Chapter 5
Network Layer

Presented By

Zahirul Islam

Lecturer

Dept. of Computer Science & Engineering

Rajshahi University of Engineering & Technology

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.

Disadvantages of Static Routing

- 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 routing has three primary uses:

- Providing ease of routing table maintenance in smaller networks that are not expected to grow significantly.
- Routing to and from stub networks.
- 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:

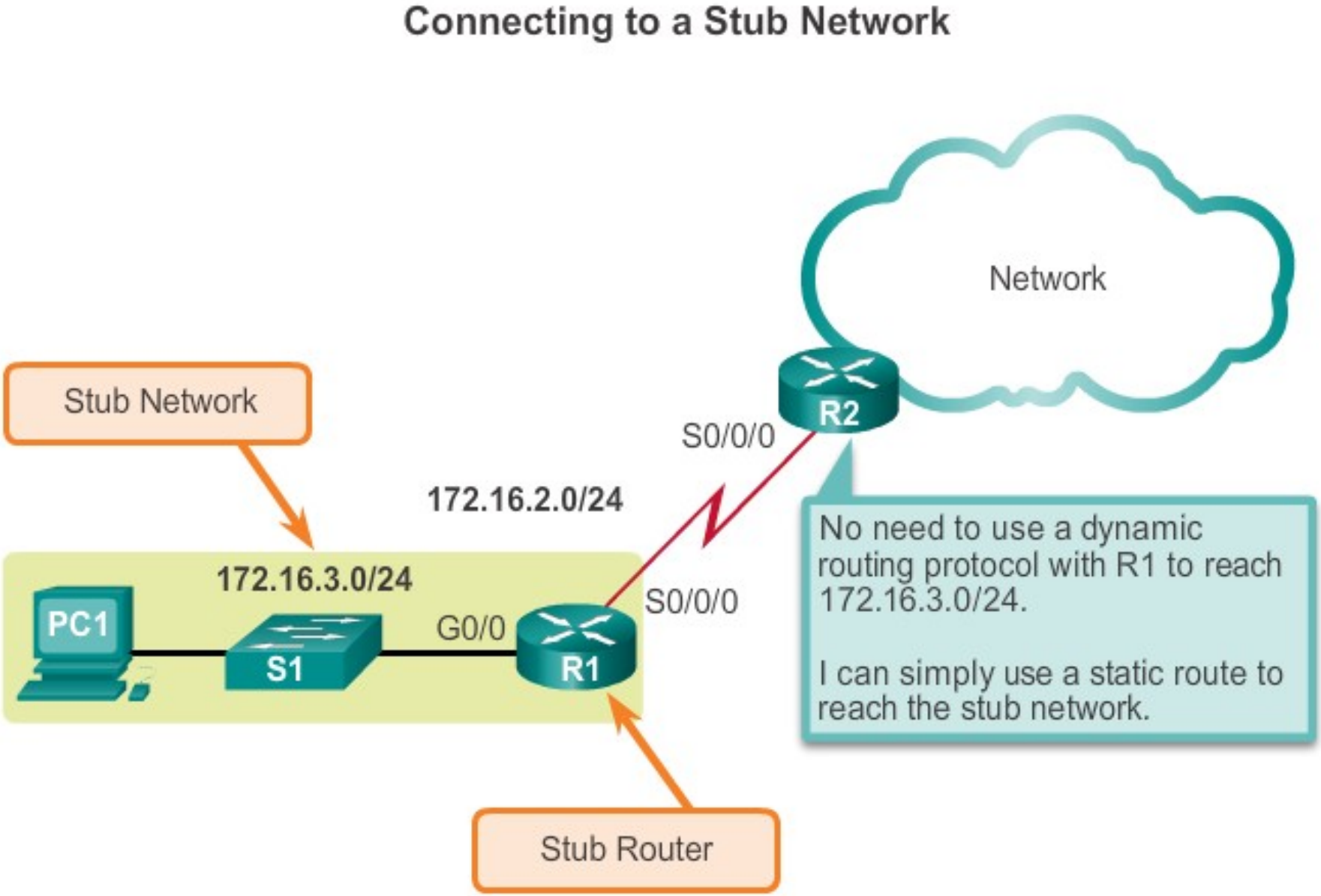
- Connect to a specific network.
- Provide a Gateway of Last Resort for a stub network.
- Reduce the number of routes advertised by summarizing several contiguous networks as one static route.
- Create a backup route in case a primary route link fails.

Types of Static Route

Static Routes are four types:

1. Standard Static Route.
2. Default Static Route.
3. Summary Static Route.
4. Floating Static Route.

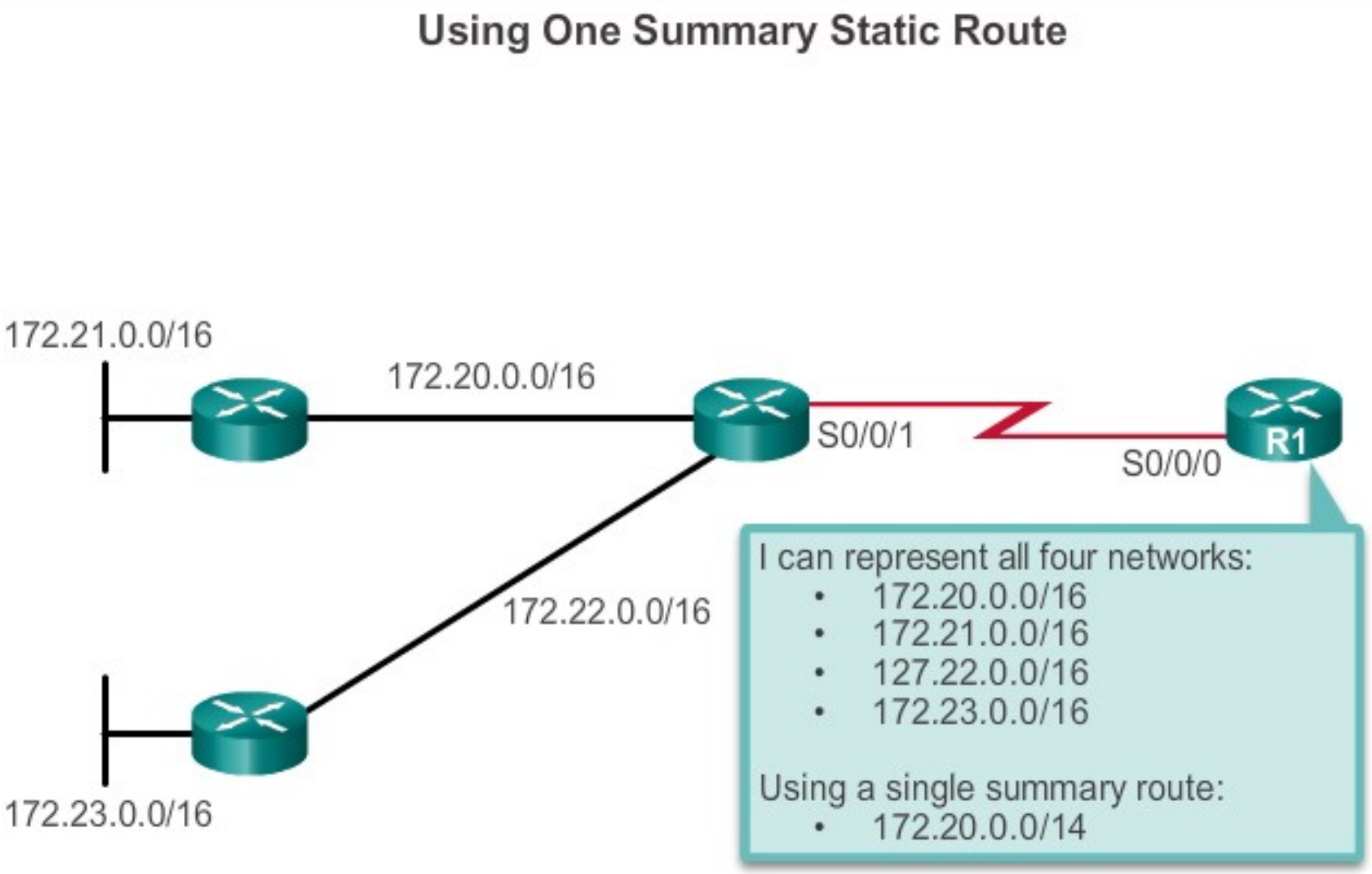
Standard Static Route



Default Static Route

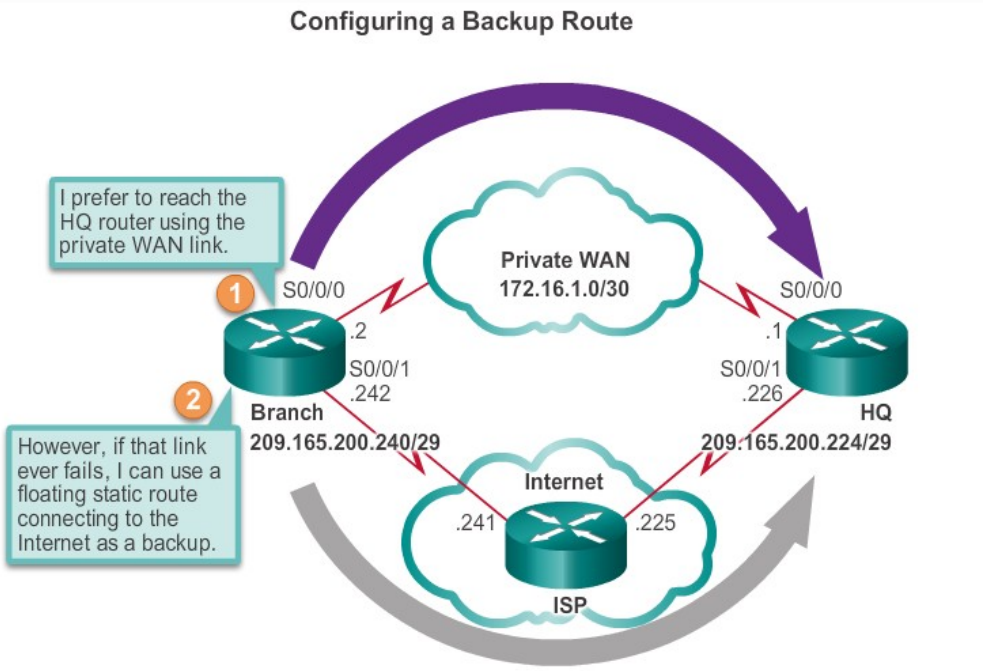
- A default static route is a route that matches all packets.
- A default route identifies the gateway IP address to which the router sends all IP packets that it does not have a learned or static route.
- A default static route is simply a static route with 0.0.0.0/0 as the destination IPv4 address.

Summary Static Route



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

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.

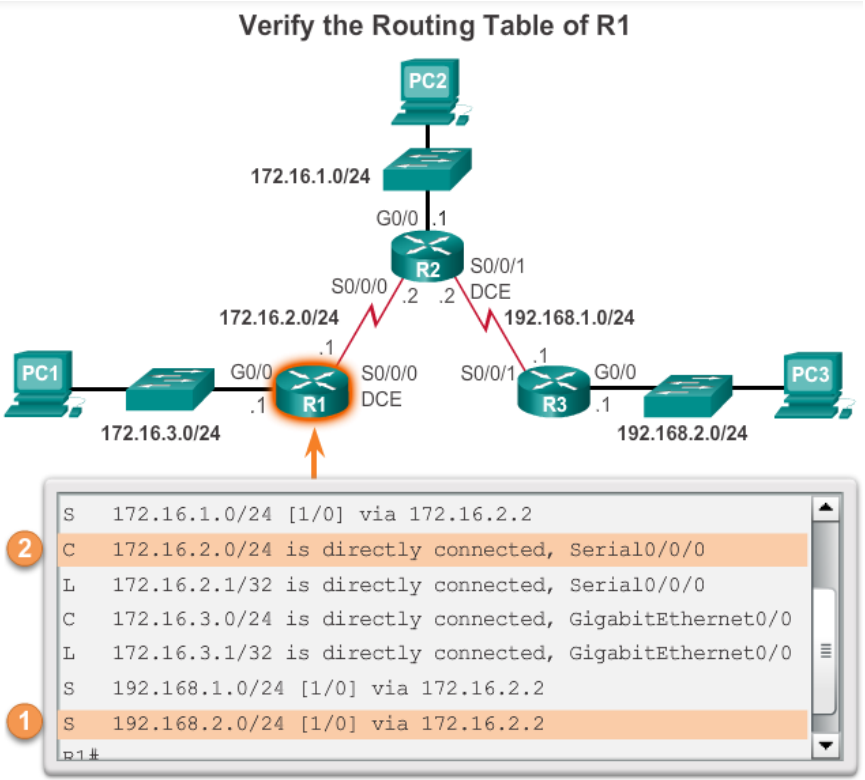
Configure IPv4 Static Routes

Configure a Next-Hop Static Route

When a packet is destined for the 192.168.2.0/24 network, R1:

1. Looks for a match in the routing table and finds that it has to forward the packets to the next-hop IPv4 address 172.16.2.2.

2. R1 must now determine how to reach 172.16.2.2; therefore, it searches a second time for a 172.16.2.2 match.



Configure Fully Specified Static Route

In a fully specified static route:

- Both the output interface and the next-hop IP address are specified.
- This is another type of static route that is used in older IOSs, prior to Cisco Express Forwarding (CEF).
- This form of static route is used when the output interface is a **multi-access** interface and it is necessary to explicitly identify the next hop.
- The next hop must be **directly** connected to the specified exit interface.

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`**

Configure IPv4 Static Routes

Default Static Route

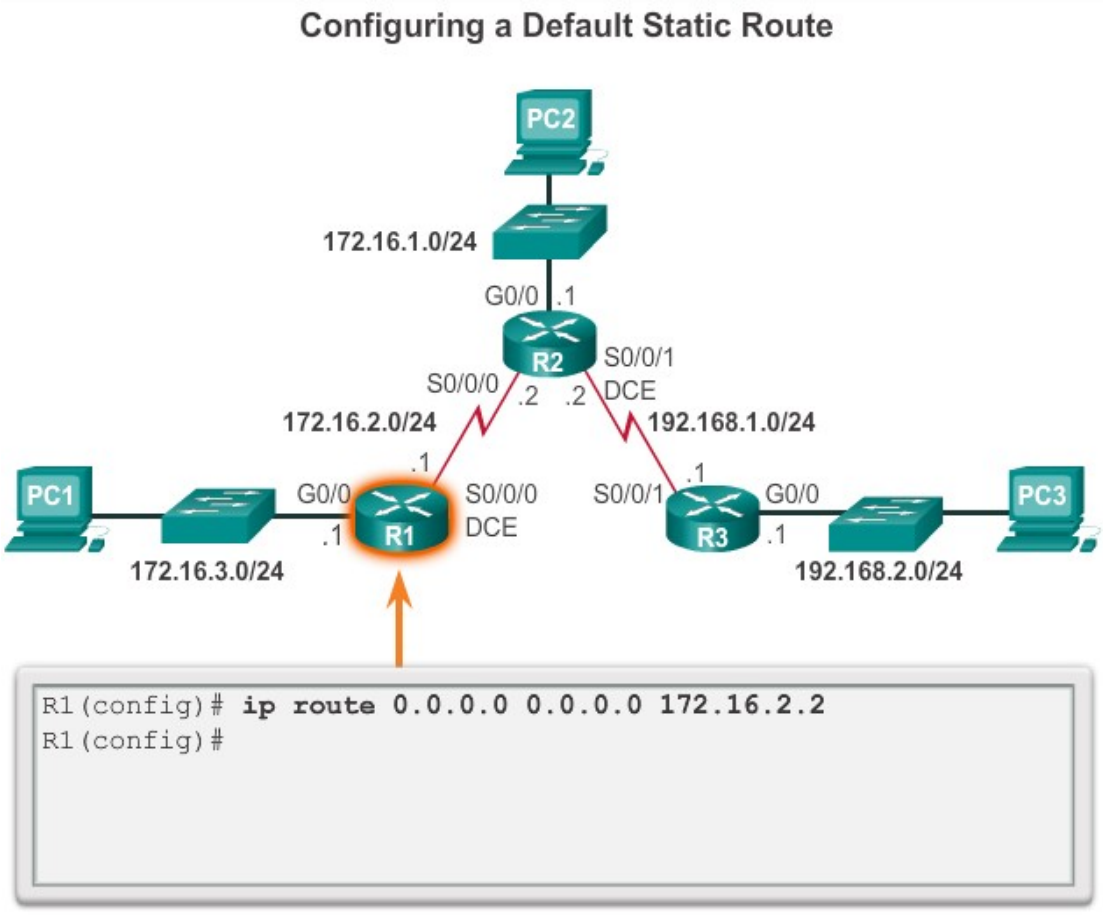
Default Static Route Syntax

```
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.

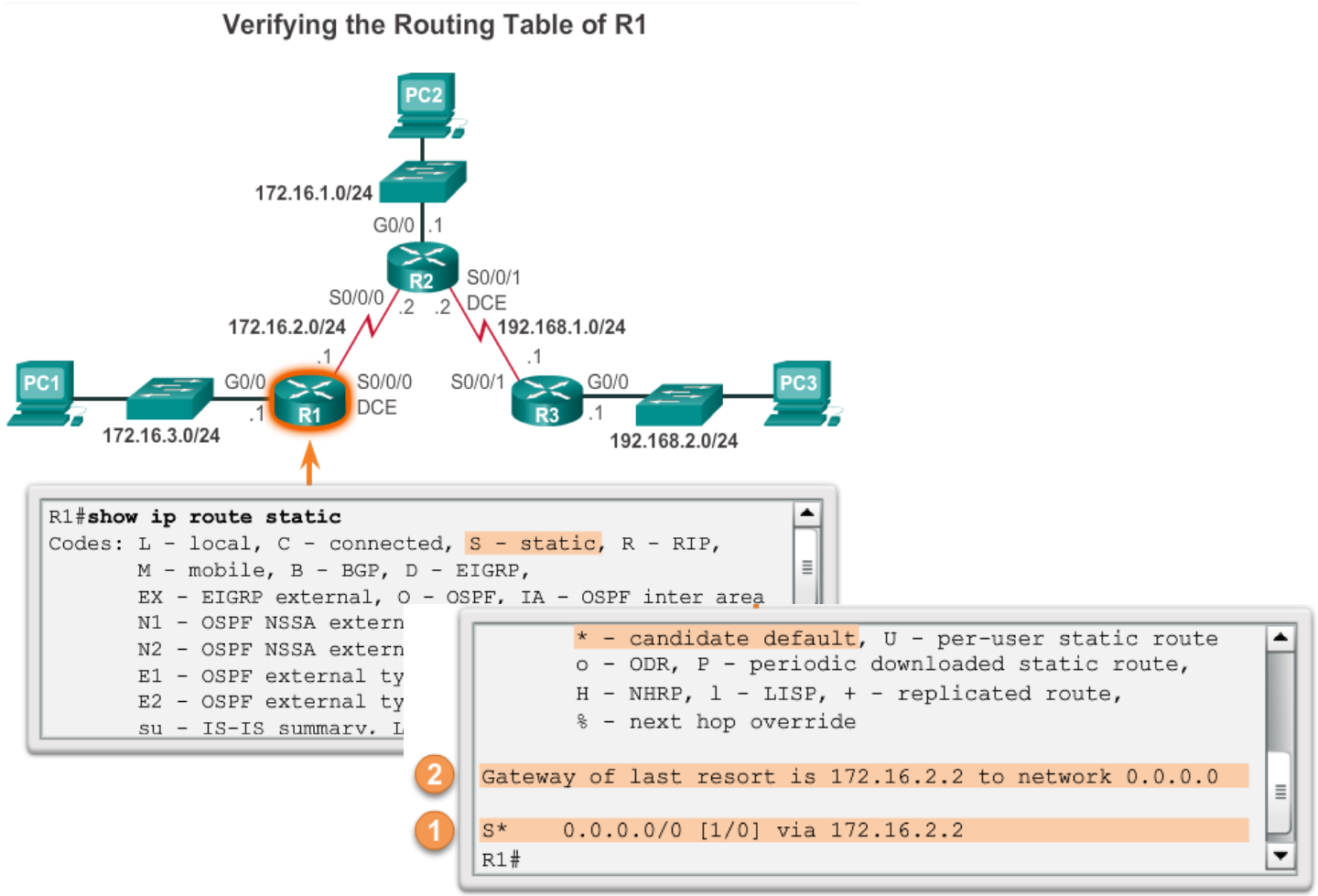
Configure IPv4 Static Routes

Configure a Default Static Route



Configure IPv4 Static Routes

Verify a Default Static Route

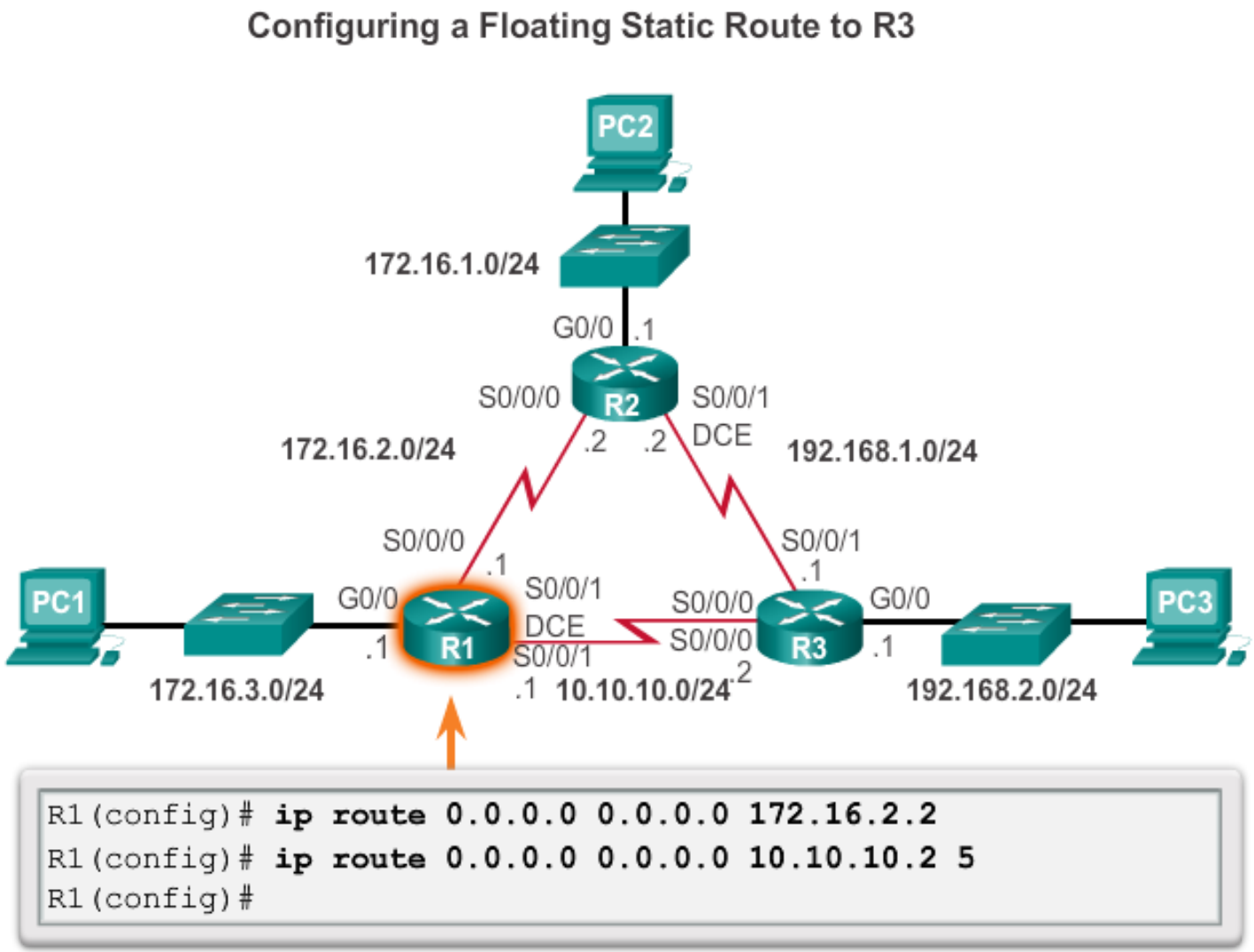


Floating Static Routes

Floating static routes are static routes that have an administrative distance greater than the administrative distance of another static route or dynamic routes:

- The administrative distance of a static route can be increased to make the route less desirable than that of another static route or a route learned through a dynamic routing protocol.
- In this way, the static route “floats” and is not used when the route with the better administrative distance is active.
- However, if the preferred route is lost, the floating static route can take over, and traffic can be sent through this alternate route.

Configure a Floating Static Routes



Configure Floating Static Routes

Test a Floating Static Routes

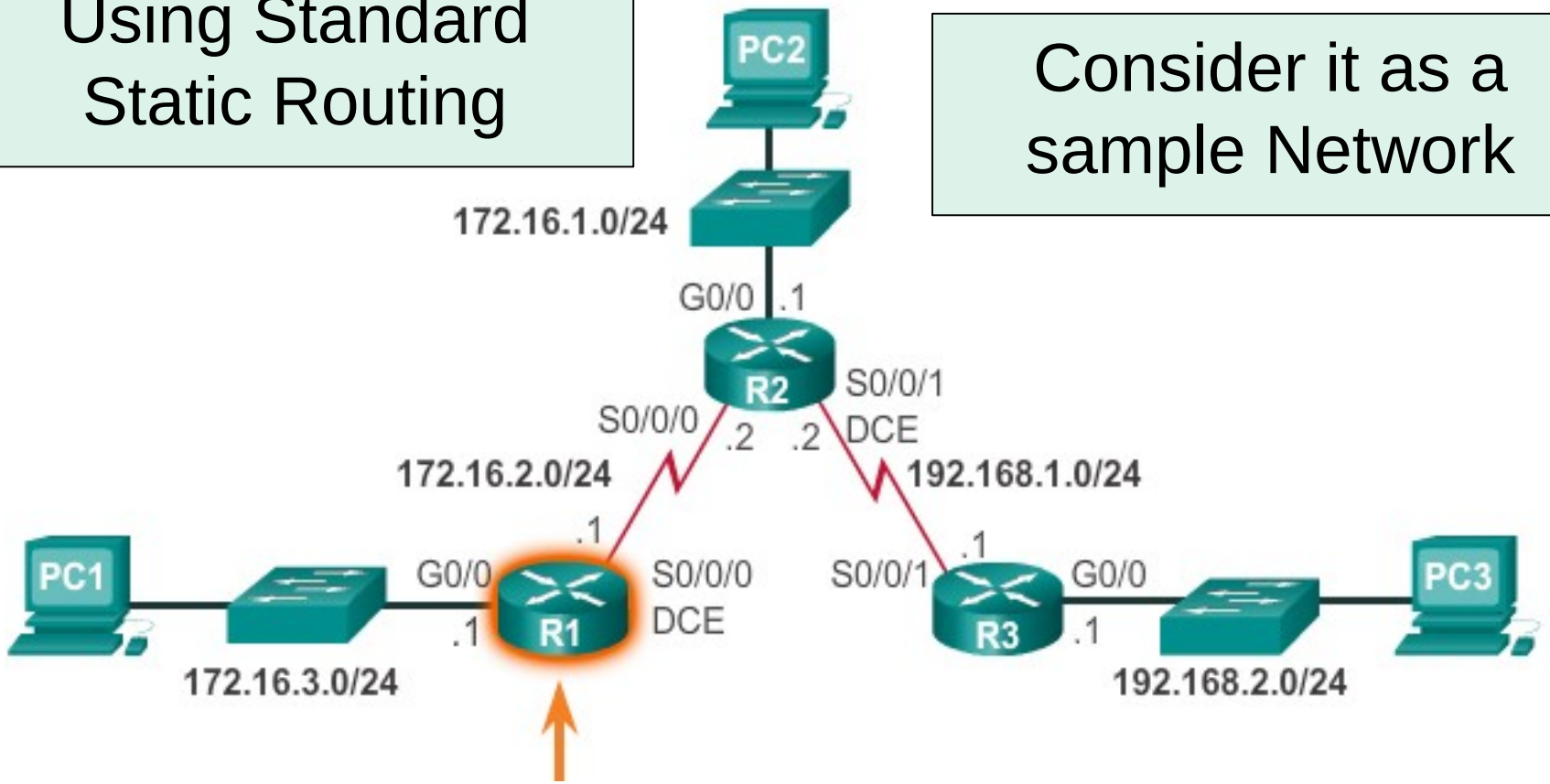
To test a floating static route:

- Use a **`show ip route`** command to verify that the routing table is using the default static route.
- Use a **`traceroute`** command to follow the traffic flow out the primary route.
- Disconnect the primary link or shutdown the primary exit interface.
- 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.

Let's go for real configuration.

Using Standard Static Routing

Consider it as a sample Network



Configure Standard Static Routing

- ip route destination_network_address subnet_mask next_hop_ip_address

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

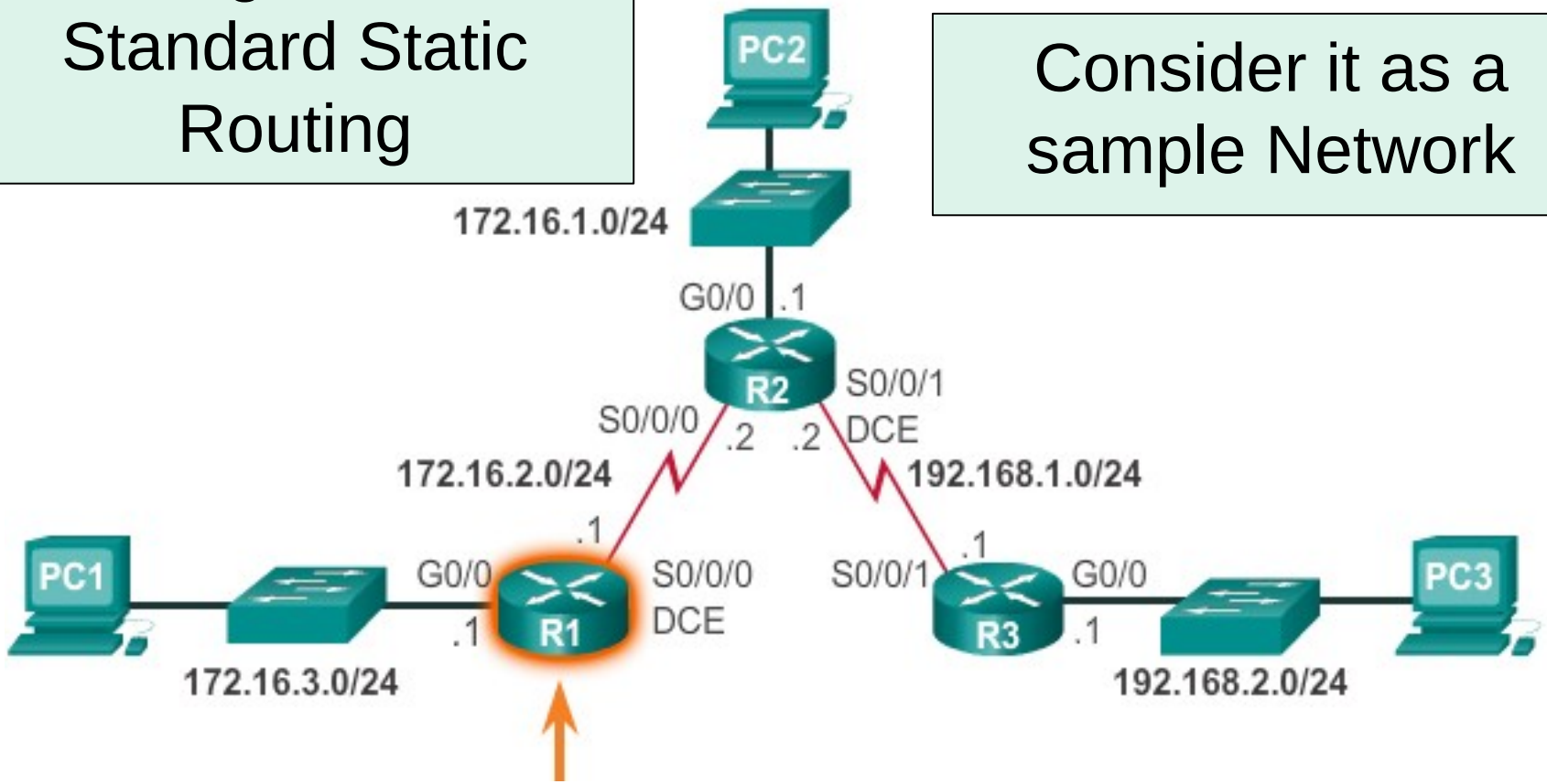
R2(config)#ip route 172.16.3.0 255.255.255.0 172.16.2.1
R2(config)#ip route 192.168.2.0 255.255.255.0 192.168.1.1

R3(config)#ip route 172.16.1.0 255.255.255.0 192.168.1.2
R3(config)#ip route 172.16.2.0 255.255.255.0 192.168.1.2
R3(config)#ip route 172.16.3.0 255.255.255.0 192.168.1.2

Let's go for real configuration.

Using Default Standard Static Routing

Consider it as a sample Network



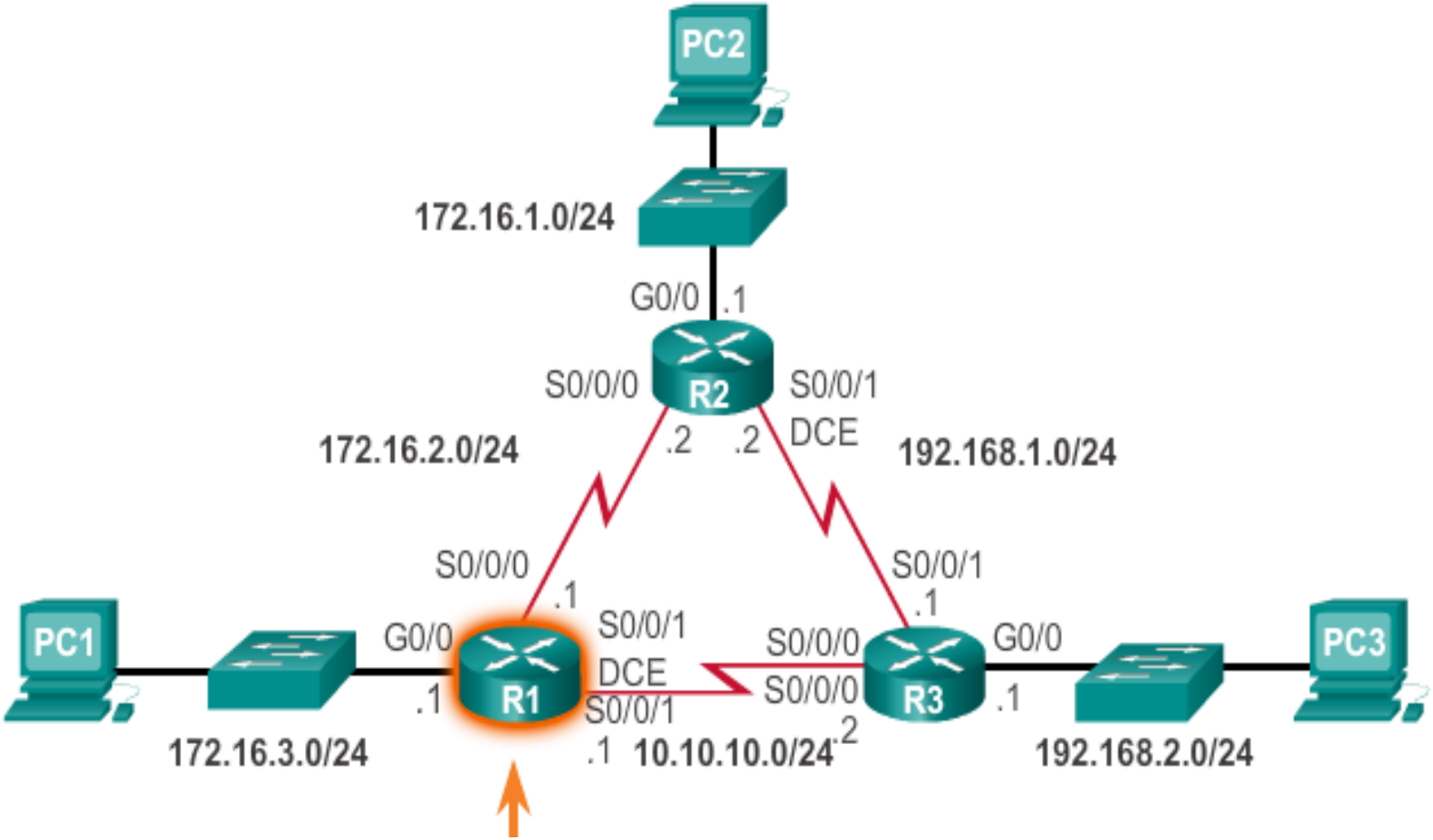
Configure Default Static Route

- Before configure default static route: R1
  - Check show ip route now.
    - ✓ Remember the result.
  - Ping 172.16.2.2 from PC1.
    - ✓ Remember the result.
- Configure default static route: R1
  - Ip route 0.0.0.0 0.0.0.0 172.16.2.2
  - Check show ip route now.
    - ✓ Is that any difference?

Configure Default Static Route (Cont'd)

- Again check Ping 172.16.2.2 from PC1. Anything??
- Don't worry, I'm here ☺
- Configure default static route: R2
  - Ip route 0.0.0.0 0.0.0.0 172.16.2.1
  - Now Ping 172.16.1.2 from PC1. **cheers.**
  - Ping 192.168.1.2 ☺
  - I **swear** last time ping 172.16.1.1
- Do the same work on R2 and R3 router.

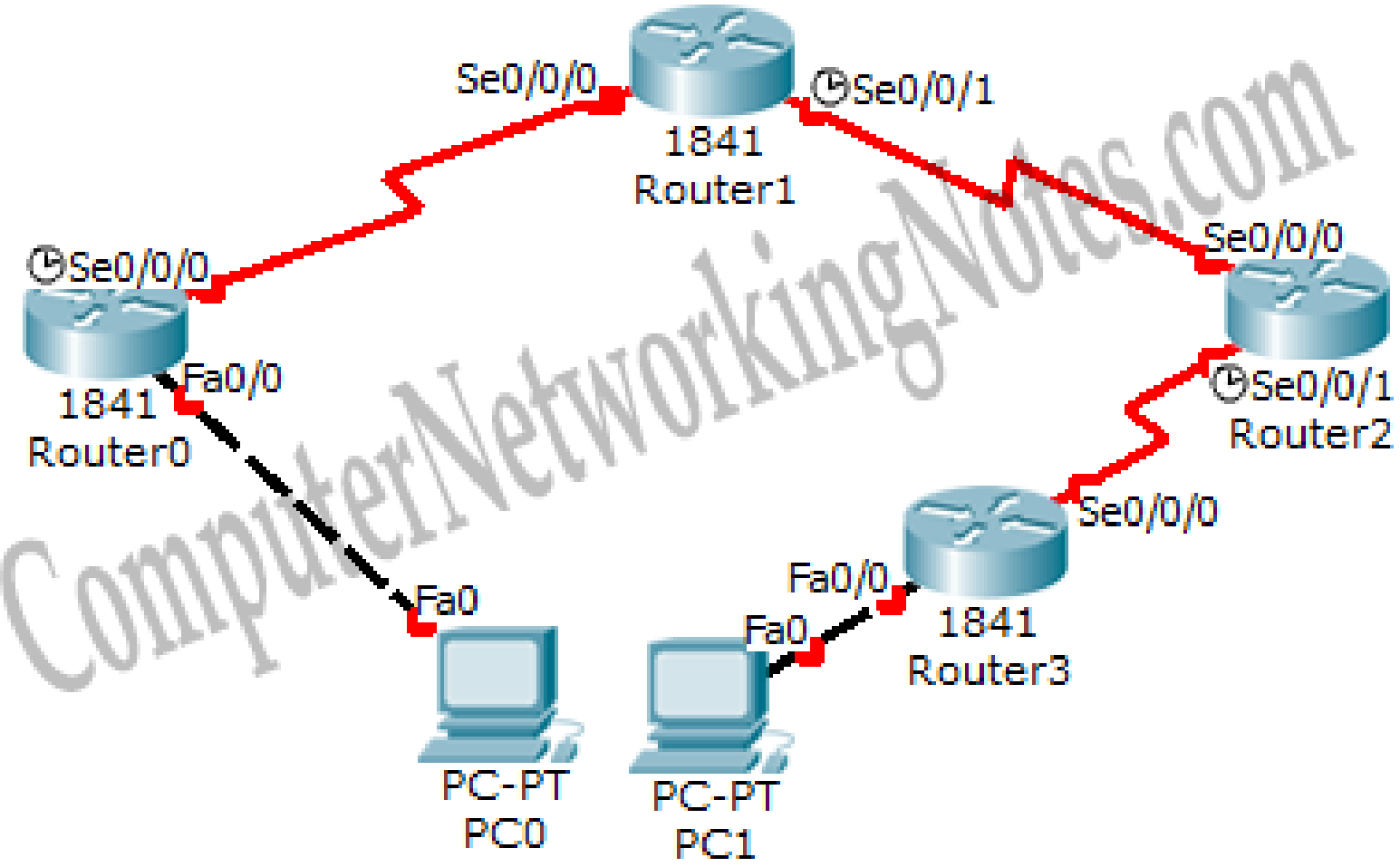
Configure a Floating Static Routes



Configure a Floating Static Routes

- Primary link is as like normal static routing configuration.
- Secondary link is same as primary just add an administrative distance!!
- Configuration on R1 router:
  - Ip route 0.0.0.0 0.0.0.0 172.16.2.2
  - Ip route 0.0.0.0 0.0.0.0 10.10.10.2 5

Sample Network 1



Sample Network 1

Device	Connected from	Connected to	IP Address
PC0	FastEthernet0	Router0's FastEthernet0/0	10.0.0.2/8
Router0	FastEthernet0/0	PC0's FastEthernet0	10.0.0.1/8
Router0	Serial 0/0/0	Router1's serial0/0/0	192.168.0.253/30
Router1	Serial0/0/0	Router0's Serial0/0/0	192.168.0.254/30
Router1	Serial0/0/1	Router2's Serial0/0/0	192.168.0.249/30
Router2	Serial0/0/0	Router1's Serial0/0/1	192.168.0.250/30
Router2	Serial0/0/1	Router3's Serial0/0/0	192.168.0.245/30
Router3	Serial0/0/0	Router2's Serial0/0/1	192.168.0.246/30
Router3	FastEthernet0/0	PC1's FastEthernet0	20.0.0.1/8
PC1	FastEthernet0	Router1's FastEthernet0/0	20.0.0.2/8

Sample Network 2