Chapter 2: Static Routing

Routing and Switching Essentials v6.0

Cisco | Networking Academy®
Mind Wide Open™

Chapter 2 - Sections & Objectives

2.1 Static Routing Implementation

- Explain the advantages and disadvantages of static routing.
- Explain the purpose of different types of static routes.

2.2 Configure Static and Default Routes

- Configure IPv4 and IPv6 static routes by specifying a next-hop address.
- Configure IPv4 and IPv6 default routes.
- Configure a floating static route to provide a backup connection.
- Configure IPv4 and IPv6 static host routes that direct traffic to a specific host

2.3 Troubleshoot Static and Default Route Issues

- Explain how a router processes packets when a static route is configured.
- Troubleshoot common static and default route configuration issues.

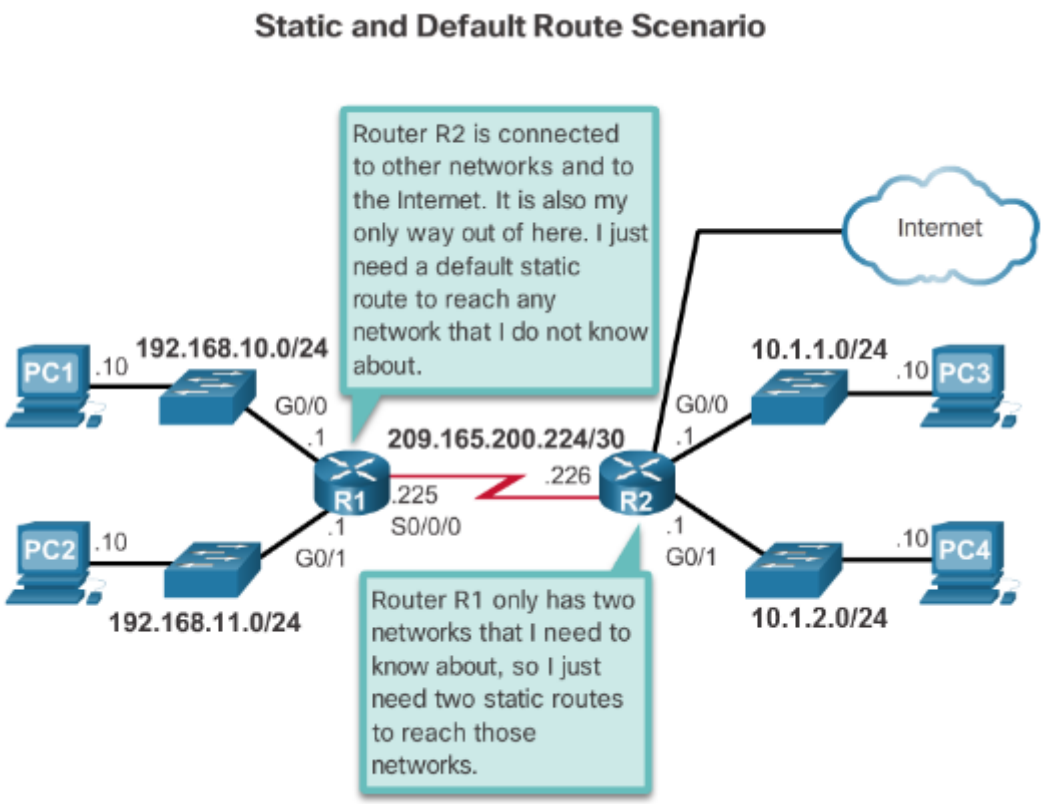
2.1 Static Routing Implementation

Cisco | Networking Academy®
Mind Wide Open™

Reach Remote Networks

A router can learn about remote networks in one of two ways:

- **Manually** - Remote networks are manually entered into the route table using static routes.
- **Dynamically** - Remote routes are automatically learned using a dynamic routing protocol.



Why Use Static Routing?

Static routing provides some advantages over dynamic routing, including:

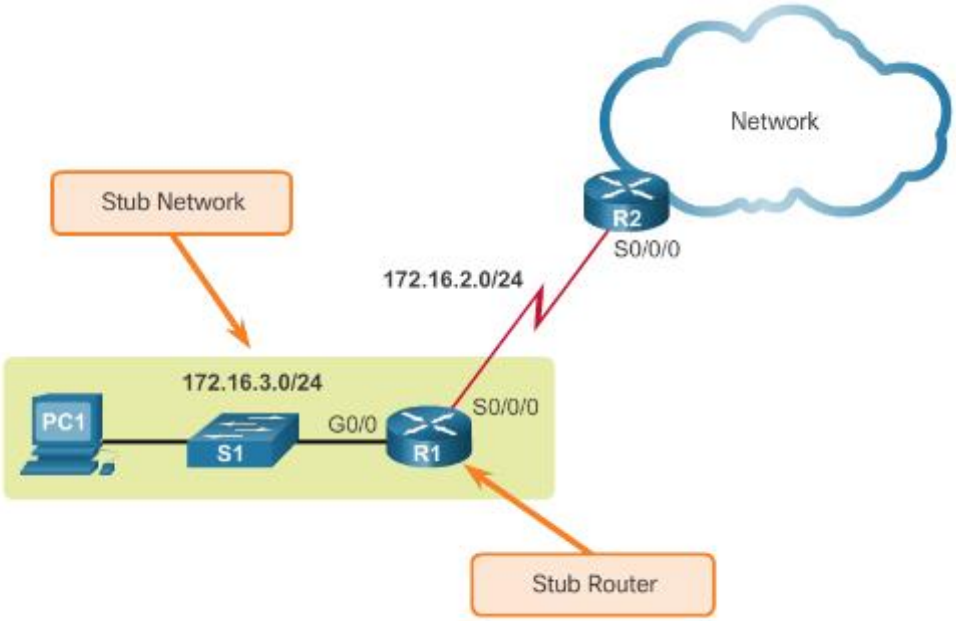
- Static routes are not advertised over the network, resulting in better security.
- Static routes use less bandwidth than dynamic routing protocols, no CPU cycles are used to calculate and communicate routes.
- The path a static route uses to send data is known.

	Dynamic Routing	Static Routing
Configuration Complexity	Generally independent of the network size	Increases with network size
Topology Changes	Automatically adapts to topology changes	Administrator intervention required
Scaling	Suitable for simple and complex topologies	Suitable for simple topologies
Security	Less secure	More secure
Resource Usage	Uses CPU, memory, link bandwith	No extra resources needed
Predictability	Route depends on the current topology	Route to destination is always the same

When to Use Static Routes

Static routing has three primary uses:

- Providing ease of routing table maintenance in smaller networks.
- Routing to and from stub networks. A stub network is a network accessed by a single route, and the router has no other neighbors.
- Using a single default route to represent a path to any network that does not have a more specific match with another route in the routing table.

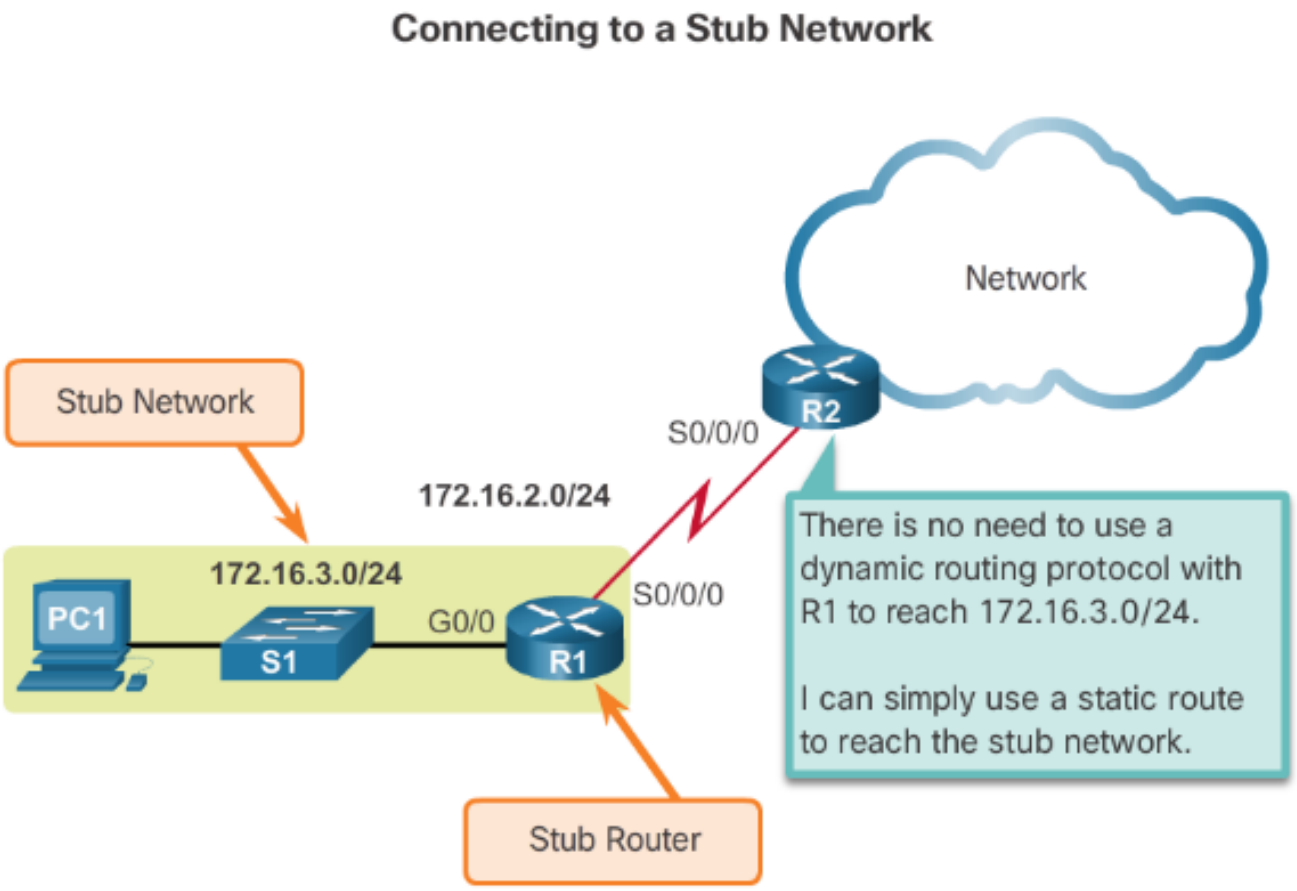


Static Route Applications

Static Routes are often used to:

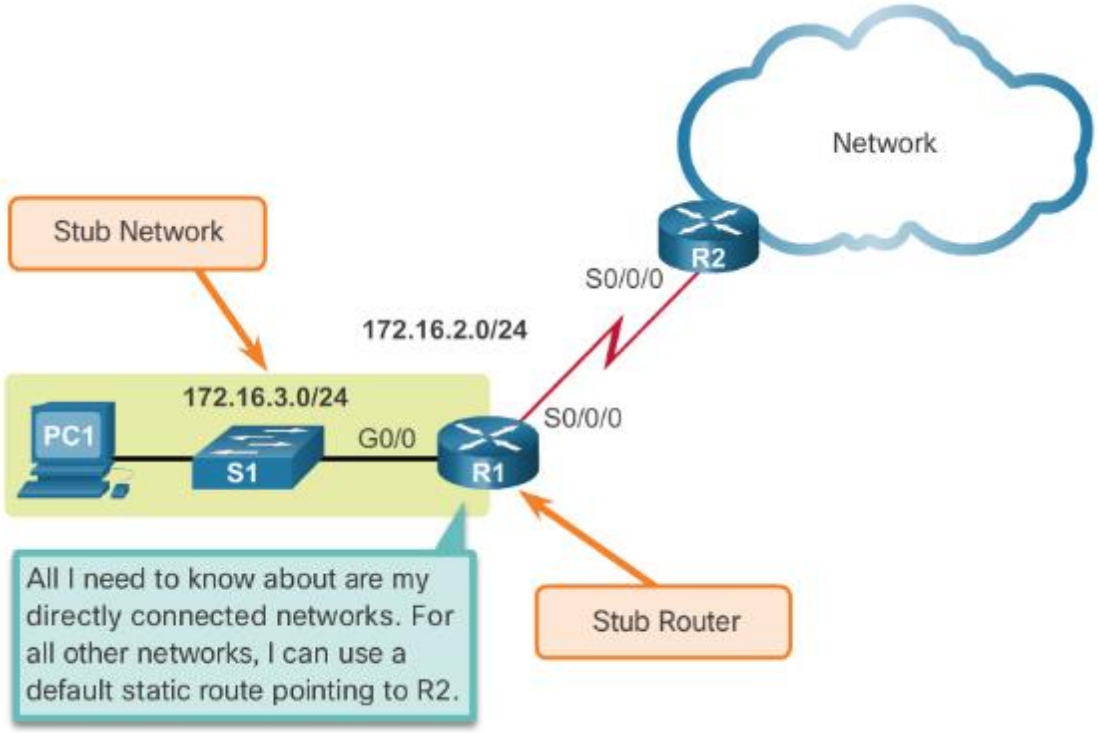
- Connect to a specific network.
- Provide a Gateway of Last Resort for a stub network.
- Reduce the number of routes advertised by summarizing several contiguous networks as one static route.
- Create a backup route in case a primary route link fails.

Standard Static Route

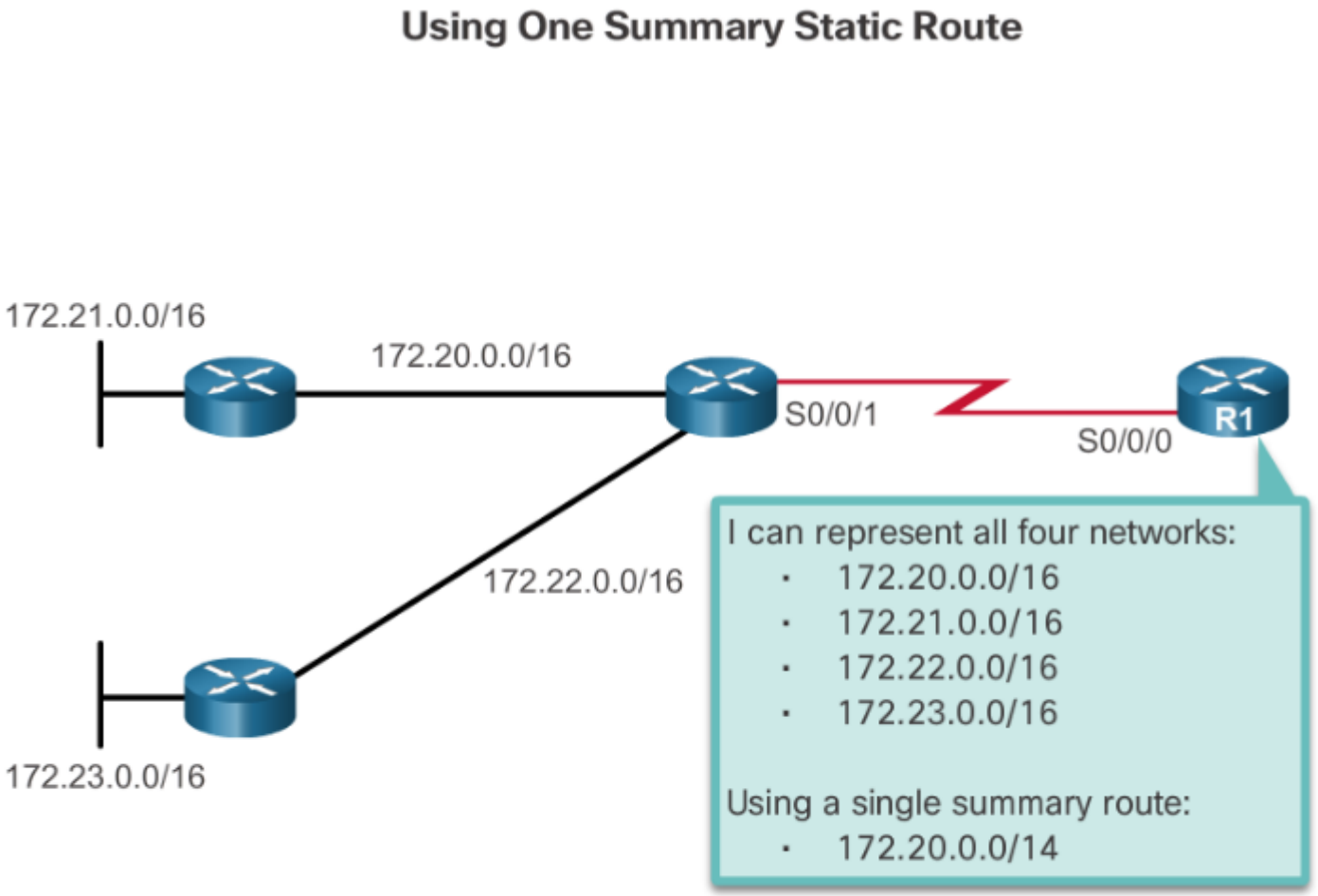


Default Static Route

- A default static route is a route that matches all packets.
- A default route identifies the gateway IP address to which the router sends all IP packets that it does not have a learned or static route.
- A default static route is simply a static route with 0.0.0.0/0 as the destination IPv4 address.

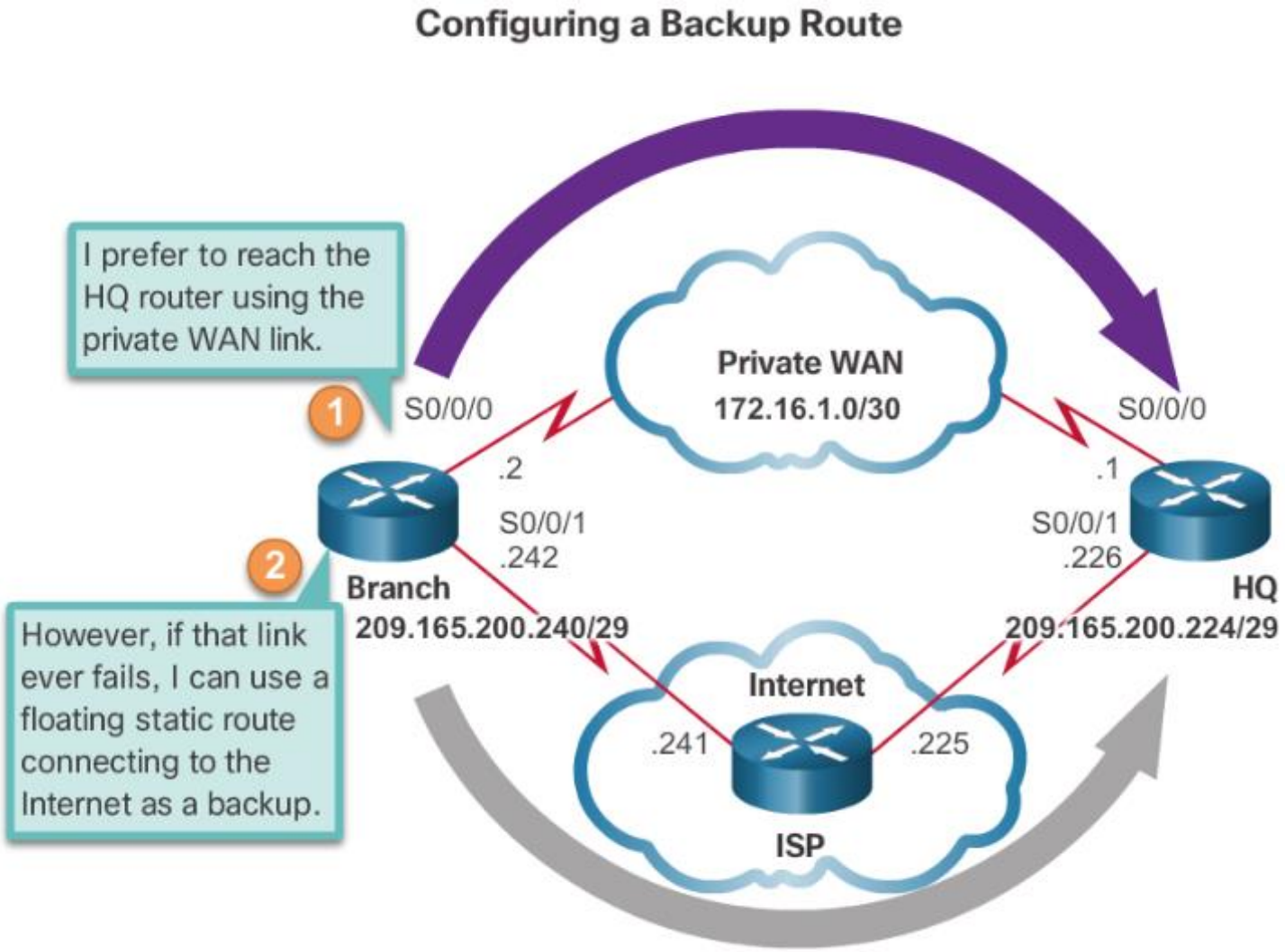


Summary Static Route



Types of Static Routes

Floating Static Route



6.2 Configure Static and Default Routes

Cisco | Networking Academy®
Mind Wide Open™

Configure IPv4 Static Routes

ip route Command

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

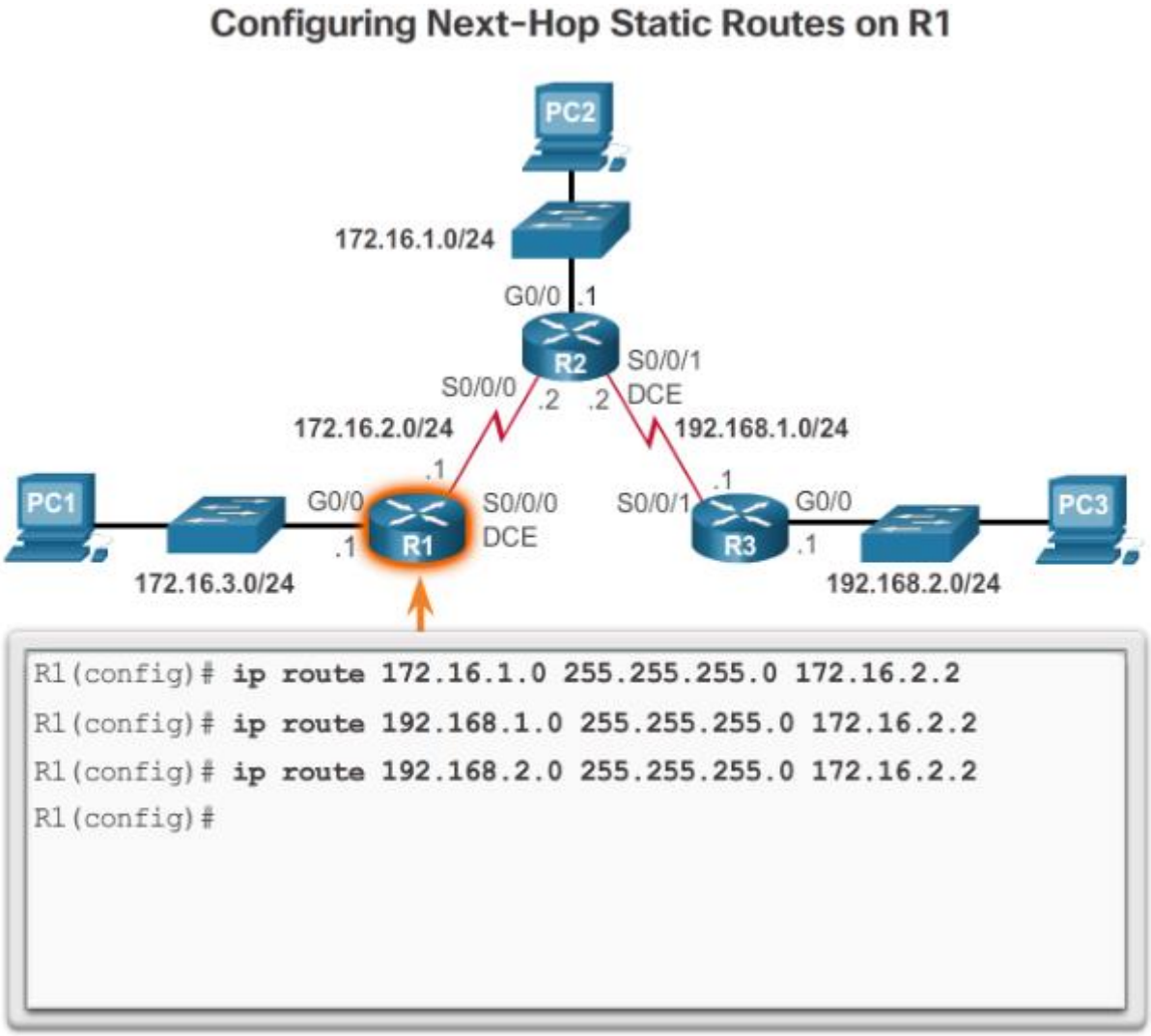
Parameter	Description
network-address	Destination network address of the remote network to be added to the routing table
subnet-mask	• Subnet mask of the remote network to be added to the routing table • The subnet mask can be modified to summarize a group of networks
ip-address	• Commonly referred to as the next-hop router's IP address • Typically used when connecting to a broadcast media (i.e., Ethernet) • Commonly creates a recursive lookup
exit-intf	• Use the outgoing interface to forward packets to the destination network • Also referred to as a directly attached static route • Typically used when connecting in a point-to-point configuration
distance	• (Optional) Configures an administrative distance • Typically used to configure a floating static route

Next-Hop Options

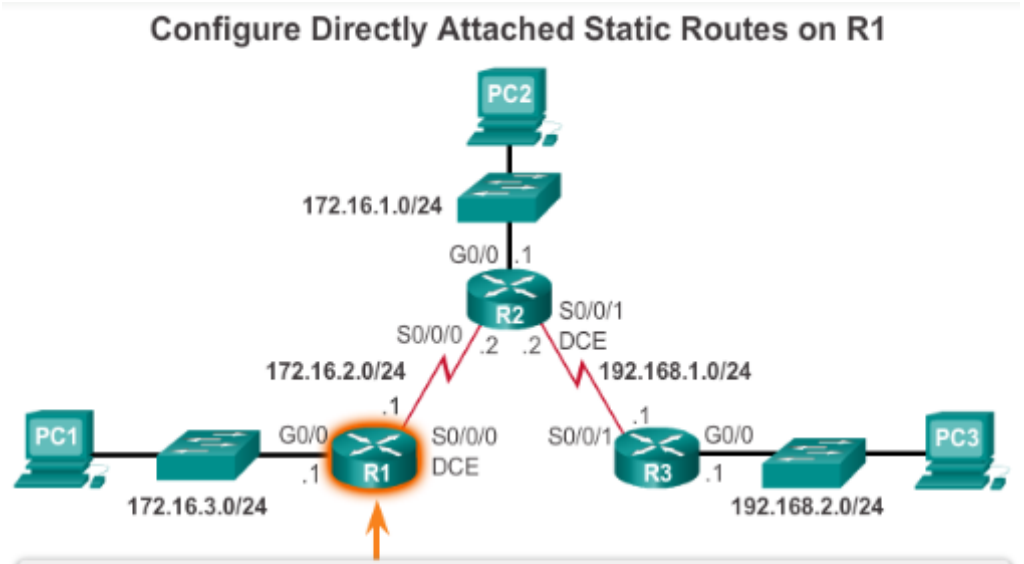
The next hop can be identified by an IP address, exit interface, or both. How the destination is specified creates one of the three following route types:

- **Next-hop route** - Only the next-hop IP address is specified.
- **Directly connected static route** - Only the router exit interface is specified.
- **Fully specified static route** - The next-hop IP address and exit interface are specified.

Configure a Next-Hop Static Route

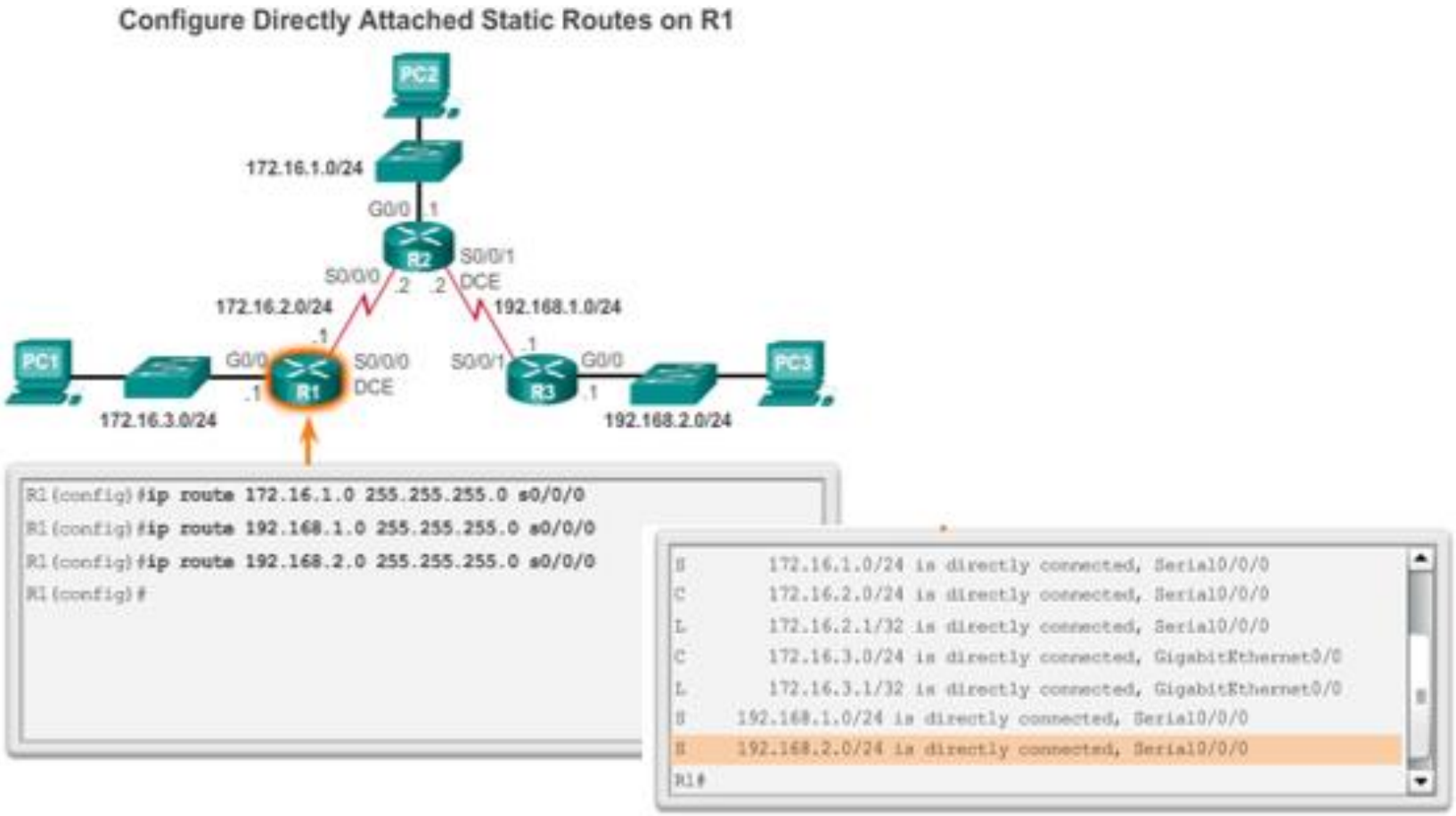


Configure Directly Connected Static Route



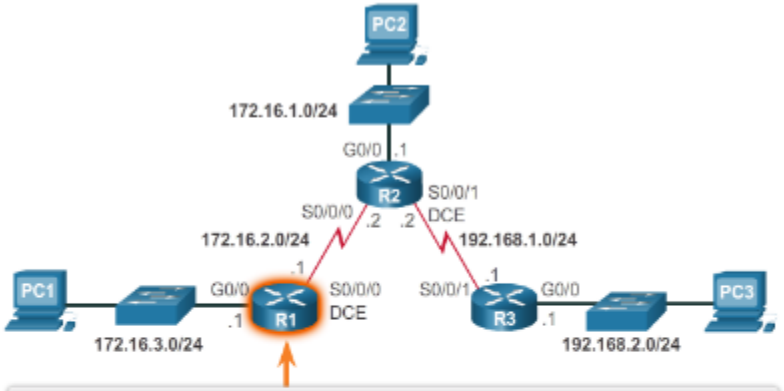

```
S       172.16.1.0/24 is directly connected, Serial0/0/0
C       172.16.2.0/24 is directly connected, Serial0/0/0
L       172.16.2.1/32 is directly connected, Serial0/0/0
C       172.16.3.0/24 is directly connected, GigabitEthernet0/0
L       172.16.3.1/32 is directly connected, GigabitEthernet0/0
S    192.168.1.0/24 is directly connected, Serial0/0/0
S    192.168.2.0/24 is directly connected, Serial0/0/0
R1#
```

Configure a Fully Specified Static Route



Configure IPv4 Static Routes

Verify a Static Route




```
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#
```

```
R1# show ip route 192.168.2.1
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#
```

```
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#
```

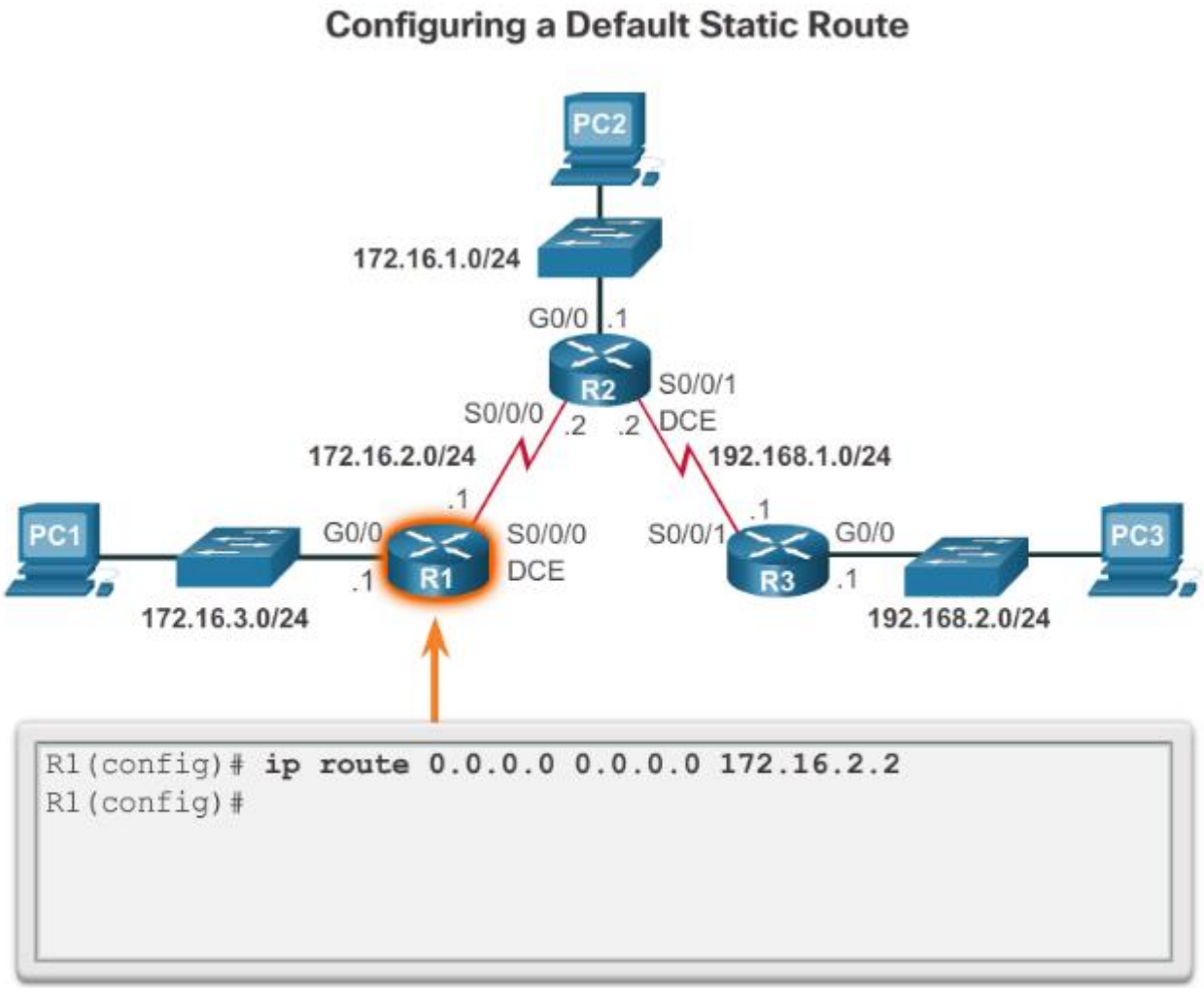
Default Static Route

Default Static Route Syntax

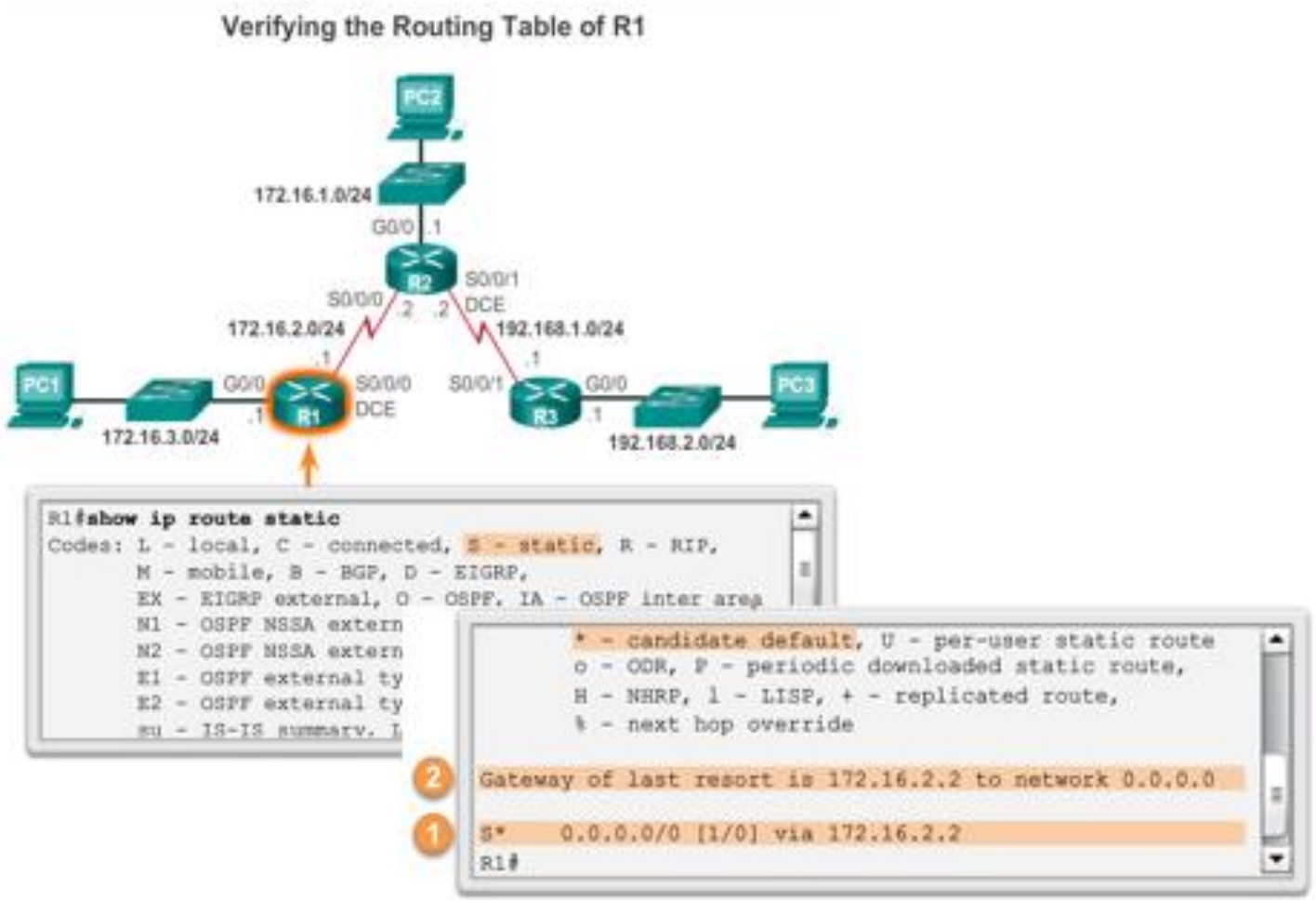
```
Router(config)#ip route 0.0.0.0 0.0.0.0 {ip-address | exit-intf}
```

Parameter	Description
0.0.0.0 0.0.0.0	Matches any network address.
ip-address	• Commonly referred to as the next-hop router's IP address. • Typically used when connecting to a broadcast media (i.e., Ethernet). • Commonly creates a recursive lookup.
exit-intf	• Use the outgoing interface to forward packets to the destination network. • Also referred to as a directly attached static route. • Typically used when connecting in a point-to-point configuration.

Configure a Default Static Route



Verify a Default Static Route



The ipv6 route Command

IPv6 Command Syntax

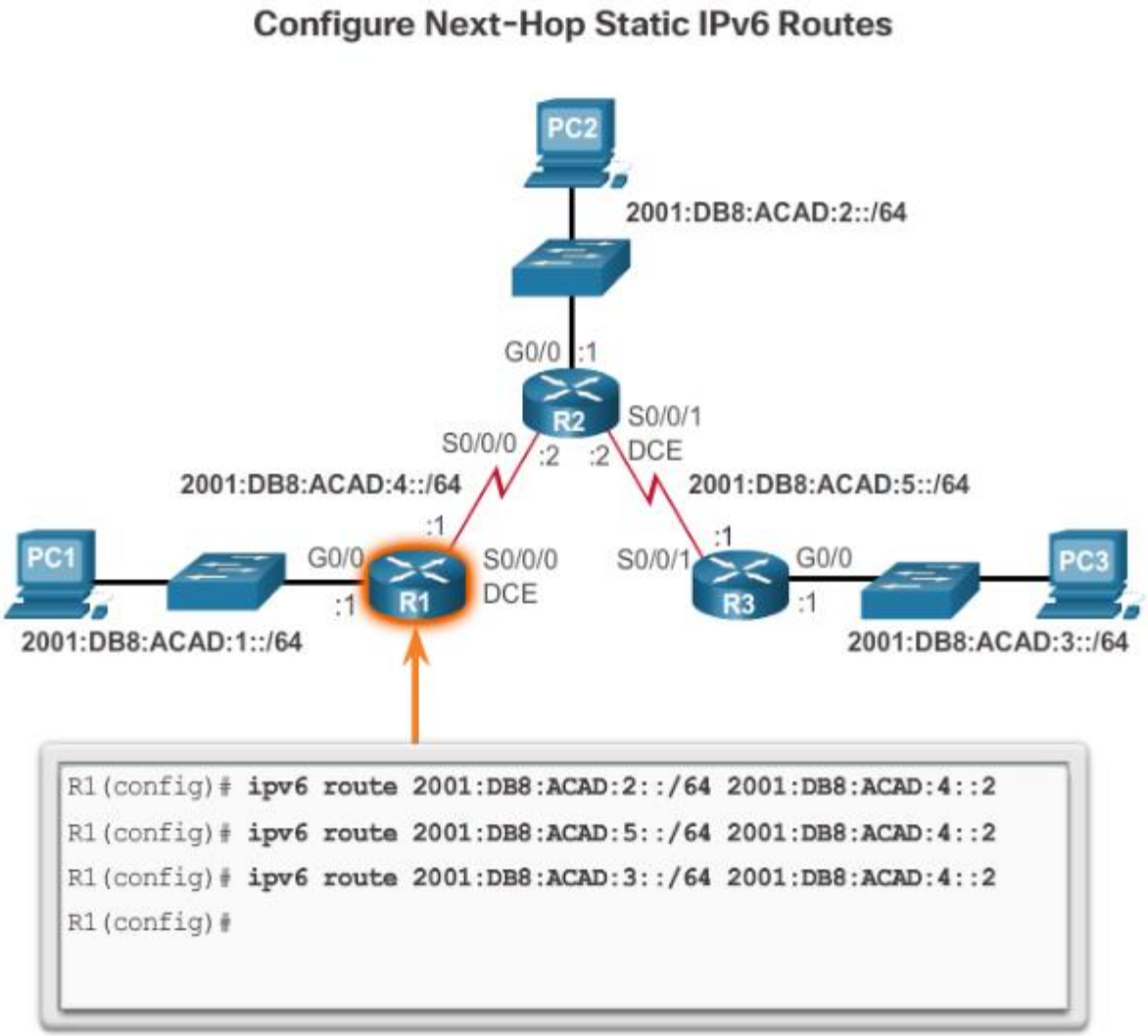
```
Router(config)# ipv6 route ipv6-prefix/prefix-length
{ipv6-address | exit-intf}
```

Parameter	Description
ipv6-prefix	Destination network address of the remote network to be added to the routing table.
prefix-length	Prefix length of the remote network to be added to the routing table.
ipv6-address	• Commonly referred to as the next-hop router's IP address. • Typically used when connecting to a broadcast media (i.e., Ethernet). • Commonly creates a recursive lookup.
exit-intf	• Use the outgoing interface to forward packets to the destination network. • Also referred to as a directly attached static route. • Typically used when connecting in a point-to-point configuration.

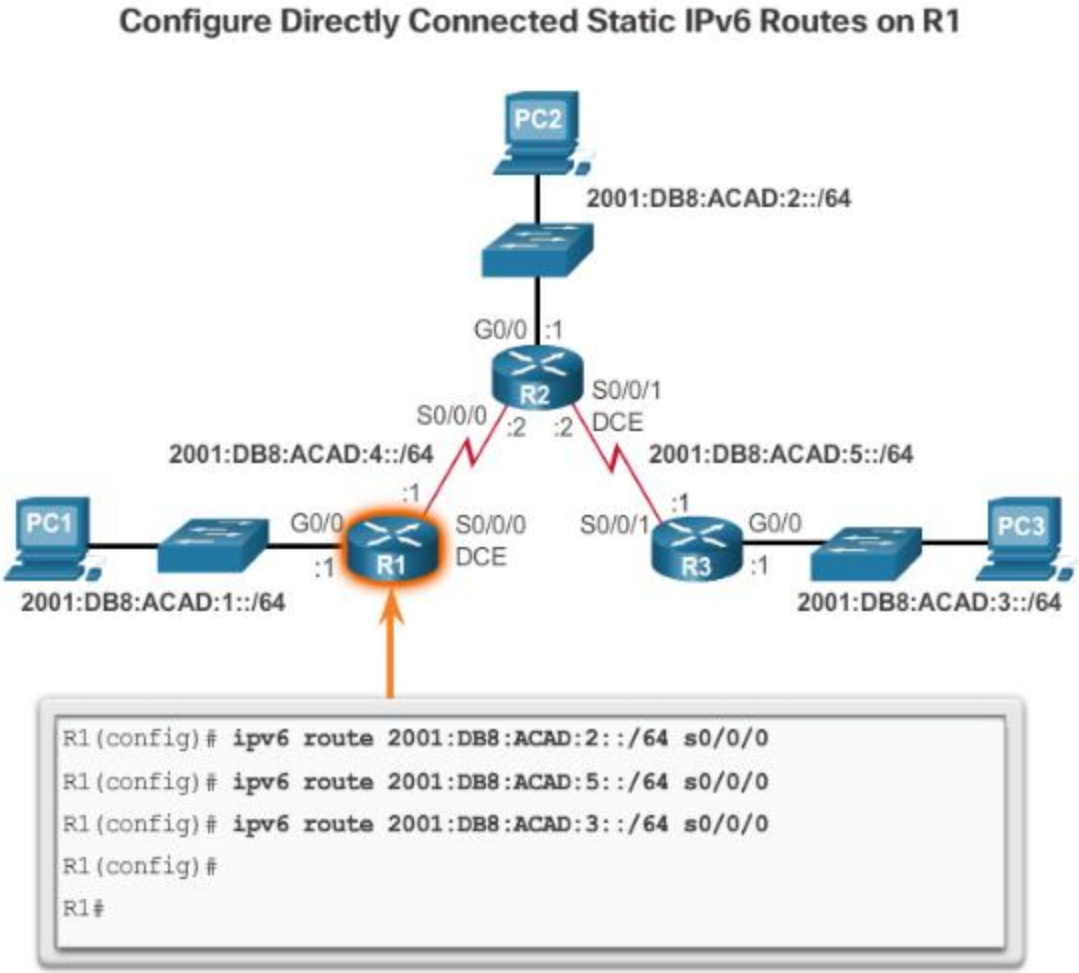
Next-Hop Options

- **Next-hop static IPv6 route** - Only the next-hop IPv6 address is specified
- **Directly connected static IPv6 route** - Only the router exit interface is specified
- **Fully specified static IPv6 route** - The next-hop IPv6 address and exit interface are specified

Configure a Next-Hop Static IPv6 Route



Directly Connected Static IPv6 Route



Fully Specified Static IPv6 Route

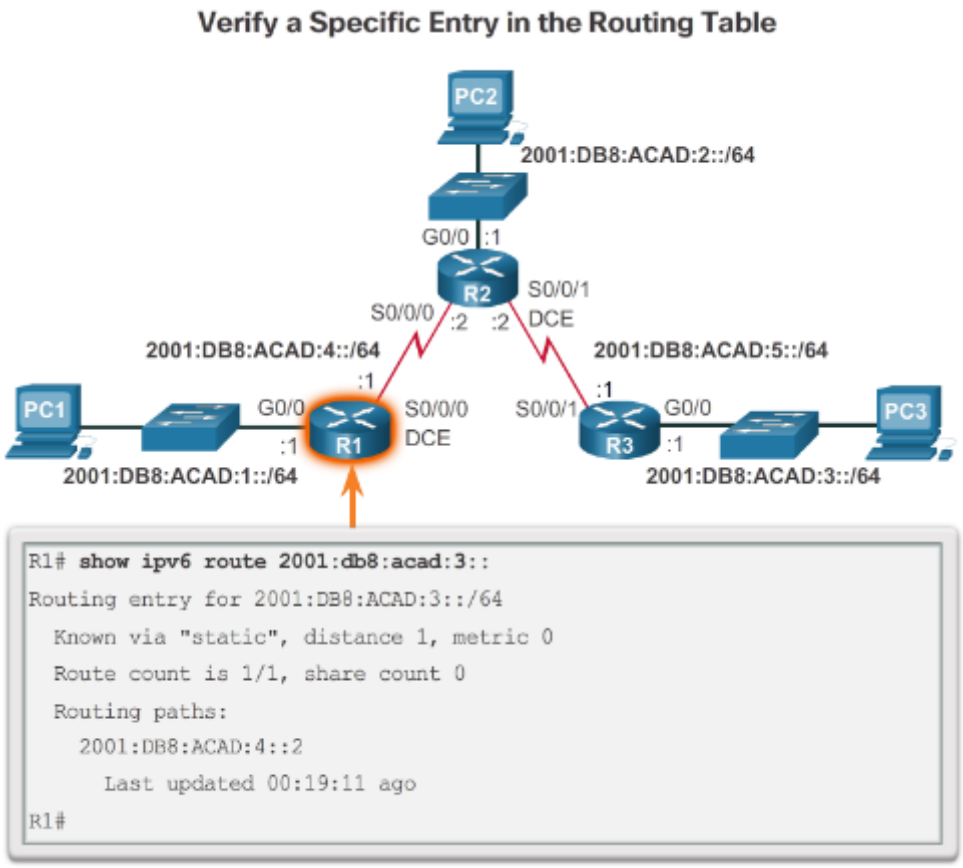
Configure Fully Specified Static IPv6 Routes on R1


```
R1(config)# ipv6 route 2001:db8:acad:2::/64 fe80::2
% Interface has to be specified for a link-local nexthop
R1(config)# ipv6 route 2001:db8:acad:2::/64 s0/0/0 fe80::2
R1(config)#
```

Verify IPv6 Static Routes

In addition to **ping** and **traceroute**, commands to verify static routes include:

- **show ipv6 route**
- **show ipv6 route static**
- **show ipv6 route** *network*



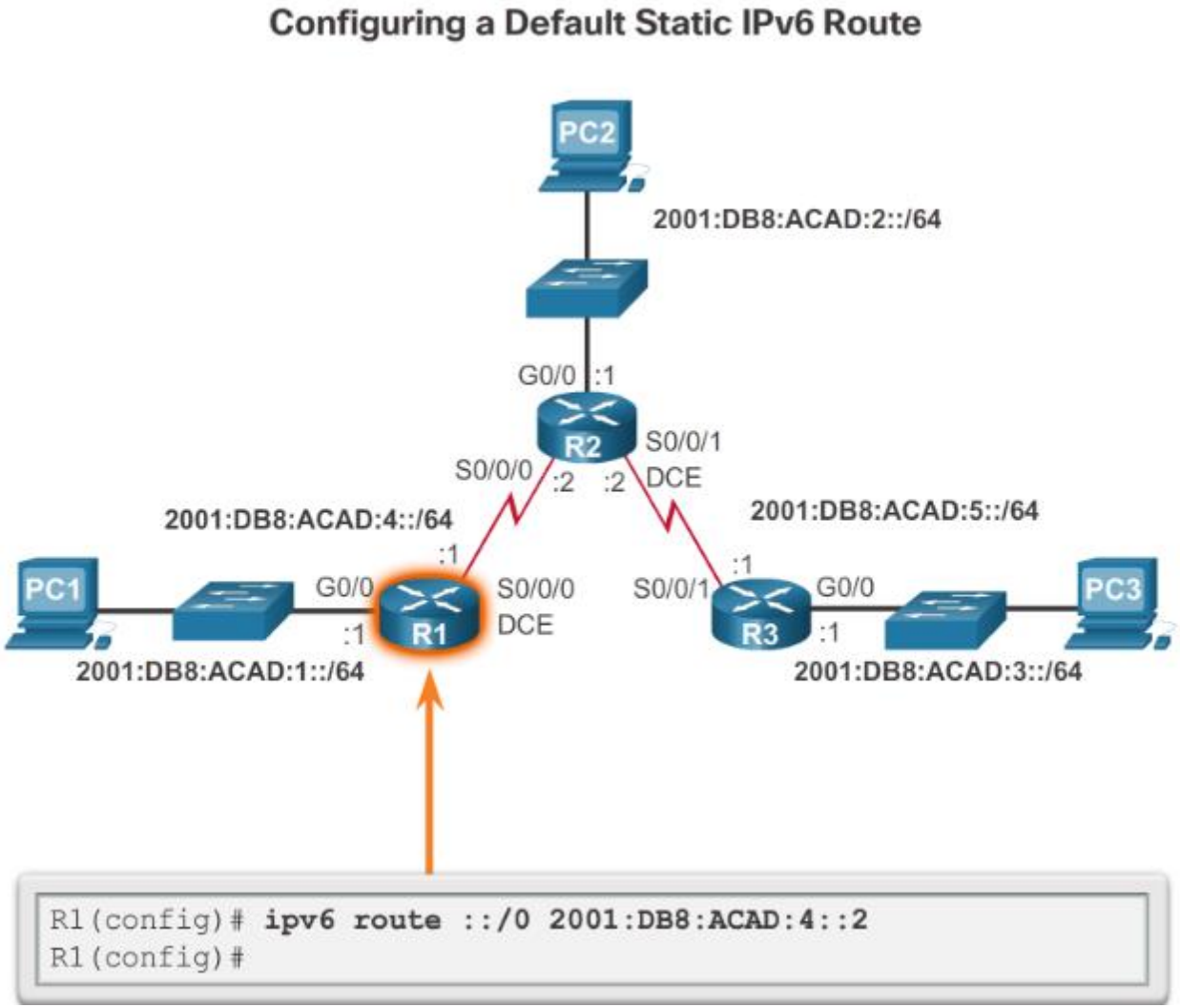
Default Static IPv6 Route

Default Static IPv6 Route Syntax

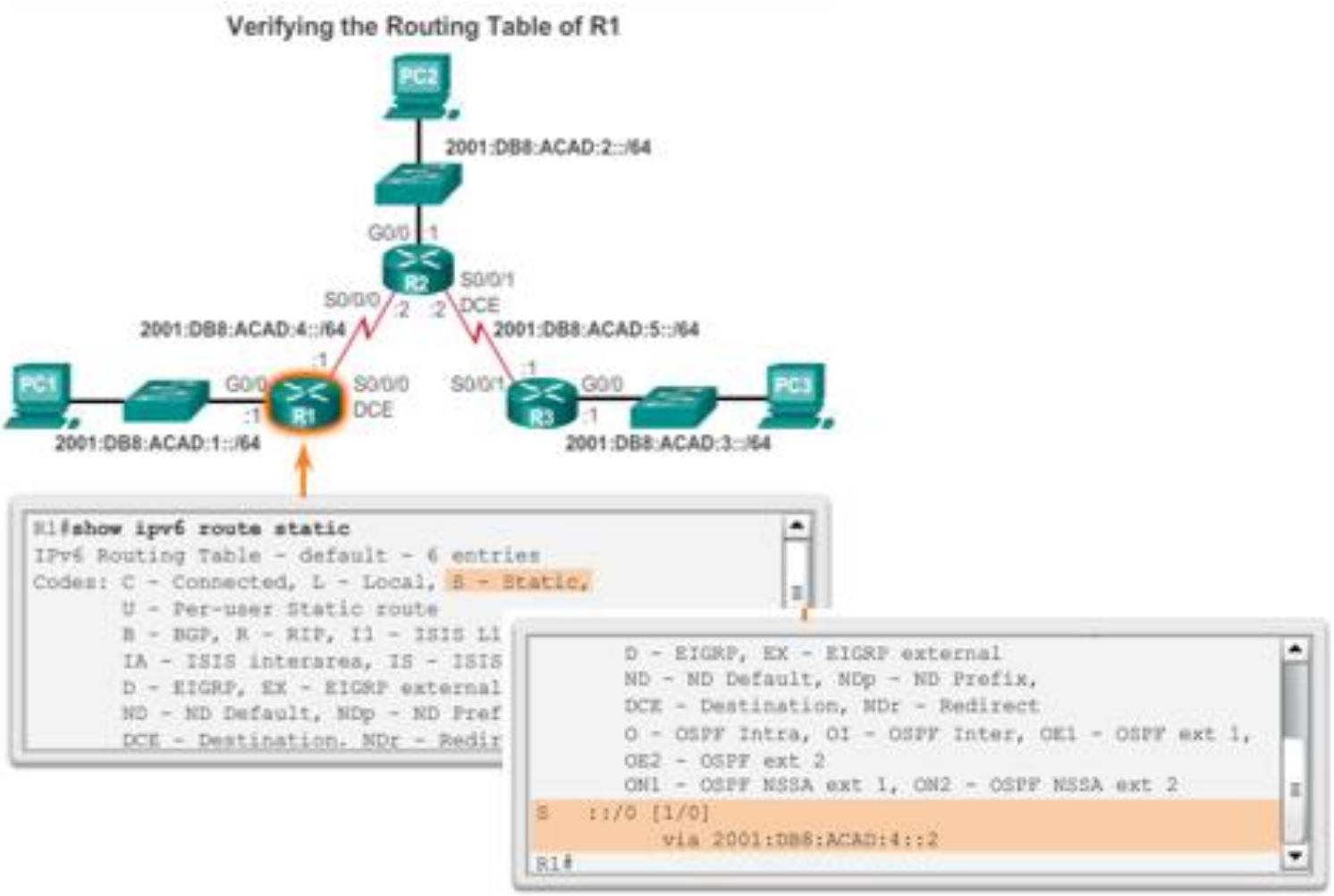
```
Router(config)# ipv6 route ::/0 {ipv6-address | exit-intf}
```

Parameter	Description
::/0	Matches any IPv6 prefix regardless of prefix length.
ipv6-address	• Commonly referred to as the next-hop router's IPv6 address. • Typically used when connecting to a broadcast media (i.e., Ethernet). • Commonly creates a recursive lookup.
exit-intf	• Use the outgoing interface to forward packets to the destination network. • Also referred to as a directly attached static route. • Typically used when connecting in a point-to-point configuration.

Configure a Default Static IPv6 Route



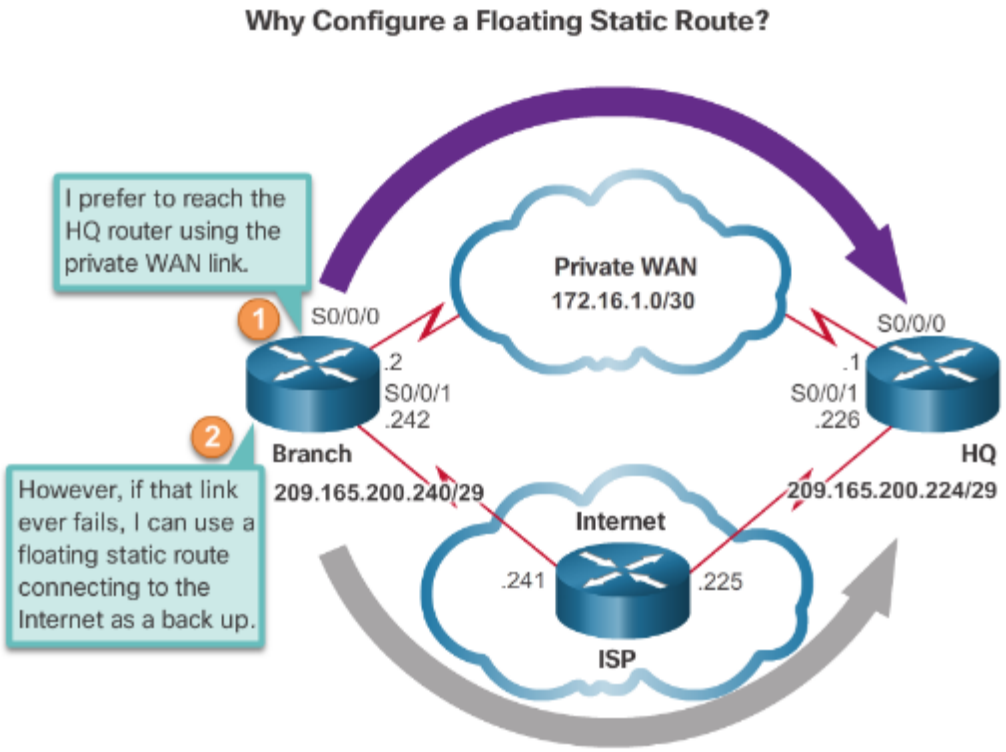
Verify a Default IPv6 Static Route



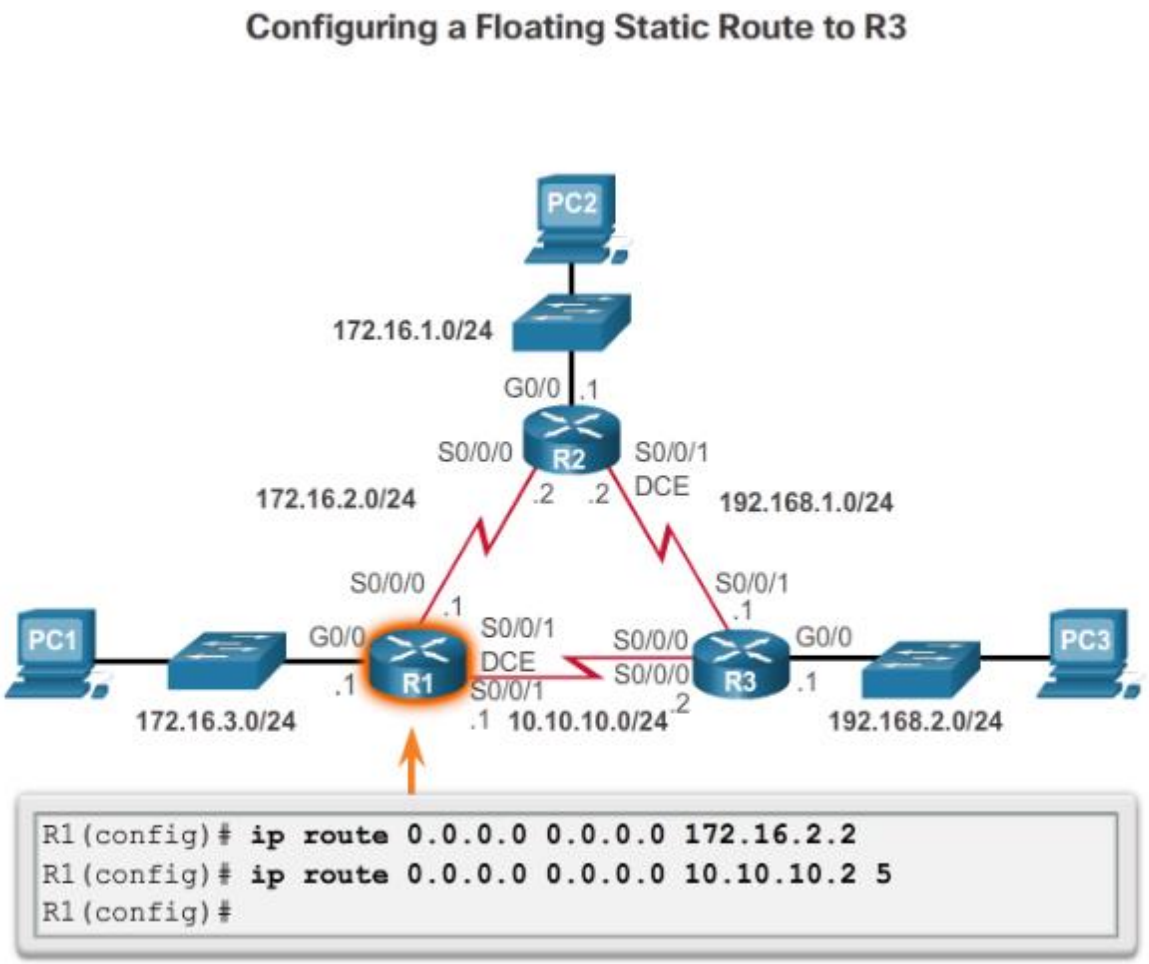
Floating Static Routes

Floating static routes have an administrative distance greater than the administrative distance of another static route or dynamic routes.

- The static route “floats” and is not used when the route with the better administrative distance is active.
- If the preferred route is lost the floating static route can take over.



Configure an IPv4 Floating Static Route

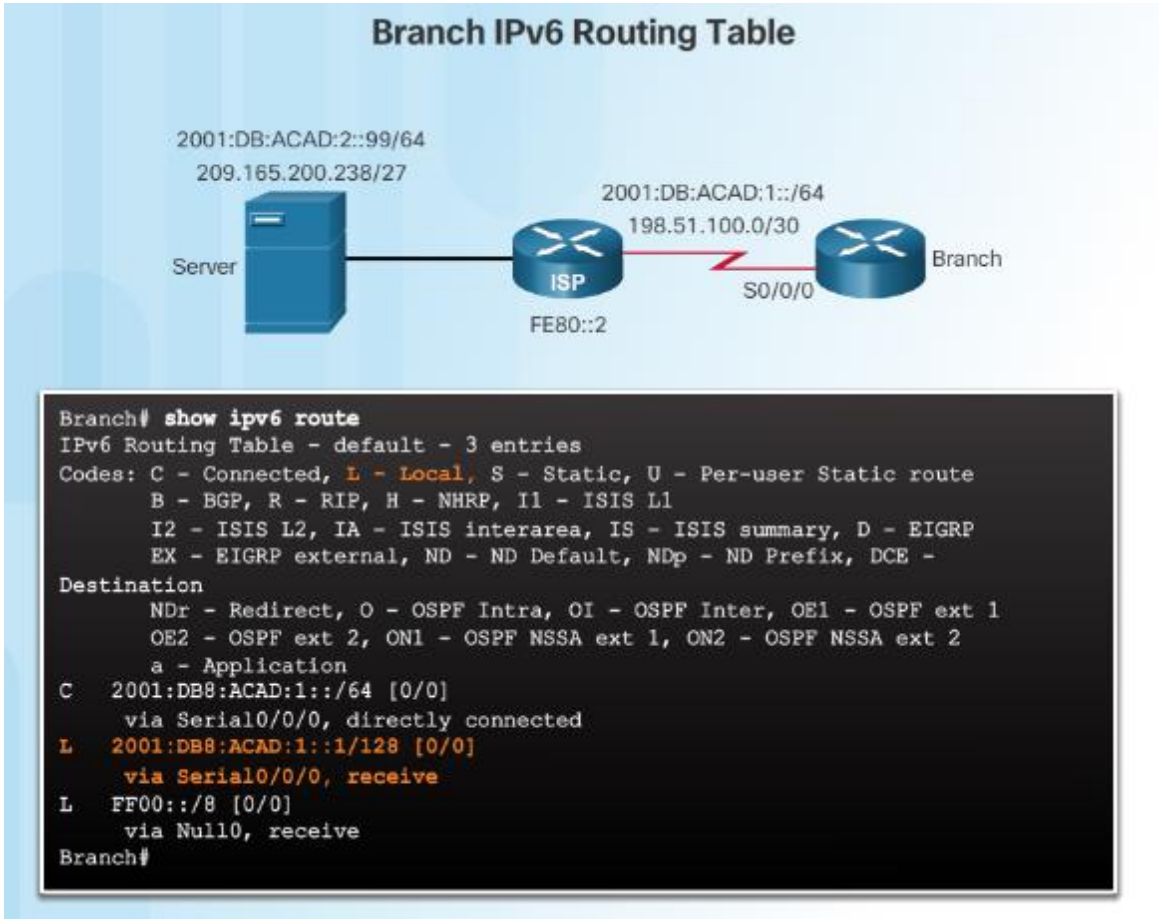


Test the IPv4 Floating Static Route

To test a floating static route:

- Use the **`show ip route`** command to verify that the routing table is using the default static route.
- Use the **`traceroute`** command to follow the traffic flow out the primary route.
- Disconnect the link or shutdown the primary interface(s). In the curriculum example the serial interfaces on R2 are shutdown.
- Use a **`show ip route`** command to verify that the routing table is using the floating static route.
- Use a **`traceroute`** command to follow the traffic flow out the backup route.

Automatically Installed Host Routes



A host route is an IPv4 address with a 32-bit mask or an IPv6 address with a 128-bit mask.

- Automatically installed when an IP address is configured on the router.
- The local routes are marked with “L” in the output of the routing table.

Configure IPv4 and IPv6 Static Host Routes

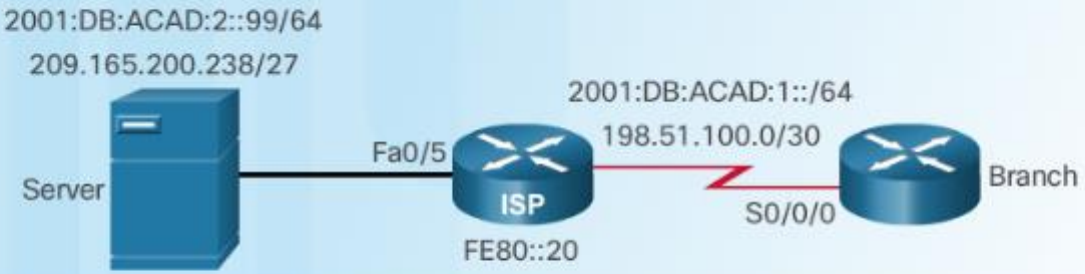
IPv4 and IPv6 Host Route Configuration and Verification


```
Branch(config)# ip route 209.165.200.238 255.255.255.255 198.51.100.2
Branch(config)# ipv6 route 2001:db8:acad:2::99/128 2001:db8:acad:1::2
Branch(config)# end
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, Serial0/0/0
L        198.51.100.1/32 is directly connected, Serial0/0/0
      209.165.200.0/32 is subnetted, 1 subnets
S        209.165.200.38 [1/0] via 198.51.100.2
Branch# show ipv6 route
<output omitted>
C   2001:DB8:ACAD:1::/64 [0/0]
     via Serial0/0/0, directly connected
L   2001:DB8:ACAD:1::1/128 [0/0]
     via Serial0/0/0, receive
S   2001:DB8:ACAD:2::99/128 [1/0]
     via 2001:DB8:ACAD:1::2
L   FF00::/8 [0/0]
     via Null0, receive
Branch#
```

Configure IPv4 and IPv6 Static Host Routes

Fully Specified IPv6 Host Route with the Next-Hop Link-Local Address



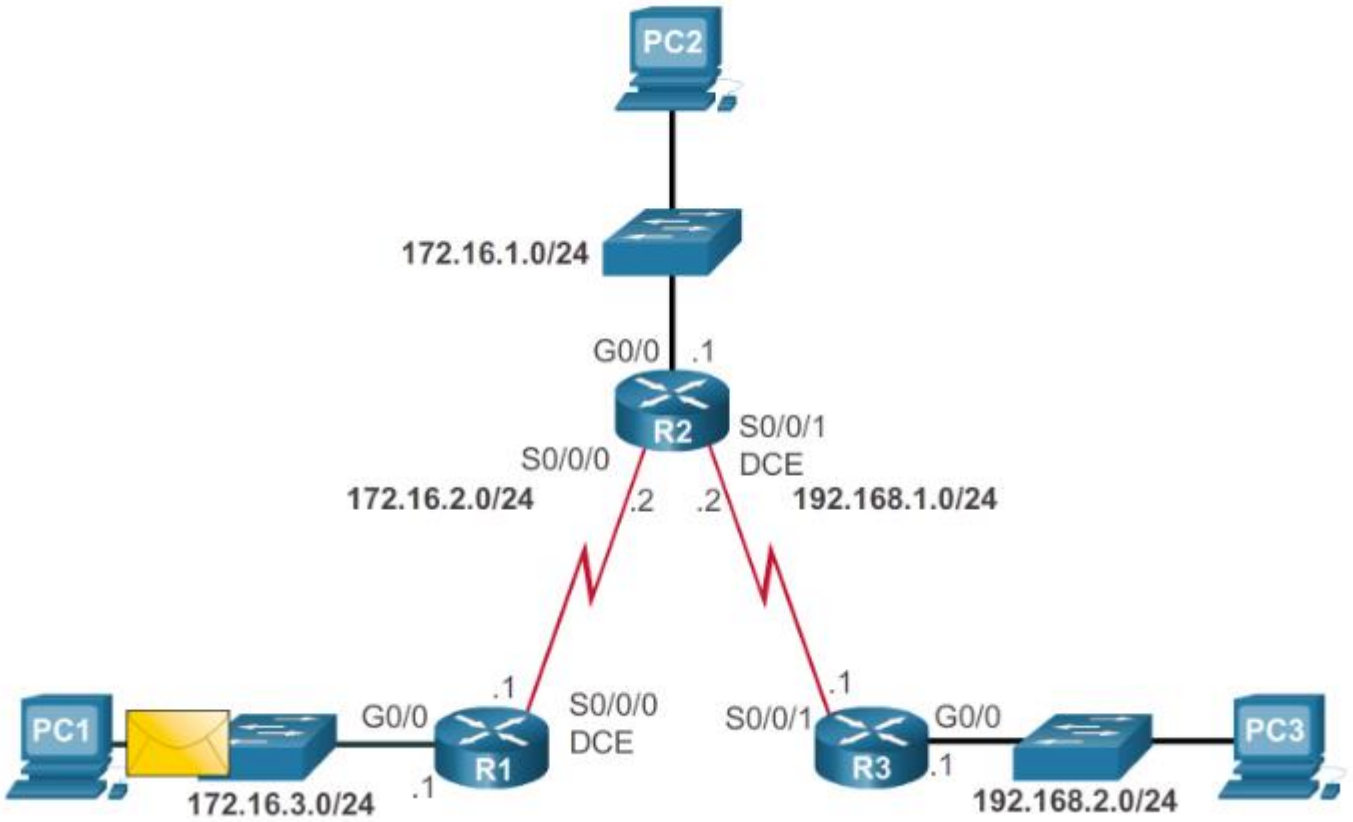

```
Branch(config)# no ipv6 route 2001:db8:acad:2::99/128 2001:db8:acad:1::2
Branch(config)# ipv6 route 2001:db8:acad:2::99/128 serial 0/0/0 fe80::2
Branch(config)# end
Branch# show ipv6 route
 <output omitted>

S    ::/0 [1/0]
      via 2001:DB8:ACAD:1::2
C    2001:DB8:ACAD:1::/64 [0/0]
      via Serial0/0/0, directly connected
L    2001:DB8:ACAD:1::1/128 [0/0]
      via Serial0/0/0, receive
S    2001:DB8:ACAD:2::99/128 [1/0]
      via FE80::2, Serial0/0/0
L    FF00::/8 [0/0]
      via Null0, receive
Branch#
```

6.2 Troubleshoot Static and Default Route Issues

Cisco | Networking Academy®
Mind Wide Open™

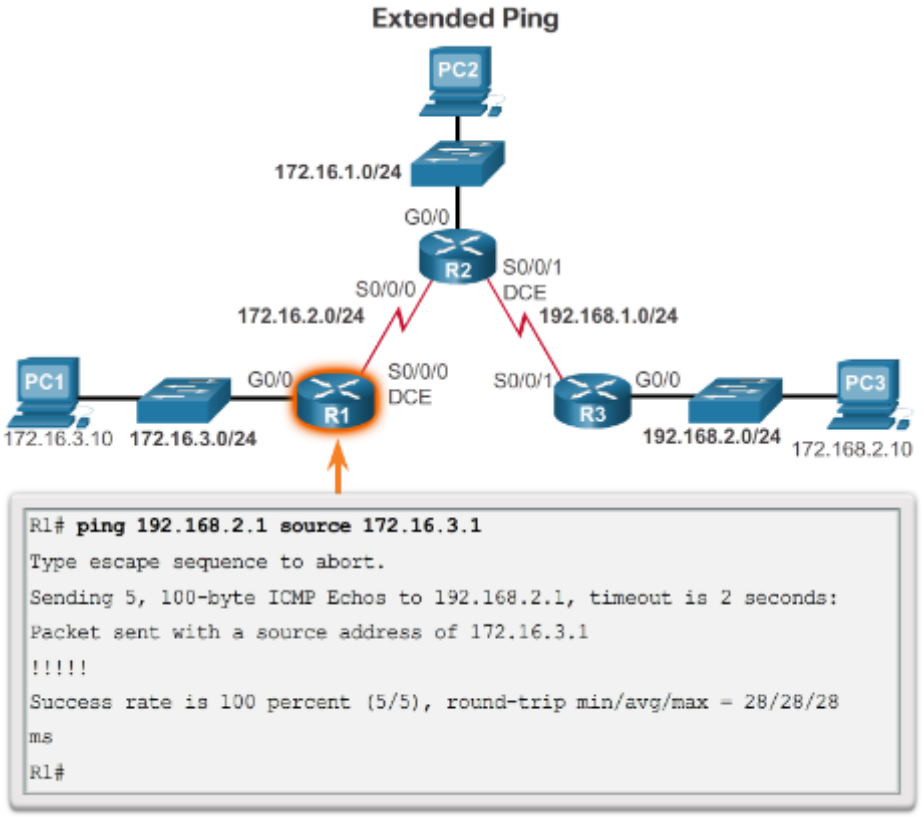
Static Routes and Packet Forwarding



Troubleshoot a Missing Route

IOS troubleshooting commands include:

- **ping**
- Extended **ping** enables you to specify the source IP address for the ping packets.
- **traceroute**
- **show ip route**
- **show ip interface brief**
- **show cdp neighbors detail**



Solve a Connectivity Problem

- Finding a missing (or misconfigured) route requires using the right tools in a methodical manner.
- Use the **ping** command to confirm the destination can't be reached.
- A **traceroute** would also reveal the closest router (or hop) that fails to respond as expected. In this case, the router would then send an Internet Control Message Protocol (ICMP) destination unreachable message back to the source.
- The next step is to investigate the routing table using the **show ip route** command. Look for missing or misconfigured routes.
- Incorrect static routes are a common cause of routing problems.