Route timer
*Oct 21 12:05:58: %7:  [RIP] [172.16.1.0/24] route timer schedule...
*Oct 21 12:05:58: %7:  [RIP] [172.16.2.0/24] RIP route update, protocol(4)
*Oct 21 12:05:58: %7:  [RIP] Old path is: nhop=202.103.2.33 routesrc=202.103.2.33 intf=2
*Oct 21 12:05:58: %7:  [RIP] New path is: nhop=202.103.2.33 routesrc=202.103.2.33 intf=2
*Oct 21 12:05:58: %7:  [RIP] [172.16.2.0/24] RIP distance apply from 202.103.2.33!
*Oct 21 12:05:58: %7:  [RIP] [172.16.2.0/24] cancel Route timer
*Oct 21 12:05:58: %7:  [RIP] [172.16.2.0/24] route timer schedule...
*Oct 21 12:05:58: %7:  [RIP] [192.168.5.16/28] RIP route update, protocol(4)
*Oct 21 12:05:58: %7:  [RIP] Old path is: nhop=202.103.2.33 routesrc=202.103.2.33 intf=2
```

分析如下：

从信息中我们可以看到：202.103.1.0/24 via 0.0.0.0 metric 16 tag 0，这是毒性反转的关键步骤。路由器将断开链路相关的网段（202.103.1.0/24）标记为不可达（metric 16），准备通告给邻居。

（另外值得一提的是，从各个[RIP] Skip 中我们可以看出路由器还用水平分割规则）

9. RIP v1 必须使用自动汇总，不支持不连续网络，请分析若使用 RIP v1，路由器 R1-R4 的路由表最终将会是怎样的？在这种情况下，PC1 和 PC2 是否仍可以联通？

若使用 RIPv1，那么 202.103.2.32/28 与 202.103.1.0/24 将会被汇总，随后导致路由失败，PC1 和 PC2 无法联通。