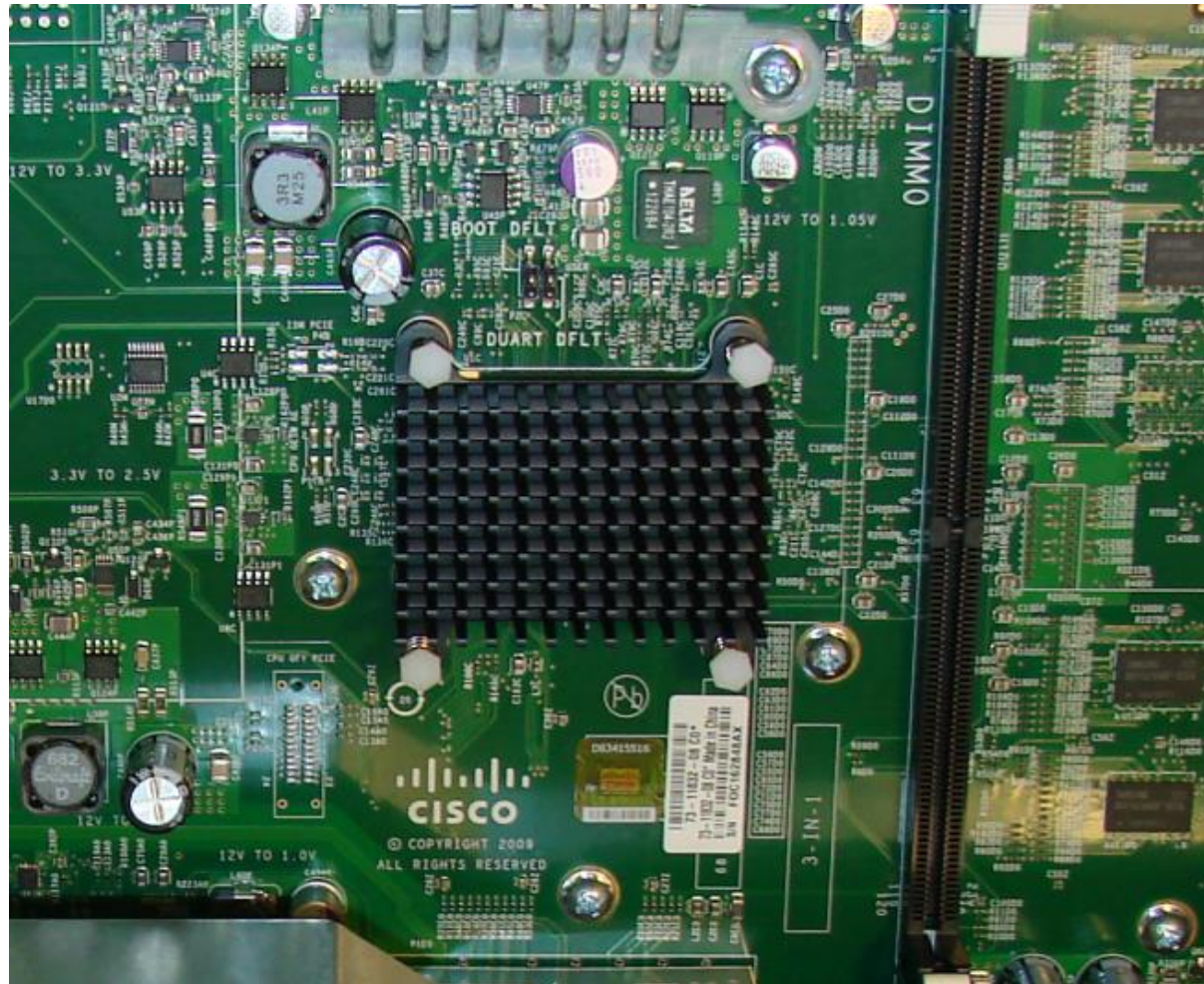# Routers & Router Configurations

A Router is a Computer

Router CPU and OS

Router Memory
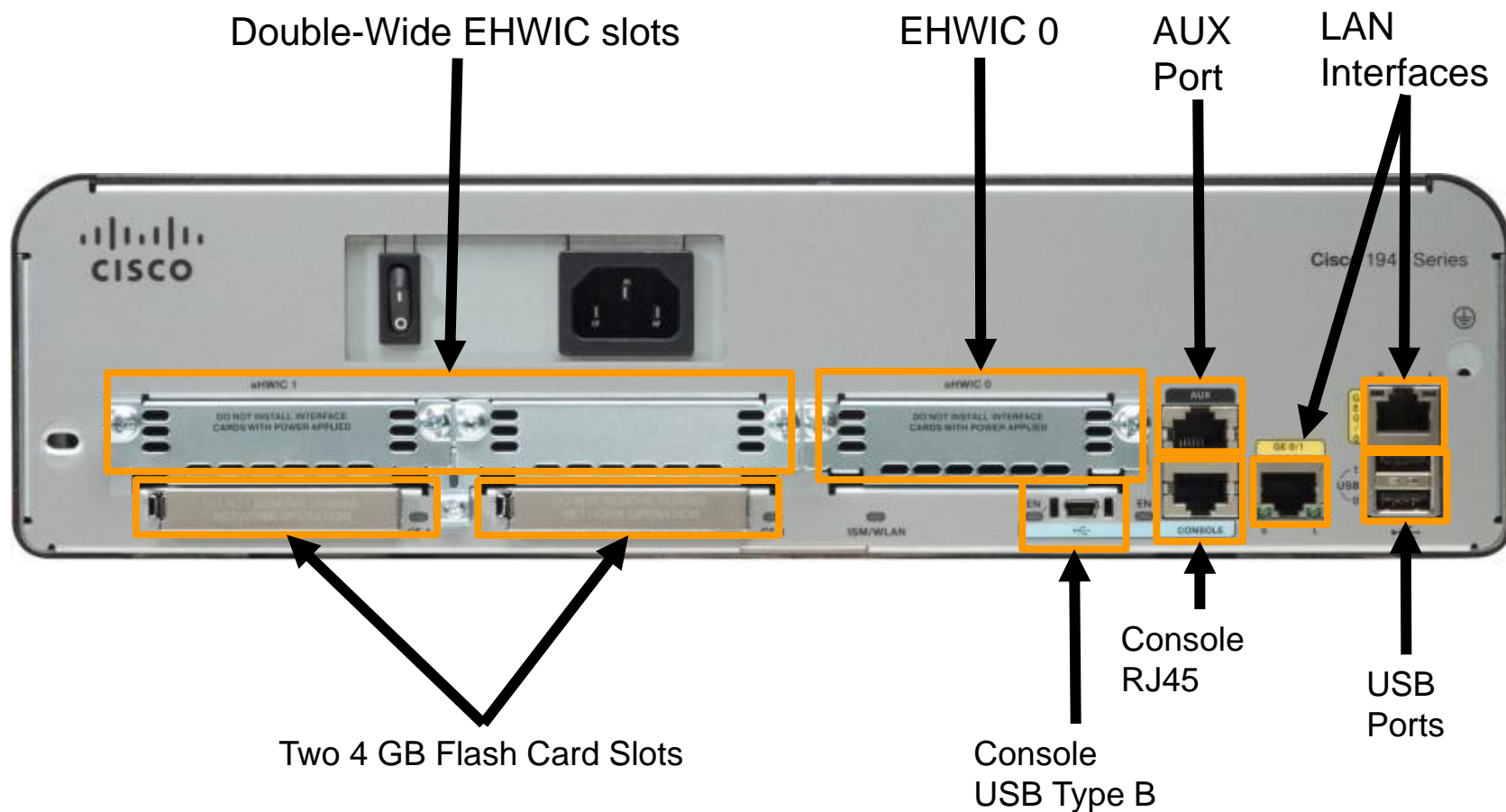
Memory	Volatile / Non-Volatile	Stores
RAM	Volatile	• Running IOS • Running configuration file • IP routing and ARP tables • Packet buffer
ROM	Non-Volatile	• Bootup instructions • Basic diagnostic software • Limited IOS
NVRAM	Non-Volatile	• Startup configuration file
Flash	Non-Volatile	• IOS • Other system files

Inside a Router

1. Power Supply

2. Shield for WIC

3. Fan

4. SDRAM

5. NVRAM
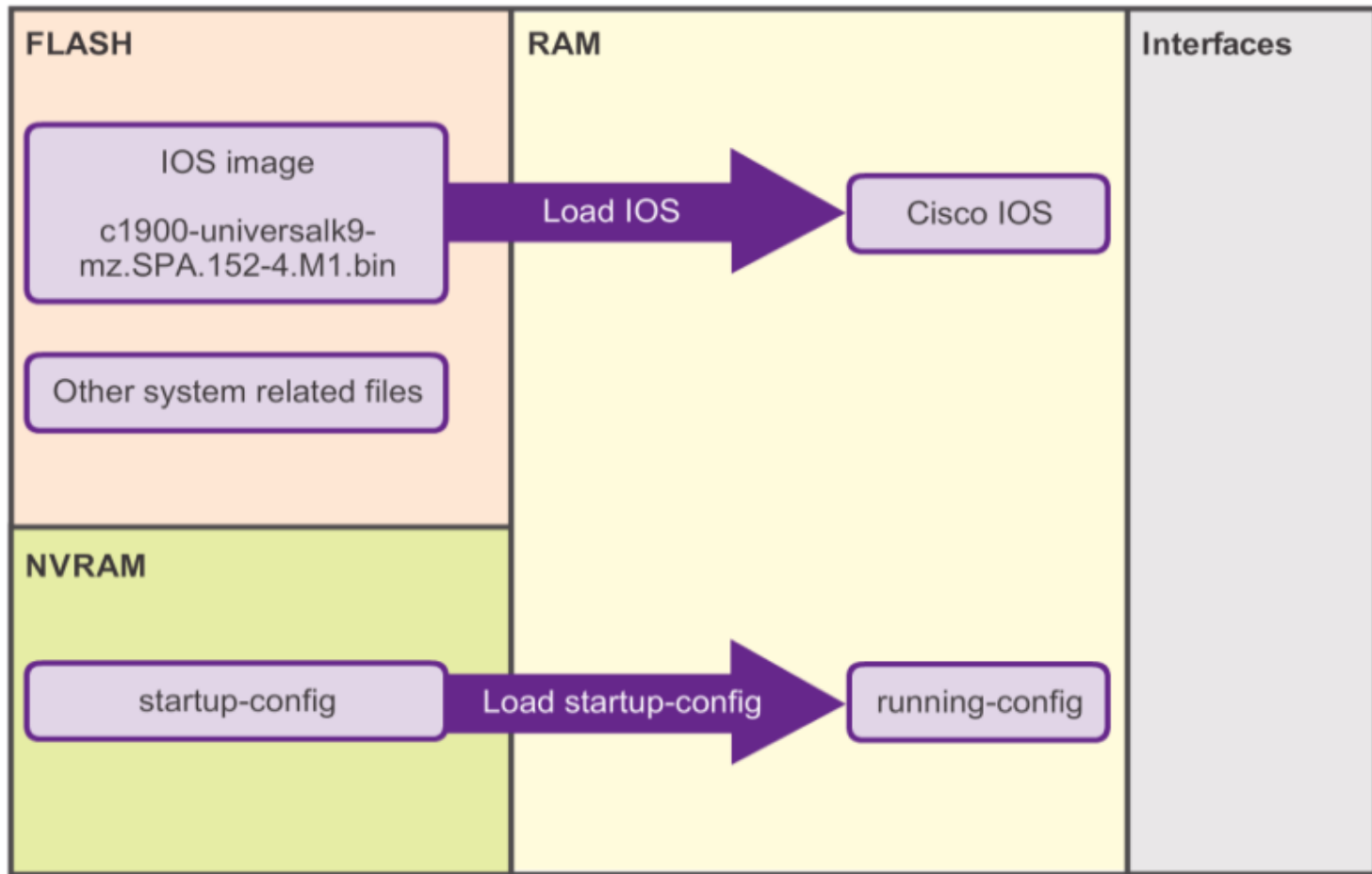
6. CPU

7. Advanced Integration Module (AIM)

Router Backplane

Double-Wide EHWIC slots

EHWIC 0

AUX Port

LAN Interfaces

Two 4 GB Flash Card Slots

Console USB Type B

Console RJ45

USB Ports

Bootset Files

Router Boot-up
Show Versions Output

```
Router# show version
Cisco IOS Software, C1900 Software (C1900-UNIVERSALK9-M), Version 15.2(4)M1, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2012 by Cisco Systems, Inc.
Compiled Thu 26-Jul-12 19:34 by prod_rel_team

ROM: System Bootstrap, Version 15.0(1r)M15, RELEASE SOFTWARE (fc1)

Router uptime is 10 hours, 9 minutes
System returned to ROM by power-on
System image file is "flash0:c1900-universalk9-mz.SPA.152-4.M1.bin"
Last reload type: Normal Reload
Last reload reason: power-on

<Output omitted>

Cisco CISCO1941/K9 (revision 1.0) with 446464K/77824K bytes of memory.
Processor board ID FTX1636848Z
2 Gigabit Ethernet interfaces
2 Serial(sync/async) interfaces
1 terminal line
DRAM configuration is 64 bits wide with parity disabled.
255K bytes of non-volatile configuration memory.
250880K bytes of ATA System CompactFlash 0 (Read/Write)

<Output omitted>

Technology Package License Information for Module:'c1900'

----------------------------------------------------------------
Technology    Technology-package        Technology-package
              Current      Type         Next reboot
----------------------------------------------------------------
ipbase        ipbasek9     Permanent    ipbasek9
security      None         None         None
data          None         None         None
```

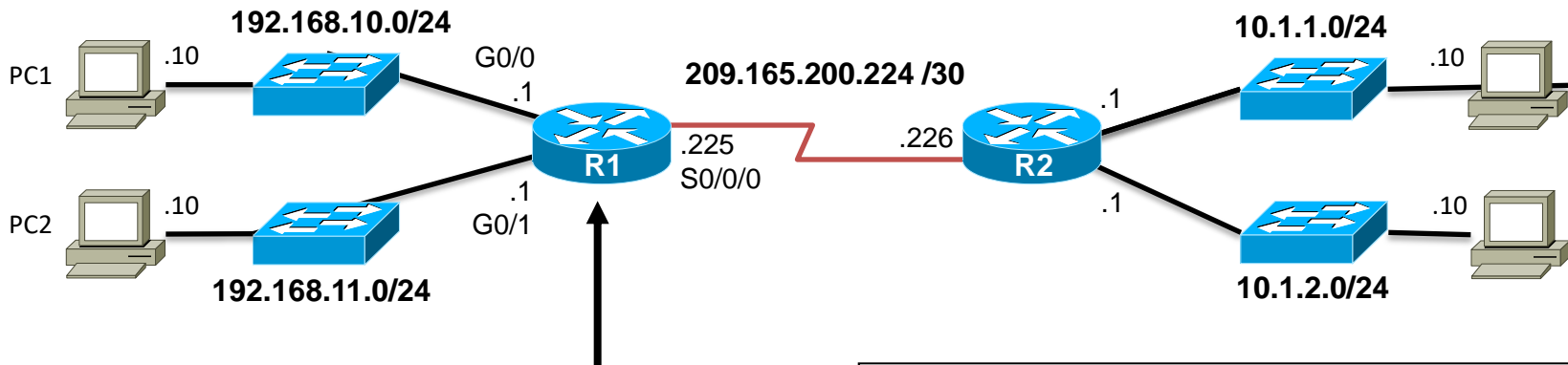Configuration register is 0x2142 (will be 0x2102 at next reload)

Router#

Configuring a Router

Router Configuration Steps

192.168.10.0/24

10.1.1.0/24

PC1 .10   G0/0   **209.165.200.224 /30**   .1   .10

.1   .225   .226   R2

R1   S0/0/0   .1

PC2 .10   .1   G0/1   .10

192.168.11.0/24   **10.1.2.0/24**

```
Router> enable
Router# configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
Router(config)# hostname R1
R1(config)#
```
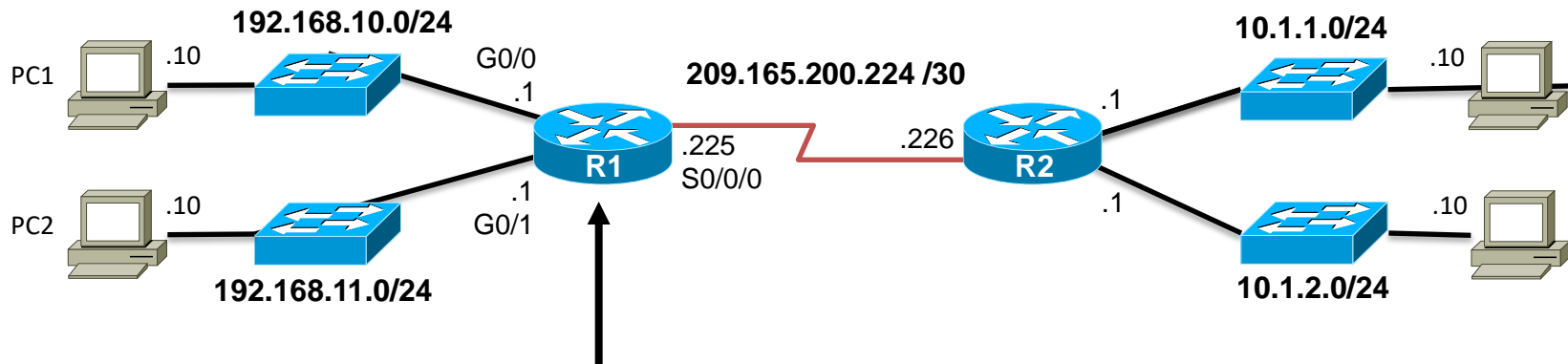
OR

```
Router> en
Router# conf t
Enter configuration commands, one per line.
End with CNTL/Z.
Router(config)# ho R1
R2(config)#
```

```
R1(config)# enable secret class
R1(config)#
R1(config)# line console 0
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)# exit
R1(config)#
R1(config)# line vty 0 4
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)# exit
R1(config)#
R1(config)# service password-encryption
R1(config)#
```

```
R1(config)# banner motd #
Enter TEXT message.  End with the character '#'.
    *************************************************
      WARNING: Unauthorized access is prohibited!
    *************************************************
#

R1(config)#
```

```
R1# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
R1#
```

Configure LAN Interfaces

192.168.10.0/24

PC1 .10

G0/0
.1

209.165.200.224 /30

10.1.1.0/24
.1
.10

.225
S0/0/0

.226

R1

R2
.1

PC2 .10

.1
G0/1

192.168.11.0/24

10.1.2.0/24
.10

```
R1# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#
R1(config)# interface gigabitethernet 0/0
R1(config-if)# ip address 192.168.10.1 255.255.255.0
R1(config-if)# description Link to LAN-10
R1(config-if)# no shutdown
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0,
changed state to up
R1(config-if)# exit
R1(config)#
R1(config)# int g0/1
R1(config-if)# ip add 192.168.11.1 255.255.255.0
R1(config-if)# des Link to LAN-11
R1(config-if)# no shut
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1,
changed state to up
R1(config-if)# exit
R1(config)#
```

Verify Interface Configuration
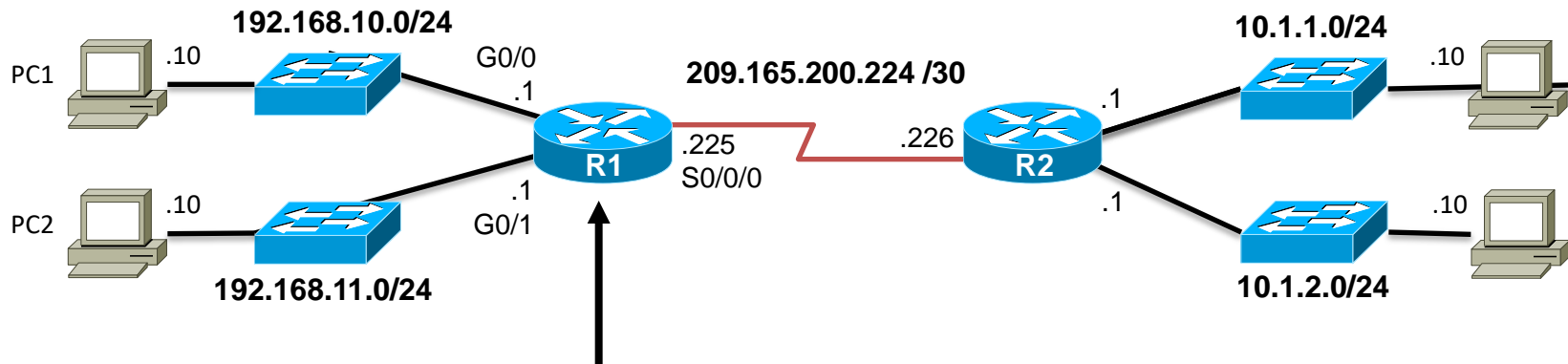

```
R1# show ip interface brief
Interface              IP-Address       OK? Method Status                Protocol

GigabitEthernet0/0     192.168.10.1     YES manual up                    up
GigabitEthernet0/1     192.168.11.1     YES manual up                    up
Serial0/0/0            209.165.200.225  YES manual up                    up
Serial0/0/1            unassigned       YES NVRAM  administratively down down
Vlan1                  unassigned       YES NVRAM  administratively down down
R1#
R1# ping 209.165.200.226

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.200.226, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/9 ms

R1#
```
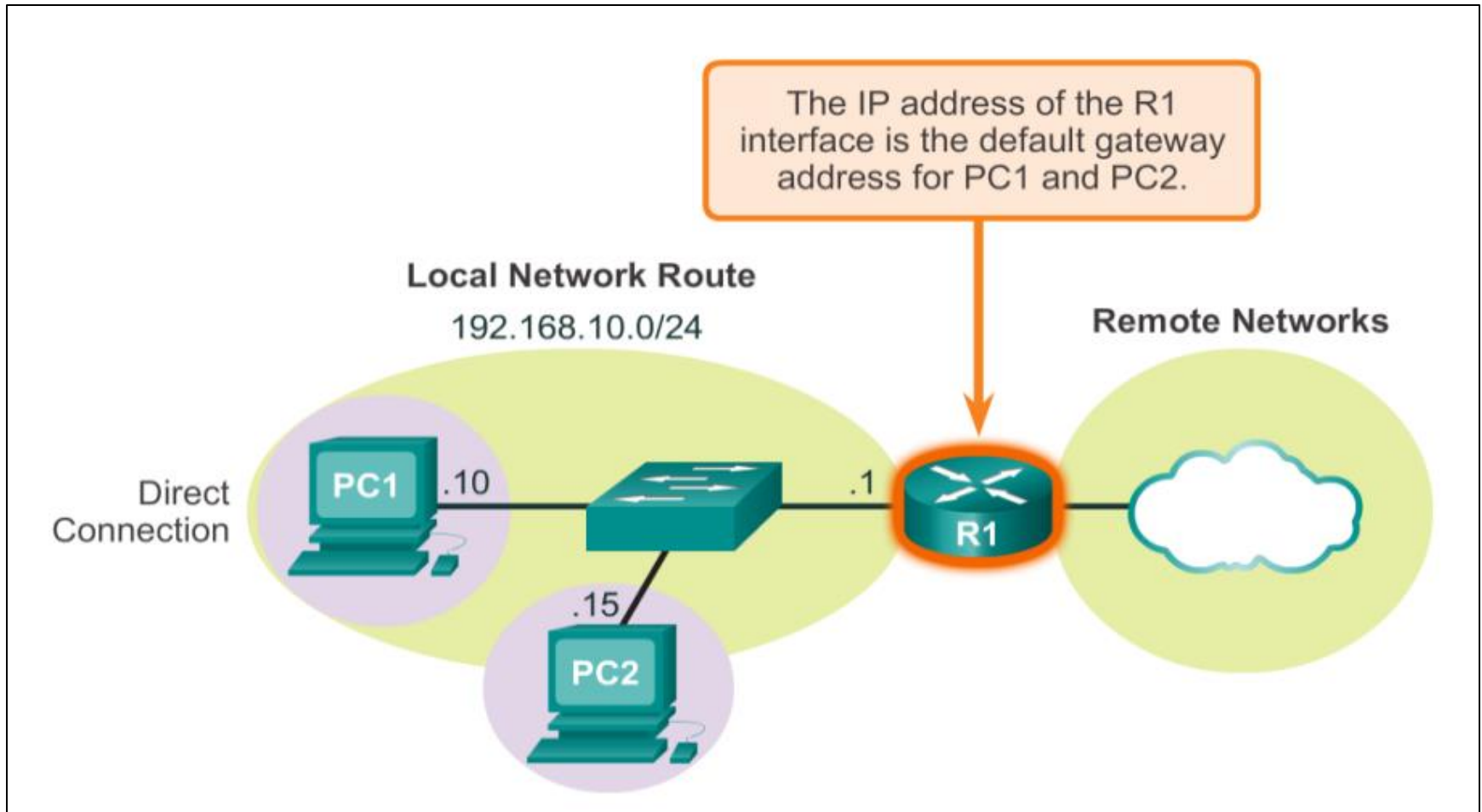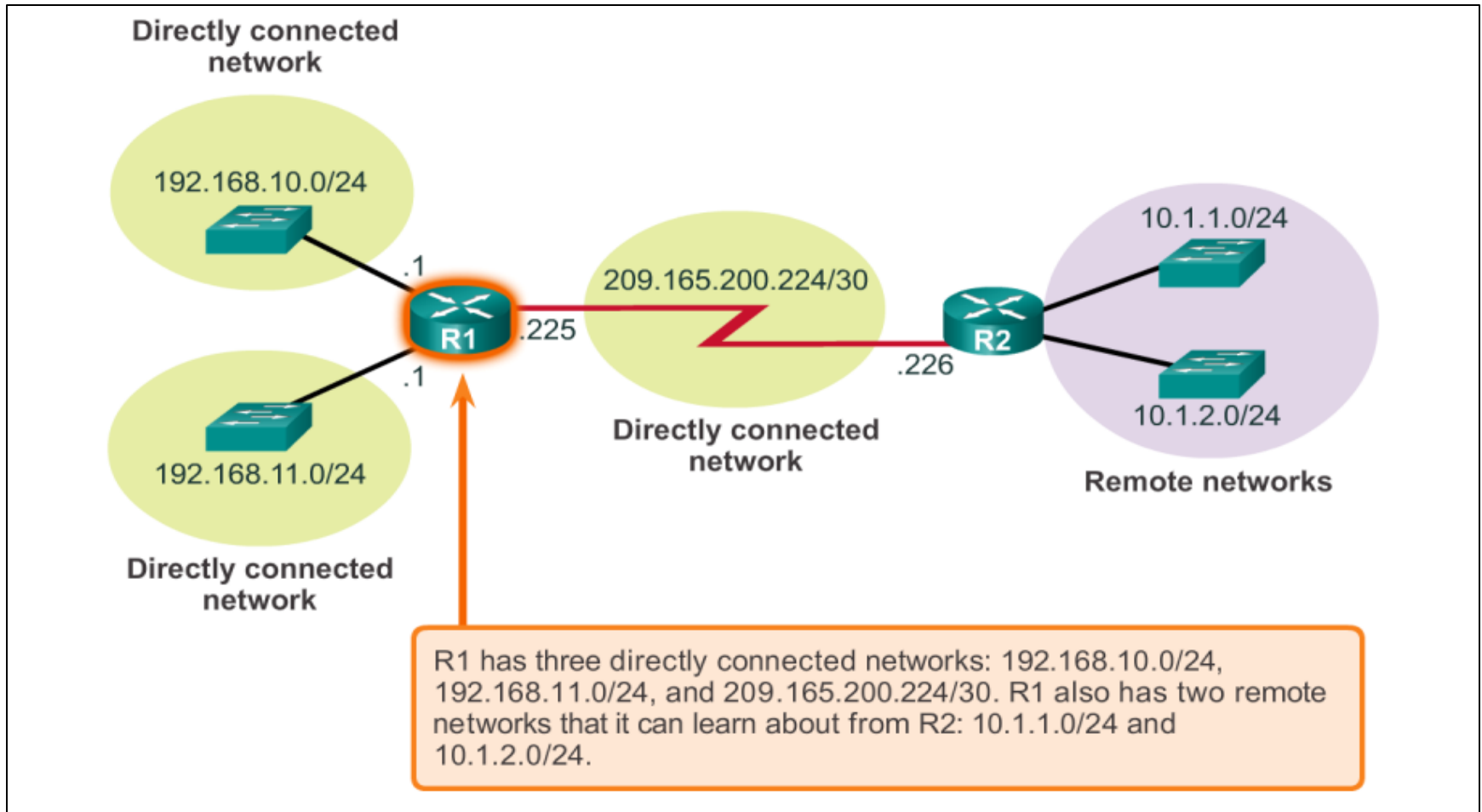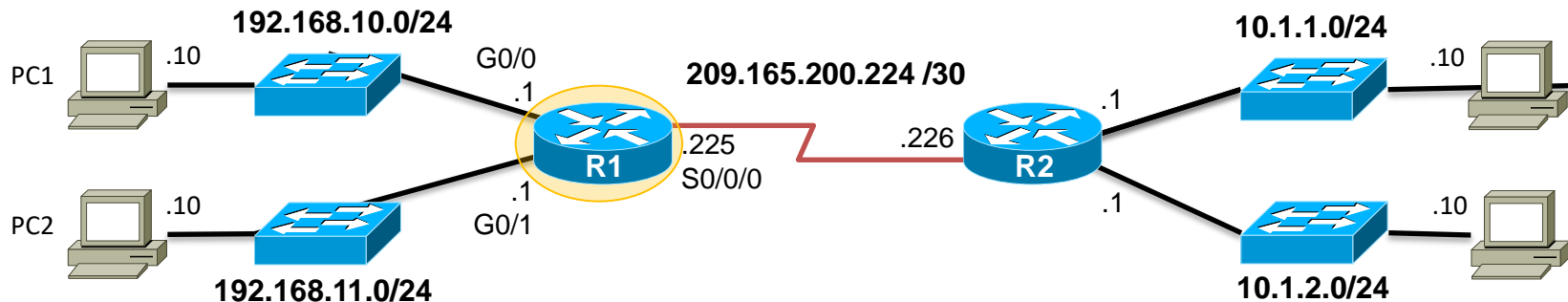
Host Packet Forwarding Decision

Router Packet Forwarding Decision

Directly connected network

192.168.10.0/24

.1

R1

.225

209.165.200.224/30

Directly connected network

.226

R2

10.1.1.0/24

10.1.2.0/24

Remote networks

.1

192.168.11.0/24

Directly connected network

R1 has three directly connected networks: 192.168.10.0/24, 192.168.11.0/24, and 209.165.200.224/30. R1 also has two remote networks that it can learn about from R2: 10.1.1.0/24 and 10.1.2.0/24.

IPv4 Router Routing Table

192.168.10.0/24

PC1 .10

G0/0

209.165.200.224 /30

10.1.1.0/24

.10

.1

R1

.225
S0/0/0

.226

.1

R2

PC2 .10

.1
G0/1

.1

192.168.11.0/24

10.1.2.0/24

.10

```
R1#show ip route
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, 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

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D       10.1.1.0/24 [90/2170112] via 209.165.200.226, 00:00:05, Serial0/0/0
D       10.1.2.0/24 [90/2170112] via 209.165.200.226, 00:00:05, Serial0/0/0
     192.168.10.0/24 is variably subnetted, 2 subnets, 3 masks
C       192.168.10.0/24 is directly connected, GigabitEthernet0/0
L       192.168.10.1/32 is directly connected, GigabitEthernet0/0
     192.168.11.0/24 is variably subnetted, 2 subnets, 3 masks
C       192.168.11.0/24 is directly connected, GigabitEthernet0/1
L       192.168.11.1/32 is directly connected, GigabitEthernet0/1
     209.165.200.0/24 is variably subnetted, 2 subnets, 3 masks
C       209.165.200.224/30 is directly connected, Serial0/0/0
L       209.165.200.225/32 is directly connected, Serial0/0/0
R1#
```
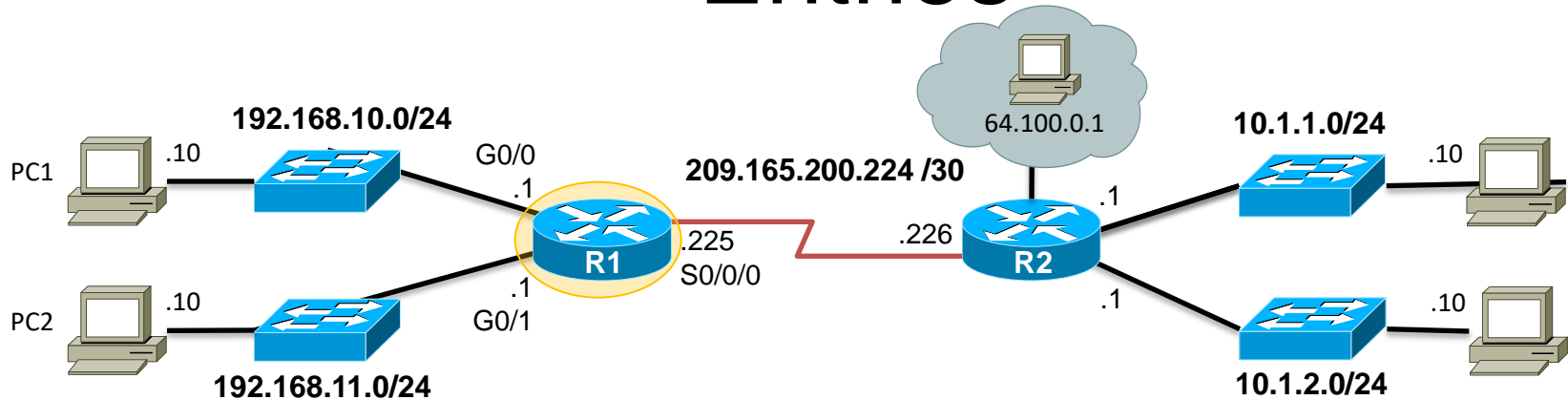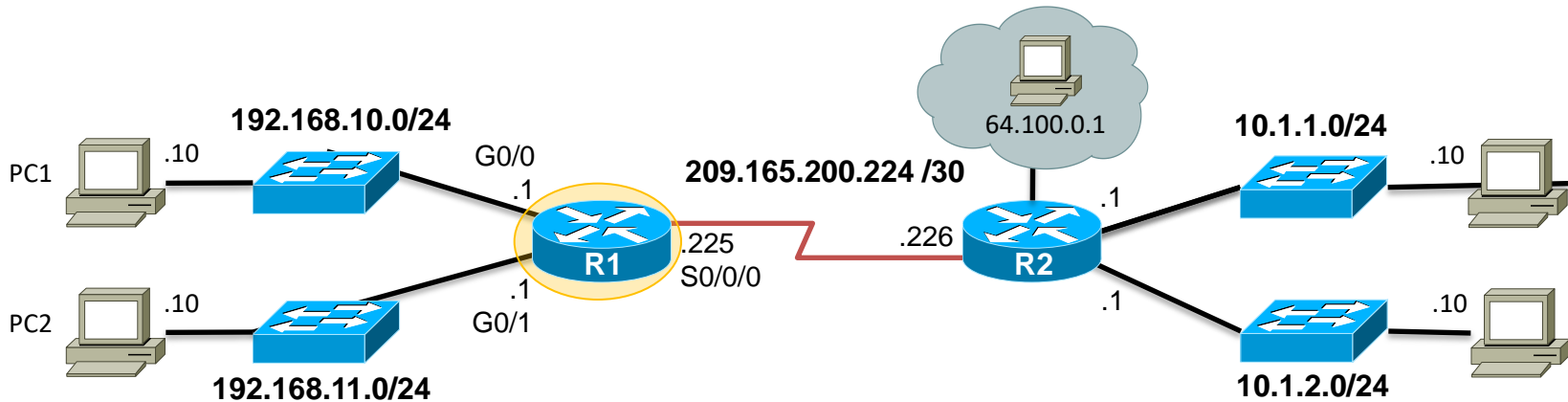
Directly Connected Routing Table Entries

A	B	C
C	**192.168.10.0/24 is directly connected,**	**GigabitEthernet0/0**
L	**192.168.10.1/32 is directly connected,**	**GigabitEthernet0/0**

A	Identifies how the network was learned by the router.
B	Identifies the destination network and how it is connected.
C	Identifies the interface on the router connected to the destination network.

Routing Table Entries

192.168.10.0/24			209.165.200.224 /30		64.100.0.1	10.1.1.0/24
PC1 .10	G0/0 .1	R1 .225 S0/0/0	.226	.1 R2	.1	.10
PC2 .10	.1 G0/1	192.168.11.0/24			.1	10.1.2.0/24 .10

| D | 10.1.1.0/24 | [90/2170112] | via | 209.165.200.226, | 00:00:05, | Serial0/0/0 |

A	Identifies how the network was learned by the router.
B	Identifies the destination network.
C	Identifies the administrative distance (trustworthiness) of the route source.
D	Identifies the metric to reach the remote network.
E	Identifies the next hop IP address to reach the remote network.
F	Identifies the amount of elapsed time since the network was discovered.
G	Identifies the outgoing interface on the router to reach the destination network.

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.

Use of Static Routes

- Providing ease of routing table maintenance in smaller networks that are not expected to grow significantly.

- 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 : Default routes are used to send traffic to any destination beyond the next upstream router.

Standard Static Route

Connecting to a Stub Network
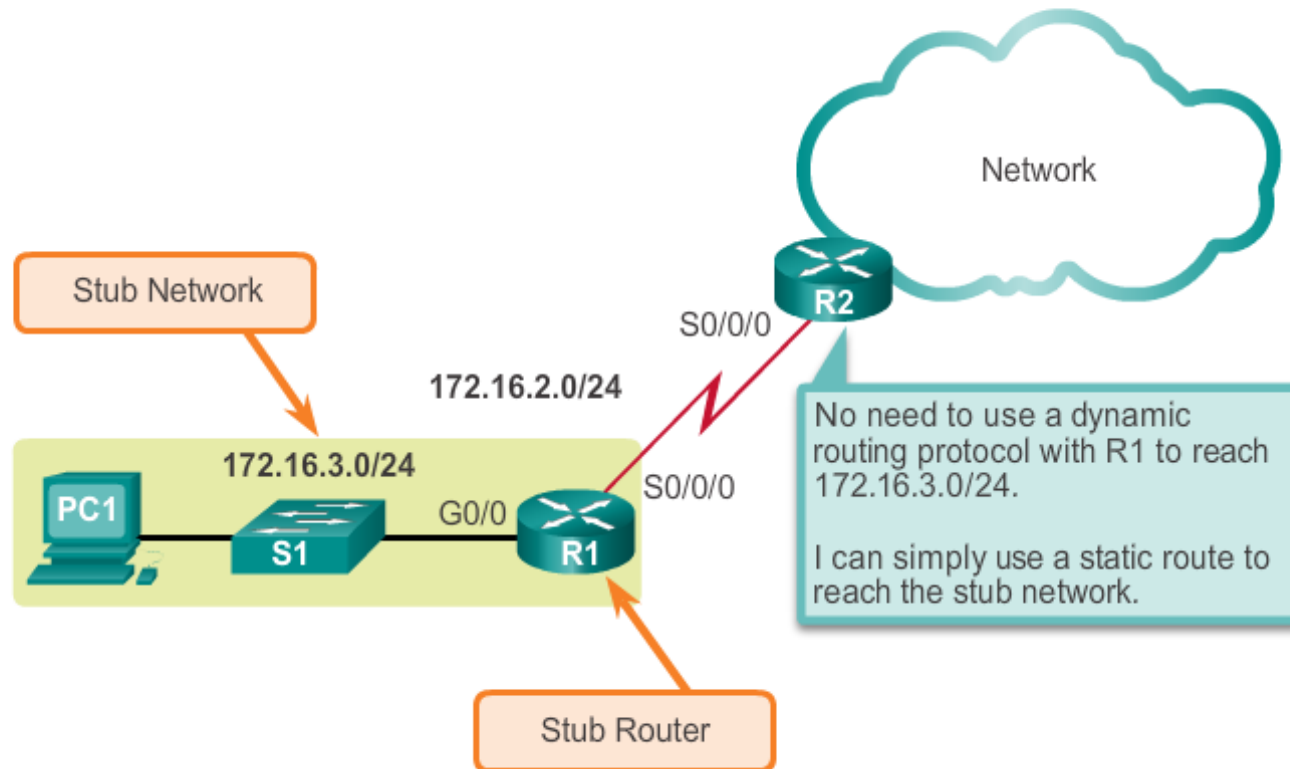
Static Route Applications

Static Routes are often used to:

- Connect to a specific network.

- Provide a Gateway 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.

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.

ip route Command to configure

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.

Configure Static Route

Configure Directly Attached Static Routes on R1
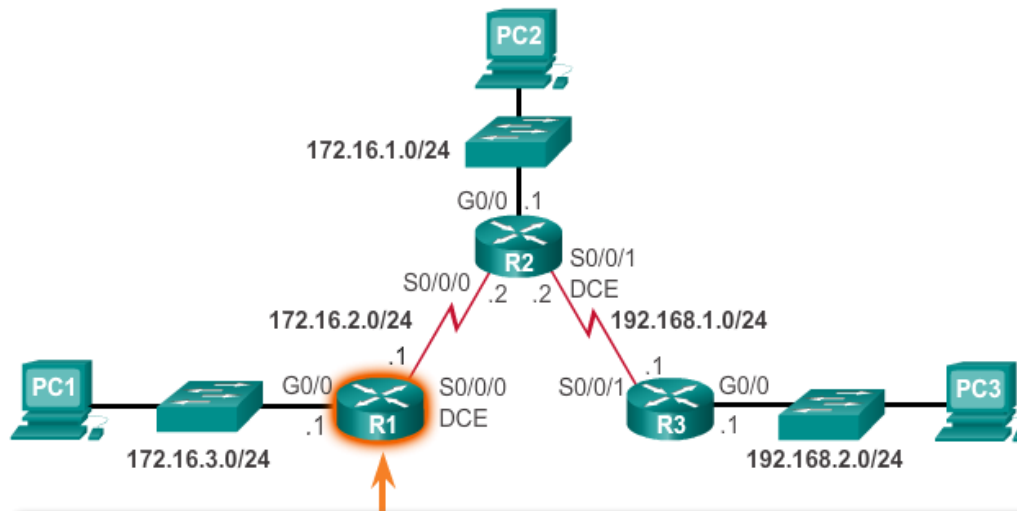
```
R1(config)#ip route 172.16.1.0 255.255.255.0 s0/0/0
R1(config)#ip route 192.168.1.0 255.255.255.0 s0/0/0
R1(config)#ip route 192.168.2.0 255.255.255.0 s0/0/0
R1(config)#
```

```
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#
```

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

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

Configuring a Default Static Route
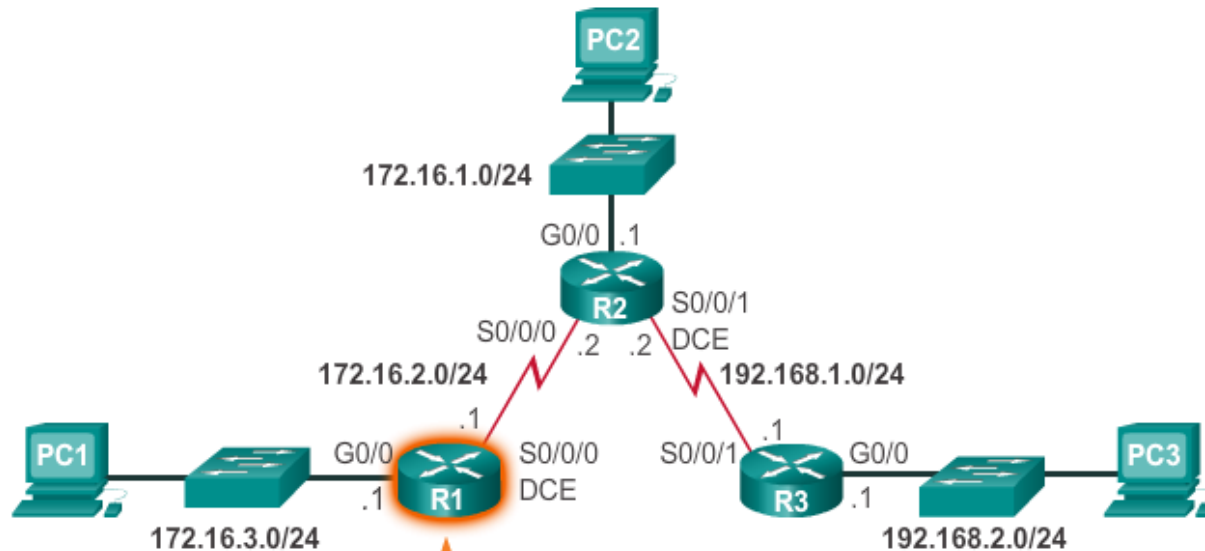
```
R1(config)# ip route 0.0.0.0 0.0.0.0 172.16.2.2
R1(config)#
```

RIP configuration
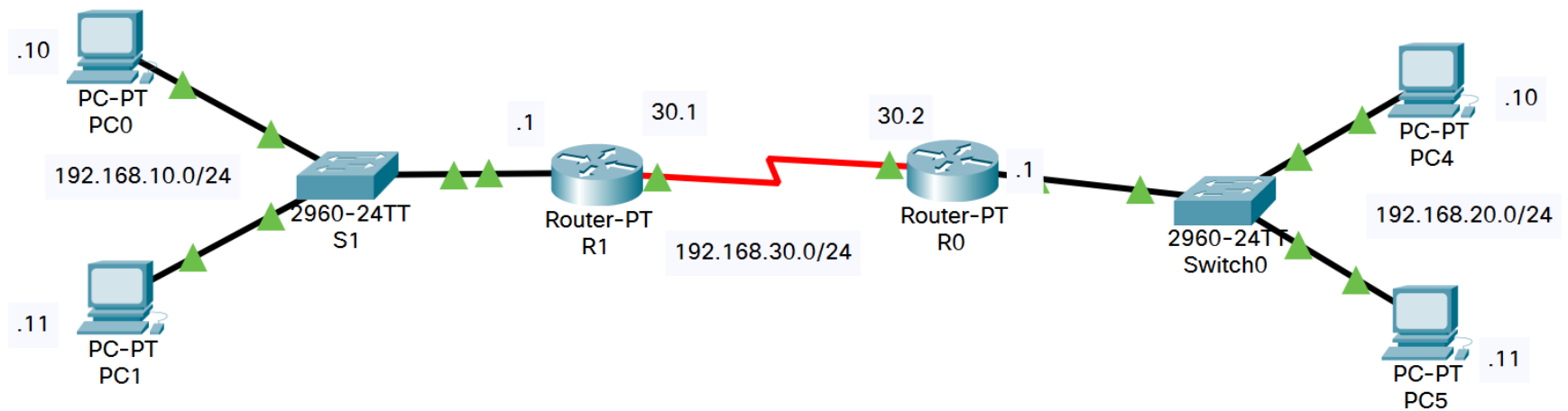
RIP configuration

R1:
- router rip
- network 192.168.10.0
- network 192.168.30.0

R0
router rip
network 192.168.20.0
network 192.168.30.0

Routing Table

```
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

C    192.168.10.0/24 is directly connected, FastEthernet0/0
R    192.168.20.0/24 [120/1] via 192.168.30.2, 00:00:23, Serial2/0
C    192.168.30.0/24 is directly connected, Serial2/0
```