# 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。**

| | | | | | |
|---|---|---|---|---|---|
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| 余世龍 | 按照实验步骤进行操作，记录实验数据，对实验数据进行分析，并且完成实验报告 | | | | |

**4.实验报告文件以 PDF 格式提交。**

【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

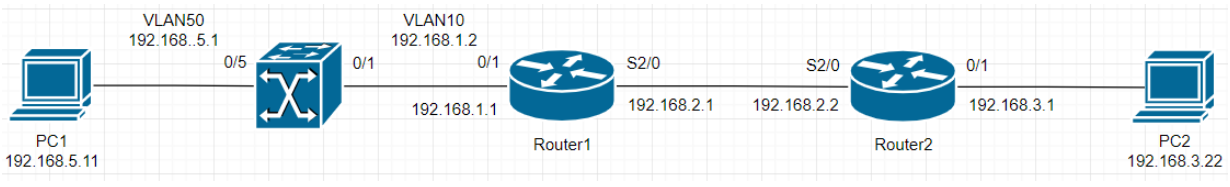
#show ip ospf interface [接口名]

【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)

1.拓扑图




步骤一：

1）按照拓扑图配置 PC1、PC2 的 IP 地址、子网掩码、网关、并测试他们的连通性

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

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

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

2）在路由器 R1、R2 执行命令，记录路由表信息

```
21-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
21-RSR20-1#
```

```
21-RSR20-2(config)#show ip route

Codes:  C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
```

步骤二：配置交换机配置 VLAN10 和 VLAN50 的 IP 地址

```
28-s5750-1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
28-s5750-1(config)#vlan 10
28-s5750-1(config-vlan)#exit
28-s5750-1(config)#vlan 50
28-s5750-1(config-vlan)#exit
28-s5750-1(config)#interface gigabitethernet 0/1
28-s5750-1(config-if-GigabitEthernet 0/1)#switchport access vlan 10
28-s5750-1(config-if-GigabitEthernet 0/1)#exit
28-s5750-1(config)#interface gigabithernet 0/5
                                ^
% Invalid input detected at '^' marker.

28-s5750-1(config)#interface gigabitethernet 0/5
28-s5750-1(config-if-GigabitEthernet 0/5)#switchport access vlan 50
28-s5750-1(config-if-GigabitEthernet 0/5)#exit
28-s5750-1(config)#interface vlan 10
28-s5750-1(config-if-VLAN 10)#*Jun 18 08:38:56: %LINEPROTO-5-UPDOWN: Line protocol on Interface VLAN 10, ch
anged state to up.

28-s5750-1(config-if-VLAN 10)#ip address 192.168.1.2 255.255.255.0
28-s5750-1(config-if-VLAN 10)#no shutdown
28-s5750-1(config-if-VLAN 10)#exit
28-s5750-1(config)#interface vlan 50
28-s5750-1(config-if-VLAN 50)#*Jun 18 08:39:39: %LINEPROTO-5-UPDOWN: Line protocol on Interface VLAN 50, ch
anged state to up.

28-s5750-1(config-if-VLAN 50)#ip address 192.168.5.1 255.255.255.0
28-s5750-1(config-if-VLAN 50)#no shutdown
28-s5750-1(config-if-VLAN 50)#exit
28-s5750-1(config)#
```

步骤三：路由器 R1 配置端口 IP

```
21-RSR20-1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
21-RSR20-1(config)#interface gigabitethernet 0/1
21-RSR20-1(config-if-GigabitEthernet 0/1)#$2.168.1.1 255.255.255.0
21-RSR20-1(config-if-GigabitEthernet 0/1)#no shutdown
21-RSR20-1(config-if-GigabitEthernet 0/1)#exit
21-RSR20-1(config)#interface serial 2/0
21-RSR20-1(config-if-Serial 2/0)#ip address 192.168.2.1 255.255.255.0
21-RSR20-1(config-if-Serial 2/0)#no shutdown
21-RSR20-1(config-if-Serial 2/0)#
```

步骤四：路由器 R2 配置端口 IP

```
21-RSR20-2(config)#interface gigabitethernet 0/1
21-RSR20-2(config-if-GigabitEthernet 0/1)#$2.168.3.1 255.255.255.0
21-RSR20-2(config-if-GigabitEthernet 0/1)#no shutdown
21-RSR20-2(config-if-GigabitEthernet 0/1)#exit
21-RSR20-2(config)#interface serial 2/0
21-RSR20-2(config-if-Serial 2/0)#ip address 192.168.2.2 255.255.255.0
21-RSR20-2(config-if-Serial 2/0)#no shutdown
21-RSR20-2(config-if-Serial 2/0)#
```

步骤五：交换机配置 OSPF

```
28-s5750-1(config)#router ospf 1
28-s5750-1(config-router)#network 192.168.5.0 0.0.0.255 area 0
28-s5750-1(config-router)#network 192.168.1.0 0.0.0.255 area 0
28-s5750-1(config-router)#end
```

步骤六：路由器 R1 配置 OSPF

```
21-RSR20-1(config)#router ospf 1
21-RSR20-1(config-router)#network 192.168.1.0 0.0.0.255 area 0
21-RSR20-1(config-router)#*Jun  5 10:01:30: %OSPF-5-ADJCHG: Proc
from Down to Init, HelloReceived.
*Jun  5 10:01:31: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.5.1-Gig
ingDone.

21-RSR20-1(config-router)#network 192.168.2.0 0.0.0.255 area 0
21-RSR20-1(config-router)#end
```

步骤七：路由器 R2 配置 OSPF

```
21-RSR20-2(config)#router ospf 1
21-RSR20-2(config-router)#network 192.168.2.0 0.0.0.255 area 0
21-RSR20-2(config-router)#network 192.168.3.0*Jun 18 07:38:58: %OS
erial 2/0 from Down to Init, HelloReceived.
 *Jun 18 07:39:00: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.2.1-Seri
% Incomplete command.

21-RSR20-2(config-router)#network 192.168.3.0 0.0.0.255 area 0
21-RSR20-2(config-router)#end
```

步骤八：查看验证三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

S5750：交换机通过 OSPF 协议学习到了下一跳地址为 R1 的 192.168,1.1 端口,到达 192.168.2.0/24 和 192.168.3.0/24 网段的转发路由,出站接口为与 VLAN10 虚接口。

```
28-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, 00:00:56, VLAN 10
O    192.168.3.0/24 [110/52] via 192.168.1.1, 00:00:26, VLAN 10
C    192.168.5.0/24 is directly connected, VLAN 50
C    192.168.5.1/32 is local host.
28-s5750-1#
```

R1：R1 通过 OSPF 协议学习到了下一跳地址为 192.168.2.2 端口,到达 192.168.3.0/24 网段,出站接口为 Serial 2/0 的转发路由;以及下一跳地址为 192.168.1.2 虚端口,到达 192.168.5.0/24 网段,出站接口为 GigabitEthernet 0/1 的转发路由。

```
21-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, 00:00:57, Serial 2/0
O    192.168.5.0/24 [110/2] via 192.168.1.2, 00:01:36, GigabitEthernet 0/1
21-RSR20-1#
```

R2：R2 通过 OSPF 协议学习到了下一跳地址为 192.168.2.1 端口,出站接口为 Seria1 2/0,分别到达 192.16.1.0/24 网段和 192.168.5.0/24 网段的转发路由。

```
21-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, 00:00:54, 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, 00:00:54, Serial 2/0
```

步骤九：测试网络的连通性

1）将此时的路由表与步骤 0 进行比较

此时路由表中出现了“C”条目,这些条目显示了网络设备直连的网段,以及网段与设备连接的端口地址;接下来各设备路由表中出现了 O 条目,这是因为每个设备都通过 OSPF 协议互相发送招手报文,并交换网络信息,通过学习设备之间建立起了基于 OSPF 协议原理的路由转发路径,并以 O 标签出现在路由表中。

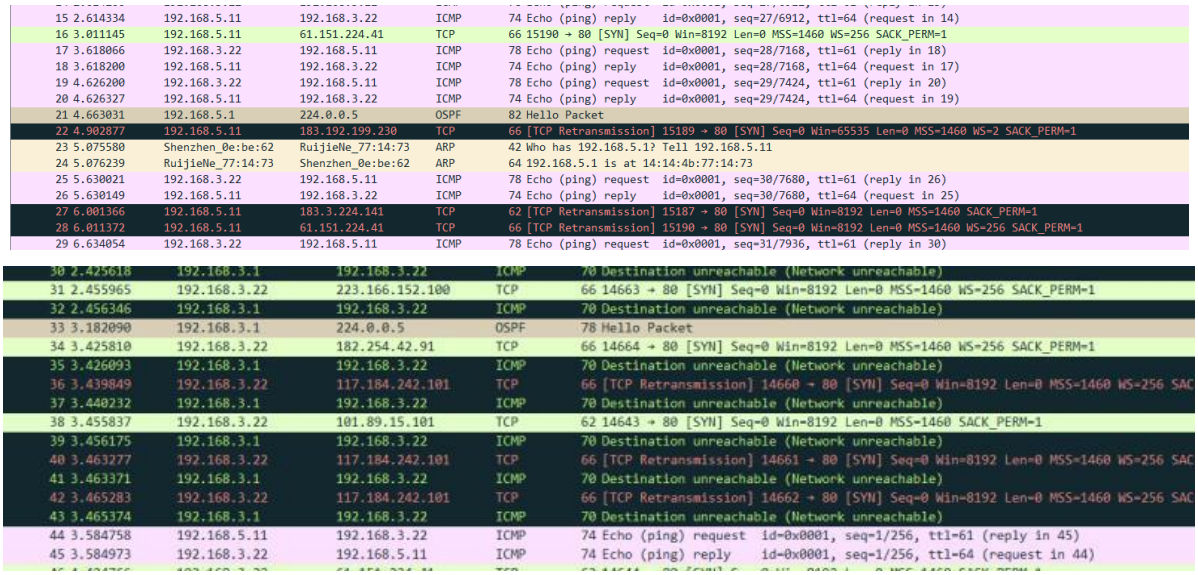
2）分析 traceroutePC1 的结果

```
C:\Users\Administrator>tracert 192.168.5.11

通过最多 30 个跃点跟踪到 192.168.5.11 的路由

  1    <1 毫秒   <1 毫秒   <1 毫秒 192.168.3.1
  2    43 ms    41 ms    42 ms  192.168.2.1
  3    52 ms    49 ms    50 ms  192.168.1.2
  4    46 ms    46 ms    47 ms  192.168.5.11

跟踪完成。
```

PC2 192.168.3.22 先通过路由器 R2 的 0/1 端口 192.168.3.1，然后到 R1 的 S2/0 端口 192.168.2.1，再到 R1 的 0/1 端口 192.168.1.1，最后到达 PC1 192.168.5.11

3）捕获数据包，分析 OSPF 头部结构，OSPF 包在 PC1 和 PC2 上可以捕获到吗？

可以在 PC1 和 PC2 上捕获到 OSPF 包



```
Destination Address: 224.0.0.5
Open Shortest Path First
  OSPF Header
    Version: 2
    Message Type: Hello Packet (1)
    Packet Length: 44
    Source OSPF Router: 192.168.5.1
    Area ID: 0.0.0.0 (Backbone)
    Checksum: 0x714b [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
      0... .... = DN: Not set
      .0.. .... = O: Not set
      ..0. .... = (DC) Demand Circuits: Not supported
      ...0 .... = (L) LLS Data block: Not Present
      .... 0... = (N) NSSA: Not supported
      .... .0.. = (MC) Multicast: Not capable
      .... ..1. = (E) External Routing: Capable
      .... ...0 = (MT) Multi-Topology Routing: No
    Router Priority: 1
    Router Dead Interval [sec]: 40
    Designated Router: 192.168.5.1
    Backup Designated Router: 0.0.0.0
```

```
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
      0... .... = DN: Not set
      .0.. .... = O: Not set
      ..0. .... = (DC) Demand Circuits: Not supported
      ...0 .... = (L) LLS Data block: Not Present
      .... 0... = (N) NSSA: Not supported
      .... .0.. = (MC) Multicast: Not capable
      .... ..1. = (E) External Routing: Capable
      .... ...0 = (MT) Multi-Topology Routing: No
    Router Priority: 1
    Router Dead Interval [sec]: 40
    Designated Router: 192.168.3.1
    Backup Designated Router: 0.0.0.0
```

4)出现了 LSA 类型。有 224.0.0.5 而没有 224.0.0.6。这两个地址是组播地址,对所有 DR/BDR 路由器的组播地址为 240.0.0.6,对所有的非 DR/BDR 路由器的组播地址为 224.0.0.5。

```
*Jun  5 10:12:39: %7:     Neighbor 192.168.2.1
*Jun  5 10:12:39: %7: ------------------------------------------------------
*Jun  5 10:12:39: %7: NFSM[192.168.5.1-GigabitEthernet 0/1]: Full (HelloReceived)
*Jun  5 10:12:39: %7: NFSM[192.168.5.1-GigabitEthernet 0/1]: nfsm_ignore called
*Jun  5 10:12:39: %7: NFSM[192.168.5.1-GigabitEthernet 0/1]: Full (2-WayReceived)
*Jun  5 10:12:42: %7: IFSM[GigabitEthernet 0/1:192.168.1.1]: Hello timer expire
*Jun  5 10:12:42: %7: SEND[Hello]: To 224.0.0.5 via GigabitEthernet 0/1:192.168.1.1, length 48
*Jun  5 10:12:42: %7: ------------------------------------------------------
*Jun  5 10:12:42: %7: Header
*Jun  5 10:12:42: %7:   Version 2
*Jun  5 10:12:42: %7:   Type 1 (Hello)
*Jun  5 10:12:42: %7:   Packet Len 48
*Jun  5 10:12:42: %7:   Router ID 192.168.2.1
*Jun  5 10:12:42: %7:   Area ID 0.0.0.0
*Jun  5 10:12:42: %7:   Checksum 0xf0f2
*Jun  5 10:12:42: %7:   AuType 0
*Jun  5 10:12:42: %7: Hello
*Jun  5 10:12:42: %7:   NetworkMask 255.255.255.0
*Jun  5 10:12:42: %7:   HelloInterval 10
*Jun  5 10:12:42: %7:   Options 0x2 (-|-|-|-|-|-|E|-)
*Jun  5 10:12:42: %7:   RtrPriority 1
*Jun  5 10:12:42: %7:   RtrDeadInterval 40
*Jun  5 10:12:42: %7:   DRouter 192.168.1.2
*Jun  5 10:12:42: %7:   BDRouter 192.168.1.1
*Jun  5 10:12:42: %7:   # Neighbors 1
*Jun  5 10:12:42: %7:     Neighbor 192.168.5.1
*Jun  5 10:12:42: %7: ------------------------------------------------------
*Jun  5 10:12:42: %7: IFSM[Serial 2/0:192.168.2.1]: Hello timer expire
*Jun  5 10:12:42: %7: SEND[Hello]: To 224.0.0.5 via Serial 2/0:192.168.2.1, length 48
*Jun  5 10:12:42: %7: ------------------------------------------------------
*Jun  5 10:12:42: %7: Header
*Jun  5 10:12:42: %7:   Version 2
*Jun  5 10:12:42: %7:   Type 1 (Hello)
*Jun  5 10:12:42: %7:   Packet Len 48
*Jun  5 10:12:42: %7:   Router ID 192.168.2.1
*Jun  5 10:12:42: %7:   Area ID 0.0.0.0
*Jun  5 10:12:42: %7:   Checksum 0x7647
*Jun  5 10:12:42: %7:   AuType 0
*Jun  5 10:12:42: %7: Hello
*Jun  5 10:12:42: %7:   NetworkMask 255.255.255.0
*Jun  5 10:12:42: %7:   HelloInterval 10
*Jun  5 10:12:42: %7:   Options 0x2 (-|-|-|-|-|-|E|-)
*Jun  5 10:12:42: %7:   RtrPriority 1
*Jun  5 10:12:42: %7:   RtrDeadInterval 40
*Jun  5 10:12:42: %7:   DRouter 0.0.0.0
*Jun  5 10:12:42: %7:   BDRouter 0.0.0.0
*Jun  5 10:12:42: %7:   # Neighbors 1
*Jun  5 10:12:42: %7:     Neighbor 192.168.3.1
*Jun  5 10:1[截图] %7: ------------------------------------------------------
*Jun  5 10:12:43: %7: LSA[Refresh]: timer expired
*Jun  5 10:12:44: %7: 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
*Jun  5 10:12:44: %7: ------------------------------------------------------
*Jun  5 10:12:44: %7: Header
*Jun  5 10:12:44: %7:   Version 2
*Jun  5 10:12:44: %7:   Type 1 (Hello)
*Jun  5 10:12:44: %7:   Packet Len 48
*Jun  5 10:12:44: %7:   Router ID 192.168.3.1
*Jun  5 10:12:44: %7:   Area ID 0.0.0.0
```

5）本实验有 DR/BDR，DR 是 ROUTER1，BDR 是 TOUTER2。

进行 DR/BDR 选举时每台路由器将自己选出的 DR 写入 Hello 报文中，发给网段上的每

台运行 OSPF 协议的路由器。当处于同一网段的两台路由器同时宣布自己是 DR 时，路由器优先级高者胜出。如果优先级相等，则 Router ID 大者胜出。如果一台路由器的优先级为 0，则它不会被选举为 DR 或 BDR。

【实验思考】

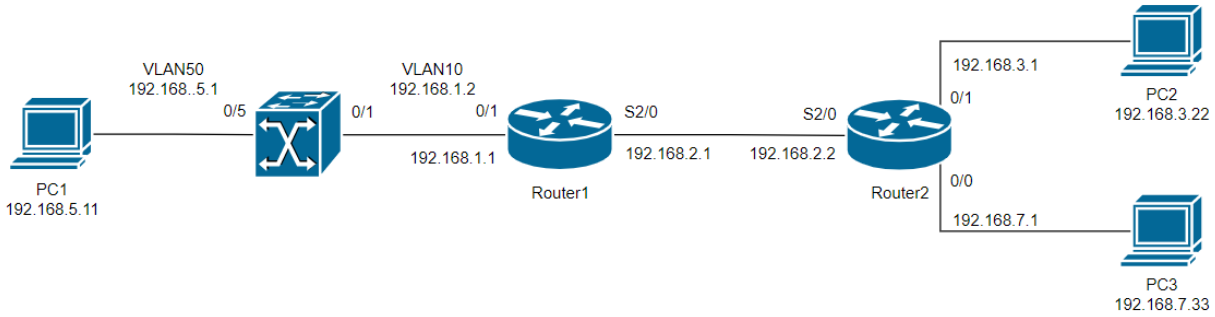
(1)如何查看 OSPF 协议发布的网段？ show ip route ospf

(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 0.0.0.1111 可以是 0.0.0.111001,也不可以是 0.0.0.1111100 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)192.168.2.0/28 的子网掩码是 255.255.255.240，192.168.2.0/28 的反掩码是 0.0.0.15

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

拓扑图：在路由器 R2 0/0 端口增加一台电脑 PC3，IP 地址为 192.168.7.33




配置：在交换机 R2 上给端口 0/0 配置端口 IP，ospf 添加新的网段 192.168.7.0

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

```
21-RSR20-2(config)#router ospf 1
21-RSR20-2(config-router)#network 192.168.7.0 0.0.0.255 area 0
21-RSR20-2(config-router)#end
```

查看路由表：可以看到生成了 192.168.7.0 的 O 条目

```
21-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, 00:06:27, Serial 2/0
O    192.168.5.0/24 [110/2] via 192.168.1.2, 00:03:47, GigabitEthernet 0/1
O    192.168.7.0/24 [110/51] via 192.168.2.2, 00:09:55, Serial 2/0
```

```
21-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, 00:07:58, 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, 00:07:01, Serial 2/0
C    192.168.7.0/24 is directly connected, GigabitEthernet 0/0
C    192.168.7.1/32 is local host.
21-RSR20-2#Connection closed by foreign host.
```

(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。

```
C:\Users\Administrator>ping 192.168.7.33

正在 Ping 192.168.7.33 具有 32 字节的数据:
来自 192.168.7.33 的回复: 字节=32 时间=551ms TTL=63
来自 192.168.7.33 的回复: 字节=32 时间<1ms TTL=63
来自 192.168.7.33 的回复: 字节=32 时间<1ms TTL=63
来自 192.168.7.33 的回复: 字节=32 时间<1ms TTL=63

192.168.7.33 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 = 0ms, 最长 = 551ms, 平均 = 137ms
```

(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。

```
*Jun  5 10:39:46: %7: IFSM[GigabitEthernet 0/1:192.168.1.1]: Hello timer expire
*Jun  5 10:39:46: %7: SEND[Hello]: To 224.0.0.5 via GigabitEthernet 0/1:192.168.1.1, length 48
*Jun  5 10:39:46: %7: ------------------------------------------------------
*Jun  5 10:39:46: %7: Header
*Jun  5 10:39:46: %7:   Version 2
*Jun  5 10:39:46: %7:   Type 1 (Hello)
*Jun  5 10:39:46: %7:   Packet Len 48
*Jun  5 10:39:46: %7:   Router ID 192.168.2.1
*Jun  5 10:39:46: %7:   Area ID 0.0.0.0
*Jun  5 10:39:46: %7:   Checksum 0xf0f2
*Jun  5 10:39:46: %7:   AuType 0
*Jun  5 10:39:46: %7: Hello
*Jun  5 10:39:46: %7:   NetworkMask 255.255.255.0
*Jun  5 10:39:46: %7:   HelloInterval 10
*Jun  5 10:39:46: %7:   Options 0x2 (-|-|-|-|-|-|E|-)
*Jun  5 10:39:46: %7:   RtrPriority 1
*Jun  5 10:39:46: %7:   RtrDeadInterval 40
*Jun  5 10:39:46: %7:   DRouter 192.168.1.2
*Jun  5 10:39:46: %7:   BDRouter 192.168.1.1
*Jun  5 10:39:46: %7:   # Neighbors 1
*Jun  5 10:39:46: %7:     Neighbor 192.168.5.1
*Jun  5 10:39:46: %7: ------------------------------------------------------
*Jun  5 10:39:51: %7: LSA[MaxAge]: Maxage walker finished (0.000000 sec)
*Jun  5 10:39:52: %7: IFSM[Serial 2/0:192.168.2.1]: Hello timer expire
*Jun  5 10:39:52: %7: SEND[Hello]: To 224.0.0.5 via Serial 2/0:192.168.2.1, length 48
*Jun  5 10:39:52: %7: ------------------------------------------------------
*Jun  5 10:39:52: %7: Header
*Jun  5 10:39:52: %7:   Version 2
*Jun  5 10:39:52: %7:   Type 1 (Hello)
*Jun  5 10:39:52: %7:   Packet Len 48
*Jun  5 10:39:52: %7:   Router ID 192.168.2.1
*Jun  5 10:39:52: %7:   Area ID 0.0.0.0
*Jun  5 10:39:52: %7:   Checksum 0x7647
*Jun  5 10:39:52: %7:   AuType 0
*Jun  5 10:39:52: %7: Hello
*Jun  5 10:39:52: %7:   NetworkMask 255.255.255.0
*Jun  5 10:39:52: %7:   HelloInterval 10
*Jun  5 10:39:52: %7:   Options 0x2 (-|-|-|-|-|-|E|-)
*Jun  5 10:39:52: %7:   RtrPriority 1
*Jun  5 10:39:52: %7:   RtrDeadInterval 40
*Jun  5 10:39:52: %7:   DRouter 0.0.0.0
*Jun  5 10:39:52: %7:   BDRouter 0.0.0.0
*Jun  5 10:39:52: %7:   # Neighbors 1
*Jun  5 10:39:52: %7:     Neighbor 192.168.3.1
*Jun  5 10:39:52: %7: ------------------------------------------------------
*Jun  5 10:39:54: %7: 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
*Jun  5 10:39:54: %7: ------------------------------------------------------
*Jun  5 10:39:54: %7: Header
*Jun  5 10:39:54: %7:   Version 2
*Jun  5 10:39:54: %7:   Type 1 (Hello)
*Jun  5 10:39:54: %7:   Packet Len 48
*Jun  5 10:39:54: %7:   Router ID 192.168.3.1
*Jun  5 10:39:54: %7:   Area ID 0.0.0.0
*Jun  5 10:39:54: %7:   Checksum 0x7647
*Jun  5 10:39:54: %7:   AuType 0
*Jun  5 10:39:54: %7: Hello
*Jun  5 10:39:54: %7:   NetworkMask 255.255.255.0
*Jun  5 10:39:54: %7:   HelloInterval 10
*Jun  5 10:39:54: %7:   Options 0x2 (-|-|-|-|-|-|E|-)
```

出现了 LSA 类型。有 224.0.0.5 而没有 224.0.0.6。这两个地址是组播地址,对所有 DR/BDR 路由器的组播地址为 240.0.0.6,对所有的非 DR/BDR 路由器的组播地址为 224.0.0.5。

(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

```
21-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: 22
  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: 80000010
  Checksum: 0x38ff
  Length: 60
   Number of Links: 3

    Link con 截图 d to: Stub Network
     (Link ID) Network/subnet number: 192.168.1.0
     (Link Data) Network Mask: 255.255.255.0
      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
```

# show ip ospf database network ！显示 network LSA

```
21-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: 23
  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: 80000004
  Checksum: 0x8f10
  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。

```
21-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

```
21-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         -          00:00:31    192.168.1.2     GigabitEthernet 0/1
192.168.3.1       1   Full/ -         -          00:00:32    192.168.2.2     Serial 2/0
```

(e) 显示并记录 R1 的所有接口信息

#show ip ospf interface [接口名]

```
21-RSR20-1(config)#show ip ospf interface
Serial 2/0 is up, line protocol is up
  Internet Address 192.168.2.1/24, Ifindex 2, 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 00:00:04
  Neighbor Count is 1, Adjacent neighbor count is 1
  Crypt Sequence Number is 0
  Hello received 245 sent 245, DD received 3 sent 4
  LS-Req received 1 sent 1, LS-Upd received 16 sent 31
  LS-Ack received 22 sent 15, Discarded 0
GigabitEthernet 0/1 is up, line protocol is up
  Internet Address 192.168.1.1/24, Ifindex 5, 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 Waiting, Priority 1
  No designated router on this network
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:04
  Neighbor Count is 1, Adjacent neighbor count is 0
  Crypt Sequence Number is 0
  Hello received 204 sent 208, DD received 15 sent 16
  LS-Req received 4 sent 4, LS-Upd received 18 sent 25
  LS-Ack received 21 sent 9, Discarded 0
```

```
21-RSR20-2(config)#show ip ospf interface
Serial 2/0 is up, line protocol is up
  Internet Address 192.168.2.2/24, Ifindex 2, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.2.0/24
  Process ID 1, Router ID 192.168.3.1, 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 00:00:03
  Neighbor Count is 1, Adjacent neighbor count is 1
  Crypt Sequence Number is 0
  Hello received 224 sent 225, DD received 4 sent 3
  LS-Req received 1 sent 1, LS-Upd received 29 sent 16
  LS-Ack received 15 sent 20, Discarded 0
GigabitEthernet 0/0 is up, line protocol is up
  Internet Address 192.168.7.1/24, Ifindex 4, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.7.0/24
  Process ID 1, Router ID 192.168.3.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.3.1, Interface Address 192.168.7.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:02
  Neighbor Count is 0, Adjacent neighbor count is 0
  Crypt Sequence Number is 0
  Hello received 0 sent 68, 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
GigabitEthernet 0/1 is up, line protocol is up
  Internet Address 192.168.3.1/24, Ifindex 5, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.3.0/24
  Process ID 1, Router ID 192.168.3.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.3.1, Interface Address 192.168.3.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:06
  Neighbor Count is 0, Adjacent neighbor count is 0
  Crypt Sequence Number is 0
  Hello received 0 sent 208, 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
```

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

# 计算机网络实验报告

| 学号 | 学生 | 自评分 |
|---|---|---|
| 19335118 | 梁冠轩 | 100 |
| 19335258 | 余世龙 | 100 |
| | | |
| | | |
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上传实验报告：　　截止日期（不迟于）：1 周之内

上传包括两个文件：

（1）小组实验报告。上传文件名格式：小组号_ Ftp 协议分析实验.pdf （由组长负责上传）

例如: 文件名“10_ Ftp 协议分析实验.pdf”表示第 10 组的 Ftp 协议分析实验报告

（2）小组成员实验体会。每个同学单独交一份只填写了实验体会的实验报告。只需填写自己的学号和姓名。

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