Static Routing

Routing and Switching Essentials

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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.

Static Routing

Advantages:

- 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.

Disadvantages:

- Initial configuration and maintenance is time-consuming.
- Configuration is error-prone, especially in large networks.
- Administrator intervention is required to maintain changing route information.
- Does not scale well with growing networks; maintenance becomes cumbersome.
- Requires complete knowledge of the whole network for proper implementation.

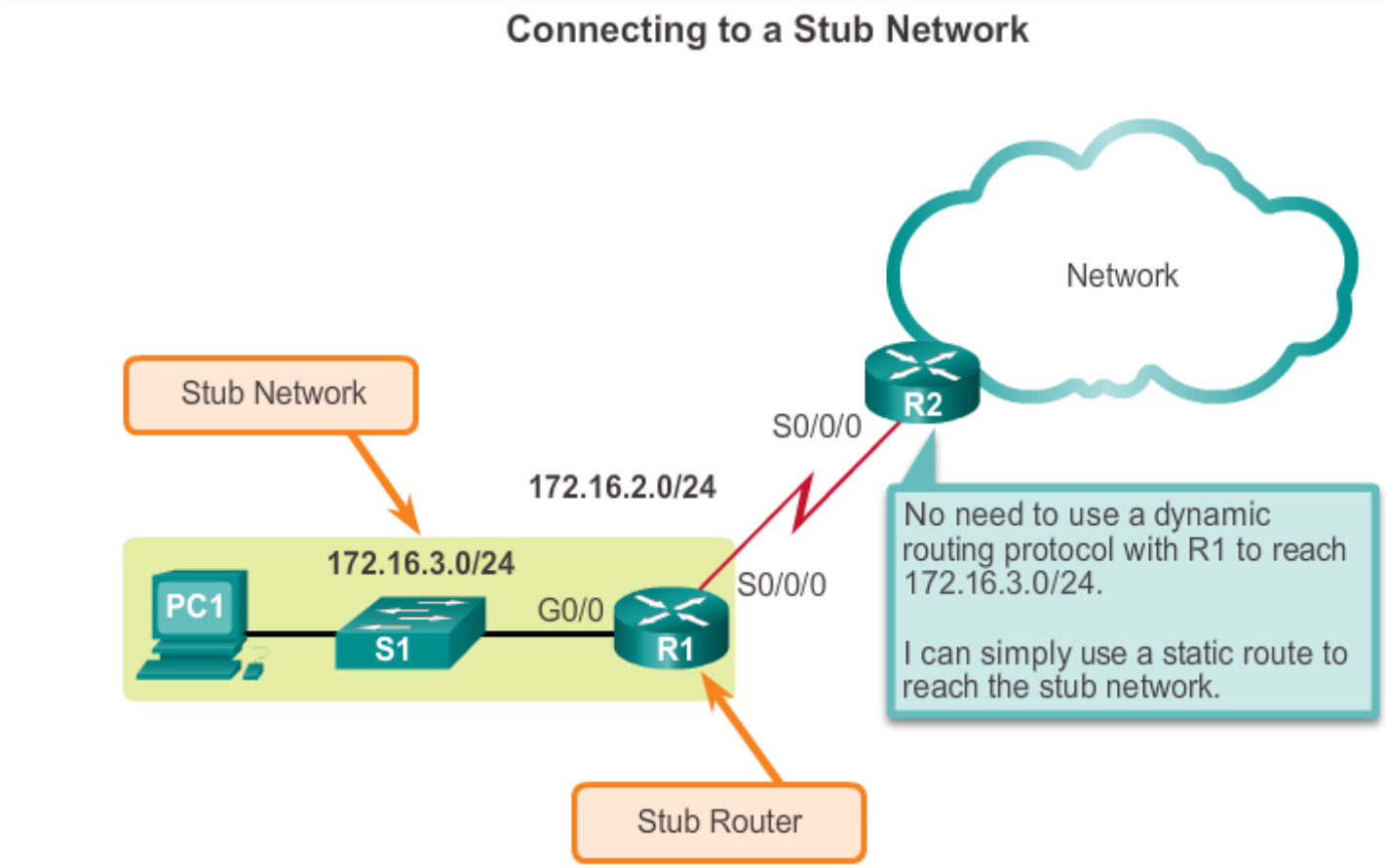
When to Use Static Routes

Static Routes are often used to:

- 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.
- 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

Types of Static Routes

Standard Static Route



Types of Static Routes

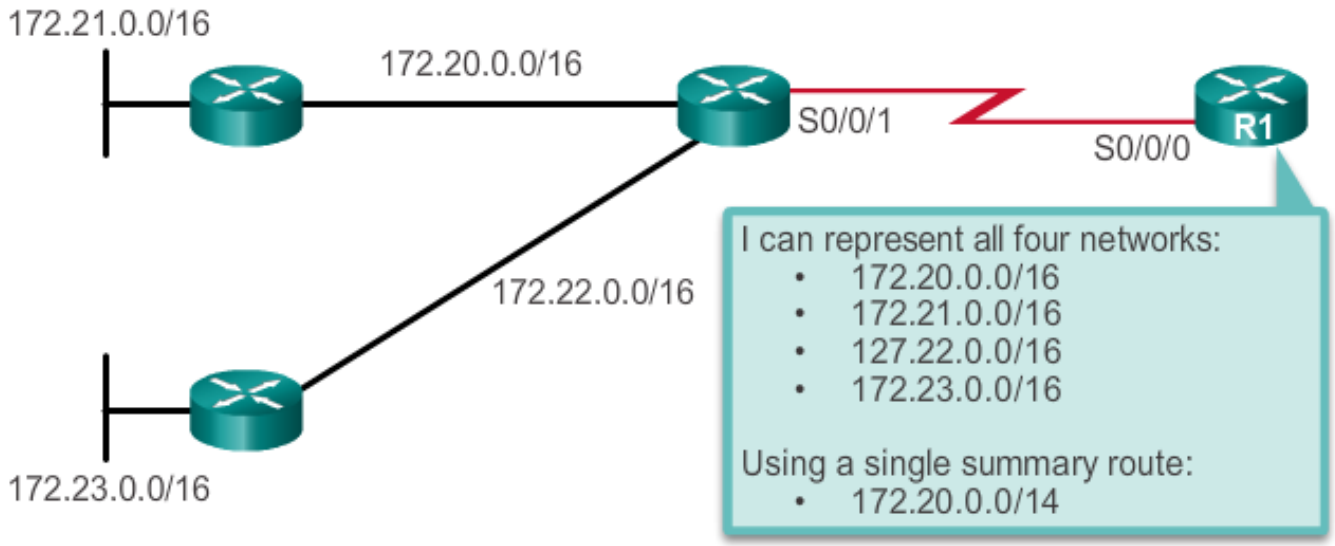
Default Static Route

- 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.

Types of Static Routes

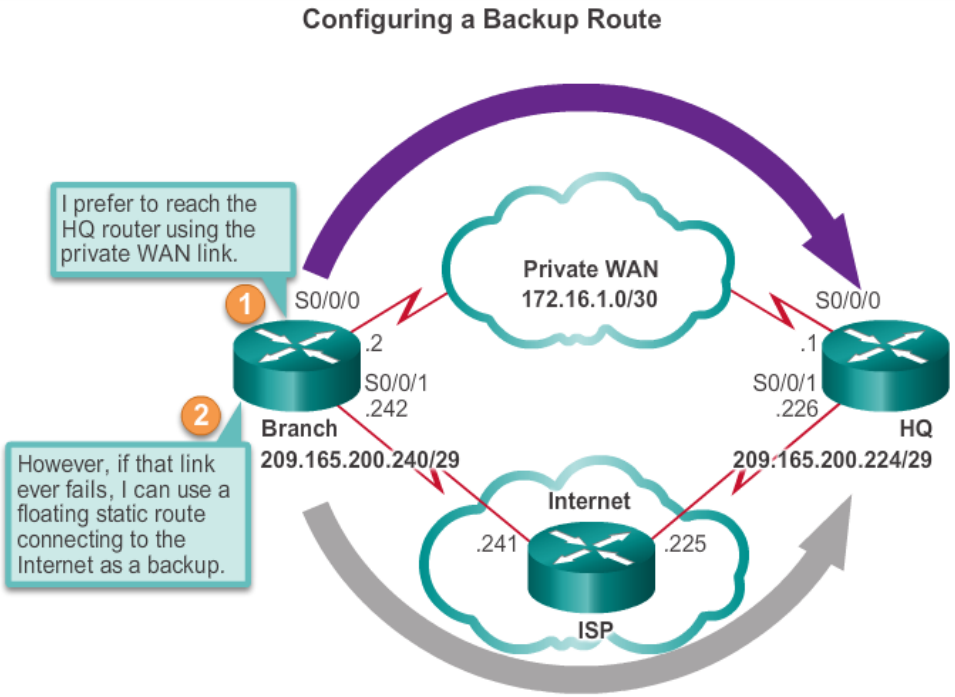
Summary Static Route

Using One Summary Static Route



Floating Static Route

- Floating static routes are static routes that are used to provide a backup path to a primary static or dynamic route, in the event of a link failure.
- The floating static route is only used when the primary route is not available.
- To accomplish this, the floating static route is configured with a higher administrative distance than the primary route.



Configure IPv4 Static Routes

ip route Command

ip route Command Syntax

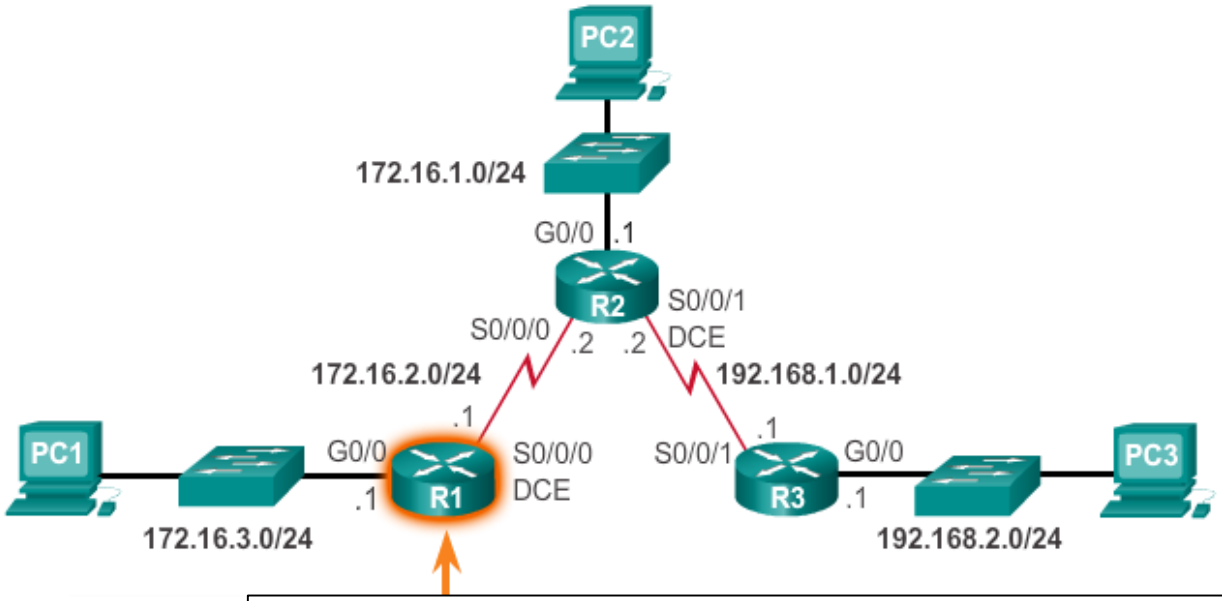
```
Router(config)#ip route network-address subnet-mask
{ip-address | exit-intf}
```

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.

Next-Hop Options

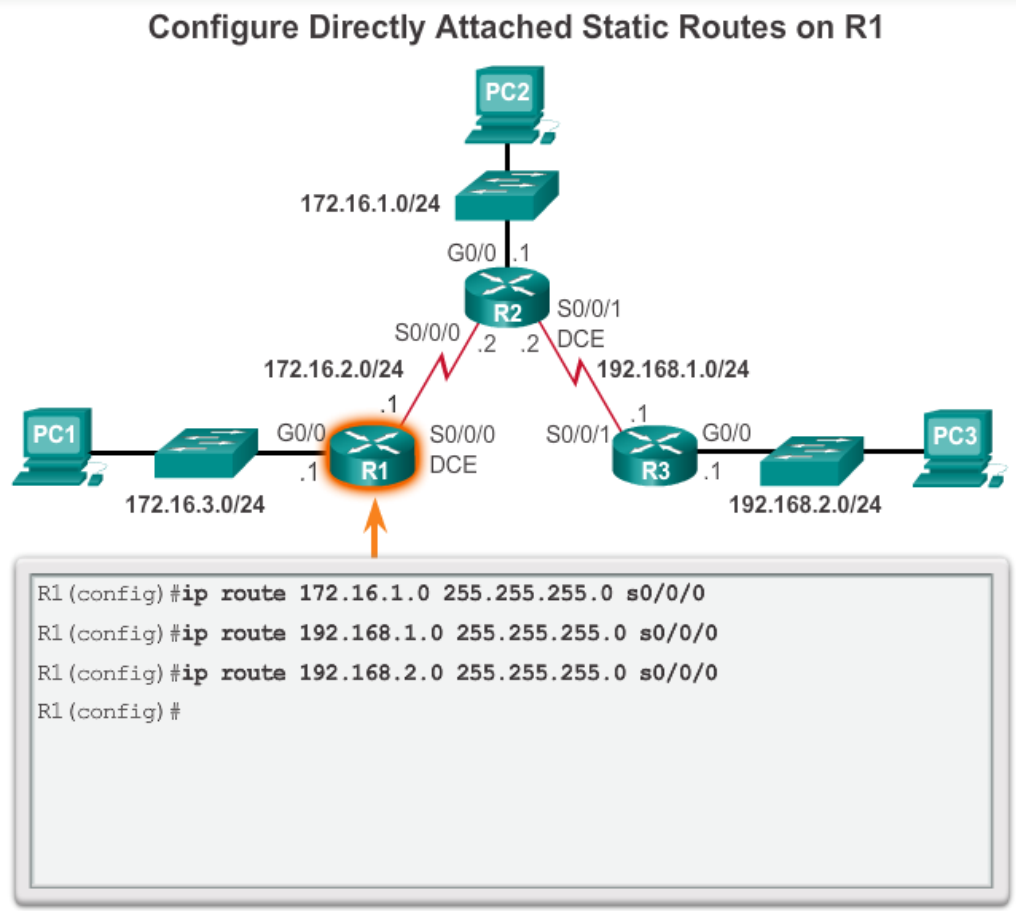
- **Next-hop route** - Only the next-hop IP address is specified.
- **Directly connected static route** - Only the router exit interface is specified.
- **Fully specified static route** - The next-hop IP address and exit interface are specified.

Configure a Next-Hop Static Route




```
R1(config)#ip route 172.16.1.0 255.255.255.0 172.16.1.2
R1(config)#ip route 192.168.1.0 255.255.255.0 172.16.1.2
R1(config)#ip route 192.168.2.0 255.255.255.0 172.16.1.2
R1(config)#
```

Configure Directly Connected Static Route



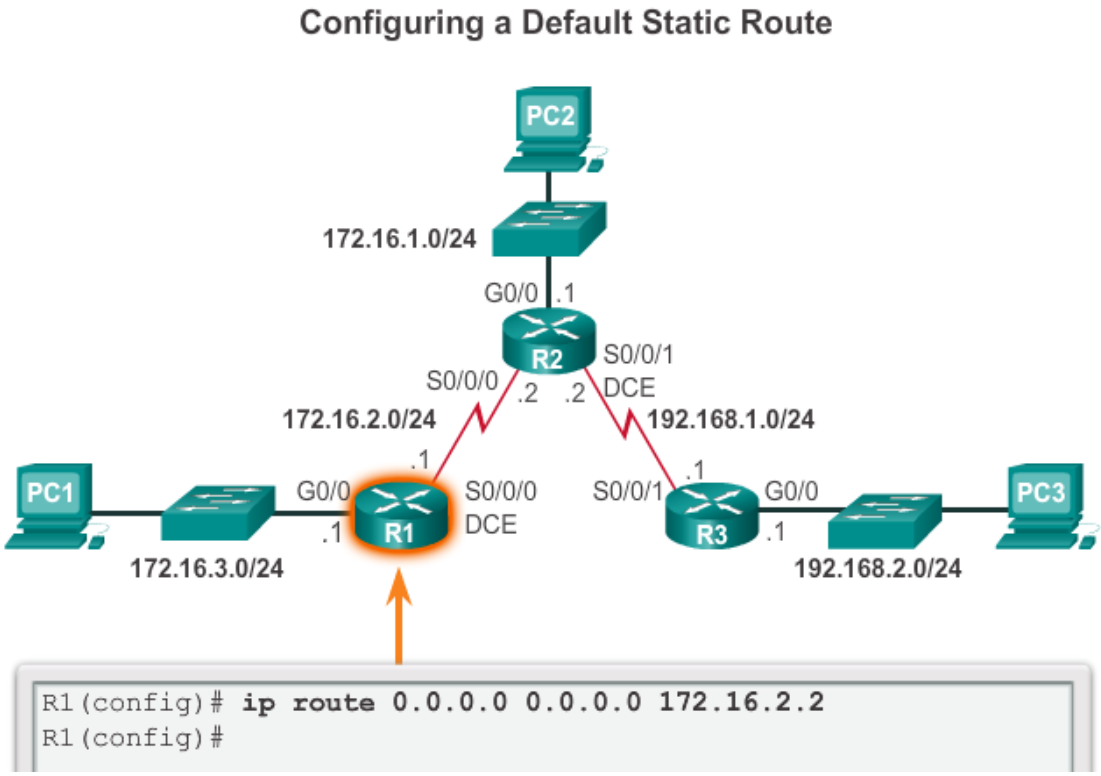
Default Static Route

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	Matches any network address.
0.0.0.0	Matches any subnet mask.
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.

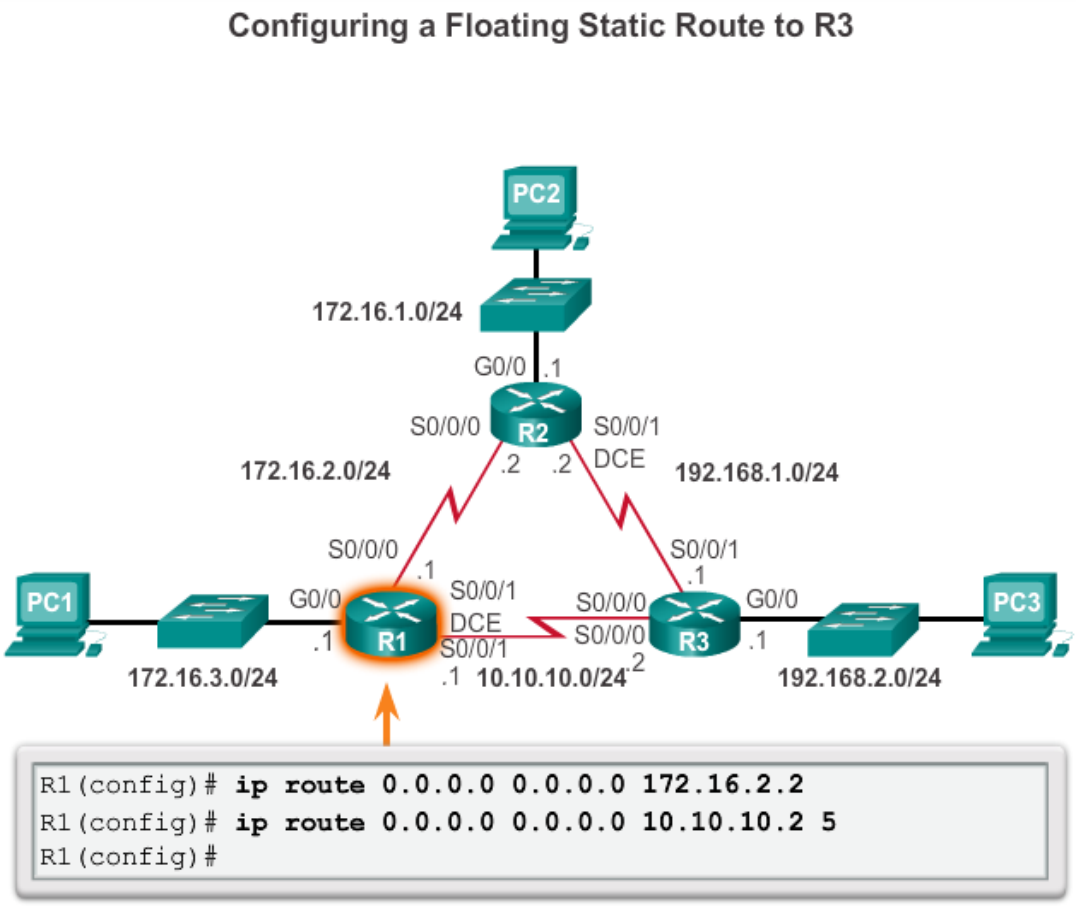
Configure a Default Static Route



R1(config)#**ip route 0.0.0.0 0.0.0.0 serial 0/0/0**

Configure Floating Static Routes

Configure a Floating Static Route



Verify a Static Route

Along with **ping** and **traceroute**, useful commands to verify static routes include:

- **show ip route**
- **show ip route static**
- **show ip route** *network*

```
S    172.16.1.0/24 [1/0] via 172.16.2.2
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 [1/0] via 172.16.2.2
S    192.168.2.0/24 [1/0] via 172.16.2.2
R1#
```

```
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#
```

The ipv6 route Command

Most of parameters are identical to the IPv4 version of the command. IPv6 static routes can also be implemented as:

- Standard IPv6 static route
- Default IPv6 static route
- Summary IPv6 static route
- Floating IPv6 static route

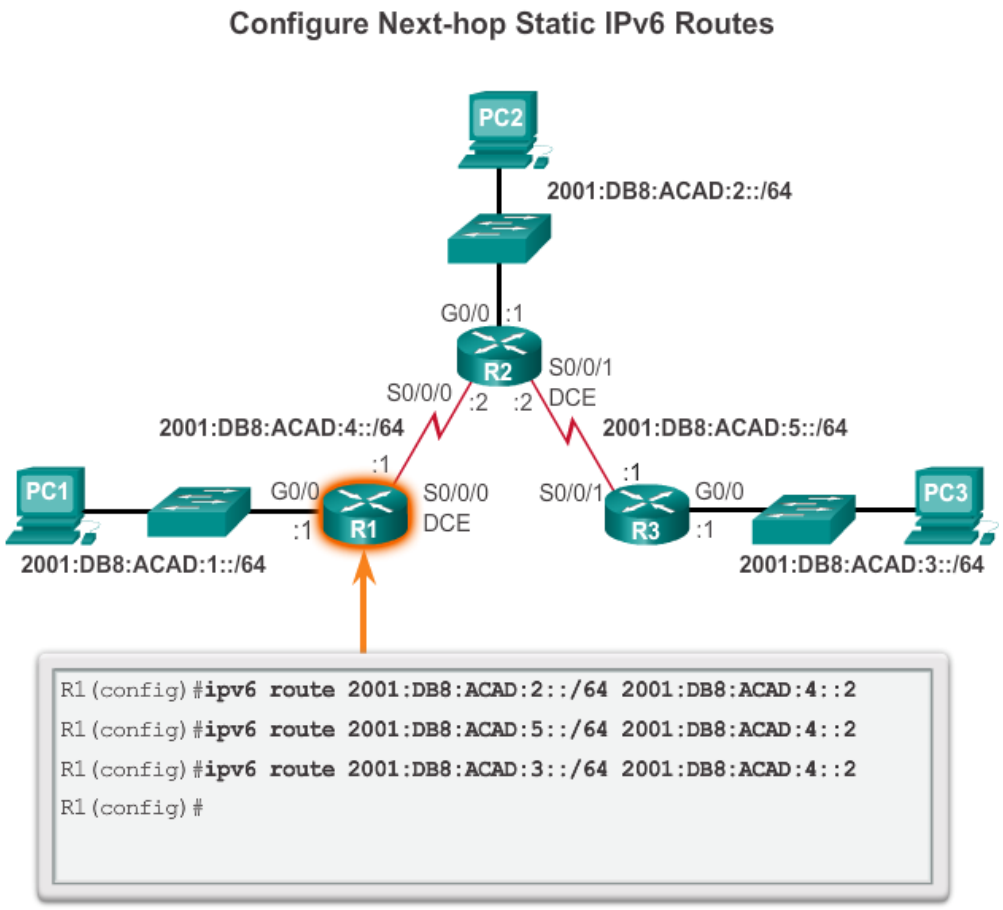
```
Router(config)#ipv6 route ipv6-prefix/ipv6-mask
{ipv6-address | exit-intf}
```

Next-Hop Options

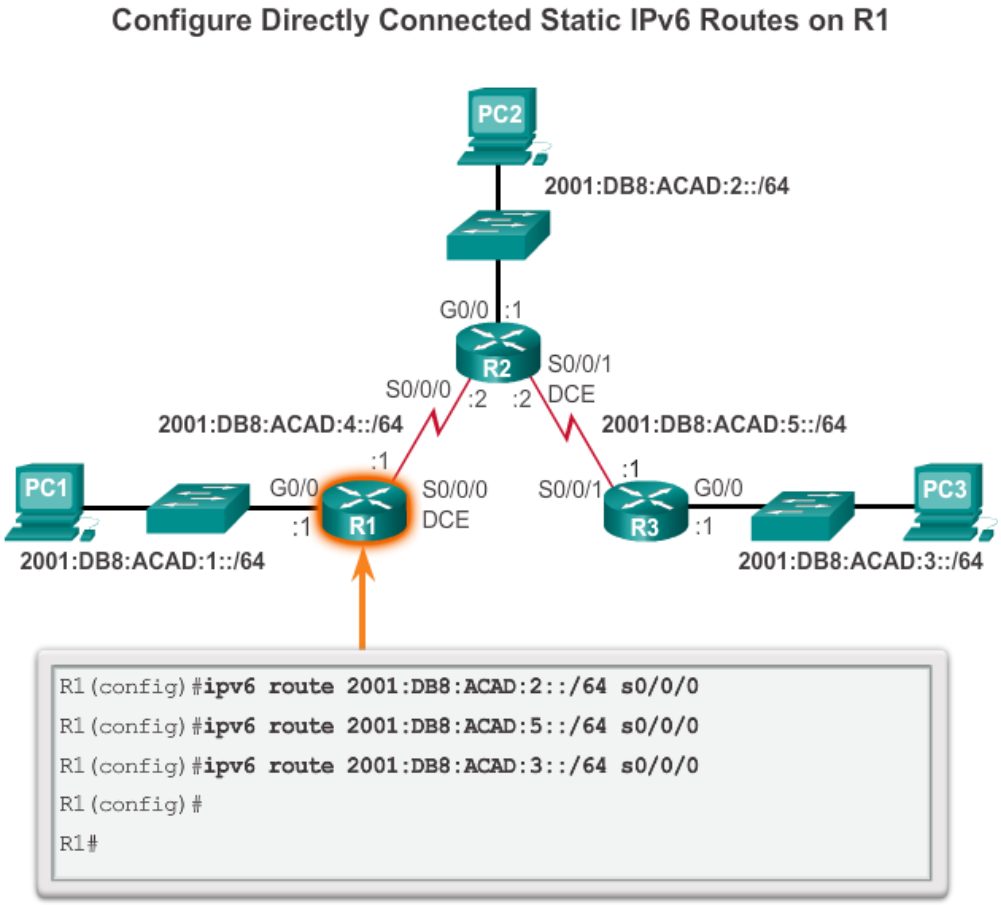
The next hop can be identified by an IPv6 address, exit interface, or both. How the destination is specified creates one of three route types:

- **Next-hop 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



Configure Directly Connected Static IPv6 Route



Verify IPv6 Static Routes

Along with **ping** and **traceroute**, useful commands to verify static routes include:

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

Configure IPv6 Default Routes

Default Static IPv6 Route

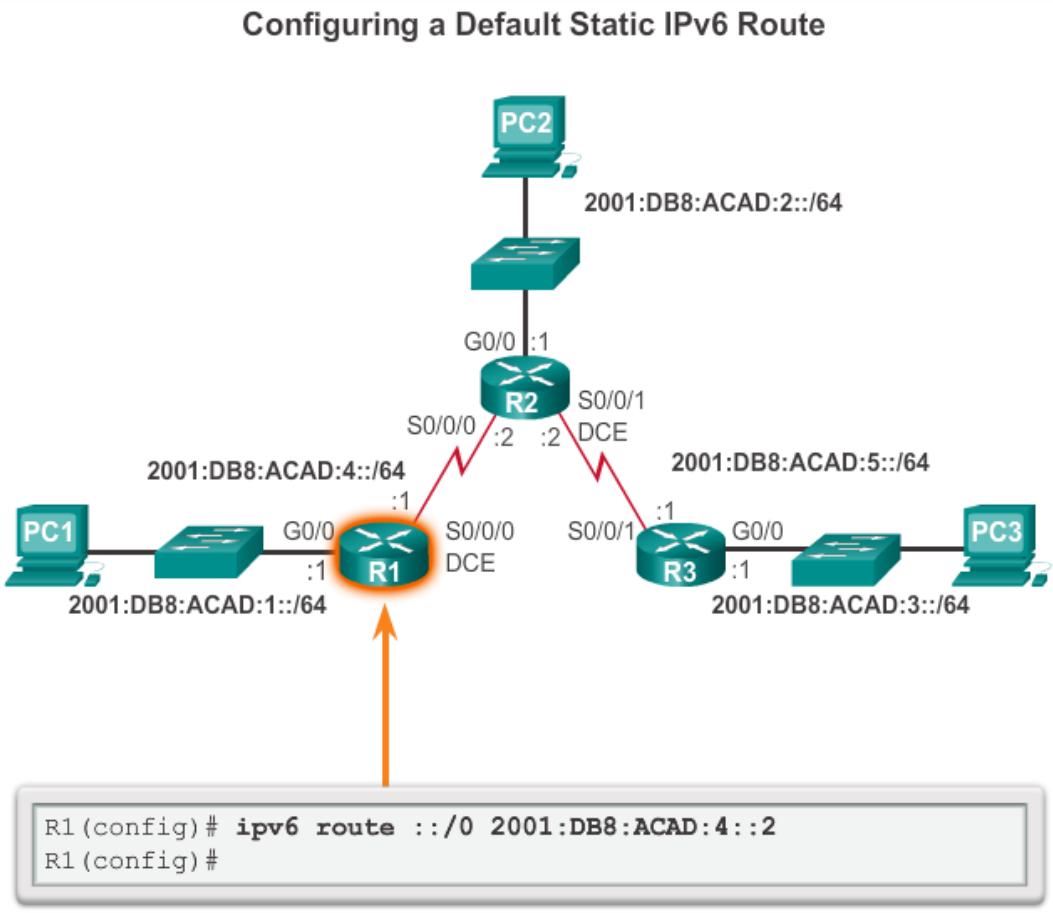
Default Static IPv6 Route Syntax

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

Parameter	Description
::/0	Matches any IPv6 prefix regardless of IPv6 mask.
ip-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 IPv6 Default Routes

Configure a Default Static IPv6 Route

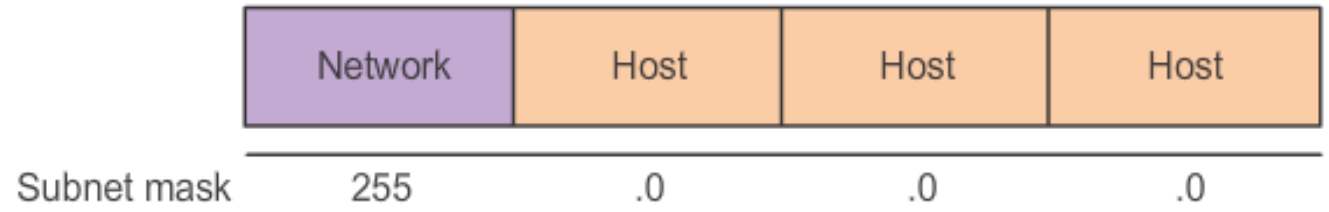


Classful Network Addressing

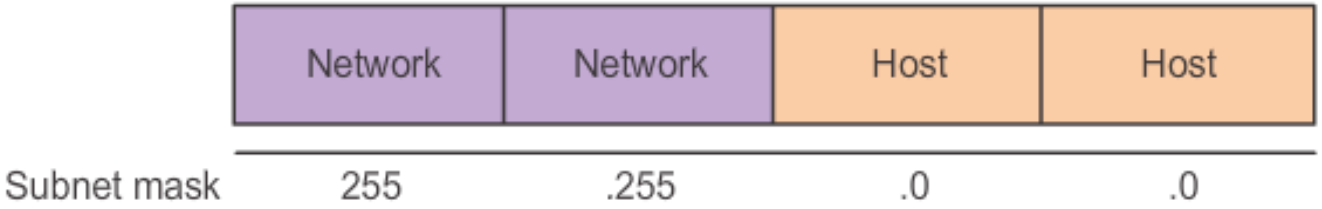
Class	High Order Bits	Start	End
Class A	0xxxxxxx	0.0.0.0	127.255.255.255
Class B	10xxxxxx	128.0.0.0	191.255.255.255
Class C	110xxxxx	192.0.0.0	223.255.255.255
Multicast	1110xxxx	224.0.0.0	239.255.255.255
Reserved	1111xxxx	240.0.0.0	255.255.255.255

Classful Subnet Masks

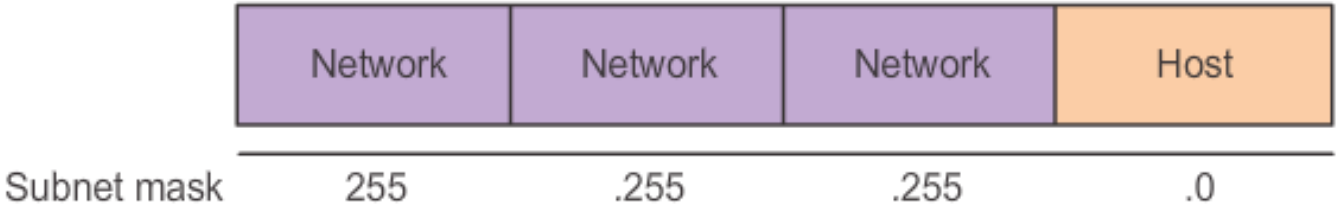
Class A



Class B



Class C



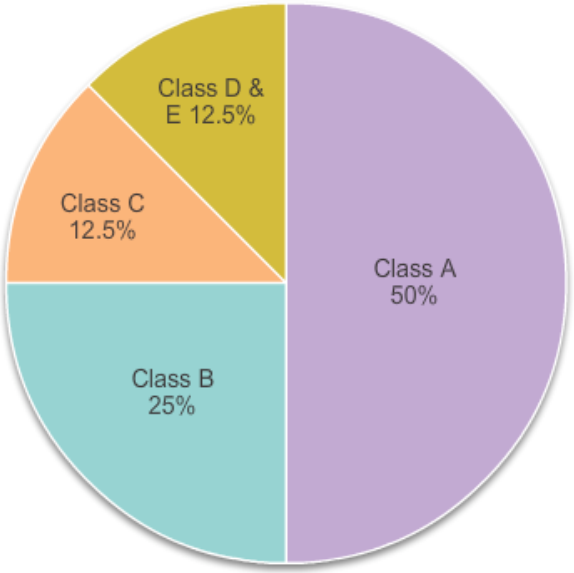
Classful Addressing Waste

Classfull IP Address Allocation = Inefficient

Class A (1 - 126)
# of possible networks: 126
# of Hosts/Net: 16,777,214
Max. # Hosts: 2,113,928,964

Class B (128 – 191)
# of possible networks: 16,384
# of Hosts/Net: 65,534
Max. # Hosts: 1,073,709,056

Class C (192 – 223)
# of possible networks: 2,097,152
# of Hosts/Net: 254
Max. # Hosts: 532,676,608



CIDR

Classless Inter-Domain Routing

Class A (1 – 126)
# of possible networks: 126
# of Hosts/Net: 16,777,214
Max. # Hosts: 16,777,214

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# of possible networks: 16,384
# of Hosts/Net: 65,534
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# of possible networks: 2,097,152
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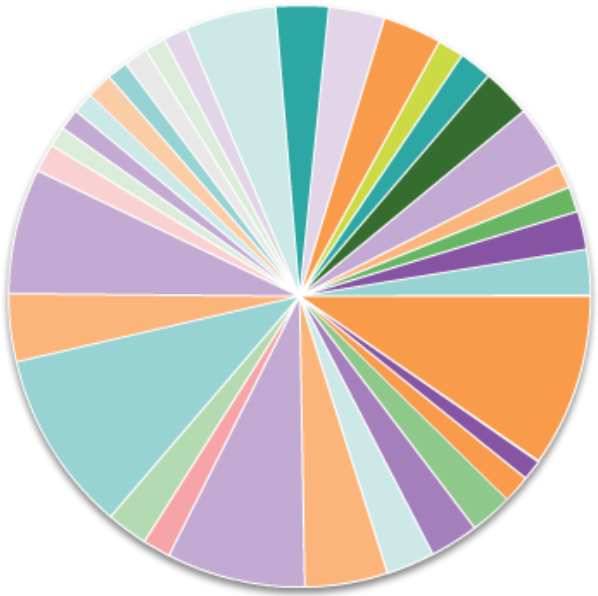
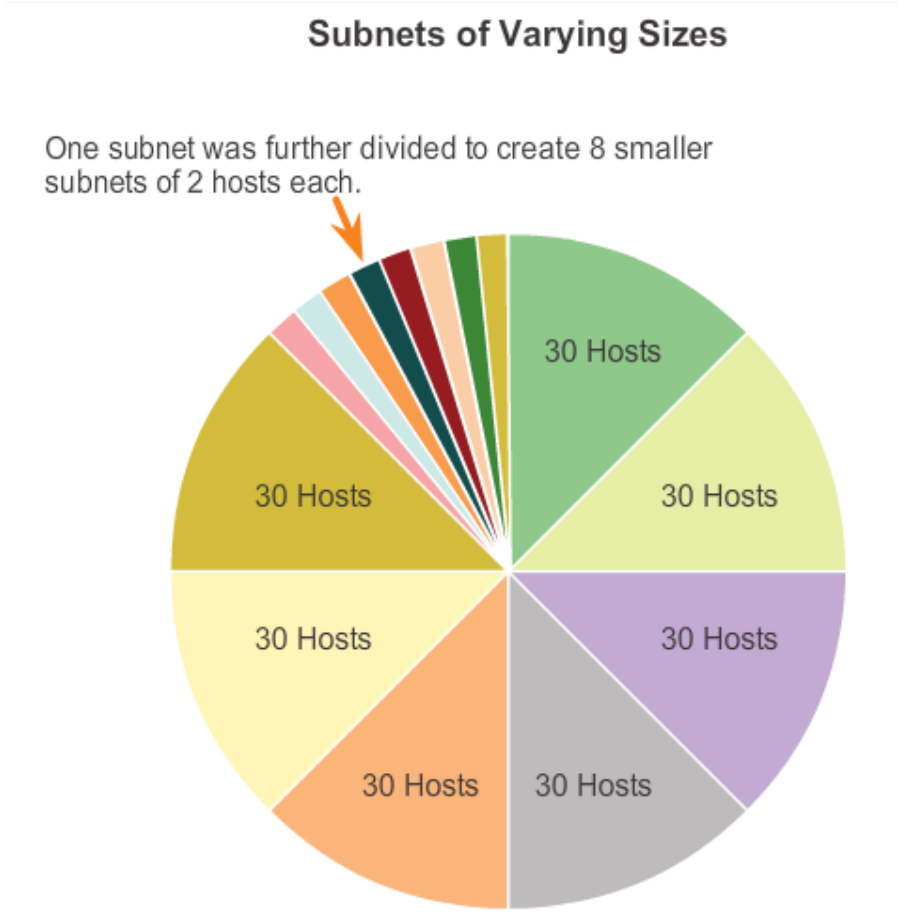


Variable Length Subnet Masking

VLSM allows the use of different masks for each subnet:

- After a network address is subnetted, those subnets can be further subnetted.
- VLSM is simply subnetting a subnet. VLSM can be thought of as sub-subnetting.
- Individual host addresses are assigned from the addresses of "sub-subnets".



VLSM in Action

VLSM allows the use of different masks for each subnet:

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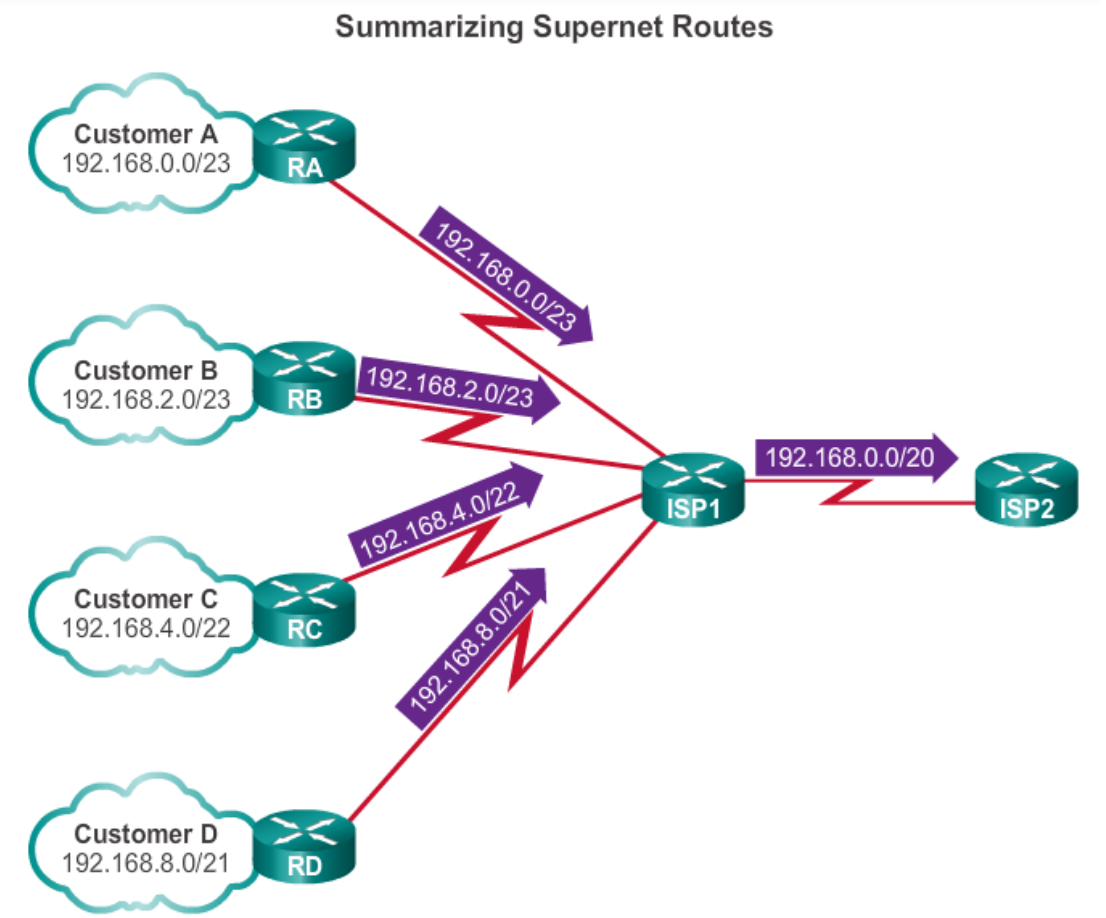
- VLSM is simply subnetting a subnet. VLSM can be thought of as sub-subnetting.
- Individual host addresses are assigned from the addresses of "sub-subnets".

Route Summarization

Route summarization, also known as route aggregation, is the process of advertising a contiguous set of addresses as a single address with a less-specific, shorter subnet mask:

- CIDR is a form of route summarization and is synonymous with the term supernetting.
- CIDR ignores the limitation of classful boundaries, and allows summarization with masks that are smaller than that of the default classful mask.
- This type of summarization helps reduce the number of entries in routing updates and lowers the number of entries in local routing tables.

CIDR and Route Summarization



Configure IPv4 Summary Routes

Calculate a Summary Route

Calculating a Route Summary

Step 1: List networks in binary format.

172.20.0.0	10101100 . 00010100 . 00000000 . 00000000
172.21.0.0	10101100 . 00010101 . 00000000 . 00000000
172.22.0.0	10101100 . 00010110 . 00000000 . 00000000
172.23.0.0	10101100 . 00010111 . 00000000 . 00000000

Step 2: Count the number of far-left matching bits to determine the mask.

Answer: 14 matching bits = /14 or 255.252.0.0

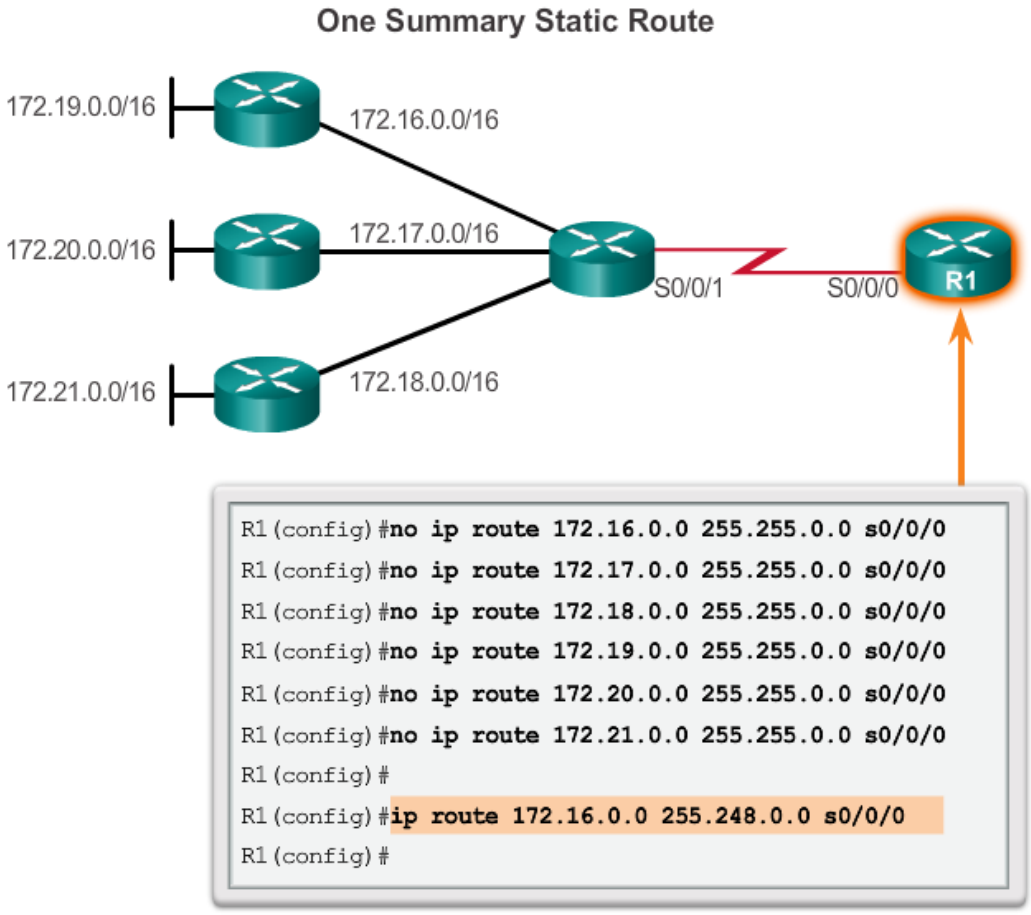
Step 3: Copy the matching bits and add zero bits to determine the network address.

10101100 . 00010100 . 00000000 . 00000000

Copy — Add zero bits

Answer: 172.20.0.0

Static Routing CIDR Example

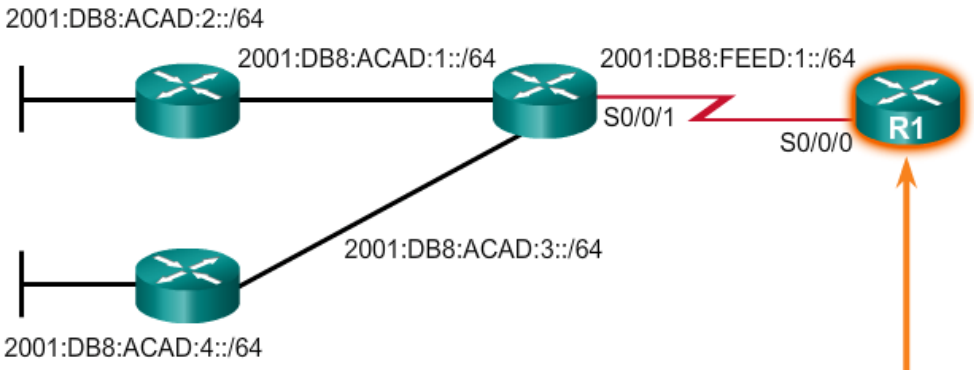


Summarize IPv6 Network Addresses

- Multiple static IPv6 routes can be summarized into a single static IPv6 route if:
  - The destination networks are contiguous and can be summarized into a single network address.
  - The multiple static routes all use the same exit interface or next-hop IPv6 address.

Configure an IPv6 Summary Address

Remove Static Routes and Configure Summary IPv6 Route




```
R1(config)# no ipv6 route 2001:DB8:ACAD:1::/64 2001:db8:feed:1::2
R1(config)# no ipv6 route 2001:DB8:ACAD:2::/64 2001:db8:feed:1::2
R1(config)# no ipv6 route 2001:DB8:ACAD:3::/64 2001:db8:feed:1::2
R1(config)# no ipv6 route 2001:DB8:ACAD:4::/64 2001:db8:feed:1::2
R1(config)#
R1(config)#
R1(config)# ipv6 route 2001:DB8:ACAD::/45 2001:db8:feed:1::2
R1(config)#
```

??

Troubleshoot commands

Common IOS troubleshooting commands include:

- **`ping`**
- **`traceroute`**
- **`show ip route`**
- **`show ip interface brief`**