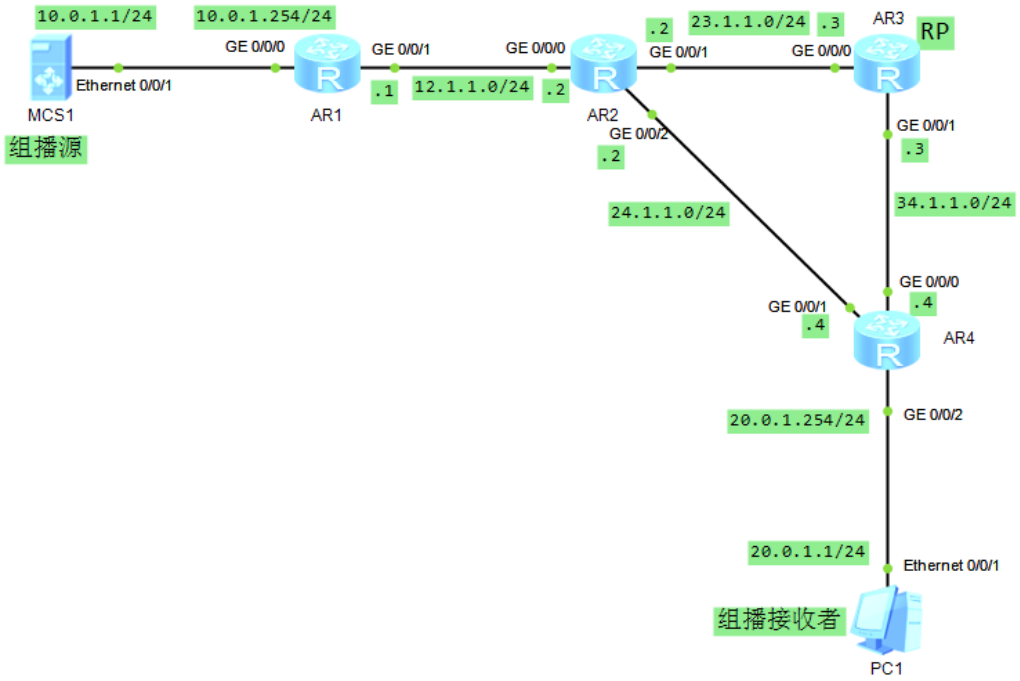
【HCIP 实验 20】PIM-SM

一、 实验拓扑



实验需求及解法

本实验模拟简单组播的网络环境，完成以下需求：

1.如图所示，配置各设备IP地址。

其中R3配置Loopback0:3.3.3.3/32

R1:

```
interface GigabitEthernet0/0/0
 ip address 10.0.1.254 255.255.255.0
#
interface GigabitEthernet0/0/1
 ip address 12.1.1.1 255.255.255.0
#
```

R2:
interface GigabitEthernet0/0/0
 ip address 12.1.1.2 255.255.255.0
#
interface GigabitEthernet0/0/1
 ip address 23.1.1.2 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 24.1.1.2 255.255.255.0
#
R3:
interface GigabitEthernet0/0/0
 ip address 23.1.1.3 255.255.255.0
#
interface GigabitEthernet0/0/1
 ip address 34.1.1.3 255.255.255.0
#
interface LoopBack0
 ip address 3.3.3.3 255.255.255.255
#
R4:
interface GigabitEthernet0/0/0
 ip address 34.1.1.4 255.255.255.0
#
interface GigabitEthernet0/0/1
 ip address 24.1.1.4 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 20.0.1.254 255.255.255.0
#
2.运行IGP
2.1 R1/2/3/4运行OSPF，进程1。
2.2 RID手动设置如下：
R1:1.1.1.1
R2:2.2.2.2
R3:3.3.3.3
R4:4.4.4.4
2.3 使用network命令宣告，通配符0.0.0.0
2.4 确认所有设备可以访问3.3.3.3。
R1:

```
ospf 1 router-id 1.1.1.1
 area 0.0.0.0
  network 10.0.1.254 0.0.0.0
  network 12.1.1.1 0.0.0.0
#
```

R2:

```
ospf 1 router-id 2.2.2.2
 area 0.0.0.0
  network 12.1.1.2 0.0.0.0
  network 23.1.1.2 0.0.0.0
  network 24.1.1.2 0.0.0.0
#
```

R3:

```
ospf 1 router-id 3.3.3.3
 area 0.0.0.0
  network 3.3.3.3 0.0.0.0
  network 23.1.1.3 0.0.0.0
  network 34.1.1.3 0.0.0.0
#
```

R4:

```
ospf 1 router-id 4.4.4.4
 area 0.0.0.0
  network 20.0.1.254 0.0.0.0
  network 24.1.1.4 0.0.0.0
  network 34.1.1.4 0.0.0.0
#
```

```
[R1]ping 3.3.3.3
  PING 3.3.3.3: 56  data bytes, press CTRL_C to break
    Reply from 3.3.3.3: bytes=56 Sequence=1 ttl=254 time=50 ms
    Reply from 3.3.3.3: bytes=56 Sequence=2 ttl=254 time=30 ms
    Reply from 3.3.3.3: bytes=56 Sequence=3 ttl=254 time=30 ms
    Reply from 3.3.3.3: bytes=56 Sequence=4 ttl=254 time=30 ms
    Reply from 3.3.3.3: bytes=56 Sequence=5 ttl=254 time=30 ms
```

其他设备自行测试。

3.R1/2/3/4运行PIM-SM

3.1 开启组播路由功能。

3.2 所有接口开启PIM-SM。

3.3 静态设置RP为3.3.3.3

R1/2/3/4

```
multicast routing-enable
```

```
pim
 static-rp 3.3.3.3
#
R1:
interface GigabitEthernet0/0/0
 pim sm
 #
interface GigabitEthernet0/0/1
 pim sm
#
R2:
interface GigabitEthernet0/0/0
 pim sm
#
interface GigabitEthernet0/0/1
 pim sm
#
interface GigabitEthernet0/0/2
 pim sm
#
R3:
interface GigabitEthernet0/0/0
 pim sm
#
interface GigabitEthernet0/0/1
 pim sm
#
R4:
interface GigabitEthernet0/0/0
 pim sm
#
interface GigabitEthernet0/0/1
 pim sm
#
interface GigabitEthernet0/0/2
 pim sm
```

3.4 R4上关闭switchover功能。

R4:

```
pim
  spt-switch-threshold infinity
```

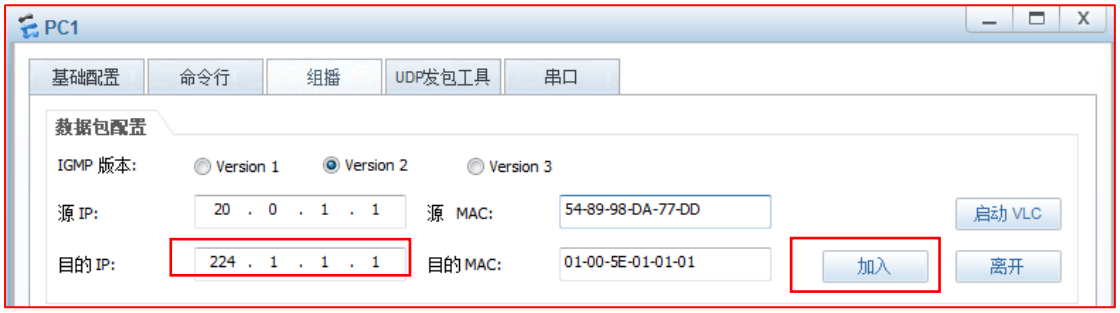
#关闭自动切换SPT的功能，默认开启。

本实验提前关闭该功能主要是为了方便查看各设备组播路由表，研究RPT和SPT建立过程。

3.5 PC1加入组播组224.1.1.1，使用IGMPv2。

R4：

```
interface GigabitEthernet0/0/2
 igmp enable
#
```



查看各路由器的组播路由表。描述RPT建立过程。

[R4]dis igmp group

```
Interface group report information of VPN-Instance: public net
 GigabitEthernet0/0/2(20.0.1.254):
  Total 1 IGMP Group reported
   Group Address    Last Reporter    Uptime      Expires
   224.1.1.1        20.0.1.1         00:00:17    00:01:53
```

[R4]dis pim routing-table

```
 (*, 224.1.1.1)
     RP: 3.3.3.3
     Protocol: pim-sm, Flag: WC
     UpTime: 00:00:45
     Upstream interface: GigabitEthernet0/0/0
         Upstream neighbor: 34.1.1.3
         RPF prime neighbor: 34.1.1.3
     Downstream interface(s) information:
     Total number of downstreams: 1
         1: GigabitEthernet0/0/2
             Protocol: igmp, UpTime: 00:00:45, Expires: -
```

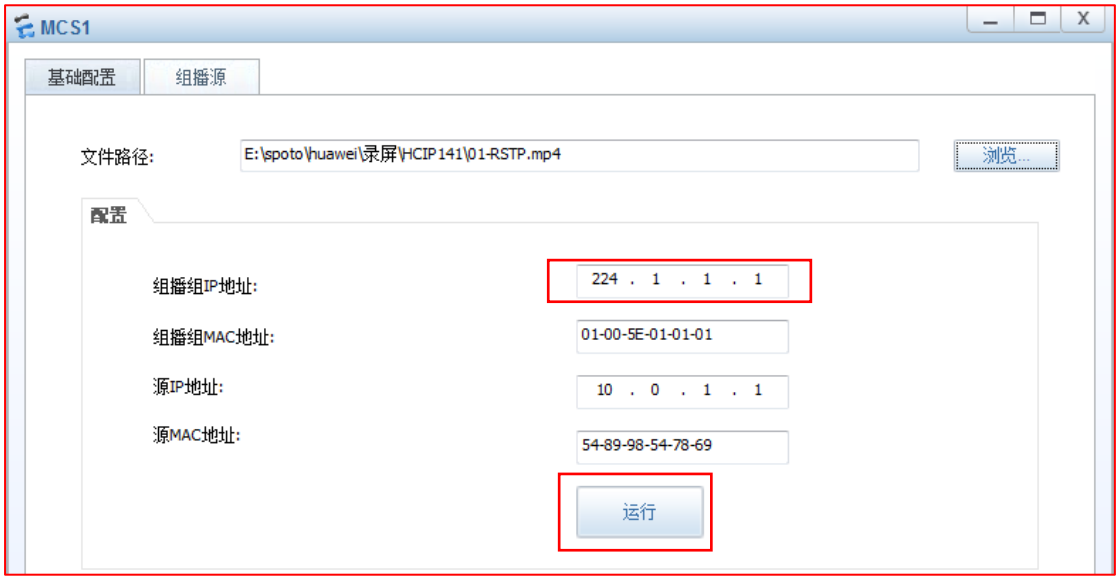
R4上的RP为3.3.3.3，根据单播路由表，找到RPF接口G0/0/0，作为组播流量上游接口。另外，收到IGMP加组消息的接口G0/0/2作为下游接口。即：将来会从G0/0/0接口收到组播，然后从G0/0/2转发出去。这就是（*,G）组播路由表。

[R3]dis pim routing-table

```
(*, 224.1.1.1)
    RP: 3.3.3.3 (local)
    Protocol: pim-sm, Flag: WC
    UpTime: 00:04:00
    Upstream interface: Register
        Upstream neighbor: NULL
        RPF prime neighbor: NULL
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/1
            Protocol: pim-sm, UpTime: 00:04:00, Expires: 00:03:30
```

R3的G0/0/1接口会收到来自R4的(*,G)Join消息，则把G0/0/1口作为组播流量的下游接口。
由于暂时没有组播源，所有没有上游接口。此时从RP到接收者的RPT建立完成。
另外，R1和R2此时没有任何组播路由表项，请自行查看。

3.6 使用组播源发送组播报文，组地址：224.1.1.1



3.7 查看各路由器的组播路由表。描述SPT建立过程。
确认组播流量的路径为组播源-R1-R2-R3-R4-PC1。
[R3]dis pim routing-table

```
(*, 224.1.1.1)
    RP: 3.3.3.3 (local)
    Protocol: pim-sm, Flag: WC
    UpTime: 00:10:42
    Upstream interface: Register
        Upstream neighbor: NULL
        RPF prime neighbor: NULL
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/1
            Protocol: pim-sm, UpTime: 00:10:42, Expires: 00:02:48

(10.0.1.1, 224.1.1.1)
    RP: 3.3.3.3 (local)
    Protocol: pim-sm, Flag: SPT 2MSDP ACT
    UpTime: 00:00:36
    Upstream interface: GigabitEthernet0/0/0
        Upstream neighbor: 23.1.1.2
        RPF prime neighbor: 23.1.1.2
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/1
            Protocol: pim-sm, UpTime: 00:00:36, Expires: -
```

组播源发送组播流量后，R1会将第一个组播报文封装为注册报文，单播发送给RP，是在RP上出现了(S,G)组播路由表。根据源地址10.1.1.1，找到RPF接口G0/0/0，于是RP将G0/0/0作为组播流量上游接口，而下游接口直接从(*,G)表中学习即可。然后RP会向着组播源10.1.1.1的方向发送(S,G)Join消息。

[R2]dis pim routing-table

```
(10.0.1.1, 224.1.1.1)
    RP: 3.3.3.3
    Protocol: pim-sm, Flag: SPT ACT
    UpTime: 00:06:59
    Upstream interface: GigabitEthernet0/0/0
        Upstream neighbor: 12.1.1.1
        RPF prime neighbor: 12.1.1.1
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/1
            Protocol: pim-sm, UpTime: 00:06:59, Expires: 00:02:30
```

R2从G0/0/1接口收到RP的(S,G)Join消息，于是将G0/0/1作为下游接口。同时，根据源地址10.1.1.1，找到RPF接口G0/0/0，于是将G0/0/0作为组播流量的上游接口。并且，继续向着组播源10.1.1.1的方向发送(S,G)Join消息。

[R1]dis pim routing-table

```
(10.0.1.1, 224.1.1.1)
    RP: 3.3.3.3
    Protocol: pim-sm, Flag: SPT LOC ACT
    UpTime: 00:09:29
    Upstream interface: GigabitEthernet0/0/0
        Upstream neighbor: NULL
        RPF prime neighbor: NULL
    Downstream interface(s) information:
    Total number of downstreams: 2
        1: GigabitEthernet0/0/1
            Protocol: pim-sm, UpTime: 00:09:29, Expires: 00:03:01
        2: Register
            Protocol: pim-sm, UpTime: 00:09:29, Expires: -
```

R1从G0/0/1接口收到R2的(S,G)Join消息，于是将G0/0/1作为下游接口。同时，R1作为组播源的网关路由器直接收到组播报文，没有上游设备。

到此，从RP到组播源的SPT建立完成。

[R4]dis pim routing-table

```
(*, 224.1.1.1)
    RP: 3.3.3.3
    Protocol: pim-sm, Flag: WC
    UpTime: 00:32:05
    Upstream interface: GigabitEthernet0/0/0
        Upstream neighbor: 34.1.1.3
        RPF prime neighbor: 34.1.1.3
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/2
            Protocol: igmp, UpTime: 00:32:05, Expires: -

(10.0.1.1, 224.1.1.1)
    RP: 3.3.3.3
    Protocol: pim-sm, Flag: ACT
    UpTime: 00:21:58
    Upstream interface: GigabitEthernet0/0/0
        Upstream neighbor: 34.1.1.3
        RPF prime neighbor: 34.1.1.3
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/2
            Protocol: pim-sm, UpTime: 00:21:58, Expires: -
```

此时组播流量已经转发到R4，所以R4也获得了(S,G)组播路由表。由于R4关闭了switchover功能，所以依旧根据RP地址3.3.3.3，把RPF接口G0/0/0作为上游接口。

3.8 R4上恢复默认的switchover功能

R4：

```
pim
 undo spt-switch-threshold
```

再次查看各路由器的组播路由表。

确认当前组播流量的路径为组播源-R1-R2-R4-PC1。

[R4]dis pim routing-table

```
(10.0.1.1, 224.1.1.1)
    RP: 3.3.3.3
    Protocol: pim-sm, Flag: RPT SPT ACT
    UpTime: 00:28:34
    Upstream interface: GigabitEthernet0/0/1
        Upstream neighbor: 24.1.1.2
        RPF prime neighbor: 24.1.1.2
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/2
            Protocol: pim-sm, UpTime: 00:28:34, Expires: -
```

R4上开启switchover功能后，虽然RP依旧是3.3.3.3，但是会根据组播源10.1.1.1查找RPF接口为G0/0/1，此时会将G0/0/1作为上游接口。首先会向RP发送剪枝消息，让RP停止转发组播报文，另外会向组播源方向发送(S,G)Join消息。

[R3]dis pim routing-table

```
(*, 224.1.1.1)
    RP: 3.3.3.3 (local)
    Protocol: pim-sm, Flag: WC
    UpTime: 00:40:17
    Upstream interface: Register
        Upstream neighbor: NULL
        RPF prime neighbor: NULL
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/1
            Protocol: pim-sm, UpTime: 00:40:17, Expires: 00:03:12

(10.0.1.1, 224.1.1.1)
    RP: 3.3.3.3 (local)
    Protocol: pim-sm, Flag: RPT
    UpTime: 00:30:11
    Upstream interface: Register
        Upstream neighbor: NULL
        RPF prime neighbor: NULL
    Downstream interface(s) information: None
```

此时R3的下游接口被剪枝，不会再转发组播报文。

[R2]dis pim routing-table

```
(10.0.1.1, 224.1.1.1)
    RP: 3.3.3.3
    Protocol: pim-sm, Flag: SPT ACT
    UpTime: 00:30:41
    Upstream interface: GigabitEthernet0/0/0
        Upstream neighbor: 12.1.1.1
        RPF prime neighbor: 12.1.1.1
    Downstream interface(s) information:
    Total number of downstreams: 1
        1: GigabitEthernet0/0/2
            Protocol: pim-sm, UpTime: 00:05:42, Expires: 00:02:47
```

由于收到R4的(S,G)Join消息，所以R2的下游接口变为了G0/0/2。
至此，组播流量切换至最佳路径。