CHAPTER 3

Introduction to Dynamic Routing Protocols

The Study Guide portion of this chapter uses a combination of matching, fill-in-the-blank, multiple-choice, and open-ended question exercises to test your knowledge of dynamic routing protocol concepts.

The Labs and Activities portion of this chapter includes all the online curriculum labs to ensure that you have mastered the hands-on skills needed to design an addressing scheme.

As you work through this chapter, use Chapter 3 in *Routing Protocols and Concepts, CCNA Exploration Companion Guide* or use the corresponding Chapter 3 in the Exploration Routing Protocols and Concepts online curriculum for assistance.

Study Guide

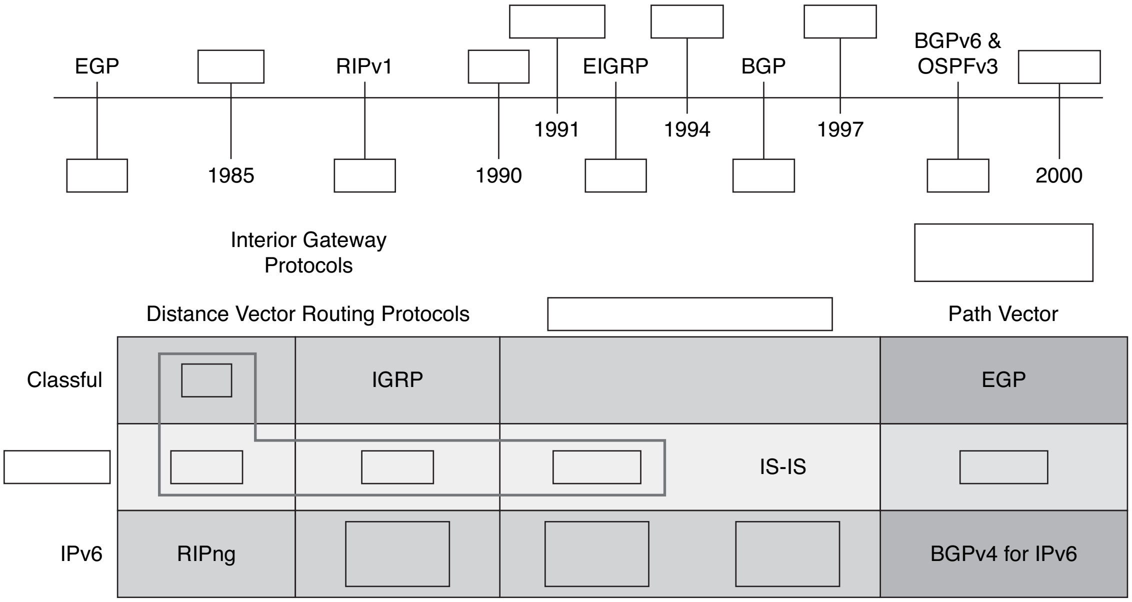
Introduction and Advantages

Dynamic routing protocols play an important role in today's networks. The following sections include exercises to reinforce your basic knowledge of dynamic routing protocols.

Routing Protocols Evolution and Classification Exercise

Figure 3-1 shows a timeline of IP routing protocols and a chart classifying the various IP routing protocols. Both the timeline and the chart are incomplete. Fill in the missing information.

Figure 3-1 Routing Protocols Evolution and Classification



Vocabulary Exercise: Matching (Key Words)

Match the definition on the left with a term on the right. This exercise is not necessarily a one-to-one matching. Some definitions might be used more than once, and some terms might have multiple definitions.

Definitions

- **a.** A protocol that *does not* include subnet mask information in its messages
- **b.** Routing protocols that operate *between* autonomous systems
- **c.** A topology that consists of a major network separating the subnets of another major network
- **d.** The ability to specify a different subnet mask for the same network number on different subnets
- **e.** Rating of trustworthiness of a routing information source
- **f.** A collection of routers under a common administration
- **g.** Speed and ability of a group of routers to agree on the topology of the network after a change in that topology
- **h.** Classification of a routing protocol that uses the shortest path first or Dijkstra algorithm
- **i.** Classification of a routing protocol that uses the Bellman-Ford algorithm to determine the best path
- **j.** A finite list of steps used by routing protocols for best-path determination
- **k.** Routing protocols that operate *within* autonomous systems
- **l.** A protocol that *does* include subnet mask information in its message
- **m.** A state when routers all have the same consistent network topology in their routing table

Terms

__ administrative distance

__ algorithm

__ autonomous system

__ classful routing protocols

__ classless routing protocols

__ converged

__ convergence

__ discontiguous network

__ distance vector

__ exterior gateway protocols

__ interior gateway protocols

__ link-state

__ VLSM

Dynamic Routing Protocol Concepts Exercise

Perspective and Background

As networks have evolved and become more complex, new routing protocols have emerged. One of the earliest routing protocols, ______________________________________, has evolved into a newer version, ___________. To address the needs of larger networks, two advanced routing protocols were developed: _____________________ and ____. Cisco developed ____and __________________________, which also scales well in larger network implementations.

Additionally, there was the need to interconnect different internetworks and provide routing among them. __________________________ is now used between Internet service providers (ISP) as well as between ISPs and their larger private clients to exchange routing information.

With the advent of numerous consumer devices using IP, the ______ addressing space is nearly exhausted. Thus, ______has emerged, which has required newer versions of the IP routing protocols to be developed.

Role of Dynamic Routing Protocols

Routing protocols determine the best ____ to each network, which is then added to the ________ table. One of the primary benefits of using a dynamic routing protocol is that routers exchange routing information whenever there is a __________________________.

Compared to static routing, dynamic routing protocols require less _____________________ overhead. However, the expense of using dynamic routing protocols is dedicating part of a router's ________ for protocol operation, including ________ time and network link _________________.

Purpose of Dynamic Routing Protocols

A routing protocol is a set of processes, ___________, and messages that are used to exchange routing information and populate the ___________________ with the routing protocol's choice of best _____.

List the four purposes of a routing protocol.

- ____
- ____
- ____
- ____

List and briefly describe the main components of a routing protocol.

- ____
  ____
- ____
- ____

Dynamic Routing Protocol Operation

The method that a routing protocol uses to accomplish its purpose depends on the _____________ it uses and the operational characteristics of that protocol.

Describe the basic operations of a dynamic routing protocol.

- ______________________________
- ______________________________
  ____
- ______________________________
- ______________________________
  ____

Dynamic Versus Static Routing Exercise

Dynamic routing certainly has several advantages over static routing. However, static routing is still used in networks today. In fact, networks typically use a combination of both static and dynamic routing.

Consider each of the features in Table 3-1, and briefly list the advantages and disadvantage of dynamic routing and static routing.

Table 3-1 Dynamic Versus Static Routing

Feature	Dynamic Routing	Static Routing
Configuration complexity		
Requires administrator knowledge		
Topology changes		
Scaling		
Security		
Resource usage		
Predictability		

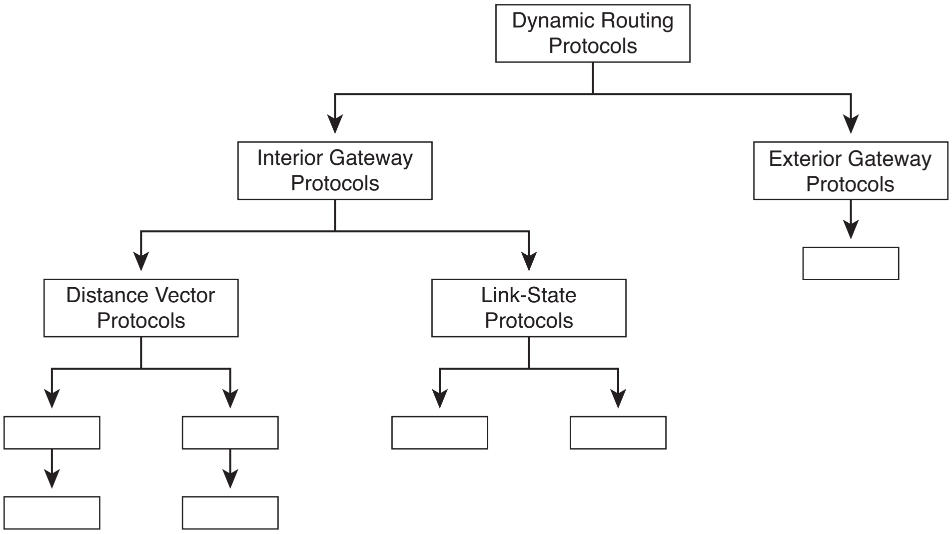
Classifying Dynamic Routing Protocols

The following sections give an overview of the most common IP routing protocols. Most of these routing protocols will be examined in detail later in this course. For now, work through these exercises to reinforce your knowledge of dynamic routing protocol classifications.

Dynamic Routing Protocols Classification Chart

The chart in Figure 3-2 is a succinct way to represent the major classifications of dynamic routing protocols. For each of the empty boxes, write in the missing protocol.

Figure 3-2 Classifying Dynamic Routing Protocols



Dynamic Routing Protocols Classification Exercise

Routing protocols can be classified into different groups according to their characteristics.

IGP and EGP

An ______________________ (AS)—otherwise known as a ___________________—is a collection of routers under a common ______________________. Because the Internet is based on the ____________________ concept, two types of routing protocols are required:

- _________________________________ (IGP)
- _________________________________ (EGP)

Characteristics of IGPs and EGPs

An IGP is used to route ___________ an ________________________. IGPs for IP include _______, ________, ___________, ____________, and ________. EGPs, on the other hand, are designed for use _________ different ____________________ that are under the control of different _______________. _________ is the only currently viable EGP and is the routing protocol used by the ________. ___ is a _______________ protocol that can use many different ______________ to measure routes.

Distance Vector and Link-State

IGPs can be classified as two types:

- ___________________ routing protocols
- ______________ routing protocols

Distance Vector Routing Protocol Operation

Distance vector means that routes are advertised as ____________ of distance and _______________. Distance is defined in terms of a ________, such as hop count, and _______________ is simply the _____- _______ router or ________ ____________. Distance vector protocols typically use the ____________-__________ algorithm for the best-path route determination.

Some distance vector protocols ___________ send complete routing tables to all connected neighbors. In large networks, these routing updates can become enormous, causing significant traffic on the links.

Distance vector protocols use routers as sign posts along the path to the final destination. The only information a router knows about a remote network is the distance or _________ to reach that network and which path or _______ to use to get there. Distance vector routing protocols do not have an actual map of the network _____________.

List four situations in which distance vector routing protocols are a good choice.

- ____
- ____
  ____
- ____
- ____

Link-State Protocol Operation

In contrast to distance vector routing protocol operation, a router configured with a link-state routing protocol can create a "complete view," or ________________, of the network. A link-state router uses _____-_________ information to create a _____________ map and to select the best path to all destination networks in the ________________.

Link-state routing protocols do not use ____________ updates. After the network has ___________, a link-state update is only sent when there is a change in the topology.

List three situations in which link-state routing protocols are a good choice.

- ____
- ____
- ____

Classful and Classless Protocols

All routing protocols can also be classified as either

- Classful routing protocols
- Classless routing protocols

Classful Routing Protocols

What feature makes a routing protocol a *classful* routing protocol?

____

There are other limitations to classful routing protocols, including their inability to support __________________ networks—a topology that consists of a major network separating the subnets of another major network.

Classful routing protocols include ___________ and __________.

Classless Routing Protocols

What feature makes a routing protocol a *classless* routing protocol?

____

Classless routing protocols are required in most networks today because of their support for _____ and networks, among other features.

Classless routing protocols are _________, ___________, ___________, ________, and ________.

Convergence

Briefly describe convergence and explain why is it important?

____

____

____

____

____

Convergence properties include the ______ of propagation of routing information and the ___________ of optimal paths. Routing protocols can be rated based on the speed to convergence; the faster the convergence, the better the routing protocol. Generally, _______ and _______ are slow to converge, whereas _______ and _______ are faster to converge.

Metrics

There are cases when a routing protocol learns of more than one route to the same destination. To select the best path, the routing protocol must be able to evaluate and differentiate among the available paths. For this purpose, a metric is used. The exercise in the following section reinforces your knowledge of metrics.

Metric Parameters Exercise

Two different routing protocols might choose different paths to the same destination because of using different metrics.

In the following list, fill in the missing metric.

- ___________ A simple metric that counts the number of routers a packet must traverse
- ___________ Influences path selection by preferring the path with the highest bandwidth
- ___________ Considers the traffic utilization of a certain link
- ___________ Considers the time a packet takes to traverse a path
- ___________ Assesses the probability of a link failure, calculated from the interface error count or previous link failures
- ___________ A value determined either by the IOS or by the network administrator to indicate a preference for a route

In the following list, fill in the missing metric or metrics for the routing protocol.

- **RIP:** ___________—Best path is chosen by the route with the lowest hop count.
- **IGRP and EIGRP:** ___________, ______, ___________, and _______—Best path is chosen by the route with the smallest composite metric value calculated from these multiple parameters. By default, only ___________ and _______ are used.
- **IS-IS and OSPF:** _________—Best path is chosen by the route with the lowest ______. The Cisco implementation of OSPF uses ___________.

Administrative Distances

Before the routing process can determine which route to use when forwarding a packet, it must first determine which routes to include in the routing table. In some cases, a router can learn a route to a remote network from more than one routing source. The exercises in the following sections reinforce your knowledge of the concept of administrative distance.

Concept of Administrative Distance Exercise

A router might learn of a route to the same network from more than one _______. For example, a _______ route might have been configured for the same network/subnet mask that was learned dynamically by a dynamic routing protocol. Although less common, more than one dynamic routing protocol can be deployed in the same network. Administrative distance (AD) defines the ___________ of a routing source.

Administrative distance is an integer value from __ to _______. The ________ the value the more preferred the route source. An administrative distance of ___ is the most preferred, which is the AD value for a ___________ ___________ network.

An administrative distance of _______ means that the router will not believe the source of that route and it will not be installed in the routing table.

On way to see the AD value for a route source is to look at the routing table. In Example 3-1, circle the AD values for the route sources that show an AD value.

Example 3-1 Routing Table with AD Value

```
R2# show ip route
<output omitted>

Gateway of last resort is not set

D    192.168.1.0/24 [90/2172416] via 192.168.2.1, 00:00:24, Serial0/0
C    192.168.2.0/24 is directly connected, Serial0/0/0
C    192.168.3.0/24 is directly connected, FastEthernet0/0
C    192.168.4.0/24 is directly connected, Serial0/0/1
R    192.168.5.0/24 [120/1] via 192.168.4.1, 00:00:08, Serial0/0/1
D    192.168.6.0/24 [90/2172416] via 192.168.2.1, 00:00:24, Serial0/0/0
R    192.168.7.0/24 [120/1] via 192.168.4.1, 00:00:08, Serial0/0/1
R    192.168.8.0/24 [120/2] via 192.168.4.1, 00:00:08, Serial0/0/1
```

What other command can be used to verify the administrative distance used by a routing protocol?

____

Notice that the directly connected networks in Example 3-1 do not show an administrative distance. What command would show the administrative distance (list as simply "distance") for the 192.168.2.0 route in R2's routing table?

____

R2 might have knowledge of more networks than is shown in the routing table. What command will display all the RIP routes learned by R2, whether or not the RIP route is installed in the routing table?

____

Routing Sources and Administrative Distance Exercise

Table 3-2 shows an incomplete chart of the different administrative distance values for various routing protocols. Fill in the missing information.

Table 3-2 Default Administrative Distances

Route Source	AD
Connected	
EIGRP summary route	5
External BGP	20
Internal EIGRP	
IGRP	100
	110
IS-IS	115
	120
External EIGRP	170
Internal BGP	200
Unknown	255

Identifying Elements of the Routing Table Exercise

The purpose of this exercise is to practice how to correctly identify the route source, administrative distance, and metric for a given route based on output from the **show ip route** command.

The output is not common for most routing tables. Running more than one routing protocol on the same router is rare. Running three, as shown here, is more of an academic exercise and has value in that it will help you learn to interpret the routing table output.

From the **show ip route** information in Example 3-2, fill in missing spaces in Table 3-3.

Example 3-2 Multiple Routing Sources in the Routing Table

```
R2# 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

     10.0.0.0/16 is subnetted, 1 subnets
S       10.4.0.0 is directly connected, Serial0/0
     172.16.0.0/24 is subnetted, 3 subnets
C       172.16.1.0 is directly connected, FastEthernet0/0
C       172.16.2.0 is directly connected, Serial0/0
D       172.16.3.0 [90/2172416] via 172.16.2.1, 00:00:18, Serial0/0
C    192.168.1.0/24 is directly connected, Serial0/1
O    192.168.100.0/24 [110/65] via 172.16.2.1, 00:00:03, Serial0/0
O    192.168.110.0/24 [110/65] via 172.16.2.1, 00:00:03, Serial0/0
R    192.168.120.0/24 [120/1] via 172.16.2.1, 00:00:18, Serial0/0
```

Table 3-3 Route Sources, AD Values, and Metrics

Route	Route Source	AD	Metric
10.4.0.0/16			
172.16.1.0/24			
172.16.2.0/24			
172.16.3.0/24			
192.168.1.0/24			
192.168.100.0/24			
192.168.110.0/24			
192.168.120.0/24			

Labs and Activities

Command Reference

In Table 3-4, record the command, *including the correct router prompt*, that fits the description.

Table 3-4 Commands for Chapter 3, Introduction to Dynamic Routing Protocols

Command	Description
	Displays all the routes known by RIP—even routes that are not currently in the routing table
	Displays detailed information about dynamic routing processes currently running on the router
	Displays detailed information about the route 172.16.3.0

Lab 3-1: Subnetting Scenario 1 (3.5.2)

Upon completion of this lab, you will be able to

- Determine the number of subnets needed
- Determine the number of hosts needed
- Design an appropriate addressing scheme
- Assign addresses and subnet mask pairs to device interfaces and hosts
- Examine the use of the available network address space
- Determine how static routing could be applied to the network

Scenario

In this lab, you have been given the network address 192.168.9.0/24 to subnet and provide the IP addressing for the network shown in Figure 3-3. The network has the following addressing requirements:

- The BRANCH1 LAN 1 will require 10 host IP addresses.
- The BRANCH1 LAN 2 will require 10 host IP addresses.
- The BRANCH2 LAN 1 will require 10 host IP addresses.
- The BRANCH2 LAN 2 will require 10 host IP addresses.
- The HQ LAN will require 20 host IP addresses.
- The link from HQ to BRANCH1 will require an IP address for each end of the link.
- The link from HQ to BRANCH2 will require an IP address for each end of the link.

Figure 3-3 Topology Diagram for Subnetting Scenario 1

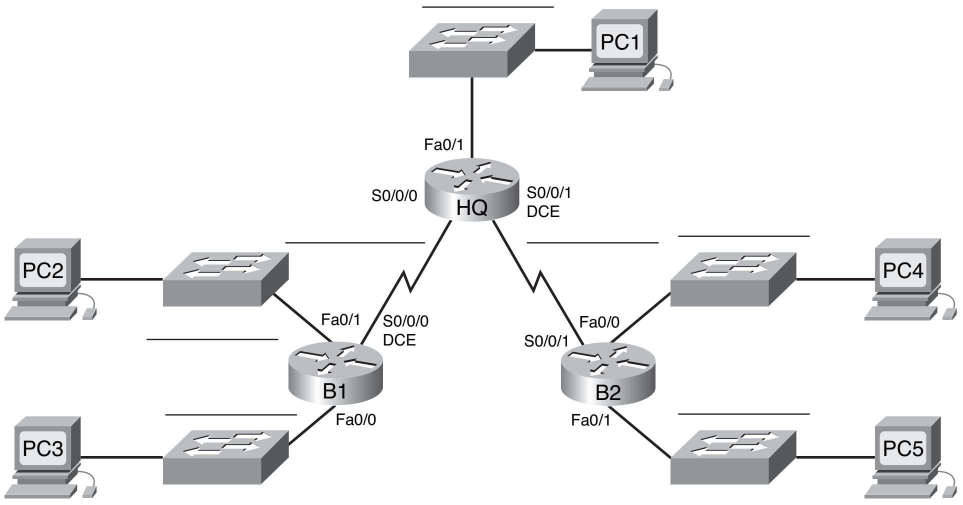


Table 3-5 provides a rough outline for the IP addresses, subnet masks, and default gateways (where applicable) for the devices shown in the network topology of Figure 3-3.

Table 3-5 Addressing Table for Lab 3-1

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0			—
	S0/0/0			—
	S0/0/1			—
BRANCH1	Fa0/0			—
	Fa0/1			—
	S0/0/0			—
BRANCH2	Fa0/0			—
	Fa0/1			—
	S0/0/1			—
PC1	NIC			
PC2	NIC			
PC3	NIC			
PC4	NIC			
PC5	NIC			

Task 1: Examine the Network Requirements

Examine the network requirements and answer the questions below. Keep in mind that IP addresses will be needed for each of the LAN interfaces.

How many subnets are needed? ___

What is the maximum number of IP addresses that are needed for a single subnet? ______

How many IP addresses are needed for each of the branch LANs? _____

What is the total number of IP addresses that are needed? _____

Task 2: Design an IP Addressing Scheme

Step 1. Subnet the 192.168.9.0 network into the appropriate number of subnets.

What will the subnet mask be for the subnetworks? _____________________

How many usable host IP addresses are there per subnet? ______

Fill in Table 3-6 with the subnet information.

Table 3-6 Subnetting Chart for Lab 3-1

Subnet Number	Subnet Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
0				
1				
2				
3				
4				
5				
6				
7				

Step 2. Assign the subnets to the network shown in the topology diagram in Figure 3-3.

When assigning the subnets, keep in mind that routing will need to occur to allow information to be sent throughout the network. The subnets will be assigned to the networks to allow route summarization on each of the routers.

1. Assign subnet 1 to the BRANCH2 LAN 2: _______________________
2. Assign subnet 2 to BRANCH2 LAN 1 subnet address: ______________________
3. Assign subnet 3 to link from HQ to BRANCH2 subnet address: _________________
4. Assign subnet 4 to HQ LAN subnet address: _______________________
5. Assign subnet 5 to link from HQ to BRANCH1 subnet address: _________________
6. Assign subnet 6 to BRANCH1 LAN 2 subnet address: ________________________
7. Assign subnet 7 to BRANCH1 LAN 1 subnet address: ____________________

Task 3: Assign IP Addresses to the Network Devices

Assign the appropriate addresses to the device interfaces. Document the addresses to be used in Table 3-5 shown earlier.

Step 1. Assign addresses to the HQ router.

1. Assign the first valid host address in the HQ LAN subnet to the LAN interface.
2. Assign the first valid host address in the link from HQ to BRANCH1 subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from HQ to BRANCH2 subnet to the S0/0/1 interface.

Step 2. Assign addresses to the BRANCH1 router.

1. Assign the first valid host address in the BRANCH1 LAN 1 subnet to the Fa0/0 LAN interface.
2. Assign the first valid host address in the BRANCH1 LAN 2 subnet to the Fa0/1 LAN interface.
3. Assign the last valid host address in the link from HQ to BRANCH1 subnet to the WAN interface.

Step 3. Assign addresses to the BRANCH2 router.

1. Assign the first valid host address in the BRANCH2 LAN 1 subnet to the Fa0/0 LAN interface.
2. Assign the first valid host address in the BRANCH2 LAN 2 subnet to the Fa0/1 LAN interface.
3. Assign the last valid host address in the link from HQ to BRANCH2 subnet to the WAN interface.

Step 4. Assign addresses to the host PCs.

1. Assign the last valid host address in the HQ LAN subnet to PC1.
2. Assign the last valid host address in the BRANCH1 LAN 1 subnet to PC2.
3. Assign the last valid host address in the BRANCH1 LAN 2 subnet to PC3.
4. Assign the last valid host address in the BRANCH2 LAN 1 subnet to PC4.
5. Assign the last valid host address in the BRANCH2 LAN 2 subnet to PC5.

Packet Tracer Companion

Task 4: Test the Network Design

You can now open the file LSG02-Lab352.pka on the CD-ROM that accompanies this book to apply and verify your addressing scheme. Check to see that all devices on directly connected networks can ping each other.

Task 5: Reflection

How many IP address in the 192.168.9.0 network are wasted in this design? ________

What would the command be to add a default static route on the WAN interface of the BRANCH1 router?

Can both of the BRANCH1 LANs be summarized into one route on the HQ router? ________

What would be the command used to add this summary route to the routing table?

Can both of the BRANCH2 LANs be summarized into one route on the HQ router? ________

What would be the command used to add this summary route to the routing table?

Can the HQ LAN and both of the BRANCH1 LANs be summarized into one route on the BRANCH2 router? This summarized route should also include the link between the HQ and BRANCH1 routers.
____

What would be the command used to add this summary route to the routing table?

Lab 3-2: Subnetting Scenario 2 (3.5.3)

Upon completion of this lab, you will be able to

- Determine the number of subnets needed
- Determine the number of hosts needed
- Design an appropriate addressing scheme
- Assign addresses and subnet mask pairs to device interfaces and hosts
- Examine the use of the available network address space
- Determine how static routing could be applied to the network

Scenario

In this lab, you have been given the network address 172.16.0.0/16 to subnet and provide the IP addressing for the network shown in Figure 3-4. The network has the following addressing requirements:

- The Branch 1 LAN will require 100 host IP addresses.
- The Branch 2 LAN will require 100 host IP addresses.
- The Branch 3 LAN will require 100 host IP addresses.
- The Branch 4 LAN will require 100 host IP addresses.
- The West LAN will require 400 hosts.
- The East LAN will require 400 hosts.

- The HQ LAN will require 500 host IP addresses.
- The links between each of the routers will require an IP address for each end of the link.

The IP addresses for the link from the HQ router to the ISP have already been assigned. The Serial 0/1/0 address of the HQ router is 209.165.200.226/27. The IP address of the Serial 0/0/0 interface of the ISP router is 209.165.200.225/27.

Figure 3-4 Topology Diagram for Subnetting Scenario 2

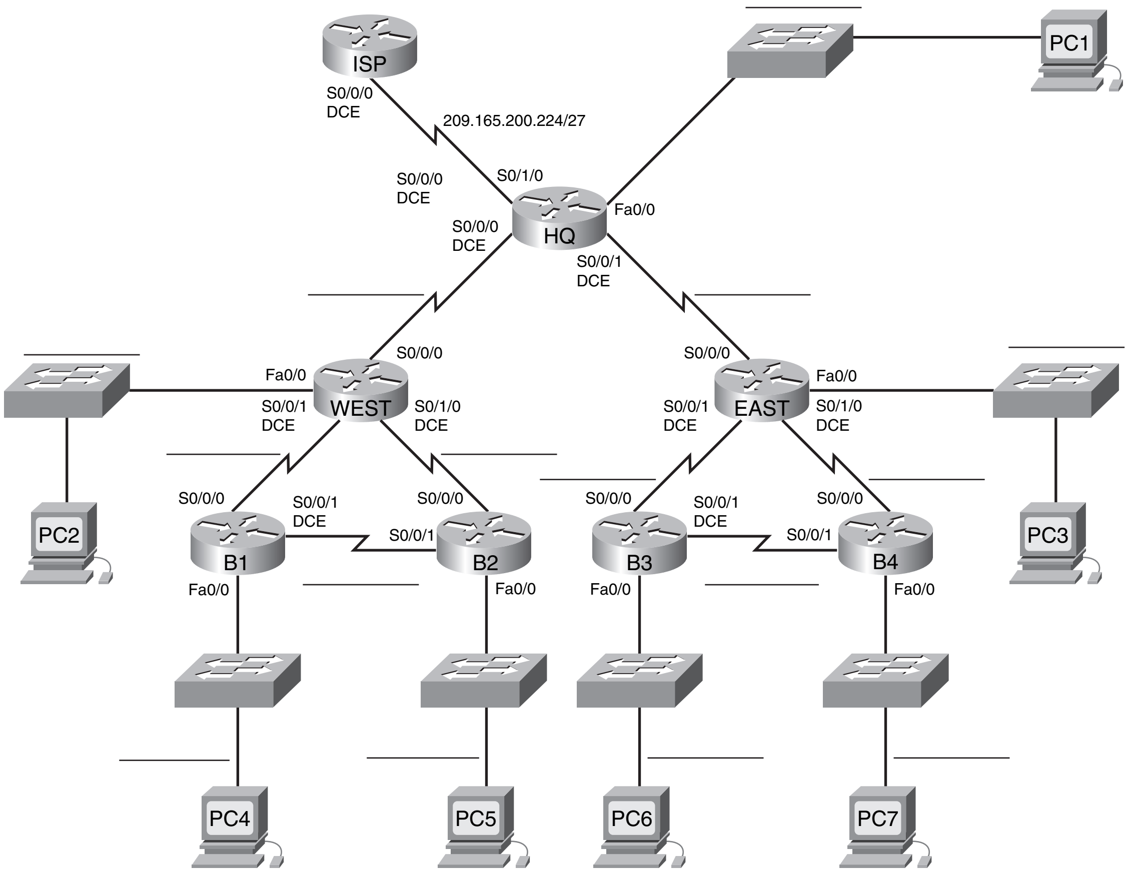


Table 3-7 provides a rough outline for the IP addresses, subnet masks, and default gateways (where applicable) for the devices shown in the network topology shown in Figure 3-4.

Table 3-7 Addressing Table for Lab 3-2

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/0			—
	S0/0/0			—
	S0/0/1			—
	S0/1/0	209.165.200.226	255.255.255.224	—

continues

Table 3-7 Addressing Table for Lab 3-2 *continued*

Device	Interface	IP Address	Subnet Mask	Default Gateway
West	Fa0/0			—
	S0/0/0			—
	S0/0/1			—
	S0/1/0			—
East	Fa0/0			—
	S0/0/0			—
	S0/0/1			—
	S0/1/0			—
Branch 1	Fa0/0			—
	S0/0/0			—
	S0/0/1			—
Branch 2	Fa0/0			—
	S0/0/0			—
	S0/0/1			—
Branch 3	Fa0/0			—
	S0/0/0			—
	S0/0/1			—
Branch 4	Fa0/0			—
	S0/0/0			—
	S0/0/1			—
PC1	NIC			
PC2	NIC			
PC3	NIC			
PC4	NIC			
PC5	NIC			
PC6	NIC			
PC7	NIC			

Task 1: Examine the Network Requirements

Examine the network requirements and answer the questions that follow. Keep in mind that IP addresses will be needed for each of the LAN interfaces.

How many subnets are needed? _____

What is the maximum number of IP addresses that are needed for a single subnet? ________

How many IP addresses are needed for each of the branch LANs? ________

How many IP addresses are needed for all the connections between routers? _____

What is the total number of IP addresses that are needed? ___________

Task 2: Design an IP Addressing Scheme

Step 1. Subnet the 172.16.0.0 network into the appropriate number of subnets.

What will the subnet mask be for the subnetworks? _________________________

How many usable host IP addresses are there per subnet? ________

Fill in Table 3-8 with the subnet information.

Table 3-8 Subnetting Chart for Lab 3-2

Subnet Number	Subnet IP	First Usable Host IP	Last Usable Host IP	Broadcast Address
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Step 2. Assign the subnets to the network shown in the topology diagram in Figure 3-4.

When assigning the subnets, keep in mind that routing will need to occur to allow information to be sent throughout the network. The subnets will be assigned to the networks to allow route summarization on each of the routers.

1. Assign subnet 1 to the Branch 1 LAN subnet: ________________________
2. Assign subnet 2 to the Branch 2 LAN subnet: ________________________
3. Assign subnet 3 to the link between the Branch 1 and Branch 2 routers: ___________
4. Assign subnet 4 to the link between the Branch 1 and West routers: ______________
5. Assign subnet 5 to the link between the Branch 2 and West routers: ______________
6. Assign subnet 6 to the West LAN subnet: ________________________
7. Assign subnet 7 to the link between the West and HQ routers: ___________________
8. Assign subnet 8 to the HQ LAN subnet: ________________________
9. Assign subnet 9 to the link between the HQ and East routers: ___________________
10. Assign subnet 10 to the East LAN subnet: ________________________
11. Assign subnet 11 to the link between the Branch 3 and East routers: ______________
12. Assign subnet 12 to the link between the Branch 4 and East routers: ______________
13. Assign subnet 13 to the link between the Branch 3 and Branch 4 routers: __________
14. Assign subnet 14 to the Branch 3 LAN subnet: ________________________
15. Assign subnet 15 to the Branch 4 LAN subnet: ________________________

Task 3: Assign IP Addresses to the Network Devices

Assign the appropriate addresses to the device interfaces. Document the addresses to be used in Table 3-7 shown earlier.

Step 1. Assign addresses to the HQ router.

1. Assign the first valid host address in the HQ LAN subnet to the LAN interface.
2. Assign the first valid host address in the link from HQ to West subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from HQ to East subnet to the S0/0/1 interface.

Step 2. Assign addresses to the West router.

1. Assign the first valid host address in the West LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from HQ to West subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from West to Branch 1 subnet to the S0/0/1 interface.

4. Assign the first valid host address in the link from West to Branch 2 subnet to the S0/1/0 interface.

Step 3. Assign addresses to the East router.

1. Assign the first valid host address in the East LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from HQ to East subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from East to Branch 3 subnet to the S0/0/1 interface.
4. Assign the first valid host address in the link from East to Branch 4 subnet to the S0/1/0 interface.

Step 4. Assign addresses to the Branch 1 router.

1. Assign the first valid host address in the Branch 1 LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from West to Branch 1 subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from Branch 1 to Branch 2 subnet to the S0/0/1 interface.

Step 5. Assign addresses to the Branch 2 router.

1. Assign the first valid host address in the Branch 2 LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from West to Branch 2 subnet to the S0/0/0 interface.
3. Assign the last valid host address in the link from Branch 1 to Branch 2 subnet to the S0/0/1 interface.

Step 6. Assign addresses to the Branch 3 router.

1. Assign the first valid host address in the Branch 3 LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from East to Branch 3 subnet to the S0/0/0 interface.
3. Assign the first valid host address in the link from Branch 3 to Branch 4 subnet to the S0/0/1 interface.

Step 7. Assign addresses to the Branch 4 router.

1. Assign the first valid host address in the Branch 4 LAN subnet to the LAN interface.
2. Assign the last valid host address in the link from East to Branch 4 subnet to the S0/0/0 interface.
3. Assign the last valid host address in the link from Branch 3 to Branch 4 subnet to the S0/0/1 interface.

Step 8. Assign addresses to the host PCs.

1. Assign the last valid host address in the HQ LAN subnet to PC1.
2. Assign the last valid host address in the West LAN subnet to PC2.

3. Assign the last valid host address in the East 1 LAN subnet to PC3.
4. Assign the last valid host address in the Branch 1 LAN subnet to PC4.
5. Assign the last valid host address in the Branch 2 LAN subnet to PC5.
6. Assign the last valid host address in the Branch 3 LAN subnet to PC6.
7. Assign the last valid host address in the Branch 4 LAN subnet to PC7.

Packet Tracer Companion

Task 4: Test the Network Design

You can now open the file LSG02-Lab353.pka on the CD-ROM that accompanies this book to apply and verify your addressing scheme. Check to see that all devices on directly connected networks can ping each other.

Task 5: Reflection

How many IP addresses in the 172.16.0.0 network are wasted in this design? ____________________

What would be the command to add a default static route for your entire network design from the HQ router to the ISP router?

____

Can the West, Branch 1, and Branch 2 networks be summarized into one route on the HQ router? This summarized route should also include the serial links that connect the West, Branch 1, and Branch 2 routers. ________

What would be the command used to add this summary route to the routing table?

____

Can the East, Branch 3, and Branch 4 networks be summarized into one route on the HQ router? This summarized route should also include the serial links that connect the East, Branch 3, and Branch 4 routers. __________

What would be the command used to add this summary route to the routing table?

____

What would be the command to add a default static route on the West router to send traffic for all unknown destinations to the HQ router?

____

What would be the command to add a default static route on the East router to send traffic for all unknown destinations to the HQ router?

____

Can the Branch 1 and Branch 2 networks be summarized into one route on the West router? This summarized route should also include the serial link that connects the Branch 1 and Branch 2 routers. ___

What would be the command to add this summary route to the routing table? Use the S0/0/1 interface of the West router as the exit interface.

____

Can the Branch 3 and Branch 4 networks be summarized into one route on the East router? This summarized route should also include the serial link that connects the Branch 3 and Branch 4 routers. ___

What would be the command to add this summary route to the routing table? Use the S0/0/1 interface of the East router as the exit interface.

____

The Branch 1 router requires a static route for traffic destined for Branch 2. All other traffic should be sent to the West router using a default static route. What commands would be used to accomplish this?

____

____

The Branch 2 router requires a static route for traffic destined for Branch 1. All other traffic should be sent to the West router using a default static route. What commands would be used to accomplish this?

____

____

The Branch 3 router requires a static route for traffic destined for Branch 4. All other traffic should be sent to the East router using a default static route. What commands would be used to accomplish this?

____

____

The Branch 4 router requires a static route for traffic destined for Branch 3. All other traffic should be sent to the East router using a default static route. What commands would be used to accomplish this?

____

____

Lab 3-3: Subnetting Scenario 3 (3.5.4)

Upon completion of this lab, you will be able to

- Determine the number of subnets needed
- Determine the number of hosts needed
- Design an appropriate addressing scheme
- Conduct research to find a possible solution

Scenario

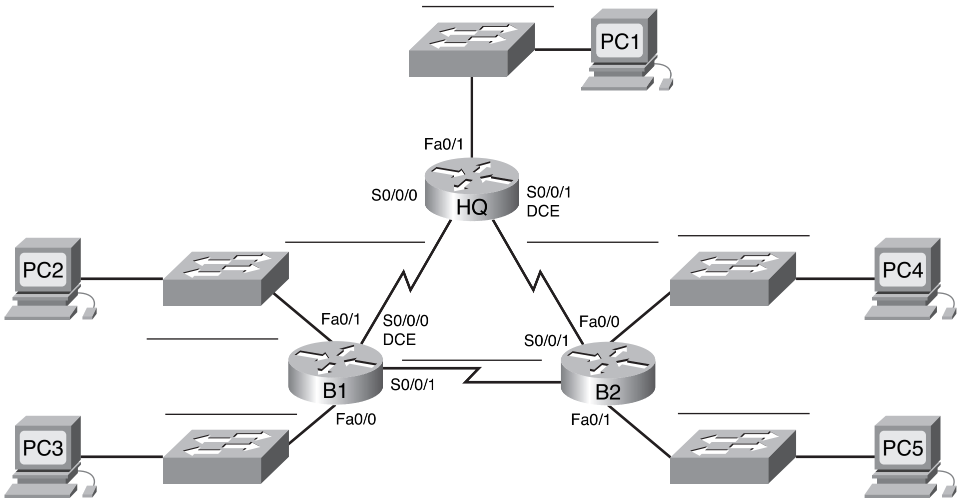
In this lab, you have been given the network address 192.168.1.0/24 to subnet and provide the IP addressing for the network shown in Figure 3-5. The network has the following addressing requirements:

- The BRANCH1 LAN 1 will require 15 host IP addresses.

- The BRANCH1 LAN 2 will require 15 host IP addresses.
- The BRANCH2 LAN 1 will require 15 host IP addresses.
- The BRANCH2 LAN 2 will require 15 host IP addresses.
- The HQ LAN will require 30 host IP addresses.
- The link from HQ to BRANCH1 will require an IP address for each end of the link.
- The link from HQ to BRANCH2 will require an IP address for each end of the link.
- The link from HQ to Branch 3 will require an IP address for each end of the link.

Figure 3-5 Topology Diagram for Subnetting Scenario 3

Table 3-9 provides a rough outline for you to assign the IP addresses, subnet masks, and default gate-



ways (where applicable) for the devices shown in the network topology of Figure 3-5.

Table 3-9 Addressing Table for Lab 3-3

Device	Interface	IP Address	Subnet Mask	Default Gateway
HQ	Fa0/1			—
	S0/0/0			—
	S0/0/1			—
BRANCH1	Fa0/0			—
	Fa0/1			—
	S0/0/0			—
	S0/0/1			—
BRANCH2	Fa0/0			—
	Fa0/1			—
	S0/0/0			—
	S0/0/1			—

Device	Interface	IP Address	Subnet Mask	Default Gateway
PC1	NIC			
PC2	NIC			
PC3	NIC			
PC4	NIC			
PC5	NIC			

Task 1: Examine the Network Requirements

Examine the network requirements and answer the questions that follow. Keep in mind that IP addresses will be needed for each of the LAN interfaces.

How many subnets are needed? _____

What is the maximum number of IP addresses that are needed for a single subnet? _____

How many IP addresses are needed for each of the branch LANs? _____

What is the total number of IP addresses that are needed? _____

Task 2: Design an IP Addressing Scheme

Subnet the 192.168.1.0/24 network into the appropriate number of subnets.

Can the 192.168.1.0/24 network be subnetted to fit the network requirements? _____

If the "number of subnets" requirement is met, what is the maximum number of hosts per subnet? ____

If the "maximum number of hosts" requirement is met, what is the number of subnets that will be available to use? __

Task 3: Reflection

You do not have enough address space to implement an addressing scheme. Research this problem and propose a possible solution. Increasing the size of your original address space is not an acceptable solution. (Hint: We will discuss solutions to this problem in Chapter 6, "VLSM and CIDR.")

____

____

____

____

Packet Tracer Companion

Attempt to implement your solution using Packet Tracer. You can now open the file LSG02-Lab354.pka on the CD-ROM that accompanies this book to apply and verify your addressing scheme. Check to see that all devices on directly connected networks can ping each other.

Successful implementation of a solution requires that

- Only the 192.168.1.0/24 address space is used.
- PCs and routers can ping all IP addresses.

Packet Tracer Challenge

Packet Tracer Skills Integration Challenge

Introduction

This activity focuses on subnetting skills, basic device configurations, and static routing. After you configure all devices, test for end-to-end connectivity and examine your configuration. Open the file LSG02-PTSkills3.pka on the CD-ROM that accompanies this book. Use the topology in Figure 3-6 and the addressing table in Table 3-10 to document your design.

Upon completion of this lab, you will be able to

- Design and document an addressing scheme based on requirements
- Select appropriate equipment and cable the devices
- Apply a basic configuration to the devices
- Configure static and default routing
- Verify full connectivity between all devices in the topology

Figure 3-6 Packet Tracer Skills Integration Challenge Topology

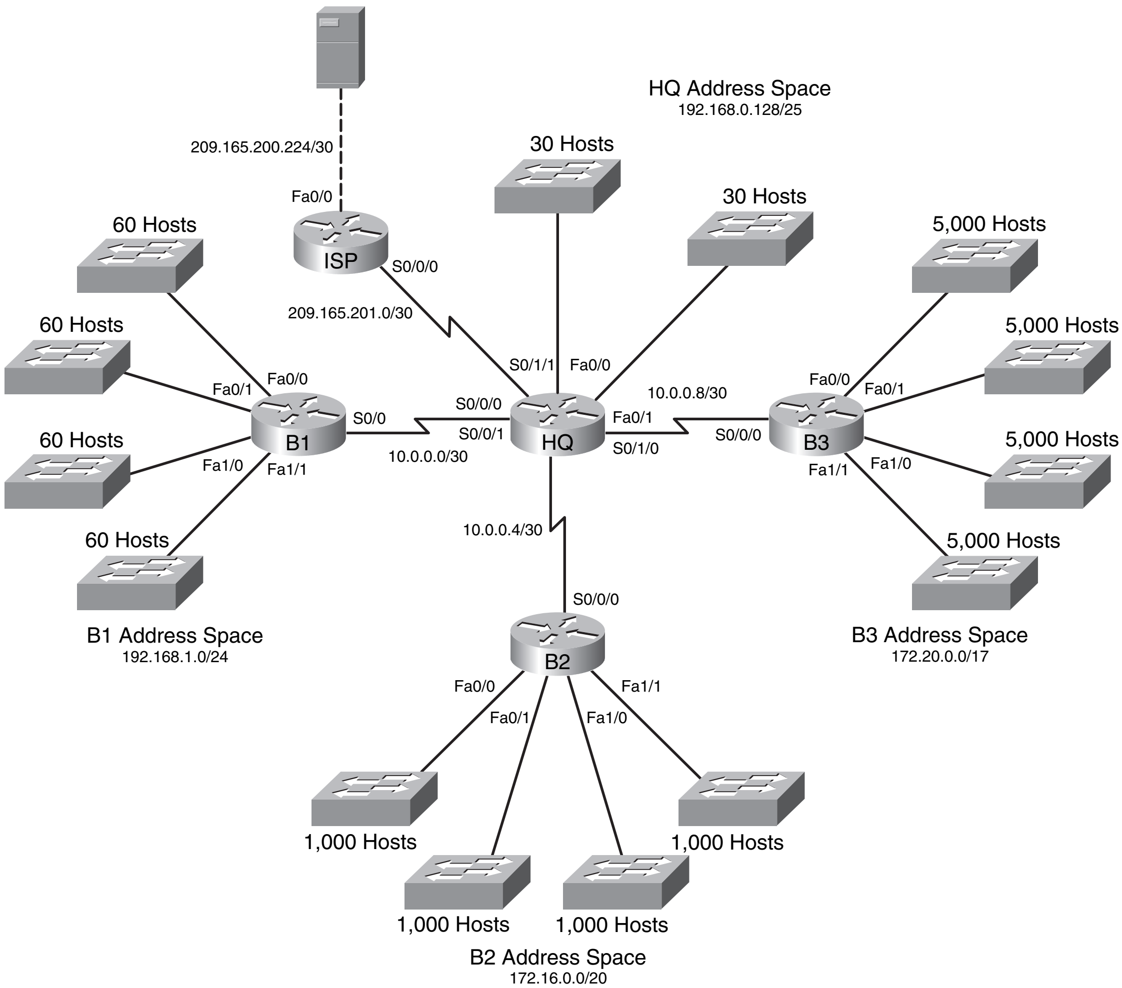


Table 3-10 provides a rough outline for you to assign the IP addresses and subnet masks for the devices shown in the network topology of Figure 3-6.

Table 3-10 Addressing Table for Packet Tracer Skills Integration Challenge

Device	Interface	IP Address	Subnet Mask
HQ	Fa0/0		
	Fa0/1		
	S0/0/0	10.0.0.1	255.255.255.252
	S0/0/1	10.0.0.5	255.255.255.252
	S0/1/0	10.0.0.9	255.255.255.252
	S0/1/1	209.165.201.2	255.255.255.252
B1	Fa0/0		
	Fa0/1		
	Fa1/0		
	Fa1/1		
	S0/0/0	10.0.0.2	255.255.255.252
B2	Fa0/0		
	Fa0/1		
	Fa1/0		
	Fa1/1		
	S0/0/0	10.0.0.6	255.255.255.252
B3	Fa0/0		
	Fa0/1		
	Fa1/0		
	Fa1/1		
	S0/0/0	10.0.0.10	255.255.255.252
ISP	S0/0/0	209.165.201.1	255.255.255.252
	Fa0/0	209.165.200.225	255.255.255.252
Web Server	NIC	209.165.200.226	255.255.255.252

Task 1: Design and Document an Addressing Scheme

Step 1. Design an addressing scheme.

Based on the network requirements shown in Figure 3-6, design an appropriate addressing scheme.

- The HQ, B1, B2, and B3 routers each have an address space. Subnet the address space based on the host requirements.
- For each address space, assign subnet 0 to the Fa0/0 LAN, subnet 1 to the Fa0/1, and so on.

Step 2. Document the addressing scheme.

- Use Table 3-10 to document the IP addresses and subnet masks. Assign the first IP address to the router interface.
- For the WAN links, assign the first IP address to HQ.

Task 2: Apply a Basic Configuration

Using your documentation, configure the routers with basic configurations including addressing and host names. Use **cisco** as the line passwords and **class** as the secret password. Use **64000** as the clock rate. ISP is the DCE in its WAN link to HQ, and HQ is the DCE for all other WAN links.

Task 3: Configure Static and Default Routing

Configure static and default routing using the exit interface argument, according to the following criteria:

- HQ should have three static routes and one default route.
- B1, B2, and B3 should have one default route.
- ISP should have seven static routes. This will include the three WAN links between HQ and the branch routers B1, B2, and B3.

Task 4: Test Connectivity and Examine the Configuration

Step 1. Test connectivity.

You should now have end-to-end connectivity. Use ping to test connectivity across the network. Each router should be able to ping all other router interfaces and the web server.

Use extended ping to test LAN connectivity to the web server. For example, to test the Fa0/0 interface on B1, you would do the following:

```
B1# ping
Protocol [ip]:
Target IP address: 209.165.200.226
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: yes
Source address or interface: 192.168.1.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 209.165.200.226, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 67/118/138 ms
```

Troubleshoot until pings are successful.

Step 2. Examine the configuration.

Use verification commands to make sure that your configurations are complete.