**路由选路 3 大原则：**

**1.  首先，按最长匹配原则：当有多条路径到达目标时，以其** IP 地址或网络号最长匹配的作为最佳路由。例如在  10.1.1.1/18、10.1.1.1/24、10.1.1.1/32 将选择 10.1.1.1/32 这个掩码最长的 IP；

**2.  其次，按最小管理距离优先：在相同掩码长度的情况下，按照路由的管理距离：**

管理距离越小，路由越优先。例如 S 10.1.1.1/8 为静态路由，R 10.1.1.1/8 为 RIP  产生的动态路由，静态路由的默认管理距离值为 1，而 RIP  默认管理距离为 120，因而选 S 10.1.1.1/8；

**3.  最后，按度量值最小优先：当掩码长度、管理距离都相同时，比较路由的度量值（**Metric）或称代价，度量值越小越优先。例如：S 10.1.1.1/8[1/20]，其度量值为 20 ； S 10.1.1.1/8 [1/40]，

其度量值为 40 ，因而选 S 10.1.1.1/8[1/20]

步骤1：接口ip配置

R1：

Router(config)#int fa 0/0

Router(config-if)#ip add 13.13.13.1 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

Router(config)#int fa 0/1

Router(config-if)#ip add 14.14.14.1 255.255.255.0

Router(config-if)#no sh

Router(config-if)#int fa 1/0

Router(config-if)#ip add 192.168.1.1 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

R2：

Router(config)#int fa 0/0

Router(config-if)#ip add 23.23.23.2 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

Router(config)#int s 0/0/0

Router(config-if)#ip add 24.24.24.2 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

Router(config)#int lo0

Router(config-if)#ip add 2.2.2.2 255.255.255.0

Router(config-if)#exit

R3:

Router(config)#int fa 0/0

Router(config-if)#ip add 13.13.13.3 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

Router(config)#int fa 0/1

Router(config-if)#ip add 23.23.23.3 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

Router(config)#int fa 1/0

Router(config-if)#ip add 34.34.34.3 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

Router(config)#int lo0

Router(config-if)#ip add 3.3.3.3 255.255.255.0

Router(config-if)#exit

R4:

Router(config)#int fa 0/0

Router(config-if)#ip add 14.14.14.4 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

Router(config)#int fa 0/1

Router(config-if)#ip add 34.34.34.4 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

Router(config)#int s 0/0/0

Router(config-if)#ip add 24.24.24.4 255.255.255.0

Router(config-if)#no sh

Router(config-if)#exit

Router(config)#int lo0

Router(config-if)#ip add 4.4.4.4 255.255.255.0

Router(config-if)#exit

需求1、全网不启用动态路由协议 ，在R1上配置静态路由，下一跳为R3（ip route 3.3.3.0 255.255.255.0 13.13.13.3）,再在R1上配置一条到3.3.3.3的静态路由，下一跳为R4（ip route 3.3.3.3 255.255.255.255 14.14.14.4），比较两条到3.3.3.3的路由有什么不同，R1会优选哪一条路由，为什么，这个时候看是否能够ping通，为什么不通，如何才能使之ping通。

答：两条路由的网段和掩码都不同，一个是3.3.3.0/24，另一个是3.3.3.3/32。如果在R1上ping 3.3.3.3，R1会优选3.3.3.3/32网段的路由，因为掩码更长，这个时候是不通的，因为下一跳R4没用到3.3.3.3的路由，R3也没用回包的路由（也就是14.14.14.0网段的路由），必须都添加才能ping通。

配置命令：

R1：

Router(config)#ip route 3.3.3.0 255.255.255.0 13.13.13.3

Router(config)#ip route 3.3.3.3 255.255.255.255 14.14.14.4

Router(config)#do sh 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

1.0.0.0/24 is subnetted, 1 subnets

C 1.1.1.0 is directly connected, Loopback0

3.0.0.0/8 is variably subnetted, 2 subnets, 2 masks

S 3.3.3.0/24 [1/0] via 13.13.13.3

S 3.3.3.3/32 [1/0] via 14.14.14.4

13.0.0.0/24 is subnetted, 1 subnets

C 13.13.13.0 is directly connected, FastEthernet0/0

14.0.0.0/24 is subnetted, 1 subnets

C 14.14.14.0 is directly connected, FastEthernet0/1

如果R1要ping通3.3.3.3，必须添加如下命令

R4：Router(config)#ip route 3.3.3.3 255.255.255.255 34.34.34.3

R3：Router(config)#ip route 14.14.14.0 255.255.255.0 34.34.34.4

需求2：先删除需求1的静态路由，R1/2/3/4 运行 OSPF，且所有路由器的所有接口都运行 OSPF，观察从 R2 去 3.3.3.3和4.4.4.4 的下一跳分别是哪里，为什么；在 R2 上配置一条静态路由（ip route 3.3.3.0 255.255.255.0 24.24.24.4），再次观察下一条是哪里，为什么；

Ospf的相关配置

R1：

Router(config)#router ospf 1

Router(config-router)#net 192.168.1.0 0.0.0.255 are 0

Router(config-router)#net 13.13.13.0 0.0.0.255 are 0

Router(config-router)#net 14.14.14.0 0.0.0.255 are 0

Router(config-router)#exit

R2：

Router(config)#router ospf 1

Router(config-router)#net 2.2.2.0 0.0.0.255 are 0

Router(config-router)#net 23.23.23.0 0.0.0.255 are 0

Router(config-router)#net 24.24.24.0 0.0.0.255 are 0

Router(config-router)#exit

R3：

Router(config)#router ospf 1

Router(config-router)#net 3.3.3.0 0.0.0.255 area 0

Router(config-router)#net 23.23.23.0 0.0.0.255 area 0

Router(config-router)#net 34.34.34.0 0.0.0.255 area 0

Router(config-router)#exit

R4：

Router(config)#router ospf 1

Router(config-router)#net 3.3.3.0 0.0.0.255 area 0

Router(config-router)#net 23.23.23.0 0.0.0.255 area 0

Router(config-router)#net 34.34.34.0 0.0.0.255 area 0

Router(config-router)#exit

答：R2到达3.3.3.3和4.4.4.4的下一跳都是23.23.23.3（R3），因为管理距离一样（都是110），去R3的度量值要小一些（如去4.4.4.4，下一跳为23.23.23.3的cost是3，ospf计算cost算法是108/带宽，100M以上cost都为1，而下一跳为24.24.24.4的度量值为64，算法100000/1544）。如果R2配置一条到达3.3.3.0的静态路由，掩码24的下一跳必定是24.24.24.4，掩码32的下一跳是23.23.23.3（可以看的出来ospf对于环回接口掩码都认为是32），静态路由的管理距离为1，而下一跳23.23.23.3的为110。

启用ospf后，R2此时的路由表：

Router#sh 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

2.0.0.0/24 is subnetted, 1 subnets

C 2.2.2.0 is directly connected, Loopback0

3.0.0.0/32 is subnetted, 1 subnets

O 3.3.3.3 [110/2] via 23.23.23.3, 00:02:36, FastEthernet0/0

4.0.0.0/32 is subnetted, 1 subnets

O 4.4.4.4 [110/3] via 23.23.23.3, 00:00:14, FastEthernet0/0

13.0.0.0/24 is subnetted, 1 subnets

O 13.13.13.0 [110/2] via 23.23.23.3, 00:02:36, FastEthernet0/0

14.0.0.0/24 is subnetted, 1 subnets

O 14.14.14.0 [110/3] via 23.23.23.3, 00:00:46, FastEthernet0/0

23.0.0.0/24 is subnetted, 1 subnets

C 23.23.23.0 is directly connected, FastEthernet0/0

24.0.0.0/24 is subnetted, 1 subnets

C 24.24.24.0 is directly connected, Serial0/0/0

34.0.0.0/24 is subnetted, 1 subnets

O 34.34.34.0 [110/2] via 23.23.23.3, 00:00:14, FastEthernet0/0

O 192.168.1.0/24 [110/3] via 23.23.23.3, 00:02:36, FastEthernet0/0

如果R2配置静态路由，路由表就是如下：

Router(config)#ip route 3.3.3.0 255.255.255.0 24.24.24.4

Router#sh 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

2.0.0.0/24 is subnetted, 1 subnets

C 2.2.2.0 is directly connected, Loopback0

3.0.0.0/8 is variably subnetted, 2 subnets, 2 masks

S 3.3.3.0/24 [1/0] via 24.24.24.4

O 3.3.3.3/32 [110/2] via 23.23.23.3, 00:09:09, FastEthernet0/0

4.0.0.0/32 is subnetted, 1 subnets

O 4.4.4.4 [110/3] via 23.23.23.3, 00:06:47, FastEthernet0/0

13.0.0.0/24 is subnetted, 1 subnets

O 13.13.13.0 [110/2] via 23.23.23.3, 00:09:09, FastEthernet0/0

14.0.0.0/24 is subnetted, 1 subnets

O 14.14.14.0 [110/3] via 23.23.23.3, 00:07:19, FastEthernet0/0

23.0.0.0/24 is subnetted, 1 subnets

C 23.23.23.0 is directly connected, FastEthernet0/0

24.0.0.0/24 is subnetted, 1 subnets

C 24.24.24.0 is directly connected, Serial0/0/0

34.0.0.0/24 is subnetted, 1 subnets

O 34.34.34.0 [110/2] via 23.23.23.3, 00:06:47, FastEthernet0/0

O 192.168.1.0/24 [110/3] via 23.23.23.3, 00:09:09, FastEthernet0/0

需求3: 观察R1到34网段有几条路径，配置命令使到34网段只有一个下一跳 14.14.14.4；在 R1 的接口上配置命令（ip ospf cost 30）增大那个接口的 cost 值，思考要完成上面的需求，应该在哪个接口上配置。

答：有两条路径（管理距离和度量值都一样时就有多条路由），如果只有一个下一跳就应该在与R3相连的接口fa 0/0配置，增大此接口的cost值，命令如下：

原来的R1的路由表：

Router#sh 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

2.0.0.0/32 is subnetted, 1 subnets

O 2.2.2.2 [110/3] via 13.13.13.3, 00:04:02, FastEthernet0/0

3.0.0.0/32 is subnetted, 1 subnets

O 3.3.3.3 [110/2] via 13.13.13.3, 00:04:02, FastEthernet0/0

4.0.0.0/32 is subnetted, 1 subnets

O 4.4.4.4 [110/2] via 14.14.14.4, 00:02:17, FastEthernet0/1

13.0.0.0/24 is subnetted, 1 subnets

C 13.13.13.0 is directly connected, FastEthernet0/0

14.0.0.0/24 is subnetted, 1 subnets

C 14.14.14.0 is directly connected, FastEthernet0/1

23.0.0.0/24 is subnetted, 1 subnets

O 23.23.23.0 [110/2] via 13.13.13.3, 00:04:02, FastEthernet0/0

24.0.0.0/24 is subnetted, 1 subnets

O 24.24.24.0 [110/65] via 14.14.14.4, 00:02:17, FastEthernet0/1

34.0.0.0/24 is subnetted, 1 subnets

O 34.34.34.0 [110/2] via 13.13.13.3, 00:01:55, FastEthernet0/0

[110/2] via 14.14.14.4, 00:01:55, FastEthernet0/1

C 192.168.1.0/24 is directly connected, FastEthernet1/0

Router(config)#int fa 0/0

Router(config-if)#ip ospf cost 30

Router(config-if)#exit

Router#sh 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

2.0.0.0/32 is subnetted, 1 subnets

O 2.2.2.2 [110/4] via 14.14.14.4, 00:00:03, FastEthernet0/1

3.0.0.0/32 is subnetted, 1 subnets

O 3.3.3.3 [110/3] via 14.14.14.4, 00:00:03, FastEthernet0/1

4.0.0.0/32 is subnetted, 1 subnets

O 4.4.4.4 [110/2] via 14.14.14.4, 00:26:07, FastEthernet0/1

13.0.0.0/24 is subnetted, 1 subnets

C 13.13.13.0 is directly connected, FastEthernet0/0

14.0.0.0/24 is subnetted, 1 subnets

C 14.14.14.0 is directly connected, FastEthernet0/1

23.0.0.0/24 is subnetted, 1 subnets

O 23.23.23.0 [110/3] via 14.14.14.4, 00:00:03, FastEthernet0/1

24.0.0.0/24 is subnetted, 1 subnets

O 24.24.24.0 [110/65] via 14.14.14.4, 00:26:07, FastEthernet0/1

34.0.0.0/24 is subnetted, 1 subnets

O 34.34.34.0 [110/2] via 14.14.14.4, 00:00:03, FastEthernet0/1

C 192.168.1.0/24 is directly connected, FastEthernet1/0