计算机网络 实验九

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【实验步骤】

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。 配置好之后，此时无法连通

(2) 在路由器R1（或R2）上执行 show ip route 命令，记录路由表信息。

```
5-RSR20-1#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
5-RSR20-1#
```

```
5-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
5-RSR20-2#
```

步骤2：三层交换机的基本配置。 步骤3：路由器R1的基本配置 步骤4：路由器R2的基本配置 步骤5：配置OSPF路由协议。交换机S5750配置OSPF。 步骤6：路由器R1配置OSPF. 步骤7：路由器R2配置OSPF. 步骤8：查看验证3台路由设备的路由表是自动学习了其他网段的路由信息，请注意路由条目 O 项。

- 首先，通过查阅资料知道O条目是怎样产生的。条目前的"O"代表 ospf （开放式最短路径优先）区域内的路由，路由器只把最优的路由条目添加到自己的路由表中，路由器在选择路由条目并将其添加到路由表中时，使用两个参数 Metrics （度量值）和 DistanceMetric （管理距离）。度量值代表距离，由度量值来确定寻路时的最优路由。管理距离是指一种路由协议的路由可信度。当路由器收到相同目的地址的路由条目时，首先比较管理距离，选择管理距离小的路由条目添加到路由表中。如果管理距离相同，则比较度量值，选择度量值小的路由条目添加到路由表中。 OSPF 的管理距离默认是110，度量值是接口代价。

S5750# show ip route

```
9-S5750-1#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.
O    192.168.2.0/24 [110/51] via 192.168.1.1, 00:03:43, VLAN 10
O    192.168.3.0/24 [110/52] via 192.168.1.1, 00:02:12, VLAN 10
C    192.168.5.0/24 is directly connected, VLAN 50
C    192.168.5.1/32 is local host.
9-S5750-1#
```

- 分析交换机S5750的路由表，表中有 O 条目吗？如果有，是怎样产生的？ 有O条目，是通过前面的配置命令配置OSPF路由协议的时候产生的。 "O"代表是通过 OSPF 学习到了路由协议："192.168.2.0/24"代表学习的路由前缀："[110/51]"代表 OSPF 协议的管理距离为110, COST 开销为51，"00:03:43"代表学习到路由信息时间，以后看路由状态更新的时候，需要自己的观察路由条目时间与其他时间的不同,"via192.168.1.1"，表示的是下一跳地址,"VLAN 10"表示从哪一个接口学习过来的。

Routerl # show ip route

```
5-RSR20-1#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.
O    192.168.3.0/24 [110/51] via 192.168.2.2, 00:01:36, Serial 2/0
O    192.168.5.0/24 [110/2] via 192.168.1.2, 00:03:21, GigabitEthernet 0/1
5-RSR20-1#
```

- 分析路由器R1的路由表，表中有 O 条目吗？如果有，是怎样产生的？ 有O条目，原因同上。 "O"代表是通过 OSPF 学习到了路由协议："192.168.3.0/24"代表学习的路由前缀："[110/51]"代表 OSPF 协议的管理距离为110, COST 开销为51，"00:01:36"代表学习到路由信息时间，以后看路由状态更新的时候，需要自己的观察路由条目时间与其他时间的不同,"via192.168.2.2"，表示的是下一跳地址,"Serial 2/0"表示从哪一个接口学习过来的.

Router2# show ip route

```
5-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
O    192.168.1.0/24 [110/51] via 192.168.2.1, 00:00:01, 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.
O    192.168.5.0/24 [110/52] via 192.168.2.1, 00:00:01, Serial 2/0
5-RSR20-2#
```

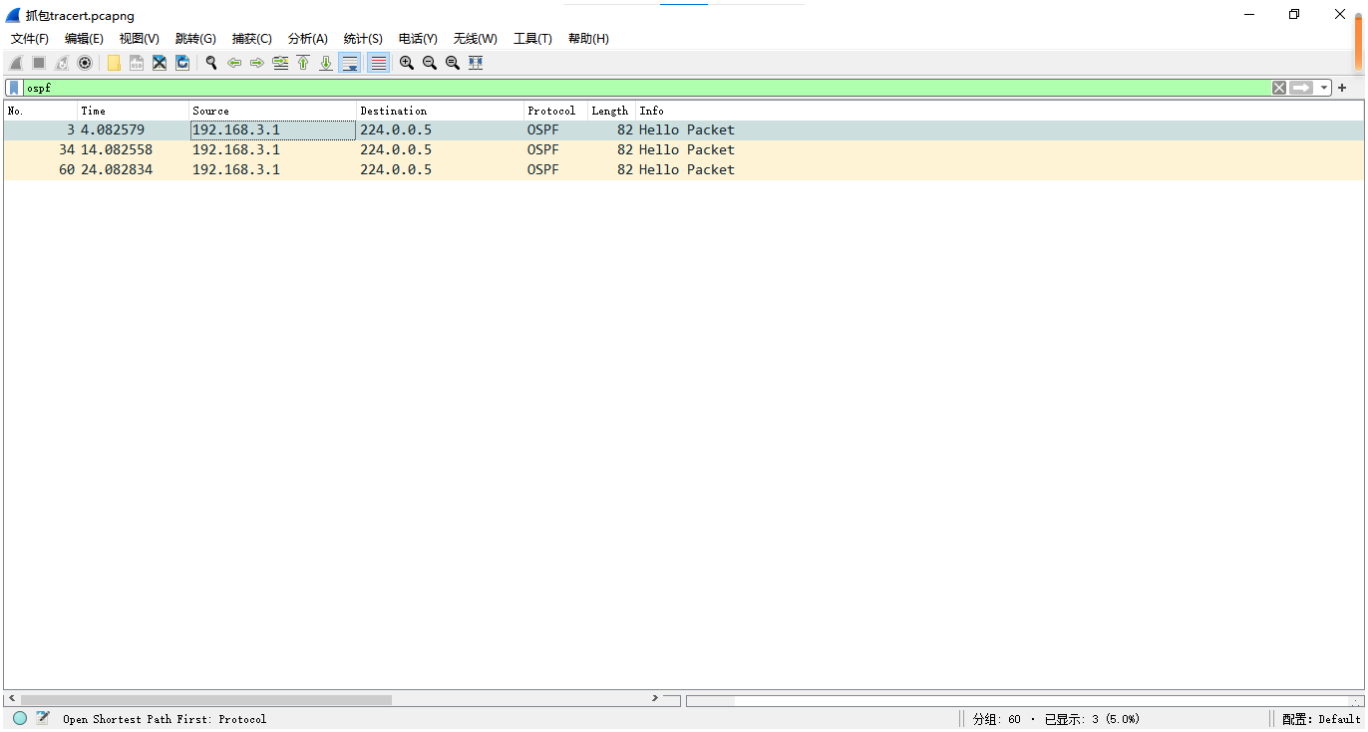
- 分析路由器R2的路由表，表中有 O 条目吗？如果有，是怎样产生的？ 有，理由同上。

步骤9：测试网络的连通性。 (1) 将此时的路由表与步骤0的路由表进行比较，有什么结论？ 此时的路由表没有172开头的IP地址（因为关闭了校园网）

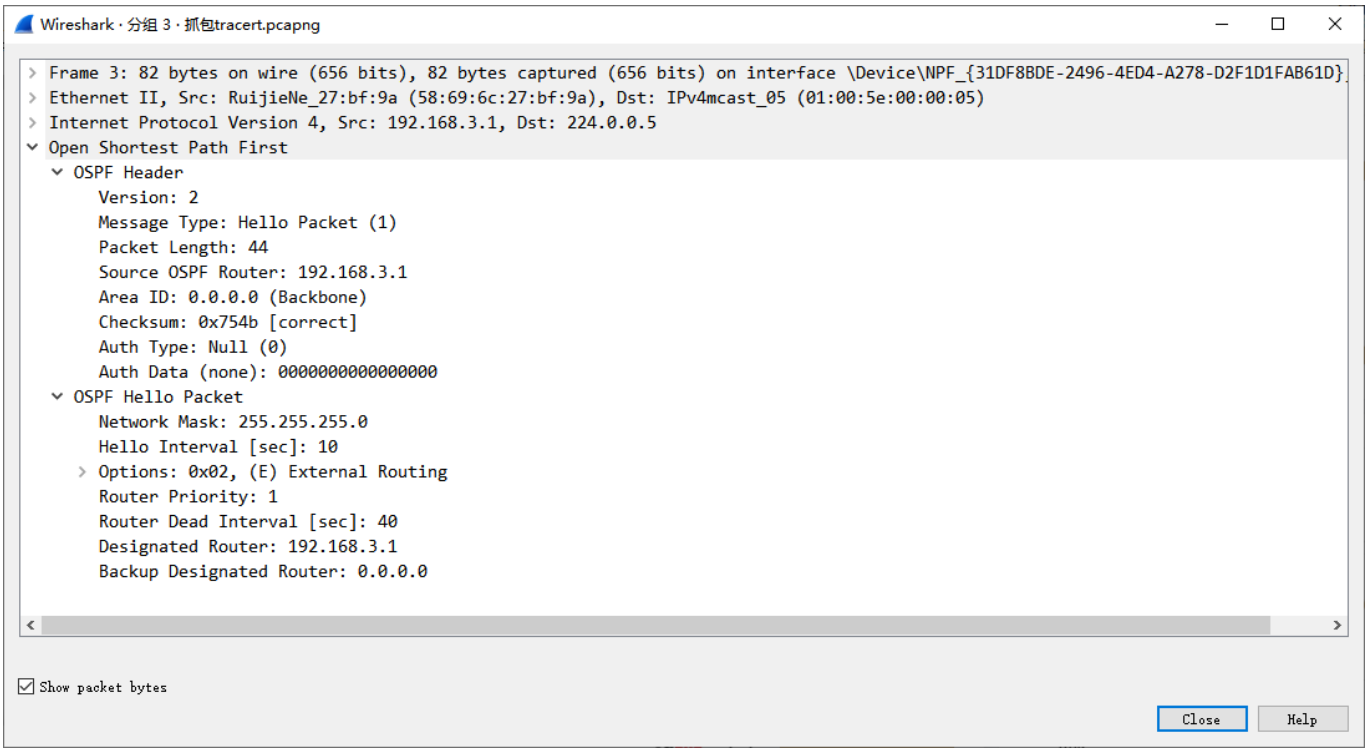
(2) 分析 traceroute PC1（或PC2）的执行结果。

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

正在 Ping 192.168.5.11 具有 32 字节的数据:
来自 192.168.5.11 的回复: 字节=32 时间=40ms TTL=125
来自 192.168.5.11 的回复: 字节=32 时间=38ms TTL=125
来自 192.168.5.11 的回复: 字节=32 时间=39ms TTL=125
来自 192.168.5.11 的回复: 字节=32 时间=40ms TTL=125

192.168.5.11 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 = 39ms

C:\Users\D502>tracert 192.168.5.11

通过最多 30 个跃点跟踪
到 D52_14 [192.168.5.11] 的路由:

  1    <1 毫秒    <1 毫秒    <1 毫秒 192.168.3.1
  2    42 ms     41 ms     42 ms  192.168.2.1
  3    49 ms     49 ms     49 ms  192.168.1.2
  4    46 ms     45 ms     45 ms  D52_14 [192.168.5.11]

跟踪完成。

C:\Users\D502>_
```

都会经过4跳到达目标IP地址，其中经过的IP为PC1，PC2的默认网关，R1,R2的地址和VLAN 10，VLAN 50. (3) 捕获数据包，分析 OSPF 头部结构。 OSPF 包在PC1或PC2上能捕获到吗？如果希望2台主机都能捕获到，请描述方法。 OSPF包能捕获到，下面是tracert PC1是用wireshark抓的包：



发现都是hello数据包，打开其中一条OSPF数据：



version是OSPF的版本号，为2
Message Type是OSPF的数据包类型，为Hello Packet，Type Code为1
Packet Length是OSPF的数据包长度，为44 Source OSPF Router是始发OSPF数据包的路由器的router-id Area ID是是始发OSPF数据包的路由器接口所在的区域 Checksum是数据包的校验和 Auth Type是OSPF的认证类型，为Null（0），表示不检查该字段

(4) 使用# debug ip ospf 命令显示上述 OSPF 协议的运行情况，观察并保存路由器R1发送和接收的 Update 分组（可以通过改变链路状态触发），注意其中 LSA 类型；观察有无224.0.0.5、224.0.0.6的 IP 地址，如有请说明这两个地址的作用。

```
*Nov  8 08:17:19: %7: IFSM[VLAN 10:192.168.1.2]: Hello timer expire
*Nov  8 08:17:19: %7: SEND[Hello]: To 224.0.0.5 via VLAN 10:192.168.1.2, length 48
*Nov  8 08:17:19: %7: ------------------------------------------------------
*Nov  8 08:17:19: %7: Header
*Nov  8 08:17:19: %7:   Version 2
*Nov  8 08:17:19: %7:   Type 1 (Hello)
*Nov  8 08:17:19: %7:   Packet Len 48
*Nov  8 08:17:19: %7:   Router ID 192.168.5.1
*Nov  8 08:17:19: %7:   Area ID 0.0.0.0
*Nov  8 08:17:19: %7:   Checksum 0xf0f2
*Nov  8 08:17:19: %7:   AuType 0
*Nov  8 08:17:19: %7: Hello
*Nov  8 08:17:19: %7:   NetworkMask 255.255.255.0
*Nov  8 08:17:19: %7:   HelloInterval 10
*Nov  8 08:17:19: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:17:19: %7:   RtrPriority 1
*Nov  8 08:17:19: %7:   RtrDeadInterval 40
*Nov  8 08:17:19: %7:   DRouter 192.168.1.2
*Nov  8 08:17:19: %7:   BDRouter 192.168.1.1
*Nov  8 08:17:19: %7:   # Neighbors 1
*Nov  8 08:17:19: %7:     Neighbor 192.168.2.1
*Nov  8 08:17:19: %7: ------------------------------------------------------
*Nov  8 08:17:23: %7: IFSM[VLAN 50:192.168.5.1]: Hello timer expire
*Nov  8 08:17:23: %7: SEND[Hello]: To 224.0.0.5 via VLAN 50:192.168.5.1, length 44
*Nov  8 08:17:23: %7: ------------------------------------------------------
*Nov  8 08:17:23: %7: Header
*Nov  8 08:17:23: %7:   Version 2
*Nov  8 08:17:23: %7:   Type 1 (Hello)
*Nov  8 08:17:23: %7:   Packet Len 44
*Nov  8 08:17:23: %7:   Router ID 192.168.5.1
*Nov  8 08:17:23: %7:   Area ID 0.0.0.0
*Nov  8 08:17:23: %7:   Checksum 0x714b
*Nov  8 08:17:23: %7:   AuType 0
*Nov  8 08:17:23: %7: Hello
*Nov  8 08:17:23: %7:   NetworkMask 255.255.255.0
*Nov  8 08:17:23: %7:   HelloInterval 10
*Nov  8 08:17:23: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:17:23: %7:   RtrPriority 1
*Nov  8 08:17:23: %7:   RtrDeadInterval 40
*Nov  8 08:17:23: %7:   DRouter 192.168.5.1
*Nov  8 08:17:23: %7:   BDRouter 0.0.0.0
*Nov  8 08:17:23: %7:   # Neighbors 0
*Nov  8 08:17:23: %7: ------------------------------------------------------
```

```
*Nov  8 08:20:53: %7:    Area ID 0.0.0.0
*Nov  8 08:20:53: %7:    Checksum 0x714b
*Nov  8 08:20:53: %7:    AuType 0
*Nov  8 08:20:53: %7: Hello
*Nov  8 08:20:53: %7:    NetworkMask 255.255.255.0
*Nov  8 08:20:53: %7:    HelloInterval 10
*Nov  8 08:20:53: %7:    Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:20:53: %7:    RtrPriority 1
*Nov  8 08:20:53: %7:    RtrDeadInterval 40
*Nov  8 08:20:53: %7:    DRouter 192.168.5.1
*Nov  8 08:20:53: %7:    BDRouter 0.0.0.0
*Nov  8 08:20:53: %7:    # Neighbors 0
*Nov  8 08:20:53: %7: ----------------------------------------------------
*Nov  8 08:20:57: %7: LSA[MaxAge]: Maxage walker finished (0.000000 sec)
*Nov  8 08:20:58: %7: RECV[Hello]: From 192.168.2.1 via VLAN 10:192.168.1.2 (192.168.1.1 -> 224.0.0.5), len = 48, cksum = 0xf0f2
*Nov  8 08:20:58: %7: ----------------------------------------------------
*Nov  8 08:20:58: %7: Header
*Nov  8 08:20:58: %7:    Version 2
*Nov  8 08:20:58: %7:    Type 1 (Hello)
*Nov  8 08:20:58: %7:    Packet Len 48
*Nov  8 08:20:58: %7:    Router ID 192.168.2.1
*Nov  8 08:20:58: %7:    Area ID 0.0.0.0
*Nov  8 08:20:58: %7:    Checksum 0xf0f2
*Nov  8 08:20:58: %7:    AuType 0
*Nov  8 08:20:58: %7: Hello
*Nov  8 08:20:58: %7:    NetworkMask 255.255.255.0
*Nov  8 08:20:58: %7:    HelloInterval 10
*Nov  8 08:20:58: %7:    Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:20:58: %7:    RtrPriority 1
*Nov  8 08:20:58: %7:    RtrDeadInterval 40
*Nov  8 08:20:58: %7:    DRouter 192.168.1.2
*Nov  8 08:20:58: %7:    BDRouter 192.168.1.1
*Nov  8 08:20:58: %7:    # Neighbors 1
*Nov  8 08:20:58: %7:      Neighbor 192.168.5.1
*Nov  8 08:20:58: %7: ----------------------------------------------------
*Nov  8 08:20:58: %7: NFSM[192.168.2.1-VLAN 10]: Full (HelloReceived)
*Nov  8 08:20:58: %7: NFSM[192.168.2.1-VLAN 10]: nfsm_ignore called
*Nov  8 08:20:58: %7: NFSM[192.168.2.1-VLAN 10]: Full (2-WayReceived)
*Nov  8 08:20:59: %7: IFSM[VLAN 10:192.168.1.2]: Hello timer expire
*Nov  8 08:20:59: %7: SEND[Hello]: To 224.0.0.5 via VLAN 10:192.168.1.2, length 48
*Nov  8 08:20:59: %7: ----------------------------------------------------
*Nov  8 08:20:59: %7: Header
*Nov  8 08:20:59: %7:    Version 2
*Nov  8 08:20:59: %7:    Type 1 (Hello)
*Nov  8 08:20:59: %7:    Packet Len 48
*Nov  8 08:20:59: %7:    Router ID 192.168.5.1
*Nov  8 08:20:59: %7:    Area ID 0.0.0.0
*Nov  8 08:20:59: %7:    Checksum 0xf0f2
*Nov  8 08:20:59: %7:    AuType 0
*Nov  8 08:20:59: %7: Hello
*Nov  8 08:20:59: %7:    NetworkMask 255.255.255.0
*Nov  8 08:20:59: %7:    HelloInterval 10
*Nov  8 08:20:59: %7:    Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:20:59: %7:    RtrPriority 1
*Nov  8 08:20:59: %7:    RtrDeadInterval 40
*Nov  8 08:20:59: %7:    DRouter 192.168.1.2
*Nov  8 08:20:59: %7:    BDRouter 192.168.1.1
*Nov  8 08:20:59: %7:    # Neighbors 1
*Nov  8 08:20:59: %7:      Neighbor 192.168.2.1
*Nov  8 08:20:59: %7: ----------------------------------------------------
```

```
*Nov  8 08:23:58: %7:   Area ID 0.0.0.0
*Nov  8 08:23:58: %7:   Checksum 0xf0f2
*Nov  8 08:23:58: %7:   AuType 0
*Nov  8 08:23:58: %7: Hello
*Nov  8 08:23:58: %7:   NetworkMask 255.255.255.0
*Nov  8 08:23:58: %7:   HelloInterval 10
*Nov  8 08:23:58: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:23:58: %7:   RtrPriority 1
*Nov  8 08:23:58: %7:   RtrDeadInterval 40
*Nov  8 08:23:58: %7:   DRouter 192.168.1.2
*Nov  8 08:23:58: %7:   BDRouter 192.168.1.1
*Nov  8 08:23:58: %7:   # Neighbors 1
*Nov  8 08:23:58: %7:     Neighbor 192.168.5.1
*Nov  8 08:23:58: %7: ----------------------------------------------------
*Nov  8 08:23:58: %7: NFSM[192.168.2.1-VLAN 10]: Full (HelloReceived)
*Nov  8 08:23:58: %7: NFSM[192.168.2.1-VLAN 10]: nfsm_ignore called
*Nov  8 08:23:58: %7: NFSM[192.168.2.1-VLAN 10]: Full (2-WayReceived)
*Nov  8 08:23:59: %7: IFSM[VLAN 10:192.168.1.2]: Hello timer expire
*Nov  8 08:23:59: %7: SEND[Hello]: To 224.0.0.5 via VLAN 10:192.168.1.2, length 48
*Nov  8 08:23:59: %7: ----------------------------------------------------
*Nov  8 08:23:59: %7: Header
*Nov  8 08:23:59: %7:   Version 2
*Nov  8 08:23:59: %7:   Type 1 (Hello)
*Nov  8 08:23:59: %7:   Packet Len 48
*Nov  8 08:23:59: %7:   Router ID 192.168.5.1
*Nov  8 08:23:59: %7:   Area ID 0.0.0.0
*Nov  8 08:23:59: %7:   Checksum 0xf0f2
*Nov  8 08:23:59: %7:   AuType 0
*Nov  8 08:23:59: %7: Hello
*Nov  8 08:23:59: %7:   NetworkMask 255.255.255.0
*Nov  8 08:23:59: %7:   HelloInterval 10
*Nov  8 08:23:59: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:23:59: %7:   RtrPriority 1
*Nov  8 08:23:59: %7:   RtrDeadInterval 40
*Nov  8 08:23:59: %7:   DRouter 192.168.1.2
*Nov  8 08:23:59: %7:   BDRouter 192.168.1.1
*Nov  8 08:23:59: %7:   # Neighbors 1
*Nov  8 08:23:59: %7:     Neighbor 192.168.2.1
*Nov  8 08:23:59: %7: ----------------------------------------------------
*Nov  8 08:24:04: %7: IFSM[VLAN 50:192.168.5.1]: Hello timer expire
*Nov  8 08:24:04: %7: SEND[Hello]: To 224.0.0.5 via VLAN 50:192.168.5.1, length 44
*Nov  8 08:24:04: %7: ----------------------------------------------------
*Nov  8 08:24:04: %7: Header
*Nov  8 08:24:04: %7:   Version 2
*Nov  8 08:24:04: %7:   Type 1 (Hello)
*Nov  8 08:24:04: %7:   Packet Len 44
*Nov  8 08:24:04: %7:   Router ID 192.168.5.1
*Nov  8 08:24:04: %7:   Area ID 0.0.0.0
*Nov  8 08:24:04: %7:   Checksum 0x714b
*Nov  8 08:24:04: %7:   AuType 0
*Nov  8 08:24:04: %7: Hello
*Nov  8 08:24:04: %7:   NetworkMask 255.255.255.0
*Nov  8 08:24:04: %7:   HelloInterval 10
*Nov  8 08:24:04: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:24:04: %7:   RtrPriority 1
*Nov  8 08:24:04: %7:   RtrDeadInterval 40
*Nov  8 08:24:04: %7:   DRouter 192.168.5.1
*Nov  8 08:24:04: %7:   BDRouter 0.0.0.0
*Nov  8 08:24:04: %7:   # Neighbors 0
*Nov  8 08:24:04: %7: ----------------------------------------------------
```

有观察到224.0.0.5的IP地址，所在的信息表示一个OSPF协议的Hello消息被发送到多播地址 224.0.0.5，并通过VLAN 50的接口发送，源IP地址为 192.168.5.1，消息长度为 44 字节。这个地址帮助路由器建立和维护邻居关系，从而构建OSPF路由表。

(5) 本实验有没有 DR / BDR （指派路由器 / 备份指派路由器）？ 如果有，请指出 DR 与 BDR 分别是哪个设备，讨论 DR / BDR的选举规则和更新方法（通过拔线改变拓扑，观察 DR / BDR 的变化情况）；如没有，请说明原因。 有。DR是192.168.1.2和192.168.5.1，BDR是192.168.1.1和0.0.0.0。 换线前：

```
*Nov  8 08:25:38: %7:   Router ID 192.168.5.1
*Nov  8 08:25:38: %7:   Area ID 0.0.0.0
*Nov  8 08:25:38: %7:   Checksum 0xf0f2
*Nov  8 08:25:38: %7:   AuType 0
*Nov  8 08:25:38: %7: Hello
*Nov  8 08:25:38: %7:   NetworkMask 255.255.255.0
*Nov  8 08:25:38: %7:   HelloInterval 10
*Nov  8 08:25:38: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:25:38: %7:   RtrPriority 1
*Nov  8 08:25:38: %7:   RtrDeadInterval 40
*Nov  8 08:25:38: %7:   DRouter 192.168.1.2
*Nov  8 08:25:38: %7:   BDRouter 192.168.1.1
*Nov  8 08:25:38: %7:   # Neighbors 1
*Nov  8 08:25:38: %7:     Neighbor 192.168.2.1
*Nov  8 08:25:38: %7: ----------------------------------------------------
*Nov  8 08:25:38: %7: RECV[Hello]: From 192.168.2.1 via VLAN 10:192.168.1.2 (192.168.1.1 -> 224.0.0.5), len = 48, cksum = 0xf0f2
*Nov  8 08:25:38: %7: ----------------------------------------------------
*Nov  8 08:25:38: %7: Header
*Nov  8 08:25:38: %7:   Version 2
*Nov  8 08:25:38: %7:   Type 1 (Hello)
*Nov  8 08:25:38: %7:   Packet Len 48
*Nov  8 08:25:38: %7:   Router ID 192.168.2.1
*Nov  8 08:25:38: %7:   Area ID 0.0.0.0
*Nov  8 08:25:38: %7:   Checksum 0xf0f2
*Nov  8 08:25:38: %7:   AuType 0
*Nov  8 08:25:38: %7: Hello
*Nov  8 08:25:38: %7:   NetworkMask 255.255.255.0
*Nov  8 08:25:38: %7:   HelloInterval 10
*Nov  8 08:25:38: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:25:38: %7:   RtrPriority 1
*Nov  8 08:25:38: %7:   RtrDeadInterval 40
*Nov  8 08:25:38: %7:   DRouter 192.168.1.2
*Nov  8 08:25:38: %7:   BDRouter 192.168.1.1
*Nov  8 08:25:38: %7:   # Neighbors 1
*Nov  8 08:25:38: %7:     Neighbor 192.168.5.1
*Nov  8 08:25:38: %7: ----------------------------------------------------
*Nov  8 08:25:38: %7: NFSM[192.168.2.1-VLAN 10]: Full (HelloReceived)
*Nov  8 08:25:38: %7: NFSM[192.168.2.1-VLAN 10]: nfsm_ignore called
*Nov  8 08:25:38: %7: NFSM[192.168.2.1-VLAN 10]: Full (2-WayReceived)
*Nov  8 08:25:44: %7: IFSM[VLAN 50:192.168.5.1]: Hello timer expire
*Nov  8 08:25:44: %7: SEND[Hello]: To 224.0.0.5 via VLAN 50:192.168.5.1, length 44
*Nov  8 08:25:44: %7: ----------------------------------------------------
*Nov  8 08:25:44: %7: Header
*Nov  8 08:25:44: %7:   Version 2
*Nov  8 08:25:44: %7:   Type 1 (Hello)
*Nov  8 08:25:44: %7:   Packet Len 44
*Nov  8 08:25:44: %7:   Router ID 192.168.5.1
*Nov  8 08:25:44: %7:   Area ID 0.0.0.0
*Nov  8 08:25:44: %7:   Checksum 0x714b
*Nov  8 08:25:44: %7:   AuType 0
*Nov  8 08:25:44: %7: Hello
*Nov  8 08:25:44: %7:   NetworkMask 255.255.255.0
*Nov  8 08:25:44: %7:   HelloInterval 10
*Nov  8 08:25:44: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:25:44: %7:   RtrPriority 1
*Nov  8 08:25:44: %7:   RtrDeadInterval 40
*Nov  8 08:25:44: %7:   DRouter 192.168.5.1
*Nov  8 08:25:44: %7:   BDRouter 0.0.0.0
*Nov  8 08:25:44: %7:   # Neighbors 0
*Nov  8 08:25:44: %7: ----------------------------------------------------
```

DR / BDR的选举规则和更新方法： 先比较接口优先级，越大越优先。优先级相同，比较RID，越大越优先。 换线后（之前交换机连接路由器1，现在连路由器2）：

```
*Nov  8 08:31:23: %7:  ----------------------------------------------------
*Nov  8 08:31:23: %7:  Header
*Nov  8 08:31:23: %7:    Version 2
*Nov  8 08:31:23: %7:    Type 1 (Hello)
*Nov  8 08:31:23: %7:    Packet Len 44
*Nov  8 08:31:23: %7:    Router ID 192.168.5.1
*Nov  8 08:31:23: %7:    Area ID 0.0.0.0
*Nov  8 08:31:23: %7:    Checksum 0x754a
*Nov  8 08:31:23: %7:    AuType 0
*Nov  8 08:31:23: %7:  Hello
*Nov  8 08:31:23: %7:    NetworkMask 255.255.255.0
*Nov  8 08:31:23: %7:    HelloInterval 10
*Nov  8 08:31:23: %7:    Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:31:23: %7:    RtrPriority 1
*Nov  8 08:31:23: %7:    RtrDeadInterval 40
*Nov  8 08:31:23: %7:    DRouter 192.168.1.2
*Nov  8 08:31:23: %7:    BDRouter 0.0.0.0
*Nov  8 08:31:23: %7:    # Neighbors 0
*Nov  8 08:31:23: %7:  ----------------------------------------------------
*Nov  8 08:31:27: %7: LSA[MaxAge]: Maxage walker finished (0.000000 sec)
*Nov  8 08:31:28: %7: LSA[Refresh]: timer expired
*Nov  8 08:31:31: %7: IPSM[VLAN 50:192.168.5.1]: Hello timer expire
*Nov  8 08:31:31: %7: SEND[Hello]: To 224.0.0.5 via VLAN 50:192.168.5.1, length 44
*Nov  8 08:31:31: %7:  ----------------------------------------------------
*Nov  8 08:31:31: %7:  Header
*Nov  8 08:31:31: %7:    Version 2
*Nov  8 08:31:31: %7:    Type 1 (Hello)
*Nov  8 08:31:31: %7:    Packet Len 44
*Nov  8 08:31:31: %7:    Router ID 192.168.5.1
*Nov  8 08:31:31: %7:    Area ID 0.0.0.0
*Nov  8 08:31:31: %7:    Checksum 0x714b
*Nov  8 08:31:31: %7:    AuType 0
*Nov  8 08:31:31: %7:  Hello
*Nov  8 08:31:31: %7:    NetworkMask 255.255.255.0
*Nov  8 08:31:31: %7:    HelloInterval 10
*Nov  8 08:31:31: %7:    Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:31:31: %7:    RtrPriority 1
*Nov  8 08:31:31: %7:    RtrDeadInterval 40
*Nov  8 08:31:31: %7:    DRouter 192.168.5.1
*Nov  8 08:31:31: %7:    BDRouter 0.0.0.0
*Nov  8 08:31:31: %7:    # Neighbors 0
*Nov  8 08:31:31: %7:  ----------------------------------------------------
*Nov  8 08:31:31: %7: RECV[Hello]: From 192.168.3.1 via VLAN 10:192.168.1.2 (192.168.3.1 -> 224.0.0.5): match source fail
*Nov  8 08:31:32: %7: IPSM[VLAN 10:192.168.1.2]: Hello timer expire
*Nov  8 08:31:32: %7: SEND[Hello]: To 224.0.0.5 via VLAN 10:192.168.1.2, length 44
*Nov  8 08:31:32: %7:  ----------------------------------------------------
*Nov  8 08:31:32: %7:  Header
*Nov  8 08:31:32: %7:    Version 2
*Nov  8 08:31:32: %7:    Type 1 (Hello)
*Nov  8 08:31:32: %7:    Packet Len 44
*Nov  8 08:31:32: %7:    Router ID 192.168.5.1
*Nov  8 08:31:32: %7:    Area ID 0.0.0.0
*Nov  8 08:31:32: %7:    Checksum 0x754a
*Nov  8 08:31:32: %7:    AuType 0
*Nov  8 08:31:32: %7:  Hello
*Nov  8 08:31:32: %7:    NetworkMask 255.255.255.0
*Nov  8 08:31:32: %7:    HelloInterval 10
*Nov  8 08:31:32: %7:    Options 0x2 (*|-|-|-|-|-|E|-)
*Nov  8 08:31:32: %7:    RtrPriority 1
*Nov  8 08:31:32: %7:    RtrDeadInterval 40
*Nov  8 08:31:32: %7:    D
```

可以看到DR没有发生变化，BDR发生变化。DR是192.168.1.2和192.168.5.1，BDR是0.0.0.0

实验中在申明直连网段时，注意要写该网段的反掩码，并且必须指明所属的区域。

【实验思考】 (1) 如何查看 OSPF 协议发布的网段?

- 可以使用show ip ospf database router命令来查看OSPF协议发布的网段。

(2) 关于 OSPF 反掩码：反掩码可以简单地理解成掩码取反，而且不允许出现不连续的1和0。例如，可以是0.0.0.11111111，但不可以是0.0.0.11110011，也不可以是0.0.0.11111100。反掩码总是奇数或0，因为其最后一位总是1，除非全部为0。

(3)255.255.255.255减去子网掩码就得出反掩码。例如：子网掩码是255.255.255.252，则255.255.255.255-255.255.255.252得出反掩码是0.0.0.3。请问：192.168.2.0/28的反掩码是多少?

- 192.168.2.0/28的子网掩码是255.255.255.240，所以反掩码为0.0.0.15。