

# 浙江大学

## 本科实验报告

课程名称：网络系统设计与工程

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学 院：计算机学院与软件学院

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# 浙江大学实验报告

课程名称： 网络系统设计与工程 实验类型： 设计性实验

实验项目名称： 动态路由协议OSPF实验

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实验地点： 网络实验室 实验日期： 2015 年 6 月 17 日

## 一. 实验目的和要求

1. 理解链路状态路由协议的工作原理。
2. 理解OSPF协议的工作机制。
3. 掌握配置和调试OSPF协议的方法。

## 二. 实验内容和原理

本实验由**2**部分组成。

### 第一部分 单域OSPF路由协议配置

1. 搭建实验环境，由3个以上路由器通过以太网互联构成，每个路由器分别与一台PC连接，构成一个IP子网；
2. 给各个子网分配地址（采用非标准类别的子网掩码），并配置各路由器端口；
3. 测试直连PC与路由器之间的联通性，以及直连路由器之间的联通性；
4. 去除路由器内的静态路由设置和其他的动态路由协议设置；
5. 给各路由器配置Loopback地址；
6. 在各路由器上配置OSPF路由协议（所有的路由器接口都属于Area 0）；
7. 测试各PC之间的联通性，查看各路由器的路由表；
8. 查看各路由器上OSPF状态和数据（如：Router ID选择了哪个地址）；
9. 断开某个路由器的接口，查看路由表和OSPF状态和数据的变化；

10. 改变路由器之间的连接，查看路由表和OSPF状态和数据的变化；

## 第二部分 多域OSPF路由协议配置

1. 在第一部分的实验环境的基础上，添加1台路由器；
2. 在网络中设置多个Area，让部分路由器属于不同的Area；
3. 根据所属Area，重新给各路由器配置OSPF；
4. 测试各PC之间的联通性，查看各路由器的路由表；
5. 查看各路由器上OSPF状态和数据；

### 三. 主要仪器设备

PC机、路由器、Console连接线、直联网络线、交叉网络线

其中，路由器R1型号为\_\_\_\_\_Cisco 2800\_\_\_\_\_

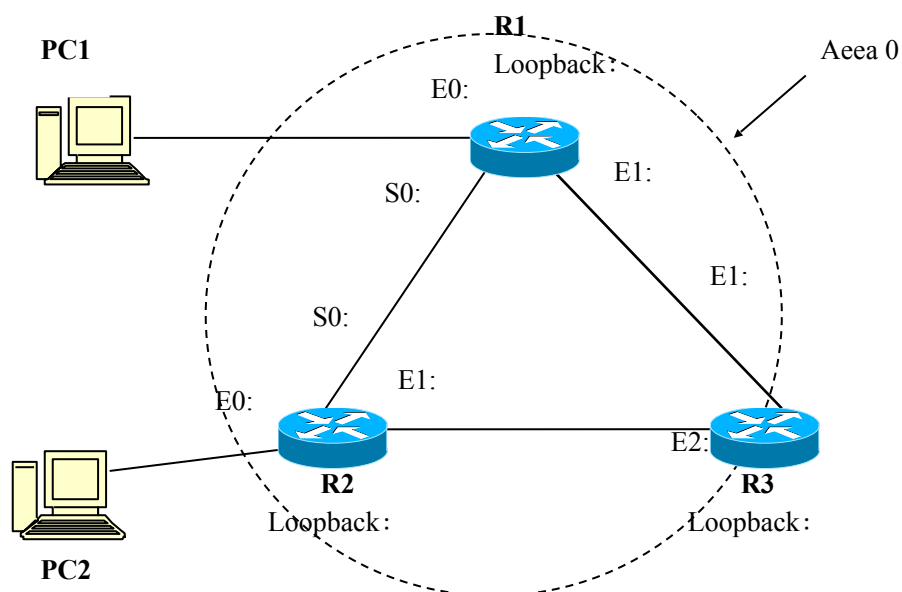
路由器R2型号为\_\_\_\_\_Cisco 1900\_\_\_\_\_

路由器R3型号为\_\_\_\_\_Cisco 1900\_\_\_\_\_

路由器R4型号为\_\_\_\_\_Cisco 3700\_\_\_\_\_

### 四. 操作方法与实验步骤

#### 第一部分 单域OSPF路由协议配置



1. 如图连接设备，搭建实验环境，R1与R2之间采用Serial口连接，R1与R3之间采用

Ethernet口连接，R2和R3之间也采用Ethernet口连接，R4与R3采用Serial口连接

2. 给各个子网分配地址：使用同一组网络地址，但采用非标准类别的子网掩码进行子网扩展，如A类地址使用255.255.0.0，B类地址使用255.255.255.0
3. 按图对各路由器配置主机名，并根据分配的IP地址，配置路由器的Ethernet端口和Serial端口
4. 配置各路由器的Loopback地址
  - a) Router(config)# interface loopback 0
  - b) Router(config-if)# ip address < ip> <mask>
5. 配置各PC的IP地址，并将PC1、PC2、PC3的默认网关分别设置为R1、R2、R4的相应端口IP地址
6. 去除路由器内的静态路由设置和其他的动态路由协议设置

```
Router(config)# no router rip
Router(config)# no ip route <ip_net> <mask> <next_hop>
```
7. 在各路由器上激活OSPF协议（进程号可以任意取，Area统一设置为0）

```
Router(config)# router ospf <process-id>
```
8. 将各网络加入到路由信息交换队列

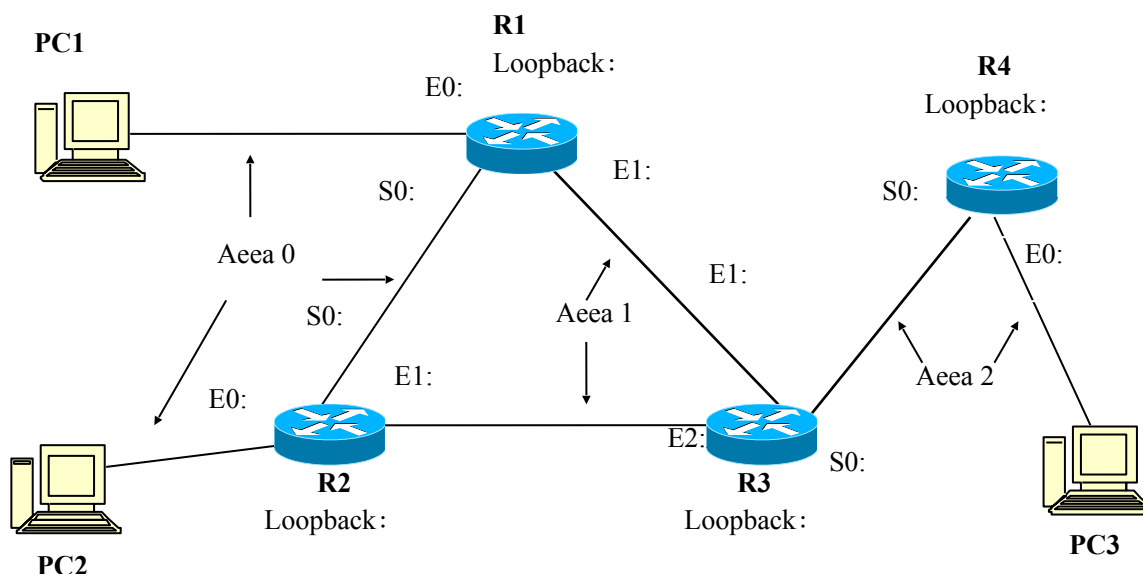
```
Router(config-router)# network <ip_net> <mask> area <area-id>
```
9. 通过Ping检查PC2和R2的各接口之间的联通性
10. 观察各路由器的路由表，特别是R1会选择哪条路由到达PC2所在的网络
11. 观察各路由器的OSPF邻居关系，并注意观察路由器选择了哪个地址作为RouterID

```
Router# show ip ospf neighbor detail
```
12. 观察各路由器的OSPF学习到的拓扑数据，看是否与实际相符

```
Router# show ip ospf database
```
13. 使用debug命令分析路由器之间交换的路由信息

```
Router# debug ip ospf
```
14. 断开R2和R3的网络连接，查看OSPF的数据变化以及路由表的变化，并测试PC间的联通性

## 第二部分 多域OSPF路由协议配置



1. 在第一部分的网络实验环境基础上，增加一台路由器和PC机，如图所示连接
2. 给路由器R4的各接口配置IP地址
3. 给PC3配置IP地址，并设置默认网关为R4
4. 在路由器R4上启用OSPF路由协议
5. 将各网络加入到路由信息交换队列，按图重新指定各网络地址所属的Area
6. 测试各PC间的联通性，特别是PC3与其他PC间的联通性
7. 由于Area 2没有物理上直接与Area 0连接，所以需要利用Area 1作为中介，在R3和R1之间为Area 2建立一个虚链路，<area-id>填写1（Area 1为用于传递数据的区域），<routerID>分别设为对方的RouterID

```
Router(config-router)# area <area-id> virtual-link <routerID>
```

8. 测试PC3与其他PC间的联通性
9. 查看各路由器中的路由表，特别是R4是否对Area 0中的网络地址进行了自动合并，也可以手工指定特定路由进行合并：

```
Router(config-router)# area <area-id> range <ip_net> <mask>
```

10. 查看各路由器中OSPF的数据和状态

```
Router# show ip ospf database
```

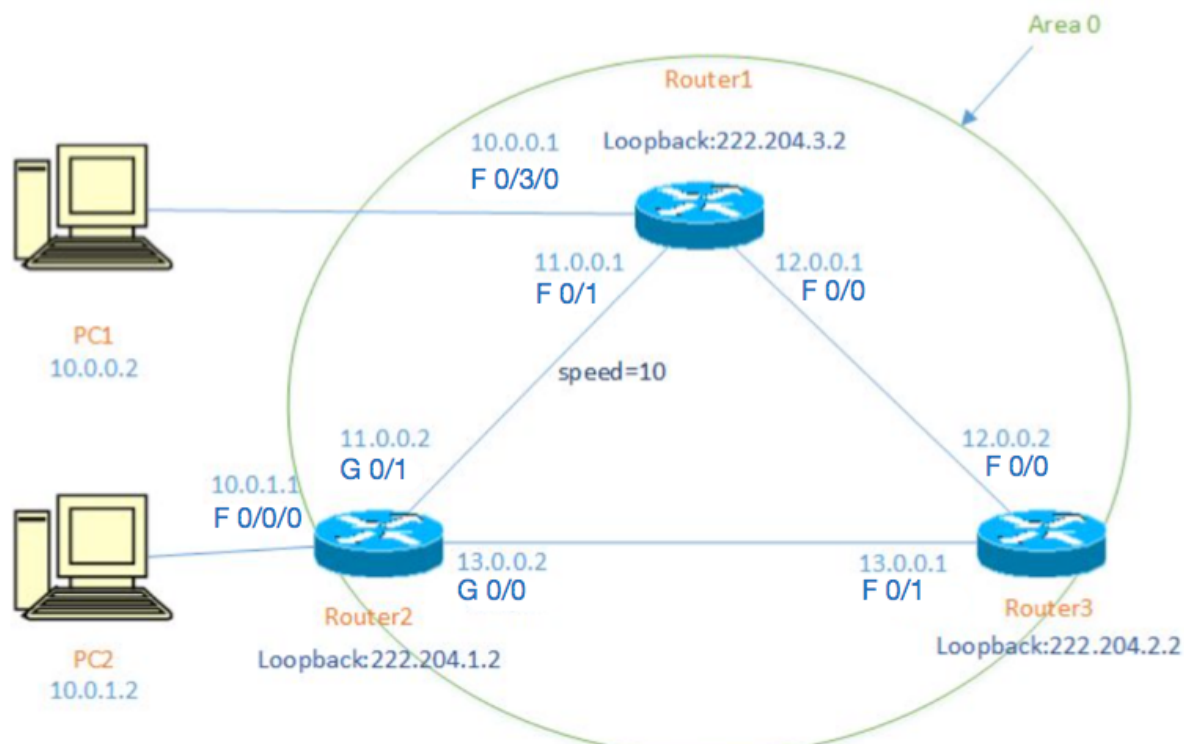
```
Router# show ip ospf neighbor detail
```

11. 使用debug命令查看不同Area之间路由器是否会交换路由信息

## 五. 实验数据记录和处理

### 第一部分 单域OSPF路由协议配置

实验拓扑图（请在图中描述接口信息、IP地址）



所使用的命令及实验数据

1. 配置路由器R1的命令（接口、OSPF）：

R1寄存器f 0/3/0端口配置

```
R1#config t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#interface f 0/3/0
R1(config-if)#no shutdown
R1(config-if)#ip address 10.0.0.1 255.255.255.0

% IP addresses may not be configured on L2 links.
R1(config-if)#
```

```
R1(config)#interface vlan 1
R1(config-if)#ip address 10.0.0.1 255.255.255.0
R1(config-if)#
```

### R1寄存器f 0/0端口配置

```
R1(config)#int f 0/0
R1(config-if)#ip address 12.0.0.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#
```

### R1寄存器f 0/1端口配置

```
R1(config)#int f 0/1
R1(config-if)#ip address 11.0.0.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#
```

### R1 loopback配置

```
R1(config)#interface loopback 0
R1(config-if)#ip address 222.204.3.2 255.255.255.255
R1(config-if)#
```

### R1 ospf配置

```
R1(config)#no router rip
R1(config)#router ospf 100
R1(config-router)#network 10.0.0.0 0.255.255.255 area 0
R1(config-router)#network 11.0.0.0 0.255.255.255 area 0
R1(config-router)#network 12.0.0.0 0.255.255.255 area 0
R1(config-router)#exit
R1(config)#
```

## 2. 配置路由器R2的命令（接口、OSPF）：

### R2寄存器f 0/0/0端口配置

```
R2(config)#interface f 0/0/0
R2(config-if)#ip address 10.0.1.1 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#
```

### R2寄存器g 0/0端口配置

```
R2(config)#interface g 0/0
R2(config-if)#ip address 13.0.0.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#
```

### R2寄存器g 0/1端口配置

```
R2(config)#interface g 0/1
R2(config-if)#ip address 11.0.0.2 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)#
```

### R2 loopback配置

```
R2(config)#interface loopback 0
R2(config-if)#ip address 222.204.1.2 255.255.255.255
R2(config-if)#
```

### R2 ospf配置

```
R2(config)#no router rip
R2(config)#router ospf 100
R2(config-router)#network 10.0.1.0 0.255.255.255 area 0
R2(config-router)#network 11.0.0.0 0.255.255.255 area 0
R2(config-router)#network 13.0.0.0 0.255.255.255 area 0
R2(config-router)#
```

## 3. 配置路由器R3的命令（接口、OSPF）：

### R3寄存器f 0/0/0端口配置

```
R3(config)#interface f 0/0/0
R3(config-if)#ip address 12.0.0.2 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#
```

### R3寄存器f 0/0/1端口配置

```
R3(config)#interface f 0/0/1
R3(config-if)#ip address 13.0.0.1 255.255.255.0
R3(config-if)#no shutdown
```

### R3 loopback配置

```
R3(config)#interface loopback 0
R3(config-if)#ip address 222.204.2.2 255.255.255.255
R3(config-if)#
```

### R3 ospf配置

```
R3(config)#no router rip
R3(config)#router ospf 100
R3(config-router)#network 12.0.0.0 0.255.255.255 area 0
R3(config-router)#network 13.0.0.0 0.255.255.255 area 0
R3(config-router)#
```



#### 4. 配置R1与R2之间bandwidth

R1 f 0/1 bandwidth

```
R1(config)#interface f 0/1
R1(config-if)#bandwidth 10
R1(config-if)#
```

R2 g 0/1 bandwidth

```
R2(config)#interface g 0/1
R2(config-if)#bandwidth 10
R2(config-if)#
```

#### 5. 在PC1、PC2上设置的默认网关分别为：

PC1 ip 配置

常规

如果网络支持此功能，则可以获取自动指派的 IP 设置。否则，您需从网络系统管理员处获得适当的 IP 设置。

☐ 自动获得 IP 地址 (0)

☒ 使用下面的 IP 地址 (S):

IP 地址 (I): 10 . 0 . 0 . 2

子网掩码 (M): 255 . 255 . 255 . 0

默认网关 (D): 10 . 0 . 0 . 1

PC2 ip 配置

常规

如果网络支持此功能，则可以获取自动指派的 IP 设置。否则，您需从网络系统管理员处获得适当的 IP 设置。

☐ 自动获得 IP 地址 (0)

☒ 使用下面的 IP 地址 (S):

IP 地址 (I): 10 . 0 . 1 . 2

子网掩码 (M): 255 . 255 . 255 . 0

默认网关 (D): 10 . 0 . 1 . 1

#### 5. 使用Ping测试各PC之间的结果：

PC1 ping PC2，可以ping通；

```
C:\Users\root>ping 10.0.1.2
```

正在 Ping 10.0.1.2 具有 32 字节的数据:

来自 10.0.1.2 的回复: 字节=32 时间<1ms TTL=125

来自 10.0.1.2 的回复: 字节=32 时间<1ms TTL=125

来自 10.0.1.2 的回复: 字节=32 时间<1ms TTL=125

来自 10.0.1.2 的回复: 字节=32 时间<1ms TTL=125

10.0.1.2 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 = 0ms, 平均 = 0ms

PC2 ping PC1, 可以ping通;

```
C:\Users\root>ping 10.0.0.2

正在 Ping 10.0.0.2 具有 32 字节的数据:
来自 10.0.0.2 的回复: 字节=32 时间=1ms TTL=125
来自 10.0.0.2 的回复: 字节=32 时间<1ms TTL=125
来自 10.0.0.2 的回复: 字节=32 时间<1ms TTL=125
来自 10.0.0.2 的回复: 字节=32 时间<1ms TTL=125

10.0.0.2 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 = 1ms, 平均 = 0ms
```

6. 显示R1、R2、R3的路由表内容（断开R2和R3之间网络连接的前后数据比较）：  
断开前，R1路由表：

```
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

    222.204.3.0/32 is subnetted, 1 subnets
C       222.204.3.2 is directly connected, Loopback0
    10.0.0.0/24 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, Vlan1
O       10.0.1.0 [110/3] via 12.0.0.2, 00:07:57, FastEthernet0/0
    11.0.0.0/24 is subnetted, 1 subnets
C       11.0.0.0 is directly connected, FastEthernet0/1
    12.0.0.0/24 is subnetted, 1 subnets
C       12.0.0.0 is directly connected, FastEthernet0/0
    13.0.0.0/24 is subnetted, 1 subnets
O       13.0.0.0 [110/2] via 12.0.0.2, 00:07:57, FastEthernet0/0
R1#
```

断开前，R2路由表：

```
R2#show ip route
Codes: L - local, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O       10.0.0.0/24 [110/3] via 13.0.0.1, 00:08:40, GigabitEthernet0/0
C       10.0.1.0/24 is directly connected, FastEthernet0/0/0
L       10.0.1.1/32 is directly connected, FastEthernet0/0/0
    11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       11.0.0.0/24 is directly connected, GigabitEthernet0/1
L       11.0.0.2/32 is directly connected, GigabitEthernet0/1
    12.0.0.0/24 is subnetted, 1 subnets
O       12.0.0.0 [110/2] via 13.0.0.1, 00:15:55, GigabitEthernet0/0
    13.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       13.0.0.0/24 is directly connected, GigabitEthernet0/0
L       13.0.0.2/32 is directly connected, GigabitEthernet0/0
    222.204.1.0/32 is subnetted, 1 subnets
C       222.204.1.2 is directly connected, Loopback0
R2#
```

断开前，R3路由表：

```
R3#show ip route
Codes: L - local, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/24 is subnetted, 2 subnets
O       10.0.0.0 [110/2] via 12.0.0.1, 00:09:17, FastEthernet0/0/0
O       10.0.1.0 [110/2] via 13.0.0.2, 00:17:35, FastEthernet0/0/1
    11.0.0.0/24 is subnetted, 1 subnets
O       11.0.0.0 [110/10001] via 13.0.0.2, 00:17:35, FastEthernet0/0/1
           [110/10001] via 12.0.0.1, 00:09:17, FastEthernet0/0/0
    12.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       12.0.0.0/24 is directly connected, FastEthernet0/0/0
L       12.0.0.2/32 is directly connected, FastEthernet0/0/0
    13.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       13.0.0.0/24 is directly connected, FastEthernet0/0/1
L       13.0.0.1/32 is directly connected, FastEthernet0/0/1
    222.204.2.0/32 is subnetted, 1 subnets
C       222.204.2.2 is directly connected, Loopback0
R3#
```

断开后，R1路由表：

```
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

    222.204.3.0/32 is subnetted, 1 subnets
C       222.204.3.2 is directly connected, Loopback0
    10.0.0.0/24 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, Vlan1
O       10.0.1.0 [110/10001] via 11.0.0.2, 00:01:29, FastEthernet0/1
    11.0.0.0/24 is subnetted, 1 subnets
C       11.0.0.0 is directly connected, FastEthernet0/1
    12.0.0.0/24 is subnetted, 1 subnets
C       12.0.0.0 is directly connected, FastEthernet0/0
R1#
```

断开后，R2路由表：

```
R2#show ip route
Codes: L - local, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O       10.0.0.0/24 [110/10001] via 11.0.0.1, 00:02:39, GigabitEthernet0/1
C       10.0.1.0/24 is directly connected, FastEthernet0/0/0
L       10.0.1.1/32 is directly connected, FastEthernet0/0/0
    11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       11.0.0.0/24 is directly connected, GigabitEthernet0/1
L       11.0.0.2/32 is directly connected, GigabitEthernet0/1
    12.0.0.0/24 is subnetted, 1 subnets
O       12.0.0.0 [110/10001] via 11.0.0.1, 00:02:39, GigabitEthernet0/1
    222.204.1.0/32 is subnetted, 1 subnets
C       222.204.1.2 is directly connected, Loopback0
R2#
```

断开后，R3路由表：

```
R3#show ip route
Codes: L - local, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/24 is subnetted, 2 subnets
O       10.0.0.0 [110/2] via 12.0.0.1, 00:28:46, FastEthernet0/0/0
O       10.0.1.0 [110/10002] via 12.0.0.1, 00:03:07, FastEthernet0/0/0
    11.0.0.0/24 is subnetted, 1 subnets
O       11.0.0.0 [110/10001] via 12.0.0.1, 00:28:46, FastEthernet0/0/0
    12.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       12.0.0.0/24 is directly connected, FastEthernet0/0/0
L       12.0.0.2/32 is directly connected, FastEthernet0/0/0
    222.204.2.0/32 is subnetted, 1 subnets
C       222.204.2.2 is directly connected, Loopback0
R3#
```

7. 显示R1、R2、R3的OSPF数据信息（断开R2和R3之间网络连接的前后数据比较）：

断开前，R1 ospf neighbor detail:

```
R1#show ip ospf neighbor detail
Neighbor 222.204.2.2, interface address 12.0.0.2
  In the area 0 via interface FastEthernet0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 12.0.0.2 BDR is 12.0.0.1
  Options is 0x52
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:31
  Neighbor is up for 00:12:54
  Index 2/2, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 222.204.1.2, interface address 11.0.0.2
  In the area 0 via interface FastEthernet0/1
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 11.0.0.2 BDR is 11.0.0.1
  Options is 0x52
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:34
  Neighbor is up for 00:13:31
  Index 1/1, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R1#
```

断开前，R1 ospf database:

```
R1#show ip ospf database

        OSPF Router with ID (222.204.3.2) (Process ID 100)

        Router Link States (Area 0)

Link ID        ADV Router    Age         Seq#          Checksum Link count
222.204.1.2    222.204.1.2   1014       0x800000016  0x0065C1  3
222.204.2.2    222.204.2.2   976        0x800000013  0x002C4D  2
222.204.3.2    222.204.3.2   975        0x80000000E  0x00FF2F  3

        Net Link States (Area 0)

Link ID        ADV Router    Age         Seq#          Checksum
11.0.0.2       222.204.1.2   1014       0x800000001  0x00B866
12.0.0.2       222.204.2.2   976        0x800000001  0x00AD6E
13.0.0.1       222.204.2.2   1468       0x800000003  0x008C8F
R1#
```

断开前，R2 ospf neighbor detail:

```
R2#show ip ospf neighbor detail
Neighbor 222.204.2.2, interface address 13.0.0.1
  In the area 0 via interface GigabitEthernet0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 13.0.0.1 BDR is 13.0.0.2
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:33
  Neighbor is up for 00:22:45
  Index 1/1, retransmission queue length 0, number of retransmission 1
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 1, maximum is 1
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 222.204.3.2, interface address 11.0.0.1
  In the area 0 via interface GigabitEthernet0/1
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 11.0.0.2 BDR is 11.0.0.1
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:39
  Neighbor is up for 00:14:31
  Index 2/2, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R2#
```

断开前，R2 ospf database:

```
R2#show ip ospf database

          OSPF Router with ID (222.204.1.2) (Process ID 100)

          Router Link States (Area 0)

Link ID        ADV Router    Age         Seq#          Checksum Link count
222.204.1.2    222.204.1.2   1033        0x80000016   0x0065C1 3
222.204.2.2    222.204.2.2   997         0x80000013   0x002C4D 2
222.204.3.2    222.204.3.2   997         0x8000000E   0x00FF2F 3

          Net Link States (Area 0)

Link ID        ADV Router    Age         Seq#          Checksum
11.0.0.2       222.204.1.2   1033        0x80000001   0x00B866
12.0.0.2       222.204.2.2   997         0x80000001   0x00AD6E
13.0.0.1       222.204.2.2   1489        0x80000003   0x008C8F
R2#
```

断开前，R3 ospf neighbor detail:

```
R3#show ip ospf neighbor detail
Neighbor 222.204.1.2, interface address 13.0.0.2
  In the area 0 via interface FastEthernet0/0/1
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 13.0.0.1 BDR is 13.0.0.2
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:33
  Neighbor is up for 00:24:26
  Index 1/1, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 222.204.3.2, interface address 12.0.0.1
  In the area 0 via interface FastEthernet0/0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 12.0.0.2 BDR is 12.0.0.1
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:36
  Neighbor is up for 00:15:34
  Index 2/2, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R3#
```

断开前，R3 ospf database:

```
R3#show ip ospf database

        OSPF Router with ID (222.204.2.2) (Process ID 100)

        Router Link States (Area 0)

Link ID        ADV Router    Age          Seq#           Checksum Link count
222.204.1.2    222.204.1.2   1043        0x800000016   0x0065C1 3
222.204.2.2    222.204.2.2   1004        0x800000013   0x002C4D 2
222.204.3.2    222.204.3.2   1005        0x80000000E   0x00FF2F 3

        Net Link States (Area 0)

Link ID        ADV Router    Age          Seq#           Checksum
11.0.0.2       222.204.1.2   1043        0x800000001   0x00B866
12.0.0.2       222.204.2.2   1004        0x800000001   0x00AD6E
13.0.0.1       222.204.2.2   1496        0x800000003   0x008C8F
R3#
```



断开后，R1 ospf neighbor detail:

```
R1#show ip ospf neighbor detail
Neighbor 222.204.2.2, interface address 12.0.0.2
  In the area 0 via interface FastEthernet0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 12.0.0.2 BDR is 12.0.0.1
  Options is 0x52
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:31
  Neighbor is up for 00:31:15
  Index 2/2, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 222.204.1.2, interface address 11.0.0.2
  In the area 0 via interface FastEthernet0/1
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 11.0.0.2 BDR is 11.0.0.1
  Options is 0x52
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:30
  Neighbor is up for 00:31:53
  Index 1/1, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R1#
```

断开后，R1 ospf database:

```
R1# show ip ospf database

        OSPF Router with ID (222.204.3.2) (Process ID 100)

        Router Link States (Area 0)

Link ID        ADV Router    Age          Seq#          Checksum Link count
222.204.1.2    222.204.1.2    246         0x80000017   0x0067EB 2
222.204.2.2    222.204.2.2    243         0x80000015   0x006142 1
222.204.3.2    222.204.3.2    1787        0x8000000E   0x00FF2F 3

        Net Link States (Area 0)

Link ID        ADV Router    Age          Seq#          Checksum
11.0.0.2       222.204.1.2    1826        0x80000001   0x00B866
12.0.0.2       222.204.2.2    1788        0x80000001   0x00AD6E
R1#
```



断开后，R2 ospf neighbor detail:

```
R2#show ip ospf neighbor detail
Neighbor 222.204.3.2, interface address 11.0.0.1
  In the area 0 via interface GigabitEthernet0/1
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 11.0.0.2 BDR is 11.0.0.1
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:39
  Neighbor is up for 00:32:11
  Index 2/2, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R2#
```

断开后，R2 ospf database:

```
R2# show ip ospf database

        OSPF Router with ID (222.204.1.2) (Process ID 100)

        Router Link States (Area 0)

Link ID        ADV Router    Age         Seq#          Checksum Link count
222.204.1.2    222.204.1.2    277        0x80000017   0x0067EB 2
222.204.2.2    222.204.2.2    277        0x80000015   0x006142 1
222.204.3.2    222.204.3.2    1821       0x8000000E   0x00FF2F 3

        Net Link States (Area 0)

Link ID        ADV Router    Age         Seq#          Checksum
11.0.0.2       222.204.1.2    1857       0x80000001   0x00B866
12.0.0.2       222.204.2.2    1820       0x80000001   0x00AD6E
R2#
```

断开后，R3 ospf neighbor detail:

```
R3#show ip ospf neighbor detail
Neighbor 222.204.3.2, interface address 12.0.0.1
  In the area 0 via interface FastEthernet0/0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 12.0.0.2 BDR is 12.0.0.1
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:32
  Neighbor is up for 00:31:48
  Index 2/2, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R3#
```

断开后，R3 ospf database:

```
R3# show ip ospf database

      OSPF Router with ID (222.204.2.2) (Process ID 100)

      Router Link States (Area 0)

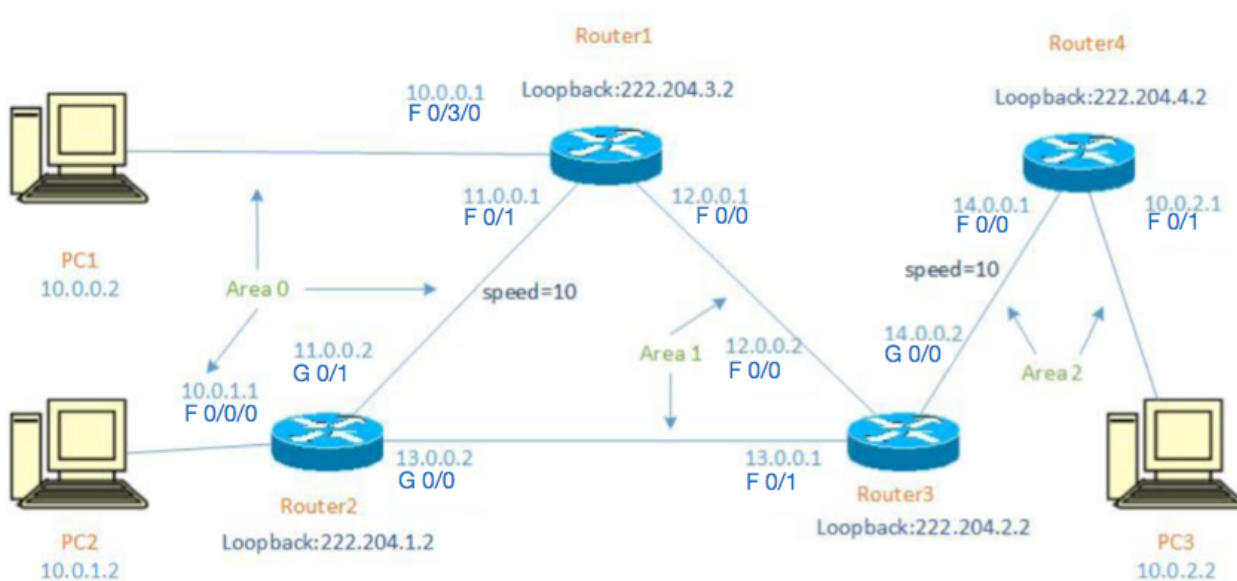
Link ID        ADV Router    Age          Seq#           Checksum Link count
222.204.1.2    222.204.1.2   306          0x800000017   0x0067EB 2
222.204.2.2    222.204.2.2   301          0x800000015   0x006142 1
222.204.3.2    222.204.3.2   1847         0x80000000E   0x00FF2F 3

      Net Link States (Area 0)

Link ID        ADV Router    Age          Seq#           Checksum
11.0.0.2       222.204.1.2   1885         0x800000001   0x00B866
12.0.0.2       222.204.2.2   1846         0x800000001   0x00AD6E
R3#
```

## 第二部分 多域OSPF路由协议配置

实验拓扑图（请在图中描述接口信息、IP地址）



所使用的命令及实验数据

1. 配置路由器R1、R2、R3的命令（接口、OSPF）：

R1 ospf area 1 配置

```
R1(config)#router ospf 100
R1(config-router)#network 12.0.0.0 0.255.255.255 area 1
R1(config-router)#
```

R2 ospf area 1 配置

```
R2(config)#router ospf 100
R2(config-router)#network 13.0.0.0 0.255.255.255 area 1
R2(config-router)#
```

R3 g 0/0端口配置

```
R3(config)#interface g 0/0
R3(config-if)#ip address 14.0.0.2 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#
```

R3 ospf 配置

```
R3(config)#router ospf 100
R3(config-router)#network 13.0.0.0 0.255.255.255 area 1
R3(config-router)#network 12.0.0.0 0.255.255.255 area 1
R3(config-router)#network 14.0.0.0 0.255.255.255 area 2
R3(config-router)#
```

## 2. 配置路由器R4的命令（接口、OSPF）：

R4 f 0/0端口配置

```
R4(config)#interface f 0/0
R4(config-if)#ip address 14.0.0.1 255.255.255.0
R4(config-if)#no shutdown
R4(config-if)#
```

R4 f 0/0端口配置

```
R4(config)#interface f 0/1
R4(config-if)#ip address 10.0.2.1 255.255.255.0
R4(config-if)#no shutdown
R4(config-if)#
```

R4 loopback配置

```
R4(config)#interface loopback 0
R4(config-if)#ip address 222.204.4.2 255.255.255.255
R4(config-if)#
```

R4 router ospf配置

```
R4(config)#router ospf 100
R4(config-router)#network 14.0.0.0 0.255.255.255 area 2
R4(config-router)#network 10.0.0.0 0.255.255.255 area 2
R4(config-router)#
```

### 3. 在PC3上设置的默认网关分别为：

常规

如果网络支持此功能，则可以获取自动指派的 IP 设置。否则，您需要从网络系统管理员处获得适当的 IP 设置。

☐ 自动获得 IP 地址 (I)

☒ 使用下面的 IP 地址 (S):

IP 地址 (I):	10 . 0 . 2 . 2
子网掩码 (M):	255 . 255 . 255 . 0
默认网关 (D):	10 . 0 . 2 . 1

### 4. 使用Ping测试PC3与其他PC的结果：

添加virtual link前，PC3无法ping通PC1/2：

```
C:\Users\root>ping 10.0.1.2

正在 Ping 10.0.1.2 具有 32 字节的数据:
请求超时。
请求超时。
请求超时。
请求超时。

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

C:\Users\root>ping 10.0.0.2

正在 Ping 10.0.0.2 具有 32 字节的数据:
请求超时。
请求超时。
请求超时。
请求超时。

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

添加virtual link:

```
R1(config-router)#area 1 virtual-link 222.204.2.2
R1(config-router)#

R3(config)#router ospf 100
R3(config-router)#area 1 virtual-link 222.204.3.2
R3(config-router)#
```

添加virtual link后，PC3可ping通PC1/2：

```
C:\Users\root>ping 10.0.0.2

正在 Ping 10.0.0.2 具有 32 字节的数据:
来自 10.0.0.2 的回复: 字节=32 时间=2ms TTL=125
来自 10.0.0.2 的回复: 字节=32 时间<1ms TTL=125
来自 10.0.0.2 的回复: 字节=32 时间<1ms TTL=125
来自 10.0.0.2 的回复: 字节=32 时间<1ms TTL=125

10.0.0.2 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\root>ping 10.0.1.2

正在 Ping 10.0.1.2 具有 32 字节的数据:
来自 10.0.1.2 的回复: 字节=32 时间=1ms TTL=125
来自 10.0.1.2 的回复: 字节=32 时间<1ms TTL=125
来自 10.0.1.2 的回复: 字节=32 时间<1ms TTL=125
来自 10.0.1.2 的回复: 字节=32 时间<1ms TTL=125

10.0.1.2 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 = 1ms, 平均 = 0ms
```

5. 显示路由器R1、R2、R3、R4的路由表（合并路由的前后数据比较）：  
合并路由前，R1路由表：

```
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

    222.204.3.0/32 is subnetted, 1 subnets
C      222.204.3.2 is directly connected, Loopback0
    10.0.0.0/24 is subnetted, 3 subnets
O IA   10.0.2.0 [110/3] via 12.0.0.2, 00:16:05, FastEthernet0/0
C      10.0.0.0 is directly connected, Vlan1
O      10.0.1.0 [110/3] via 12.0.0.2, 00:16:05, FastEthernet0/0
    11.0.0.0/24 is subnetted, 1 subnets
C      11.0.0.0 is directly connected, FastEthernet0/1
    12.0.0.0/24 is subnetted, 1 subnets
C      12.0.0.0 is directly connected, FastEthernet0/0
    13.0.0.0/24 is subnetted, 1 subnets
O      13.0.0.0 [110/2] via 12.0.0.2, 00:16:05, FastEthernet0/0
    14.0.0.0/24 is subnetted, 1 subnets
O IA   14.0.0.0 [110/2] via 12.0.0.2, 00:16:05, FastEthernet0/0
```

合并路由前，R2路由表：

```
R2#show ip route
Codes: L - local, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O      10.0.0.0/24 [110/3] via 13.0.0.1, 00:18:46, GigabitEthernet0/0
C      10.0.1.0/24 is directly connected, FastEthernet0/0/0
L      10.0.1.1/32 is directly connected, FastEthernet0/0/0
O IA   10.0.2.0/24 [110/3] via 13.0.0.1, 00:18:36, GigabitEthernet0/0
    11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C      11.0.0.0/24 is directly connected, GigabitEthernet0/1
L      11.0.0.2/32 is directly connected, GigabitEthernet0/1
    12.0.0.0/24 is subnetted, 1 subnets
O      12.0.0.0 [110/2] via 13.0.0.1, 00:30:17, GigabitEthernet0/0
    13.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C      13.0.0.0/24 is directly connected, GigabitEthernet0/0
L      13.0.0.2/32 is directly connected, GigabitEthernet0/0
    14.0.0.0/24 is subnetted, 1 subnets
O IA   14.0.0.0 [110/2] via 13.0.0.1, 00:18:36, GigabitEthernet0/0
    222.204.1.0/32 is subnetted, 1 subnets
C      222.204.1.2 is directly connected, Loopback0
R2#
```

合并路由前，R3路由表：

```
R3#show ip route
Codes: L - local, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/24 is subnetted, 3 subnets
O       10.0.0.0 [110/2] via 12.0.0.1, 00:21:59, FastEthernet0/0/0
O       10.0.1.0 [110/2] via 13.0.0.2, 00:21:59, FastEthernet0/0/1
O       10.0.2.0 [110/2] via 14.0.0.1, 00:22:19, GigabitEthernet0/0
    11.0.0.0/24 is subnetted, 1 subnets
O       11.0.0.0 [110/10001] via 13.0.0.2, 00:21:59, FastEthernet0/0/1
           [110/10001] via 12.0.0.1, 00:21:59, FastEthernet0/0/0
    12.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       12.0.0.0/24 is directly connected, FastEthernet0/0/0
L       12.0.0.2/32 is directly connected, FastEthernet0/0/0
    13.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       13.0.0.0/24 is directly connected, FastEthernet0/0/1
L       13.0.0.1/32 is directly connected, FastEthernet0/0/1
    14.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       14.0.0.0/24 is directly connected, GigabitEthernet0/0
L       14.0.0.2/32 is directly connected, GigabitEthernet0/0
    222.204.2.0/32 is subnetted, 1 subnets
C       222.204.2.2 is directly connected, Loopback0
R3#
```

合并路由前，R4路由表：

```
R4#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

    222.204.4.0/32 is subnetted, 1 subnets
C       222.204.4.2 is directly connected, Loopback0
    10.0.0.0/24 is subnetted, 3 subnets
C       10.0.0.2.0 is directly connected, FastEthernet0/1
O IA    10.0.0.0 [110/3] via 14.0.0.2, 00:08:11, FastEthernet0/0
O IA    10.0.1.0 [110/3] via 14.0.0.2, 00:08:06, FastEthernet0/0
    11.0.0.0/24 is subnetted, 1 subnets
O IA    11.0.0.0 [110/10002] via 14.0.0.2, 00:08:11, FastEthernet0/0
    12.0.0.0/24 is subnetted, 1 subnets
O IA    12.0.0.0 [110/2] via 14.0.0.2, 00:08:27, FastEthernet0/0
    13.0.0.0/24 is subnetted, 1 subnets
O IA    13.0.0.0 [110/2] via 14.0.0.2, 00:08:27, FastEthernet0/0
    14.0.0.0/24 is subnetted, 1 subnets
C       14.0.0.0 is directly connected, FastEthernet0/0
R4#
```



合并路由后，R3路由表：

```
R3#show ip route
Codes: L - local, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O       10.0.0.0/8 is a summary, 00:28:23, Null0
O       10.0.0.0/24 [110/2] via 12.0.0.1, 00:28:23, FastEthernet0/0/0
O       10.0.1.0/24 [110/2] via 13.0.0.2, 00:28:23, FastEthernet0/0/1
O       10.0.2.0/24 [110/2] via 14.0.0.1, 00:28:23, GigabitEthernet0/0
    11.0.0.0/24 is subnetted, 1 subnets
O       11.0.0.0 [110/10001] via 13.0.0.2, 00:28:23, FastEthernet0/0/1
        [110/10001] via 12.0.0.1, 00:28:23, FastEthernet0/0/0
    12.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       12.0.0.0/24 is directly connected, FastEthernet0/0/0
L       12.0.0.2/32 is directly connected, FastEthernet0/0/0
    13.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       13.0.0.0/24 is directly connected, FastEthernet0/0/1
L       13.0.0.1/32 is directly connected, FastEthernet0/0/1
    14.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       14.0.0.0/24 is directly connected, GigabitEthernet0/0
L       14.0.0.2/32 is directly connected, GigabitEthernet0/0
    222.204.2.0/32 is subnetted, 1 subnets
C       222.204.2.2 is directly connected, Loopback0
R3#
```

合并路由后，R4路由表：

```
R4#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

    222.204.4.0/32 is subnetted, 1 subnets
C       222.204.4.2 is directly connected, Loopback0
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.0.2.0/24 is directly connected, FastEthernet0/1
O IA    10.0.0.0/8 [110/3] via 14.0.0.2, 00:01:16, FastEthernet0/0
    11.0.0.0/24 is subnetted, 1 subnets
O IA    11.0.0.0 [110/10002] via 14.0.0.2, 00:02:51, FastEthernet0/0
    12.0.0.0/24 is subnetted, 1 subnets
O IA    12.0.0.0 [110/2] via 14.0.0.2, 00:02:51, FastEthernet0/0
    13.0.0.0/24 is subnetted, 1 subnets
O IA    13.0.0.0 [110/2] via 14.0.0.2, 00:02:52, FastEthernet0/0
    14.0.0.0/24 is subnetted, 1 subnets
C       14.0.0.0 is directly connected, FastEthernet0/0
R4#
```

6. 显示路由器R1、R2、R3、R4的OSPF状态和数据信息（合并路由的前后数据比较）：

合并路由前，R1 ospf database:

```
R1#show ip ospf database

                OSPF Router with ID (222.204.3.2) (Process ID 100)

                Router Link States (Area 0)

Link ID        ADV Router    Age          Seq#           Checksum Link count
222.204.1.2    222.204.1.2    413          0x80000001B   0x0062EB 2
222.204.2.2    222.204.2.2    1            (DNA) 0x80000001A   0x00BD3B 1
222.204.3.2    222.204.3.2    1040         0x800000011   0x005730 3

                Net Link States (Area 0)

Link ID        ADV Router    Age          Seq#           Checksum
11.0.0.2       222.204.1.2    1167         0x800000003   0x00B468

                Summary Net Link States (Area 0)

Link ID        ADV Router    Age          Seq#           Checksum
10.0.2.0       222.204.2.2    6            (DNA) 0x800000001   0x00AED0
12.0.0.0       222.204.1.2    1728         0x800000001   0x00B1CE
12.0.0.0       222.204.2.2    6            (DNA) 0x800000001   0x00A0DF
12.0.0.0       222.204.3.2    620          0x800000002   0x0097E6
13.0.0.0       222.204.1.2    413          0x800000002   0x0098E6
13.0.0.0       222.204.2.2    6            (DNA) 0x800000001   0x0093EB
13.0.0.0       222.204.3.2    1733         0x800000001   0x0096E6
14.0.0.0       222.204.2.2    6            (DNA) 0x800000001   0x0086F7

                Router Link States (Area 1)

Link ID        ADV Router    Age          Seq#           Checksum Link count
222.204.1.2    222.204.1.2    1738         0x800000002   0x00AE07 1
222.204.2.2    222.204.2.2    1046         0x800000004   0x004D36 2
222.204.3.2    222.204.3.2    1045         0x800000003   0x006A46 1

                Net Link States (Area 1)

Link ID        ADV Router    Age          Seq#           Checksum
12.0.0.1       222.204.3.2    1844         0x800000001   0x00AC6F
13.0.0.2       222.204.1.2    1739         0x800000001   0x00918C

                Summary Net Link States (Area 1)

Link ID        ADV Router    Age          Seq#           Checksum
10.0.0.0       222.204.3.2    625          0x800000002   0x00B1CE
10.0.1.0       222.204.1.2    419          0x800000002   0x00B4CC
10.0.2.0       222.204.2.2    1052         0x800000001   0x00AED0
11.0.0.0       222.204.1.2    419          0x800000002   0x00A9A1
11.0.0.0       222.204.3.2    627          0x800000002   0x009BAD
14.0.0.0       222.204.2.2    1054         0x800000001   0x0086F7
R1#
```



合并路由前，R1 ospf neighbor detail:

```
R1# show ip ospf neighbor detail
Neighbor 222.204.2.2, interface address 13.0.0.1
  In the area 0 via interface OSPF_VL1
  Neighbor priority is 0, State is FULL, 6 state changes
  DR is 0.0.0.0 BDR is 0.0.0.0
  Options is 0x72
  LLS Options is 0x1 (LR)
  Neighbor is up for 00:18:09
  Index 2/3, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 222.204.1.2, interface address 11.0.0.2
  In the area 0 via interface FastEthernet0/1
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 11.0.0.2 BDR is 11.0.0.1
  Options is 0x52
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:32
  Neighbor is up for 01:26:20
  Index 1/1, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 222.204.2.2, interface address 12.0.0.2
  In the area 1 via interface FastEthernet0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 12.0.0.1 BDR is 12.0.0.2
  Options is 0x52
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:31
  Neighbor is up for 00:31:28
  Index 1/2, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R1#
```

合并路由前，R2 ospf database:

```
R2# show ip ospf database

        OSPF Router with ID (222.204.1.2) (Process ID 100)

        Router Link States (Area 0)

Link ID        ADV Router    Age      Seq#           Checksum Link count
222.204.1.2    222.204.1.2    531      0x80000001B   0x0062EB 2
222.204.2.2    222.204.2.2    2        (DNA) 0x80000001A   0x00BD3B 1
222.204.3.2    222.204.3.2    1160     0x800000011   0x005730 3

        Net Link States (Area 0)

Link ID        ADV Router    Age      Seq#           Checksum
11.0.0.2       222.204.1.2    1285     0x800000003   0x00B468

        Summary Net Link States (Area 0)

Link ID        ADV Router    Age      Seq#           Checksum
10.0.2.0       222.204.2.2    7        (DNA) 0x800000001   0x00AED0
12.0.0.0       222.204.1.2    29       0x800000002   0x00AFCF
12.0.0.0       222.204.2.2    7        (DNA) 0x800000001   0x00A0DF
12.0.0.0       222.204.3.2    740      0x800000002   0x0097E6
13.0.0.0       222.204.1.2    531      0x800000002   0x0098E6
13.0.0.0       222.204.2.2    7        (DNA) 0x800000001   0x0093EB
13.0.0.0       222.204.3.2    1847     0x800000001   0x0096E6
14.0.0.0       222.204.2.2    7        (DNA) 0x800000001   0x0086F7

        Router Link States (Area 1)

Link ID        ADV Router    Age      Seq#           Checksum Link count
222.204.1.2    222.204.1.2    29       0x800000003   0x00AC08 1
222.204.2.2    222.204.2.2    1160     0x800000004   0x004D36 2
222.204.3.2    222.204.3.2    1161     0x800000003   0x006A46 1

        Net Link States (Area 1)

Link ID        ADV Router    Age      Seq#           Checksum
12.0.0.1       222.204.3.2    1959     0x800000001   0x00AC6F
13.0.0.2       222.204.1.2    29       0x800000002   0x008F8D

        Summary Net Link States (Area 1)

Link ID        ADV Router    Age      Seq#           Checksum
10.0.0.0       222.204.3.2    741      0x800000002   0x00B1CE
10.0.1.0       222.204.1.2    531      0x800000002   0x00B4CC
10.0.2.0       222.204.2.2    1166     0x800000001   0x00AED0
11.0.0.0       222.204.1.2    531      0x800000002   0x00A9A1
11.0.0.0       222.204.3.2    741      0x800000002   0x009BAD
14.0.0.0       222.204.2.2    1166     0x800000001   0x0086F7
R2#
```

合并路由前，R2 ospf neighbor detail:

```
R2#show ip ospf neighbor detail
Neighbor 222.204.3.2, interface address 11.0.0.1
  In the area 0 via interface GigabitEthernet0/1
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 11.0.0.2 BDR is 11.0.0.1
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:33
  Neighbor is up for 01:28:37
  Index 2/2, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 222.204.2.2, interface address 13.0.0.1
  In the area 1 via interface GigabitEthernet0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 13.0.0.2 BDR is 13.0.0.1
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:39
  Neighbor is up for 00:31:58
  Index 1/1, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R2#
```

合并路由前，R3 ospf database:

```
R3#show ip ospf database
```

OSPF Router with ID (222.204.2.2) (Process ID 100)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
222.204.1.2	222.204.1.2	1294	(DNA) 0x8000001A	0x0064EA	2
222.204.2.2	222.204.2.2	1372	0x8000001A	0x00BD3B	1
222.204.3.2	222.204.3.2	1	(DNA) 0x80000011	0x005730	3

Net Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum
11.0.0.2	222.204.1.2	127	(DNA) 0x80000003	0x00B468

Summary Net Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum
10.0.2.0	222.204.2.2	1383	0x80000001	0x00AED0
12.0.0.0	222.204.1.2	688	(DNA) 0x80000001	0x00B1CE
12.0.0.0	222.204.2.2	1383	0x80000001	0x00A0DF
12.0.0.0	222.204.3.2	1534	(DNA) 0x80000001	0x0099E5
13.0.0.0	222.204.1.2	1285	(DNA) 0x80000001	0x009AE5
13.0.0.0	222.204.2.2	1383	0x80000001	0x0093EB
13.0.0.0	222.204.3.2	687	(DNA) 0x80000001	0x0096E6
14.0.0.0	222.204.2.2	1383	0x80000001	0x0086F7

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
222.204.1.2	222.204.1.2	248	0x80000003	0x00AC08	1
222.204.2.2	222.204.2.2	1377	0x80000004	0x004D36	2
222.204.3.2	222.204.3.2	1378	0x80000003	0x006A46	1

Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
12.0.0.1	222.204.3.2	194	0x80000002	0x00AA70
13.0.0.2	222.204.1.2	248	0x80000002	0x008F8D

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
10.0.0.0	222.204.3.2	958	0x80000002	0x00B1CE
10.0.1.0	222.204.1.2	750	0x80000002	0x00B4CC
10.0.2.0	222.204.2.2	1383	0x80000001	0x00AED0
11.0.0.0	222.204.1.2	750	0x80000002	0x00A9A1
11.0.0.0	222.204.3.2	958	0x80000002	0x009BAD
14.0.0.0	222.204.2.2	1383	0x80000001	0x0086F7

Router Link States (Area 2)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
14.0.0.1	14.0.0.1	1779	0x80000003	0x0011C5	2
222.204.2.2	222.204.2.2	1382	0x80000006	0x00A607	1

Net Link States (Area 2)

Link ID	ADV Router	Age	Seq#	Checksum
14.0.0.2	222.204.2.2	1778	0x80000001	0x00CBEF

Summary Net Link States (Area 2)

合并路由前，R3 ospf neighbor detail:

```
R3# show ip ospf neighbor detail
Neighbor 222.204.3.2, interface address 12.0.0.1
  In the area 0 via interface OSPF_VL0
  Neighbor priority is 0, State is FULL, 6 state changes
  DR is 0.0.0.0 BDR is 0.0.0.0
  Options is 0x32 in Hello (E-bit, L-bit, DC-bit)
  Options is 0x72 in DBD (E-bit, L-bit, DC-bit, O-bit)
  LLS Options is 0x1 (LR)
  Neighbor is up for 00:23:48
  Index 1/4, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 222.204.1.2, interface address 13.0.0.2
  In the area 1 via interface FastEthernet0/0/1
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 13.0.0.2 BDR is 13.0.0.1
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:38
  Neighbor is up for 00:35:20
  Index 2/2, retransmission queue length 0, number of retransmission 1
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 1, maximum is 1
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 222.204.3.2, interface address 12.0.0.1
  In the area 1 via interface FastEthernet0/0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 12.0.0.1 BDR is 12.0.0.2
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:33
  Neighbor is up for 00:37:06
  Index 1/1, retransmission queue length 0, number of retransmission 1
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 1, maximum is 1
  Last retransmission scan time is 0 msec, maximum is 0 msec
Neighbor 14.0.0.1, interface address 14.0.0.1
  In the area 2 via interface GigabitEthernet0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 14.0.0.2 BDR is 14.0.0.1
  Options is 0x12 in Hello (E-bit, L-bit)
  Options is 0x52 in DBD (E-bit, L-bit, O-bit)
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:35
  Neighbor is up for 00:30:34
  Index 1/3, retransmission queue length 0, number of retransmission 1
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 1, maximum is 1
  Last retransmission scan time is 0 msec, maximum is 0 msec
R3#
```

合并路由前，R4 ospf database:

```
R4# show ip ospf database

        OSPF Router with ID (14.0.0.1) (Process ID 100)

        Router Link States (Area 2)

Link ID      ADV Router    Age      Seq#          Checksum Link count
14.0.0.1     14.0.0.1      1020     0x80000003   0x0011C5 2
222.204.2.2  222.204.2.2   625      0x80000006   0x00A607 1

        Net Link States (Area 2)

Link ID      ADV Router    Age      Seq#          Checksum
14.0.0.2     222.204.2.2   1021     0x80000001   0x00CBEF

        Summary Net Link States (Area 2)

Link ID      ADV Router    Age      Seq#          Checksum
10.0.0.0     222.204.2.2   605      0x80000001   0x00C4BC
10.0.1.0     222.204.2.2   600      0x80000002   0x00B7C7
11.0.0.0     222.204.2.2   605      0x80000001   0x00AE9B
12.0.0.0     222.204.2.2   625      0x80000001   0x00A0DF
13.0.0.0     222.204.2.2   625      0x80000001   0x0093EB
R4#
```

合并路由前，R4 ospf neighbor detail:

```
R4#show ip ospf neigh deta
Neighbor 222.204.2.2, interface address 14.0.0.2
  In the area 2 via interface FastEthernet0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 14.0.0.2 BDR is 14.0.0.1
  Options is 0x52
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:31
  Neighbor is up for 00:16:16
  Index 1/1, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R4#
```

合并路由后，R4 ospf database:

```
R4#show ip ospf database

        OSPF Router with ID (14.0.0.1) (Process ID 100)

        Router Link States (Area 2)

Link ID      ADV Router    Age      Seq#          Checksum Link count
14.0.0.1     14.0.0.1      469      0x80000004   0x000FC6 2
222.204.2.2  222.204.2.2   122      0x80000007   0x00A408 1

        Net Link States (Area 2)

Link ID      ADV Router    Age      Seq#          Checksum
14.0.0.2     222.204.2.2   624      0x80000002   0x00C9F0

        Summary Net Link States (Area 2)

Link ID      ADV Router    Age      Seq#          Checksum
10.0.0.0     222.204.2.2   122      0x80000003   0x00C0BE
11.0.0.0     222.204.2.2   122      0x80000002   0x00AC9C
12.0.0.0     222.204.2.2   122      0x80000002   0x009EE0
13.0.0.0     222.204.2.2   122      0x80000002   0x0091EC
R4#
```



合并路由后，R4 ospf neighbor detail:

```
R4#show ip ospf neighbor detail
Neighbor 222.204.2.2, interface address 14.0.0.2
  In the area 2 via interface FastEthernet0/0
  Neighbor priority is 1, State is FULL, 6 state changes
  DR is 14.0.0.2 BDR is 14.0.0.1
  Options is 0x52
  LLS Options is 0x1 (LR)
  Dead timer due in 00:00:35
  Neighbor is up for 00:42:01
  Index 1/1, retransmission queue length 0, number of retransmission 0
  First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
  Last retransmission scan length is 0, maximum is 0
  Last retransmission scan time is 0 msec, maximum is 0 msec
R4#
```

7. 实验结束后，各路由器上的当前运行配置为（从show running-config的显示结果中，截取与本实验相关的内容）：

R1 show running-config

```
interface Loopback0
 ip address 222.204.3.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 12.0.0.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 bandwidth 10
 ip address 11.0.0.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/3/0
!
interface FastEthernet0/3/1
!
interface FastEthernet0/3/2
!
interface FastEthernet0/3/3
!
interface Vlan1
 ip address 10.0.0.1 255.255.255.0
!
router ospf 100
 log-adjacency-changes
 area 1 virtual-link 222.204.2.2
 area 1 virtual-link 22.204.2.2
 network 10.0.0.0 0.255.255.255 area 0
 network 11.0.0.0 0.255.255.255 area 0
 network 12.0.0.0 0.255.255.255 area 1
!
!
```

## R2 show running-config

```
interface Loopback0
 ip address 222.204.1.2 255.255.255.255
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 ip address 11.0.0.2 255.255.255.0
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 ip address 13.0.0.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/0/0
 ip address 10.0.0.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
router ospf 100
 network 10.0.0.0 0.255.255.255 area 0
 network 11.0.0.0 0.255.255.255 area 0
 network 13.0.0.0 0.255.255.255 area 1
!
ip forward-protocol nd
!
```

## R3 show running-config

```
interface Loopback0
 ip address 222.204.2.2 255.255.255.255
!
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
!
interface GigabitEthernet0/0
 ip address 14.0.0.2 255.255.255.0
 duplex auto
 speed auto
!
interface GigabitEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface FastEthernet0/0/0
 ip address 12.0.0.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/0/1
 ip address 13.0.0.1 255.255.255.0
 duplex auto
 speed auto
!
router ospf 100
 area 0 range 10.0.0.0 255.0.0.0
 area 1 virtual-link 222.204.3.2
 network 12.0.0.0 0.255.255.255 area 1
 network 13.0.0.0 0.255.255.255 area 1
 network 14.0.0.0 0.255.255.255 area 2
!
ip forward-protocol nd
!
```



R4 show running-config

```
!
interface Loopback0
 ip address 222.204.4.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 14.0.0.1 255.255.255.0
 duplex auto
 speed auto
!
interface Serial0/0
 no ip address
 shutdown
!
interface FastEthernet0/1
 ip address 10.0.2.1 255.255.255.0
 duplex auto
 speed auto
!
interface Serial0/1
 no ip address
 shutdown
!
router ospf 100
 log-adjacency-changes
 area 2 range 10.0.0.0 255.255.0.0
 area 2 range 10.0.0.0 255.0.0.0
 network 10.0.0.0 0.255.255.255 area 2
 network 14.0.0.0 0.255.255.255 area 2
!
```

## 六. 实验结果与分析

1. 实验第一部分中，由于R1 f0/3/0端口扩展端口，只能给对应的vlan 进行ip 配置；
2. 实验第一部分中，由于R1, R2之间的带宽限制为10，在OSPF路由协议下，PC1通过Router1->Router3->Router2到达PC2反而更短(2)，所以数据包不采用Router1到Router2的路径；
3. 在实验第一部分断开前，观察路由表R1可知，10.0.1.0网段通过FastEthernet 0/0端口发送数据，即经过R3；在断开R2,R3连接之后，观察R1路由表，可知，10.0.1.0网段数据包通过FastEthernet发送，即经过R2发送，与理论相符；
4. 实验第一部分中，在断开R2与R3之间连接之后，R2, R3 ospf表中database和neighbor detail数据中项数减少了一项，与理论相符；
5. 实验第二部分中，在建立virtual link之前，PC3无法ping通PC2和PC1，在建立之后，可以ping通，和理论相符合；
6. 实验第二部分中，在合并路由R3中area 0 10.0.0.0/8网络之后，R3路由表中多出了10.0.0.0/8 is as summary 一项；

7. 实验第二部分，在合并并路由R3中area 0 10.0.0.0/8网络之前，R4路由表中，10.0.0.0与10.0.1.0网段路由信息分为2条进行存储，在合并之后，R4路由表中只剩余10.0.0.0/8一项路由信息；

## 七. 讨论、心得

### 思考题

1. OSPF有什么特性？

OSPF协议最大的特点是无环路，每个area必须与area 0 相邻，保证了area之间没有环路；OSPF协议快速收敛，维护3张表，邻居表，拓扑表，路由表；链路通告(度量标准是带宽、延迟)；开放式；带宽开销少；

2. 描述OSPF协议的路由计算过程。

首先相邻路由之间建立邻接关系(发送自身ID信息Hello报文，相邻接受Hello报文，将ID信息加入自己的Hello报文，如果接受到含有自己ID的Hello报文，则确定是否可以建立邻接关系)；在建立相邻关系之后，选举DR和BDR路由器；发送LSA(链路状态广播数据包，包涵路由器上所有相连链路、所有端口的状态信息)；创建路由表；维护路由信息；

3. 理解RouterID、DR和BDR、区域、路由聚合的概念和OSPF的路由包类型。

RouterID：每一台OSPF路由器只有一个Router-ID，使用IP地址的形式表示；

DR, BDR：DR(Designated Router), BDR(BDR Backup Designated Router)，为了减少LSA的传播数量，通过选出核心路由器(DR)，网段中所有的OSPF路由器都喝DR互换LSA，DR失效之后，使用BDR代替DR进行工作；

区域：OSPF区域长度为32位，主要为了缓解LSDB的计算压力，分区域进行计算；

路由聚合：对边界路由器进行聚合，进一步减少区域间的路由信息传递；

OSPF路由包类型：type = 0, Hello数据包；type = 1 ,数据库描述包；type = 3 ,链路状态请求包；type = 4, 链路状态更新包；type = 5, 链路状态确认包；

4. 如果一台路由器没有手工配置routerID，则系统会如何选择？

优先使用loopback IP，之后采用状态为up的最大IP地址；

5. 请解释OSPF连接状态数据库的详细信息。

Link ID : 连接ID, IP地址;

ADV Router : 路由链路状态;

Age : 老化更新时间;

Seq# : 进程序列号;

Checksum : 链路状态校验;

Link count : 链路计算的次数;

6. 请问OSPF协议是怎样描述点对点网络和广播网络的。

点到点网络只有1类LSA, 广播有1/2类;

7. 请说明在路由器之间OSPF路由包交换的整个过程。

路由A发送hello报文给路由B, 包含自己的router-id, 同时转变为INIT;

路由B回复hello报文, 包括B路由router-id和A的router-id(在邻居字段);

路由A接收到B报文中有自己的router-id, 则A和B进入2-way状态, 建立成功;

发送LSA, 创建\更新路由表;

8. 比较虚链路配置前后的路由表, 是不是有到区域2的路由呢?

配置虚拟路由后, R1路由中有区域2网段的路由;

9. 综合几个实验, 试比较各种路由选择算法。

RIP协议为距离矢量路由协议, 以跳数作为度量标准, 同时最大跳数为15跳; 而ospf协议是链路状态路由选择协议, 度量标准是带宽、延迟, 无跳数限制;

RIP version1 不支持可变长子网掩码(VLSM), version2 支持VLSM, ospf支持VLSM;

RIP周期性广播/组播路由信息, ospf使用触发更新, 带宽利用率更高;

RIP收敛速度慢于OSPF;

OSPF提出area划分概念, 大大减少了传递的路由信息数量。