

# 15 IP 静态路由



# 单元目标

模块标题： IP 静态路由

模块目标： 配置 IPv4 和 IPv6 静态路由。

主题标题	主题目标
静态路由	描述静态路由的命令语法。
配置 IP 静态路由	配置 IPv4 和 IPv6 静态路由。
配置 IP 默认静态路由	配置 IPv4 和 IPv6 默认静态路由。
配置浮动静态路由	配置浮动静态路由，提供备用连接。
配置静态主机路由	配置 IPv4 和 IPv6 静态主机路由，直接将流量定向至特定主机。

# 15.1 静态路由

## 静态路由的类型

- **IPv4和IPv6**均支持以下类型的静态路由：
  - **标准**静态路由 Standard static route
  - **默认**静态路由 Default static route
  - **浮动**静态路由 Floating static route
  - **总结**静态路由 Summary static route
- 使用 **ip route** 和 **ipv6 route** 全局配置命令配置静态路由
- 在配置静态路由时，下一跳可以使用 **IP地址** 或者 **送出接口**，也可以 **两者** 一起使用。

# 静态路由命令

- IPv4

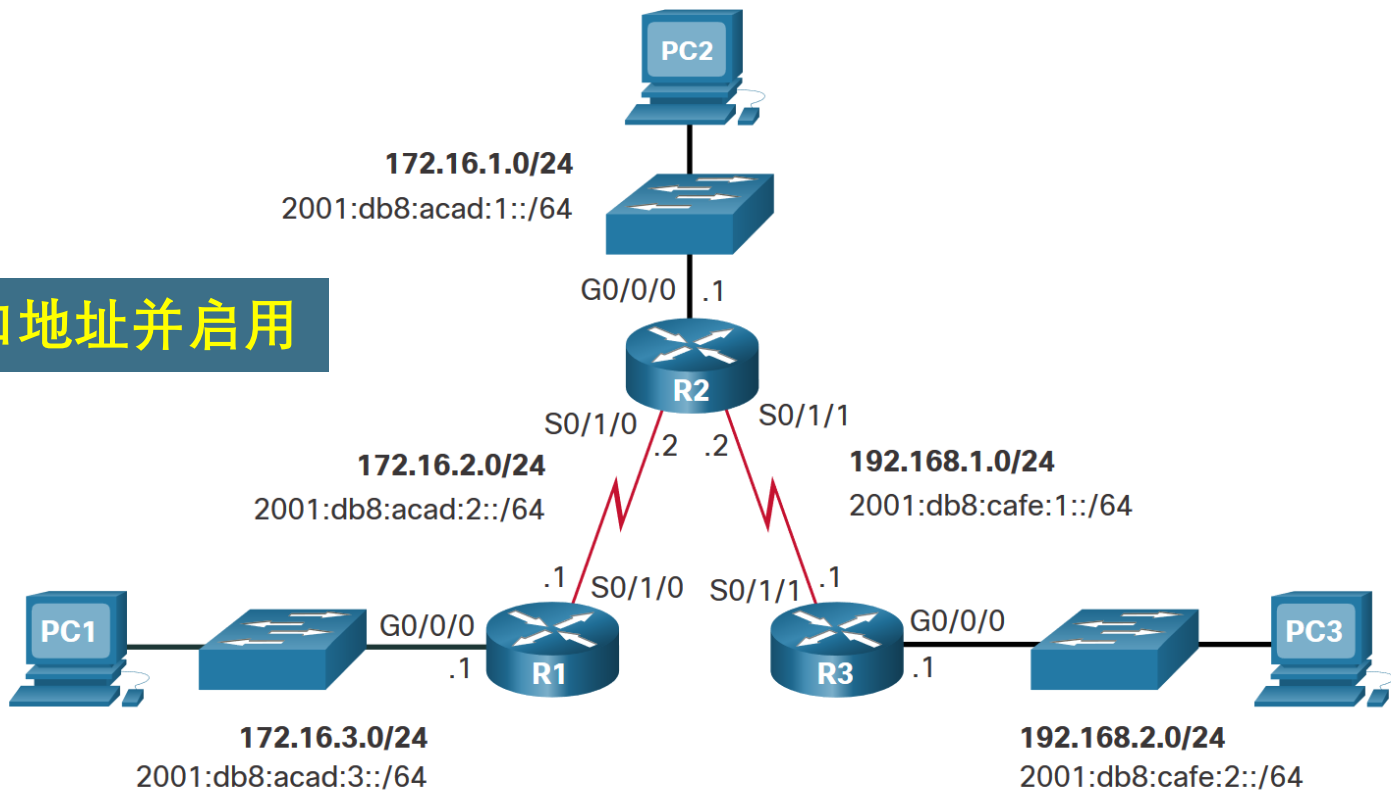
```
Router(config)# ip route network-address subnet-mask  
{ ip-address | exit-intf [ip-address] } [distance]
```

- IPv6

```
Router(config)# ipv6 route ipv6-prefix/prefix-length {ipv6-  
address | exit-intf [ipv6-address] } [distance]
```

# 双栈拓扑

首先配置接口地址并启用



# IPv4初始路由表

```
R1# show ip route | begin Gateway
```

```
Gateway of last resort is not set
```

```
172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
```

```
C 172.16.2.0/24 is directly connected, Serial0/1/0
```

```
L 172.16.2.1/32 is directly connected, Serial0/1/0
```

```
C 172.16.3.0/24 is directly connected, GigabitEthernet0/0/0
```

```
L 172.16.3.1/32 is directly connected, GigabitEthernet0/0/0
```

```
R1#
```

```
R1# ping 172.16.2.2
```

```
Type escape sequence to abort. Sending 5, 100-byte ICMP Echos to 172.16.2.2, timeout is 2 seconds:
```

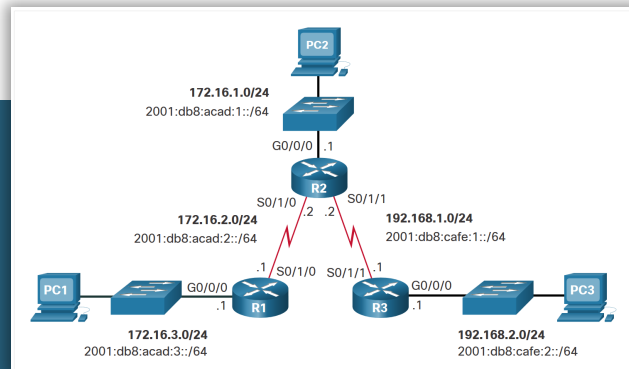
```
!!!!
```

```
Success rate is 100 percent (5/5)
```

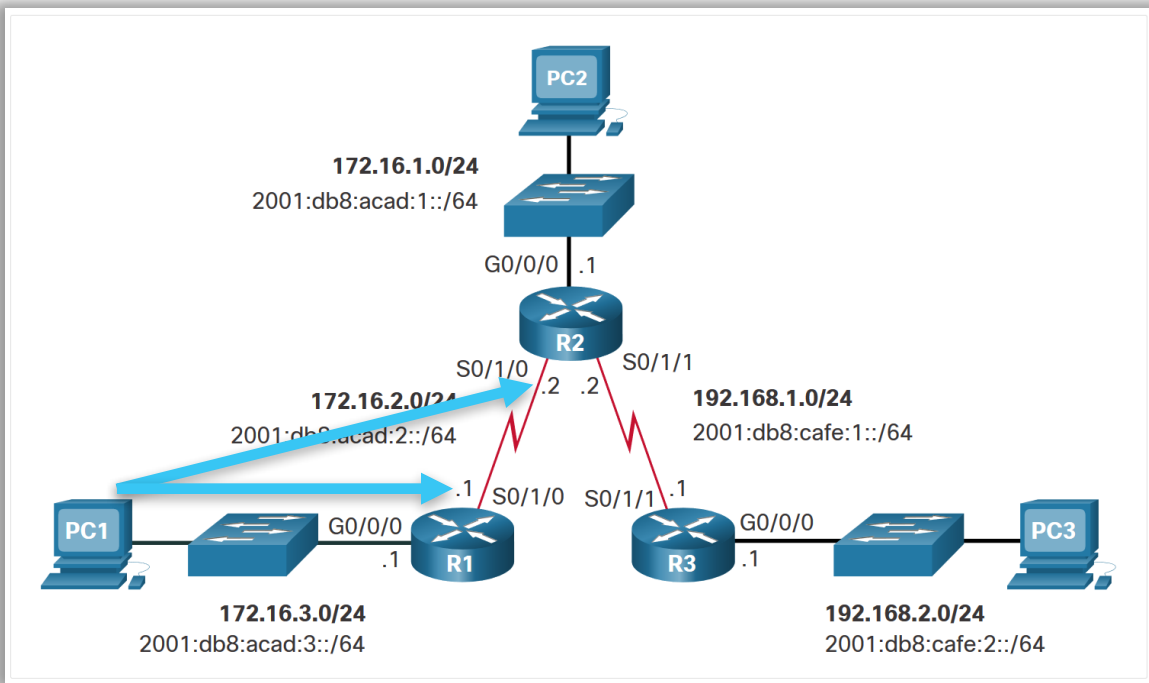
```
R1# ping 192.168.2.1
```

```
Type escape sequence to abort. Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds: .....
```

```
Success rate is 0 percent (0/5)
```



# IPv4初始路由表



## 问题：

- PC1是否可以ping通172.16.2.1？
- PC1是否可以ping通172.16.2.2？



# IPv6初始路由表

R1# **show ipv6 route | begin C**

C 2001:DB8:ACAD:2::/64 [0/0]

via Serial0/1/0, directly connected

L 2001:DB8:ACAD:2::1/128 [0/0]

via Serial0/1/0, receive

C 2001:DB8:ACAD:3::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:3::1/128 [0/0]

via GigabitEthernet0/0/0, receive

L FF00::/8 [0/0]

via Null0, receive

R1#

R1# **ping 2001:db8:acad:2::2**

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:2::2, timeout is 2 seconds:

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 2/2/3 ms)

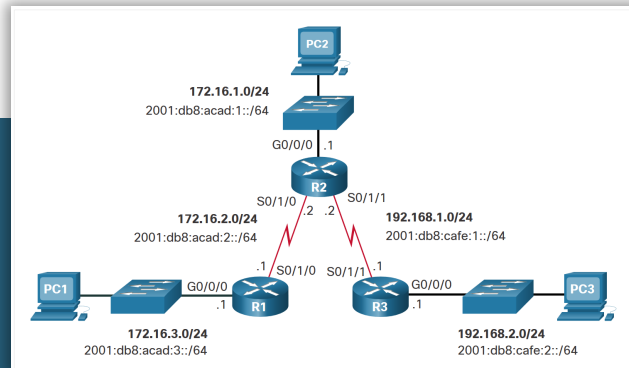
R1# **ping 2001:DB8:cafe:2::1**

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:CAFE:2::1, timeout is 2 seconds:

% No valid route for destination

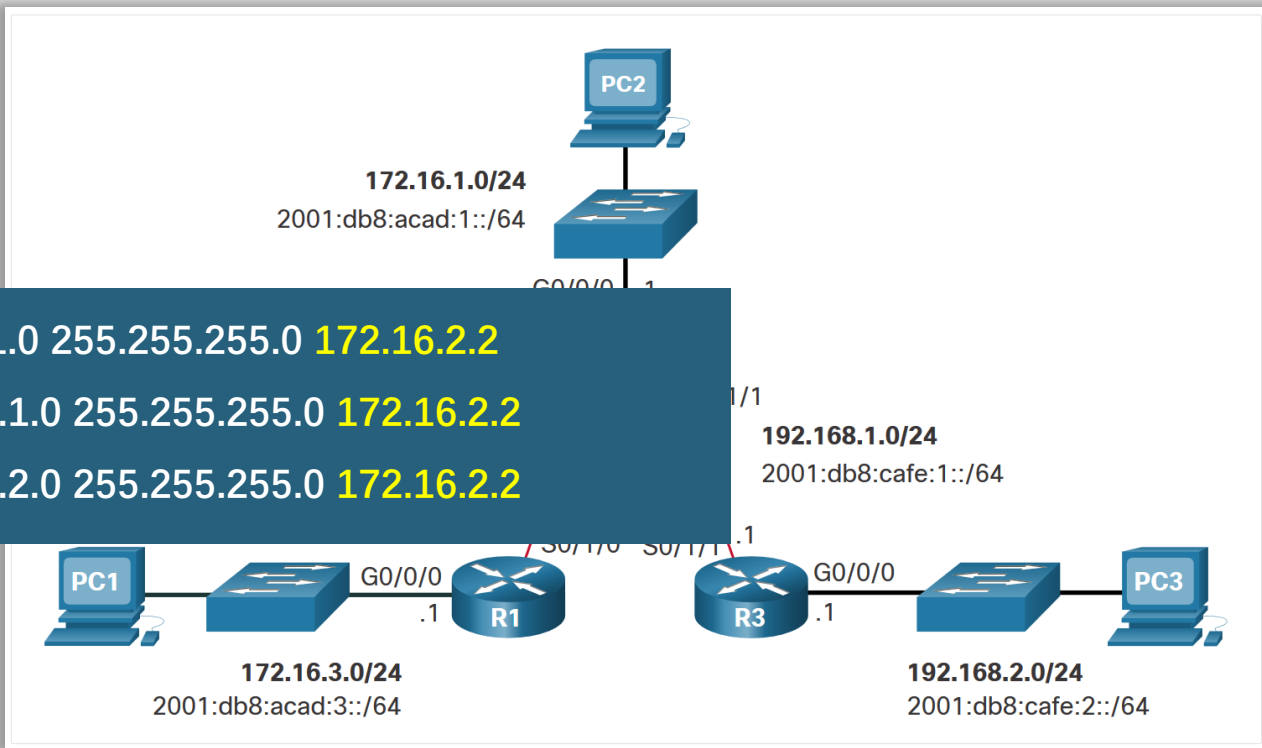
Success rate is 0 percent (0/1)



# 15.2 配置 IP 静态路由

# IPv4下一跳静态路由

```
R1(config)# ip route 172.16.1.0 255.255.255.0 172.16.2.2
R1(config)# ip route 192.168.1.0 255.255.255.0 172.16.2.2
R1(config)# ip route 192.168.2.0 255.255.255.0 172.16.2.2
```



# IPv6下一跳静态路由

```
R1# show ip route | begin Gateway
```

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks

```
S    172.16.1.0/24 [1/0] via 172.16.2.2
```

```
C    172.16.2.0/24 is directly connected, Serial0/1/0
```

```
L    172.16.2.1/32 is directly connected, Serial0/1/0
```

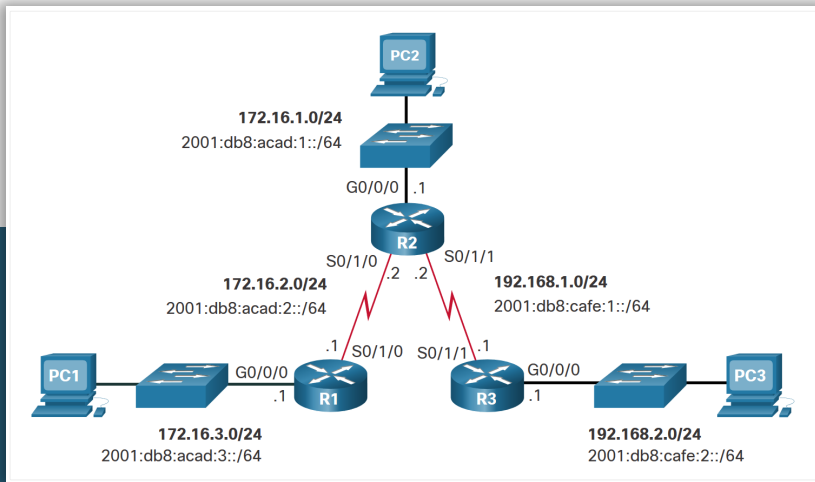
```
C    172.16.3.0/24 is directly connected, GigabitEthernet0/0/0
```

```
L    172.16.3.1/32 is directly connected, GigabitEthernet0/0/0
```

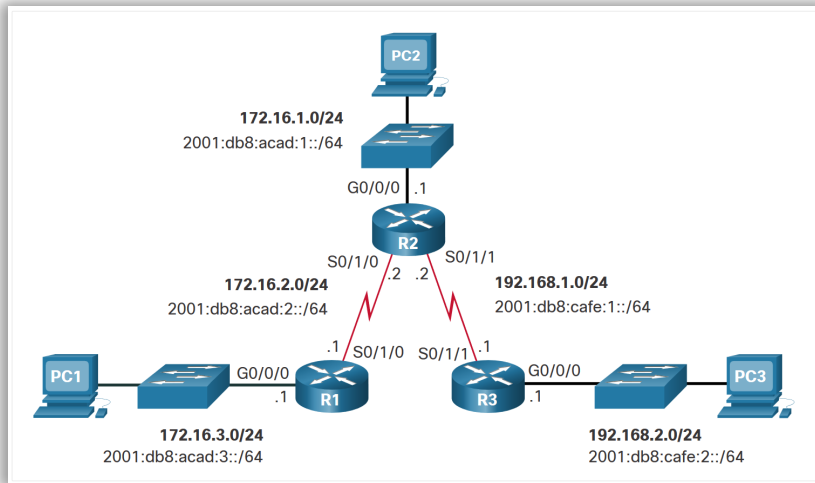
```
S    192.168.1.0/24 [1/0] via 172.16.2.2
```

```
S    192.168.2.0/24 [1/0] via 172.16.2.2
```

```
R1#
```



# IPv6下一跳静态路由



```
R1(config)# ipv6 unicast-routing
```

```
R1(config)# ipv6 route 2001:db8:acad:1::/64 2001:db8:acad:2::2
```

```
R1(config)# ipv6 route 2001:db8:cafe:1::/64 2001:db8:acad:2::2
```

```
R1(config)# ipv6 route 2001:db8:cafe:2::/64 2001:db8:acad:2::2
```

```
R1# show ipv6 route
```

IPv6 Routing Table - default - 8 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, H - NHRP, I1 - ISIS L1

I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP

EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination

NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter

OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1

ON2 - OSPF NSSA ext 2, Ia - LISP alt, Ir - LISP site-registrations

Id - LISP dyn-eid, IA - LISP away, le - LISP extranet-policy

a - Application

S 2001:DB8:ACAD:1::/64 [1/0]

via 2001:DB8:ACAD:2::2

C 2001:DB8:ACAD:2::/64 [0/0]

via Serial0/1/0, directly connected

L 2001:DB8:ACAD:2::1/128 [0/0]

via Serial0/1/0, receive

C 2001:DB8:ACAD:3::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:3::1/128 [0/0]

via GigabitEthernet0/0/0, receive

S 2001:DB8:CAFE:1::/64 [1/0]

via 2001:DB8:ACAD:2::2

S 2001:DB8:CAFE:2::/64 [1/0]

via 2001:DB8:ACAD:2::2

L FF00::/8 [0/0]

via Null0, receive

# Configure a Next-Hop Static Route

为什么要进行递归查找？

```
R1# show ip route
```

```
Gateway of last resort is not set
```

```
172.16.0.0/24 is subnetted, 1 subnets
```

```
C    172.16.2.0 is directly connected, Serial0/0
```

```
C    172.16.3.0 is directly connected, FastEthernet0/0
```

```
C    192.168.3.0/24 is directly connected, Serial0/1
```

```
ip route 192.168.1.0 255.255.255.0 192.168.3.1
```

```
S 192.168.1.0 [1/0] via 192.168.3.1
```

Interface ?

可解析性：路由器在能够转发数据包之前必须确定转发的出口。

递归查找：查找当前路由表，确定是否存在下一跳地址192.168.3.1的路由？

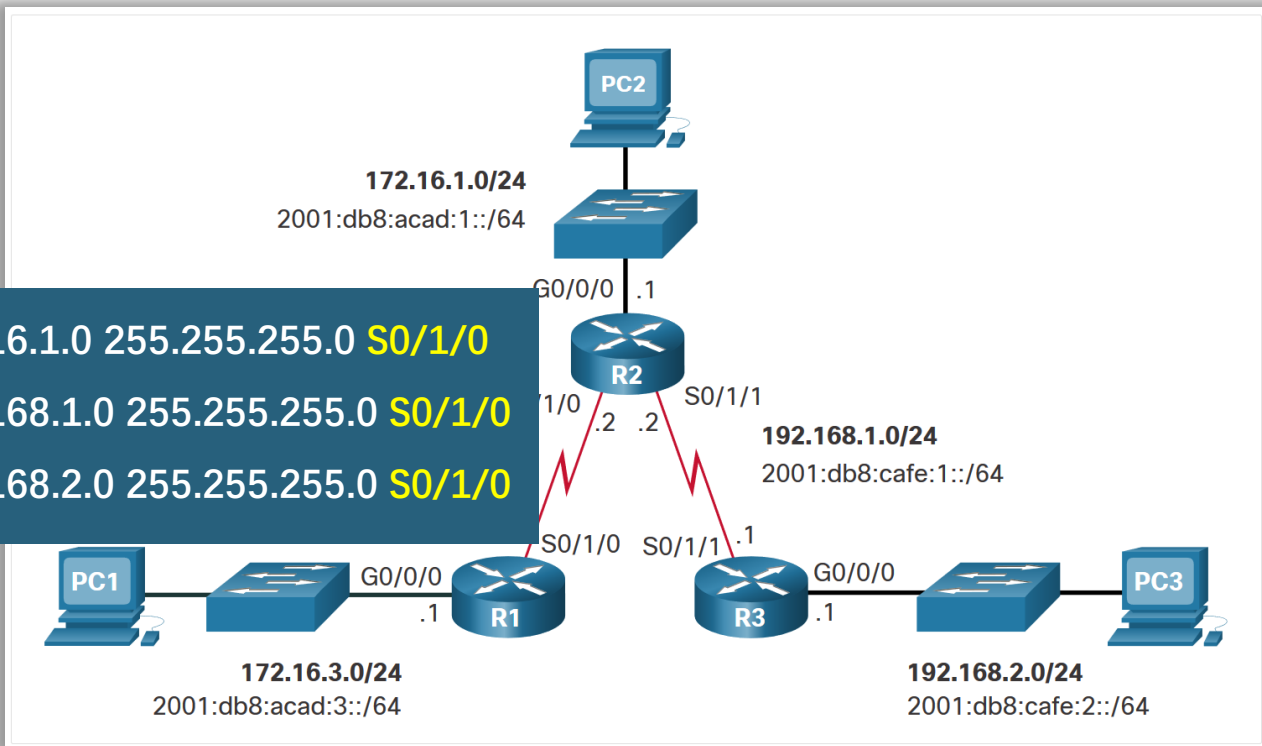
找到出口

找不到出口

对于只写了下一跳地址的静态路由，路由器以60秒为周期进行递归查找。

# IPv4直连静态路由

```
R1(config)# ip route 172.16.1.0 255.255.255.0 S0/1/0
R1(config)# ip route 192.168.1.0 255.255.255.0 S0/1/0
R1(config)# ip route 192.168.2.0 255.255.255.0 S0/1/0
```



# IPv4直连静态路由

```
R1# show ip route | begin Gateway
```

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks

S 172.16.1.0/24 is directly connected, Serial0/1/0

C 172.16.2.0/24 is directly connected, Serial0/1/0

L 172.16.2.1/32 is directly connected, Serial0/1/0

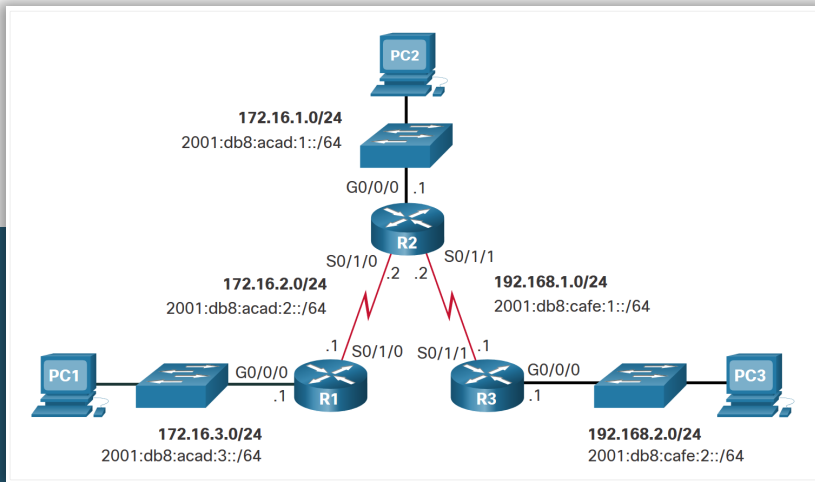
C 172.16.3.0/24 is directly connected, GigabitEthernet0/0/0

L 172.16.3.1/32 is directly connected, GigabitEthernet0/0/0

S 192.168.1.0/24 is directly connected, Serial0/1/0

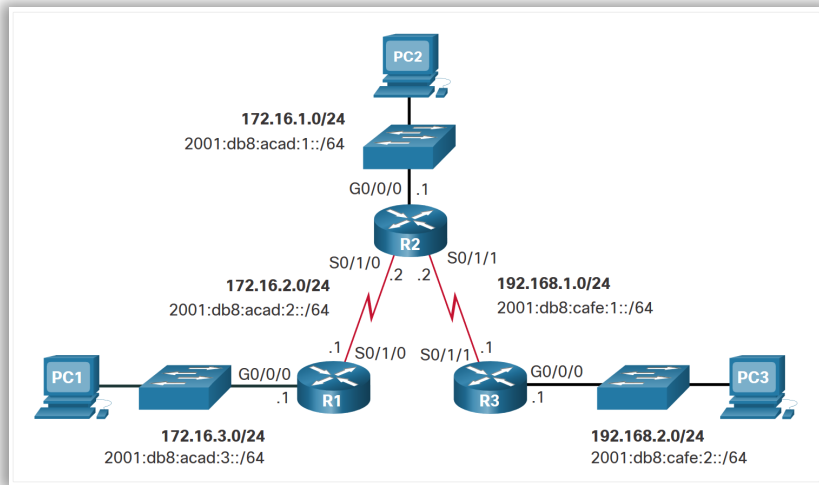
S 192.168.2.0/24 is directly connected, Serial0/1/0

R1#





# IPv6直连静态路由



```
R1(config)# ipv6 unicast-routing
```

```
R1(config)# ipv6 route 2001:db8:acad:1::/64 s0/1/0
```

```
R1(config)# ipv6 route 2001:db8:cafe:1::/64 s0/1/0
```

```
R1(config)# ipv6 route 2001:db8:cafe:2::/64 s0/1/0
```

```
R1# show ipv6 route
```

IPv6 Routing Table - default - 8 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, H - NHRP, I1 - ISIS L1

I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP

EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination

NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter

OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1

ON2 - OSPF NSSA ext 2, la - LISP alt, lr - LISP site-registrations

ld - LISP dyn-eid, IA - LISP away, le - LISP extranet-policy

a - Application

S 2001:DB8:ACAD:1::/64 [1/0]

via Serial0/1/0, directly connected

C 2001:DB8:ACAD:2::/64 [0/0]

via Serial0/1/0, directly connected

L 2001:DB8:ACAD:2::1/128 [0/0]

via Serial0/1/0, receive

C 2001:DB8:ACAD:3::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

L 2001:DB8:ACAD:3::1/128 [0/0]

via GigabitEthernet0/0/0, receive

S 2001:DB8:CAFE:1::/64 [1/0]

via Serial0/1/0, directly connected

S 2001:DB8:CAFE:2::/64 [1/0]

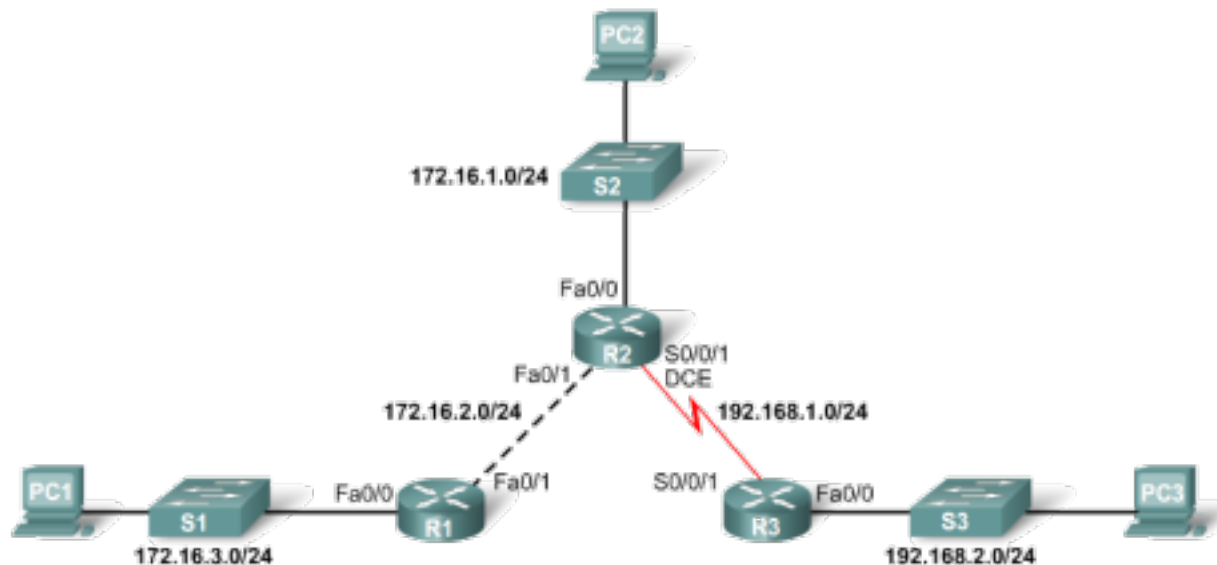
via Serial0/1/0, directly connected

L FF00::/8 [0/0]

via Null0, receiveIPv6 Routing Table - default - 8 entries via Null0, receive

# Configure a Fully Specified Static Route

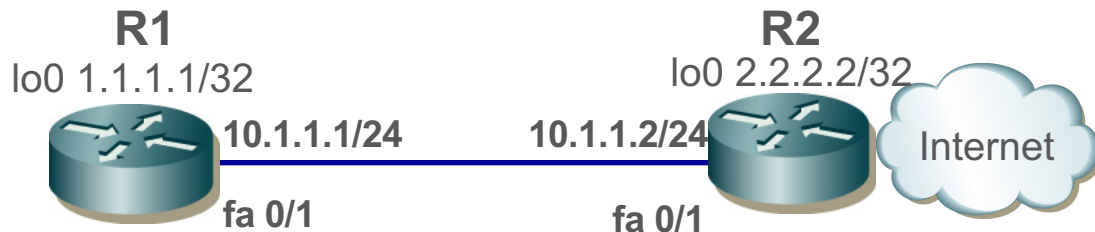
Exit interface and next-hop address



方案1: R1(config)#ip route 192.168.2.0 255.255.255.0 172.16.2.2 ✓

方案2: R1(config)#ip route 192.168.2.0 255.255.255.0 fastethernet 0/1 ? 思科机密信息

R1: ip route 0.0.0.0 0.0.0.0 10.1.1.2



R1# **show ip route**

<output omitted>

1.0.0.0/32 is subnetted, 1 subnets

C 1.1.1.1 is directly connected, Loopback0

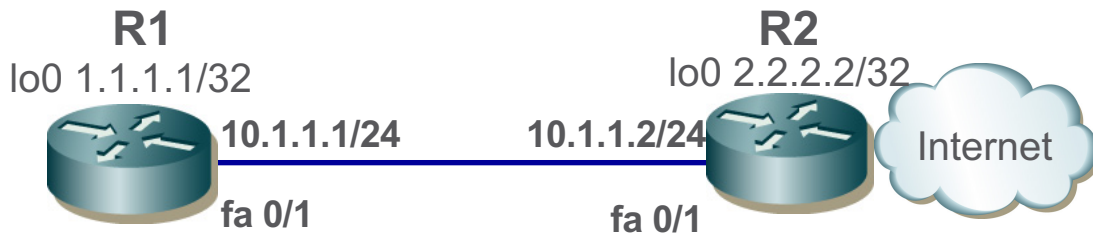
10.0.0.0/24 is subnetted, 1 subnets

C 10.1.1.0 is directly connected, FastEthernet0/1

**S\* 0.0.0.0/0 [1/0] via 10.1.1.2** ←

Demo: ping 2.2.2.2 from R1

A: ip route 0.0.0.0 0.0.0.0 10.1.1.2



R1# ping 2.2.2.2

Type escape sequence to abort.

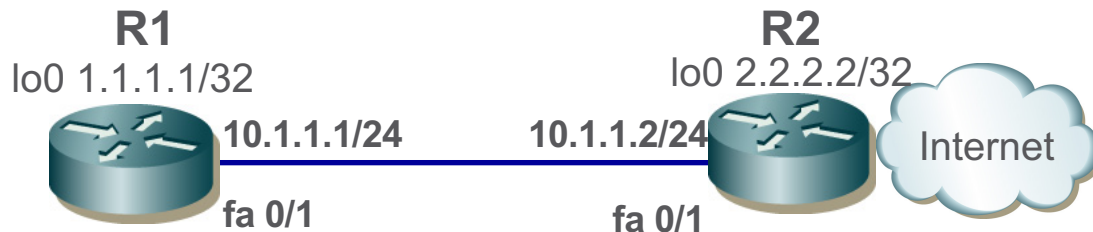
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:

!!!!

R1# show arp

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	10.1.1.2	0	0013.8046.5b61	ARPA	FastEthernet0/1
Internet	10.1.1.1	-	0012.d9f4.9d81	ARPA	FastEthernet0/1

A: ip route 0.0.0.0 0.0.0.0 10.1.1.2



R1# ping 3.3.3.3

Type escape sequence to abort.

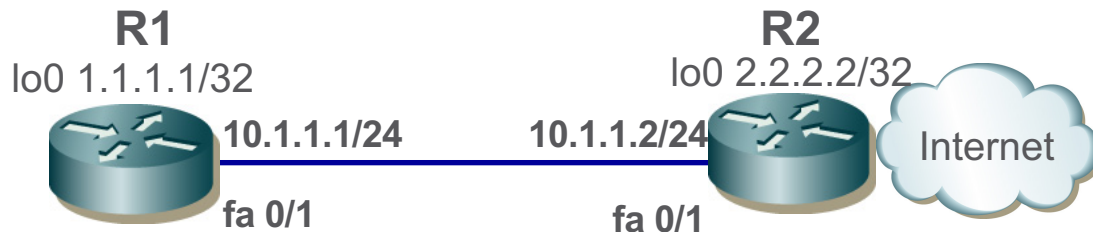
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:

!!!!

R1# show arp

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	10.1.1.2	0	0013.8046.5b61	ARPA	FastEthernet0/1
Internet	10.1.1.1	-	0012.d9f4.9d81	ARPA	FastEthernet0/1

R1: ip route 0.0.0.0 0.0.0.0 fa 0/1



R1# **show ip route**

<output omitted>

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

10.0.0.0/24 is subnetted, 1 subnets

C 10.1.1.0 is directly connected, FastEthernet0/1

S\* 0.0.0.0/0 is directly connected, FastEthernet0/1



Demo: ping 2.2.2.2 from R1

# Demo Result: ping 2.2.2.2 from R1 ip route

R1# **show arp**

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	10.1.1.1	-	0012.d9f4.9d81	ARPA	FastEthernet0/1

R1# **ping 2.2.2.2**

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:

.!!!!

R1# **show arp**

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	2.2.2.2	0	0013.8046.5b61	ARPA	FastEthernet0/1
Internet	10.1.1.2	43	0013.8046.5b61	ARPA	FastEthernet0/1
Internet	10.1.1.1	-	0012.d9f4.9d81	ARPA	FastEthernet0/1

# Demo result: ping 3.3.3.3 (lo1 interface in R2)

```
R1#debug ip packet
```

```
R1#ping 3.3.3.3
```

```
*Mar 1 09:18:21.621: IP ARP: creating incomplete entry for IP address:  
3.3.3.3 interface FastEthernet0/1
```

```
*Mar 1 09:18:21.621: IP ARP: sent req src 10.1.1.1 0012.d9f4.9d81,  
dst 3.3.3.3 0000.0000.0000 FastEthernet0/1
```

```
*Mar 1 09:18:21.625: IP ARP: rcvd rep src 3.3.3.3 0013.8046.5b61, dst  
10.1.1.1 FastEthernet0/1 .!!!!
```

```
R1#show arp
```

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	3.3.3.3	3	0013.8046.5b61	ARPA	FastEthernet0/1
Internet	2.2.2.2	22	0013.8046.5b61	ARPA	FastEthernet0/1
Internet	10.1.1.2	43	0013.8046.5b61	ARPA	FastEthernet0/1
Internet	10.1.1.1	-	0012.d9f4.9d81	ARPA	FastEthernet0/1

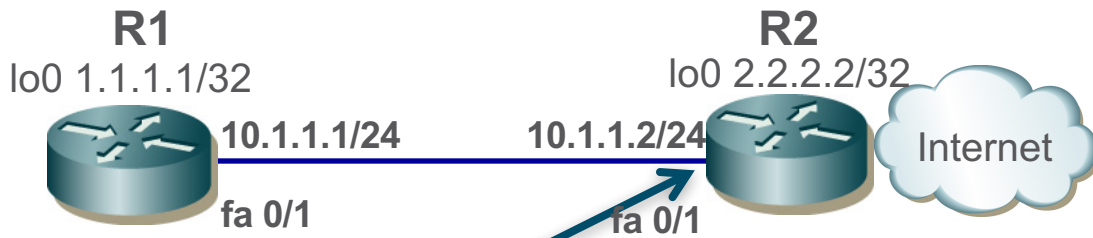
Why?

New entry (3.3.3.3) in arp table in R1 (每有一次新的连接, ARP 表会加一项条目)。

Proxy ARP is enabled by default!



# 关闭ARP代理功能 (Fa 0/1 interface in R2)



```
R2(config)# inte fa 0/1  
R2(config-if)# no ip proxy-arp  
R2(config-if)# exit  
R2(config)#inter loopback 2  
R2(config-if)#ip add 4.4.4.4 255.255.255.255
```

Disable proxy arp

R1# **show arp**

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	3.3.3.3	13	0013.8046.5b61	ARPA	FastEthernet0/1
Internet	2.2.2.2	13	0013.8046.5b61	ARPA	FastEthernet0/1
Internet	10.1.1.1	-	0012.d9f4.9d81	ARPA	FastEthernet0/1

Can I get echo reply if I ping 4.4.4.4 from R1?

# Demo result: ping 4.4.4.4

R1# ping 4.4.4.4

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 4.4.4.4, timeout is 2 seconds:

no arp reply received

\*Mar 1 12:15:23.563: IP ARP: creating incomplete entry for IP address:  
4.4.4.4 interface FastEthernet0/1

\*Mar 1 12:15:23.563: IP ARP: sent req src 10.1.1.1 0012.d9f4.9d81,  
dst 4.4.4.4 0000.0000.0000 FastEthernet0/1 .

\*Mar 1 12:15:25.563: IP ARP: sent req src 10.1.1.1 0012.d9f4.9d81,  
dst 4.4.4.4 0000.0000.0000 FastEthernet0/1 .

\*Mar 1 12:15:27.566: IP ARP: sent req src 10.1.1.1 0012.d9f4.9d81,  
dst 4.4.4.4 0000.0000.0000 FastEthernet0/1 .

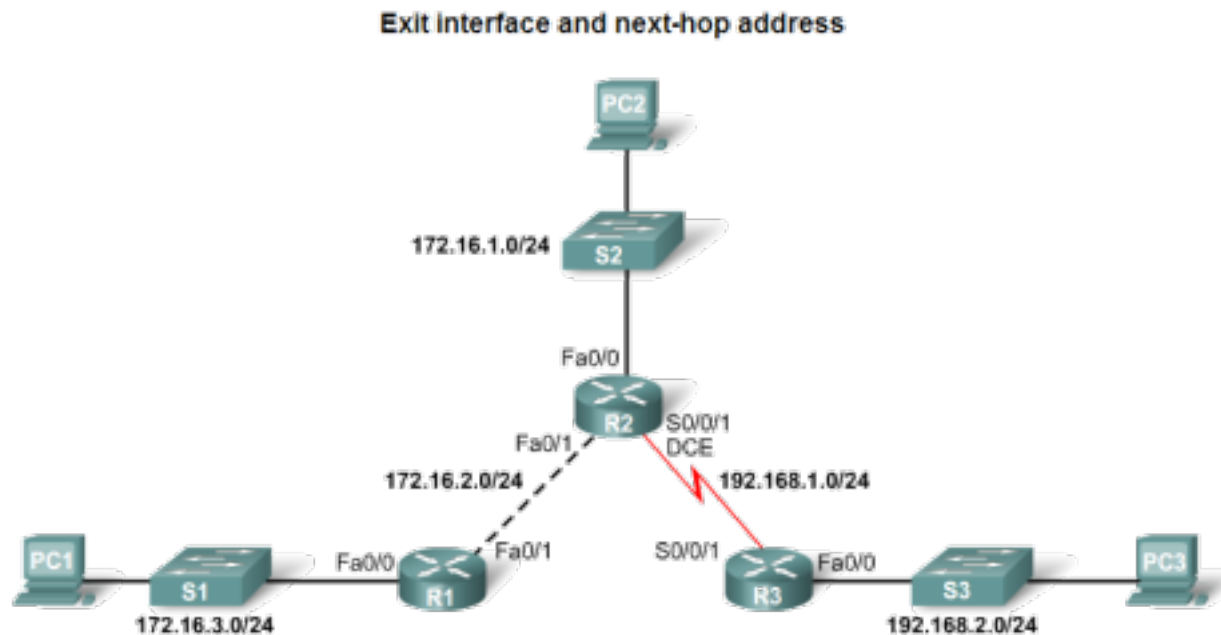
\*Mar 1 12:15:29.569: IP ARP: sent req src 10.1.1.1 0012.d9f4.9d81,  
dst 4.4.4.4 0000.0000.0000 FastEthernet0/1 .

\*Mar 1 12:15:31.572: IP ARP: sent req src 10.1.1.1 0012.d9f4.9d81,  
dst 4.4.4.4 0000.0000.0000 FastEthernet0/1 .

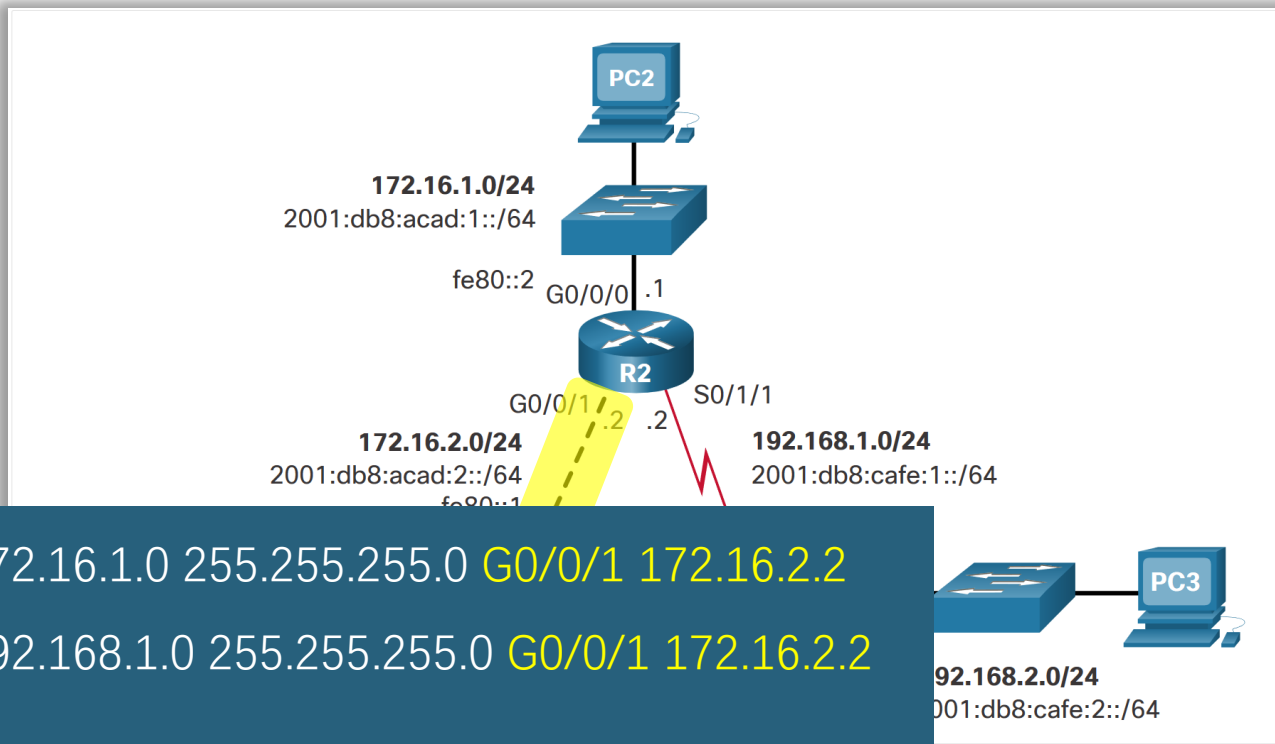
Success rate is 0 percent (0/5)

# Static routes and Ethernet exit interfaces

- 解决方法



# IPv4完全指定的静态路由



```
R1(config)# ip route 172.16.1.0 255.255.255.0 G0/0/1 172.16.2.2
```

```
R1(config)# ip route 192.168.1.0 255.255.255.0 G0/0/1 172.16.2.2
```

```
R1(config)# ip route 192.168.2.0 255.255.255.0 G0/0/1 172.16.2.2
```

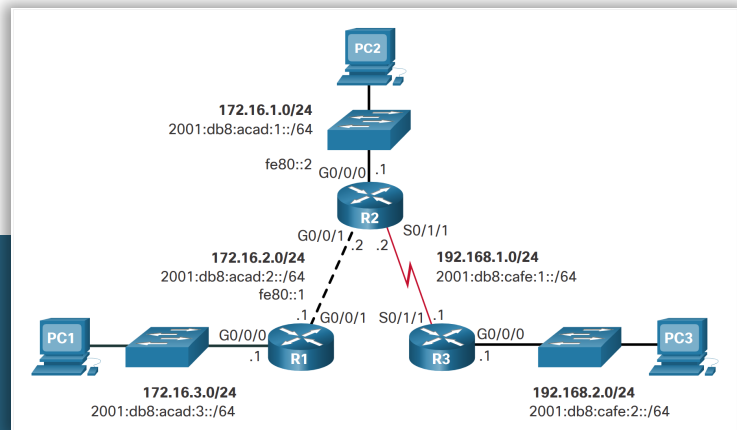
# IPv4完全指定的静态路由

```
R1# show ip route | begin Gateway
```

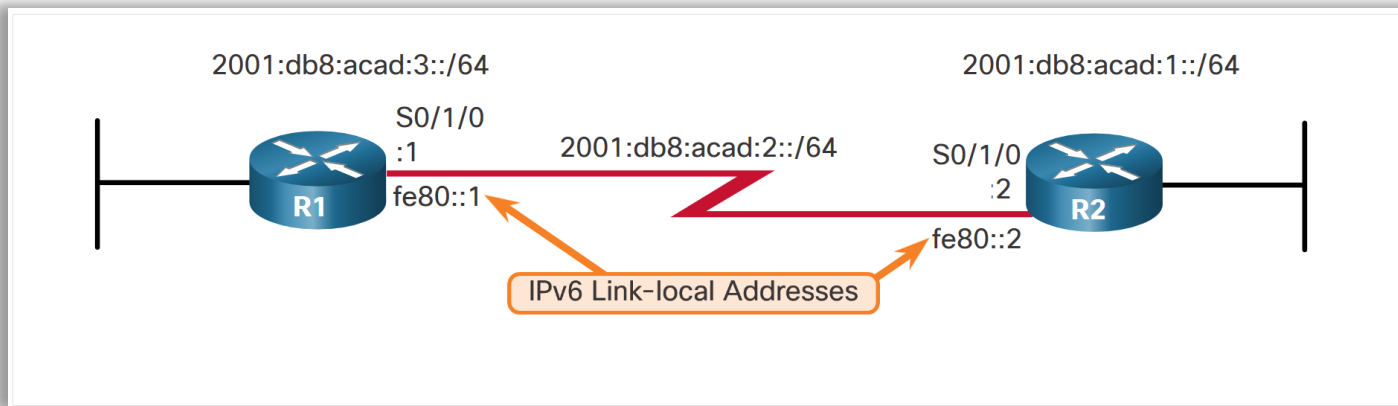
Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks

```
S    172.16.1.0/24 [1/0] via 172.16.2.2, GigabitEthernet0/0/1
C    172.16.2.0/24 is directly connected, GigabitEthernet0/0/1
L    172.16.2.1/32 is directly connected, GigabitEthernet0/0/1
C    172.16.3.0/24 is directly connected, GigabitEthernet0/0/0
L    172.16.3.1/32 is directly connected, GigabitEthernet0/0/0
S    192.168.1.0/24 [1/0] via 172.16.2.2, GigabitEthernet0/0/1
S    192.168.2.0/24 [1/0] via 172.16.2.2, GigabitEthernet0/0/1
```



# IPv6完全指定的静态路由

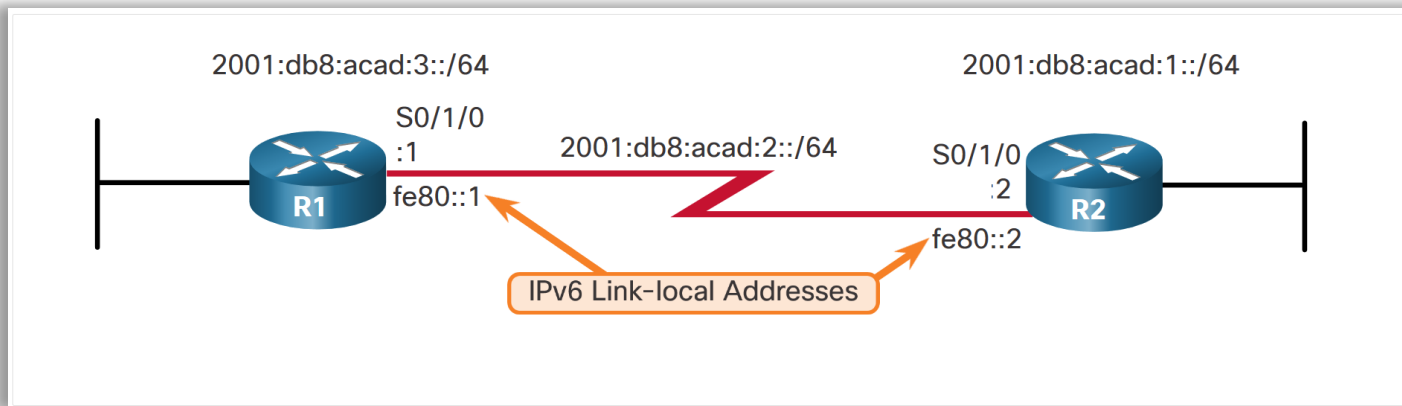


```
R1(config)# ipv6 route 2001:db8:acad:1::/64 fe80::2
```

%Interface has to be specified for a link-local nexthop

```
R1(config)# ipv6 route 2001:db8:acad:1::/64 s0/1/0 fe80::2
```

# IPv6完全指定的静态路由



```
R1# show ipv6 route static | begin 2001:db8:acad:1::/64
S  2001:DB8:ACAD:1::/64 [1/0]
   via FE80::2, Serial0/1/0
```

# 检验静态路由

```
R1# show ip route static | begin Gateway
```

Gateway of last resort is not set

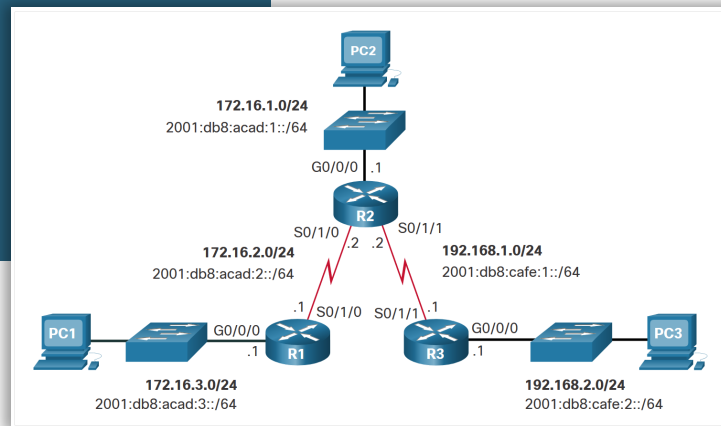
172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks

```
S    172.16.1.0/24 [1/0] via 172.16.2.2
```

```
S    192.168.1.0/24 [1/0] via 172.16.2.2
```

```
S    192.168.2.0/24 [1/0] via 172.16.2.2
```

```
R1#
```





# 检验静态路由

R1# **show ip route 192.168.2.0**

Routing entry for 192.168.2.0/24

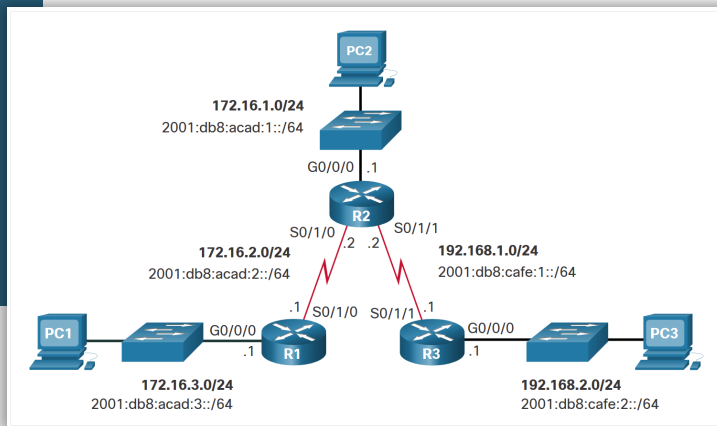
Known via "static", distance 1, metric 0

Routing Descriptor Blocks:

\* 172.16.2.2

Route metric is 0, traffic share count is 1

R1#



# 检验静态路由

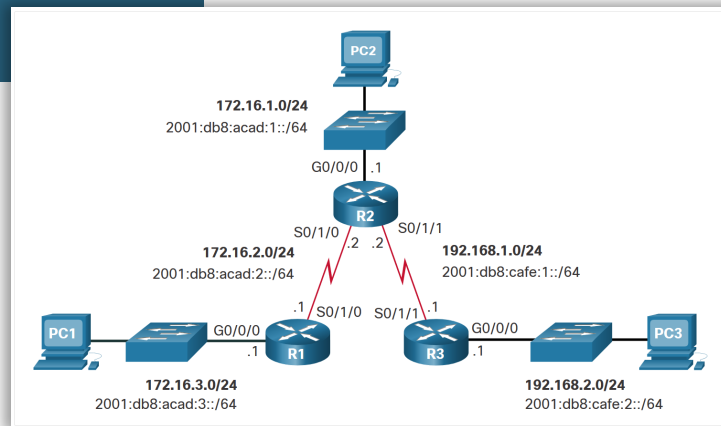
```
R1# show running-config | section ip route
```

```
ip route 172.16.1.0 255.255.255.0 172.16.2.2
```

```
ip route 192.168.1.0 255.255.255.0 172.16.2.2
```

```
ip route 192.168.2.0 255.255.255.0 172.16.2.2
```

```
R1#
```



配置静态路由

# 检验静态路由

R1# **show ipv6 route static**

IPv6 Routing Table - default - 8 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, H - NHRP, I1 - ISIS L1

I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP

EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination

NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter

OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1

ON2 - OSPF NSSA ext 2, Ia - LISP alt, Ir - LISP site-registrations

Id - LISP dyn-eid, IA - LISP away, le - LISP extranet-policy

a - Application

S 2001:DB8:ACAD:1::/64 [1/0]

via 2001:DB8:ACAD:2::2

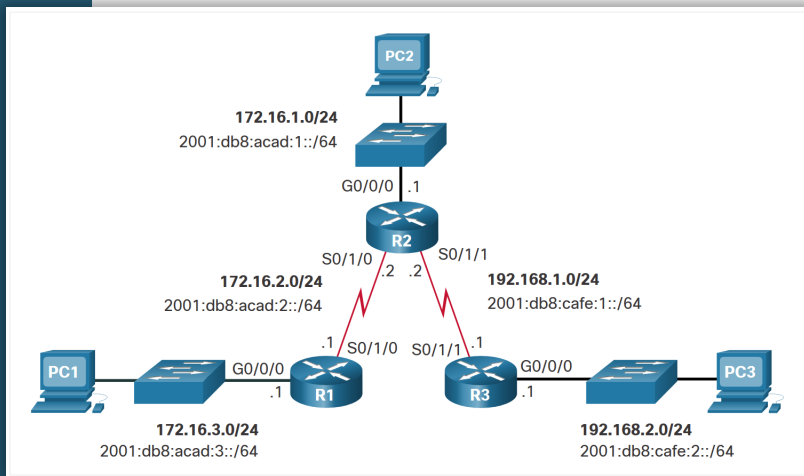
S 2001:DB8:CAFE:1::/64 [1/0]

via 2001:DB8:ACAD:2::2

S 2001:DB8:CAFE:2::/64 [1/0]

via 2001:DB8:ACAD:2::2

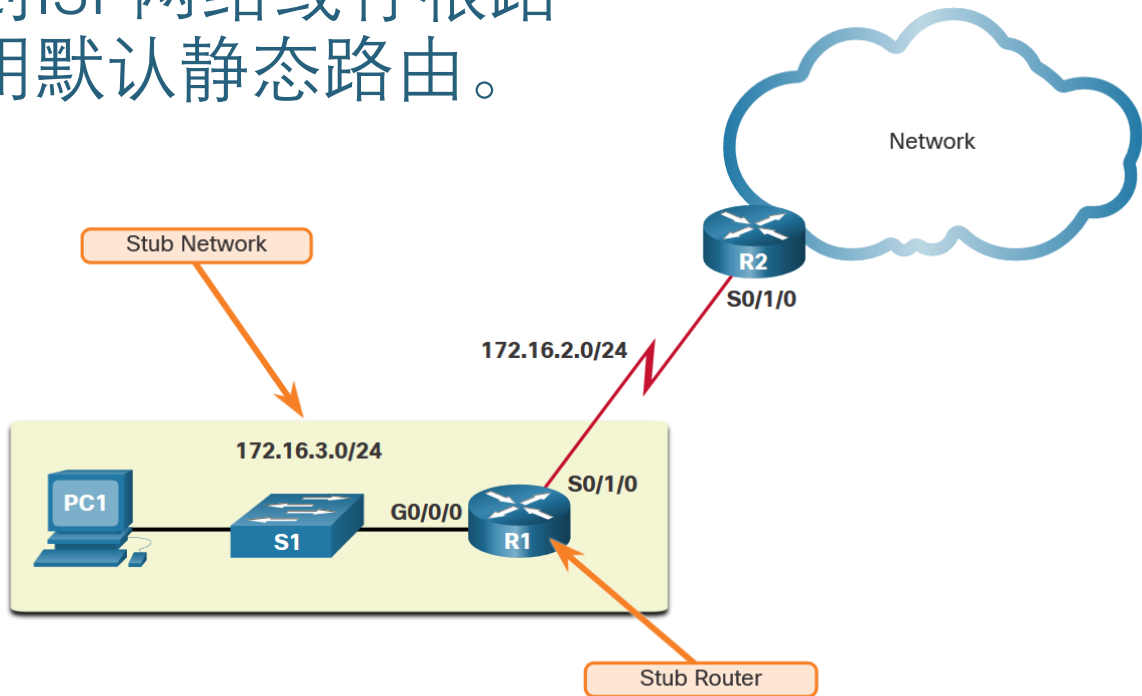
R1#



# 15.3 配置 IP 默认静态路由

# 默认静态路由

- **边缘路由器**连接到ISP网络或存根路由由器时，通常使用默认静态路由。



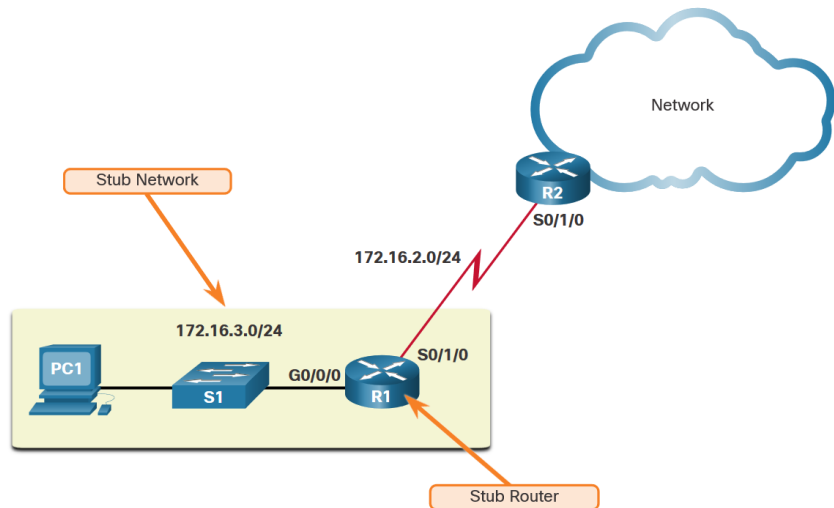
# 默认静态路由

## • IPv4

Router(config)# **ip route 0.0.0.0 0.0.0.0** {ip-address / exit-intf}

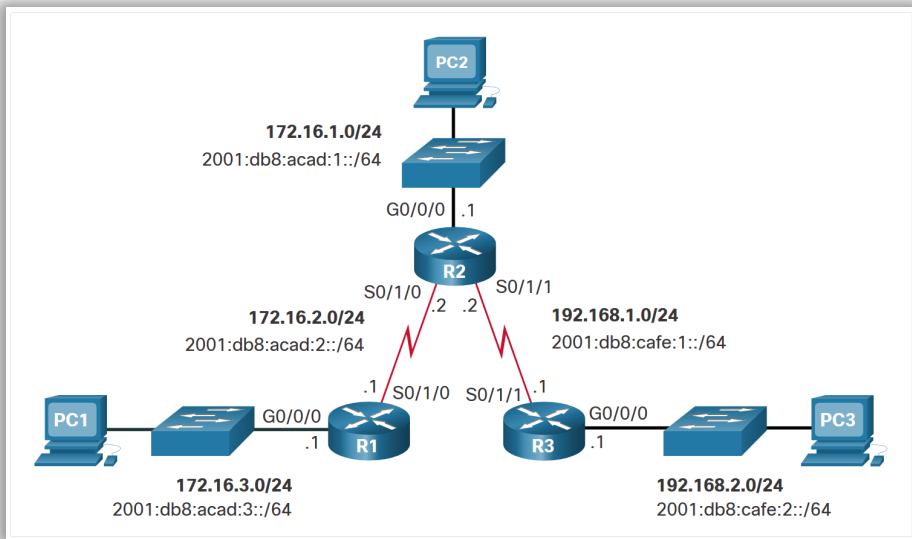
## • IPv6

Router(config)# **ipv6 route ::/0** {ipv6-address / exit-intf}

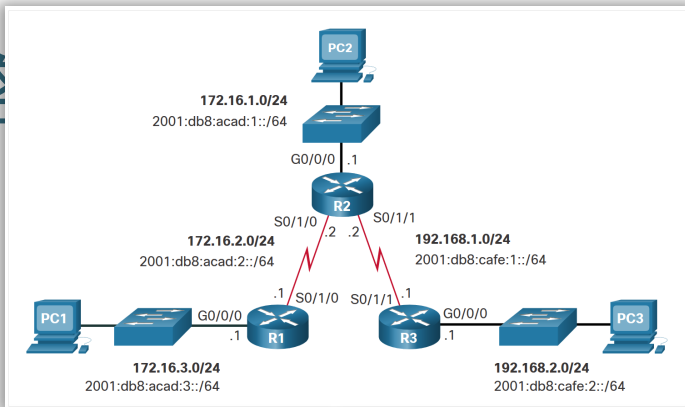


# 配置默认静态路由

- R1(config)# ip route **0.0.0.0 0.0.0.0** 172.16.2.2
- R1(config)# ipv6 route **::/0 2001:db8:acad:2::2**



# 检验默认静态路由



R1# show ip route static

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, I - LISP

+ - replicated route, % - next hop override

Gateway of last resort is 172.16.2.2 to network 0.0.0.0

S\* 0.0.0.0/0 [1/0] via 172.16.2.2

R1# show ipv6 route static

IPv6 Routing Table - default - 8 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, H - NHRP, I1 - ISIS L1

I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP

EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination

NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter

OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1

ON2 - OSPF NSSA ext 2, la - LISP alt, lr - LISP site-registrations

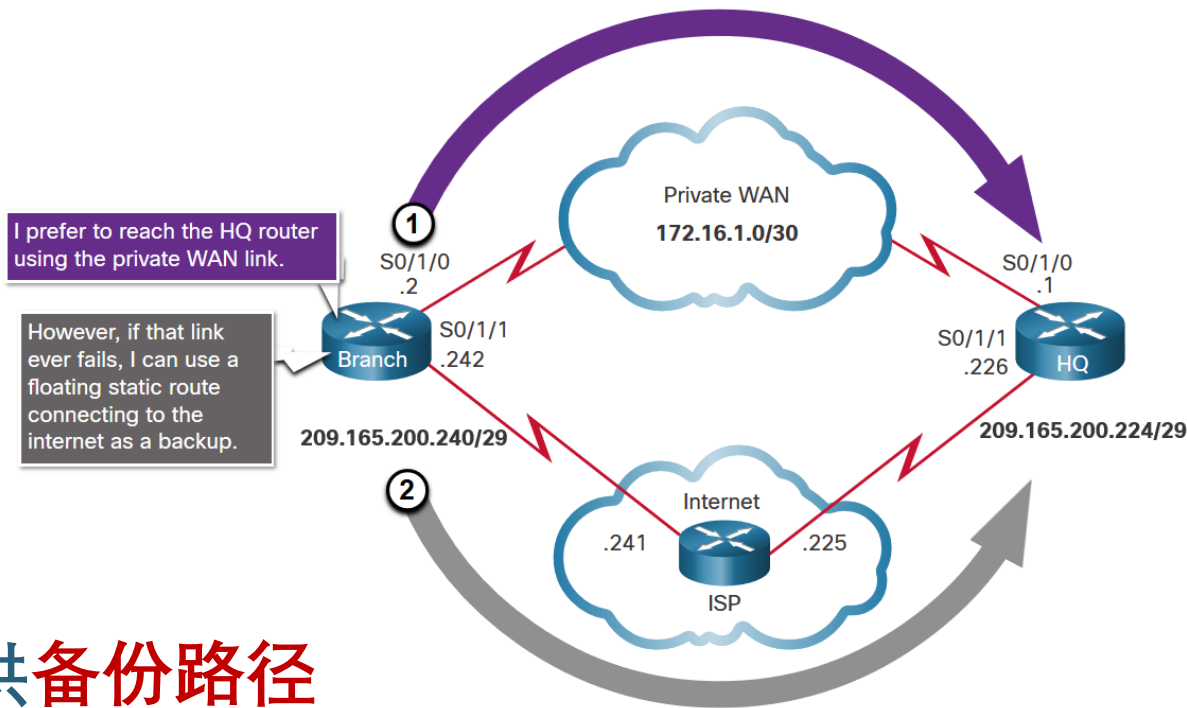
S ::0 [1/0]

via 2001:DB8:ACAD:2::2



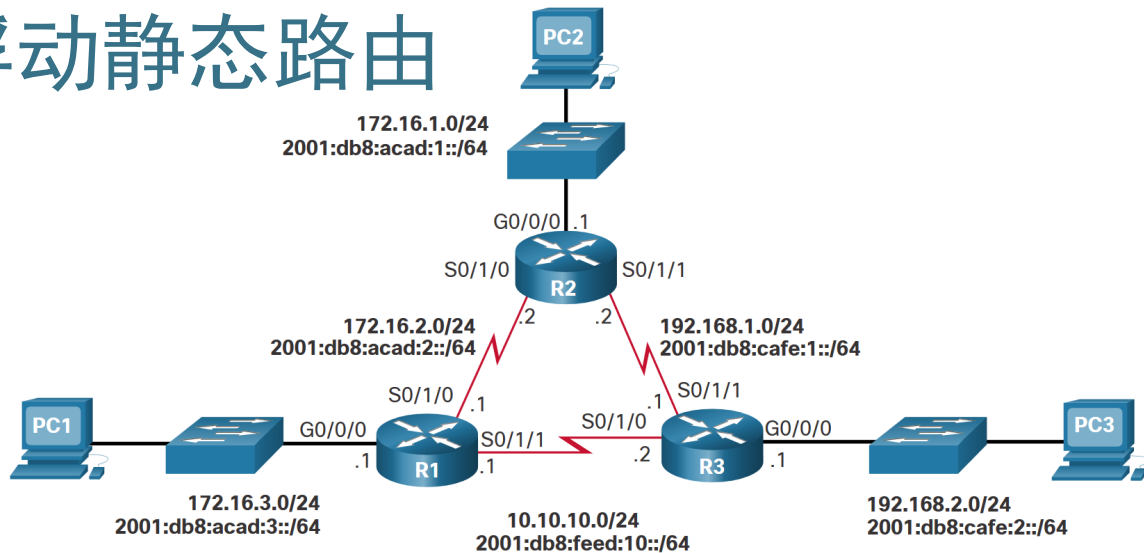
# 15.4 配置浮动静态路由

# 浮动静态路由



- 浮动路由提供**备份路径**
- 浮动静态路由比主路由具有更高值的**管理距离**

# 配置IPv4和IPv6浮动静态路由



```
R1(config)# ip route 0.0.0.0 0.0.0.0 172.16.2.2
```

```
R1(config)# ip route 0.0.0.0 0.0.0.0 10.10.10.2 5
```

```
R1(config)# ipv6 route ::/0 2001:db8:acad:2::2
```

```
R1(config)# ipv6 route ::/0 2001:db8:feed:10::2 5
```

# 配置IPv4和IPv6浮动静态路由

```
R1# show ip route static | begin Gateway
```

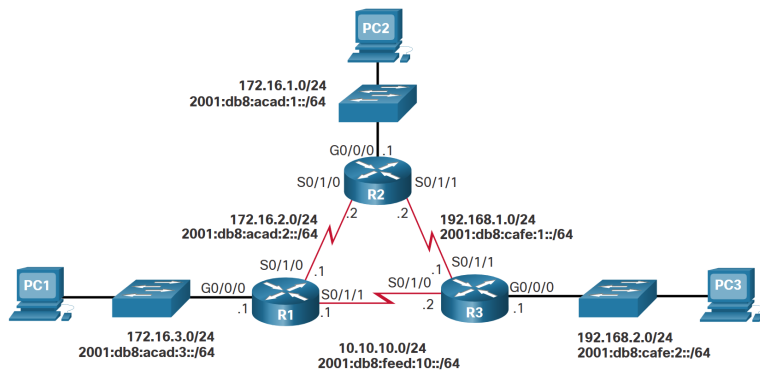
```
Gateway of last resort is 172.16.2.2 to network 0.0.0.0
```

```
S* 0.0.0.0/0 [1/0] via 172.16.2.2
```

```
R1# show ipv6 route static | begin S :
```

```
S :::/0 [1/0]
```

```
via 2001:DB8:ACAD:2::2
```



# 测试浮动静态路由

```
R1# show ip route static | begin Gateway
```

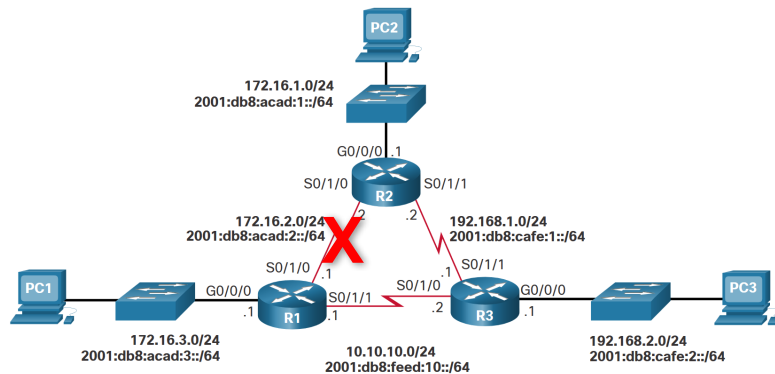
```
Gateway of last resort is 10.10.10.2 to network 0.0.0.0
```

```
S* 0.0.0.0/0 [5/0] via 10.10.10.2
```

```
R1# show ipv6 route static | begin S :
```

```
S :::/0 [5/0]
```

```
via 2001:DB8:FEED:10::2
```

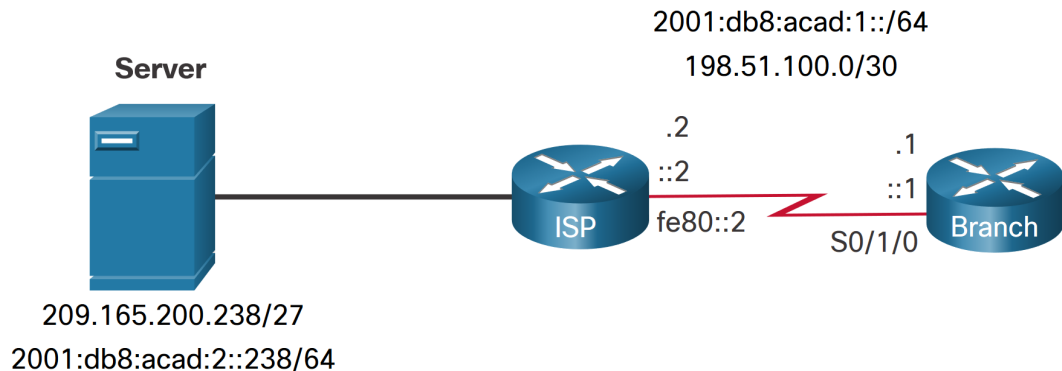


# 15.5 配置静态主机路由

# 主机路由

- 主机路由：具有**32位掩码**的IPv4地址或具有**128位**后缀的IPv6地址。
- 下面显示了将主机路由添加到路由表的三种方式：
  1. 在路由器上配置接口IP地址时**自动添加**
  2. **手工配置**静态主机路由
  3. 通过其他方法自动获取的主机路由（在以后的课程中讨论）

# 自动添加主机路由



```
Branch# show ip route | begin Gateway
```

```
Gateway of last resort is not set
```

```
198.51.100.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C    198.51.100.0/30 is directly connected, Serial0/1/0
```

```
L    198.51.100.1/32 is directly connected, Serial0/1/0
```

```
Branch# show ipv6 route | begin ::
```

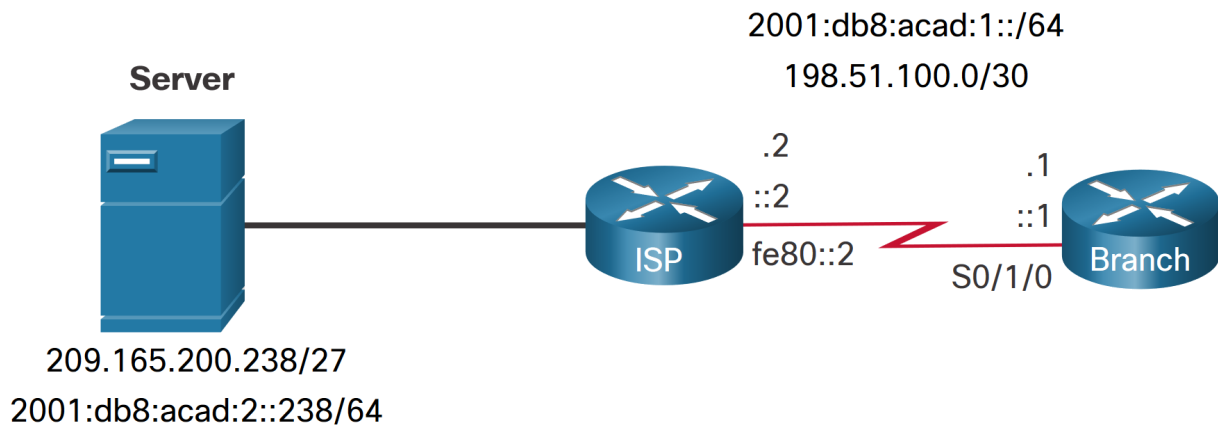
```
C    2001:DB8:ACAD:1::/64 [0/0]
    via Serial0/1/0, directly connected
```

```
L    2001:DB8:ACAD:1::1/128 [0/0]
    via Serial0/1/0, receive
```

```
L    FF00::/8 [0/0]
    via Null0, receive
```

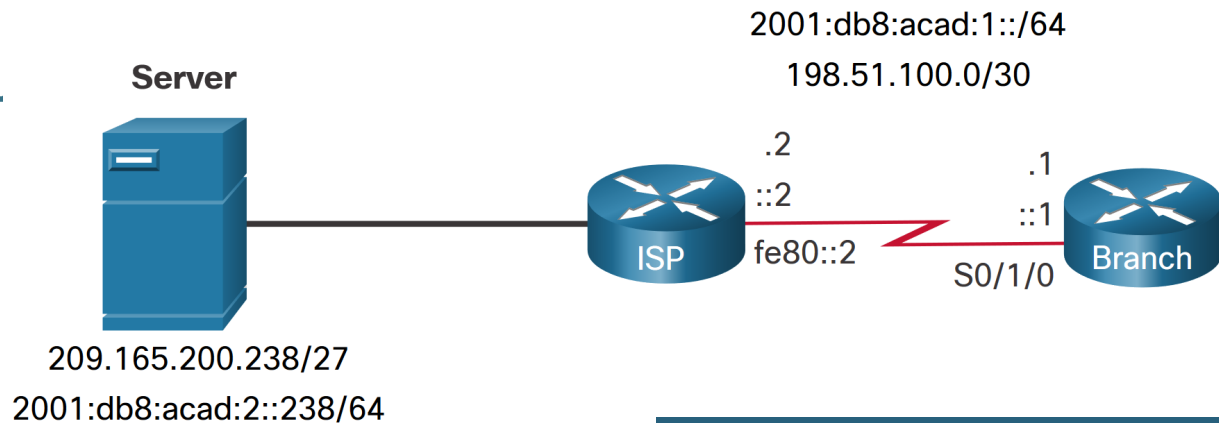


# 配置静态主机路由



```
Branch(config)# ip route 209.165.200.238 255.255.255.255 198.51.100.2  
Branch(config)# ipv6 route 2001:db8:acad:2::238/128 2001:db8:acad:1::2
```

## 配置静态主机



```
Branch# show ip route | begin Gateway
```

```
Gateway of last resort is not set
```

```
198.51.100.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C    198.51.100.0/30 is directly connected, Serial0/1/0
```

```
L    198.51.100.1/32 is directly connected, Serial0/1/0
```

```
209.165.200.0/32 is subnetted, 1 subnets
```

```
S    209.165.200.238 [1/0] via 198.51.100.2
```

```
Branch# show ipv6 route
```

```
(Output omitted)
```

```
C    2001:DB8:ACAD:1::/64 [0/0]
```

```
via Serial0/1/0, directly connected
```

```
L    2001:DB8:ACAD:1::1/128 [0/0]
```

```
via Serial0/1/0, receive
```

```
S    2001:DB8:ACAD:2::238/128 [1/0]
```

```
via 2001:DB8:ACAD:1::2
```

# 使用本地链路下一跳配置静态主机路由

```
Branch(config)# no ipv6 route 2001:db8:acad:2::238/128 2001:db8:acad:1::2
```

```
Branch(config)# ipv6 route 2001:db8:acad:2::238/128 serial 0/1/0 fe80::2
```

```
Branch# show ipv6 route | begin ::
```

```
C 2001:DB8:ACAD:1::/64 [0/0]
```

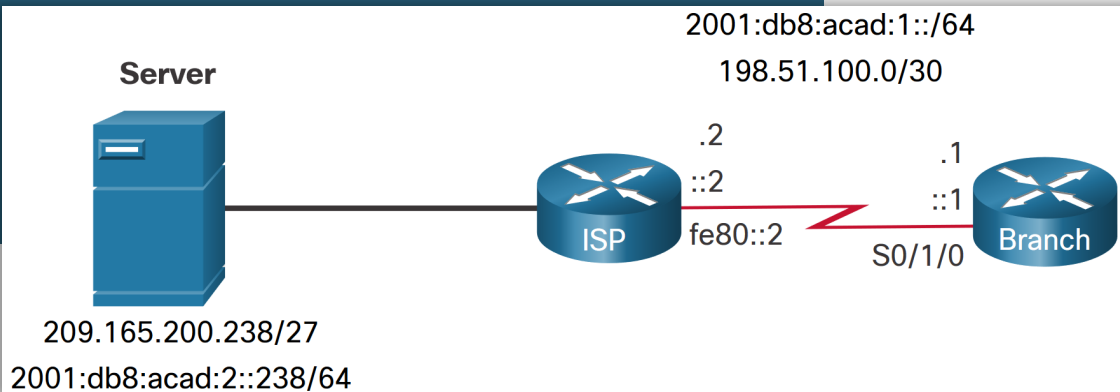
```
via Serial0/1/0, directly connected
```

```
L 2001:DB8:ACAD:1::1/128 [0/0]
```

```
via Serial0/1/0, receive
```

```
S 2001:DB8:ACAD:2::238/128 [1/0]
```

```
via FE80::2, Serial0/1/0
```

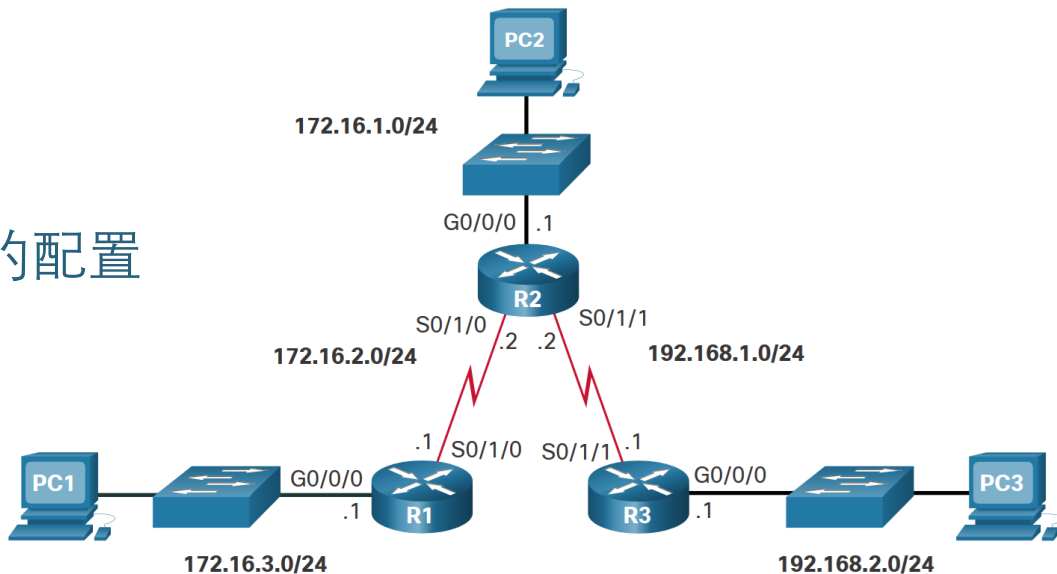


# 15.6 排除静态路由和默认路由故障

## 网络变化

**网络失效**的原因有很多：

- **接口**可能会失效
- **服务提供商**断开连接
- **链路**可能变得过饱和
- **管理员**可能输入了错误的配置



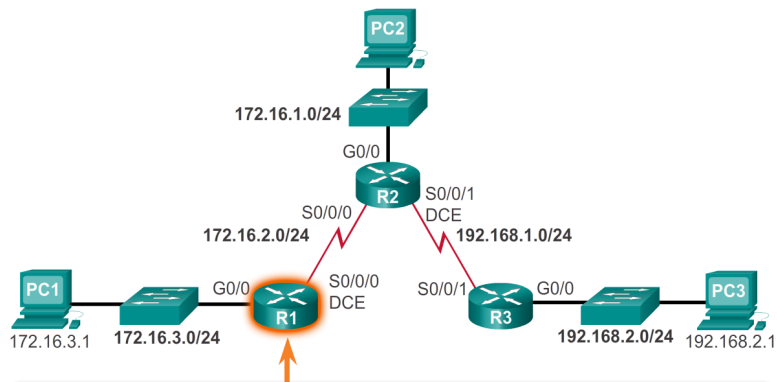
## 常用排错命令

命令	描述
<b>ping</b>	<ul style="list-style-type: none"><li>• 检验到目的地的第3层连通性</li><li>• 扩展ping提供附加的选项</li></ul>
<b>tracert</b>	<ul style="list-style-type: none"><li>• 检验到达目标网络的路径</li><li>• 它ICMP echo reply 信息确定到目的地的跳数</li></ul>
<b>show ip route</b>	<ul style="list-style-type: none"><li>• 显示路由表</li><li>• 用来检验到目的IP地址的路由条目</li></ul>
<b>show ip interface brief</b>	<ul style="list-style-type: none"><li>• 显示设备接口状态</li><li>• 用来检验接口的运行状态和IP地址</li></ul>
<b>show cdp neighbors</b>	<ul style="list-style-type: none"><li>• 显示直连的Cisco设备</li><li>• 用来验证第1层和第2层的连接</li></ul>

# 排除IPv4静态和默认路由故障

## 缺失路由故障排除

### PC1不能ping通PC3



```
R1# ping 192.168.2.1 source g0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.3.1
.....
Success rate is 0 percent (0/5)
R1#
```

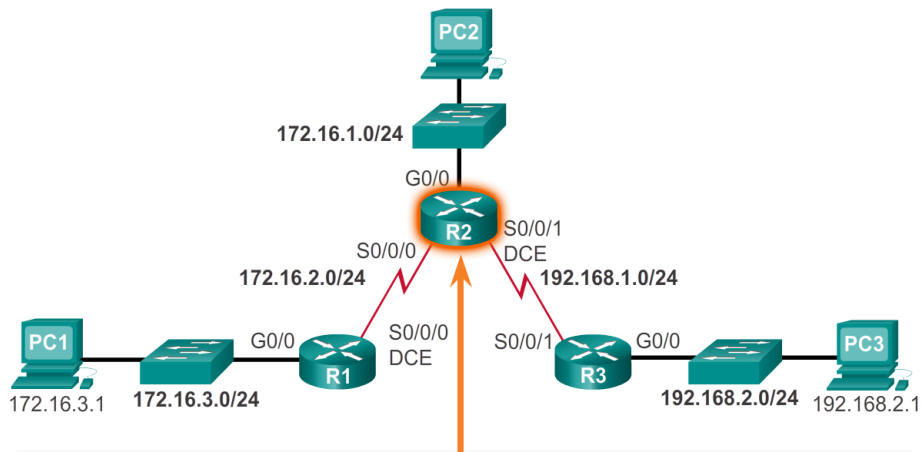
```
R1# traceroute 192.168.2.1
Type escape sequence to abort.
Tracing the route to 192.168.2.1
VRF info: (vrf in name/id, vrf out name/id)
 1 172.16.2.2 4 msec 4 msec 8 msec
 2 172.16.2.1 12 msec 12 msec 12 msec
 3 172.16.2.2 12 msec 8 msec 8 msec
 4 172.16.2.1 20 msec 16 msec 20 msec
 5 172.16.2.2 16 msec 16 msec 16 msec
 6 172.16.2.1 20 msec 20 msec 24 msec
 7 172.16.2.2 20 msec
R1#
```

```
R2# show ip route | begin Gateway
Gateway of last resort is not set

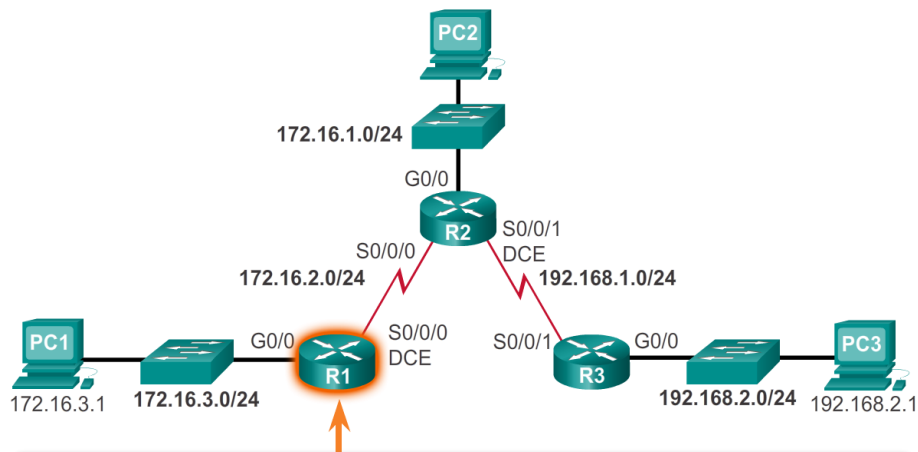
172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
C    172.16.1.0/24 is directly connected, GigabitEthernet0/0
L    172.16.1.1/32 is directly connected, GigabitEthernet0/0
C    172.16.2.0/24 is directly connected, Serial0/0/0
L    172.16.2.2/32 is directly connected, Serial0/0/0
S    172.16.3.0/24 is directly connected, Serial0/0/0
    192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.1.0/24 is directly connected, Serial0/0/1
L    192.168.1.2/32 is directly connected, Serial0/0/1
S    192.168.2.0/24 [1/0] via 172.16.2.1
R2#
```

## 排除IPv4静态和默认路由故障

# 缺失路由故障排除



```
R2# show running-config | section ip route
ip route 172.16.3.0 255.255.255.0 172.16.2.1
ip route 192.168.2.0 255.255.255.0 172.16.2.1
R2#
R2# conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)# no ip route 192.168.2.0 255.255.255.0 172.16.2.1
R2(config)# ip route 192.168.2.0 255.255.255.0 192.168.1.1
R2(config)#
```



```
R1# ping 192.168.2.1 source g0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.3.1
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/28
ms
R1#
```



# 15.7 单元练习与测验

# Packet Tracer – 配置 IPv4 和 IPv6 静态和默认路由

在这个 Packet Tracer 练习中，您需要配置：

- 配置 IPv4 静态和浮动静态默认路由
- 配置 IPv6 静态和浮动静态默认路由
- 配置 IPv4 静态和浮动静态路由指向内部局域网
- 配置 IPv6 静态和浮动静态路由指向内部局域网
- 配置 IPv4 主机路由
- 配置 IPv6 主机路由

在本实验中，您将完成以下目标：

- 建立网络并配置设备的基本设置
- 配置并验证 R1 和 R2 上的 IP 和 IPv6 地址
- 配置并验证 R1 和 R2 上的 IPv4 静态路由和默认路由
- 配置并验证 R1 和 R2 上的 IPv6 静态路由和默认路由

## 在这个模块中我学到了什么？

- 可以配置 IPv4 和 IPv6 静态路由。两种协议都支持以下类型的静态路由：标准静态路由、默认静态路由、浮动静态路由和汇总静态路由。
- 在配置一条静态路由时，可以使用 IP 地址、出站接口，或者这两者来指定下一跳。指定目的的方式会创建出下面三种类型的静态路由之一：下一跳路由、直连路由和完全指定路由。
- IPv4 静态路由使用以下全局配置命令进行配置：`ip route network-address subnet-mask { ip-address | exit-intf [ip-address] } [distance]`。
- IPv6 静态路由使用以下全局配置命令进行配置：`ipv6 route ipv6-prefix/prefix-length { ipv6-address | exit-intf [ipv6-address] } [distance]`。
- 在下一跳静态路由中，仅指定下一跳 IP 地址。出站接口是从下一跳获得的。
- 当配置静态路由时，另一种方法是使用出站接口指定下一跳地址。直连静态路由只应该用于点到点串行接口。
- 在完全指定静态路由中，同时指定出站接口和下一跳 IP 地址。当出站接口是多接入接口时，则使用这种形式的静态路由，并且需要明确标识下一跳。下一跳必须直接连接到指定的出站接口。
- 在一条完全指定的 IPv6 静态路由中，需要同时指定出站接口和下一跳 IPv6 地址。

## 在这个模块中我学到了什么？(续)

- 默认路由是与所有数据包都匹配的静态路由。
- 在把一台边缘路由器连接到服务提供商网络和一台末节路由器时，通常会使用默认静态路由。
- IPv4默认静态路由的命令语法和其他IPv4静态路由的语法类似，不过网络地址需要配置为0.0.0.0，子网掩码则为0.0.0.0。
- IPv6默认静态路由的命令语法类似于其他IPv6静态路由，但ipv6-prefix/prefix-length应该配置为::/0，这样可以匹配所有路由。
- 浮动静态路由属于静态路由，在链路发生故障的情况下，浮动静态路由可以为主用的静态或动态路由提供备份路径。
- 浮动静态路由的管理距离比主路由的管理距离要大。默认情况下，静态路由的管理距离为 1，因此它们优先于通过动态路由协议获知的路由。
- 在配置 IP 浮动静态路由时，可以使用 distance 参数来指定管理距离。
- 主机路由为具有 32 位掩码的 IPv4 地址或具有 128 位掩码的 IPv6 地址。

## 在这个模块中我学到了什么？(续)

- 有三种方式可以把一条主机路由添加到路由表中：在路由器上配置 IP 地址时自动添加、配置静态主机路由，或者通过本模块没有涵盖的其他方法自动获取主机路由。
- 当路由器上配置接口地址时，思科 IOS 会自动添加主机路由（也称为本地主机路由）。
- 主机路由可以是手动配置的静态路由，用来把流量定向给一个特定目标设备。
- 对于 IPv6 静态路由，下一跳地址可以是相邻路由器的链路本地地址；但是，在使用链接本地地址作为下一跳时，必须指定接口类型和接口号。为此，需要删除原始的 IPv6 静态主机路由，然后使用服务器的 IPv6 地址和 ISP 路由器的 IPv6 链路本地地址配置完全指定路由。

# New Terms and Commands

- static route
- default static route
- floating static route
- summary static route
- next-hop route
- directly connected static route
- Fully specified static route
- `ip route network-address subnet-mask { ip-address | exit-intf [ip-address]} [distance]`
- `ipv6 route ipv6-prefix/prefix-length {ipv6-address | exit-intf [ipv6-address]} [distance]`
- `show ip route static`
- `show ipv6 route static`
- quad-zero route
- `ip route 0.0.0.0 0.0.0.0 {ip-address | exit-intf}`
- `ipv6 route ::/0 {ipv6-address | exit-intf}`
- host route
- local host route
- static host route

