



【实验题目】OSPF 配置实验

【实验目的】掌握 OSPF 协议单区域配置方法。

【实验内容】

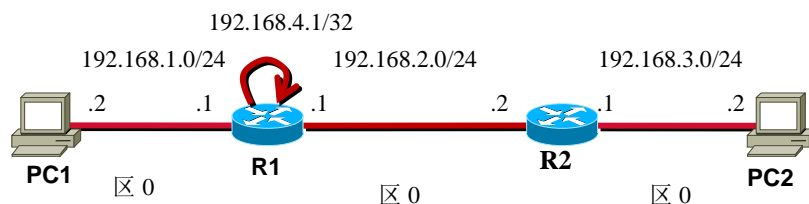
**** 下面路由器均启动 OSPF 协议。实验结果和分析直接记录在下面每一个步骤后面。**

**** Loopback 网位于区 0。**

**** 命令#relaod 可以通过重启路由器。**

****Loopback 接口的名: loopback num (num 为编号, 可以任意取)**

1、按下图配置两台路由器为 OSPF 协议。



注意：中间采用以太网连接，要 shutdown 原来的串行接口。

[1A、连通后截屏 PC1 ping PC2 的结果。]

```
C:\Users\Administrator>ping 192.168.3.2

正在 Ping 192.168.3.2 具有 32 字节的数据:
来自 192.168.3.2 的回复: 字节=32 时间<1ms TTL=126
来自 192.168.3.2 的回复: 字节=32 时间=2ms TTL=126
来自 192.168.3.2 的回复: 字节=32 时间<1ms TTL=126
来自 192.168.3.2 的回复: 字节=32 时间<1ms TTL=126

192.168.3.2 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 = 2ms, 平均 = 0ms

C:\Users\Administrator>
```

[1B、分别显示并截屏路由器 R1 和 R2 的 LS 数据库信息(database, router LSA, network LSA)]

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

R1:

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

```
OSPF Router with ID (1.1.1.1) (Process ID 1)
```

```
Router Link States (Area 0.0.0.0)
```

Link ID	ADV Router	Age	Seq#	CkSum	Link count
1.1.1.1	1.1.1.1	466	0x80000009	0x75f9	3
2.2.2.2	2.2.2.2	472	0x80000006	0x8a5b	2

```
Network Link States (Area 0.0.0.0)
```

Link ID	ADV Router	Age	Seq#	CkSum
192.168.2.2	2.2.2.2	471	0x80000001	0xdff8



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

        OSPF Router with ID (1.1.1.1) (Process ID 1)

        Router Link States (Area 0.0.0.0)

LS age: 504
Options: 0x2 (-|-|-|-|-|E|-)
Flags: 0x0
LS Type: router-LSA
Link State ID: 1.1.1.1
Advertising Router: 1.1.1.1
LS Seq Number: 80000009
Checksum: 0x75f9
Length: 60
Number of Links: 3
```

```
Link connected 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: Stub Network
(Link ID) Network/subnet number: 192.168.4.1
(Link Data) Network Mask: 255.255.255.255
Number of TOS metrics: 0
TOS 0 Metric: 0
```

```
Link connected to: a Transit Network
(Link ID) Designated Router address: 192.168.2.2
(Link Data) Router Interface address: 192.168.2.1
Number of TOS metrics: 0
TOS 0 Metric: 1
```

```
LS age: 510
Options: 0x2 (-|-|-|-|-|E|-)
Flags: 0x0
LS Type: router-LSA
Link State ID: 2.2.2.2
Advertising Router: 2.2.2.2
LS Seq Number: 80000006
Checksum: 0x8a5b
Length: 48
Number of Links: 2
```

```
Link connected to: a Transit Network
(Link ID) Designated Router address: 192.168.2.2
(Link Data) Router Interface address: 192.168.2.2
Number of TOS metrics: 0
TOS 0 Metric: 1
```

```
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
```

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

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

```
        OSPF Router with ID (1.1.1.1) (Process ID 1)
```

```
        Network Link States (Area 0.0.0.0)
```

```
LS age: 538
Options: 0x2 (-|-|-|-|-|E|-)
LS Type: network-LSA
Link State ID: 192.168.2.2 (address of Designated Router)
Advertising Router: 2.2.2.2
LS Seq Number: 80000001
Checksum: 0xdff8
Length: 32
Network Mask: /24
Attached Router: 2.2.2.2
Attached Router: 1.1.1.1
```

R2:

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

```
        OSPF Router with ID (2.2.2.2) (Process ID 1)
```

```
        Router Link States (Area 0.0.0.0)
```

Link ID	ADV Router	Age	Seq#	CkSum	Link count
1.1.1.1	1.1.1.1	427	0x80000009	0x75f9	3
2.2.2.2	2.2.2.2	431	0x80000006	0x8a5b	2

```
        Network Link States (Area 0.0.0.0)
```

Link ID	ADV Router	Age	Seq#	CkSum
192.168.2.2	2.2.2.2	431	0x80000001	0xdff8

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

```
13-RSR20-2(config-if-GigabitEthernet 0/0)#show ip ospf database router
```

```
        OSPF Router with ID (2.2.2.2) (Process ID 1)
```

```
        Router Link States (Area 0.0.0.0)
```

```
LS age: 726
Options: 0x2 (-|-|-|-|-|E|-)
Flags: 0x0
LS Type: router-LSA
Link State ID: 1.1.1.1
Advertising Router: 1.1.1.1
LS Seq Number: 80000009
Checksum: 0x75f9
Length: 60
Number of Links: 3
```

```
Link connected 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: Stub Network
(Link ID) Network/subnet number: 192.168.4.1
(Link Data) Network Mask: 255.255.255.255
Number of TOS metrics: 0
TOS 0 Metric: 0
```

```
Link connected to: a Transit Network
(Link ID) Designated Router address: 192.168.2.2
(Link Data) Router Interface address: 192.168.2.1
Number of TOS metrics: 0
TOS 0 Metric: 1
```

```
LS age: 730
Options: 0x2 (-|-|-|-|-|E|-)
Flags: 0x0
LS Type: router-LSA
Link State ID: 2.2.2.2
Advertising Router: 2.2.2.2
LS Seq Number: 80000006
Checksum: 0x8a5b
Length: 48
Number of Links: 2
```

```
Link connected to: a Transit Network
(Link ID) Designated Router address: 192.168.2.2
(Link Data) Router Interface address: 192.168.2.2
Number of TOS metrics: 0
TOS 0 Metric: 1
```

```
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
```



```
13-RSR20-2(config-if-GigabitEthernet 0/0)#show ip ospf database network
```

```
OSPF Router with ID (2.2.2.2) (Process ID 1)
```

```
Network Link States (Area 0.0.0.0)
```

```
LS age: 803
Options: 0x2 (-|-|-|-|-|E|-)
LS Type: network-LSA
Link State ID: 192.168.2.2 (address of Designated Router)
Advertising Router: 2.2.2.2
LS Seq Number: 80000001
Checksum: 0xdff8
Length: 32
Network Mask: /24
    Attached Router: 2.2.2.2
    Attached Router: 1.1.1.1
```

```
13-RSR20-2(config-if-GigabitEthernet 0/0)#
```

[1C、显示并截屏 R1 的邻居状态]

```
# show ip ospf neighbor
```

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

```
OSPF process 1, 1 Neighbors, 1 is Full:
```

Neighbor ID	Pri	State	BFD State	Dead Time	Address	Interface
2.2.2.2	1	Full/DR	-	00:00:38	192.168.2.2	GigabitEthernet 0/0

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

[1D、显示并截屏 R1 的所有接口信息]

```
# show ip ospf interface
```

```
13-RSR20-1(config)#show ip ospf interface
GigabitEthernet 0/0 is up, line protocol is up
  Internet Address 192.168.2.1/24, Ifindex 4, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.2.0/24
  Process ID 1, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 2.2.2.2, Interface Address 192.168.2.2
  Backup Designated Router (ID) 1.1.1.1, Interface Address 192.168.2.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  Hello due in 00:00:01
  Neighbor Count is 1, Adjacent neighbor count is 1
  Crypt Sequence Number is 0
  Hello received 74 sent 74, DD received 3 sent 4
  LS-Req received 1 sent 1, LS-Upd received 4 sent 2
  LS-Ack received 2 sent 2, 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 1.1.1.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 1.1.1.1, Interface Address 192.168.1.1
  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 162, 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
Loopback 0 is up, line protocol is up
  Internet Address 192.168.4.1/32, Ifindex 16385, Area 0.0.0.0, MTU 1500
  Matching network config: 192.168.4.1/32
  Process ID 1, Router ID 1.1.1.1, Network Type LOOPBACK, Cost: 0
  Transmit Delay is 1 sec, State Loopback
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
13-RSR20-1(config)#
```

[1E、显示并截屏 R1 和 R2 的路由表]

```
# show ip route
```

R1:

```
13-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, GigabitEthernet 0/0
C 192.168.2.1/32 is local host.
O 192.168.3.0/24 [110/2] via 192.168.2.2, 00:12:42, GigabitEthernet 0/0
C 192.168.4.1/32 is local host.
13-RSR20-1(config)#
```



R2:

```
13-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 [110/2] via 192.168.2.1, 00:07:50, GigabitEthernet 0/0
C    192.168.2.0/24 is directly connected, GigabitEthernet 0/0
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    192.168.4.1/32 [110/1] via 192.168.2.1, 00:07:50, GigabitEthernet 0/0
13-RSR20-2(config)#
```

[1F、把 R1 和 R2 的当前配置信息保存在 s1.txt 中]

show run

[1G]、问题 1: R1 和 R2 的路由器 ID 是 1.1.1.1 和 2.2.2.2 , 是否符合 RID 的获得方法? (是/否) 是(手动配置)

问题 2: R1 和 R2 之间的网络的 DR (指定路由器) 是 R2 , BDR (指定路由器) 是 R1 。

问题 3: 网络 192.168.1.0/24、192.168.2.0/24、192.168.3.0/24、192.168.4.1/32 的链路开销(metric)分别是 1 , 1 , 1 , 0 。*指各直连路由器到这些网络的链路开销。

[1I、拔去 R2 连到 PC2 的接口连线, 截屏 R1 的路由表]

show ip route

```
13-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, GigabitEthernet 0/0
C    192.168.2.1/32 is local host.
C    192.168.4.1/32 is local host.
13-RSR20-1(config)#
```

2、接步骤 1, 通过加大另一台路由器的优先权使之成为 DR。

命令: **(config-if)#ip ospf priority 8** ! 合法的范围是 0~255。缺省的优先级为 1。优先级为 0 不参与选举 DR

[2A、问题: 在配置完毕后, R1 和 R2 之间的网络的 DR 是 R1 , BDR 是 R2 。]

[2B、在调试状态下, 先断开或者 shutdown R1 和 R2 的连接, 然后接通, 看是否可以捕捉到指定路由器的选举过程。

命令: **#debug ip ospf** ! 进入调试状态
#no debug all ! 取消调试状态]

描述有关的发包情况。

R1 和 R2 每隔一会就发出一个 HELLO 分组, 每个分组由头部和数据部分组成, 头部包含了版本号, 分组类型, RID 和校验和等, 数据部分包括了 DR 和 BDR 的 IP 地址等。此外两个路由器还会互相发送更新链路状态的更新包。

由于接收到的信息非常多, 我们观察部分来得及截取的发包情况发现, 192.168.2.0 网段的 DR 选举过程是: R1 收到了 R2 发来的 HELLO 分组, 指出 DR 和 BDR 都为 192.168.2.1 (R1 的一个接口 IP 地址); 而后 R2 收到 R1 多播一个 HELLO 分组, 指出 DR 为 192.168.2.1, 而 BDR 变为 0.0.0.0; 再然后 R1



又收到了 R2 的 HELLO 分组，指出 DR 为 192.168.2.1，而此时 BDR 为 192.168.2.2（R2 的一个接口 IP 地址），至此 192.168.2.0 网段的 DR 和 BDR 选举完成，往后的 HELLO 分组中 DR 和 BDR 都不变。对于 192.168.1.0 这一网段，由于该网段只有 R1 一个路由器，我们看到了 R1 发送的 HELLO 分组中的 DR 为 192.168.1.1（R1 在该网段的一个接口的 IP 地址），BDR 为 0.0.0.0，一直不变。

[2C、问题：接通后，R1 和 R2 之间的网络的 DR 是 R1，BDR 是 R2。]

[2D、在调试状态下，查看并截屏 R1 和 R2 之间接口接通后数据库同步的发包情况。

命令：#debug ip ospf ! 进入调试状态

#no debug all ! 取消调试状态]

```
*Jun 14 00:41:42: %7: DRouter 192.168.2.1
*Jun 14 00:41:42: %7: BDRouter 192.168.2.2
*Jun 14 00:41:42: %7: # Neighbors 1
*Jun 14 00:41:42: %7: Neighbor 1.1.1.1
*Jun 14 00:41:42: %7:
*Jun 14 00:41:42: %7: NFSM[2.2.2-GigabitEthernet 0/0]: Full (HelloReceived)
*Jun 14 00:41:42: %7: NFSM[2.2.2-GigabitEthernet 0/0]: nfm ignore called
*Jun 14 00:41:42: %7: NFSM[2.2.2-GigabitEthernet 0/0]: Full (2-WayReceived)
*Jun 14 00:41:44: %7: IFSM[GigabitEthernet 0/0:192.168.2.1]: Hello timer expire
*Jun 14 00:41:44: %7: SEND[Hello]: To 224.0.0.5 via GigabitEthernet 0/0:192.168.2.1, length 48
*Jun 14 00:41:44: %7:
*Jun 14 00:41:44: %7: Header
*Jun 14 00:41:44: %7: Version 2
*Jun 14 00:41:44: %7: Type 1 (Hello)
*Jun 14 00:41:44: %7: Packet Len 48
*Jun 14 00:41:44: %7: Router ID 1.1.1.1
*Jun 14 00:41:44: %7: Area ID 0.0.0.0
*Jun 14 00:41:44: %7: Checksum 0x7042
*Jun 14 00:41:44: %7: AuType 0
*Jun 14 00:41:44: %7: Hello
*Jun 14 00:41:44: %7: NetworkMask 255.255.255.0
*Jun 14 00:41:44: %7: HelloInterval 10
*Jun 14 00:41:44: %7: Options 0x2 (-|-|-|-|E|-)
*Jun 14 00:41:44: %7: RtrPriority 255
*Jun 14 00:41:44: %7: RtrDeadInterval 40
*Jun 14 00:41:44: %7: DRouter 192.168.2.1
*Jun 14 00:41:44: %7: BDRouter 192.168.2.2
*Jun 14 00:41:44: %7: # Neighbors 1
*Jun 14 00:41:44: %7: Neighbor 2.2.2.2
*Jun 14 00:41:49: %7:
*Jun 14 00:41:49: %7: LSA[Refresh]: timer expired
*Jun 14 00:41:49: %7: LSA[MaxAge]: Maxage walker finished (0.000000 sec)
*Jun 14 00:41:49: %7: IFSM[GigabitEthernet 0/1:192.168.1.1]: Hello timer expire
*Jun 14 00:41:49: %7: SEND[Hello]: To 224.0.0.5 via GigabitEthernet 0/1:192.168.1.1, length 44
*Jun 14 00:41:49: %7:
*Jun 14 00:41:49: %7: Header
*Jun 14 00:41:49: %7: Version 2
*Jun 14 00:41:49: %7: Type 1 (Hello)
*Jun 14 00:41:49: %7: Packet Len 44
*Jun 14 00:41:49: %7: Router ID 1.1.1.1
*Jun 14 00:41:49: %7: Area ID 0.0.0.0
*Jun 14 00:41:49: %7: Checksum 0x38f3
*Jun 14 00:41:49: %7: AuType 0
*Jun 14 00:41:49: %7: Hello
*Jun 14 00:41:49: %7: NetworkMask 255.255.255.0
*Jun 14 00:41:49: %7: HelloInterval 10
*Jun 14 00:41:49: %7: Options 0x2 (-|-|-|-|E|-)
*Jun 14 00:41:49: %7: RtrPriority 1
*Jun 14 00:41:49: %7: RtrDeadInterval 40
*Jun 14 00:41:49: %7: DRouter 192.168.1.1
*Jun 14 00:41:49: %7: BDRouter 0.0.0.0
*Jun 14 00:41:49: %7: # Neighbors 0
*Jun 14 00:41:52: %7:
*Jun 14 00:41:52: %7: RECV[Hello]: From 2.2.2.2 via GigabitEthernet 0/0:192.168.2.1 (192.168.2.2 -> 224.0.0.5), len = 48, cksum = 0x7140
*Jun 14 00:41:52: %7:
*Jun 14 00:41:52: %7: Header
*Jun 14 00:41:52: %7: Version 2
*Jun 14 00:41:52: %7: Type 1 (Hello)
*Jun 14 00:41:52: %7: Packet Len 48
*Jun 14 00:41:52: %7: Router ID 2.2.2.2
```

[2E、截屏#show ip ospf neighbor 的结果]

R1:

```
13-RSR20-1#show ip ospf neighbor

OSPF process 1, 1 Neighbors, 1 is Full:
Neighbor ID    Pri   State           BFD State  Dead Time   Address        Interface
2.2.2.2        1     Full/BDR        -          00:00:32    192.168.2.2   GigabitEthernet 0/0
```

R2:

```
13-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
1.1.1.1        255   Full/DR        -          00:00:38    192.168.2.1   GigabitEthernet 0/0

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

3、接步骤 2，PC1 和 PC2 同时在控制窗口用命令 telnet 192.168.2.2 进入 R2，并在执行以下命令后截屏：

(config)#sh ip rou



[3A、PC1 截屏]

```
Telnet 192.168.2.2

Translating "config"...
% Unrecognized host or address, or protocol not running.
13-RSR20-2>en 14

Password:
13-RSR20-2#config
Enter configuration commands, one per line. End with CNTL/Z.
13-RSR20-2(config)#show ip rou

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 [110/2] via 192.168.2.1, 00:07:22, GigabitEthernet 0/0
C    192.168.2.0/24 is directly connected, GigabitEthernet 0/0
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    192.168.4.1/32 [110/1] via 192.168.2.1, 00:07:22, GigabitEthernet 0/0
13-RSR20-2(config)#
```

[3B、PC2 截屏]

```
13-RSR20-2(config)#sh ip rou

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 [110/2] via 192.168.2.1, 00:07:25, GigabitEthernet 0/0
C    192.168.2.0/24 is directly connected, GigabitEthernet 0/0
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    192.168.4.1/32 [110/1] via 192.168.2.1, 00:07:25, GigabitEthernet 0/0
13-RSR20-2(config)#
```

[3C、这个步骤说明了什么?]

【实验体会】

写出实验过程中的问题，思考及解决方法，简述实验体会（如果有的话）。要求每个同学分别写并署名。打分是统一的。

【交实验报告】

实验报告上传地址: <http://172.18.187.9/netdisk/default.aspx?vm=17net>

截止日期（不迟于）: 2019 年 6 月 23 日（周日）23:00

每个小组统一交一份实验报告。需填写小组所有同学的学号和姓名。

上传文件名: 最小学号_OSPF 协议.doc

最小学号_OSPF 协议.rar （包含.txt 文件）