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】

(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。

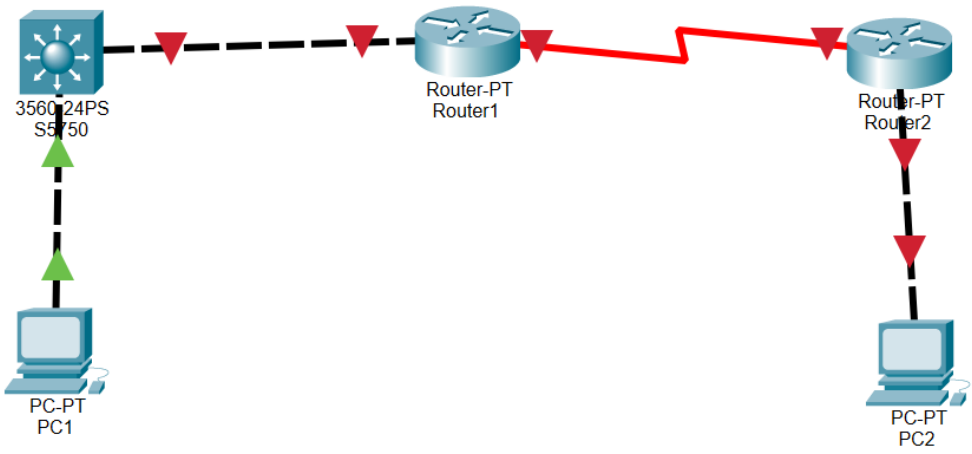
【实验记录】(如有实验拓扑请自行画出)

1. 完成路由器配置实验 7-3，并回答步骤 1、步骤 9 问题：

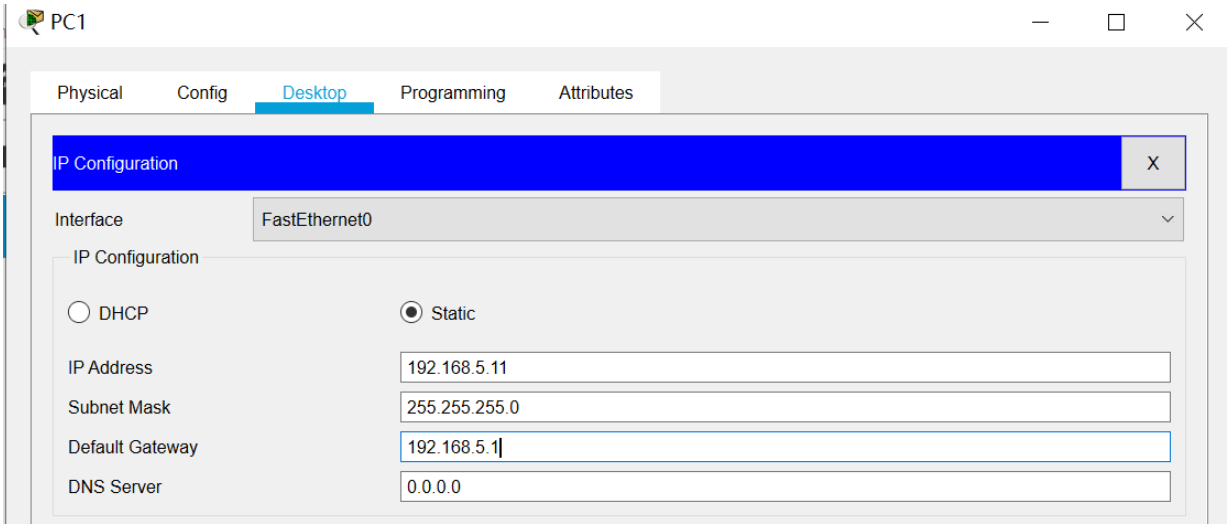
步骤 1：

配置 PC1 和 PC2，测试连通性；并记录路由 1 与路由 2 的路由表

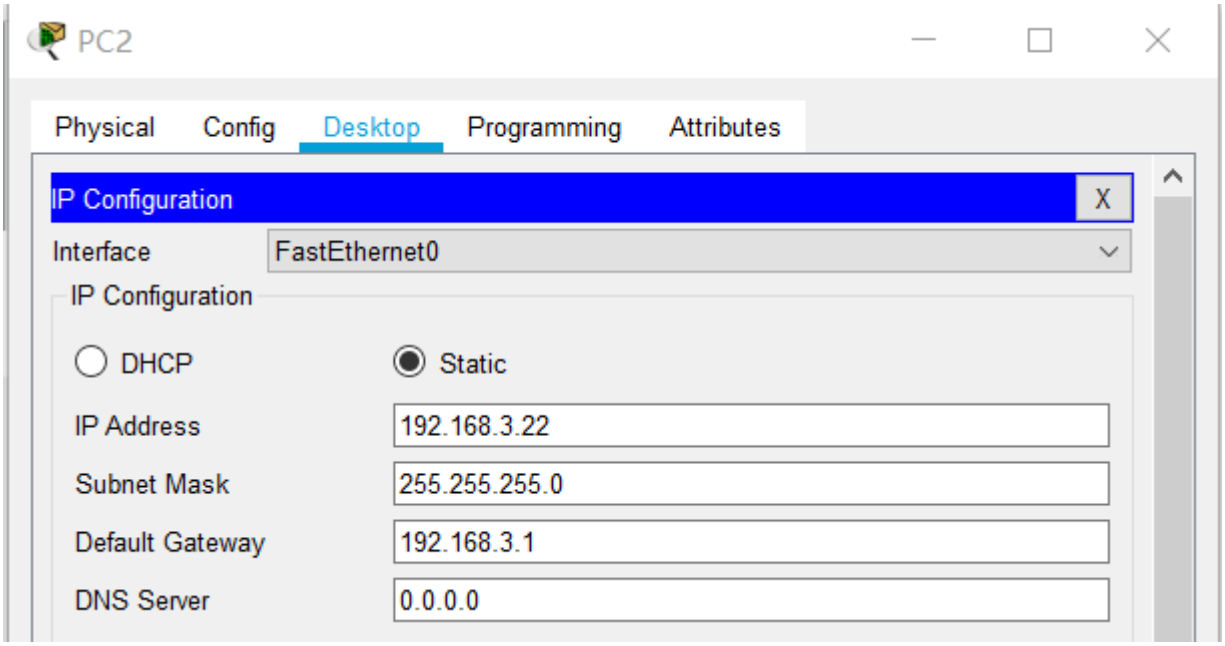
拓扑图：



配置 PC1：



配置 PC2：



测试连通性，发现 PC1 与 PC2 并不连通：

```
C:\>ping 192.168.3.22

Pinging 192.168.3.22 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.3.22:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

路由 1 路由表：

```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set
```

路由 2 路由表：

```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set
```

步骤 2：三层交换机的配置

```
Switch(config)#vlan 10
Switch(config-vlan)#exit
Switch(config)#vlan 50
Switch(config-vlan)#exit
Switch(config)#int fa0/1
Switch(config-if)#switchport access vlan 10
Switch(config-if)#exit
Switch(config)#int fa0/5
Switch(config-if)#switchport access vlan 50
Switch(config-if)#exit
Switch(config)#int vlan 10
Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan10, changed state to up

Switch(config-if)#ip address 192.168.1.2 255.255.255.0
Switch(config-if)#no shutdown
Switch(config-if)#exit
Switch(config)#int vlan 50
Switch(config-if)#
%LINK-5-CHANGED: Interface Vlan50, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan50, changed state to up

Switch(config-if)#ip address 192.168.5.1 255.255.255.0
Switch(config-if)#no shutdown
Switch(config-if)#exit
```

步骤 3：路由器 1 的配置

```
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Router(config-if)#exit
Router(config)#int serial 2/0
Router(config-if)#ip address 192.168.2.1 255.255.255.0
Router(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial2/0, changed state to down
Router(config-if)#exit
```

步骤 4：路由器 2 的配置

```
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip address 192.168.3.1 255.255.255.0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Router(config-if)#exit
Router(config)#int serial 2/0
Router(config-if)#ip address 192.168.2.2 255.255.255.0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface Serial2/0, changed state to up

Router(config-if)#exit
```

步骤 5：交换机配置 OSPF

```
Switch(config)#ip routing
Switch(config)#router ospf 1
Switch(config-router)#network 192.168.5.0 0.0.0.255 area 0
Switch(config-router)#network 192.168.1.0 0.0.0.255 area 0
Switch(config-router)#end
Switch#
```

步骤 6：路由器 1 配置 OSPF

```
Router(config)#router ospf 1
Router(config-router)#network 192.168.1.0 0.0.0.255 area 0
Router(config-router)#network 192.168.2.0 0.0.0
00:12:34: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.5.1 on FastEthernet0/0 from LOADING t
% Incomplete command.
Router(config-router)#network 192.168.2.0 0.0.0.255 area 0
Router(config-router)#end
Router#
```

步骤 7：路由器 2 配置 OSPF

```
Router(config)#router ospf 1
Router(config-router)#network 192.168.2.0 255.255.255.0 area 0
Router(config-router)#network 192.168.3.0 255.255
00:13:48: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.2.1 on Serial2/0 from LOADING to FULL, Loading Done
.255.0 area 0
Router(config-router)#end
Router#
```

步骤 8：验证交换机和路由器的路由表

交换机的路由表：

```
Switch#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, Vlan10
O    192.168.2.0/24 [110/65] via 192.168.1.1, 00:01:22, Vlan10
O    192.168.3.0/24 [110/66] via 192.168.1.1, 00:00:28, Vlan10
C    192.168.5.0/24 is directly connected, Vlan50
```

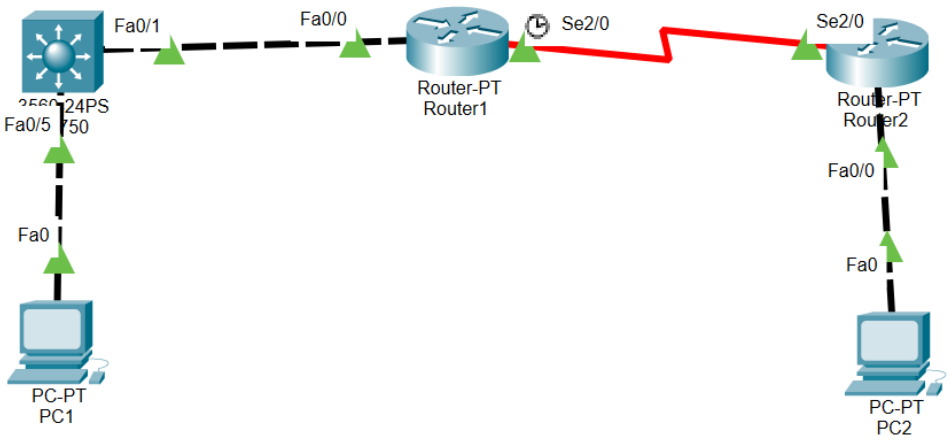
路由器 1 的路由表：

```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
C    192.168.2.0/24 is directly connected, Serial2/0
O    192.168.3.0/24 [110/65] via 192.168.2.2, 00:00:48, Serial2/0
O    192.168.5.0/24 [110/2] via 192.168.1.2, 00:02:05, FastEthernet0/0
```

路由器 2 的路由表：

```
Router#
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

O    192.168.1.0/24 [110/65] via 192.168.2.1, 00:01:00, Serial2/0
C    192.168.2.0/24 is directly connected, Serial2/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
O    192.168.5.0/24 [110/66] via 192.168.2.1, 00:01:00, Serial2/0
```

配置完成后的拓扑图：



步骤 9：测验网络的连通性

将这时路由器的路由表与步骤 1 的路由表进行对比：

1. 步骤 0 的路由表为空

2. 步骤 9 先是接入两个 C 条目，这些条目显示了网络设备直连的网段，以及该网段与设备的端口地址；

3. 在此之后出现了 O 条目，每个直连网段运用了 OSPF 协议，设备通过该协议发送招手报文，交换网络信息，学习网络信息，从而在设备之间建立起基于 OSPF 协议的路由转发路径。

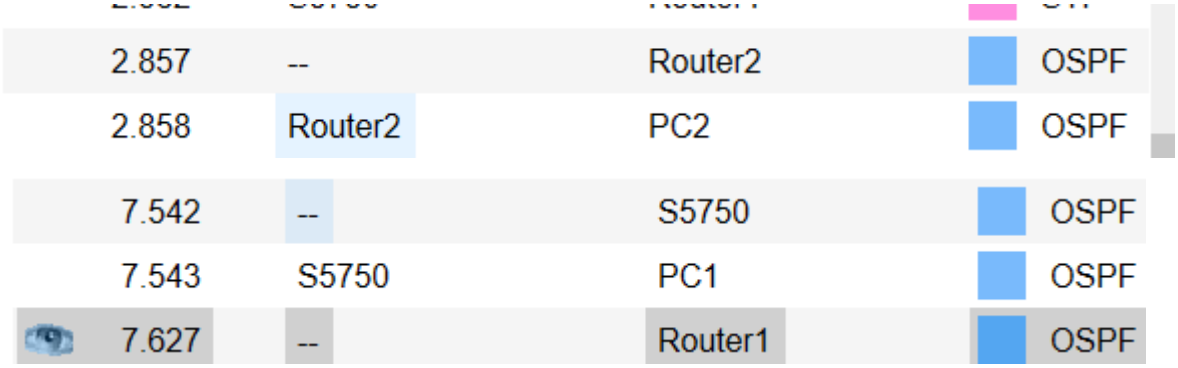
分析 tracertPC2 的结果：

```
C:\>tracert 192.168.3.22

Tracing route to 192.168.3.22 over a maximum of 30 hops:

  1    0 ms      0 ms      0 ms      192.168.5.1
  2    0 ms      0 ms      1 ms      192.168.1.1
  3    0 ms      1 ms      0 ms      192.168.2.2
  4    *         28 ms     1 ms      192.168.3.22

Trace complete.
```

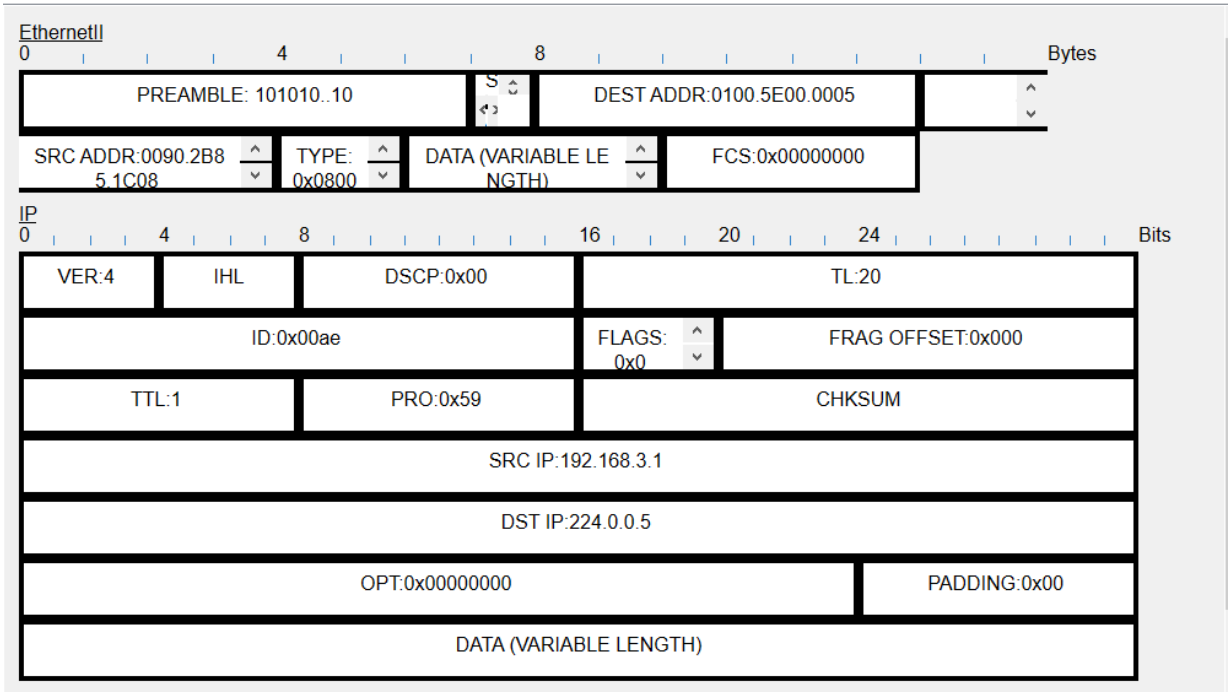
说明 PC1 能够连通 PC2

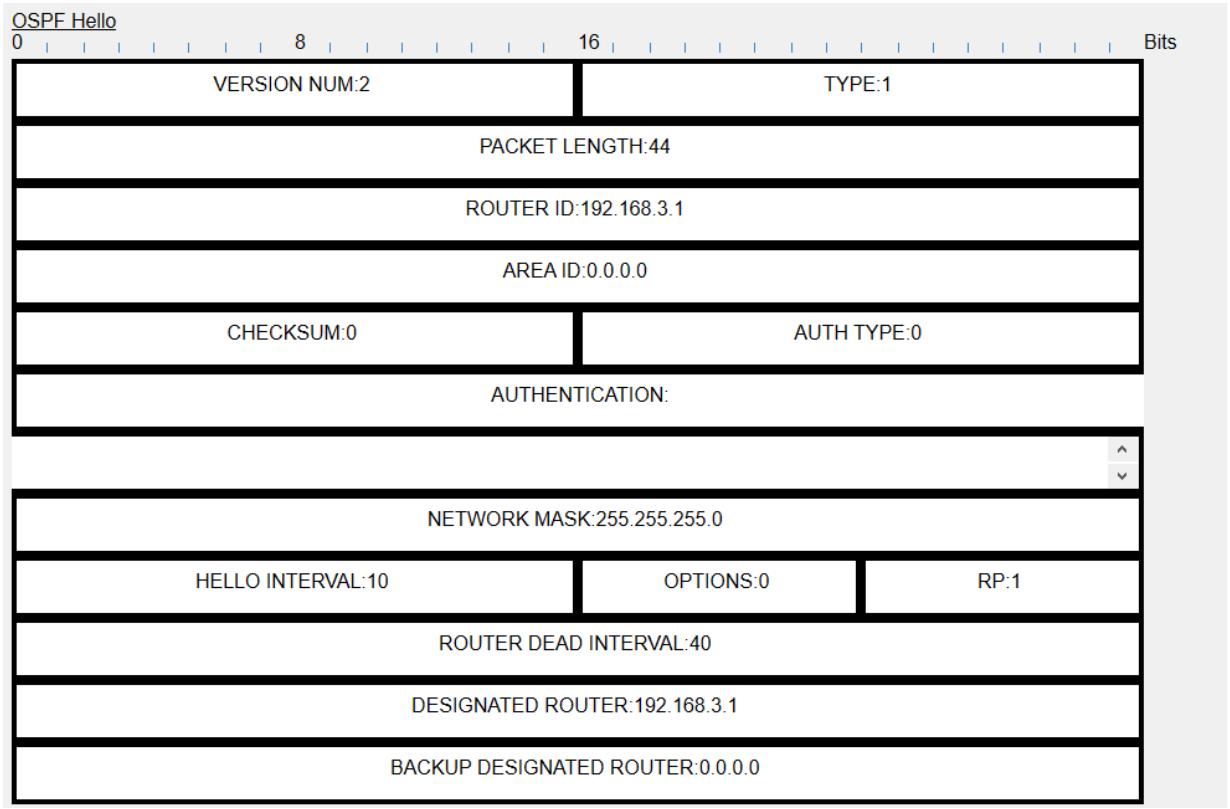
捕获数据包，分析 OSPF 头部结构。OSPF 包能否在 PC1 或者 PC2 上捕获到？

OSPF 数据包：



OSPF 数据包报文：





从头部报文中我们可以看出，这是可以 Hello 数据包

Version Num：2（OSPF 版本为 2）

Type ：1（HELLO 报文）

Packet length：44（报文长度 44）

Router id：192.168.3.1（由路由器 ip 为 102.168.3.1 发送）

Area id：0.0.0.0（区域为 0）

Check sum：0（包校检核为 0）

Auth Type：0（鉴定类型为 0）

从图中我们可以看出 PC1 和 PC2 是可以接收到 OSPF 数据包的。

使用#debug ip ospf 命令显示 OSPF 运行过程

在 packet tracer 中我们发现 debug ip ospf 命令是不完整的

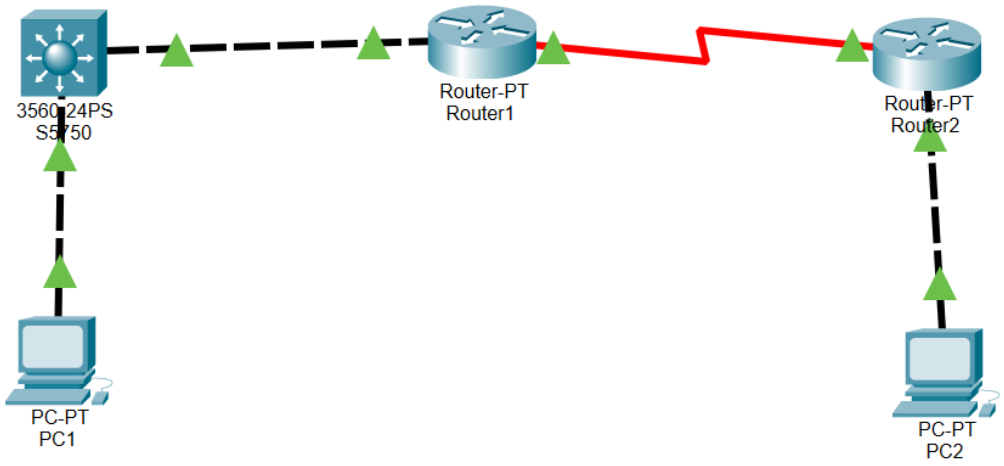
```
Router#debug ip ospf
% Incomplete command.
Router#debug ip ospf
% Incomplete command.
Router#debug ip ospf?
ospf
Router#debug ip ospf ?
  adj      OSPF adjacency events
  events   OSPF events
```

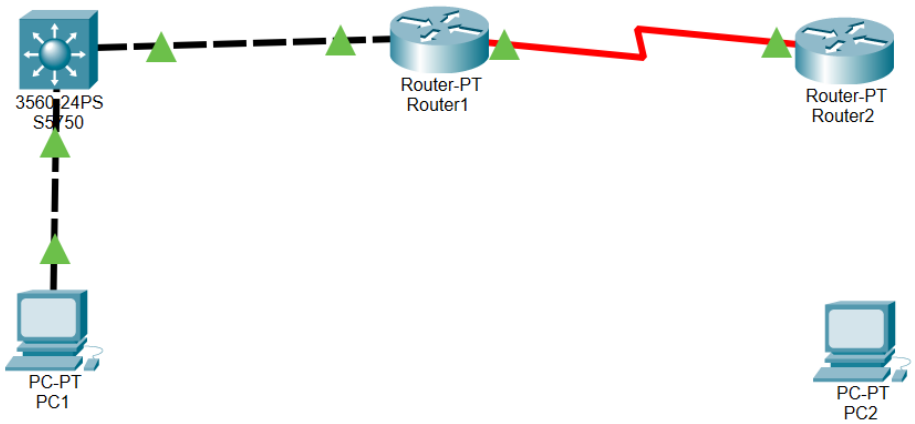
在 ospf 后面我们需要加上 adj 或者 events 的指令，在通过网络学习后我们了解到：

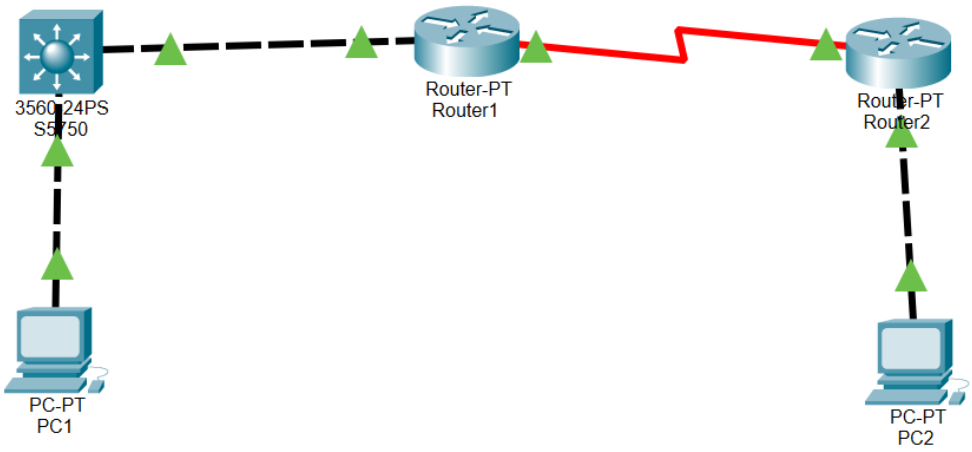
debug ip ospf events 为调试 ospf 事件,显示发送，接受 hello（已解读），邻居改变事件，DR 选取，显示建立邻接关系的过程，比 debug ip ospf adj，多了显示 发送接收 hello 数据包。所以我们尝试使用 debug ip ospf events 指令来代替原指令。

在实验过程中我们多次改变链路状态：

拓扑图改变：







ping 命令改变为：

```
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=4ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=6ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Request timed out.
Reply from 192.168.5.1: Destination host unreachable.
Request timed out.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
```

```
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Request timed out.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Request timed out.
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=2ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=2ms TTL=125
```

Debug 信息改变为：

```
00:26:59: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2

00:26:59: OSPF: End of hello processing

00:27:00: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2

00:27:00: OSPF: End of hello processing

00:27:09: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2

00:27:09: OSPF: End of hello processing

00:27:10: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2

00:27:10: OSPF: End of hello processing

00:27:19: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2

00:27:19: OSPF: End of hello processing

00:27:20: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2

00:27:20: OSPF: End of hello processing

00:27:29: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2

00:27:29: OSPF: End of hello processing
```

```
00:28:19: OSPF: End of hello processing
00:28:21: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2
00:28:21: OSPF: End of hello processing
00:28:29: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2
00:28:29: OSPF: End of hello processing
00:28:31: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2
00:28:31: OSPF: End of hello processing
00:28:39: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2
00:28:39: OSPF: End of hello processing
00:28:41: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2
00:28:41: OSPF: End of hello processing
00:28:49: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2
```

```
00:29:51: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2
00:29:51: OSPF: End of hello processing
00:29:59: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2
00:29:59: OSPF: End of hello processing
00:30:01: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2
00:30:01: OSPF: End of hello processing
00:30:09: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2
00:30:09: OSPF: End of hello processing
00:30:11: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2
00:30:11: OSPF: End of hello processing
00:30:19: OSPF: Rcv hello from 192.168.3.1 area 0 from Serial2/0 192.168.2.2
00:30:19: OSPF: End of hello processing
00:30:21: OSPF: Rcv hello from 192.168.5.1 area 0 from FastEthernet0/0 192.168.1.2
00:30:21: OSPF: End of hello processing
```

我们从中可以发现并没有出现实验要求中的 Update 分组，也没有其中的 LSA 类型，同时并没有出现向上次的实验一样向 224.0.0.5 或者 224.0.0.6 广播 ip 发送数据包的现象。看来由于 packet tracer 的删改，导致该命令被移除，从而我们无法捕捉到相关数据包，无法完成此要求。后续的 b 小问也无法完成。

本实验有无 DR\BDR，如果有则讨论其选举规则和更新方法

本实验有 DR\BDR。

```
OSPF: DR/BDR election on FastEthernet0/0

OSPF: Elect BDR 192.168.2.1

OSPF: Elect DR 192.168.5.1

        DR: 192.168.5.1 (Id)    BDR: 192.168.2.1 (Id)
```

选举规则为所有配置了 OSDF 的路由器都会向外宣称自己为 BDR，然后路由器之间比较优

先级和 router id，如果该路由器的优先级或者 router id 大于收到包的优先级或者 router id，则宣称自己为 DR，反之则宣称自己为 BDR；假如自己的优先级或者 router id 小于两台设备，则放弃选举，传递 DR 和 BDR 信息。

更新方法：

```
00:39:54: OSPF: Elect BDR 192.168.2.1

00:39:54: OSPF: Elect DR 192.168.5.1

00:39:54:        DR: 192.168.5.1 (Id)   BDR: 192.168.2.1 (Id)

00:39:54: OSPF: Rcv DBD from 192.168.5.1 on FastEthernet0/0 seq 0x2048 opt 0x00 flag 0x7 len 32  mtu
1500 state EXSTART

00:39:54: OSPF: NBR Negotiation Done. We are the SLAVE

00:39:54: OSPF: Send DBD to 192.168.5.1 on FastEthernet0/0 seq 0x2048 opt 0x00 flag 0x2 len 112

00:39:54: OSPF: Rcv DBD from 192.168.5.1 on FastEthernet0/0 seq 0x2049 opt 0x00 flag 0x3 len 92  mtu
1500 state EXCHANGE

00:39:54: OSPF: Send DBD to 192.168.5.1 on FastEthernet0/0 seq 0x2049 opt 0x00 flag 0x0 len 32

00:39:54: OSPF: Rcv DBD from 192.168.5.1 on FastEthernet0/0 seq 0x204a opt 0x00 flag 0x1 len 32  mtu
1500 state EXCHANGE

00:39:54: OSPF: Send DBD to 192.168.5.1 on FastEthernet0/0 seq 0x204a opt 0x00 flag 0x0 len 32

00:39:54: Exchange Done with 192.168.5.1 on FastEthernet0/0

00:39:54: Synchronized with with 192.168.5.1 on FastEthernet0/0, state FULL

00:39:54: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.5.1 on FastEthernet0/0 from LOADING to FULL, Loading
Done

00:39:54: OSPF: Send DBD to 192.168.5.1 on FastEthernet0/0 seq 0x204a opt 0x00 flag 0x0 len 32
```

实验思考：

1、如何查看 OSPF 协议发布的网段

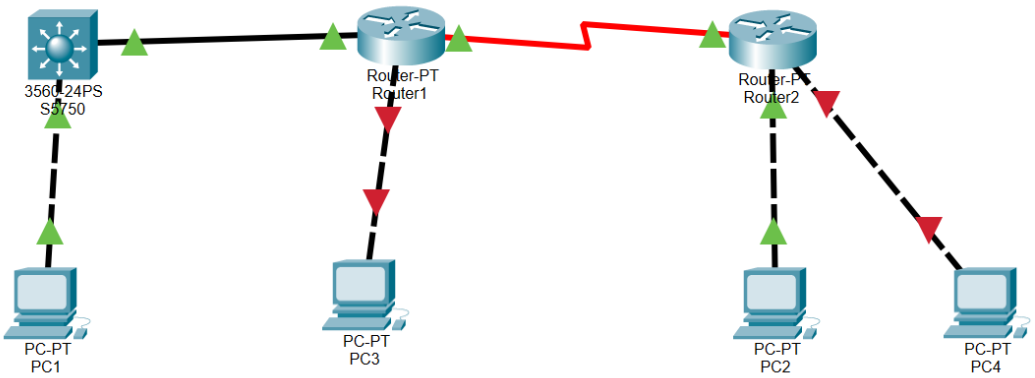
使用 show ip ospf database network 进行查看

```
Router#show ip ospf database network

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

                Net Link States (Area 0)

  Routing Bit Set on this LSA
  LS age: 621
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.1.2  (address of Designated Router)
  Advertising Router: 192.168.5.1
  LS Seq Number: 80000002
  Checksum: 0xe449
  Length: 32
  Network Mask: /24
        Attached Router: 192.168.2.1
        Attached Router: 192.168.5.1
```

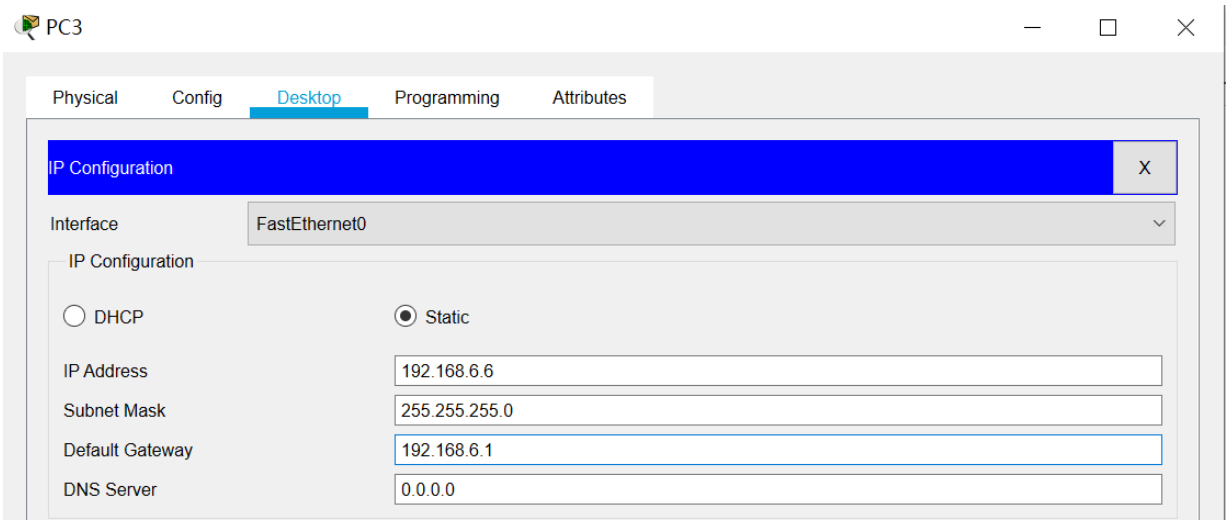
2、计算 192.168.2.0/28 的反子网掩码

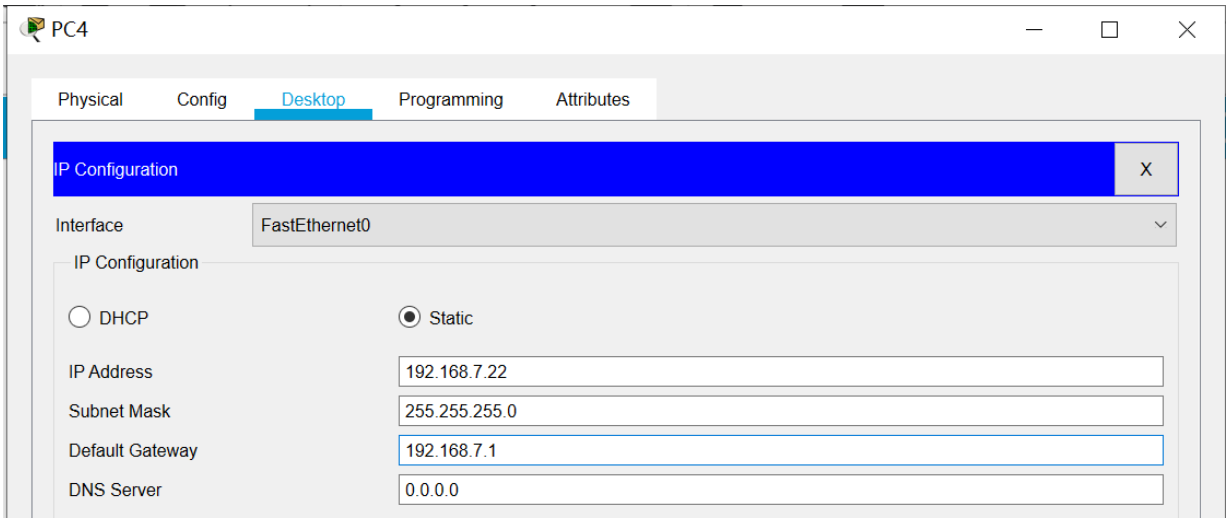
从/28 中我们可以看出其子网掩码为 255.255.255.240，则其反子网掩码为 0.0.0.15

2. 在 1 的基础上在每台路由器上加入一台电脑，并且回答 a-e 五个小问：
实验拓扑图：



（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。
我们首先配置 PC3 和 PC4：





之后我们使用 PC1ping 其他 PC：
PC1pingPC2：

```
C:\>ping 192.168.3.22

Pinging 192.168.3.22 with 32 bytes of data:

Reply from 192.168.3.22: bytes=32 time=2ms TTL=125
Reply from 192.168.3.22: bytes=32 time=2ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125

Ping statistics for 192.168.3.22:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms
```

PC1pingPC3：

```
C:\>ping 192.168.6.6

Pinging 192.168.6.6 with 32 bytes of data:

Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.

Ping statistics for 192.168.6.6:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

PC1pingPC4：

```
C:\>ping 192.168.7.22

Pinging 192.168.7.22 with 32 bytes of data:

Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.
Reply from 192.168.5.1: Destination host unreachable.

Ping statistics for 192.168.7.22:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

之后我们配置路由器 1 和路由器 2：

路由器 1：

```
Router(config)#interface FastEthernet1/0
Router(config-if)#ip address 192.168.6.1 255.255.255.0
Router(config-if)#ip address 192.168.6.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet1/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up

Router(config-if)#exit
Router(config)#router ospf 1
Router(config-router)#network 192.168.6.0 0.0.0.255 area 0
Router(config-router)#end
```

路由器 2：

```
Router(config)#interface FastEthernet1/0
Router(config-if)#ip address 192.168.7.1 255.255.255.0
Router(config-if)#ip address 192.168.7.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet1/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up

Router(config-if)#exit
Router(config)#router ospf 1
Router(config-router)#network 192.168.7.0 0.0.0.255 area 0
Router(config-router)#end
```

然后我们再次使用 PC1ping 其他 PC：

PC1pingPC2：

```
C:\>ping 192.168.3.22

Pinging 192.168.3.22 with 32 bytes of data:

Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=1ms TTL=125
Reply from 192.168.3.22: bytes=32 time=16ms TTL=125

Ping statistics for 192.168.3.22:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 16ms, Average = 4ms
```

PC1pingPC3/4：

```
C:\>ping 192.168.6.6

Pinging 192.168.6.6 with 32 bytes of data:

Request timed out.
Reply from 192.168.6.6: bytes=32 time<1ms TTL=126
Reply from 192.168.6.6: bytes=32 time<1ms TTL=126
Reply from 192.168.6.6: bytes=32 time<1ms TTL=126

Ping statistics for 192.168.6.6:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.7.22

Pinging 192.168.7.22 with 32 bytes of data:

Request timed out.
Reply from 192.168.7.22: bytes=32 time=1ms TTL=125
Reply from 192.168.7.22: bytes=32 time=1ms TTL=125
Reply from 192.168.7.22: bytes=32 time=1ms TTL=125

Ping statistics for 192.168.7.22:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

这时我们发现 PC1 与其他 PC 均能连通。
同时我们查看交换机和两个路由器的路由表：
交换机：

```
Switch#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, Vlan10
O    192.168.2.0/24 [110/65] via 192.168.1.1, 00:12:41, Vlan10
O    192.168.3.0/24 [110/66] via 192.168.1.1, 00:12:41, Vlan10
C    192.168.5.0/24 is directly connected, Vlan50
O    192.168.6.0/24 [110/2] via 192.168.1.1, 00:02:10, Vlan10
O    192.168.7.0/24 [110/66] via 192.168.1.1, 00:01:25, Vlan10
```

路由器 1：

```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
C    192.168.2.0/24 is directly connected, Serial2/0
O    192.168.3.0/24 [110/65] via 192.168.2.2, 00:33:33, Serial2/0
O    192.168.5.0/24 [110/2] via 192.168.1.2, 00:11:43, FastEthernet0/0
C    192.168.6.0/24 is directly connected, FastEthernet1/0
O    192.168.7.0/24 [110/65] via 192.168.2.2, 00:00:27, Serial2/0
```

路由器 2：

```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

O    192.168.1.0/24 [110/65] via 192.168.2.1, 00:12:06, Serial2/0
C    192.168.2.0/24 is directly connected, Serial2/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
O    192.168.5.0/24 [110/66] via 192.168.2.1, 00:12:06, Serial2/0
O    192.168.6.0/24 [110/65] via 192.168.2.1, 00:01:35, Serial2/0
C    192.168.7.0/24 is directly connected, FastEthernet1/0
```

可以看出其中多了几个 O 条目和 C 条目，分别对应我们新增的 2 个 PC 子网。

（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。

在步骤 9 中说明过，该指令已被移除，剩余指令无法显示所需要的数据包。

（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

```
Router#show ip ospf database router

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

                Router Link States (Area 0)

  LS age: 934
  Options: (No TOS-capability, DC)
  LS Type: Router Links
  Link State ID: 192.168.5.1
  Advertising Router: 192.168.5.1
  LS Seq Number: 80000009
  Checksum: 0x18fd
  Length: 48
  Number of Links: 2

    Link connected to: a 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 Metrics: 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 Metrics: 1

  LS age: 307
```

 # show ip ospf database network ！显示 network LSA

```
Router#show ip ospf database network

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

                Net Link States (Area 0)

  Routing Bit Set on this LSA
  LS age: 956
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 192.168.1.2  (address of Designated Router)
  Advertising Router: 192.168.5.1
  LS Seq Number: 80000003
  Checksum: 0xd071
  Length: 32
  Network Mask: /24
        Attached Router: 192.168.2.1
        Attached Router: 192.168.5.1
```

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

Show ip ospf database database 在 packet tracer 中不存在，我们使用其他的命令来代替其数据库信息。

Show ip ospf database Asbr-summart，external，summary：

```
Router#show ip ospf database asbr-summary

            OSPF Router with ID (192.168.2.1) (Process ID 1)
Router#show ip ospf database external

            OSPF Router with ID (192.168.2.1) (Process ID 1)
Router#show ip ospf database summary

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

Show ip ospf database：

```
Router#show ip ospf database
            OSPF Router with ID (192.168.2.1) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
192.168.5.1     192.168.5.1     1008        0x80000009 0x0018fd 2
192.168.2.1     192.168.2.1     381         0x8000000b 0x000e28 4
192.168.3.1     192.168.3.1     336         0x80000011 0x00e9ad 4

                Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
192.168.1.2     192.168.5.1     1008        0x80000003 0x00d071
```

（d）显示并记录邻居状态。

 # show ip ospf neighbor

```
Router#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.5.1       1   FULL/DR         00:00:32    192.168.1.2     FastEthernet0/0
192.168.3.1       0   FULL/  -        00:00:31    192.168.2.2     Serial2/0
```

（e）显示并记录 R1 的所有接口信息

#show ip ospf interface [接口名]

Fa0/0：

```
Router#show ip ospf int fa0/0

FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.1.1/24, Area 0
  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 00:00:03
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.5.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
Router#show ip ospf int fa0/1
%Invalid interface type and number
```

Fa1/0：

```
Router#show ip ospf int fa1/0

FastEthernet1/0 is up, line protocol is up
  Internet address is 192.168.6.1/24, Area 0
  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 00:00:06
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
```

S2/0：

```
Router#show ip ospf int serial2/0

Serial2/0 is up, line protocol is up
  Internet address is 192.168.2.1/24, Area 0
  Process ID 1, Router ID 192.168.2.1, Network Type POINT-TO-POINT, Cost: 6
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:05
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1 , Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.3.1
  Suppress hello for 0 neighbor(s)
```

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）

学号	学生	自评分
郑卓民	18342138	100
南樟	18342077	100

计算机网络实验报告

【交实验报告】

上传实验报告：ftp://me.aceralon.com:10086　　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

视频文件名与实验报告文件名相当，扩展名 MP4。

（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。

文件名格式：小组号_学号_姓名_ Ftp 协议分析实验.pdf （由组员自行上传）

例如: 文件名“10_05373092_张三_ Ftp 协议分析实验.pdf”表示第 10 组的 Ftp 协议分析实验报告。

注意：不要打包上传！