Module 2

Static Routing

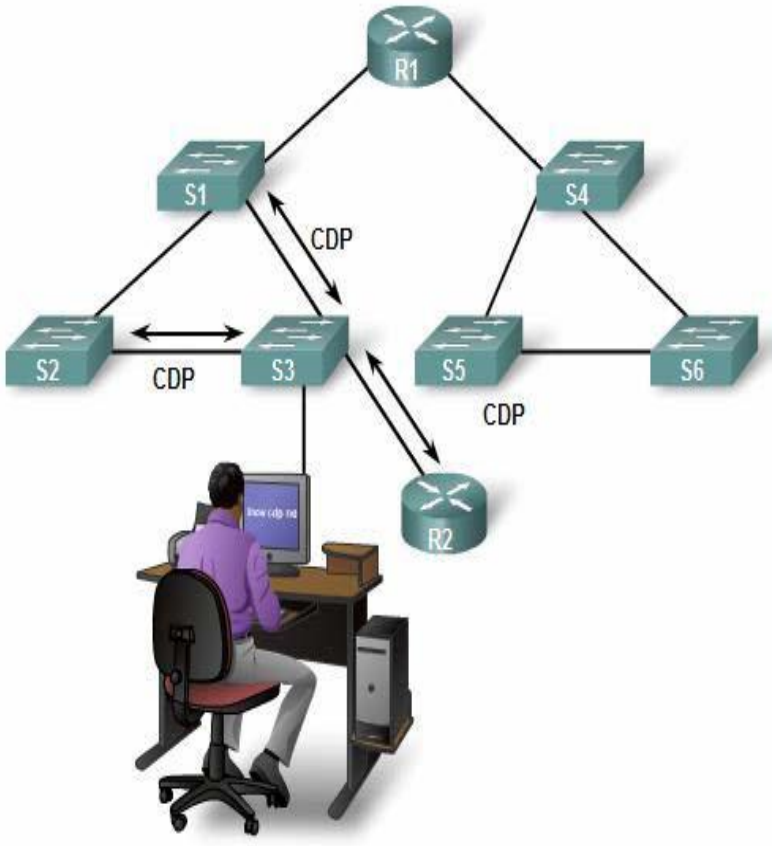
Objectives

- **Cisco Discovery Protocol (CDP) protocol**
- **Describe static routes with next-hop address**
- **Describe static routes with exit interface**
- **Describe summary and default route**

Cisco Discovery Protocol (CDP)

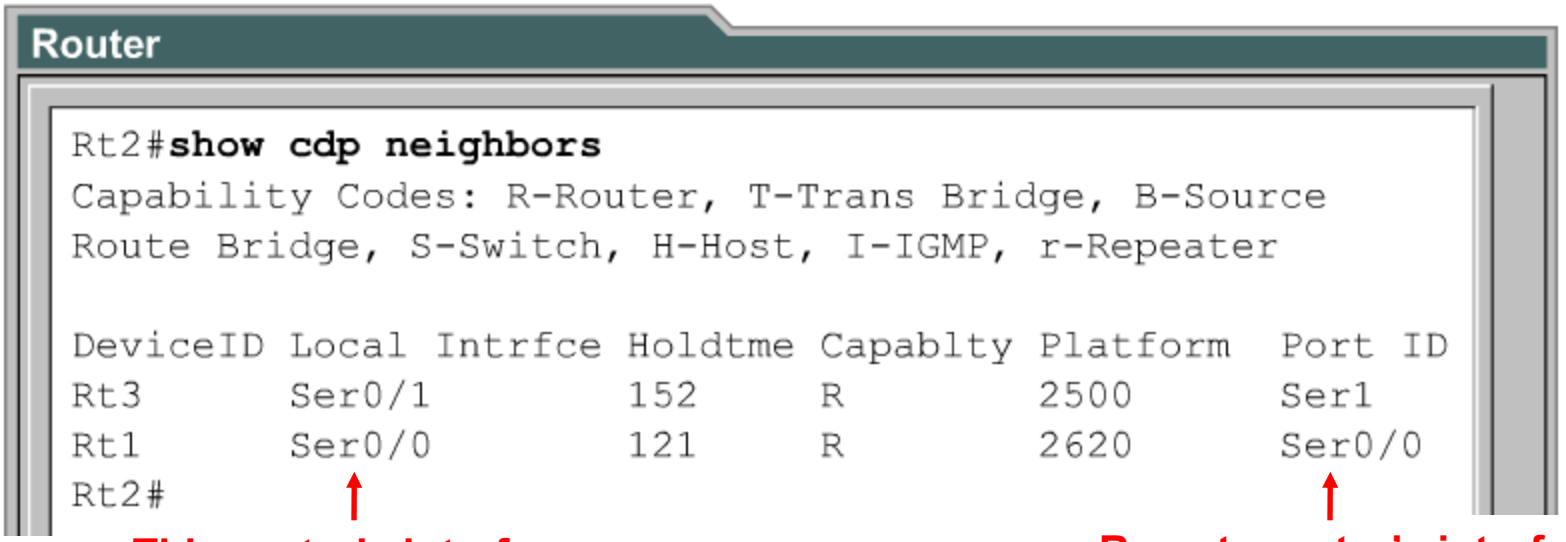
Cisco Discovery Protocol (CDP)

- CDP is an information-gathering tool used by network administrators to get information about directly connected Cisco devices.
- CDP is a proprietary tool that enables you to access a summary of protocol and address information about Cisco devices that are directly connected.
- These advertisements contain information such as:
  - Types of devices that are connected
  - The router interfaces they are connected to
  - The interfaces used to make the connections
  - The model numbers of the devices.



Cisco Discovery Protocol (CDP)

- **CDP Operation:**
  - **CDP runs at the Data Link layer connecting the physical media to the upper-layer protocols.**
  - **Cisco network devices, such as routers that support different Network layer protocols (for example, IP and Novell IPX), can learn about each other**



Cisco Discovery Protocol (CDP)

Router#show cdp neighbor detail

same as

Router#show cdp entry *Device_ID*

Router

```
Rtl#show cdp entry Rt2
-------------------
Device ID: Rt2
Entry address(es):
IP address: 192.168.2.2
Platform: cisco 2621, Capabilities: Router
Interface: Serial0/0, PortID(outgoing port): Serial0/0
Holdtime: 139 sec

Version:
Cisco Internetwork Operating System Software
IOS (tm)C2600 Software(C2600-DO3S-M), Version 12.0(5)TI,
RELEASE
SOFTWARE(fcl)
Copyright(c) 1986-1999 by cisco System, Inc.
Compiled Tue 17-Aug-99 13:18 bycmong
```

Disable CDP

- If you need to disable CDP globally, for the entire device, use this command:

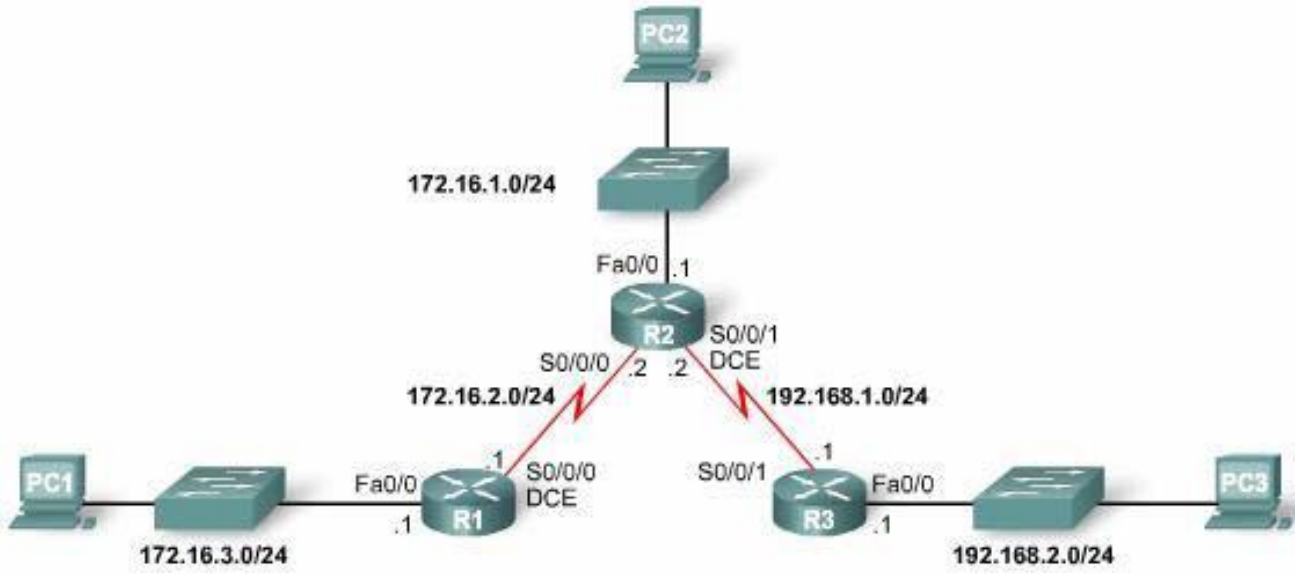
```
Router(config)#no cdp run
```

- If you want to use CDP but need to stop CDP advertisements on a particular interface, use this command:

```
Router(config-if)#no cdp enable
```

Static Routes

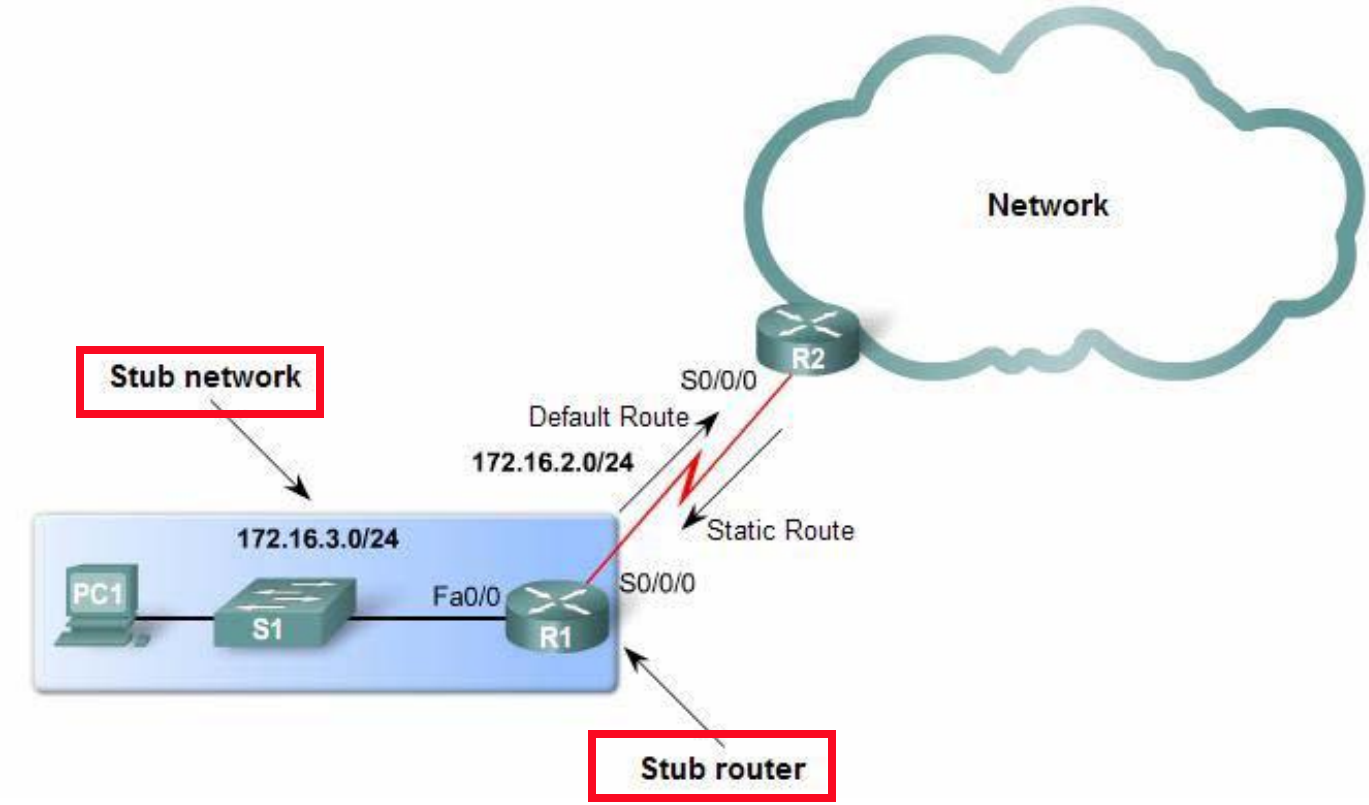
Routing Table Principles and Static Routes



- **Principle 1:**
  - **"Every router makes its decision alone, based on the information it has in its own routing table."**
- **Principle 2:**
  - **"The fact that one router has certain information in its routing table does not mean that other router have the same information."**
- **Principle 3:**
  - **"Routing information about a path from one network to another does not provide routing information about reverse, or return path."**

Purpose and Command Syntax of *ip route*

- **Static routes are commonly used when routing from a network to a stub network.**
- **A stub network is a network accessed by a single route.**



Purpose and Command Syntax of *ip route*

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

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.
exit-interface	Outgoing interface that is used to forward packets to the destination network.

Static route operations can be divided into these three parts:

- **Network administrator configures the route**
- **Router installs the route in the routing table**
- **Packets are routed using the static route**

Steps to Configure Static Routes

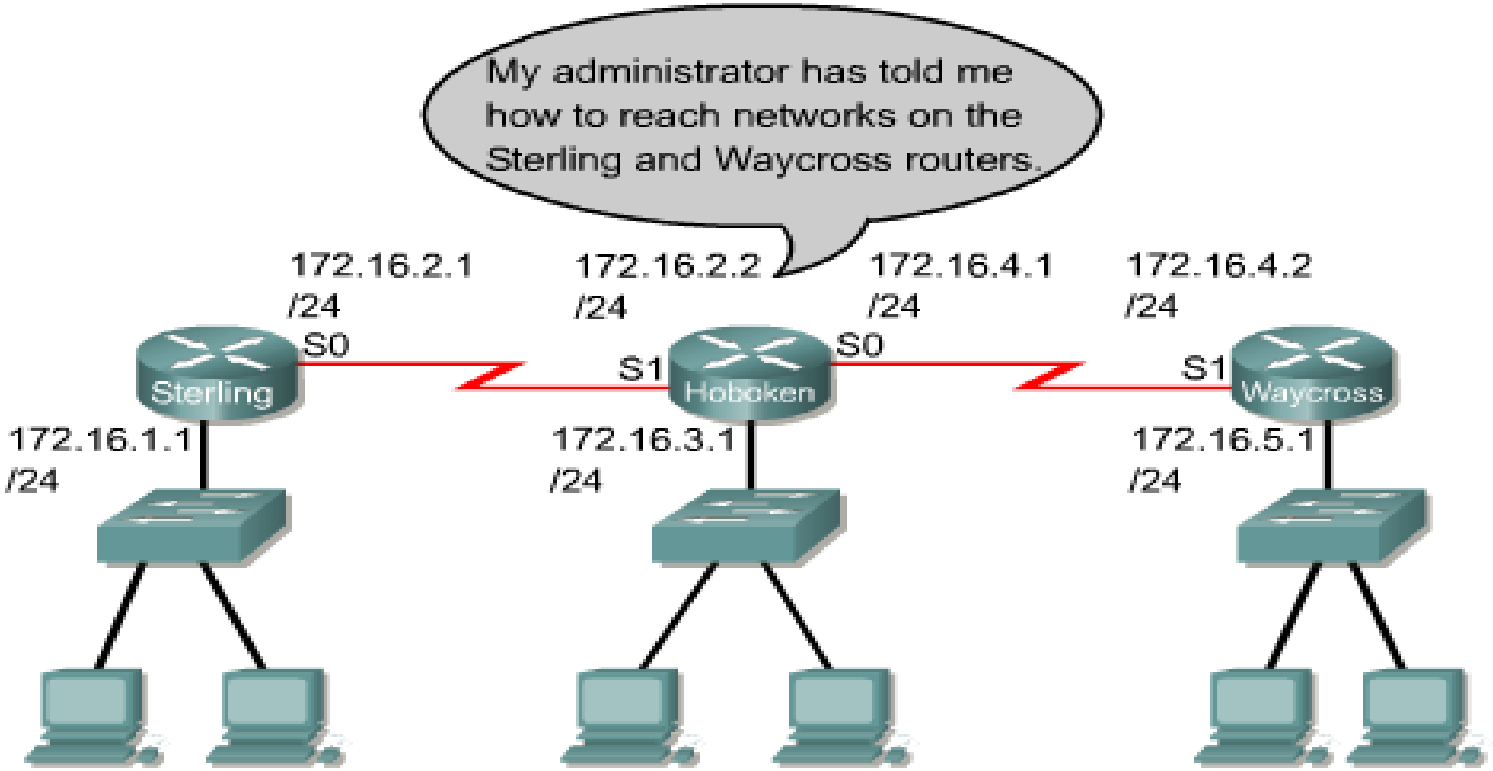
1. Determine all desired destination networks, their subnet masks, and their gateways.
2. Enter global configuration mode.
3. Type the **`ip route`** command with a destination address and subnet mask followed by their corresponding gateway, administrative distance (option) from Step 1.
4. Repeat Step 3 for as many destination networks as were defined in Step 1.
5. Exit global configuration mode.
6. Save the active configuration to NVRAM by using the **`copy running-config startup-config`** command.

Configuring a Static Route with an Exit Interface

```
R1(config)#ip route 192.168.2.0 255.255.255.0 serial 0/0/0
R1(config)#end
R1#show 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

     172.16.0.0/24 is subnetted, 3 subnets
S       172.16.1.0 [1/0] via 172.16.2.2
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
S    192.168.1.0/24 [1/0] via 172.16.2.2
S    192.168.2.0/24 is directly connected, Serial0/0/0
```

Exit interface now specified in the static route. No need for a recursive lookup.

Example - Using Local Interface




```
Hoboken(config)#ip route 172.16.1.0 255.255.255.0 s1
```

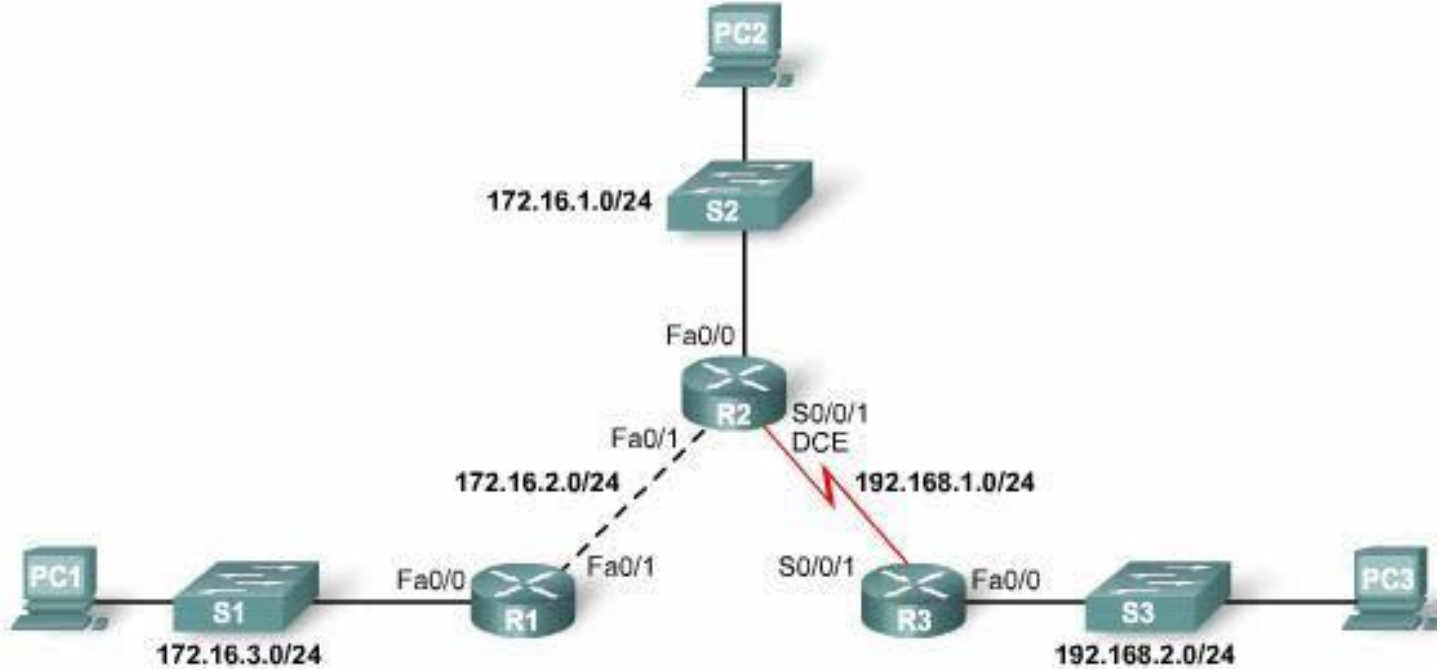
This command points to the Sterling LAN

```
Hoboken(config)#ip route 172.16.5.0 255.255.255.0 s0
```

This command points to the Waycross LAN

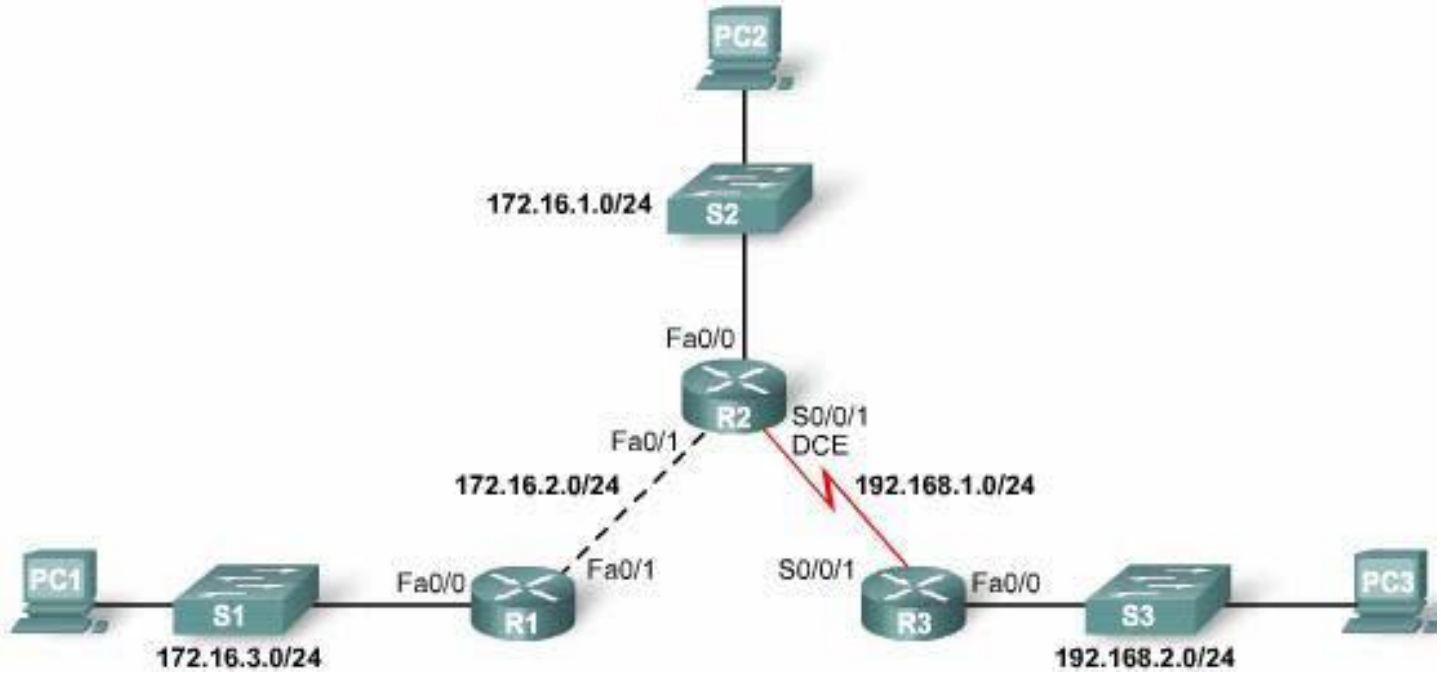
Static Routes with Ethernet Interfaces

Exit interface and next-hop address



- If the packet is sent to the next-hop router then the destination MAC address will be the address of the next hop's Ethernet interface
- This is found by the router consulting the ARP table. If an entry isn't found then an ARP request will be sent out

Static Routes with Ethernet Interfaces



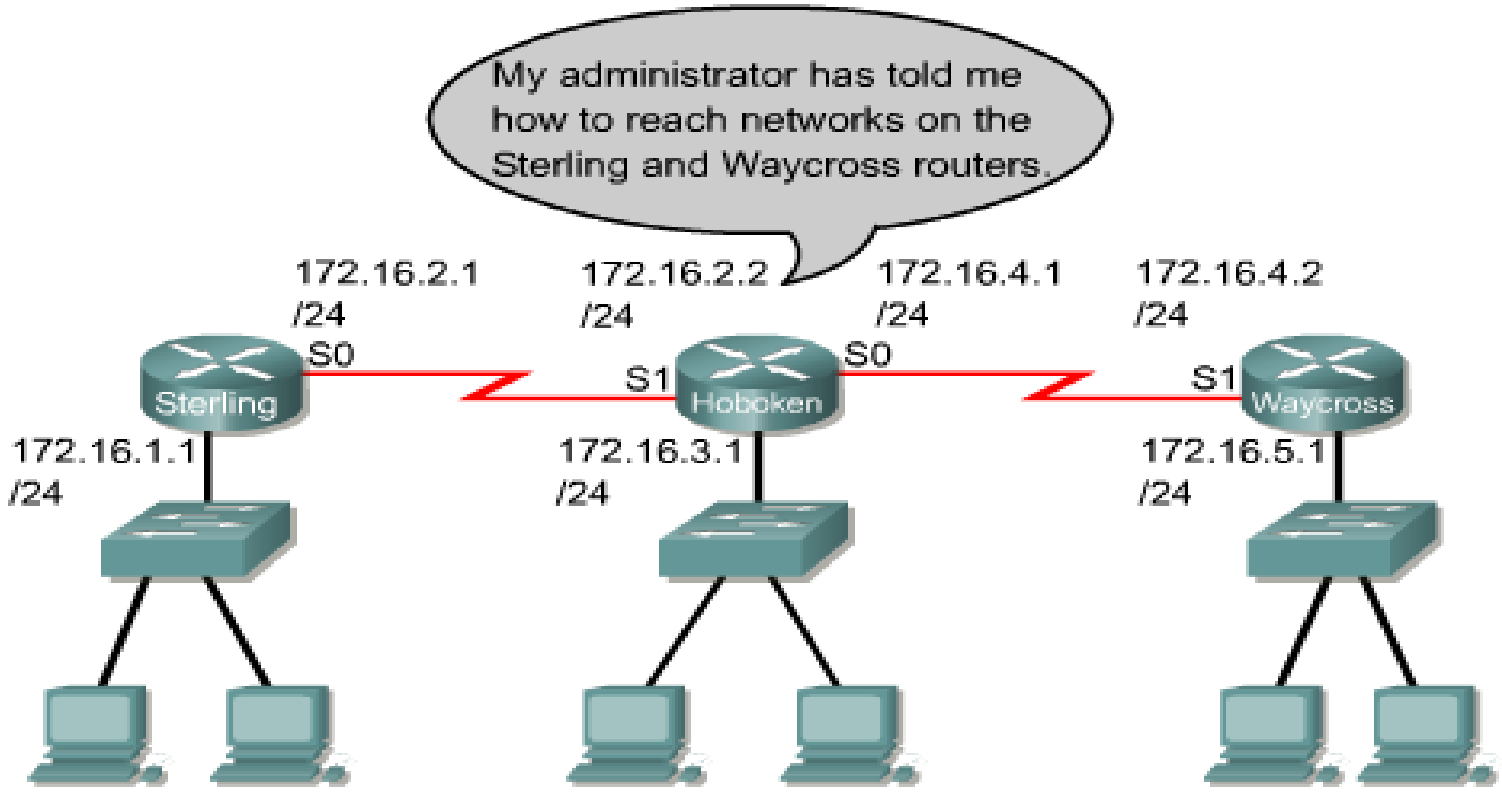

```
R1(config)#ip route 192.168.2.0 255.255.255.0 FastEthernet 0/1
```

- With Ethernet networks, router does not know the next-hop IP address and therefore it cannot determine the destination MAC address for the Ethernet frame
- So a better way is use with the next-hop ip address

Configuring a Static Route with Next-hop Address

```
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
R1(config)#end
R1#show 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

     172.16.0.0/24 is subnetted, 3 subnets
S       172.16.1.0 [1/0] via 172.16.2.2
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
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
```

Example - Using Next Hop




```
Hoboken(config)#ip route 172.16.1.0 255.255.255.0 172.16.2.1
```

This command points to the Sterling LAN

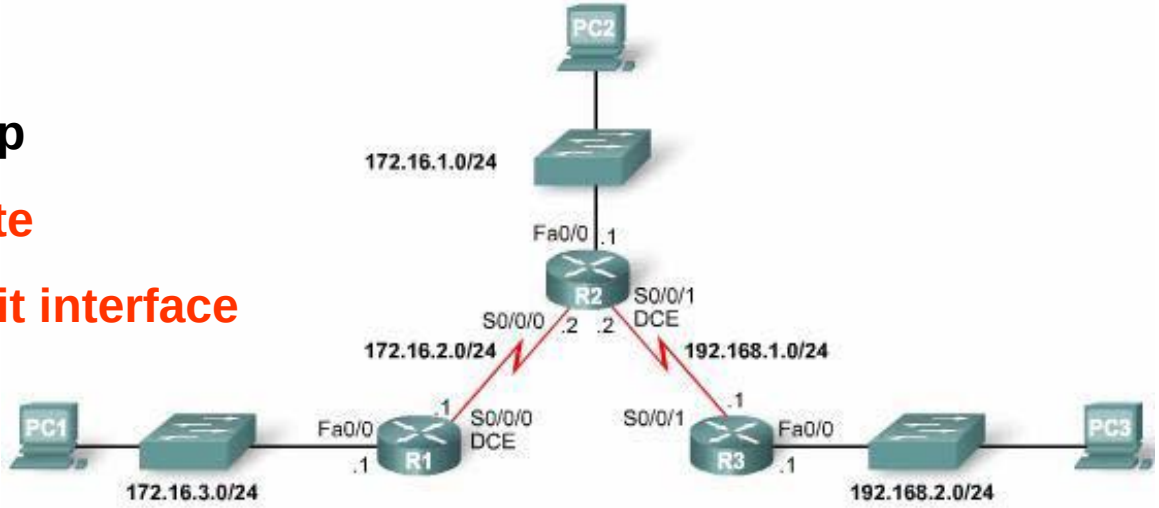
```
Hoboken(config)#ip route 172.16.5.0 255.255.255.0 172.16.4.2
```

This command points to the Waycross LAN

Path Determining Process: Resolving to an Exit Interface

Recursive Route Lookup

- **Step 1:** Find a route
- **Step 2:** Find an exit interface




```
R1#show ip route
<output omitted>
        172.16.0.0/24 is subnetted, 3 subnets
S               172.16.1.0 [1/0] via 172.16.2.2
C               172.16.2.0 is directly connected, Serial 0/0/0
C               172.16.3.0 is directly connected, Fastethernet0/0
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
```

Resolving to an Exit Interface

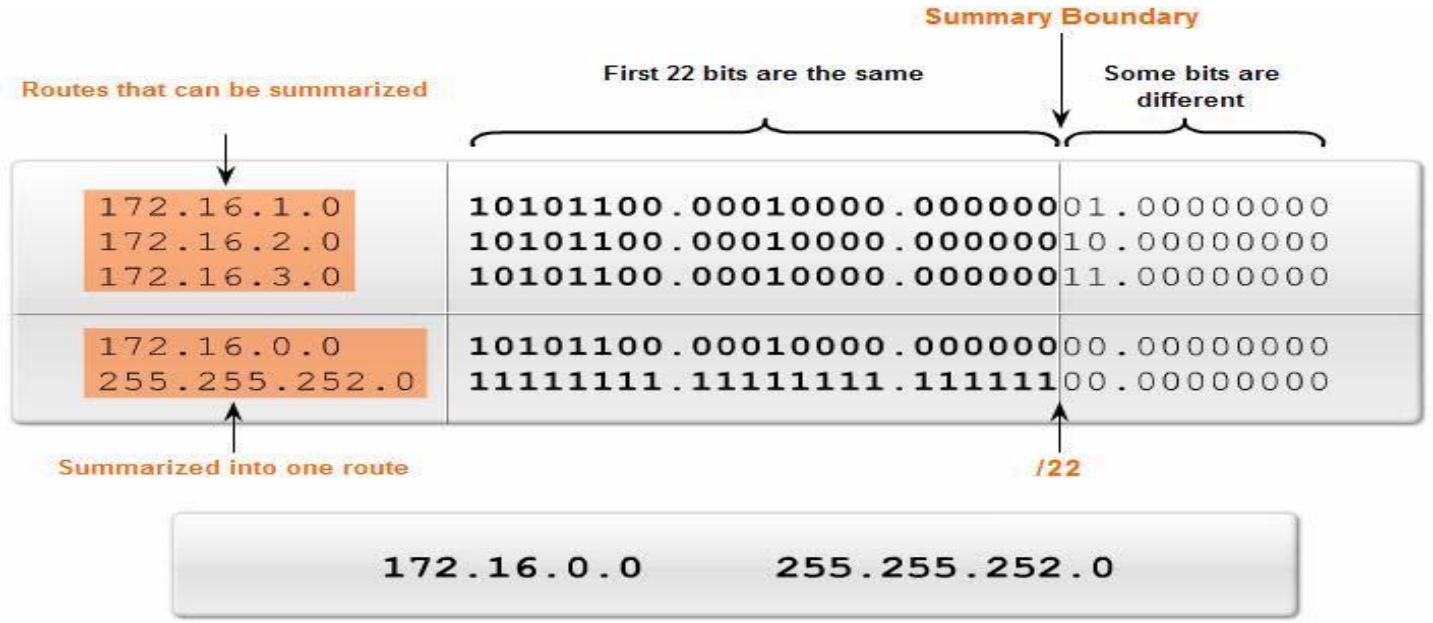
- **Exit Interface is Down**

```
R1(config)#int s0/0/0
R1(config-if)#shutdown
R1(config-if)#end

is_up: 0 state: 6 sub state: 1 line: 0
RT: interface Serial0/0/0 removed from routing table
RT: del 172.16.2.0/24 via 0.0.0.0, connected metric [0/0]
RT: delete subnet route to 172.16.2.0/24
RT: del 192.168.1.0 via 172.16.2.2, static metric [1/0]
RT: delete network route to 192.168.1.0
RT: del 172.16.1.0/24 via 172.16.2.2, static metric [1/0]
RT: delete subnet route to 172.16.1.0/24

R1#show ip route
<output omitted>
Gateway of last resort is not set
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.3.0 is directly connected, FastEthernet0/0
```

Four routes are removed.
Only one route is left in the table.

Summary and Default Static Routes

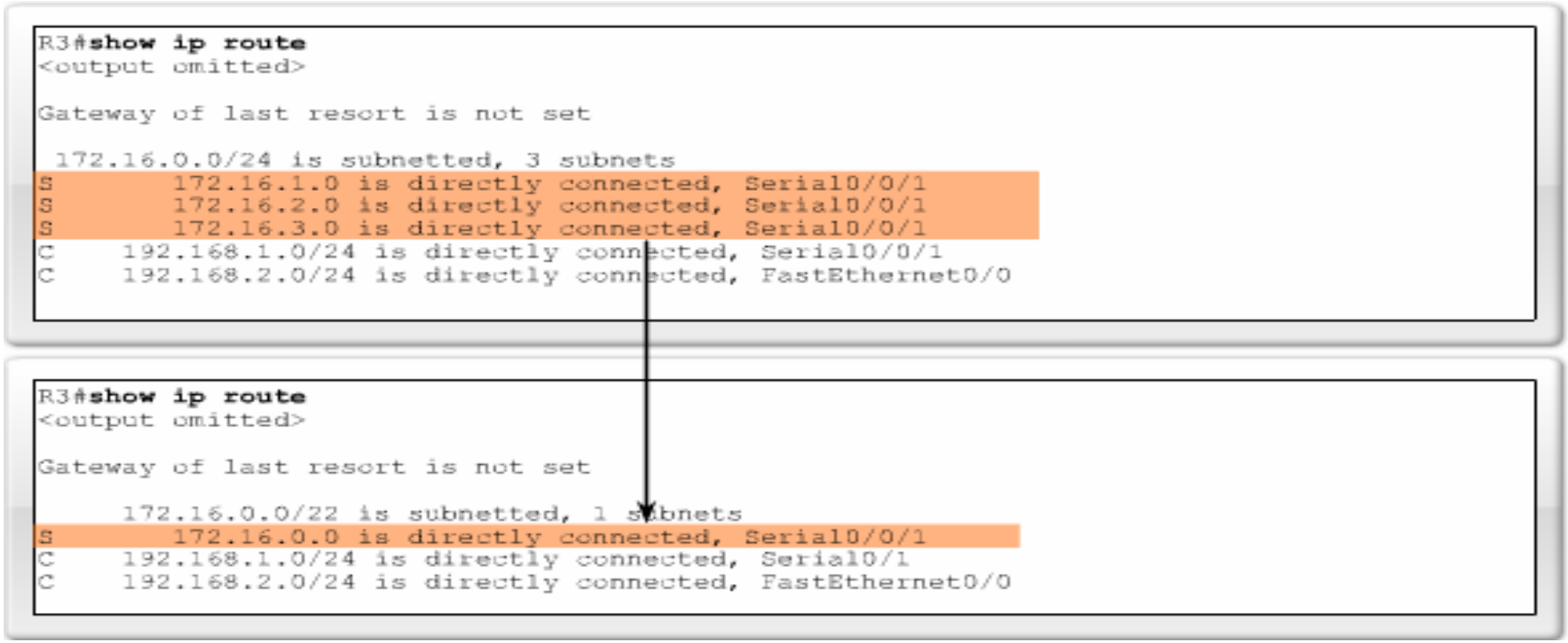
Summary Static Routes



- **Summarizing Routes to reduce the size of the Routing Table**
- **Route Summarization: Multiple static routes can be summarized into a single static route if:**
  - **The destination networks can be summarized into a single network address, and**
  - **The multiple static routes all use the same exit-interface or next-hop IP address**

Summary Static Routes

- **Configuring a summary route:**
  - **Delete the current static route**
  - **Configure the summary static route**
  - **Verify the new static route**

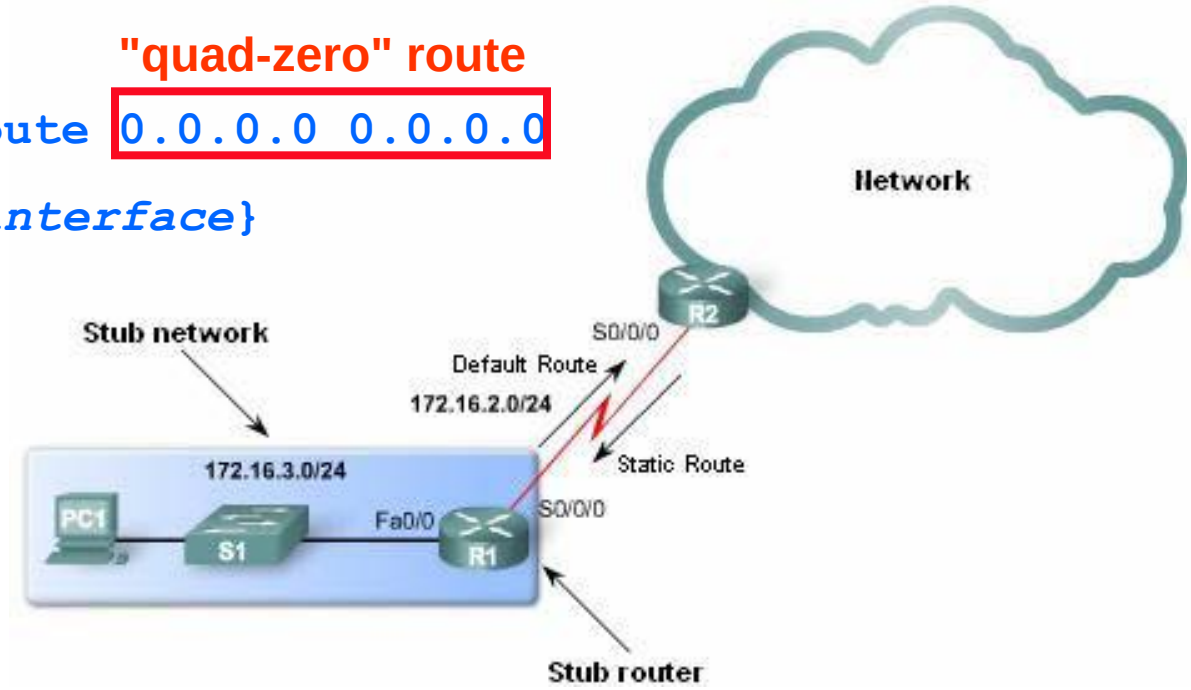


Default Static Route

- **A default static route is a route that will match all packets.**
- **Default static routes are used:**
  - **When no other routes in the routing table match the packet's destination IP address. A common use is when connecting a company's edge router to the ISP network.**
  - **When a router has only one other router to which it is connected. This condition is known as a stub router.**

"quad-zero" route

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



Default Static Route

```
R1#show ip route
<output omitted>

Gateway of last resort is not set

 172.16.0.0/24 is subnetted, 3 subnets
S       172.16.1.0 is directly connected, Serial0/0/0
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
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#
```

Before Summarizing Routes

```
R1#show ip route
<some codes omitted>
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
S*   0.0.0.0/0 is directly connected, Serial0/0/0
R1#
```

After Summarizing Routes

Troubleshooting a Missing Route

- **Tools that can be used to isolate routing problems include:**
  - **ping – tests end to end connectivity**
  - **traceroute – used to discover all of the hops (routers) along the path between 2 points**
  - **show ip route – used to display routing table & ascertain forwarding process**
  - **show ip interface brief - used to show status of router interfaces**
  - **show cdp neighbors detail – used to gather configuration information about directly connected neighbors**