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】OSPF 路由协议实验

【实验目的】

掌握 OSPF 协议单区域的配置和使用方法。

【实验内容】

【实验内容】

(1) 完成路由器配置实验实例 7-3（P252）的“OSPF 单区域配置”，回答步骤 1、步骤 9 问题。

(2) 在（1）的基础上每台路由器上各加入一台电脑，画出新拓扑，然后：

(a) 检查任意两个 PC 之间是否可以 Ping 通，对一台主机 ping 其它主机的结果进行截屏。

(b) 采用#depug ip ospf 显示上面 OSPF 协议的运行情况，观察并保存 R1 发送和接收的 Update 分组(可以改变链路状态来触发)，注意其中 LSA 类型；观察有无 224.0.0.5、224.0.0.6 IP 地址，如有说明这两地址的作用。

(c) 显示并记录路由器 R1 数据库的 Router LSA，Network LSA，LS 数据库信息汇总

 # show ip ospf database router ！ 显示 router LSA

 # show ip ospf database network ！显示 network LSA

 # show ip ospf database database ！显示 OSPF 链路状态数据库信息。

(d) 显示并记录邻居状态。

 # show ip ospf neighbor

(e) 显示并记录 R1 的所有接口信息

#show ip ospf interface [接口名]

【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)

计算机网络实验报告

【内容一】完成路由器配置实验实例 7-3（P252）的“OSPF 单区域配置”，回答步骤 1、步骤 9 问题。

【实验拓扑】

本实验以 2 台路由器和 1 台三层交换机为例。交换机 S5750 上划分有 VLAN 10 和 VLAN 50,其中 VLAN 10 用于连接路由器 R1,VLAN 50 用于连接校园网主机。将路由器分别命名为 R1 和 R2,路由器之间的串口采用 V35 DCE/DTE 电缆连接,DCE 端连接到路由器 R1 (RSR20)。路由器和主机直连时既可以使用交叉线,也可以使用直通线。路由器 R1 的端口 s2/0 为 DCE 端口。本实验拓扑结构如图 7-23 所示。

本实验拓扑结构如图 7-23 所示。

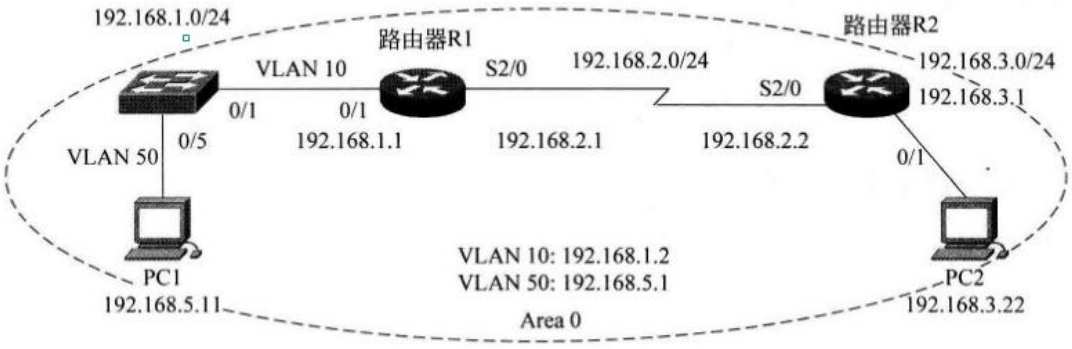


图 7-23　OSPF 单区域实验拓扑

图 7-23 中 PC1 的 IP 地址和默认网关分别为 192. 168.5.11 和 192. 168. 5. 1,PC2 的 IP 地址和默认网关分别为 192. 168. 3.22 和 192. 168.3.1,子网掩码都是 255. 255. 255.0

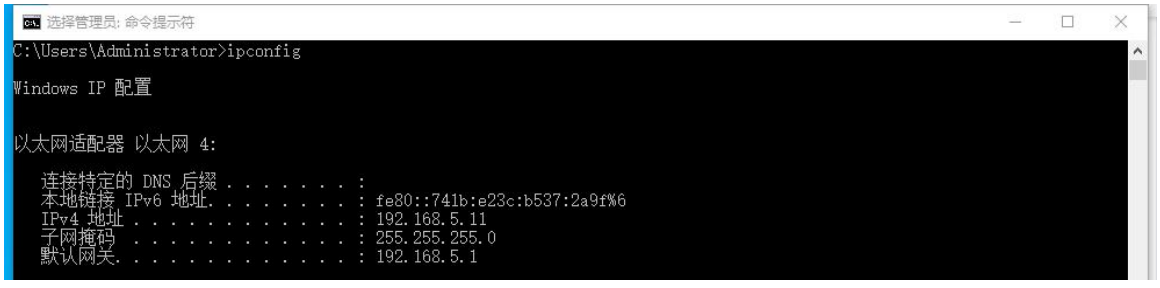
【实验步骤】

分析:本实验的预期目标是通过配置动态路由协议 OSPF,自动学习网段的路由信息,在区域内实现网络的互连互通。

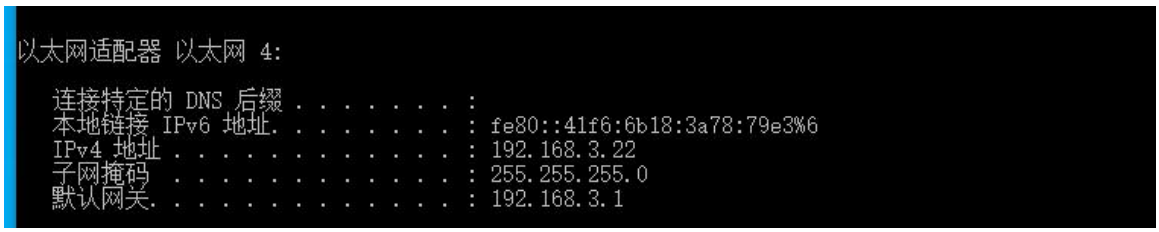
步骤 1:

(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。

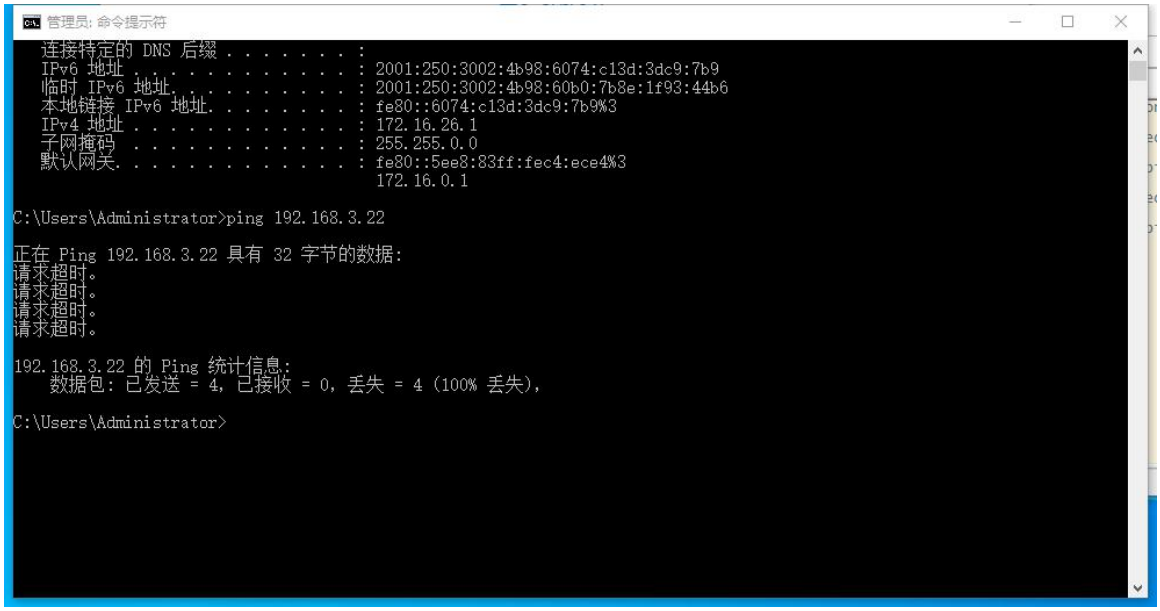
pc 1



pc2



网络连通性：此时两台电脑无法连通



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

R1：此时没有路由表信息

```
26-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
26-RSR20-1(config)#
```

步骤 2:三层交换机的基本配置。

```
*Jan  6 07:44:25: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEtherne
t 0/1, changed state to up.


26-S5750-1>enable 14

Password:
26-S5750-1#config
Enter configuration commands, one per line.  End with CNTL/Z.
26-S5750-1(config)#vlan 10
26-S5750-1(config-vlan)#exit
26-S5750-1(config)#vlan 50
26-S5750-1(config-vlan)#exit
26-S5750-1(config)#interface giga 0/1
26-S5750-1(config-if-GigabitEthernet 0/1)#switchport access vlan 10
26-S5750-1(config-if-GigabitEthernet 0/1)#exit
26-S5750-1(config)#interface giga 0/5
26-S5750-1(config-if-GigabitEthernet 0/5)#switchport access vlan 50
26-S5750-1(config-if-GigabitEthernet 0/5)#exit
26-S5750-1(config)#interface vlan 10
26-S5750-1(config-if-VLAN 10)#*Jan  6 07:52:09: %LINEPROTO-5-UPDOWN: Line protoc
ol on Interface VLAN 10, changed state to up.

26-S5750-1(config-if-VLAN 10)#ip address 192.168.1.2 255.255.255.0
26-S5750-1(config-if-VLAN 10)#no shutdown
26-S5750-1(config-if-VLAN 10)#exit
26-S5750-1(config)#interface vlan 50
26-S5750-1(config-if-VLAN 50)#*Jan  6 07:53:21: %LINEPROTO-5-UPDOWN: Line protoc
ol on Interface VLAN 50, changed state to up.

26-S5750-1(config-if-VLAN 50)#ip address 192.168.5.1 255.255.255.0
26-S5750-1(config-if-VLAN 50)#no shutdown
26-S5750-1(config-if-VLAN 50)#exit
26-S5750-1(config)#
```

步骤 3：路由器 R1 的基本配置

```
26-RSR20-1(config)#interface gigabitethernet 0/1
26-RSR20-1(config-if-GigabitEthernet 0/1)#$2.168.1.1 255.255.255.0
26-RSR20-1(config-if-GigabitEthernet 0/1)#no shut down
                                          ^
% Invalid input detected at '^' marker.

26-RSR20-1(config-if-GigabitEthernet 0/1)#no shutdown
26-RSR20-1(config-if-GigabitEthernet 0/1)#exit
26-RSR20-1(config)#interface serial 2/0
26-RSR20-1(config-if-Serial 2/0)#ip address 192.168.2.1 255.255.255.0
26-RSR20-1(config-if-Serial 2/0)#no shutdown
26-RSR20-1(config-if-Serial 2/0)#exit
26-RSR20-1(config)#
```

```
26-RSR20-1(config)#show ip interface
Serial 2/0
  IP interface state is: UP
  IP interface type is: POINTOPOINT
  IP interface MTU is: 1500
  IP address is:
    192.168.2.1/24 (primary)
  IP address negotiate is: OFF
  Forward direct-broadcast is: OFF
  ICMP mask reply is: ON
  Send ICMP redirect is: ON
  Send ICMP unreachabled is: ON
  DHCP relay is: OFF
  Fast switch is: ON
  Help address is:
  Proxy ARP is: ON
```

```
GigabitEthernet 0/1
  IP interface state is: UP
  IP interface type is: BROADCAST
  IP interface MTU is: 1500
  IP address is:
    192.168.1.1/24 (primary)
  IP address negotiate is: OFF
  Forward direct-broadcast is: OFF
  ICMP mask reply is: ON
  Send ICMP redirect is: ON
  Send ICMP unreachabled is: ON
  DHCP relay is: OFF
  Fast switch is: ON
  Help address is:
  Proxy ARP is: ON
```

步骤 4：路由器 R2 的基本配置

```
26-RSR20-2#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
26-RSR20-2(config)#interface gigabitethernet 0/1
26-RSR20-2(config-if-GigabitEthernet 0/1)#$2.168.3.1 255.255.255.0
26-RSR20-2(config-if-GigabitEthernet 0/1)#no shutdown
26-RSR20-2(config-if-GigabitEthernet 0/1)#exit
26-RSR20-2(config)#interface serial 2/0
26-RSR20-2(config-if-Serial 2/0)#ip address 192.168.2.2 255.255.255.0
26-RSR20-2(config-if-Serial 2/0)#no shutdown
```

步骤 5:配置 OSPF 路由协议。交换机 S5750 配置 OSPF。

```
26-S5750-1(config)#router ospf 1
26-S5750-1(config-router)#network 192.168.5.0 0.0.0.255 area 0
26-S5750-1(config-router)#network 192.168.1.0 0.0.0.255 area 0
26-S5750-1(config-router)#end
26-S5750-1#*Jan  6 07:56:49: %SYS-5-CONFIG_I: Configured from console by consol
*Jan  6 07:56:54: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.2.1-VLAN 10 from Down
o Init, HelloReceived.
*Jan  6 07:56:54: %OSPF-5-ADJCHG: Pro 截图(Alt + A) 192.168.2.1-VLAN 10 from Loadi
g to Full, LoadingDone.
```

步骤 6：路由器 R1 配置 OSPF

```
26-RSR20-1(config)#router ospf 1
26-RSR20-1(config-router)#network 192.168.1.0 0.0.0.255 area 0
26-RSR20-1(config-router)#network 192.168.2.0 0.0.0.255 area 0
26-RSR20-1(config-router)#end
26-RSR20-1#*May 31 16:40:16: %SYS-5-CONFIG_I: Configured from console by console
```

步骤 7：路由器 R2 配置 OSPF

```
26-RSR20-2(config)#
26-RSR20-2(config)#router ospf 1
26-RSR20-2(config-router)#network 192.168.2.0 0.0.0.255 area 0
26-RSR20-2(config-router)#network 192.168.3.0 0.0.0.255 area 0
26-RSR20-2(config-router)#end
```

步骤 8:查看验证 3 台路由设备的路由表是否自动学习了其他网段的路由信息,请注意"路由条目 O 项。如下图，交换机和两台路由器都有两条 O 条目，说明他们都通过 OSPF 自动学习了其他设备的路由信息。

交换机：网段 192.168.2.0 通过 IP 地址 IP192.168.1.1，自动学习了其他网段的路由信息；网段 192.168.3.0 通过 IP 地址 IP192.168.1.1，自动学习了其他网段的路由信息。

```
26-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, 00:01:05, VLAN 10
O    192.168.3.0/24 [110/52] via 192.168.1.1, 00:01:05, VLAN 10
C    192.168.5.0/24 is directly connected, VLAN 50
C    192.168.5.1/32 is local host.
```

路由器 R1：网段 192.168.5.0/24 通过 IP 地址 192.168.1.2，即通过 VLAN 10 自动学习了其他网段的路由信息；网段 192.168.3.0/24 通过 IP 地址 192.168.2.2，自动学习了其他网段的路由信息。

```
26-RSR20-1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
26-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
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, 00:03:17, Serial 2/0
O    192.168.5.0/24 [110/2] via 192.168.1.2, 00:02:08, GigabitEthernet 0/1
26-RSR20-1(config)#
```

路由器 R2：网段 192.168.1.0/24 通过 IP 地址 192.168.2.1，自动学习了其他网段的路由信息；网段 192.168.5.0/24 通过 IP 地址 192.168.2.1，自动学习了其他网段的路由信息。

```
26-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, 00:03:51, 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, 00:02:44, Serial 2/0
26-RSR20-2#
```

步骤 9:测试网络的连通性。此时两台主机之间可以连通

```
C:\Users\Administrator>ping 192.168.3.22

正在 Ping 192.168.3.22 具有 32 字节的数据:
来自 192.168.3.22 的回复: 字节=32 时间=38ms TTL=61
来自 192.168.3.22 的回复: 字节=32 时间=40ms TTL=61
来自 192.168.3.22 的回复: 字节=32 时间=38ms TTL=61
来自 192.168.3.22 的回复: 字节=32 时间=39ms TTL=61

192.168.3.22 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
```

(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?

答：此时的路由表相比之前未进行配置时的路由表，交换机 S5750 通过 vlan 10 直接连接网段 192.168.1.0，交换机 S5750 通过 vlan 50 直接连接网段 192.168.5.0；路由器 R1 通过端口 G0/0 直接连接网段 192.168.1.0，并通过端口 G0/0 自动学习网段 192.168.5.0；路由器 R2 通过端口 G0/0 直接连接网段 192.168.3.0。

(2) 分析 traceroute PC1(或 PC2)的执行结果。

```
选择管理员: 命令提示符
或批处理文件。

C:\Users\Administrator>tracert 192.168.3.22

通过最多 30 个跃点跟踪
到 DESKTOP-BVAQLT3 [192.168.3.22] 的路由:

  1    <1 毫秒   <1 毫秒   <1 毫秒 192.168.5.1
  2    <1 毫秒   <1 毫秒   <1 毫秒 192.168.1.1
  3    42 ms    41 ms    41 ms  192.168.2.2
  4    47 ms    45 ms    45 ms  DESKTOP-BVAQLT3 [192.168.3.22]

跟踪完成。

C:\Users\Administrator>
```

经过 192.168.5.1 -> 192.168.1.1 -> 192.168.2.2 -> 192.168.3.22 到达终点

```
C:\windows\system32>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    43 ms    43 ms    43 ms  192.168.2.1
  3    52 ms    51 ms    51 ms  192.168.1.2
  4    44 ms    47 ms    47 ms  DESKTOP-BVAQLT3 [192.168.5.11]

跟踪完成。
```

(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

可以捕获得到，其头部信息如下：包括版本、类型、数据包长度、源 OSPF 路由器、区域 ID、校验和、认证类型、认证信息。

ospf

No.	Time	Source	Destination	Protocol	Length	Info
2	2.680274	192.168.3.1	224.0.0.5	OSPF	82	Hello Packet
24	12.679891	192.168.3.1	224.0.0.5	OSPF	82	Hello Packet
48	22.679601	192.168.3.1	224.0.0.5	OSPF	82	Hello Packet
70	32.679180	192.168.3.1	224.0.0.5	OSPF	82	Hello Packet

```
▾ Open Shortest Path First
  ▾ OSPF Header
      Version: 2
      Message Type: Hello Packet (1)
      Packet Length: 44
      Source OSPF Router: 192.168.3.1
      Area ID: 0.0.0.0 (Backbone)
      Checksum: 0x754b [correct]
      Auth Type: Null (0)
      Auth Data (none): 0000000000000000
  ▾ OSPF Hello Packet
      Network Mask: 255.255.255.0
      Hello Interval [sec]: 10
    › Options: 0x02, (E) External Routing
      Router Priority: 1
      Router Dead Interval [sec]: 40
      Designated Router: 192.168.3.1
      Backup Designated Router: 0.0.0.0
```

(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。

一开始使用 debug ip ospf 命令各设备的 debug 信息如下

R1

```
*May 31 16:58:24: %7: ------------------------------------------------------
*May 31 16:58:24: %7: Header
*May 31 16:58:24: %7:   Version 2
*May 31 16:58:24: %7:   Type 1 (Hello)
*May 31 16:58:24: %7:   Packet Len 48
*May 31 16:58:24: %7:   Router ID 192.168.3.1
*May 31 16:58:24: %7:   Area ID 0.0.0.0
*May 31 16:58:24: %7:   Checksum 0x7647
*May 31 16:58:24: %7:   AuType 0
*May 31 16:58:24: %7: Hello
*May 31 16:58:24: %7:   NetworkMask 255.255.255.0
*May 31 16:58:24: %7:   HelloInterval 10
*May 31 16:58:24: %7:   Options 0x2 (-|-|-|-|-|-|E|-)
*May 31 16:58:24: %7:   RtrPriority 1
*May 31 16:58:24: %7:   RtrDeadInterval 40
*May 31 16:58:24: %7:   DRouter 0.0.0.0
*May 31 16:58:24: %7:   BDRouter 0.0.0.0
*May 31 16:58:24: %7:   # Neighbors 1
*May 31 16:58:24: %7:     Neighbor 192.168.2.1
*May 31 16:58:24: %7: ------------------------------------------------------
*May 31 16:58:24: %7: NFSM[192.168.3.1-Serial 2/0]: Full (HelloReceived)
*May 31 16:58:24: %7: NFSM[192.168.3.1-Serial 2/0]: nfsm_ignore called
*May 31 16:58:24: %7: NFSM[192.168.3.1-Serial 2/0]: Full (2-WayReceived)
eb*May 31 16:58:26: %7: IFSM[Serial 2/0:192.168.2.1]: Hello timer expire
*May 31 16:58:26: %7: SEND[Hello]: To 224.0.0.5 via Serial 2/0:192.168.2.1, length 48
*May 31 16:58:26: %7: ------------------------------------------------------
```

```
------------------------------------------------------------
Header
  Version 2
  Type 1 (Hello)
  Packet Len 48
  Router ID 192.168.2.1
  Area ID 0.0.0.0
  Checksum 0x7647
  AuType 0
Hello
  NetworkMask 255.255.255.0
  HelloInterval 10
  Options 0x2 (-|-|-|-|-|-|E|-)
  RtrPriority 1
  RtrDeadInterval 40
  DRouter 0.0.0.0
  BDRouter 0.0.0.0
  # Neighbors 1
    Neighbor 192.168.3.1
------------------------------------------------------------
IFSM[GigabitEthernet 0/1:192.168.1.1]: Hello timer expire
SEND[Hello]: To 224.0.0.5 via GigabitEthernet 0/1:192.168.1.1, length 48
------------------------------------------------------------
```

交换机：

```
26-S5750-1#*Jan  6 08:21:01: %7: LSA[MaxAge]: Maxage walker finished (0.000000 sec)
*Jan  6 08:21:01: %7: IFSM[VLAN 50:192.168.5.1]: Hello timer expire
*Jan  6 08:21:01: %7: SEND[Hello]: To 224.0.0.5 via VLAN 50:192.168.5.1, length 44
*Jan  6 08:21:01: %7: ------------------------------------------------------
*Jan  6 08:21:01: %7: Header
*Jan  6 08:21:01: %7:   Version 2
*Jan  6 08:21:01: %7:   Type 1 (Hello)
*Jan  6 08:21:01: %7:   Packet Len 44
*Jan  6 08:21:01: %7:   Router ID 192.168.5.1
*Jan  6 08:21:01: %7:   Area ID 0.0.0.0
*Jan  6 08:21:01: %7:   Checksum 0x714b
*Jan  6 08:21:01: %7:   AuType 0
*Jan  6 08:21:01: %7: Hello
*Jan  6 08:21:01: %7:   NetworkMask 255.255.255.0
*Jan  6 08:21:01: %7:   HelloInterval 10
*Jan  6 08:21:01: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
*Jan  6 08:21:01: %7:   RtrPriority 1
*Jan  6 08:21:01: %7:   RtrDeadInterval 40
*Jan  6 08:21:01: %7:   DRouter 192.168.5.1
*Jan  6 08:21:01: %7:   BDRouter 0.0.0.0
*Jan  6 08:21:01: %7:   # Neighbors 0
*Jan  6 08:21:01: %7: ------------------------------------------------------
```

```
'Jan  6 08:21:01: %7:   # Neighbors 0
'Jan  6 08:21:01: %7: ------------------------------------------------------
'Jan  6 08:21:04: %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
'Jan  6 08:21:04: %7: ------------------------------------------------------
'Jan  6 08:21:04: %7: Header
'Jan  6 08:21:04: %7:   Version 2
'Jan  6 08:21:04: %7:   Type 1 (Hello)
'Jan  6 08:21:04: %7:   Packet Len 48
'Jan  6 08:21:04: %7:   Router ID 192.168.2.1
'Jan  6 08:21:04: %7:   Area ID 0.0.0.0
'Jan  6 08:21:04: %7:   Checksum 0xf0f2
'Jan  6 08:21:04: %7:   AuType 0
'Jan  6 08:21:04: %7: Hello
'Jan  6 08:21:04: %7:   NetworkMask 255.255.255.0
'Jan  6 08:21:04: %7:   HelloInterval 10
'Jan  6 08:21:04: %7:   Options 0x2 (*|-|-|-|-|-|E|-)
'Jan  6 08:21:04: %7:   RtrPriority 1
'Jan  6 08:21:04: %7:   RtrDeadInterval 40
'Jan  6 08:21:04: %7:   DRouter 192.168.1.1
'Jan  6 08:21:04: %7:   BDRouter 192.168.1.2
'Jan  6 08:21:04: %7:   # Neighbors 1
'Jan  6 08:21:04: %7:     Neighbor 192.168.5.1
'Jan  6 08:21:04: %7: ------------------------------------------------------
```

```
----------------------------------------------------------
Header
  Version 2
  Type 1 (Hello)
  Packet Len 48
  Router ID 192.168.5.1
  Area ID 0.0.0.0
  Checksum 0xf0f2
  AuType 0
Hello
  NetworkMask 255.255.255.0
  HelloInterval 10
  Options 0x2 (-|-|-|-|-|-|E|-)
  RtrPriority 1
  RtrDeadInterval 40
  DRouter 192.168.1.1
  BDRouter 192.168.1.2
  # Neighbors 1
    Neighbor 192.168.2.1
----------------------------------------------------------
NFSM[192.168.5.1-GigabitEthernet 0/1]: Full (HelloReceived)
NFSM[192.168.5.1-GigabitEthernet 0/1]: nfsm_ignore called
NFSM[192.168.5.1-GigabitEthernet 0/1]: Full (2-WayReceived)
```

```
----------------------------------------------------------
Header
  Version 2
  Type 1 (Hello)
  Packet Len 48
  Router ID 192.168.2.1
  Area ID 0.0.0.0
  Checksum 0xf0f2
  AuType 0
Hello
  NetworkMask 255.255.255.0
  HelloInterval 10
  Options 0x2 (-|-|-|-|-|-|E|-)
  RtrPriority 1
  RtrDeadInterval 40
  DRouter 192.168.1.1
  BDRouter 192.168.1.2
  # Neighbors 1
    Neighbor 192.168.5.1
----------------------------------------------------------
RECV[Hello]: From 192.168.5.1 via GigabitEthernet 0/1:192.168.1.1 (192.168.1.2 -> 224.0.0.5), len = 48, cksum = 0xf0f2
----------------------------------------------------------
```

R2

```
26-RSR20-2#debug ip ospf
26-RSR20-2#*Jun  2 21:28:27: %7: RECV[Hello]: From 192.168.2.1 via Serial 2/0:192.168.2.2 (192.1
68.2.1 -> 224.0.0.5), len = 48, cksum = 0x7647
*Jun  2 21:28:27: %7: ----------------------------------------------------------
*Jun  2 21:28:27: %7: Header
*Jun  2 21:28:27: %7:   Version 2
*Jun  2 21:28:27: %7:   Type 1 (Hello)
*Jun  2 21:28:27: %7:   Packet Len 48
*Jun  2 21:28:27: %7:   Router ID 192.168.2.1
*Jun  2 21:28:27: %7:   Area ID 0.0.0.0
*Jun  2 21:28:27: %7:   Checksum 0x7647
*Jun  2 21:28:27: %7:   AuType 0
*Jun  2 21:28:27: %7: Hello
*Jun  2 21:28:27: %7:   NetworkMask 255.255.255.0
*Jun  2 21:28:27: %7:   HelloInterval 10
*Jun  2 21:28:27: %7:   Options 0x2 (-|-|-|-|-|-|E|-)
*Jun  2 21:28:27: %7:   RtrPriority 1
*Jun  2 21:28:27: %7:   RtrDeadInterval 40
*Jun  2 21:28:27: %7:   DRouter 0.0.0.0
*Jun  2 21:28:27: %7:   BDRouter 0.0.0.0
*Jun  2 21:28:27: %7:   # Neighbors 1
*Jun  2 21:28:27: %7:     Neighbor 192.168.3.1
*Jun  2 21:28:27: %7: ----------------------------------------------------------
*Jun  2 21:28:27: %7: NFSM[192.168.2.1-Serial 2/0]: Full (HelloReceived)
*Jun  2 21:28:27: %7: NFSM[192.168.2.1-Serial 2/0]: nfsm_ignore called
*Jun  2 21:28:27: %7: NFSM[192.168.2.1-Serial 2/0]: Full (2-WayReceived)
*Jun  2 21:28:35: %7: IFSM[GigabitEthernet 0/1:192.168.3.1]: Hello timer expire
*Jun  2 21:28:35: %7: SEND[Hello]: To 224.0.0.5 via GigabitEthernet 0/1:192.168.3.1, length 44
*Jun  2 21:28:35: %7: ----------------------------------------------------------
*Jun  2 21:28:35: %7: Header
*Jun  2 21:28:35: %7:   Version 2
*Jun  2 21:28:35: %7:   Type 1 (Hello)
*Jun  2 21:28:35: %7:   Packet Len 44
*Jun  2 21:28:35: %7:   Router ID 192.168.3.1
*Jun  2 21:28:35: %7:   Area ID 0.0.0.0
*Jun  2 21:28:35: %7:   Checksum 0x754b
*Jun  2 21:28:35: %7:   AuType 0
*Jun  2 21:28:35: %7: Hello
*Jun  2 21:28:35: %7:   NetworkMask 255.255.255.0
*Jun  2 21:28:35: %7:   HelloInterval 10
*Jun  2 21:28:35: %7:   Options 0x2 (-|-|-|-|-|-|E|-)
*Jun  2 21:28:35: %7:   RtrPriority 1
*Jun  2 21:28:35: %7:   RtrDeadInterval 40
*Jun  2 21:28:35: %7:   DRouter 192.168.3.1
*Jun  2 21:28:35: %7:   BDRouter 0.0.0.0
*Jun  2 21:28:35: %7:   # Neighbors 0
*Jun  2 21:28:35: %7: ----------------------------------------------------------
*Jun  2 21:28:36: %7: IFSM[Serial 2/0:192.168.2.2]: Hello timer expire
*Jun  2 21:28:36: %7: SEND[Hello]: To 224.0.0.5 via Serial 2/0:192.168.2.2, length 48
*Jun  2 21:28:36: %7: ----------------------------------------------------------
```

通过拔掉连接交换机和路由器之间的线来获取 update 情况，拔线之后有 224.0.0.5 的接收地址出现，有 LSA 类型的 header

```
: ----------------------------------------------------
: LSA[Refresh]: timer expired
: IFSM[GigabitEthernet 0/1.192.168.1.1]: Hello timer expire
: SEND[Hello]: To 224.0.0.5 via GigabitEthernet 0/1:192.168.1.1, length 48
: ----------------------------------------------------
: Header
:   Version 2
:   Type 1 (Hello)
:   Packet Len 48
:   Router ID 192.168.2.1
:   Area ID 0.0.0.0
:   Checksum 0xf0f2
:   AuType 0
: Hello
:   NetworkMask 255.255.255.0
:   HelloInterval 10
:   Options 0x2 (-|-|-|-|-|-|E|-)
:   RtrPriority 1
:   RtrDeadInterval 40
:   DRouter 192.168.1.1
:   BDRouter 192.168.1.2
:   # Neighbors 1
:     Neighbor 192.168.5.1
:
```

```
----------------------------------------------------------
Header
  Version 2
  Type 4 (Link State Update)
  Packet Len 60
  Router ID 192.168.2.1
  Area ID 0.0.0.0
  Checksum 0xe051
  AuType 0
Link State Update
  # LSAs 1
  LSA Header
    LS age 3600
    Options 0x2
    LS type 2 (network-LSA)
    Link State ID 192.168.1.1
    Advertising Router 192.168.2.1
    LS sequence number 0x80000002
    LS checksum 0xbee6
    length 32
  Network-LSA
    Network Mask 255.255.255.0
    # Attached Routers 2
      Attached Router 192.168.2.1
      Attached Router 192.168.5.1
----------------------------------------------------------
SEND[LS-Upd]: To 224.0.0.5 via Serial 2/0:192.168.2.1, length 76
----------------------------------------------------------
```

(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。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。

答;本次实验只使用了两台路由器进行数据转发，没有 DR 和 BDR。

【实验思考】

(1) 如何查看 OSPF 协议发布的网段?

利用 show ip protocols 命令可以查看当前路由器或者三层交换机所发布的网段

交换机

```
26-S5750-1(config)#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.5.1
  Memory Overflow is enabled
  Router is not in overflow state now
  Number of areas in this router is 1: 1 normal 0 stub 0 nssa
  Routing for Networks:
    192.168.1.0 0.0.0.255 area 0
    192.168.5.0 0.0.0.255 area 0
  Reference bandwidth unit is 100 mbps
  Distance: (default is 110)
```

```
26-S5750-1(config)#show ip ospf database

            OSPF Router with ID (192.168.5.1) (Process ID 1)

                Router Link States (Area 0.0.0.0)

Link ID         ADV Router      Age  Seq#       CkSum  Link count
192.168.2.1     192.168.2.1     269  0x8000000e 0x8c41 3
192.168.3.1     192.168.3.1     885  0x80000006 0xb786 3
192.168.5.1     192.168.5.1     274  0x8000000f 0xed20 2

                Network Link States (Area 0.0.0.0)

Link ID         ADV Router      Age  Seq#       CkSum
192.168.1.2     192.168.5.1     275  0x80000001 0x950d
```

R1

```
26-RSR20-1(config)#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.2.1
  Memory Overflow is enabled
  Router is not in overflow state now
  Number of areas in this router is 1: 1 normal 0 stub 0 nssa
  Routing for Networks:
    192.168.1.0 0.0.0.255 area 0
    192.168.2.0 0.0.0.255 area 0
  Reference bandwidth unit is 100 mbps
  Distance: (default is 110)
```

R2

```
26-RSR20-2(config)#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 192.168.3.1
  Memory Overflow is enabled
  Router is not in overflow state now
  Number of areas in this router is 1: 1 normal 0 stub 0 nssa
  Routing for Networks:
    192.168.2.0 0.0.0.255 area 0
    192.168.2.0 0.0.0.0 area 0
    192.168.3.0 0.0.0.255 area 0
  Reference bandwidth unit is 100 mbps
  Distance: (default is 110)
```

利用 show ip ospf database 命令，可以查看 OSPF 的 LSDB 信息，根据 Link ID 可以找到局域网内所有应用 OSPF 协议的网段：

R1

```
26-RSR20-1(config)#show ip ospf database

            OSPF Router with ID (192.168.2.1) (Process ID 1)

                Router Link States (Area 0.0.0.0)

Link ID         ADV Router      Age  Seq#       CkSum  Link count
192.168.2.1     192.168.2.1     298  0x8000000e 0x8c41 3
192.168.3.1     192.168.3.1     914  0x80000006 0xb786 3
192.168.5.1     192.168.5.1     305  0x8000000f 0xed20 2

                Network Link States (Area 0.0.0.0)

Link ID         ADV Router      Age  Seq#       CkSum
192.168.1.2     192.168.5.1     306  0x80000001 0x950d

26-RSR20-1(config)#
```

R2

```
26-RSR20-2(config)#show ip ospf database

            OSPF Router with ID (192.168.3.1) (Process ID 1)

                Router Link States (Area 0.0.0.0)

Link ID         ADV Router      Age  Seq#       CkSum  Link count
192.168.2.1     192.168.2.1     228  0x8000000e 0x8c41 3
192.168.3.1     192.168.3.1     843  0x80000006 0xb786 3
192.168.5.1     192.168.5.1     236  0x8000000f 0xed20 2

                Network Link States (Area 0.0.0.0)

Link ID         ADV Router      Age  Seq#       CkSum
192.168.1.2     192.168.5.1     237  0x80000001 0x950d
```

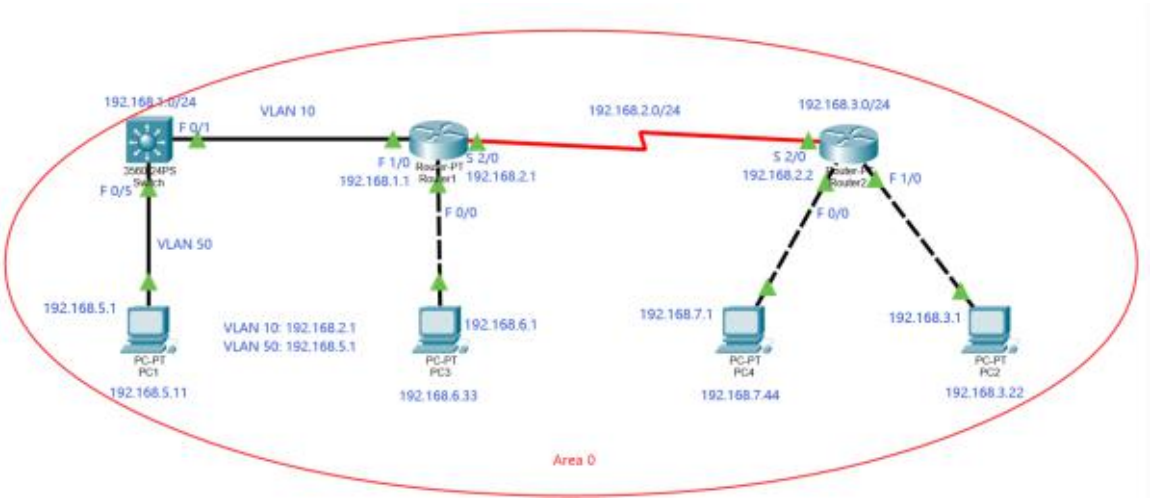
(2) 关于OSPF反掩码:反掩码可以简单地理解成掩码取反,而且不允许出现不连续的1和0,例如,可以是0.0.0. 1111111,但不可以是0.0.0. 11110011 ,也不可以是0.0.0.11111100,反掩码总是奇数或0,因为其最后一位总是1,除非全部为0.

答：反掩码可以用255.255.255.255减去子网掩码得到，子网掩码的每个子网只有下列几种可能，分别是0、128、192、224、240、248、252、254、255，所以最终得到的反掩码总是奇数或者0，并且不会出现不连续的1或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?

答：192.168.2.0/28说明32位的子网掩码的高28位都是1，即11111111.11111111.11111111.11110000，它的子网掩码换算成10进制是255.255.255.240，则255.255.255.255 - 255.255.255.240得出反掩码是0.0.0.15。所以，192.168.2.0/28的反掩码是0.0.0.15。

【内容二】在（1）的基础上每台路由器上各加入一台电脑，画出新拓扑，然后：



(a) 检查任意两个 PC 之间是否可以 Ping 通，对一台主机 ping 其它主机的结果进行截屏。设置新增的两台主机：

pc3

```
以太网适配器 校园网:

   连接特定的 DNS 后缀 . . . . . . . :
   IPv6 地址 . . . . . . . . . . . . : 2001:250:3002:4b98:e4e5:72aa:6aeb:bca1
   临时 IPv6 地址. . . . . . . . . . : 2001:250:3002:4b98:448a:5652:b800:4c86
   本地链接 IPv6 地址. . . . . . . . : fe80::e4e5:72aa:6aeb:bca1%3
   IPv4 地址 . . . . . . . . . . . . : 172.16.26.2
   子网掩码 . . . . . . . . . . . . : 255.255.0.0
   默认网关. . . . . . . . . . . . . : fe80::5ee8:83ff:fec4:ece4%3
                                       172.16.0.1

以太网适配器 实验网:

   连接特定的 DNS 后缀 . . . . . . . :
   本地链接 IPv6 地址. . . . . . . . : fe80::d1c9:af9:3440:674f%5
   IPv4 地址 . . . . . . . . . . . . : 192.168.6.33
   子网掩码 . . . . . . . . . . . . : 255.255.255.0
   默认网关. . . . . . . . . . . . . : 192.168.6.1
```

PC4

```
以太网适配器 以太网:

   连接特定的 DNS 后缀 . . . . . . . :
   本地链接 IPv6 地址. . . . . . . . : fe80::61b5:bbc6:3442:425e%7
   IPv4 地址 . . . . . . . . . . . . : 192.168.7.44
   子网掩码 . . . . . . . . . . . . : 255.255.255.0
   默认网关. . . . . . . . . . . . . : 192.168.7.1
```

在路由器 R1 上配置

```
26-RSR20-1(config)#interface gigabitethernet 0/0
26-RSR20-1(config-if-GigabitEthernet 0/0)#$2.168.6.1 255.255.255.0
26-RSR20-1(config-if-GigabitEthernet 0/0)#no shutdown
26-RSR20-1(config-if-GigabitEthernet 0/0)#
```

```
26-RSR20-1(config)#router ospf 1
26-RSR20-1(config-router)#network 192.168.6.0 0.0.0.255 area 0
26-RSR20-1(config-router)#end
26-RSR20-1#*May 31 17:44:38: %SYS-5-CONFIG_I: Configured from console by console
```

```
26-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
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, 01:15:58, Serial 2/0
O    192.168.5.0/24 [110/2] via 192.168.1.2, 00:00:43, GigabitEthernet 0/1
C    192.168.6.0/24 is directly connected, GigabitEthernet 0/0
C    192.168.6.1/32 is local host.
O    192.168.7.0/24 [110/51] via 192.168.2.2, 00:01:20, Serial 2/0
26-RSR20-1(config)#
```

在路由器 R2 上进行配置

```
26-RSR20-2(config)#interface gigabitethernet 0/0
26-RSR20-2(config-if-GigabitEthernet 0/0)#$2.168.7.1 255.255.255.0
26-RSR20-2(config-if-GigabitEthernet 0/0)#no shutdown
26-RSR20-2(config-if-GigabitEthernet 0/0)#
```

```
26-RSR20-2(config)#router ospf 1
26-RSR20-2(config-router)#network *Jun  2 22:16:00: %LINK-3-UPDOWN: Interfac
gabitEthernet 0/0, changed state to down.
*Jun  2 22:16:00: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEth
t 0/0, changed state to down.
19
26-RSR20-2(config-network-region)#
26-RSR20-2(config-network-region)#exit
26-RSR20-2(config)#router ospf 1
26-RSR20-2(config-router)#network 192.168.7.0 0.0.0.255 area 0
26-RSR20-2(config-router)#end
```

```
26-RSR20-2(config)#
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
O    192.168.1.0/24 [110/51] via 192.168.2.1, 00:01:41, 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, 00:00:53, Serial 2/0
O    192.168.6.0/24 [110/51] via 192.168.2.1, 00:11:10, Serial 2/0
C    192.168.7.0/24 is directly connected, GigabitEthernet 0/0
C    192.168.7.1/32 is local host.
26-RSR20-2(config)#
```

最后交换机上有 4 条 O 目录产生

```
26-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, 00:00:55, VLAN 10
O    192.168.3.0/24 [110/52] via 192.168.1.1, 00:00:55, VLAN 10
C    192.168.5.0/24 is directly connected, VLAN 50
C    192.168.5.1/32 is local host.
O    192.168.6.0/24 [110/2] via 192.168.1.1, 00:00:55, VLAN 10
O    192.168.7.0/24 [110/52] via 192.168.1.1, 00:00:55, VLAN 10
26-S5750-1#
```

这时 PC2 去 ping 其他主机都可以连通得到

```
C:\windows\system32>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=38ms TTL=61
来自 192.168.5.11 的回复: 字节=32 时间=38ms TTL=61
来自 192.168.5.11 的回复: 字节=32 时间=37ms TTL=61
来自 192.168.5.11 的回复: 字节=32 时间=37ms TTL=61

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 = 37ms, 最长 = 38ms, 平均 = 37ms

C:\windows\system32>ping 192.168.7.44

正在 Ping 192.168.7.44 具有 32 字节的数据:
来自 192.168.7.44 的回复: 字节=32 时间<1ms TTL=63
来自 192.168.7.44 的回复: 字节=32 时间<1ms TTL=63
来自 192.168.7.44 的回复: 字节=32 时间<1ms TTL=63
来自 192.168.7.44 的回复: 字节=32 时间<1ms TTL=63

192.168.7.44 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 = 0ms, 最长 = 0ms, 平均 = 0ms

C:\windows\system32>ping 192.168.6.33

正在 Ping 192.168.6.33 具有 32 字节的数据:
来自 192.168.6.33 的回复: 字节=32 时间=910ms TTL=62
来自 192.168.6.33 的回复: 字节=32 时间=37ms TTL=62
来自 192.168.6.33 的回复: 字节=32 时间=37ms TTL=62
来自 192.168.6.33 的回复: 字节=32 时间=40ms TTL=62

192.168.6.33 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 = 37ms, 最长 = 910ms, 平均 = 256ms
```

(b) 采用#depug ip ospf 显示上面 OSPF 协议的运行情况，观察并保存 R1 发送和接收的 Update 分组(可以改变链路状态来触发)，注意其中 LSA 类型；观察有无 224.0.0.5、224.0.0.6 IP 地址，如有说明这两地址的作用。

一开始的 debug 信息

```
------------------------------------------------------
Header
  Version 2
  Type 1 (Hello)
  Packet Len 48
  Router ID 192.168.2.1
  Area ID 0.0.0.0
  Checksum 0xf0f2
  AuType 0
Hello
  NetworkMask 255.255.255.0
  HelloInterval 10
  Options 0x2 (-|-|-|-|-|-|E|-)
  RtrPriority 1
  RtrDeadInterval 40
  DRouter 192.168.1.2
  BDRouter 192.168.1.1
  # Neighbors 1
    Neighbor 192.168.5.1
------------------------------------------------------
IFSM[GigabitEthernet 0/0:192.168.6.1]: Hello timer expire
SEND[Hello]: To 224.0.0.5 via GigabitEthernet 0/0:192.168.6.1, length 44
------------------------------------------------------
```

```
------------------------------------------------
Header
  Version 2
  Type 1 (Hello)
  Packet Len 48
  Router ID 192.168.5.1
  Area ID 0.0.0.0
  Checksum 0xf0f2
  AuType 0
Hello
  NetworkMask 255.255.255.0
  HelloInterval 10
  Options 0x2 (-|-|-|-|-|-|E|-)
  RtrPriority 1
  RtrDeadInterval 40
  DRouter 192.168.1.2
  BDRouter 192.168.1.1
  # Neighbors 1
    Neighbor 192.168.2.1
------------------------------------------------
NFSM[192.168.5.1-GigabitEthernet 0/1]: Full (HelloReceived)
NFSM[192.168.5.1-GigabitEthernet 0/1]: nfsm_ignore called
NFSM[192.168.5.1-GigabitEthernet 0/1]: Full (2-WayReceived)
RECV[Hello]: From 192.168.3.1 via Serial 2/0:192.168.2.1 (192.168.2.2 -> 224.0.0.5), len = 48, cksum = 0x7647
```

```
Header
  Version 2
  Type 1 (Hello)
  Packet Len 48
  Router ID 192.168.3.1
  Area ID 0.0.0.0
  Checksum 0x7647
  AuType 0
Hello
  NetworkMask 255.255.255.0
  HelloInterval 10
  Options 0x2 (-|-|-|-|-|-|E|-)
  RtrPriority 1
  RtrDeadInterval 40
  DRouter 0.0.0.0
  BDRouter 0.0.0.0
  # Neighbors 1
    Neighbor 192.168.2.1
------------------------------------------------------
NFSM[192.168.3.1-Serial 2/0]: Full (HelloReceived)
NFSM[192.168.3.1-Serial 2/0]: nfsm_ignore called
NFSM[192.168.3.1-Serial 2/0]: Full (2-WayReceived)
IFSM[GigabitEthernet 0/1:192.168.1.1]: Hello timer expire
SEND[Hello]: To 224.0.0.5 via GigabitEthernet 0/1:192.168.1.1, length 48
------------------------------------------------------
```

拔线之后，有 LSA 类型出现，以及 224.0.0.5 地址出现

```
IFSM[Serial 2/0:192.168.2.1]: Hello timer expire
SEND[Hello]: To 224.0.0.5 via Serial 2/0:192.168.2.1, length 48
------------------------------------------------------
Header
  Version 2
  Type 1 (Hello)
  Packet Len 48
  Router ID 192.168.2.1
  Area ID 0.0.0.0
  Checksum 0x7647
  AuType 0
Hello
  NetworkMask 255.255.255.0
  HelloInterval 10
  Options 0x2 (-|-|-|-|-|-|E|-)
  RtrPriority 1
  RtrDeadInterval 40
  DRouter 0.0.0.0
  BDRouter 0.0.0.0
  # Neighbors 1
    Neighbor 192.168.3.1
------------------------------------------------------
LSA[MaxAge]: Maxage walker finished (0.000000 sec)
RECV[Hello]: From 192.168.3.1 via Serial 2/0:192.168.2.1 (192.168.2.2 -> 224.0.0.5), len = 48, cksum = 0x7647
------------------------------------------------------
```

(c) 显示并记录路由器 R1 数据库的 Router LSA，Network LSA，LS 数据库信息汇总

 # show ip ospf database router ！ 显示 router LSA

```
26-RSR20-1(config)#show ip ospf database router

            OSPF Router with ID (192.168.2.1) (Process ID 1)

                Router Link States (Area 0.0.0.0)

  LS age: 187
  Options: 0x2 (-|-|-|-|-|-|E|-)
  Flags: 0x0
  LS Type: router-LSA
  Link State ID: 192.168.2.1
  Advertising Router: 192.168.2.1
  LS Seq Number: 80000014
  Checksum: 0xda6c
  Length: 72
   Number of Links: 4

    Link connected to: a Transit Network
     (Link ID) Designated Router address: 192.168.1.2
     (Link Data) Router Interface address: 192.168.1.1
      Number of TOS metrics: 0
       TOS 0 Metric: 1

    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 192.168.3.1
     (Link Data) Router Interface address: 192.168.2.1
      Number of TOS metrics: 0
       TOS 0 Metric: 50

    Link connected to: Stub Network
     (Link ID) Network/subnet number: 192.168.2.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metric: 50

    Link connected to: Stub Network
     (Link ID) Network/subnet number: 192.168.6.0
     (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
       TOS 0 Metric: 1
```

```
LS age: 174
Options: 0x2 (-|-|-|-|-|-|E|-)
Flags: 0x0
LS Type: router-LSA
Link State ID: 192.168.3.1
Advertising Router: 192.168.3.1
LS Seq Number: 8000000c
Checksum: 0x3383
Length: 72
 Number of Links: 4

  Link connected to: another Router (point-to-point)
   (Link ID) Neighboring Router ID: 192.168.2.1
   (Link Data) Router Interface address: 192.168.2.2
    Number of TOS metrics: 0
     TOS 0 Metric: 50

  Link connected to: Stub Network
   (Link ID) Network/subnet number: 192.168.2.0
   (Link Data) Network Mask: 255.255.255.0
    Number of TOS metrics: 0
     TOS 0 Metric: 50

  Link connected to: Stub Network
   (Link ID) Network/subnet number: 192.168.3.0
   (Link Data) Network Mask: 255.255.255.0
    Number of TOS metrics: 0
     TOS 0 Metric: 1

  Link connected to: Stub Network
   (Link ID) Network/subnet number: 192.168.7.0
   (Link Data) Network Mask: 255.255.255.0
    Number of TOS metrics: 0
     TOS 0 Metric: 1
```

```
LS age: 189
Options: 0x2 (-|-|-|-|-|-|E|-)
Flags: 0x0
LS Type: router-LSA
Link State ID: 192.168.5.1
Advertising Router: 192.168.5.1
LS Seq Number: 80000014
Checksum: 0xe325
Length: 48
 Number of Links: 2

  Link connected to: Stub Network
   (Link ID) Network/subnet number: 192.168.5.0
   (Link Data) Network Mask: 255.255.255.0
    Number of TOS metrics: 0
     TOS 0 Metric: 1

  Link connected to: a Transit Network
   (Link ID) Designated Router address: 192.168.1.2
   (Link Data) Router Interface address: 192.168.1.2
    Number of TOS metrics: 0
     TOS 0 Metric: 1
```

 # show ip ospf database network ！显示 network LSA

```
26-RSR20-1(config)#show ip ospf database network

            OSPF Router with ID (192.168.2.1) (Process ID 1)

                Network Link States (Area 0.0.0.0)

  LS age: 289
  Options: 0x2 (-|-|-|-|-|-|E|-)
  LS Type: network-LSA
  Link State ID: 192.168.1.2 (address of Designated Router)
  Advertising Router: 192.168.5.1
  LS Seq Number: 80000003
  Checksum: 0x910f
  Length: 32
  Network Mask: /24
        Attached Router: 192.168.5.1
        Attached Router: 192.168.2.1
```

 # show ip ospf database database　　！显示 OSPF 链路状态数据库信息。

```
26-RSR20-1(config)#show ip ospf database database

OSPF process 1:

Area 0.0.0.0 database summary:
Router Link States        : 3
Network Link States       : 1
Summary Link States       : 0
ASBR-Summary Link States  : 0
NSSA-external Link States: 0
Link-Local Opaque-LSA     : 0
Area-Local Opaque-LSA     : 0
Total LSA                 : 4

Process 1 database summary:
Router Link States        : 3
Network Link States       : 1
Summary Link States       : 0
ASBR-Summary Link States  : 0
AS External Link States   : 0
NSSA-external Link States: 0
Link-Local Opaque-LSA     : 0
Area-Local Opaque-LSA     : 0
AS-Global Opaque-LSA      : 0
Total LSA                 : 4
```

(d)　显示并记录邻居状态

 # show ip ospf neighbor

交换机：

```
26-S5750-1#show ip ospf neighbor

OSPF process 1, 1 Neighbors, 1 is Full:
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.2.1       1   Full/BDR        00:00:39    192.168.1.1     VLAN 10
```

R1

```
26-RSR20-1(config)#show ip ospf neighbor

OSPF process 1, 2 Neighbors, 2 is Full:
Neighbor ID     Pri   State           BFD State  Dead Time   Address         Interface
192.168.5.1       1   Full/DR         -          00:00:37    192.168.1.2     GigabitEthernet 0/1
192.168.3.1       1   Full/ -         -          00:00:37    192.168.2.2     Serial 2/0
```

R2

```
26-RSR20-2(config)#
26-RSR20-2(config)#show ip ospf neighbor

OSPF process 1, 1 Neighbors, 1 is Full:
Neighbor ID     Pri   State           BFD State  Dead Time   Address
  Interface
192.168.2.1       1   Full/ -         -          00:00:38    192.168.2.1
  Serial 2/0


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

(e) 显示并记录 R1 的所有接口信息

#show ip ospf interface [接口名]

```
GigabitEthernet 0/1 is up, line protocol is up
  Internet Address 192.168.1.1/24, Ifindex 4, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.1.0/24
  Process ID 1, Router ID 192.168.2.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.5.1, Interface Address 192.168.1.2
  Backup Designated Router (ID) 192.168.2.1, Interface Address 192.168.1.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:08
  Neighbor Count is 1, Adjacent neighbor count is 1
  Crypt Sequence Number is 0
  Hello received 439 sent 450, DD received 11 sent 12
  LS-Req received 3 sent 3, LS-Upd received 14 sent 20
  LS-Ack received 17 sent 12, Discarded 0
```

```
GigabitEthernet 0/0 is up, line protocol is up
  Internet Address 192.168.6.1/24, Ifindex 5, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.6.0/24
  Process ID 1, Router ID 192.168.2.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.2.1, Interface Address 192.168.6.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:08
  Neighbor Count is 0, Adjacent neighbor count is 0
  Crypt Sequence Number is 0
  Hello received 0 sent 104, DD received 0 sent 0
  LS-Req received 0 sent 0, LS-Upd received 0 sent 0
  LS-Ack received 0 sent 0, Discarded 0
```

```
Serial 2/0 is up, line protocol is up
  Internet Address 192.168.2.1/24, Ifindex 37, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.2.0/24
  Process ID 1, Router ID 192.168.2.1, Network Type POINTOPOINT, Cost: 50
  Transmit Delay is 1 sec, State Point-To-Point
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:09
  Neighbor Count is 1, Adjacent neighbor count is 1
  Crypt Sequence Number is 0
  Hello received 494 sent 495, DD received 3 sent 4
  LS-Req received 1 sent 1, LS-Upd received 11 sent 35
  LS-Ack received 31 sent 10, Discarded 0
```

【实验心得】

这次实验了解了 ospf 协议， OSPF 路由协议是一种典型的链路状态（Link-state）的路由协议，一般用于同一个路由域内。在这里，路由域是指一个自治系统（Autonomous System），即 AS，它是指一组通过统一的路由政策或路由协议互相交换路由信息的网 络。在这个 AS 中，所有的 OSPF 路由器都维护一个相同的描述这个 AS 结构的数据库， 该数据库中存放的是路由域中相应链路的状态信息，OSPF 路由器正是通过这个数据库计算出 OSPF 路由表的。

同时也了解了关于 224.0.0.5 和 224.0.0.6 这两个 ip 地址的不同。224.0.0.6 指代一个多路访问网络中 DR 和 BDR 的组播接收地址， 224.0.0.5 指代在任意网络中所有运行 OSPF 进程的接口都

属于该组，于是接收所有 224.0.0.5 的组播数据包。

【自评】

学号	学生	自评分
19335112	李钰	99
19335134	林雁纯	99
19335156	毛羽翎	99