Contents

Chapter 1: Routing Concepts

CCNA Routing and Switching

Routing and Switching Essentials v6.0

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Chapter 1 - Sections & Objectives

1.1 Router Initial Configuration

- Describe the primary functions and features of a router.
- Configure basic settings on a router to route between two directly-connected networks, using CLI.
- Verify connectivity between two networks that are directly connected to a router.

1.2 Routing Decisions

- Explain the encapsulation and de-encapsulation process used by routers when switching packets between interfaces.
- Explain the path determination function of a router.

1.3 Router Operation

- Explain routing table entries for directly connected networks.
- Explain how a router builds a routing table of directly connected networks.
- Explain how a router builds a routing table using static routes.
- Explain how a router builds a routing table using a dynamic routing protocol.

1.4 Summary

1.1 Router Initial Configuration

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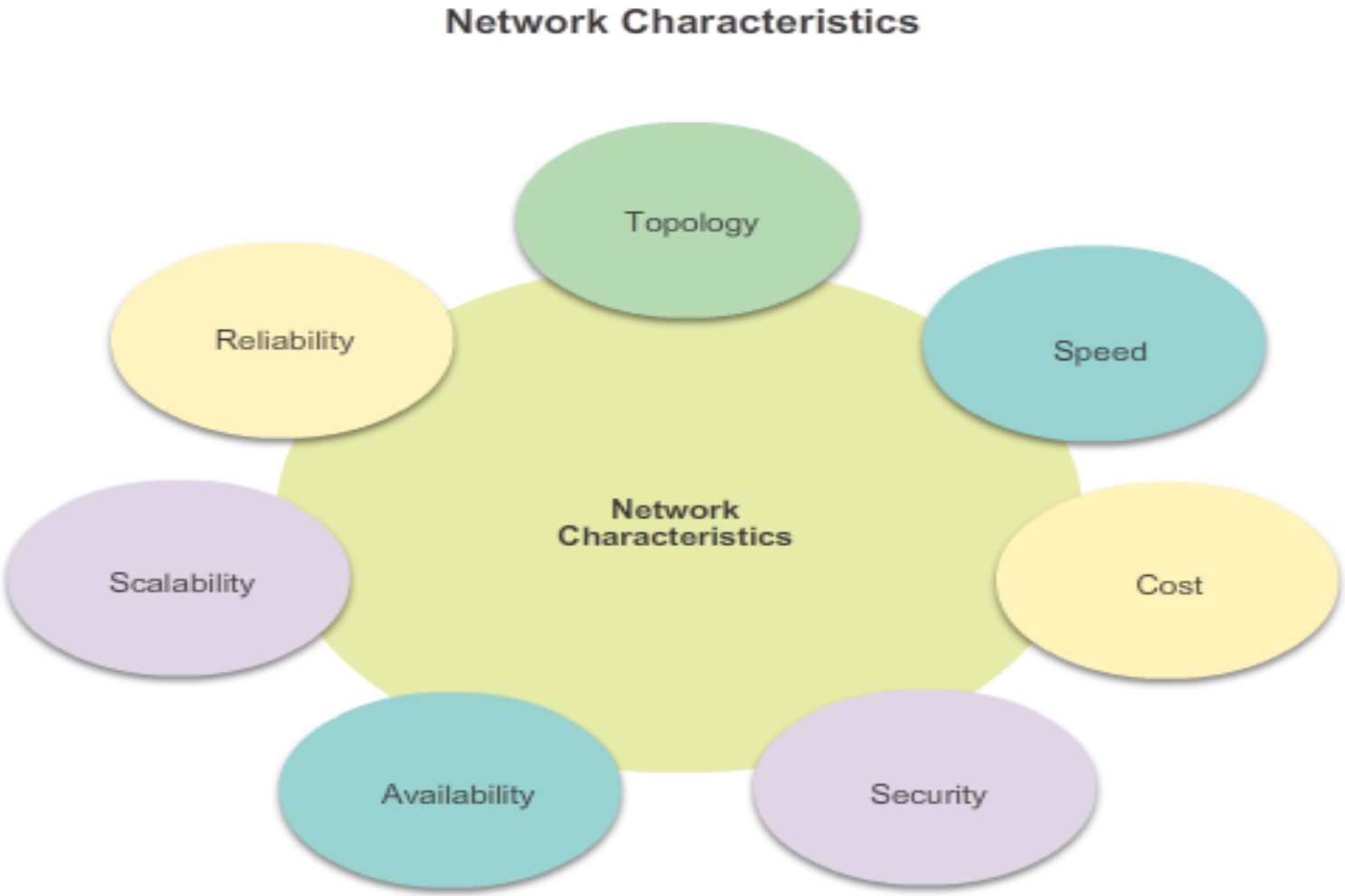
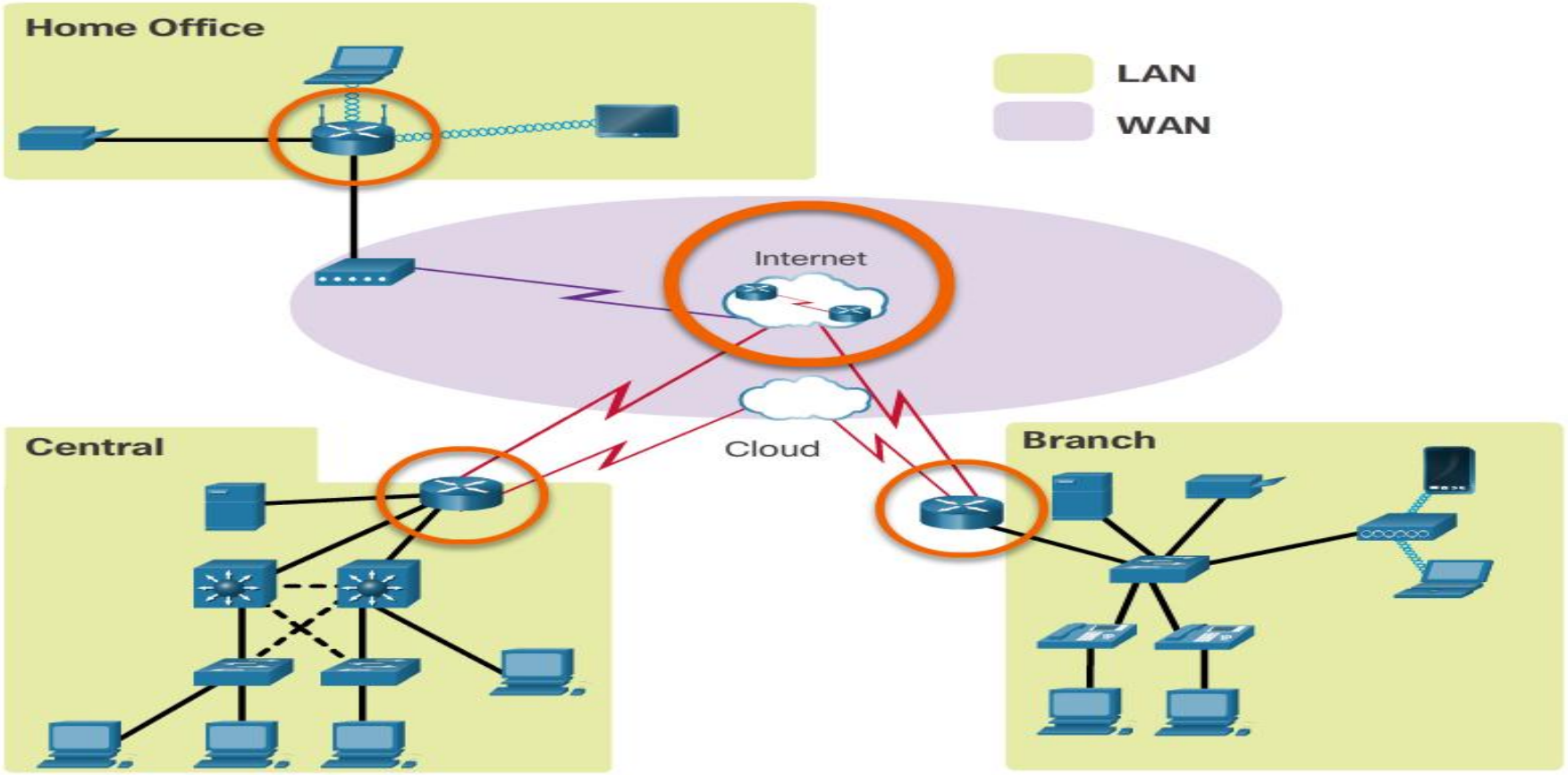
Characteristics of a Network



Why Routing?

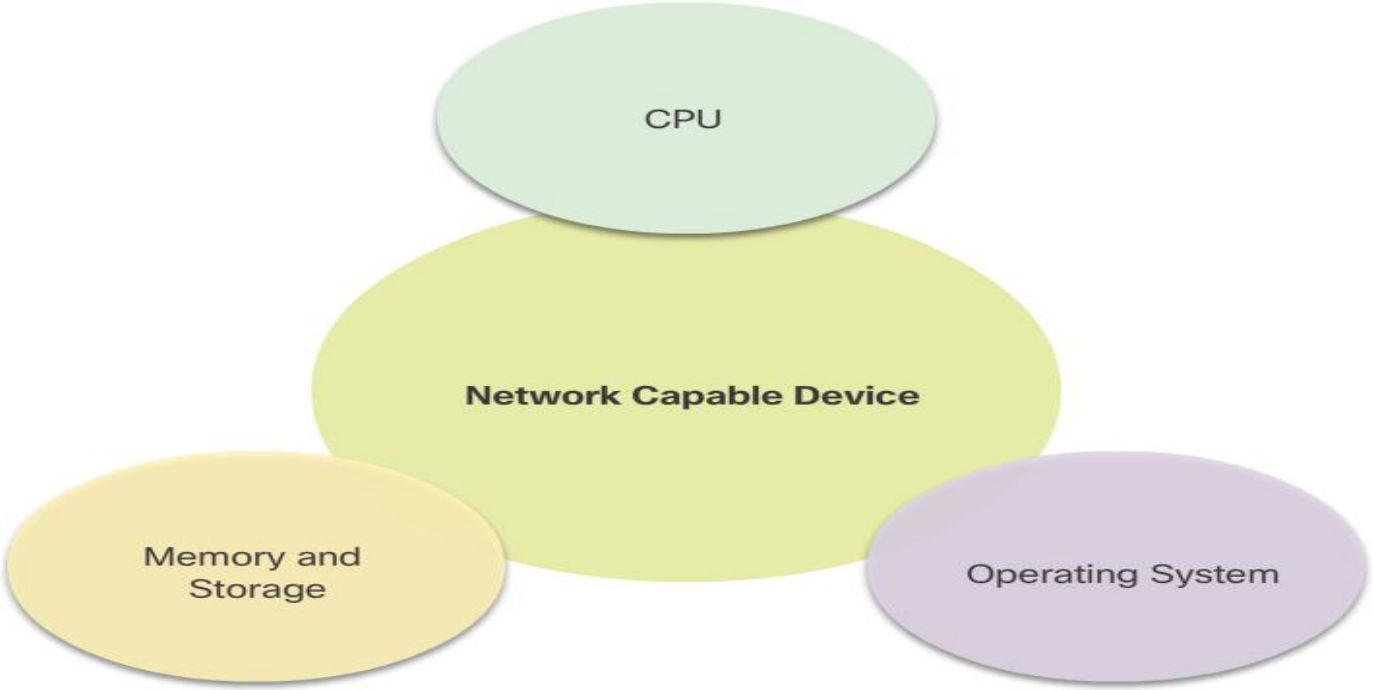
The router is responsible for the routing of traffic between networks.



Routers are Computers

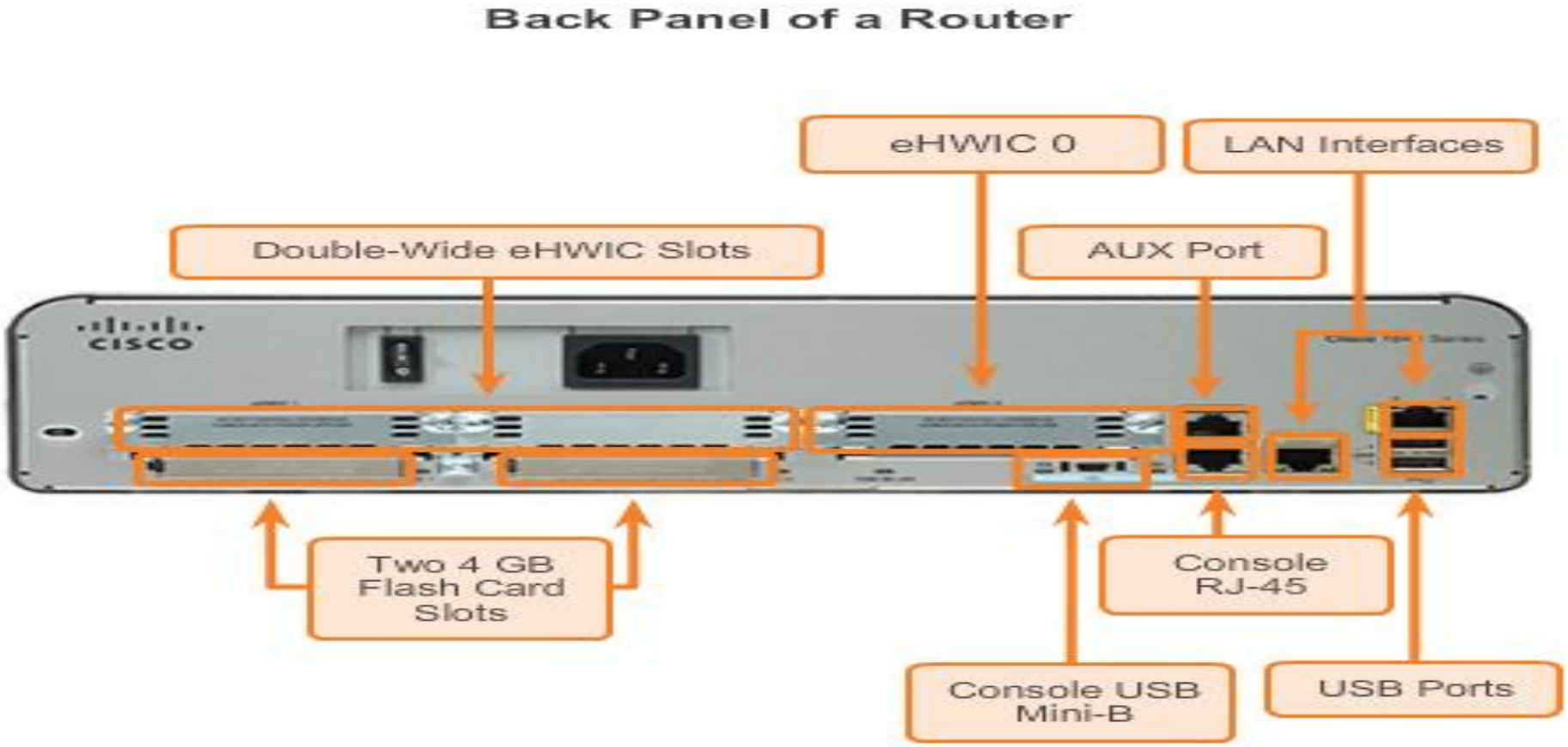
Routers are specialized computers containing the following required components to operate:

- Central processing unit (CPU)
- Operating system (OS) - Routers use Cisco IOS
- Memory and storage (RAM, ROM, NVRAM, Flash, hard drive)



Routers are Computers (cont.)

Routers use specialized ports and network interface cards to interconnect to other networks.

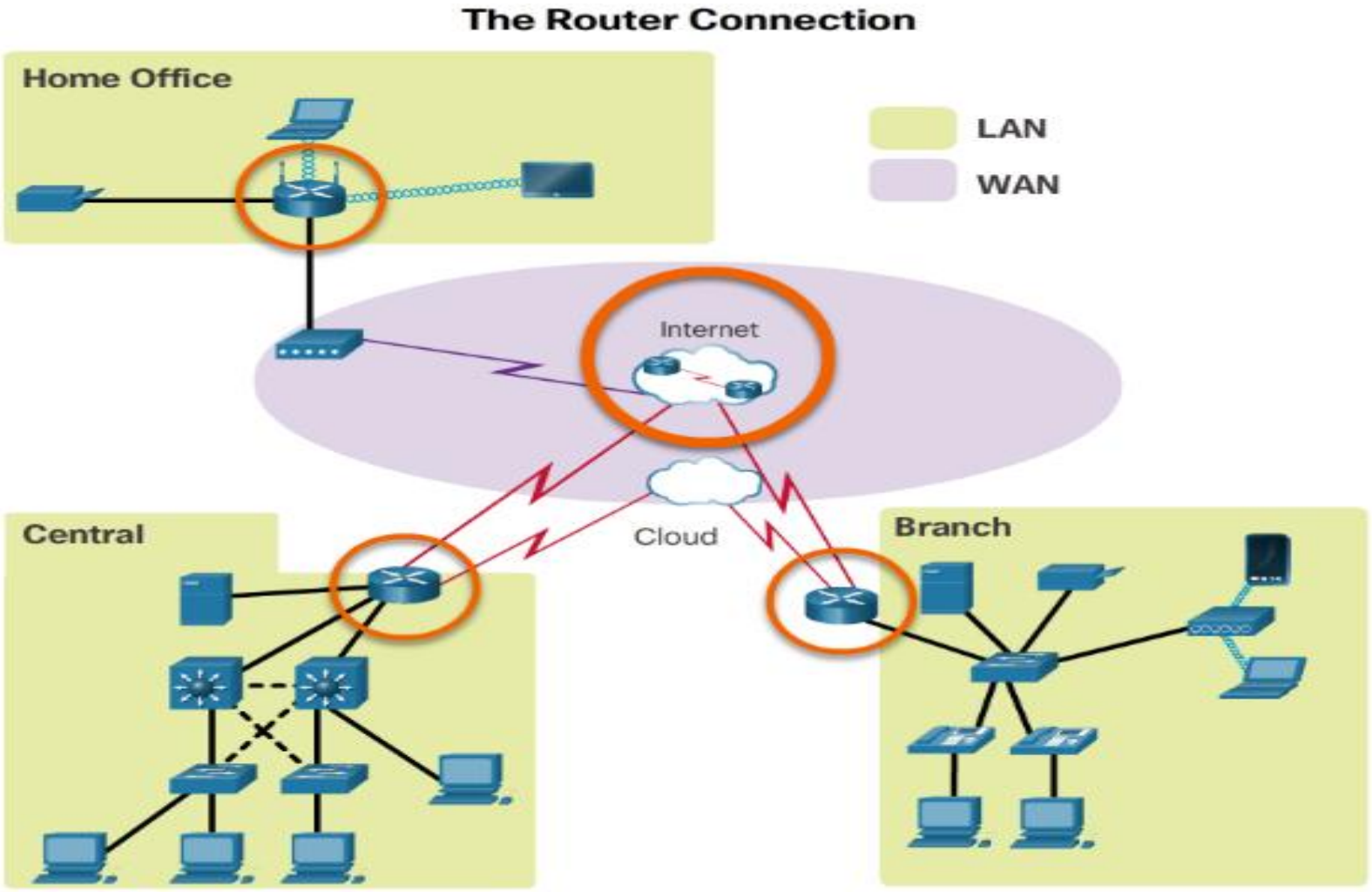


Routers are Computers

Router Memory

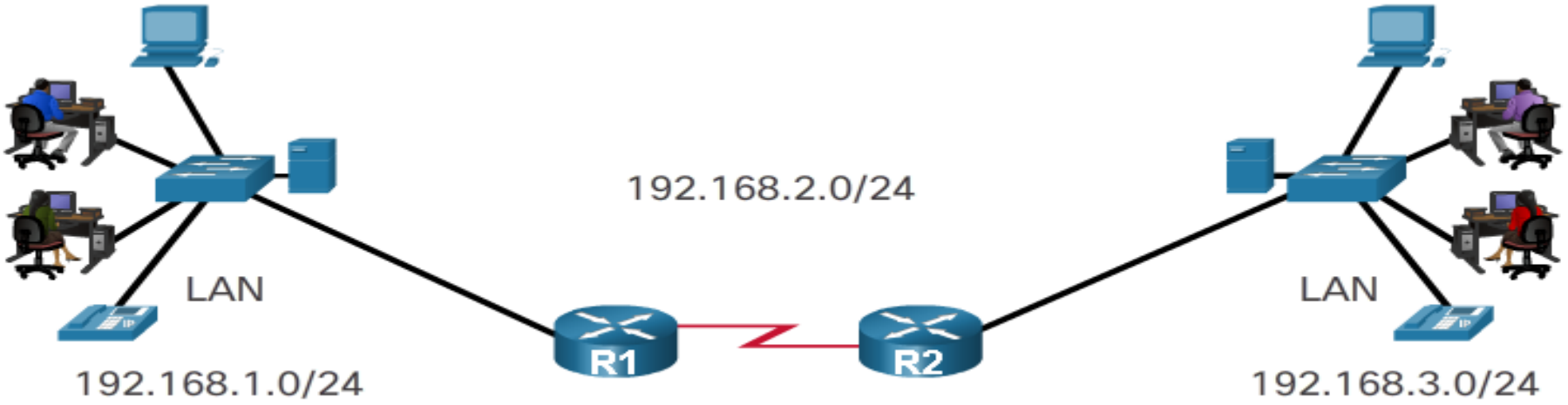
Memory	Description
Random Access Memory (RAM)	Volatile memory that provides temporary storage for various applications and processes including: • Running IOS • Running configuration file • IP routing and ARP tables • Packet buffer
Read-Only Memory (ROM)	Non-volatile memory that provides permanent storage for: • Bootup instructions • Basic diagnostic software • Limited IOS in case the router cannot load the full featured IOS
Non-Volatile Random Access Memory (NVRAM)	Non-volatile memory that provides permanent storage for the: • Startup configuration file
Flash	Non-volatile memory that provides permament storage for: • IOS • Other system-related files

Routers Interconnect Networks



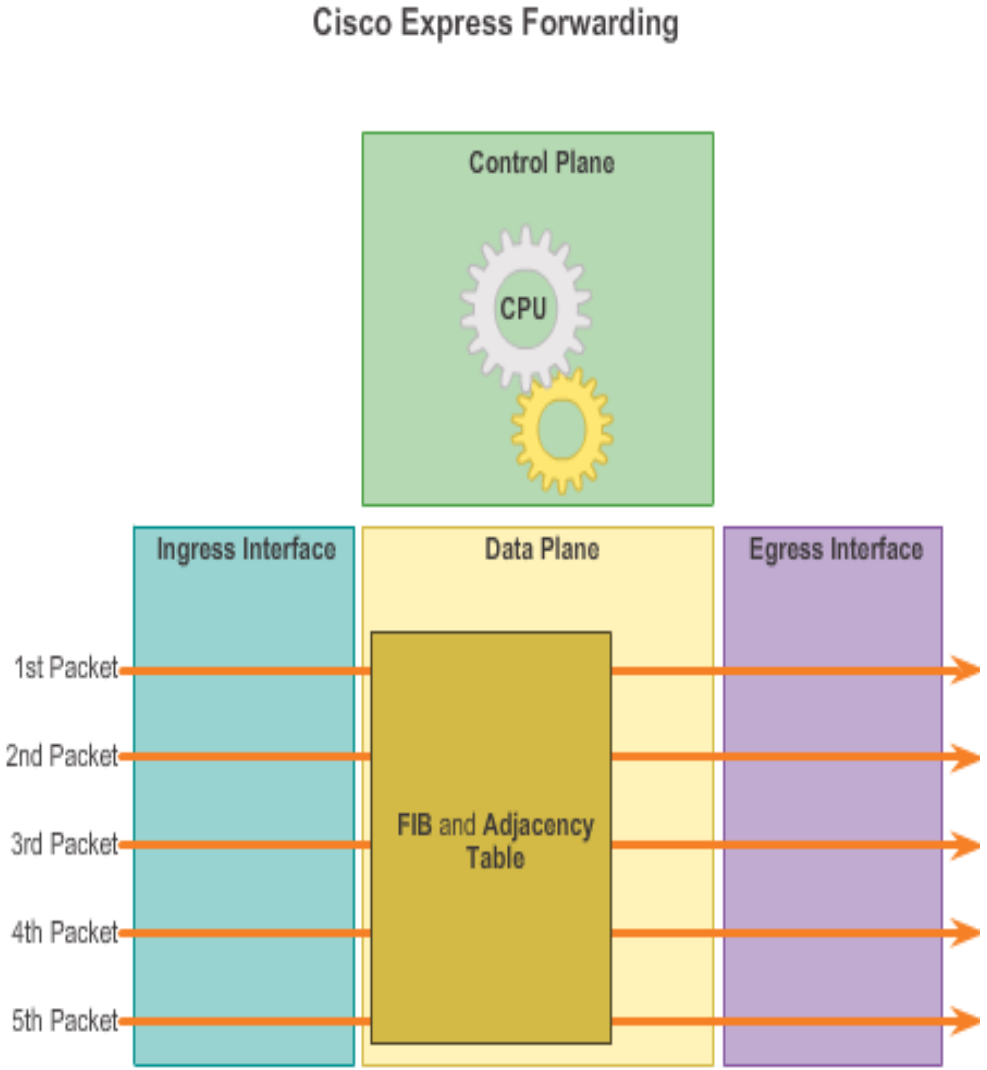
Routers Choose Best Paths

- Routers use static routes and dynamic routing protocols to learn about remote networks and build their routing tables.
- Routers use routing tables to determine the best path to send packets.
- Routers encapsulate the packet and forward it to the interface indicated in routing table.

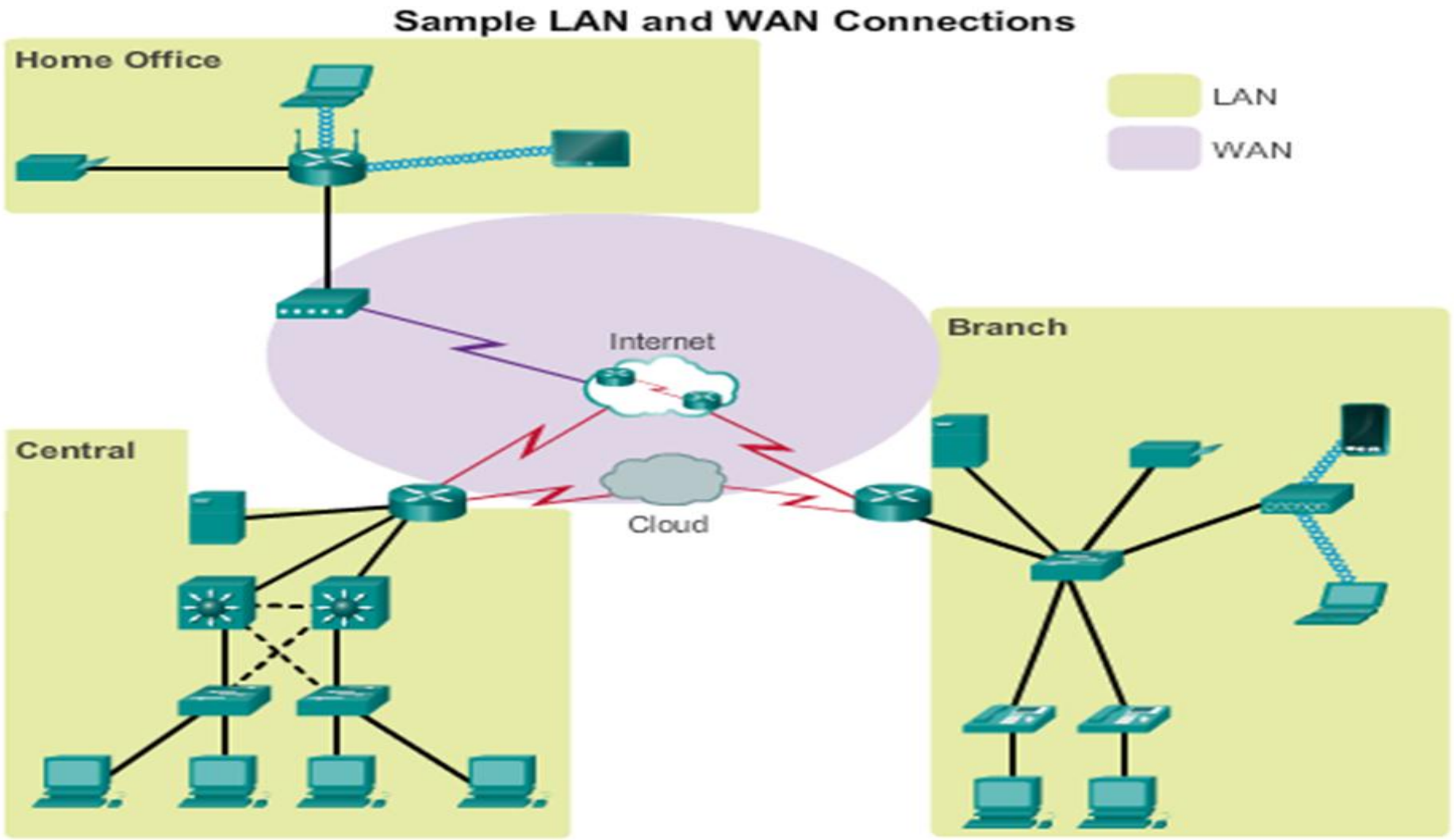


Packet Forwarding Methods

- **Process switching** – An older packet forwarding mechanism still available for Cisco routers.
- **Fast switching** – A common packet forwarding mechanism which uses a fast-switching cache to store next hop information.
- **Cisco Express Forwarding (CEF)** – The most recent, fastest, and preferred Cisco IOS packet-forwarding mechanism.



Connect to a Network

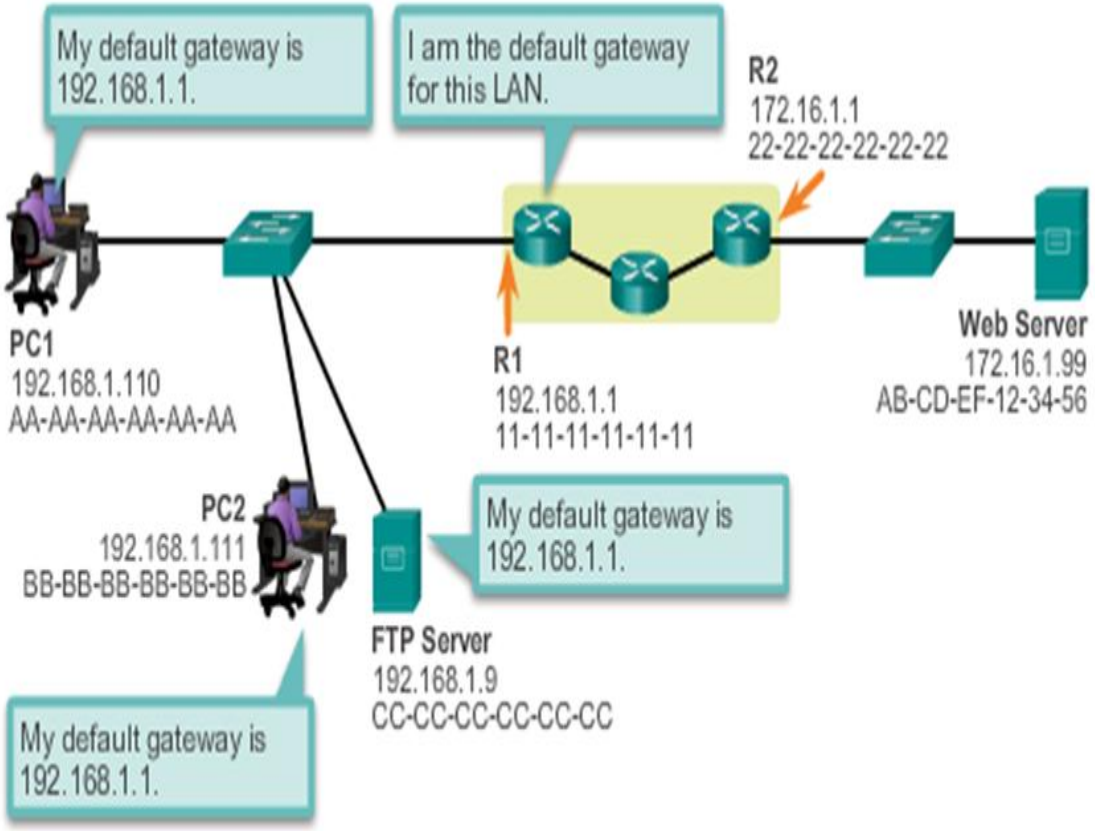


Default Gateways

To enable network access devices, must be configured with the following IP address information:

- **IP address** - Identifies a unique host on a local network.
- **Subnet mask** - Identifies the host's network subnet.
- **Default gateway** - Identifies the router a packet is sent to when the destination is not on the same local network subnet.

Destination MAC Address	Source MAC Address	Source IP Address	Destination MAC Address	Data
11-11-11-11-11-11	AA-AA-AA-AA-AA-AA	192.168.1.110	172.16.1.99	

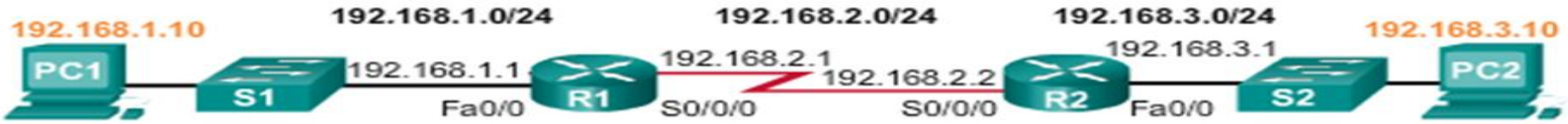


Document Network Addressing

Network documentation should include at least the following in a topology diagram and addressing table:

- Device names
- Interfaces
- IP addresses and

  subnet masks
- Default gateways



Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0	192.168.2.1	255.255.255.0	N/A
R2	Fa0/0	192.168.3.1	255.255.255.0	N/A
	S0/0/0	192.168.2.2	255.255.255.0	N/A
PC1	N/A	192.168.1.10	255.255.255.0	192.168.1.1
PC2	N/A	192.168.3.10	255.255.255.0	192.168.3.1

Enable IP on a Host

Statically Assigned IP address – The host is manually assigned an IP address, subnet mask and default gateway. A DNS server IP address can also be assigned.

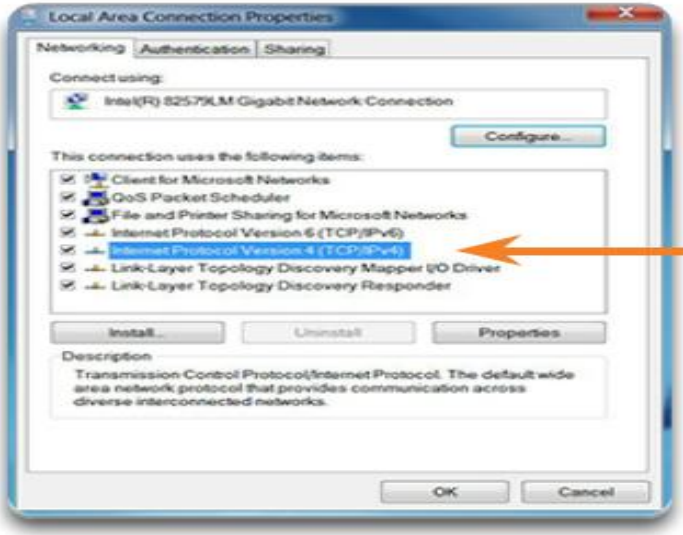
- Used to identify specific network resources such as network servers and printers.
- Can be used in very small networks with few hosts.

Dynamically Assigned IP Address – IP Address information is dynamically assigned by a server using Dynamic Host Configuration Protocol (DHCP).

- Most hosts acquire their IP address information through DHCP.
- DHCP services can be provided by Cisco routers.

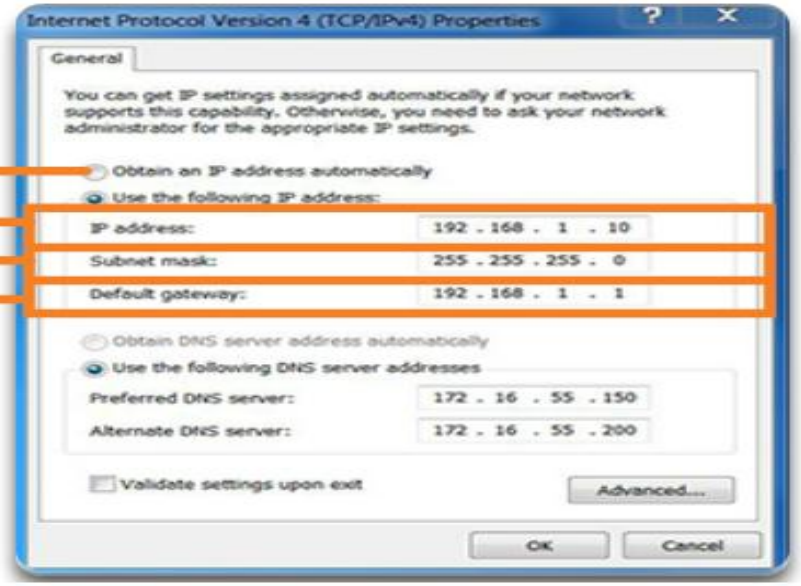
Enable IP on a Host

Statically Assigning an IP Address



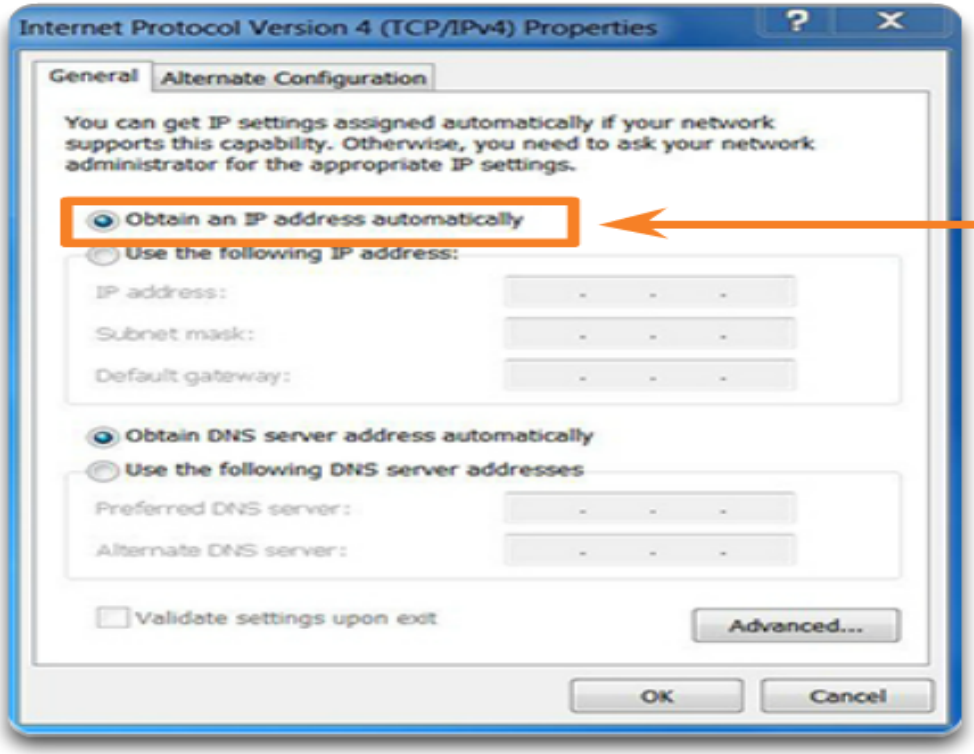
For static assignments, enter addresses:

IP Address
Subnet Mask
Default Gateway



Enable IP on a Host

Dynamically Assigning an IP Address

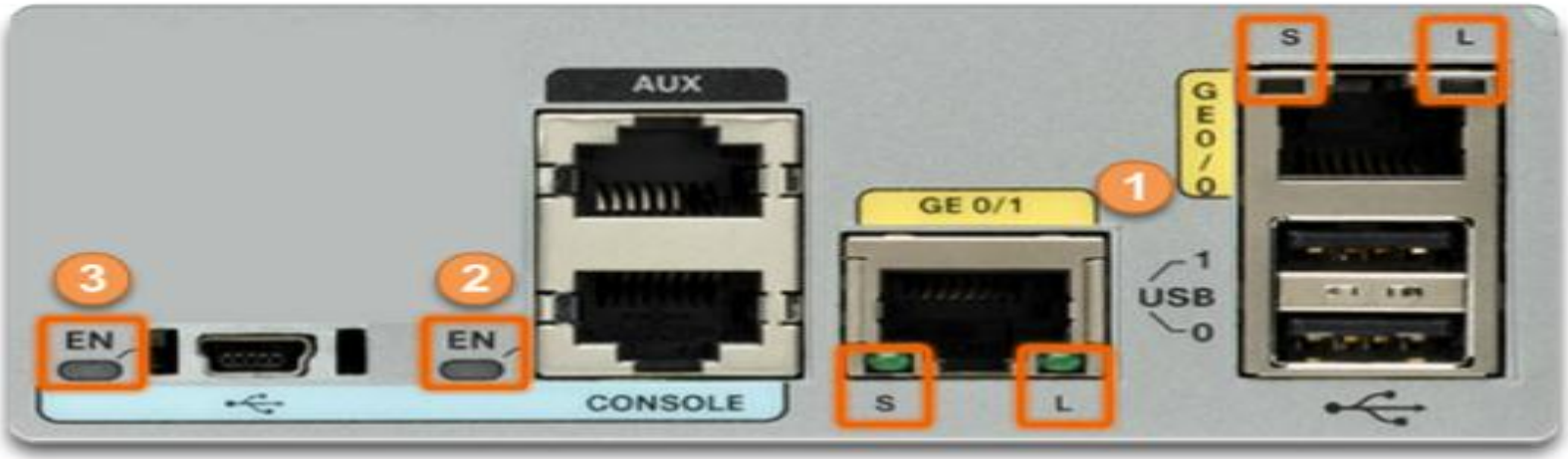


This property will set the device to obtain an IP address automatically.

Connect devices

Device LEDs

CISCO 1941 LEDs



#	Port	LED	Color	Description
1	GE0/0 and GE0/1	S (Speed)	1 blink + pause	Port operating at 10 Mb/s
			2 blink + pause	Port operating at 100 Mb/s
			3 blink + pause	Port operating at 1000 Mb/s
		L (Link)	Green	Link is active
			Off	Link is inactive
2	Console	EN	Green	Port is active
			Off	Port is inactive
3	USB	EN	Green	Port is active
			Off	Port is inactive

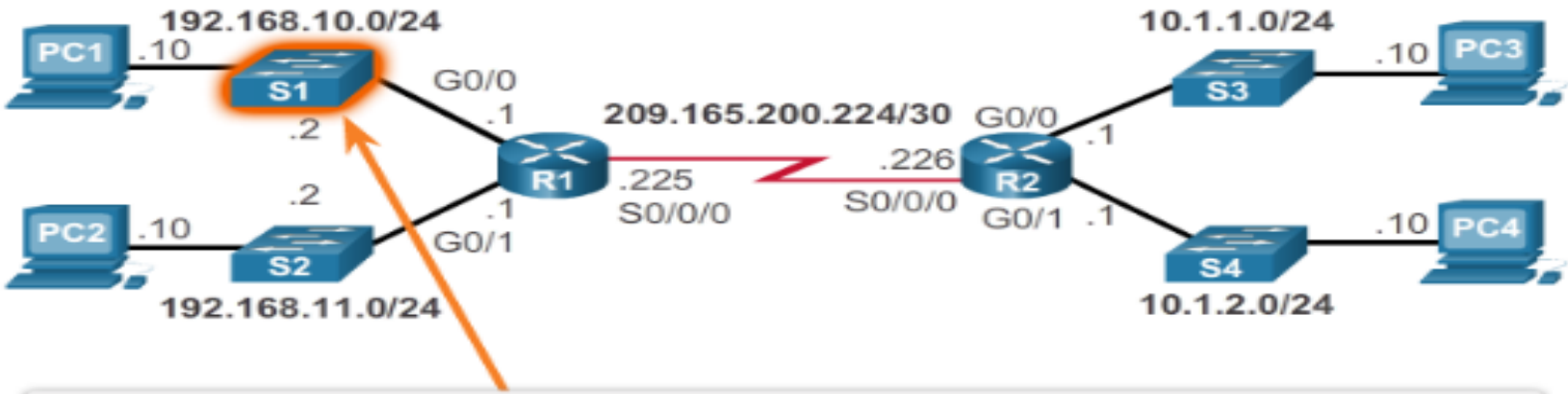
Console Access

Console Connection Requirements

Port on Computer	Cable Required	Port on ISR	Terminal Emulation
Serial Port	RJ-45-to-DB-9 Console Cable	RJ-45 Console Port	 Tera Term
USB Type-A Port	• USB-to-RS-232 compatible serial port adapter • Adapter may require a software driver • RJ-45-to-DB-9 console cable		 PuTTY
	• USB Type-A to USB Type-B (Mini-B USB) • A device driver is required and available from cisco.com.	USB Type-B (Mini-B USB)	

Enable IP on a Switch

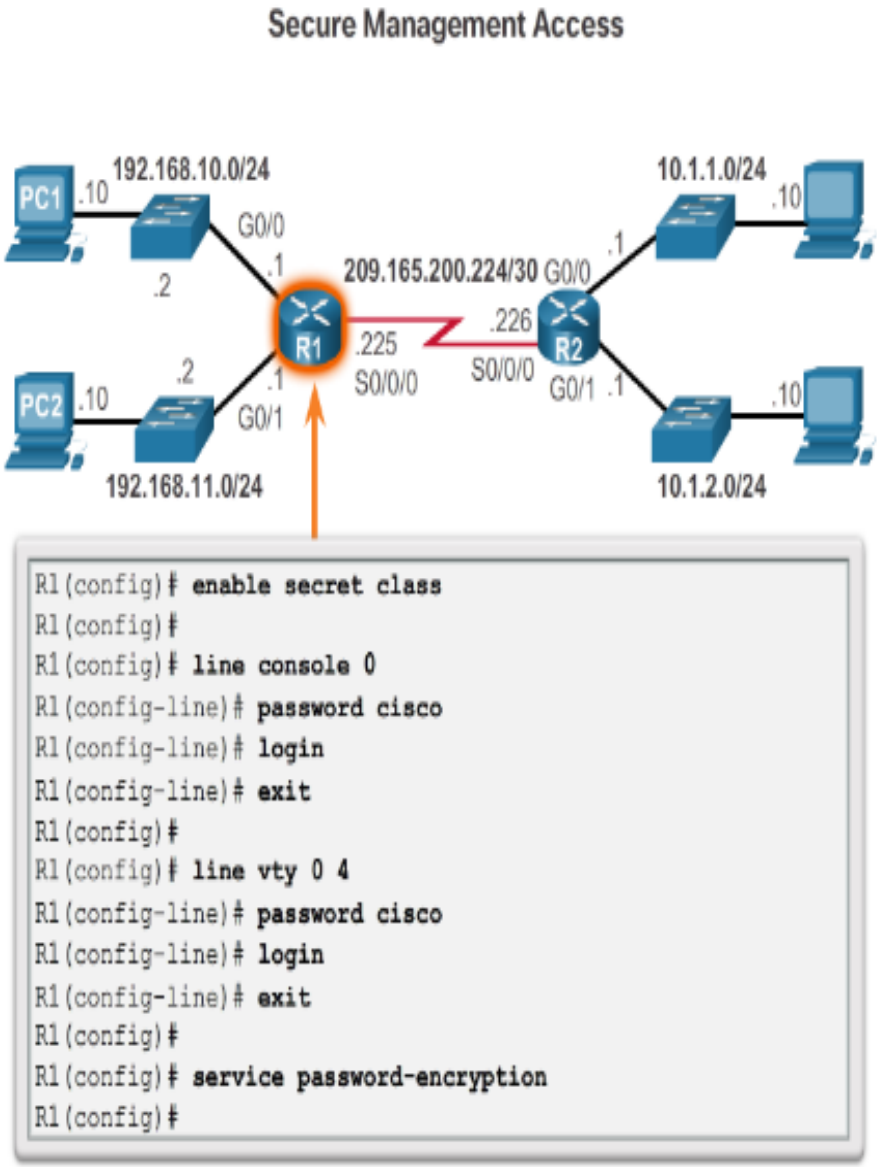
- Network infrastructure devices require IP addresses to enable remote management.
- On a switch, the management IP address is assigned on a virtual interface called a switched virtual interface (SVI)




```
S1(config)# interface vlan 1
S1(config-if)# ip address 192.168.10.2 255.255.255.0
S1(config-if)# no shutdown
%LINK-5-CHANGED: Interface Vlan1, changed state to up
S1(config-if)# exit
S1(config)#
S1(config)# ip default-gateway 192.168.10.1
S1(config)#
```

Configure Router Basic Settings

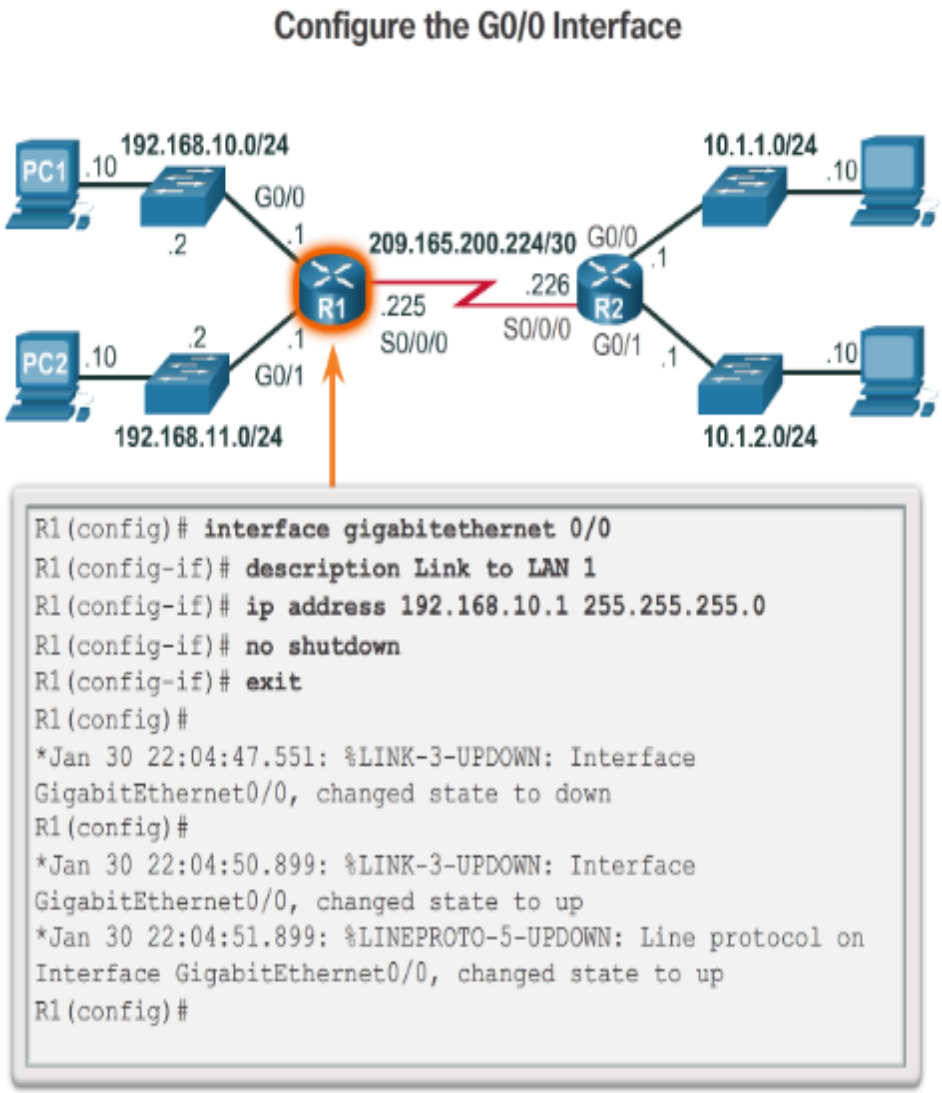
- **Name the device –** Distinguishes it from other routers
- **Secure management access –** Secures privilegec EXEC, user EXEC, and Telnet access, and encrypts passwords .
- **Configure a banner –** Provides legal notification o unauthorized access.
- **Save the Configuration**



Configure an IPv4 Router Interface

To be available, a router interface must be:

- Configured with an address and subnet mask.
- Activated using **no shutdown** command. By default LAN and WAN interfaces are not activated.
- Configured with the clock rate command on the Serial cable end labeled DCE.
- Optional description can be included.



Configure an IPv6 Router Interface

Configure interface with IPv6 address and subnet mask:

- Use the **ipv6 address** *ipv6-address*|*ipv6-length* [link-local | eui-64]interface configuration command.
- Activate using the **no shutdown** command.

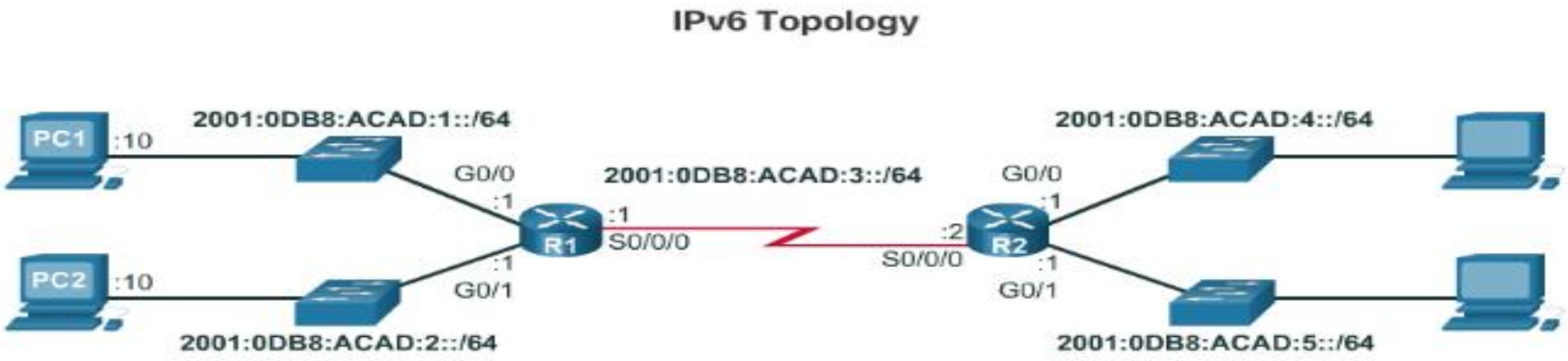
Configure the R1 G0/0 Interface


```
R1(config)#interface gigabitethernet 0/0
R1(config-if)#description Link to LAN 1
R1(config-if)#ipv6 address 2001:db8:acad:1::1/64
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#
*Feb  3 21:38:37.279: %LINK-3-UPDOWN: Interface
GigabitEthernet0/0, changed state to down
*Feb  3 21:38:40.967: %LINK-3-UPDOWN: Interface
GigabitEthernet0/0, changed state to up
*Feb  3 21:38:41.967: %LINEPROTO-5-UPDOWN: Line protocol on
Interface GigabitEthernet0/0, changed state to up
R1(config)#
```

Configure an IPv6 Router Interface (cont.)

IPv6 interfaces can support more than one address:

- Configure a specified global unicast – **ipv6address** *ipv6-address* / *ipv6-length*
- Configure a global IPv6 address with an interface identifier (ID) in the low-order 64 bits - **ipv6address** *ipv6-address* / *ipv6-length* eui-64
- Configure a link-local address - **ipv6address** *ipv6-address* / *ipv6-length* link-local

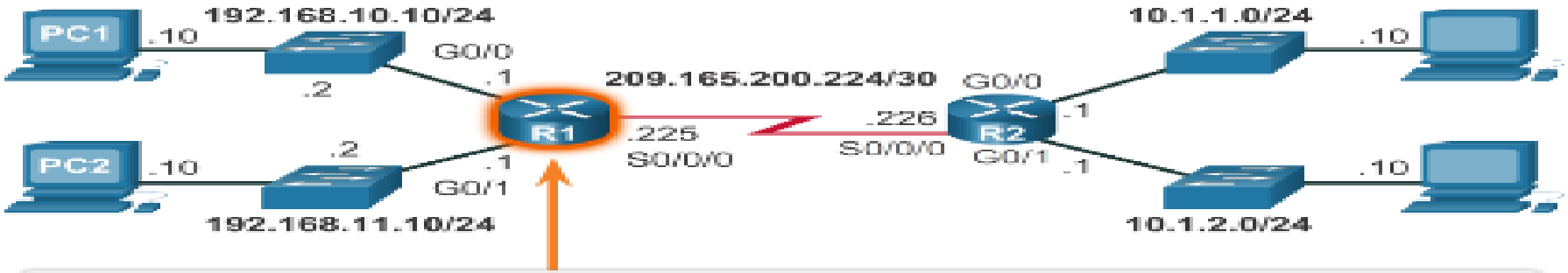


Configure an IPv4 Loopback Interface

A loopback interface is a logical interface that is internal to the router:

- It is not assigned to a physical port, it is considered a software interface that is automatically in an UP state.
- A loopback interface is useful for testing.
- It is important in the OSPF routing process.

Configure the Loopback0 Interface




```
R1(config)# interface loopback 0
R1(config-if)# ip address 10.0.0.1 255.255.255.0
R1(config-if)# exit
R1(config)#
*Jan 30 22:04:50.899: %LINK-3-UPDOWN: Interface Loopback0,
changed state to up
*Jan 30 22:04:51.899: %LINEPROTO-5-UPDOWN: Line protocol on
Interface Loopback0, changed state to up
```

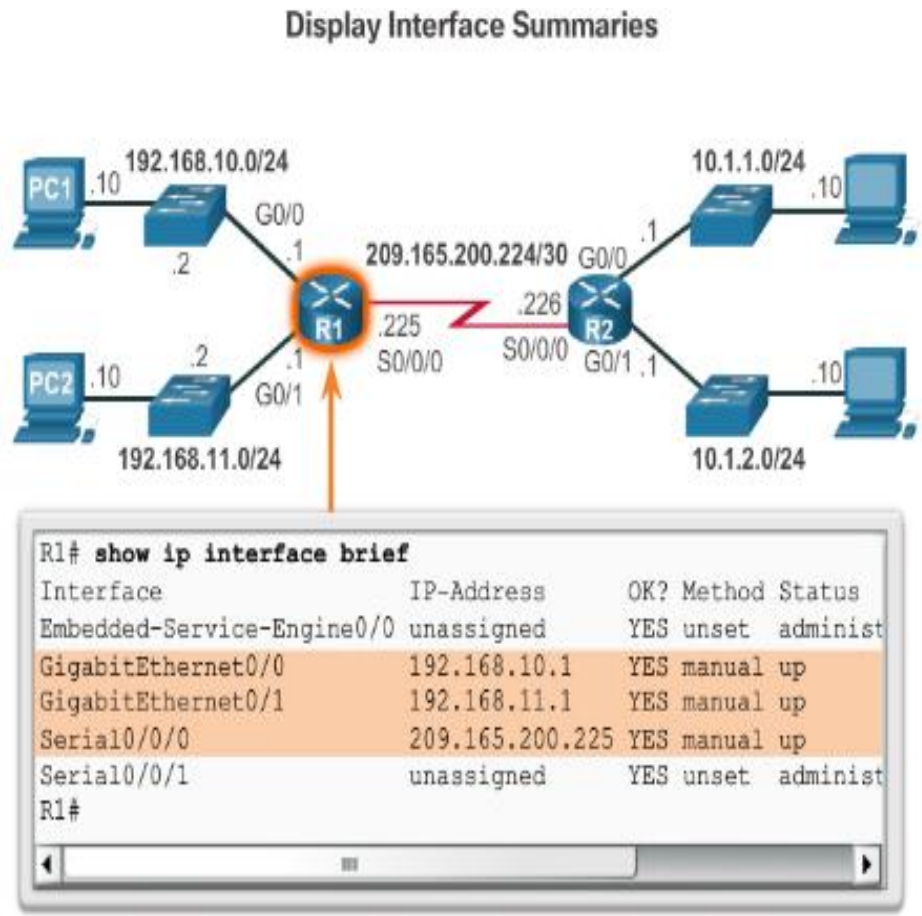
Verify Interface Settings

Show commands are used to verify operation and configuration of interface:

- **show ip interfaces brief**
- **show ip route**
- **show running-config**

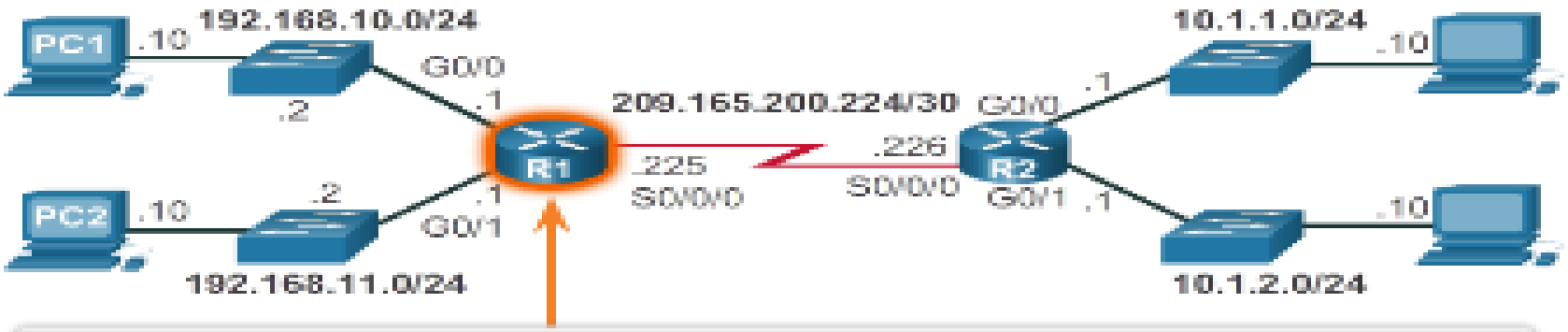
Show commands that are used to gather more detailed interface information:

- **show interfaces**
- **show ip interfaces**



Verify Interface Settings (cont.)

Verify the Routing Table

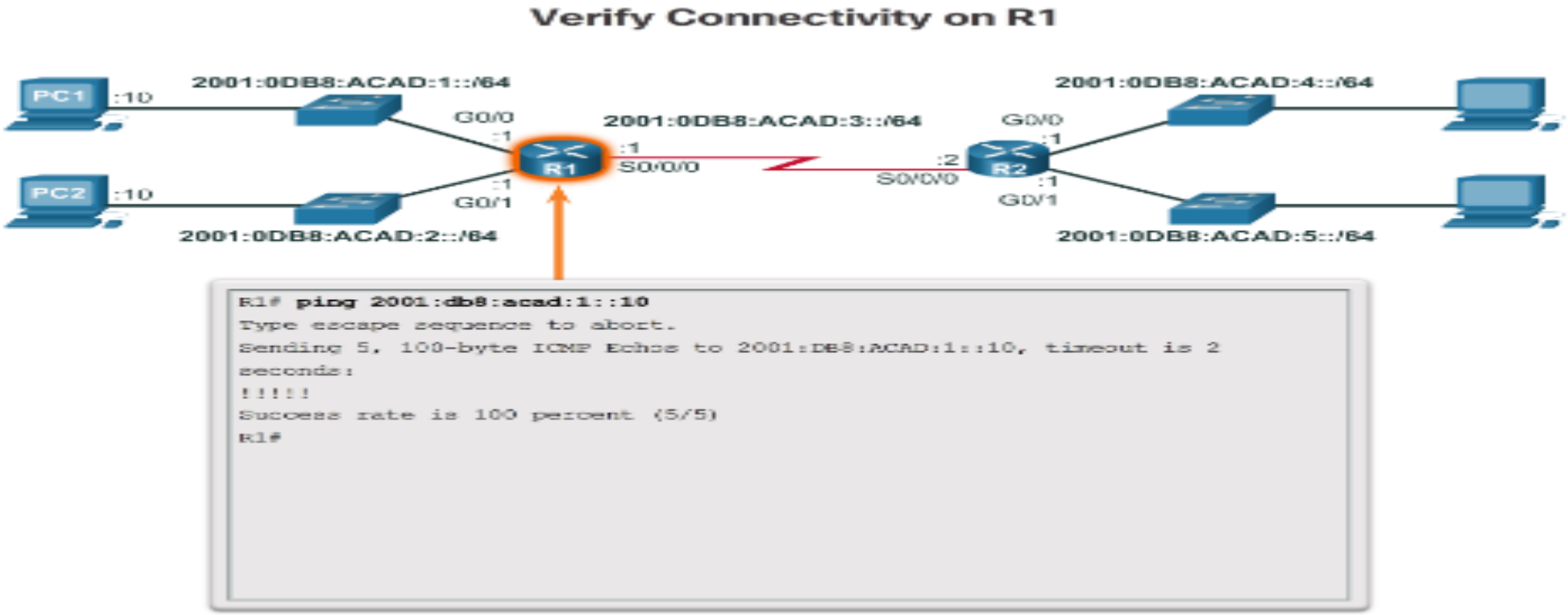



```
R1# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mo

<output omitted>

Gateway of last resort is not set

      192.168.10.0/24 is variably subnetted, 2 subnets, 2 ma
C        192.168.10.0/24 is directly connected, GigabitEther
L        192.168.10.1/32 is directly connected, GigabitEther
      192.168.11.0/24 is variably subnetted, 2 subnets, 2 ma
C        192.168.11.0/24 is directly connected, GigabitEther
L        192.168.11.1/32 is directly connected, GigabitEther
      209.165.200.0/24 is variably subnetted, 2 subnets, 2 m
```

Verify IPv6 Interface Settings

Common commands to verify the IPv6 interface configuration:

- **show ipv6 interface brief -** displays a summary for each of the interfaces.
- **show ipv6 interface gigabitethernet 0/0 -** displays the interface status and all the IPv6 addresses for this interface.
- **show ipv6 route -** verifies that IPv6 networks and specific IPv6 interface addresses have been installed in the IPv6 routing table.



Filter Show Command Output

Show command output can be managed using the following command and filters:

- Use the **terminal length** *number* command to specify the number of lines to be displayed.
- To filter specific output of commands use the **(|)pipe character** after show command. Parameters that can be used after pipe include:
  - **section, include, exclude, begin**

Filtering Show Commands

```
R1# show running-config | section line vty
line vty 0 4
 password 7 030752180500
 login
 transport input all
R1#
```

Filtering Show Commands

```
R1# show ip interface brief
Interface                  IP-Address      OK? Method Status
Embedded-Service-Engine0/0 unassigned      YES unset  administ
GigabitEthernet0/0         192.168.10.1    YES manual up
GigabitEthernet0/1         192.168.11.1    YES manual up
Serial0/0/0                209.165.200.225 YES manual up
Serial0/0/1                unassigned      YES unset  administ
R1#
R1# show ip interface brief | include up
GigabitEthernet0/0         192.168.10.1    YES manual up
GigabitEthernet0/1         192.168.11.1    YES manual up
Serial0/0/0                209.165.200.225 YES manual up
R1#
```

Command History Feature

The command history feature temporarily stores a list of executed commands for access:

- To recall commands press **Ctrl+P** or the **UP Arrow**.
- To return to more recent commands press **Ctrl+N** or the **Down Arrow**.
- By default, command history is enabled and the system captures the last 10 commands in the buffer. Use the **show history** privileged EXEC command to display the buffer contents.
- Use the **terminal history size** user EXEC command to increase or decrease size of the buffer.

```
R1# terminal history size 200
R1#
R1# show history
   show ip interface brief
   show interface g0/0
   show ip interface g0/1
   show ip route
   show ip route 209.165.200.224
   show running-config interface s0/0/0
   terminal history size 200
   show history
R1#
```