

## 一、环境准备

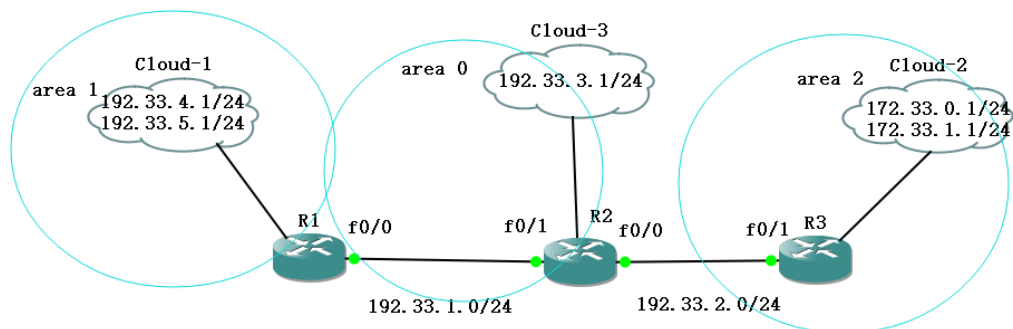
1. 软件：GNS3
2. 路由：c7200

## 二、实验操作

### 实验要求：

- 1、掌握多区域的 OSPF 配置方法。
- 2、区别不同区域的路由。
- 3、掌握 OSPF 的路由汇总配置。
- 4、掌握 OSPF 的基本配置命令。
- 5、掌握 OSPF 接口认证及区域认证的配置方法。

### 实验拓扑：



### 实验过程：

- 1、根据实验拓扑，对路由器各接口配置 IP 地址。
- 2、在各路由器上配置 OSPF 协议。

#### R1 上的配置清单：

```
R1(config)#router ospf 33

R1(config-router)#net

R1(config-router)#network 192.33.4.0 0.0.0.255 area 1
```

```
R1(config-router)#network 192.33.5.0 0.0.0.255 area 1
```

```
R1(config-router)#network 192.33.1.0 0.0.0.255 area 0
```

R2 上的配置清单：

```
R2(config)#router ospf 33
```

```
R2(config-router)#network 192.33.1.0 0.0.0.255 area 0
```

```
R2(config-router)#network 192.33.3.0 0.0.0.255 area 0
```

```
R2(config-router)#network 192.33.2.0 0.0.0.255 area 2
```

R3 上的配置清单：

```
R3(config)#router ospf 33
```

```
R3(config-router)#network 192.33.2.0 0.0.0.255 area 2
```

```
R3(config-router)#network 172.33.0.0 0.0.0.255 area 2
```

```
R3(config-router)#network 172.33.1.0 0.0.0.255 area 2
```

问题 1：在 R2 上查看邻居信息，一共有几个邻居？邻居的路由 ID 是多少？

参考命令：

```
show ip ospf neighbor
```

答：一共有两个邻居，邻居 ID 为：192.33.4.1 、192.33.0.1

```
R2#show ip ospf neighbor
```

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.33.4.1	1	FULL/DR	00:00:33	192.33.1.1	FastEthernet0/1
172.33.0.1	1	FULL/BDR	00:00:33	192.33.2.2	FastEthernet0/0

```
R2#
```

问题 2：在 R3 上查看 OSPF 链路状态数据库，一共有几种链路状态，哪几种？

参考命令：

```
show ip ospf database
```

答：共有三种链路状态：Router Link States、Net Link States、Summary Net Link States。

```

R3#show ip ospf database

                OSPF Router with ID (172.33.0.1) (Process ID 33)

                Router Link States (Area 2)

Link ID        ADV Router    Age         Seq#          Checksum Link count
172.33.0.1     172.33.0.1     544        0x80000002   0x0061A8 3
192.33.3.1     192.33.3.1     545        0x80000002   0x00E7B3 1

                Net Link States (Area 2)

Link ID        ADV Router    Age         Seq#          Checksum
192.33.2.1     192.33.3.1     545        0x80000001   0x00B703

                Summary Net Link States (Area 2)

Link ID        ADV Router    Age         Seq#          Checksum
192.33.1.0     192.33.3.1     585        0x80000001   0x00462D
192.33.3.1     192.33.3.1     585        0x80000001   0x00264A
192.33.4.1     192.33.3.1     541        0x80000001   0x002549
192.33.5.0     192.33.3.1     541        0x80000001   0x00244A
R3#

```

问题 3：在 R1 上查看路由表，有哪些是其他区域路由？

答：其他区域路由条目

```

O IA    172.33.1.0/24 [110/3] via 192.33.1.2, 02:41:47, FastEthernet0/0
O IA    172.33.0.1/32 [110/3] via 192.33.1.2, 02:41:47, FastEthernet0/0
O IA    192.33.2.0/24 [110/2] via 192.33.1.2, 02:41:47, FastEthernet0/0

```

```

R1#show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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

    172.33.0.0/16 is variably subnetted, 2 subnets, 2 masks
O IA  172.33.1.0/24 [110/3] via 192.33.1.2, 02:41:47, FastEthernet0/0
O IA  172.33.0.1/32 [110/3] via 192.33.1.2, 02:41:47, FastEthernet0/0
C     192.33.4.0/24 is directly connected, Loopback0
C     192.33.5.0/24 is directly connected, Loopback0
C     192.33.1.0/24 is directly connected, FastEthernet0/0
O IA  192.33.2.0/24 [110/2] via 192.33.1.2, 02:41:47, FastEthernet0/0
      192.33.3.0/32 is subnetted, 1 subnets
O     192.33.3.1 [110/2] via 192.33.1.2, 02:41:47, FastEthernet0/0
R1#

```

### 3、区域汇总

在路由器 R1 中查看链路状态数据库，会发现有 2 条类型 3 的 LSA，我们可以在路由器 R2（ABR）上进行区域汇总，减少路由条目。

参考命令：

```
R2(config)#router ospf 33
```

```
R2(config-router)#area 2 range 172.33.0.0 255.255.0.0
```

问题 4：在每个路由器上清空路由表，查看 R1 上路由表有什么变化？

答：172.33.0.1/24 和 172.33.1.1/24 两个网络的路由条目汇总为一条路由条目。

初始 R1 路由：

```
R1#show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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

    172.33.0.0/16 is variably subnetted, 2 subnets, 2 masks
O IA   172.33.1.0/24 [110/3] via 192.33.1.2, 03:35:49, FastEthernet0/0
O IA   172.33.0.1/32 [110/3] via 192.33.1.2, 03:35:49, FastEthernet0/0
C      192.33.4.0/24 is directly connected, Loopback0
C      192.33.5.0/24 is directly connected, Loopback0
C      192.33.1.0/24 is directly connected, FastEthernet0/0
O IA   192.33.2.0/24 [110/2] via 192.33.1.2, 03:35:49, FastEthernet0/0
       192.33.3.0/32 is subnetted, 1 subnets
O      192.33.3.1 [110/2] via 192.33.1.2, 03:35:49, FastEthernet0/0
R1#
```

改变 R1 路由：

```
R1#show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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 IA 172.33.0.0/16 [110/3] via 192.33.1.2, 00:00:46, FastEthernet0/0
C     192.33.4.0/24 is directly connected, Loopback0
C     192.33.5.0/24 is directly connected, Loopback0
C     192.33.1.0/24 is directly connected, FastEthernet0/0
O IA 192.33.2.0/24 [110/2] via 192.33.1.2, 03:45:21, FastEthernet0/0
       192.33.3.0/32 is subnetted, 1 subnets
O     192.33.3.1 [110/2] via 192.33.1.2, 03:45:21, FastEthernet0/0
R1#
```

同样我们可以在 R1 上对区域 1 的路由进行汇总，

参考命令：

```
R1(config-router)#area 1 range 192.33.4.0 255.255.254.0
```

问题 5：在每个路由器上清空路由表，查看 R3 上路由表有什么变化？

答：R3 路由器上对路由器 R1 上的 Loopback 0 接口的网络进行了汇总。

```
R3#show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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

    172.33.0.0/24 is subnetted, 2 subnets
C      172.33.1.0 is directly connected, Loopback0
C      172.33.0.0 is directly connected, Loopback0
O IA   192.33.1.0/24 [110/2] via 192.33.2.1, 00:00:01, FastEthernet0/1
C      192.33.2.0/24 is directly connected, FastEthernet0/1
    192.33.3.0/32 is subnetted, 1 subnets
O IA   192.33.3.1 [110/2] via 192.33.2.1, 00:00:01, FastEthernet0/1
O IA   192.33.4.0/23 [110/3] via 192.33.2.1, 00:00:01, FastEthernet0/1
R3#
```

4、在 R1 和 R2 上启用接口认证

明文认证：

R1 上的参考命令：

```
R1(config)#int f0/0

R1(config-if)#ip ospf authentication

R1(config-if)#ip ospf authentication-key jtc
```

问题 6：配置后等待若干秒，在 R1 上查看路由表，还能看到 R2 和 R3 上的路由吗？

答：在 R1 上查看路由表，不能看到 R2 和 R3 上的路由条目。

```
R1#show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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      192.33.4.0/24 is directly connected, Loopback0
C      192.33.5.0/24 is directly connected, Loopback0
C      192.33.1.0/24 is directly connected, FastEthernet0/0
O      192.33.4.0/23 is a summary, 00:00:05, Null0
R1#
```

问题 7：参考 R1 的配置在 R2 的接口 f0/1 上配置认证，配置后等若干秒，在 R1 上能看到其他路由器上的路由吗？

答：在 R1 上查看路由表，能看到 R2 和 R3 上的路由条目。

```

R1#show ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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 IA 172.33.0.0/16 [110/3] via 192.33.1.2, 00:00:04, FastEthernet0/0
C     192.33.4.0/24 is directly connected, Loopback0
C     192.33.5.0/24 is directly connected, Loopback0
C     192.33.1.0/24 is directly connected, FastEthernet0/0
O IA 192.33.2.0/24 [110/2] via 192.33.1.2, 00:00:04, FastEthernet0/0
     192.33.3.0/32 is subnetted, 1 subnets
O       192.33.3.1 [110/2] via 192.33.1.2, 00:00:04, FastEthernet0/0
O     192.33.4.0/23 is a summary, 00:00:04, Null0
R1#

```

5、密文认证：在 R2 和 R3 的接口上配置密文，参考下列命令配置密文认证，检查结果。

R2 上的参考命令：

```

R2(config)#interface f0/0

R2(config-if)#ip ospf authentication message-digest

R2(config-if)#ip ospf message-digest-key 1 md5 jtc

```

在 R3 的 f0/1 接口上参考 R1 的配置进行配置。