ROUTE

Implementing Cisco IP Routing

Version 1.0

Lab Guide

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ROUTE

Lab Guide

Overview

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Lab 1-1: Assess Skills for Implementing Complex Networks

Complete this lab activity to confirm and refresh your Layer 2 and Layer 3 skills from *Interconnecting Cisco Networking Devices Part 2* (ICND2).

Activity Objective

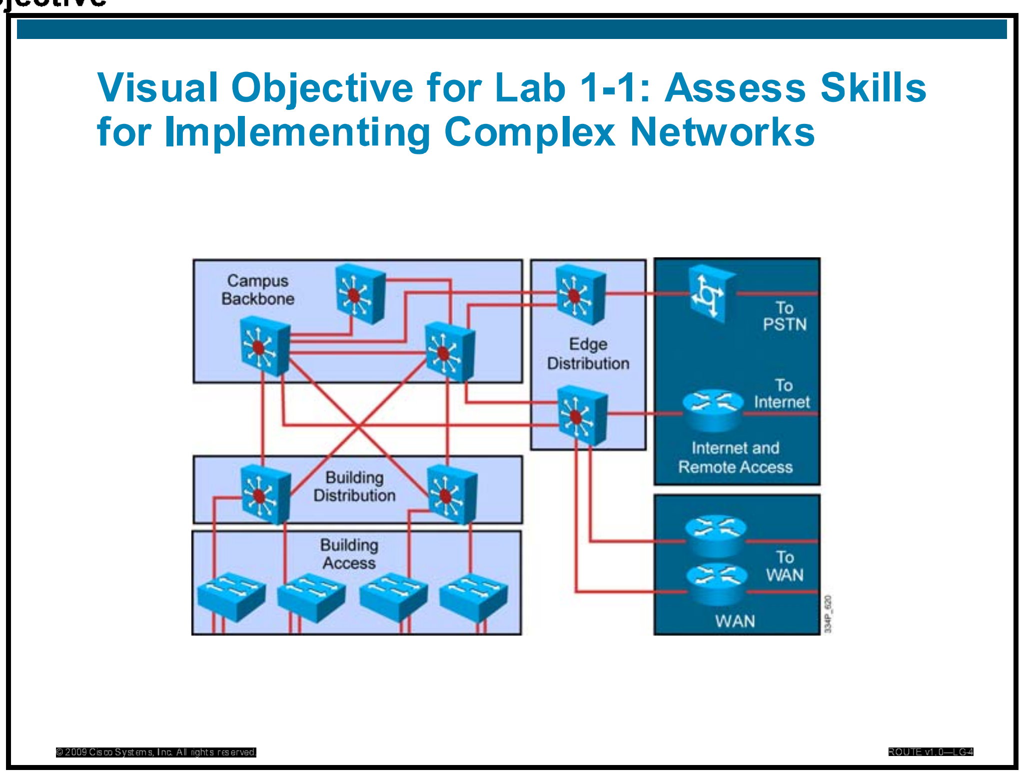
In this activity, you will put together a network implementation plan for an complex enterprise network. This lab activity is designed to reinforce the skills necessary to build a network implementation plan for complex networks. You will need to identify network requirements, acquire required information, and create a network implementation plan for one part of the complex enterprise network. One campus network will be implemented. After completing this activity, you will be able to meet these objectives:

- Identify the requirements the network has to provide
- Identify the required information
- Identify the tasks necessary for the implementation and create an implementation plan
- Verify the activity

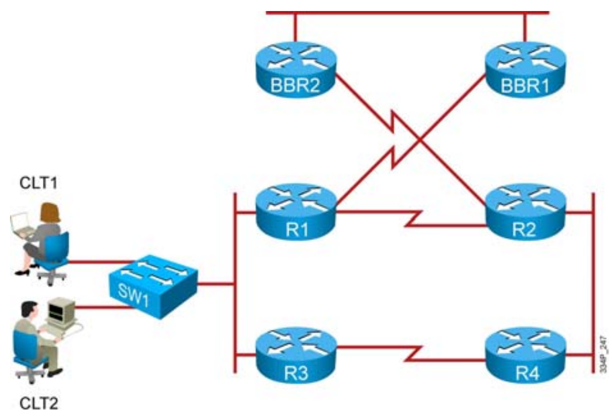
Information Packet

The figures illustrate what you will accomplish in this activity.

Visual Objective



Visual Objective for Lab 1-1: Campus Network To Be Implemented



 ROUTE v1.0—LG-5

Implementation Policy

You were hired by No-route, Inc. to implement their Layer 3 enterprise network. They provided you with a cabling plan and asked you to help them implement routing in their network. As you were collecting information about their network infrastructure, they provided the following diagrams and list of equipment.

The first figure in the Visual Objective diagrams represents an enterprise network. The second figure represents network at No-route, Inc., which is simplified in order to create the implementation plan as part of Lab 1-1.

Their infrastructure includes these submodules:

- Access
- Distribution
- Backbone

The equipment is not installed yet. At the beginning typical requirements for a network must be identified. A quick call to the local administrator results in identification of the following requirements:

- **Functionality**: The enterprise network must support the applications and data flows required within the required time frames.
- **Performance**: Performance includes three primary metrics: responsiveness, throughput (volume), and utilization.
- **Scalability**: Networks must provide scalability for future growth including new users and the amount of data and applications that the network must support.

- **Availability**: Nearly 100 percent availability is required for most enterprise data networks. (Critical applications may be required to meet a standard of availability approaching 99.999 percent ["five nines"]).
- **Manageability**: A network must be manageable across the entire infrastructure.
- **Cost-effectiveness**: Cost-effectiveness is a key concern for most enterprises, given limited budgets.

Based on the important parameters above, determine what network information must be identified.

The detailed requirements for the implementation plan to employ routing in a customer network must be collected. Collect all of the required parameters in order to correctly implement the network. All of the details needed for the configuration must be provided by the customer.

When all details are defined and documented, you can plan the implementation and create the implementation plan, which describes the steps required to implement routing in the customer network. Planning means deciding on a starting point and determining the progression of steps necessary to configure the network and make it operational. Spend some time discussing the best course of action with your pod partner to allow for the most efficient way of configuring the network.

Device Information

The table provides the information specific to each switch in the network:

Device name	Role	IP address	Gateway	VLAN
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
SW1	POD switch			
BBR1	Backbone router			
BBR2	Backbone router			

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank network device requirements list	Task 1
Blank implementation requirements list	Task 2
Blank implementation and verification plan form	Task 3
Debrief alternate solutions form	End of this lab
Implementation requirement hints	"Hints" section at the end of this lab
Implementation hints	"Hints" section at the end of this lab
Verification hints	"Hints" section at the end of this lab

Task 1: Identify the Network Requirements

The first step in your configuration deployment is to identify the requirements of each device according to the customer network requirements.. If you are unsure, you can use the information provided in the “Hints” section at the end of this lab.

Device	Implementation Requirement

Task 2: Identify and Gather the Required Information

The second step in your configuration deployment is to gather and document all the detailed information that will be used to create an implementation and verification plan. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Implementation Order	Values and Items to Implement

Complete √	Device	Implementation Order	Values and Items to Implement

Task 3: Create an Implementation and Verification Plan

The beginning of any successful implementation is the creation of the implementation and verification plan. Create a list of steps needed to implement and verify the routing in the customer network. For the purpose of Lab 1-1, there is no need to use configuration commands. The implementation plan should define the general steps required to implement and verify routing in the customer network. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Feature	Verification Method and Expected Results

Complete √	Device	Feature	Verification Method and Expected Results

Alternate Resources and Solutions

Other groups may have implemented a solution that is different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 1-1 Hint Sheet: Assess Skills for Implementing Complex Networks

Identify the Requirements the Network Must Provide

To facilitate the configuration of your network, the first task asks you to identify the requirements of the network—the things that the network must provide according to the customer specifications. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

No.	Implementation Requirement	
1.	Application and data requirements	
2.	Existing equipment and software version	
3.	Existing topology (logical and physical)	
4.	IP addressing plan	
5.	Select routing protocols	
6.	Scalability configuration (summarization, stub areas, and so on)	

Implementation Requirements

The second task asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list with details:

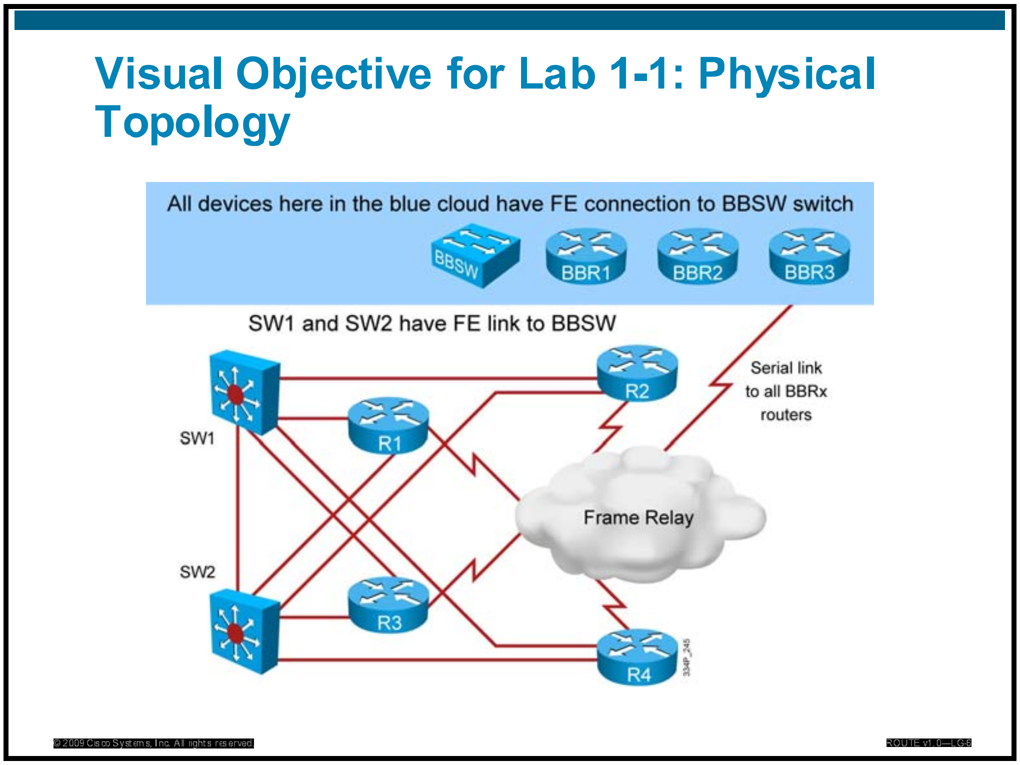
- Application and data requirements

Name of Application	Building or Location	Type of Application	Number of Users	Number of Servers	Bandwidth/ Delay Tolerance/ Loss Characteristics
Marketing DSS	Building 1	Database (OLAP)	137	3	High bandwidth High delay tolerance Low loss
Corporate email	Building 2	Email	65	2	Low bandwidth Low delay tolerance Low loss
File server	Building 3	File sharing (FTP)	48	1	Low bandwidth Medium delay tolerance Low loss

- Existing equipment and software version

Device	Role	Software Version
CLT1	Client station	Mac OS
CLT2	Client station	Windows OS
SW1	Access switch	Advanced IP service 12.2-46
R1	Distribution router	Advanced IP service 12.4(10)
R2	Distribution router	Advanced IP service 12.4(10)
R3	Distribution router	Advanced IP service 12.4(10)
R4	Distribution router	Advanced IP service 12.4(10)
BBR1	Core router	Advanced IP service 12.4(10)
BBR2	Core router	Advanced IP service 12.4(10)

- Existing topology (logical and physical)



- IP addressing plan

Link	Network
R1 to R2	10.1.112.0/24
R1 LAN, R3 LAN	172.30.13.0/24
R3 to R4	10.1.134.0/24
R2 AN, R4 LAN	172.30.24.0/24
R1 to BBR1	10.1.115.0/24
R2 to BBR2	10.1.116.0/24

- Select routing protocols

  EIGRP is selected as the interior gateway protocol because the following network characteristics are required for the customer: supports large network size, has very high speed of convergence, and supports VLSM.

  BGP is selected as the exterior gateway protocol because complex enterprise networks support redundant connectivity to ISPs and the customer has its own public IP addresses and public BGP autonomus system number.

- Scalability configuration (summarization, stub areas, and so on)

  The network design uses IP addressing, which supports summarization on every distribution router.

  Some branch offices are configured as stub networks. The default route is sent inside the stub network and only summary IP addresses are propagated outside of the stub network.

Implementation Plan

In Task 3 you need to create an implementation and verification plan and document the plan. There are several possible ways to accomplish this task. One possible way is to group items that are common to all devices in a template, and then apply this template to all of the devices. You can then configure each device with items that are unique to each device, such as IP addresses or gateway. The implementation steps are specified in the following list:

- Document network information.
- Prepare the required resources.
  - Connect the PC to the equipment.
  - Select specific tools and equipment.
  - Select and reserve resources (project contact list).
- Configure the IP addressing on all devices in the network.
- Enable all of the interfaces.
- Configure the IP routing protocol where needed.
- Configure summarization and stub areas.
- Verify proper operation of IP routing protocol; check the connectivity in the network.
- Measure the performance and document the results.
- Create a backup of the configuration.
- Document the implementation plan, baseline, performance, and recommendations.

Verification Plan

Complete √	Device	Feature	Verification Method and Expected Results	Hint
	ALL		All Interfaces must be enabled.	
	ALL		Configuration of the routing protocol must be done and the verification must prove that the routing protocol is running.	
	ALL		Required networks must be advertised.	
	R1, R2		Summary route to Null0 must appear on every customer edge router.	
	ALL		Preferred path must be selected by the routing protocol.	

Complete √	Device	Feature	Verification Method and Expected Results	Hint

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Lab 2-1: Configure and Verify EIGRP Operations

Complete this lab activity to practice what you learned in the related module.

Activity Objective

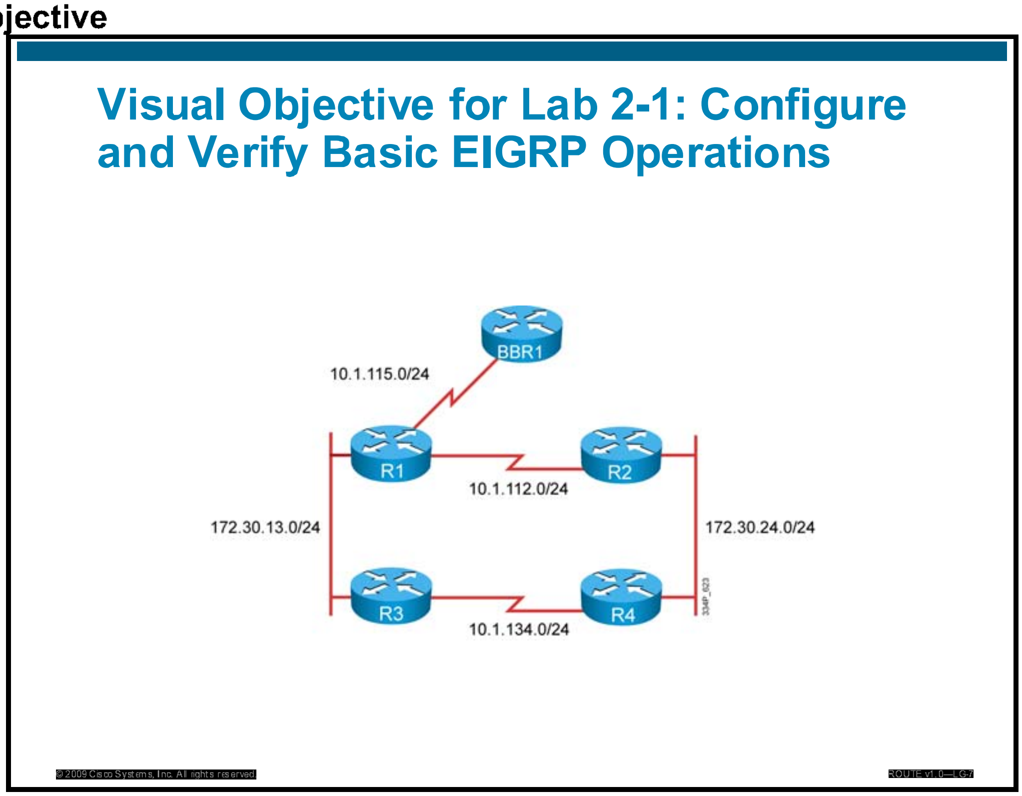
In this activity, you will use correct commands, tools, and steps to configure and verify a basic EIGRP implementation. After completing this activity, you will be able to meet these objectives:

- Configure and verify basic EIGRP operation over WAN and LAN interfaces
- Select the required tools and commands to configure basic EIGRP operations
- Configure EIGRP on the LAN interfaces using a secondary IP address on one router
- Influence the path selection for EIGRP by changing the metric
- Optimize EIGRP operation to prevent unnecessary hellos from being sent
- Optimize EIGRP operation by minimizing the routing table size using summarization
- Make a list of the configuration and implementation steps
- Write a verification and test plan to verify the proper implementation and operation according to the expected performance criteria
- Verify the configuration and operation by using the proper **show** and **debug** commands

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following lists the detailed configuration requirements for all devices in the company network:

- Set the proper initial configuration on all devices in your lab. The instructor will provide the necessary information on how to set the initial configuration on all devices.
- First, a basic EIGRP configuration is required on each of the routers in your network—routers R1, R2, R3, and R4. The EIGRP will be used to exchange routing information in order to achieve IP connectivity between the subnets deployed on your routers and backbone BBR1 router as well. The EIGRP configuration should be so specific that if an additional network is added to the router, such a network is not automatically advertised. The IP routing tables on all your routers should be populated with all of the specific IP subnets in your network. Automatic summarization must be disabled.
- Basic EIGRP configuration must be verified in order to see if it meets requirements. Verify that the proper EIGRP adjacencies have been set up between the routers in your pod and between routers R1 and BBR1. Router R1 should have established three adjacencies and routers R2, R3, and R4 should have established two adjacencies. Examine each router and make sure that EIGRP has been set up to advertise the IP subnets present on WAN and LAN interfaces with the correct mask, without examining the IP routing table and EIGRP topology database. Verify the EIGRP topology database and compare it against the EIGRP information that was put into the IP routing table on router R1. You should be able to see that all of the networks acquired via EIGRP were put into the routing table and that the metric related to an individual route corresponds to the value present in the topology table. Examine the EIGRP topology table and IP routing table on router R4 also. Keep in mind that R4 has two paths in the topology and IP routing table for the networks that are external to your pod. If you look at the metric either in the topology table or in the IP routing table for the network 192.168.1.0/24, you can see that the metric is the same for both sources. Therefore there are equal cost paths for the same destination being installed in the routing table. Examine the EIGRP in action: enable EIGRP event debugging on router R4 and disable the interface between routers R1 and R2. When the **debug** output is observed, you should see EIGRP packets being exchanged, and that for network 10.1.112.0/24 (the one used between R1 and R2), router R4 responds with an infinite metric to an EIGRP query.
- EIGRP can install multiple equal cost paths into the routing table, which is what happens on router R4. Tis router has two possible paths to the destination networks that are external to your pod. For the metric calculation, EIGRP uses multiple parameters such as delay and bandwidth. In this task, you will influence EIGRP path selection by changing the metric of the routes to eliminate equal cost paths from the router R4 routing table, but still preserve the EIGRP fast convergence in a case of topology change.
- Verify the path selection process by examining the router R4 EIGRP topology table and verify that two paths still exist for the 192.168.x.0/24 subnets, with the path via router R3 being the secondary option. Verify on the router R4 routing table that only the best path to destination networks 192.168.x.0/24 exists, the path through router R2. Verify that the secondary path through router R3 is put into the routing table of router R4 in case of a primary path failure without an FD change.
- When a network statement is used under EIGRP, EIGRP not only starts to advertise that subnet but also tries to form an adjacency through that interface. EIGRP does so by sending hello packets. Sometimes this is not desired; thus, the adjacency formation should be prevented by suppressing the hello packets. Disable the unnecessary EIGRP adjacencies to preserve the interface bandwidth and the CPU resources of the router. The configuration will be added to routers R1 and R3.

- Verify that you have disabled EIGRP between routers R1 and R3 on the LAN segment and that hello packets are suppressed and not being sent over the LAN interface on routers R1 and R3. An EIGRP adjacency between routers R1 and R3 over the LAN interface must not be present. At the same time, the IP routing table on router R4 still has information on how to access the network 172.30.13.0/24 used on the LAN interface between routers R1 and R3.
- As a last step, you must enable the EIGRP route summarization for the networks external to your pod, that is, the 192.168.x.0/24 networks. This configuration will add to the stability and speed of the convergence for the network by controlling the scope of queries, minimizing update traffic, and minimizing routing table size.
- Verify that manual route summarization for subnets 192.168.x.0/24 is applied on router R1, the more specific 192.168.x.0/24 subnets, and the 192.168.0.0/16 summary route pointing to the Null0 interface in the router R1 routing table. Routing tables on routers R2, R3, and R4 must have a summary route 192.168.0.0/16 and no specific 192.168.x.0/24 subnets. You do not have to apply summarization on the LAN interface because an EIGRP adjacency is disabled there. Keep in mind that you also do not have to enable summarization on Serial0/0/0.2 toward router BBR1 because the subnets are received from router BBR1.

Device Information

The table provides information specific to each switch in the network:

Device Name	Role	IP Address	Gateway	VLAN
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR1	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
(no) auto-summary	Enables (disables) automatic summarization of classless subnets
(no) shutdown	Administratively disables (enables) the interface
debug ip eigrp	Enables EIGRP event debugging
delay *tens-of-microsec*	Specifies the delay on interfaces (used for routing processes)
interface *type slot/port*	Enters the interface configuration mode
ip summary-address eigrp *as-number network mask*	Configures manual EIGRP summarization on an interface
network *x.x.x.x*	Enables EIGRP on interfaces belonging to a specified network
passive-interface *interface*	Disables EIGRP hellos to be sent on an interface
router eigrp *as-number*	Starts an EIGRP routing process with the given AS number
show ip eigrp neighbors	Lists the EIGRP neighbors and relevant information on EIGRP neighbor adjacencies
show ip eigrp topology [**prefix**] [**mask**]	Displays the EIGRP topology table (whole, or only per prefix/mask)
show ip protocols	Shows the information about the configured IP protocols
show ip route [**eigrp**]	Displays the whole IP routing table or EIGRP routes only
undebug all	Disables debugging on the router

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	"Hints" section at the end of this lab
Implementation and verification form hints	"Hints" section at the end of this lab
Implementation and verification hints	"Hints" section at the end of this lab
Solution configuration answer key (step-by-step procedure)	End of the "Hints" section at the end of this lab

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Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what you need in order to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirements list. If you are unsure, you can use the information provided in the “Hints” section at the end of this lab.

Device	Implementation Requirement

Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. You can use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation and verification plan. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once you implement your solution, you need to verify that your configuration is working and fulfills all of the requirements specified by the customer. Keep in mind that once you leave the customer location, a network specialist will verify your configuration. Your ability to implement the solution according to the specifications provided by the customer will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure of the verification steps, use the information provided in the “Hints” section at the end of this lab.

Student Notes:

Alternate Resources and Solutions

Other groups may have implemented a solution that is different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

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Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 2-1 Hint Sheet: Configure and Verify EIGRP Operations

Implementation Requirements

To facilitate the configuration of your network, the first task asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Define EIGRP AS number used in the lab.	Check AS number used in the BBR1 router
ALL	Define which networks are used in the lab in order to advertise all specific networks.	Visual Objective diagrams
R4	Examine and write down the metric for 192.168.x.0/24 subnets for both possible paths by looking into the EIGRP topology table.	Lab
R1, R3	Examine and write down the current delay value of the FastEthernet0/0 interfaces.	Lab
R4	Check for the specific 192.168.x.0/24 subnets in order to apply manual summarization.	Lab

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load initial configuration	All pod routers must be preloaded with the initial configuration for the lab.	Step 1
	R1	2	Enable EIGRP routing protocol on router R1 on the WAN interfaces Serial 0/0.1, Serial0/0.2, and on the LAN interface FastEthernet0/0. Router BBR1 is preconfigured with EIGRP AS 1. Apply the configuration in a way that EIGRP does not automatically advertise any additional network that is added to the router.	Verify that the proper EIGRP adjacencies have been set up between the routers in your pod and between routers R1 and BBR1.	Step 2
	R1–R4	3	Enable EIGRP routing protocol on routers R2, R3, and R4, on the WAN interface Serial 0/0.1, and on the LAN interface FastEthernet0/0. Apply the configuration in a way that EIGRP does not automatically advertise any additional networks that are added to the router.	Verify that router R1 has established three adjacencies, and routers R2, R3, and R4 have two adjacencies. Also examine how long the adjacencies have been set up and whether there is any problem with neighbor communication, such as routing packets remaining in the queue.	Step 3
	R1, R4	4		Verify on routers R1 and R4 that the EIGRP has been set up to advertise the IP subnets present on the WAN and LAN interfaces with the correct mask without examining the IP routing table and EIGRP topology database.	Step 4

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1	5		Verify the EIGRP topology database and compare it to the EIGRP information that was put into the IP routing table on router R1. You should be able to see that all networks acquired via EIGRP were put into the routing table and that the metric related to an individual route corresponds to the value present in the topology table.	Step 4
	R4	6		Examine the EIGRP topology table and IP routing table on router R4. Keep in mind that R4 has two paths in the topology and the IP routing table for the networks that are external to your pod. If you look at the metric either in the topology table or in the IP routing table for the network 192.168.1.0/24, you can see that the metric is the same for both sources, thus we have equal cost paths for the same destination being installed in the routing table.	Step 4
	R1, R2, R4	7		Examine the EIGRP in action; that is, enable EIGRP event debugging on router R4 and disable the interface between routers R1 and R2. Observing the debug output, you should see EIGRP packets being exchanged and that for network 10.1.112.0/24 (the one used between R1 and R2), R4 responds with an infinite metric to an EIGRP query.	Step 5

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1, R3, R4	8	Change the delay parameter on the LAN segment between routers R1 and R3 so that the preferred path to the 192.168.x.0/24 subnets for router R4 is through router R2. Enable the interfaces that were disabled in order to simulate the failure.	Examine the EIGRP topology table for router R4 and verify that two paths still exist for the 192.168.x.0/24 subnets, with the path via R3 being the secondary option. Examine the routing table for router R4 to verify that only the best path to destination networks 192.168.x.0/24 exist, the one through router R2.	Step 6
	R4	9	The configuration should not prevent router R4 from using the second path in case of a primary path failure; that is, the secondary path should become a successor.	Verify that the secondary path through router R3 is put into the routing table of router R4 in case of a primary path failure without the FD being changed.	Step 7
	R1, R3, R4	10	Prevent routers R1 and R3 from forming an EIGRP adjacency over the LAN network to preserve the interface bandwidth and CPU resources on the routers. The configuration you apply should prevent the routers from sending EIGRP hello packets over the FastEthernet0/0 interface. You should not apply other types of filtering. Enable the interfaces that were disabled in order to simulate the failure.	Verify that EIGRP between routers R1 and R3 on the LAN segment is disabled, hello packets are suppressed from being sent over the LAN interface on routers R1 and R3, and the EIGRP adjacency between R1 and R3 over the LAN interface is not present.	Step 8

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R4	11		Verify that the IP routing table on router R4 still has the information on how to access the network 172.30.13.0/24, which is used on the LAN interface between routers R1 and R3, and that R4 still knows how to reach the network 172.30.12.0/24 on the LAN segment between routers R1 and R3. Verify that you can see the individual 192.168.x.0/24 networks in the IP routing table on router R4.	Step 8
	R1–R4	12	Enable manual summarization of the 192.168.x.0/24 networks on router R1 to advertise only 192.168.0.0/16 to the rest of the routers in your pod.	Verify that the routing table on router R1 holds the specific 192.168.x.0/24 subnets and 192.168.0.0/16 summary route pointing to the Null0 interface. Verify that the routing tables on routers R2, R3, and R4 have summary route 192.168.0.0/16 and no specific 192.168.x.0/24 subnets.	Step 9

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

   1.1. The instructor will provide the guidelines for changing the initial configuration.

2. Configure EIGRP on router R1 in your pod.

   2.1. Use the following example to configure router R1 in this lab:

```
R1#
router eigrp 1
 network 10.1.112.0 0.0.0.255
 network 10.1.115.0 0.0.0.255
 network 172.30.13.0 0.0.0.255
 no auto-summary
```

   2.2. Verify the EIGRP configuration on router R1.

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.1.115.5              Se0/0/0.4         11 00:17:16 1239  5000  0  3
```

3. Configure EIGRP on routers R2 through R4 in your pod.

3.1. Use the following example to configure the routers in this lab:

```
R2#
router eigrp 1
 network 10.1.112.0 0.0.0.255
 network 172.30.24.0 0.0.0.255
 no auto-summary

R3#
router eigrp 1
 network 10.1.134.0 0.0.0.255
 network 172.30.13.0 0.0.0.255
 no auto-summary

R4#
router eigrp 1
 network 10.1.134.0 0.0.0.255
 network 172.30.24.0 0.0.0.255
 no auto-summary
```

3.2. Verify the EIGRP adjacencies on your pod router.

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
2   10.1.115.5              Se0/0/0.4         11 00:17:16 1239   5000  0  3
1   10.1.112.2              Se0/0/0.1         12 00:17:25  538   3228  0  14
0   172.30.13.3             Fa0/0             13 00:17:31  416   2496  0  13

R2#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   10.1.112.1              Se0/0/0.1         10 00:19:56   39    234  0  20
0   172.30.24.4             Fa0/0             14 00:21:11    1    200  0  12

R3#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   172.30.13.1             Fa0/0             14 00:20:51    3    200  0  19
0   10.1.134.4              Se0/0/0.3         10 00:21:17  670   4020  0  13

R4#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   10.1.134.3              Se0/0/0.3         14 00:22:25   41    246  0  14
0   172.30.24.2             Fa0/0             11 00:23:08    1    200  0  13
```

4. Verify that the EIGRP topology and IP routing table appear on the routers in your pod.

```
R1#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.24.0 [90/2172416] via 10.1.112.2, 04:13:27, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.134.0 [90/2172416] via 172.30.13.3, 04:13:27, FastEthernet0/0
D    192.168.1.0/24 [90/2297856] via 10.1.115.5, 04:13:19, Serial0/0/0.4
D    192.168.2.0/24 [90/2297856] via 10.1.115.5, 04:13:19, Serial0/0/0.4
D    192.168.3.0/24 [90/2297856] via 10.1.115.5, 04:13:19, Serial0/0/0.4

R2#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.13.0 [90/2172416] via 10.1.112.1, 00:31:22, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 3 subnets
```



```
D       10.1.115.0 [90/2681856] via 10.1.112.1, 00:31:22, Serial0/0/0.1
D       10.1.134.0 [90/2172416] via 172.30.24.4, 00:31:22, FastEthernet0/0
D    192.168.1.0/24 [90/2809856] via 10.1.112.1, 00:31:22, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.112.1, 00:31:22, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.112.1, 00:31:22, Serial0/0/0.1
```

```
R3#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.24.0 [90/2172416] via 10.1.134.4, 00:32:20, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.115.0 [90/2172416] via 172.30.13.1, 00:32:27, FastEthernet0/0
D       10.1.112.0 [90/2172416] via 172.30.13.1, 00:32:05, FastEthernet0/0
D    192.168.1.0/24 [90/2300416] via 172.30.13.1, 00:32:27, FastEthernet0/0
D    192.168.2.0/24 [90/2300416] via 172.30.13.1, 00:32:27, FastEthernet0/0
D    192.168.3.0/24 [90/2300416] via 172.30.13.1, 00:32:27, FastEthernet0/0
```

```
R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.13.0 [90/2172416] via 10.1.134.3, 00:32:40, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.115.0 [90/2684416] via 172.30.24.2, 00:32:40, FastEthernet0/0
                   [90/2684416] via 10.1.134.3, 00:32:40, Serial0/0/0.3
D       10.1.112.0 [90/2172416] via 172.30.24.2, 00:32:40, FastEthernet0/0
D    192.168.1.0/24 [90/2812416] via 172.30.24.2, 00:32:40, FastEthernet0/0
                    [90/2812416] via 10.1.134.3, 00:32:40, Serial0/0/0.3
D    192.168.2.0/24 [90/2812416] via 172.30.24.2, 00:32:40, FastEthernet0/0
                    [90/2812416] via 10.1.134.3, 00:32:40, Serial0/0/0.3
D    192.168.3.0/24 [90/2812416] via 172.30.24.2, 00:32:40, FastEthernet0/0
                    [90/2812416] via 10.1.134.3, 00:32:40, Serial0/0/0.3
```

```
R1#show ip protocols
Routing Protocol is "eigrp 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  EIGRP maximum hopcount 100
  EIGRP maximum metric variance 1
  Redistributing: eigrp 1
  EIGRP NSF-aware route hold timer is 240s
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    10.1.112.0/24
    10.1.115.0/24
    172.30.13.0/24
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.112.2            90      00:33:19
    10.1.115.5            90      00:35:21
    172.30.13.3           90      00:33:19
  Distance: internal 90 external 170
```

```
R2#show ip protocols
Routing Protocol is "eigrp 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  EIGRP maximum hopcount 100
  EIGRP maximum metric variance 1
  Redistributing: eigrp 1
  EIGRP NSF-aware route hold timer is 240s
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
```

```
    10.1.112.0/24
    10.0.0.0
    172.30.24.0/24
    172.30.0.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.112.1            90      00:34:05
    172.30.24.4           90      00:34:05
  Distance: internal 90 external 170
```

R3#show ip protocols

```
Routing Protocol is "eigrp 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  EIGRP maximum hopcount 100
  EIGRP maximum metric variance 1
  Redistributing: eigrp 1
  EIGRP NSF-aware route hold timer is 240s
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    10.1.134.0/24
    172.30.13.0/24
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.134.4            90      00:34:35
    172.30.13.1           90      00:34:35
  Distance: internal 90 external 170
```

R4#show ip protocols

```
Routing Protocol is "eigrp 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  EIGRP maximum hopcount 100
  EIGRP maximum metric variance 1
  Redistributing: eigrp 1
  EIGRP NSF-aware route hold timer is 240s
  Automatic network summarization is not in effect
  Maximum path: 4
  Routing for Networks:
    10.1.134.0/24
    172.30.24.0/24
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.134.3            90      00:35:10
    172.30.24.2           90      00:35:10
  Distance: internal 90 external 170
```

R1#show ip eigrp topology

```
IP-EIGRP Topology Table for AS(1)/ID(172.30.13.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.1.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 192.168.2.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 192.168.3.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 10.1.115.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.4
```



```
P 10.1.112.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2172416
        via 172.30.13.3 (2172416/2169856), FastEthernet0/0
P 172.30.24.0/24, 1 successors, FD is 2172416
        via 10.1.112.2 (2172416/28160), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
```

R2#show ip eigrp topology

```
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.2)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.112.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.112.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.112.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.112.1 (2681856/2169856), Serial0/0/0.1
P 10.1.112.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2172416
        via 172.30.24.4 (2172416/2169856), FastEthernet0/0
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.112.1 (2172416/28160), Serial0/0/0.1
```

R3#show ip eigrp topology

```
IP-EIGRP Topology Table for AS(1)/ID(172.30.13.3)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.1.0/24, 1 successors, FD is 2300416
        via 172.30.13.1 (2300416/2297856), FastEthernet0/0
P 192.168.2.0/24, 1 successors, FD is 2300416
        via 172.30.13.1 (2300416/2297856), FastEthernet0/0
P 192.168.3.0/24, 1 successors, FD is 2300416
        via 172.30.13.1 (2300416/2297856), FastEthernet0/0
P 10.1.115.0/24, 1 successors, FD is 2172416
        via 172.30.13.1 (2172416/2169856), FastEthernet0/0
P 10.1.112.0/24, 1 successors, FD is 2172416
        via 172.30.13.1 (2172416/2169856), FastEthernet0/0
P 10.1.134.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 2172416
        via 10.1.134.4 (2172416/28160), Serial0/0/0.3
P 172.30.13.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
```

R4#show ip eigrp topology

```
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.4)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.1.0/24, 2 successors, FD is 2812416
        via 10.1.134.3 (2812416/2300416), Serial0/0/0.3
        via 172.30.24.2 (2812416/2809856), FastEthernet0/0
P 192.168.2.0/24, 2 successors, FD is 2812416
        via 10.1.134.3 (2812416/2300416), Serial0/0/0.3
        via 172.30.24.2 (2812416/2809856), FastEthernet0/0
P 192.168.3.0/24, 2 successors, FD is 2812416
```

```
        via 10.1.134.3 (2812416/2300416), Serial0/0/0.3
        via 172.30.24.2 (2812416/2809856), FastEthernet0/0
P 10.1.115.0/24, 2 successors, FD is 2684416
        via 10.1.134.3 (2684416/2172416), Serial0/0/0.3
        via 172.30.24.2 (2684416/2681856), FastEthernet0/0
P 10.1.112.0/24, 1 successors, FD is 2172416
        via 172.30.24.2 (2172416/2169856), FastEthernet0/0
P 10.1.134.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.134.3 (2172416/28160), Serial0/0/0.3
```

5. Examine the EIGRP in action on router R4 in your pod. Simulate a WAN failure:

```
R1(config)#interface serial 0/0/0.1
R1(config-subif)#shutdown
```

Note	In order to simulate a WAN failure, you can shut down the interface between routers R1 and R2 on router R1. There are also other ways to simulate a WAN failure.

5.2. Examine the results after the WAN failure:

```
R4#debug ip eigrp
IP-EIGRP Route Events debugging is on
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Processing incoming QUERY packet
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 10.1.112.0/24 M 4294967295 - 0
4294967295 SM 4294967295 - 0 4294967295
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 10.1.112.0/24 - do advertise out
Serial0/0/0.3
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 10.1.112.0/24 metric 2172416 -
1657856 514560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Processing incoming UPDATE packet
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 10.1.112.0/24 M 4294967295 -
1657856 4294967295 SM 4294967295 - 1657856 4294967295
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Processing incoming QUERY packet
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.1.0/24 M 4294967295 -
1657856 4294967295 SM 4294967295 - 1657856 4294967295
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): route installed for 192.168.1.0
()
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 192.168.1.0/24 routing table not
updated thru 172.30.24.2
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.2.0/24 M 4294967295 -
1657856 4294967295 SM 4294967295 - 1657856 4294967295
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): route installed for 192.168.2.0
()
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 192.168.2.0/24 routing table not
updated thru 172.30.24.2
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.3.0/24 M 4294967295 -
1657856 4294967295 SM 4294967295 - 1657856 4294967295
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): route installed for 192.168.3.0
()
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 192.168.3.0/24 routing table not
updated thru 172.30.24.2
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 10.1.115.0/24 M 4294967295 -
1657856 4294967295 SM 4294967295 - 1657856 4294967295
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): route installed for 10.1.115.0  ()
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 10.1.115.0/24 routing table not
updated thru 172.30.24.2
```

```
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 172.30.13.0/24 M 4294967295 -
1657856 4294967295 SM 4294967295 - 1657856 4294967295
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 192.168.1.0/24 - do advertise out
FastEthernet0/0
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.1.0/24 metric 2812416
- 1657856 1154560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 192.168.2.0/24 - do advertise out
FastEthernet0/0
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.2.0/24 metric 2812416
- 1657856 1154560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 192.168.3.0/24 - do advertise out
FastEthernet0/0
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.3.0/24 metric 2812416
- 1657856 1154560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 10.1.115.0/24 - do advertise out
FastEthernet0/0
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 10.1.115.0/24 metric 2684416 -
1657856 1026560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 172.30.13.0/24 - do advertise out
FastEthernet0/0
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 172.30.13.0/24 metric 2172416
- 1657856 514560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.1.0/24 metric 2812416
- 1657856 1154560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.2.0/24 metric 2812416
- 1657856 1154560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.3.0/24 metric 2812416
- 1657856 1154560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 10.1.115.0/24 metric 2684416 -
1657856 1026560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 192.168.1.0/24 - do advertise out
FastEthernet0/0
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.1.0/24 metric 2812416
- 1657856 1154560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 192.168.2.0/24 - do advertise out
FastEthernet0/0
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.2.0/24 metric 2812416
- 1657856 1154560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 192.168.3.0/24 - do advertise out
FastEthernet0/0
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 192.168.3.0/24 metric 2812416
- 1657856 1154560
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): 10.1.115.0/24 - do advertise out
FastEthernet0/0
4w0d: IP-EIGRP(Default-IP-Routing-Table:1): Int 10.1.115.0/24 metric 2684416 -
1657856 1026560
```

6. Configure EIGRP path selection.

    6.1. Use the following example to configure the routers in this lab:

```
R1#
interface FastEthernet0/0
 ip address 172.30.13.1 255.255.255.0
 delay 100

R3#
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 delay 100

R1(config)#interface serial 0/0/0.1
R1(config-subif)#no shutdown
```

Note	Interfaces, which were disabled in order to simulate WAN failure, are now enabled.

6.2. Verify the configuration on router R4.

```
R4#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.4)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.1.0/24, 2 successors, FD is 2812416
        via 10.1.134.3 (2812416/2300416), Serial0/0/0.3
        via 172.30.24.2 (2812416/2809856), FastEthernet0/0
P 192.168.2.0/24, 2 successors, FD is 2812416
        via 10.1.134.3 (2812416/2300416), Serial0/0/0.3
        via 172.30.24.2 (2812416/2809856), FastEthernet0/0
P 192.168.3.0/24, 2 successors, FD is 2812416
        via 10.1.134.3 (2812416/2300416), Serial0/0/0.3
        via 172.30.24.2 (2812416/2809856), FastEthernet0/0
P 10.1.115.0/24, 2 successors, FD is 2684416
        via 10.1.134.3 (2684416/2172416), Serial0/0/0.3
        via 172.30.24.2 (2684416/2681856), FastEthernet0/0
P 10.1.112.0/24, 1 successors, FD is 2172416
        via 172.30.24.2 (2172416/2169856), FastEthernet0/0
P 10.1.134.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.134.3 (2195456/51200), Serial0/0/0.3

R4#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 2 subnets
C       172.30.24.0 is directly connected, FastEthernet0/0
D       172.30.13.0 [90/2195456] via 10.1.134.3, 00:02:18, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.115.0 [90/2684416] via 172.30.24.2, 00:02:08, FastEthernet0/0
D       10.1.112.0 [90/2172416] via 172.30.24.2, 00:02:08, FastEthernet0/0
C       10.1.134.0 is directly connected, Serial0/0/0.3
D    192.168.1.0/24 [90/2812416] via 172.30.24.2, 00:02:08, FastEthernet0/0
D    192.168.2.0/24 [90/2812416] via 172.30.24.2, 00:02:08, FastEthernet0/0
D    192.168.3.0/24 [90/2812416] via 172.30.24.2, 00:02:08, FastEthernet0/0
```

7. Examine EIGRP in action on router R4 in your pod.

7.1 Simulate a WAN failure:

```
R1(config)#interface serial 0/0/0.1
R1(config-subif)#shutdown
```

Note	In order to simulate WAN failure, you can shut down the interface between routers R1 and R2 on router R1. There are also other ways to simulate a WAN failure.

7.2 Examination after a WAN failure:

```
R4#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.4)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.1.0/24, 1 successors, FD is 2812416
        via 10.1.134.3 (2835456/2323456), Serial0/0/0.3
P 192.168.2.0/24, 1 successors, FD is 2812416
        via 10.1.134.3 (2835456/2323456), Serial0/0/0.3
P 192.168.3.0/24, 1 successors, FD is 2812416
        via 10.1.134.3 (2835456/2323456), Serial0/0/0.3
P 10.1.115.0/24, 1 successors, FD is 2684416
        via 10.1.134.3 (2707456/2195456), Serial0/0/0.3
P 10.1.112.0/24, 1 successors, FD is 2172416
        via 172.30.24.2 (2172416/2169856), FastEthernet0/0
P 10.1.134.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.134.3 (2195456/51200), Serial0/0/0.3

R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.13.0 [90/2195456] via 10.1.134.3, 00:05:18, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.115.0 [90/2707456] via 10.1.134.3, 00:00:48, Serial0/0/0.3
D       10.1.112.0 [90/2172416] via 172.30.24.2, 00:05:08, FastEthernet0/0
D    192.168.1.0/24 [90/2835456] via 10.1.134.3, 00:00:48, Serial0/0/0.3
D    192.168.2.0/24 [90/2835456] via 10.1.134.3, 00:00:48, Serial0/0/0.3
D    192.168.3.0/24 [90/2835456] via 10.1.134.3, 00:00:48, Serial0/0/0.3
```

8. Configure EIGRP optimization on the LAN interface.

8.1. Use the following example to configure the routers in this lab:

```
R1#
router eigrp 1
 passive-interface FastEthernet0/0

R3#
router eigrp 1
 passive-interface FastEthernet0/0

R1(config)#interface serial 0/0/0.1
R1(config-subif)#no shutdown
```

Note	Interfaces, which were disabled in order to simulate WAN failure, are now enabled.

8.2. Verify the EIGRP adjacencies and configuration the routers in your pod.

```
R1#sh ip eigrp  neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   10.1.112.2              Se0/0/0.1         11 00:00:50   68   408  0  62
2   10.1.115.5              Se0/0/0.4         14 05:47:08   44   264  0  24

R3#sh ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.1.134.4              Se0/0/0.3         13 00:07:33  843  5000  0  66
```

```
R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.13.0 [90/2172416] via 10.1.134.3, 00:19:34, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.115.0 [90/2684416] via 172.30.24.2, 00:06:24, FastEthernet0/0
D       10.1.112.0 [90/2172416] via 172.30.24.2, 00:19:40, FastEthernet0/0
D    192.168.1.0/24 [90/2812416] via 172.30.24.2, 00:06:24, FastEthernet0/0
D    192.168.2.0/24 [90/2812416] via 172.30.24.2, 00:06:24, FastEthernet0/0
D    192.168.3.0/24 [90/2812416] via 172.30.24.2, 00:06:24, FastEthernet0/0
```

9. Configure an EIGRP summarization.

9.1. Use the following example to configure router R1 in this lab:

```
R1#
interface Serial0/0/0.1 point-to-point
 description Link to R2
 ip summary-address eigrp 1 192.168.0.0 255.255.0.0 5
```

9.2. Verify the IP routing table on the routers in your pod.

```
R1#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.24.0 [90/2172416] via 10.1.112.2, 00:31:44, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.134.0 [90/2684416] via 10.1.112.2, 00:18:33, Serial0/0/0.1
D    192.168.1.0/24 [90/2297856] via 10.1.115.5, 00:31:44, Serial0/0/0.4
D    192.168.2.0/24 [90/2297856] via 10.1.115.5, 00:31:44, Serial0/0/0.4
D    192.168.3.0/24 [90/2297856] via 10.1.115.5, 00:31:44, Serial0/0/0.4
D    192.168.0.0/16 is a summary, 00:02:26, Null0

R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.13.0 [90/2172416] via 10.1.134.3, 00:35:54, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.115.0 [90/2684416] via 172.30.24.2, 00:22:43, FastEthernet0/0
D       10.1.112.0 [90/2172416] via 172.30.24.2, 00:35:59, FastEthernet0/0
D    192.168.0.0/16 [90/2812416] via 172.30.24.2, 00:06:36, FastEthernet0/0

R4#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.4)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.0.0/16, 1 successors, FD is 2812416
        via 172.30.24.2 (2812416/2809856), FastEthernet0/0
P 10.1.115.0/24, 1 successors, FD is 2684416
        via 172.30.24.2 (2684416/2681856), FastEthernet0/0
P 10.1.112.0/24, 1 successors, FD is 2172416
        via 172.30.24.2 (2172416/2169856), FastEthernet0/0
P 10.1.134.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.134.3 (2172416/28160), Serial0/0/0.3
```


Lab 2-2: Configure and Verify EIGRP Circuit Emulation and Frame Relay Operations

Complete this lab activity to confirm and refresh your Layer 2 and Layer 3 skills from *Interconnecting Cisco Networking Devices Part 2* (ICND2).

Activity Objective

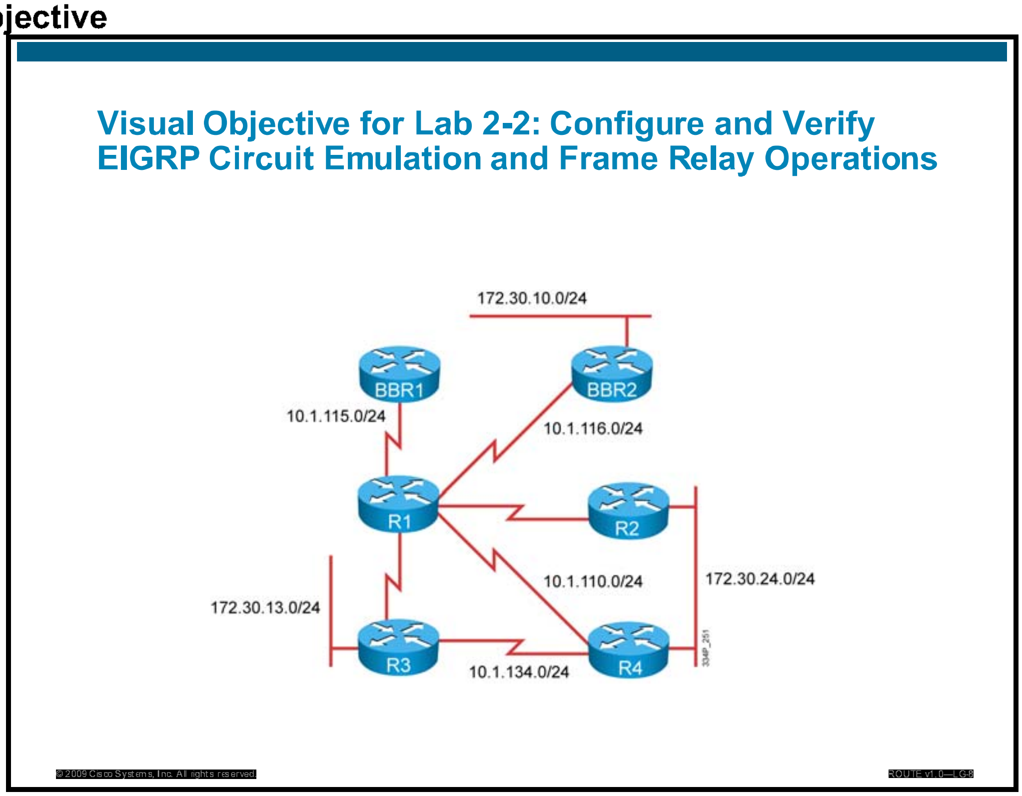
In this activity, you will use the correct commands, tools, and steps to configure and verify EIGRP operation over circuit emulation and Frame Relay. After completing this activity, you will be able to meet these objectives:

- Configure and verify EIGRP operation over the WAN interfaces (circuit emulation and Frame Relay)
- Organize the tasks into an implementation plan to implement EIGRP functions
- Use Cisco IOS commands and applications, applied in the correct order, to the selected devices and portions of the network
- Verify the correct implementation and operation according to the expected performance criteria
- Verify the configuration and operation by using the proper **show** commands
- Document the implementation, operation, and maintenance

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- Set proper initial configuration on all devices in your lab. Your instructor will provide the necessary information on how to set the initial configuration on all devices.
- Configure the EIGRP operation over WAN point-to-point interfaces toward routers BBR1 and BBR2. By deploying EIGRP toward the pod, external routers will receive IP routing information about distant networks. Additionally, you must enable EIGRP over the point-to-point WAN interface between routers R3 and R4 to announce the router's directly connected LAN segments. The EIGRP configuration should be applied in such way that additional subnet(s) from the used IP addressing pool are automatically advertised if they are added. The EIGRP configuration should allow all the networks to be reachable from any router in the network.
- After a successful configuration, verify that the EIGRP adjacencies have been set up between routers R1 and BBR1, R1 and BBR2, and R3 and R4. Verify the EIGRP topology database and compare it against the EIGRP information that was put into the IP routing table on router R1. You should be able to see that all the networks acquired via EIGRP were put into the routing table and that the metric related to an individual route corresponds to the value present in the topology table. Router R1 is receiving external networks from router BBR1; that is, 192.168.x.0/24 subnets and external network 172.30.10.0/24 from router BBR2.
- The next configuration step will be to configure EIGRP operation over the WAN multipoint interface on router R1 toward router R2 through R4. By deploying EIGRP toward the internal routers in the pod, you will allow IP routing information exchange between all of the routers in the pod.
- Verify that the EIGRP adjacencies have been set up between the routers R1 and R2, R1 and R3, and R1 and R4. Verify the EIGRP topology database and compare it against the EIGRP information that was put into the IP routing table on routers R1, R3, and R4. You should be able to see that all the networks acquired via EIGRP were put into the routing table and that the metric related to an individual route corresponds to the value present in the topology table. Simulate a WAN connectivity failure between routers R3 and R4 and examine the consequences. Verify that router R3 no longer has routing information about network 172.30.24.0/24, and that routers R2 and R4 no longer have routing information about network 172.30.13.0/24.
- Additional configuration is required in order to adjust the EIGRP operation over the WAN multipoint interface on router R1 so that routers R3 and R4 will still have the information necessary to access each other's LAN segments through the path via router R1, even in case of a WAN connectivity failure between routers R3 and R4.
- Verify that the EIGRP adjacencies between routers R1 and R2, R1 and R3, and R1 and R4 are up and running. Verify the EIGRP topology database and compare it against the EIGRP information that was put into the IP routing table on routers R1, R2, R3, and R4. You should be able to see that all the networks acquired via EIGRP were put into the routing table and that the metric related to an individual route corresponds to the value present in the topology table. Simulate a WAN connectivity failure between routers R3 and R4 and examine the consequences. Verify that router R3 still can access other networks, and that routers R2 and R4 have routing information about network 172.30.13.0/24 via the R1 WAN connection.

- The last requirement is to adjust the EIGRP operation in a way that the path via R1 will be treated as a feasible successor. This adjustment will require that the delay parameter between the WAN connection and routers R3 and R4 be changed. You will also change the default EIGRP path selection to allow router R3 to install two routes to the destination network 172.30.24.0/24 while the routers are not of equal cost.
- Verify that the path via router R1 to network 172.30.24.0/24 is a feasible successor on router R3, whereas the path via router R4 is the primary path and is also used in the IP routing table on router R3. Verify if the configuration results changed the EIGRP path selection behavior on router R3 to treat the secondary path as a valid option for the IP routing table along with the path via router R4. Finally, verify that you have connectivity to the destination network 172.30.24.0/24 from the router R3 LAN segment.

Device Information

The table provides the information specific to each switch in the network:

Device Name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR1	Backbone router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
(no) auto-summary	Enables (disables) automatic summarization of classless subnets
(no) shutdown	Administratively disables (enables) the interface
delay *tens-of-microsec*	Specifies the delay on interfaces (used for routing processes)
interface *type slot/port*	Enters the interface configuration mode
network *x.x.x.x*	Enables EIGRP on interfaces belonging to a specified network
router eigrp *as-number*	Starts an EIGRP routing process with the given AS number
show ip eigrp neighbors	Lists the EIGRP neighbors and relevant information on EIGRP neighbor adjacencies
show ip eigrp topology [**prefix**] [**mask**]	Displays the EIGRP topology table (whole, or only per prefix/mask)
show ip route [**eigrp**]	Displays the whole IP routing table or EIGRP routes only
ip address *ip mask* **secondary**	Sets the secondary ip address on the interface
[**no**] **ip split-horizon eigrp** *AS*	Disables/enables EIGRP split-horizon on an interface
variance *number*	Sets the EIGRP metric variance multipler
show interfaces serial	Displays the statistics for all interfaces configured on the router

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	"Hints" section at the end of this lab
Implementation and verification plan hints	"Hints" section at the end of this lab
Solution configuration answer key (step-by step procedure)	Configuration section at the end of this lab

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Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirement list. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Device	Implementation Requirement

Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all of the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the “Hints” section at the end of this lab.

Student Notes:

Alternate Resources and Solutions

Other groups may have implemented a solution that is different from yours. These will be discussed during the debriefing period that follows this lab. Use the following space to document other possible solutions for your reference.

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Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 2-2 Hint Sheet: Configure and Verify EIGRP Circuit Emulation and Frame Relay Operations

Implementation Requirements

To facilitate the configuration of your network, the first task asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Define an EIGRP AS number used in the lab.	Check the AS number used in the BBR1 and BBR2 router
ALL	Define which networks are used in the lab in order to advertise all major networks used in the pod.	Visual Objective diagrams
ALL	Identify the multipoint interfaces in order to disable split horizon under the EIGRP routing process for the correct routers.	Visual Objective diagrams, Lab
R3, R4	Examine and write down the current delay value of the Serial point-to-point subinterfaces.	Visual Objective diagrams, Lab

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed::

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load initial configuration	All pod routers must be preloaded with the initial configuration for the lab.	Step 1

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1	2	Enable the EIGRP routing protocol on router R1 on WAN interfaces Serial 0/0/0.4 and Serial0/0.4. Routers BBR1 and BBR2 are preconfigured with the EIGRP AS 1. Apply the configuration so that EIGRP automatically advertises any additional network that is added to the router.		Step 2
	R3, R4	3	Enable the EIGRP routing protocol on routers R3 and R4 on the WAN interface Serial 0/0.1 and advertise LAN segments. Apply the configuration in a way that EIGRP automatically advertises any additional network that is added to the router. Apply the configuration so that you will be capable of adding an EIGRP adjacency to R1 without a major reconfiguration.		Step 3
	R3	4	Add a secondary IP address 10.255.255.1/24 to the router R3 LAN interface.		Step 3
	R1, R3, R4	5		Verify that the EIGRP adjacencies have been set up between routers R1 and BBR1, R1 and BBR2, and R3 and R4.	Step 3
	R1, R3, R4	6		Verify the EIGRP topology database and compare it against the EIGRP information that was put into the IP routing table on router R1. You should be able to see that all of the networks acquired via EIGRP were put into a routing table and that the metric related to an individual route corresponds to the value present in the topology table. Router R1 receives external networks from router BBR1; that is, 192.168.x.0/24 subnets and external network 172.30.10.0/24 from router BBR2.	Step 3

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1	7	Enable the EIGRP routing protocol on the router R1 WAN interface, Serial 0/0/0.1. Use the proper EIGRP AS number to achieve seamless connectivity. Apply the configuration so that EIGRP automatically advertises any additional network that is added to the router.		Step 4
	R2, R3, R4	8	Enable the EIGRP routing protocol on the router R2, R3, and R4 WAN interface, Serial 0/0/0.1. Use the proper EIGRP AS number to achieve connectivity. Apply the configuration so that EIGRP automatically advertises any additional network that is added to the router.	Verify that the EIGRP adjacencies have been set up between routers R1 and R2, R1 and R3, and R1 and R4.	Step 4
	R1–R4	9		Verify the EIGRP topology database and compare it against the EIGRP information that was put into the IP routing table on routers R1 through R4. You should be able to see that all of the networks acquired via EIGRP were put into the routing table and that the metric related to an individual route corresponds to the value present in the topology table	Step 4
	R3, R4	10	Simulate a WAN connectivity failure between routers R3 and R4.	Create a WAN connectivity failure between routers R3 and R4, and examine the consequences. Verify that router R3 no longer has routing information about network 172.30.24.0/24, and that routers R2 and R4 no longer have routing information about network 172.30.13.0/24.	Step 5

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1	11	Change the EIGRP split-horizon behavior on the WAN multipoint interface on router R1 so that the LAN segment information for routers R2, R3, and R4 is also exchanged via that interface. Enable the interfaces that were disabled in order to simulate the failure.	Verify that the EIGRP adjacencies between the routers R1 and R2, R1 and R3, and R1 and R4 are up and running.	Step 6
	R1–R4	12	Adjust the delay parameter on the WAN interfaces for connectivity between routers R3 and R4 so that R3 load balances between R1 and R4 in order to reach network 172.30.24.0/24.	Verify the EIGRP topology database and compare it against the EIGRP information that was put into the IP routing table on routers R1 through R4. You should be able to see that all the networks acquired via EIGRP were put into the routing table and that the metric related to an individual route corresponds to the value present in the topology table.	Step 7
	R1, R3	13	Simulate a WAN connectivity failure between routers R1 and R3.	Create a WAN connectivity failure between routers R3 and R4 and examine the consequences. Verify that router R3 still can access other networks, and that routers R2 and R4 have routing information about network 172.30.13.0/24 via the router R1 WAN connection.	Step 8
		14	Change the delay parameter on the Serial 0/0/0.3 interface on routers R3 and R4 so that the path via R1 to network 172.30.24.0/24 becomes a feasible successor, while the path via router R3 to R4 is the primary one that is installed in the routing table on router R3. Enable the interfaces that were disabled in order to simulate the failure.	At first, the path via router R1 to the network 172.30.24.0/24 is a feasible successor on router R3, whereas the path via router R4 is the primary path and is also used in the IP routing table on router R3.	Step 9

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
		15	Change the EIGRP path selection behavior on router R3 so that R3 selects both the primary path via router R4 and the secondary path via router R1 to the destination network 172.30.24.0/24. Both paths should be present in the routing table.	EIGRP path selection behavior is changed on router R3 to treat the secondary path as a valid option for the IP routing table along with the path via router R4.	Step 10
		16		Verify that you have connectivity to destination network 172.30.24.0/24 from the router R3 LAN segment.	Step 10

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Configure EIGRP on router R1.

   2.1. Use the following example to configure router R1 in this lab:

```
R1#
router eigrp 1
 network 10.0.0.0
 no auto-summary
```

3. Configure EIGRP on routers R3 and R4 and verify the configuration.

   3.1. Use the following example to configure the routers in this lab:

```
R3#
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary

R4#
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
```

   3.2. Use the following example to configure router R3 in this lab.

```
R3#
  interface FastEthernet0/0
   ip address 10.255.255.1 255.255.255.0 secondary
```

   3.3. Verify the EIGRP configuration.

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
3   10.1.110.4              Se0/0/0.1         13 00:01:39   79   474  0  12
2   10.1.110.3              Se0/0/0.1         13 00:01:47   69   414  0  11
```

```
1   10.1.116.6             Se0/0/0.5         14 00:02:12  545  3270  0  40
0   10.1.115.5             Se0/0/0.4         10 00:02:12  678  4068  0  131

R3#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                           (sec)         (ms)       Cnt Num
1   10.1.134.4             Se0/0/0.3         13 00:02:10   83   498  0  11
0   10.1.110.1             Se0/0/0.1        161 00:02:19  817  4902  0  23

R4#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                           (sec)         (ms)       Cnt Num
1   10.1.110.1             Se0/0/0.1        137 00:02:34  668  4008  0  23
0   10.1.134.3        FastEthernet0/0        13 00:02:34  675  4050  0  10

R1#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(10.1.116.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 2172416
        via 10.1.110.3 (2172416/28160), Serial0/0/0.1
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 192.168.2.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 192.168.3.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 10.1.115.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.4
P 10.1.116.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.5
P 10.1.134.0/24, 2 successors, FD is 2681856
        via 10.1.110.3 (2681856/2169856), Serial0/0/0.1
        via 10.1.110.4 (2681856/2169856), Serial0/0/0.1
P 172.30.24.0/24, 1 successors, FD is 2172416

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

        via 10.1.110.4 (2172416/28160), Serial0/0/0.1
P 172.30.10.0/24, 1 successors, FD is 2172416
        via 10.1.116.6 (2172416/28160), Serial0/0/0.5
P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.110.3 (2172416/28160), Serial0/0/0.1

R3#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.13.3)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
```

```
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 2172416
        via 10.1.134.4 (2172416/28160), Serial0/0/0.3

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
```

```
R4#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.4)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 2172416
        via 10.1.134.3 (2172416/28160), Serial0/0/0.3
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.134.3 (2172416/28160), Serial0/0/0.3
```

```
R1#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.24.0 [90/2172416] via 10.1.110.4, 00:04:27, Serial0/0/0.1
D       172.30.10.0 [90/2172416] via 10.1.116.6, 00:05:01, Serial0/0/0.5
D       172.30.13.0 [90/2172416] via 10.1.110.3, 00:04:27, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.255.255.0 [90/2172416] via 10.1.110.3, 00:04:05, Serial0/0/0.1
D       10.1.134.0 [90/2681856] via 10.1.110.4, 00:04:27, Serial0/0/0.1
                   [90/2681856] via 10.1.110.3, 00:04:27, Serial0/0/0.1
D    192.168.1.0/24 [90/2297856] via 10.1.115.5, 00:05:01, Serial0/0/0.4
D    192.168.2.0/24 [90/2297856] via 10.1.115.5, 00:05:01, Serial0/0/0.4
D    192.168.3.0/24 [90/2297856] via 10.1.115.5, 00:05:01, Serial0/0/0.4
```

```
R3#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.24.0 [90/2172416] via 10.1.134.4, 00:05:03, Serial0/0/0.3
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:05:03, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:05:03, Serial0/0/0.1
```

```
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:05:03, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:05:03, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:05:03, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:05:03, Serial0/0/0.1

R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:05:22, Serial0/0/0.1
D       172.30.13.0 [90/2172416] via 10.1.134.3, 00:05:22, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 5 subnets
D       10.255.255.0 [90/2172416] via 10.1.134.3, 00:05:00, Serial0/0/0.3
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:05:22, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:05:22, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:05:22, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:05:22, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:05:22, Serial0/0/0.1
```

4. Configure EIGRP on routers R3 and R4 and verify the configuration.

4.1. Use the following example to configure the routers in this lab:

```
R2#
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
```

Note	Routers R1, R3, and R4 do not require any additional configuration because EIGRP is already enabled on those routers.

4.2. Verify the EIGRP configuration:

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
3   10.1.110.2              Se0/0/0.1         12 00:21:55  248  1488  0  33
4   10.1.116.6              Se0/0/0.5         13 00:22:57   93   558  0  9
2   10.1.110.3              Se0/0/0.1         14 00:23:00  379  2274  0  27
1   10.1.110.4              Se0/0/0.1         11 00:23:00   80   480  0  38
0   10.1.115.5              Se0/0/0.4         12 00:23:00   59   354  0  35

R2#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   172.30.24.4             Fa0/0             11 00:00:31    7   200  0  17
0   10.1.110.1              Se0/0/0.1        151 00:00:35 1001  5000  0  25

R3#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.1.134.4              Se0/0/0.3         12 00:03:17 1034  5000  0  46
1   10.1.110.1              Se0/0/0.1        137 00:28:21   48   288  0  80

R4#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.1.134.3              Se0/0/0.3         14 00:05:10  116   696  0  32
2   10.1.110.1              Se0/0/0.1        135 00:30:13  185  1110  0  81
1   172.30.24.2             Fa0/0             12 00:36:14    1   200  0  36
```

```
R1#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(10.1.116.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 2172416
        via 10.1.110.3 (2172416/28160), Serial0/0/0.1
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 192.168.2.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 192.168.3.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 10.1.115.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.4
P 10.1.116.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.5
P 10.1.134.0/24, 2 successors, FD is 2681856
        via 10.1.110.3 (2681856/2169856), Serial0/0/0.1
        via 10.1.110.4 (2681856/2169856), Serial0/0/0.1
        via 10.1.110.2 (2684416/2172416), Serial0/0/0.1
P 172.30.24.0/24, 2 successors, FD is 2172416

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

        via 10.1.110.2 (2172416/28160), Serial0/0/0.1
        via 10.1.110.4 (2172416/28160), Serial0/0/0.1
P 172.30.10.0/24, 1 successors, FD is 2172416
        via 10.1.116.6 (2172416/28160), Serial0/0/0.5
P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.110.3 (2172416/28160), Serial0/0/0.1

R2#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.2)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 2174976
        via 172.30.24.4 (2174976/2172416), FastEthernet0/0
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2172416
        via 172.30.24.4 (2172416/2169856), FastEthernet0/0
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 2174976
        via 172.30.24.4 (2174976/2172416), FastEthernet0/0
```

```
R3#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.13.3)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 2172416
        via 10.1.134.4 (2172416/28160), Serial0/0/0.3

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

R4#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.4)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 2172416
        via 10.1.134.3 (2172416/28160), Serial0/0/0.3
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.134.3 (2172416/28160), Serial0/0/0.3

R1#show ip route eigrp
```

```
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:03:30, Serial0/0/0.1
D       172.30.13.0 [90/2174976] via 172.30.24.4, 00:03:30, FastEthernet0/0
     10.0.0.0/24 is subnetted, 5 subnets
D       10.255.255.0 [90/2174976] via 172.30.24.4, 00:03:30, FastEthernet0/0
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:03:30, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:03:30, Serial0/0/0.1
D       10.1.134.0 [90/2172416] via 172.30.24.4, 00:03:30, FastEthernet0/0
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:03:30, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:03:30, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:03:30, Serial0/0/0.1

R2#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:24:58, Serial0/0/0.1
D       172.30.13.0 [90/2174976] via 172.30.24.4, 00:00:58, FastEthernet0/0
     10.0.0.0/24 is subnetted, 5 subnets
D       10.255.255.0 [90/2174976] via 172.30.24.4, 00:00:58, FastEthernet0/0
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:24:58, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:24:58, Serial0/0/0.1
D       10.1.134.0 [90/2172416] via 172.30.24.4, 00:19:03, FastEthernet0/0
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:24:58, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:24:58, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:24:58, Serial0/0/0.1

R3#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.24.0 [90/2172416] via 10.1.134.4, 00:03:20, Serial0/0/0.3
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:03:20, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:03:20, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:03:20, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:03:20, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:03:20, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:03:20, Serial0/0/0.1

R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:05:12, Serial0/0/0.1
D       172.30.13.0 [90/2172416] via 10.1.134.3, 00:05:12, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 5 subnets
D       10.255.255.0 [90/2172416] via 10.1.134.3, 00:05:12, Serial0/0/0.3
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:05:12, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:05:12, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:05:12, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:05:12, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:05:12, Serial0/0/0.1
```

5. Simulate a WAN failure and verify routers R2, R3, and R4 after the WAN failure.

   5.1. To simulate a WAN failure, run these commands:

```
R3(config)#interface se0/0/0.3
R3(config-subif)#shutdown
```

Note	In order to simulate WAN failure, you can shut down the interface on router R3. There are also other ways to simulate a WAN failure.

   5.2. Verification after a WAN failure:

```
R3#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   10.1.110.1              Se0/0/0.1        161 00:32:08   48    288  0  83
```

```
R2#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:32:55, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 4 subnets
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:32:55, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:32:55, Serial0/0/0.1
D       10.1.134.0 [90/2172416] via 172.30.24.4, 00:27:00, FastEthernet0/0
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:32:55, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:32:55, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:32:55, Serial0/0/0.1
```

```
R3#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:07:08, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 4 subnets
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:07:08, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:07:08, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:07:08, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:07:08, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:07:08, Serial0/0/0.1
```

```
R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:08:18, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 4 subnets
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:08:18, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:08:18, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:08:18, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:08:18, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:08:18, Serial0/0/0.1
```

6. Configure EIGRP on router R1 and verify the configuration.

6.1. Use the following example to configure router R1 in this lab:

```
R1#
interface Serial0/0/0.1 multipoint
 no ip split-horizon eigrp 1
```

```
R3(config)#interface serial 0/0/0.3
R3(config-subif)#no shutdown
```

Note	Interfaces, which were disabled in order to simulate WAN failure, are now enabled.

6.2. Verify the EIGRP configuration:

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
3   10.1.110.2              Se0/0/0.1         12 00:41:49  184  1104  0  43
4   10.1.116.6              Se0/0/0.5         11 00:42:51   93   558  0  9
2   10.1.110.3              Se0/0/0.1         14 00:42:53  276  1656  0  36
1   10.1.110.4              Se0/0/0.1         13 00:42:53   90   540  0  53
0   10.1.115.5              Se0/0/0.4         13 00:42:54   59   354  0  35
```

```
R2#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   10.1.110.1              Se0/0/0.1        171 01:13:19   39   234  0  157
```

```
0   172.30.24.4           Fa0/0           13 01:20:20    1   300  0  126
```

```
R3#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address               Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                          (sec)         (ms)       Cnt Num
1   10.1.110.1            Se0/0/0.1        179 00:13:45  138   828  0  157
0   10.1.134.4            Se0/0/0.3         14 00:13:46   51   306  0  128

R4#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address               Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                          (sec)         (ms)       Cnt Num
0   10.1.134.3            Se0/0/0.3         12 00:15:58  376  2256  0  87
2   10.1.110.1            Se0/0/0.1        163 01:17:22   40   240  0  157
1   172.30.24.2           Fa0/0             14 01:23:23    1   200  0  79
```

7. Configure EIGRP on routers R3 and R4 and verify the configuration.

7.1. Use the following example to configure routers R3 and R4 in this lab:

```
R3#
interface Serial0/0/0.3 point-to-point
 description Link to R4
 ip address 10.1.134.3 255.255.255.0
 delay 4000

R4#
interface Serial0/0/0.3 point-to-point
 description Link to R3
 ip address 10.1.134.4 255.255.255.0
 delay 4000
```

7.2. Verify the EIGRP configuration:

```
R1#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.24.0 [90/2172416] via 10.1.110.4, 00:10:57, Serial0/0/0.1
                    [90/2172416] via 10.1.110.2, 00:10:57, Serial0/0/0.1
D       172.30.10.0 [90/2172416] via 10.1.116.6, 01:13:36, Serial0/0/0.5
D       172.30.13.0 [90/2172416] via 10.1.110.3, 00:10:53, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.255.255.0 [90/2172416] via 10.1.110.3, 00:10:53, Serial0/0/0.1
D       10.1.134.0 [90/3193856] via 10.1.110.4, 00:07:30, Serial0/0/0.1
                   [90/3193856] via 10.1.110.3, 00:07:30, Serial0/0/0.1
D    192.168.1.0/24 [90/2297856] via 10.1.115.5, 01:13:39, Serial0/0/0.4
D    192.168.2.0/24 [90/2297856] via 10.1.115.5, 01:13:39, Serial0/0/0.4
D    192.168.3.0/24 [90/2297856] via 10.1.115.5, 01:13:39, Serial0/0/0.4

R2#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 01:13:23, Serial0/0/0.1
D       172.30.13.0 [90/2684416] via 10.1.110.1, 00:08:07, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.255.255.0 [90/2684416] via 10.1.110.1, 00:08:07, Serial0/0/0.1
D       10.1.115.0 [90/2681856] via 10.1.110.1, 01:13:23, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 01:13:23, Serial0/0/0.1
D       10.1.134.0 [90/2684416] via 172.30.24.4, 00:08:17, FastEthernet0/0
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 01:13:23, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 01:13:23, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 01:13:23, Serial0/0/0.1

R3#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.24.0 [90/2684416] via 10.1.134.4, 00:08:57, Serial0/0/0.3
                    [90/2684416] via 10.1.110.1, 00:08:57, Serial0/0/0.1
```

```
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:08:57, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:08:57, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:08:57, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:08:57, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:08:57, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:08:57, Serial0/0/0.1

R4#sh ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:11:05, Serial0/0/0.1
D       172.30.13.0 [90/2684416] via 10.1.134.3, 00:11:05, Serial0/0/0.3
                    [90/2684416] via 10.1.110.1, 00:11:05, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.255.255.0 [90/2684416] via 10.1.134.3, 00:11:05, Serial0/0/0.3
                     [90/2684416] via 10.1.110.1, 00:11:05, Serial0/0/0.1
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:11:05, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:11:05, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:11:05, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:11:05, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:11:05, Serial0/0/0.1

R1#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(10.1.116.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 2172416
        via 10.1.110.3 (2172416/28160), Serial0/0/0.1
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 192.168.2.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 192.168.3.0/24, 1 successors, FD is 2297856
        via 10.1.115.5 (2297856/128256), Serial0/0/0.4
P 10.1.115.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.4
P 10.1.116.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.5
P 10.1.134.0/24, 2 successors, FD is 3193856
        via 10.1.110.3 (3193856/2681856), Serial0/0/0.1
        via 10.1.110.4 (3193856/2681856), Serial0/0/0.1
        via 10.1.110.2 (3196416/2684416), Serial0/0/0.1, serno 21

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.24.0/24, 2 successors, FD is 2172416
        via 10.1.110.2 (2172416/28160), Serial0/0/0.1
        via 10.1.110.4 (2172416/28160), Serial0/0/0.1
P 172.30.10.0/24, 1 successors, FD is 2172416
        via 10.1.116.6 (2172416/28160), Serial0/0/0.5
P 172.30.13.0/24, 1 successors, FD is 2172416
        via 10.1.110.3 (2172416/28160), Serial0/0/0.1

R2#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.2)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 2174976
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
```

```
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2684416
        via 172.30.24.4 (2684416/2681856), FastEthernet0/0
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 2174976
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
```

R3#show ip eigrp topology

```
IP-EIGRP Topology Table for AS(1)/ID(172.30.13.3)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2681856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 2 successors, FD is 2172416
        via 10.1.134.4 (2684416/28160), Serial0/0/0.3

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
```

R4#show ip eigrp topology

```
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.4)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 2 successors, FD is 2172416
        via 10.1.134.3 (2684416/28160), Serial0/0/0.3
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
```

```
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2681856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 2 successors, FD is 2172416
        via 10.1.134.3 (2684416/28160), Serial0/0/0.3
```

8. Simulate a WAN failure and verify routers R2, R3, and R4 after the WAN failure.

8.1. To simulate a WAN failure, run these commands:

```
R3(config)#interface se0/0/0.3
R3(config-subif)#shutdown
```

Note	In order to simulate a WAN failure, you can shut down the interface on router R3. There are also other ways to simulate a WAN failure.

8.2. Verification after a WAN failure:

```
R3#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   10.1.110.1              Se0/0/0.1        146 00:18:59  117   702  0  158

R4#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
2   10.1.110.1              Se0/0/0.1        146 01:21:19   40   240  0  157
1   172.30.24.2             Fa0/0             11 01:27:20    1   200  0  79

R3#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.24.0 [90/2684416] via 10.1.110.1, 00:01:04, Serial0/0/0.1
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:14:11, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:14:11, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:14:11, Serial0/0/0.1
D       10.1.134.0 [90/3705856] via 10.1.110.1, 00:01:04, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:14:11, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:14:11, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:14:11, Serial0/0/0.1

R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:15:01, Serial0/0/0.1
D       172.30.13.0 [90/2684416] via 10.1.110.1, 00:01:47, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.255.255.0 [90/2684416] via 10.1.110.1, 00:01:47, Serial0/0/0.1
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:15:01, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:15:01, Serial0/0/0.1
```



```
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:15:01, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:15:01, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:15:01, Serial0/0/0.1

R3#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.13.3)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 3705856
        via 10.1.110.1 (3705856/3193856), Serial0/0/0.1, serno 23
P 172.30.24.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

R4#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(172.30.24.4)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.255.255.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 10.1.110.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.1
P 192.168.1.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.2.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 192.168.3.0/24, 1 successors, FD is 2809856
        via 10.1.110.1 (2809856/2297856), Serial0/0/0.1
P 10.1.115.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.116.0/24, 1 successors, FD is 2681856
        via 10.1.110.1 (2681856/2169856), Serial0/0/0.1
P 10.1.134.0/24, 1 successors, FD is 2681856
        via Connected, Serial0/0/0.3
P 172.30.24.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 2684416
```

```
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
```

9. Configure EIGRP on routers R3 and R4 and verify the configuration.

   9.1. Use the following example to configure routers R3 and R4 in this lab:

```
R3#
interface Serial0/0/0.3 point-to-point
 delay 3000

R4#
interface Serial0/0/0.3 point-to-point
 delay 3000

R3(config)#interface serial 0/0/0.3
R3(config-subif)#no shutdown
```

Note	Interfaces, which were disabled in order to simulate WAN failure, are now enabled.

   9.2. Verify the EIGRP configuration:

```
R3#show ip eigrp topology | begin 172.30.24.0
P 172.30.24.0/24, 1 successors, FD is 2428416
        via 10.1.134.4 (2428416/28160), Serial0/0/0.3
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.10.0/24, 1 successors, FD is 2684416
        via 10.1.110.1 (2684416/2172416), Serial0/0/0.1
P 172.30.13.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0

R3#show ip eigrp topology 172.30.24.0 255.255.255.0
IP-EIGRP (AS 1): Topology entry for 172.30.24.0/24
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 2428416
  Routing Descriptor Blocks:
  10.1.134.4 (Serial0/0/0.3), from 10.1.134.4, Send flag is 0x0
      Composite metric is (2428416/28160), Route is Internal
      Vector metric:
        Minimum bandwidth is 1544 Kbit
        Total delay is 30100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  10.1.110.1 (Serial0/0/0.1), from 10.1.110.1, Send flag is 0x0
      Composite metric is (2684416/2172416), Route is Internal
      Vector metric:
        Minimum bandwidth is 1544 Kbit
        Total delay is 40100 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2

R3#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.24.0 [90/2428416] via 10.1.134.4, 00:20:41, Serial0/0/0.3
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:20:41, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:20:41, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:20:41, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:20:41, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:20:41, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:20:41, Serial0/0/0.1
```


10. Configure EIGRP on router R3 and verify the configuration.

10.1. Use the following example to configure router R3 in this lab:

```
R3#
router eigrp 1
 variance 2
```

10.2. Verify the EIGRP configuration:

```
R3#show ip route eigrp
     172.30.0.0/24 is subnetted, 3 subnets
D       172.30.24.0 [90/2428416] via 10.1.134.4, 00:01:54, Serial0/0/0.3
                    [90/2684416] via 10.1.110.1, 00:01:54, Serial0/0/0.1
D       172.30.10.0 [90/2684416] via 10.1.110.1, 00:01:54, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 5 subnets
D       10.1.115.0 [90/2681856] via 10.1.110.1, 00:01:54, Serial0/0/0.1
D       10.1.116.0 [90/2681856] via 10.1.110.1, 00:01:54, Serial0/0/0.1
D    192.168.1.0/24 [90/2809856] via 10.1.110.1, 00:01:54, Serial0/0/0.1
D    192.168.2.0/24 [90/2809856] via 10.1.110.1, 00:01:54, Serial0/0/0.1
D    192.168.3.0/24 [90/2809856] via 10.1.110.1, 00:01:54, Serial0/0/0.1

R3#ping 172.30.24.2 source 172.30.13.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.24.2, timeout is 2 seconds:
Packet sent with a source address of 172.30.13.3
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/56/60 ms
```

Lab 2-3: Configure and Verify EIGRP Authentication

Complete this lab activity to practice what you learned in the related module.

Activity Objective

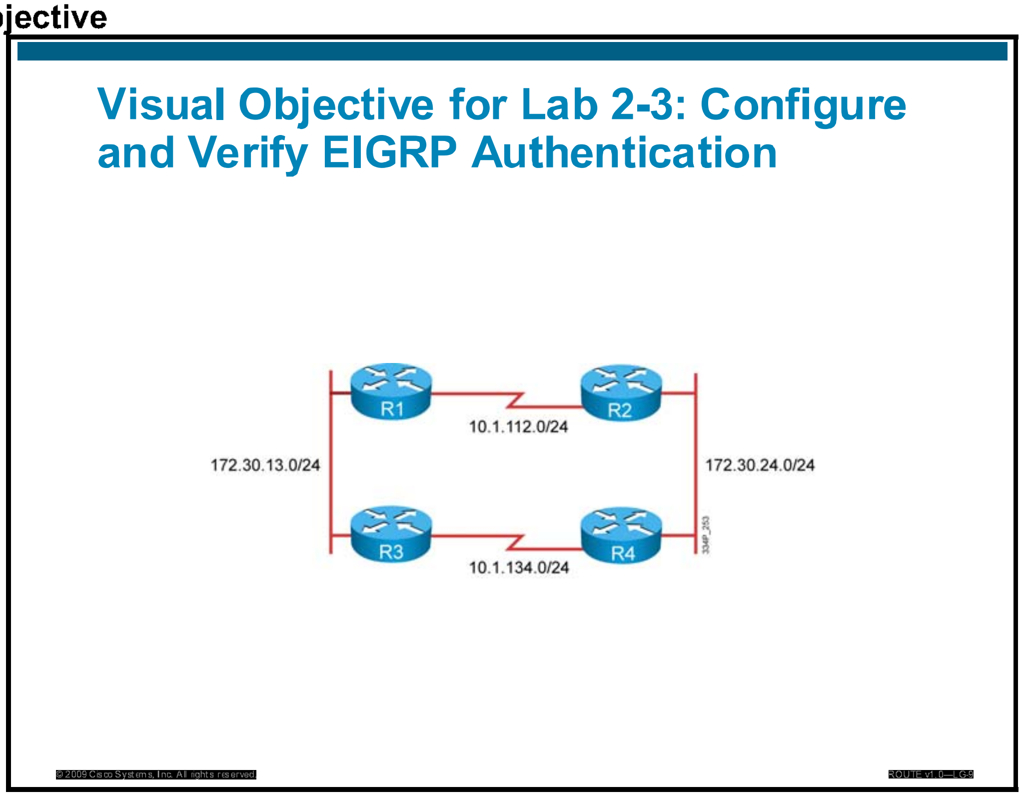
In this activity, you will use the correct commands, tools, and steps to configure and verify EIGRP authentication. After completing this activity, you will be able to meet these objectives:

- Select the required tools and commands to configure basic EIGRP authentication
- Organize the tasks into an implementation plan to implement EIGRP authentication
- Implement the identified EIGRP solution to configure basic EIGRP authentication in the provided network according to the implementation plan, using Cisco IOS commands and applications in the correct order to the selected devices and portions of the network
- Write a verification and test plan to verify the correct implementation and operation according to expected performance criteria
- Verify the implementation according to the verification plan, using the appropriate **show** and **debug** commands and applications to verify the correct operation, and document implementation, operation, and maintenance

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- First, you will configure EIGRP authentication over the LAN interfaces between the routers in your pod. The authentication should use a safe password exchange. Passwords that will be used to authenticate the routers should never expire.
- Once the authentication configuration on the LAN interfaces is done, you must verify if the proper key chain is defined on each pod's routers, and that the correct keys are used, which never expire. A successful configuration results in a neighbor relationship being formed over the LAN interfaces, and you can see all of the networks advertised by the EIGRP routing process in the IP routing table of every router in the pod.
- After a successful LAN authentication, you will configure EIGRP authentication over the WAN interfaces between the routers in your pod. The authentication should use a safe password exchange. Passwords that are used to authenticate the routers should never expire.
- Once the authentication configuration on the WAN interfaces is done, you must verify if the proper key chain is defined on each pod router and that correct keys are used, which never expire. A successful configuration results in a neighbor relationship being formed over the WAN interfaces, and you can see all of the networks advertised by the EIGRP routing process in the IP routing table of every router in the pod.

Device Information

The table provides the information specific to each switch in the network:

Device Name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			

Command List

The table describes the commands that are used in this activity.

Command	Description
interface *type slot/port*	Enters the interface configuration mode
show ip eigrp neighbors	Lists EIGRP neighbors and relevant information on EIGRP neighbor adjacencies
show ip route [**eigrp**]	Displays the whole IP routing table or EIGRP routes only
key-chain *name*	Configures the key chain
key *id*	Define a key
key-string *string*	Defines a shared secret for a key
accept-lifetime from till	Defines an acceptable lifetime for a key
send-lifetime *from till*	Defines the lifetime that is advertised for a key
ip authentication mode eigrp *AS* **md5**	Enables EIGRP MD5 authentication
ip authentication key-chain eigrp *AS key-chain*	Sets the key chain used for the EIGRP authentication
show key-chain	Shows the configured key chains and parameters
show ip eigrp interfaces detail *interface*	Shows EIGRP configuration details for an interface

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	“Hints” section at the end of this lab
Implementation and verification plan hints	“Hints” section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirements list. If you are unsure, use the information provided in the "Hints" section at the end of this lab.

Device	Implementation Requirement

Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all of the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all of the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure of the verification steps, use the information provided in the "Hints" section at the end of this lab.

Student Notes:

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Alternate Resources and Solutions

Other groups may have implemented a solution that is different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

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Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 2-3 Hint Sheet: Configure and Verify EIGRP Authentication

Implementation Requirements

To facilitate the configuration of your network, the first task asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Define the keys used for authentication and their validity	Implementation Policy

Implementation and Verification Plan

In Task 2, you need to create an implementation plan. There are, of course, several possible ways to accomplish this task. The following steps need to be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load initial configuration	All pod routers must be preloaded with the initial configuration for the lab.	Step 1
	R1–R4	2	Configure a key chain on the routers that will be used for authentication on the LAN segments. Keys in the key chain used for authentication must never expire.	Verify that the proper key chain is defined on each of the pod routers by inspecting the key chain configuration.	Step 2
	R1–R4	3	Enable secure authentication on the LAN segments between routers and use the defined key chain for authentication.	Verify that secure authentication is configured on each of the pod routers by inspecting the configuration on each router.	Step 3

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	4	Verify that the EIGRP adjacencies have been set up between the pod routers after you have applied the EIGRP authentication.	Verify that the routers form the neighbor relationship through LAN interfaces.	Step 4
	R1–R4	5	Verify that the anticipated EIGRP routes are present in the routing tables of all routers.	Verify the routing tables on every router for the EIGRP routes for involved networks.	Step 5
	R1–R4	6	Verify that the anticipated EIGRP routers have authentication enabled on the LAN interfaces.	Verify the EIGRP details on every LAN interface involved in the authentication process.	Step 6
	R1–R4	7	Configure another key chain on the routers that will be used for authentication on the WAN segments. Keys in the key chain used for authentication must never expire.	Verify that the proper key chain is defined on each of the pod routers by inspecting the key chain configuration.	Step 7
	R1–R4	8	Enable secure authentication on the WAN segments between routers and use the defined key chain for authentication.	Verify that secure authentication is configured on each of the pod routers by inspecting the configuration on each router.	Step 8
	R1–R4	9	Verify that the EIGRP adjacencies have been set up between the pod routers after you have applied the EIGRP authentication.	Verify that routers form the neighbor relationship through LAN interfaces.	Step 9
	R1–R4	10	Verify that the anticipated EIGRP routes are present in the routing tables of all routers.	Verify the routing table on every router for the EIGRP routes for involved networks.	Step 10
	R1–R4	11	Verify that anticipated EIGRP routers have authentication enabled on LAN interfaces.	Verify EIGRP details on every LAN interface involved in the authentication process.	Step 11

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Configure a key chain and keys used for authentication.

   2.1. Use the following example to configure the routers in this lab:

```
R1#
key chain LAB23-LAN
 key 1
```

```
key-string CiscoLAN
accept-lifetime 04:00:00 Jan 1 2009 infinite
send-lifetime 04:00:00 Jan 1 2009 infinite
```

Note	The same commands are also used on routers R2, R3, and R4

2.2. Verify that the proper key chain is defined on each of the pod routers.

```
R1#show key chain
Key-chain LAB23-LAN:
    key 1 -- text "CiscoLAN"
        accept lifetime (04:00:00 Jan 1 2009) - (always valid) [valid now]
        send lifetime (04:00:00 Jan 1 2009) - (always valid) [valid now]
```

Note	The same command must also be used on routers R2, R3, and R4, and the command output will be the same as well.

3. Enable secure authentication on the LAN segments.

3.1. Use the following example to configure the routers in this lab:

```
R1#
interface FastEthernet0/0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-LAN
```

Note	The same commands are used also on routers R2, R3, and R4.

3.2. Verify that secure authentication is configured and the correct key chain is used.

```
R1#show running-configuration
<output omitted>
interface FastEthernet0/0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-LAN
<output omitted>
```

Note	The same command must also be used on routers R2, R3, and R4, and the command output will be the same as well.

4. Verify that the EIGRP adjacencies have been set up and that each router forms a neighbor relationship over the LAN interface.

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
2   172.30.13.3             Fa0/0             11 00:04:34  812  4872  0  14
```

```
0   10.1.112.2             Se0/0/0.1         11 00:04:47  540  3240  0  17
```

```
R2#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                           (sec)         (ms)       Cnt Num
0   10.1.112.1             Se0/0/0.1         14 00:02:14   66    396  0  29
1   172.30.24.4            Fa0/0             10 00:05:17    1    200  0  27
```

```
R3#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                           (sec)         (ms)       Cnt Num
0   10.1.134.4             Se0/0/0.3         11 00:02:50 1037   5000  0  28
1   172.30.13.1            Fa0/0             11 00:06:33    1    200  0  31
```

```
R4# show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                           (sec)         (ms)       Cnt Num
1   10.1.134.3             Se0/0/0.3         12 00:03:30   67    402  0  29
0   172.30.24.2            Fa0/0             10 00:06:43    1    200  0  29
```

5. Verify that the LAN and WAN segments are advertised on all routers.

```
R1#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.24.0 [90/2172416] via 10.1.112.2, 00:01:31, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 2 subnets
D       10.1.134.0 [90/2172416] via 172.30.13.3, 00:01:41, FastEthernet0/0
```

```
R2#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.13.0 [90/2172416] via 10.1.112.1, 00:02:05, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 2 subnets
D       10.1.134.0 [90/2172416] via 172.30.24.4, 00:02:15, FastEthernet0/0
```

```
R3#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.24.0 [90/2172416] via 10.1.134.4, 00:02:50, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 2 subnets
D       10.1.112.0 [90/2172416] via 172.30.13.1, 00:02:50, FastEthernet0/0
```

```
R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.13.0 [90/2172416] via 10.1.134.3, 00:03:31, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 2 subnets
D       10.1.112.0 [90/2172416] via 172.30.24.2, 00:03:31, FastEthernet0/0
```

6. Verify that detailed EIGRP interface information shows you that secure LAN authentication is enabled on the LAN interfaces on all routers in your lab.

```
R1#show ip eigrp interfaces detail fastEthernet 0/0
```

```
IP-EIGRP interfaces for process 1

                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Fa0/0              1        0/0         1       0/1           50           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/12  Un/reliable ucasts: 13/10
  Mcast exceptions: 2  CR packets: 2  ACKs suppressed: 1
  Retransmissions sent: 1  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-LAN"
  Use multicast
```

R2#show ip eigrp interfaces detail fastEthernet 0/0

```
IP-EIGRP interfaces for process 1

                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Fa0/0              1        0/0         1       0/1           50           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/12  Un/reliable ucasts: 13/10
  Mcast exceptions: 2  CR packets: 2  ACKs suppressed: 1
  Retransmissions sent: 1  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-LAN"
  Use multicast
```

R3#show ip eigrp interfaces detail fastEthernet 0/0

```
IP-EIGRP interfaces for process 1

                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Fa0/0              1        0/0         1       0/1           50           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/12  Un/reliable ucasts: 13/10
  Mcast exceptions: 2  CR packets: 2  ACKs suppressed: 1
  Retransmissions sent: 1  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-LAN"
  Use multicast
```

R4#show ip eigrp interfaces detail fastEthernet 0/0

```
IP-EIGRP interfaces for process 1

                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Fa0/0              1        0/0         1       0/1           50           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/12  Un/reliable ucasts: 13/10
  Mcast exceptions: 2  CR packets: 2  ACKs suppressed: 1
  Retransmissions sent: 1  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-LAN"
  Use multicast
```

7. Configure a key chain and keys used for authentication.

7.1. Use the following example to configure the routers in this lab:

```
R1#
key chain LAB23-WAN
 key 1
   key-string CiscoWAN
   accept-lifetime 04:00:00 Jan 1 2009 infinite
   send-lifetime 04:00:00 Jan 1 2009 infinite
```

Note	The same commands are also used on routers R2, R3, and R4.

7.2. Verify that the proper key chain is defined on each of the pod routers.

```
R1#show key chain
Key-chain LAB23-LAN:
    key 1 -- text "CiscoLAN"
        accept lifetime (04:00:00 UTC Jan 1 2009) - (infinite) [valid now]
        send lifetime (04:00:00 UTC Jan 1 2009) - (infinite) [valid now]
Key-chain LAB23-WAN:
    key 1 -- text "CiscoWAN"
        accept lifetime (04:00:00 UTC Jan 1 2009) - (infinite) [valid now]
        send lifetime (04:00:00 UTC Jan 1 2009) - (infinite) [valid now]
```

Note	The same command must also be used on routers R2, R3, and R4, and the command output will be the same as well.

8. Enable secure authentication on WAN segments.

8.1. Use the following example to configure the routers in this lab:

```
R1#
interface serial0/0/0.1
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-WAN
```

Note	The same commands used on router R1 are also used on router R2.

```
R3#
interface serial0/0/0.3
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-WAN
```

Note	The same commands used on router R3 are also used on router R4.

8.2. Verify that secure authentication is configured and that the correct key chain is used.

```
R1#show running-configuration
<output omitted>
interface serial0/0/0.1
```



```
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-WAN
<output omitted>
```

Note	The same command used on router R1 must also be used on router R2, and the command output will be the same as well.

```
R3#show running-configuration
<output omitted>
interface serial0/0/0.3
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-WAN
<output omitted>
```

Note	The same command used on router R3 must also be used on router R4, and the command output will be the same as well.

9. Verify that the EIGRP adjacencies have been set up and that each router forms a neighbor relationship over the LAN interface.

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.1.112.2              Se0/0/0.1         12 00:01:40 1004  5000  0  28
1   172.30.13.3             Fa0/0             10 00:05:13    1   200  0  30

R2#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.1.112.1              Se0/0/0.1         14 00:02:14   66   396  0  29
1   172.30.24.4             Fa0/0             10 00:05:17    1   200  0  27

R3#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.1.134.4              Se0/0/0.3         11 00:02:50 1037  5000  0  28
1   172.30.13.1             Fa0/0             11 00:06:33    1   200  0  31

R4# show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   10.1.134.3              Se0/0/0.3         12 00:03:30   67   402  0  29
0   172.30.24.2             Fa0/0             10 00:06:43    1   200  0  29
```

10. Verify that LAN and WAN segments are advertised on all routers.

```
R1#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.24.0 [90/2172416] via 10.1.112.2, 00:01:31, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 2 subnets
D       10.1.134.0 [90/2172416] via 172.30.13.3, 00:01:41, FastEthernet0/0

R2#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.13.0 [90/2172416] via 10.1.112.1, 00:02:05, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 2 subnets
D       10.1.134.0 [90/2172416] via 172.30.24.4, 00:02:15, FastEthernet0/0

R3#show ip route eigrp
```

```
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.24.0 [90/2172416] via 10.1.134.4, 00:02:50, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 2 subnets
D       10.1.112.0 [90/2172416] via 172.30.13.1, 00:02:50, FastEthernet0/0
```

```
R4#show ip route eigrp
     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.13.0 [90/2172416] via 10.1.134.3, 00:03:31, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 2 subnets
D       10.1.112.0 [90/2172416] via 172.30.24.2, 00:03:31, FastEthernet0/0
```

11. Verify that detailed EIGRP interface information shows that secure LAN authentication is enabled on the LAN interfaces on all routers in your lab.

```
R1#show ip eigrp interfaces detail
IP-EIGRP interfaces for process 1

                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Se0/0/0.1          1        0/0       67       0/15          319           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/0  Un/reliable ucasts: 9/22
  Mcast exceptions: 0  CR packets: 0  ACKs suppressed: 8
  Retransmissions sent: 3  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-WAN"
  Use unicast
Fa0/0              1        0/0        2       0/1            50           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/10  Un/reliable ucasts: 12/10
  Mcast exceptions: 2  CR packets: 2  ACKs suppressed: 1
  Retransmissions sent: 1  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-LAN"
Use multicast
```

```
R2#show ip eigrp interfaces detail
IP-EIGRP interfaces for process 1

                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Se0/0/0.1          1        0/0       67       0/15          319           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/0  Un/reliable ucasts: 9/22
  Mcast exceptions: 0  CR packets: 0  ACKs suppressed: 8
  Retransmissions sent: 3  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-WAN"
  Use unicast
Fa0/0              1        0/0        2       0/1            50           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/10  Un/reliable ucasts: 12/10
  Mcast exceptions: 2  CR packets: 2  ACKs suppressed: 1
  Retransmissions sent: 1  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-LAN"
Use multicast
```

```
R3#show ip eigrp interfaces detail
IP-EIGRP interfaces for process 1

                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Se0/0/0.3          1        0/0       67       0/15          319           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/0  Un/reliable ucasts: 9/22
```



```
  Mcast exceptions: 0  CR packets: 0  ACKs suppressed: 8
  Retransmissions sent: 3  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-WAN"
  Use unicast
Fa0/0             1        0/0          2       0/1           50           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/10  Un/reliable ucasts: 12/10
  Mcast exceptions: 2  CR packets: 2  ACKs suppressed: 1
  Retransmissions sent: 1  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-LAN"
Use multicast

R4#show ip eigrp interfaces detail
IP-EIGRP interfaces for process 1

                        Xmit Queue   Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Se0/0/0.3         1        0/0         67       0/15         319           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/0  Un/reliable ucasts: 9/22
  Mcast exceptions: 0  CR packets: 0  ACKs suppressed: 8
  Retransmissions sent: 3  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-WAN"
  Use unicast
Fa0/0             1        0/0          2       0/1           50           0
  Hello interval is 5 sec
  Next xmit serial <none>
  Un/reliable mcasts: 0/10  Un/reliable ucasts: 12/10
  Mcast exceptions: 2  CR packets: 2  ACKs suppressed: 1
  Retransmissions sent: 1  Out-of-sequence rcvd: 0
  Authentication mode is md5,  key-chain is "LAB23-LAN"
Use multicast
```

Lab 2-4: Implement and Troubleshoot EIGRP Operations

Complete this lab activity to practice what you learned in the related module.

Activity Objective

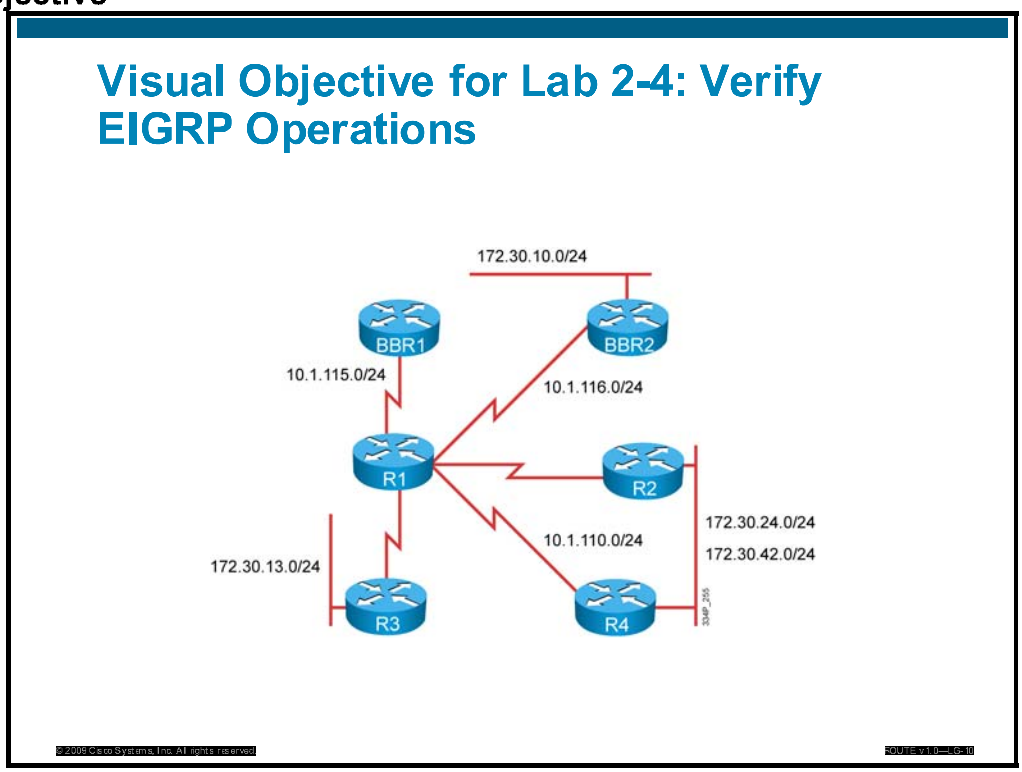
In this activity, you must analyze, locate, and fix EIGRP-related problems in your network that are caused by a misconfiguration or poor design. After this activity, you will be able to meet these objectives:

- Develop a work plan to troubleshoot configuration and security issues related to the EIGRP
- Isolate the causes of the problems
- Correct all of the identified EIGRP issues
- Document and report the troubleshooting findings and recommendations

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Troubleshooting Policy

The following lists details troubleshooting requirements and issues for all devices in the company network:

Trouble Ticket A: EIGRP Adjacency Issues

You were absent for a short period of time, and during your absence a junior engineer substituted foryou. There was a demand for additional IP subnet deployment on a LAN segment between routers R2 and R4. The junior engineer deployed additional IP subnets, but the connectivity beyond that segment to the new IP subnet is not available. You have been asked to examine and correct the issue, so that the new IP subnet will be accessible from any part of the network.

There is also an issue with the EIGRP adjacency to router BBR1. During your absence, the junior engineer was asked to improve routing security related to router BBR1. An adjacency with router BBR1 cannot be formed and you are asked to correct that problem.

Tthe engineer was also asked to optimize EIGRP operation. He applied a configuration that improved the metric calculation on R4, which broke the connectivity from that router. In addition to that, he tried to optimize the routing tables on the routers and implemented summarization to accomplish this goal, which is not working as expected. You are asked to address this issue too.

Trouble Ticket B: Limited Connectivity

Your assistant reports that there is no connectivity to the LAN subnets attached to routers R2 and R4 from a newly deployed spoke location where router R3 was deployed. Router R3 has limited connectivity—all other IP subnets in the network are accessible via router R1. You must locate and correct the issue with EIGRP routing.

Instructions

Together with your team members, create a troubleshooting and verification plan to divide the work. Assign each team member appropriate roles and coordinate device access among the team members. Together, work on Trouble Tickets A and B to resolve the issues. Document your progress in the “Troubleshooting Log” provided below as part of Task 2 in order to help facilitate efficient communication within the team and to have an overview of your troubleshooting process for reference during the lab debriefing discussions.

Device Information

The table provides the information specific to each switch in the network:

Device Name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR1	Backbone router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
interface *type slot/port*	Enters the interface configuration mode
show ip eigrp neighbors	Lists the EIGRP neighbors and relevant information on EIGRP neighbor adjacencies
show ip route [**eigrp**]	Displays the entire IP routing table or EIGRP routes only
key-chain *name*	Configures a key chain
key *id*	Defines a key
key-string *string*	Defines a shared secret for a key
accept-lifetime *from till*	Defines a key's acceptable lifetime
send-lifetime *from till*	Defines a key's lifetime that is advertised
show key-chain	Shows the configured key chains and parameters
show ip eigrp interfaces detail *interface*	Shows the EIGRP configuration details for an interface
debug eigrp packets	Enables EIGRP packet debugging
debug ip eigrp neighbor *AS ip address*	Enables EIGRP debugging per neighbor
[no] metric weights 0 *k1 k2 k3 k4 k5*	Sets EIGRP K values
ip address *ip mask* [**secondary**]	Sets the IP address on an interface

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank troubleshoouting and verification plan	Task 1
Blank troubleshooting log	Task 2
Troubleshooting and verification plan hints	“Hints” section at the end of this lab
Trouble Ticket Hints List	“Hints” section at the end of this lab
Configuration sample after trouble tickets	Configuration section at the end of this lab

Task 1: Create an Troubleshooting and Verification Plan

The first step is to establish a troubleshooting and verification plan. This is a task list of the items that must be checked and corrected in order to establish working conditions in the EIGRP network. Use the following table and the visual objective at the beginning of this lab to create your troubleshooting and verification plan. If you are unsure, you can use the information provided in the “Hints” section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 2: Troubleshooting Log

Use this log to document your actions and results during the troubleshooting process.

Trouble Ticket	Actions and Results

Trouble Ticket	Actions and Results

Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 2-4 Hint Sheet: Implement and Troubleshoot EIGRP Operations

Troubleshooting and Verification Plan

In Task 1, you will create a troubleshooting and verification plan. Although there are several ways to set up this plan, the following tasks must be completed::

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	
	R1–R4	1	Load initial configuration.	All pod routers must be preloaded with the initial configuration for the LAB.	
	R1–R4	2	On all the routers, examine the EIGRP adjacency tables and write down the information.	Use the **show ip eigrp neighbor** command in order to see if neighbors are adjacent.	
	R1, R2, R4	3	Observe the messages that appear on the routers because they might indicate that there is some kind of IP address mismatch and that the metric calculation is not in sync on all the routers.	Verify the IP address configuration on all routers and establish a working configuration by using the **show running-configuration** command.	
	R2, R4	4	Verify how a secondary IP subnet is applied on the LAN segment.	Verify the secondary IP address configuration on the LAN segments by issuing the **show running-configuration** command.	
	R1	5	Verify IP connectivity toward router BBR1. Enable EIGRP packet debugging and debugging for neighbor BBR1 to explore the problem toward that neighbor.	Debug the EIGRP packets in order to identify the source of the connectivity issues. Use the following commands: **debug eigrp packets** and **debug eigrp neighbors**.	
	R1–R4	6	Examine the IP routing tables on the routers in your pod and verify whether specific IP subnet information is present.	Identify the presence of EIGRP routes inside the IP routing table using the **show ip route eigrp** command. Verify if all IP subnets from the pod are present.	

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	
	R1, R3	7	Verify the neighbor relationship between routers R1 and R3.	Use the **show ip eigrp neighbors** command to verify if the neighbor relationship is established between the routers.	
	R1, R3	8	Examine the IP routing table and the EIGRP topology table on routers R1 and R3.	Use the **show ip route eigrp** and **show ip eigrp topology** commands to verify that the IP routing table reflecting the correct EIGRP topology and costs.	
	R3	9	Enable EIGRP debugging for the neighbor and observe what information is advertised to router R3.	Use the **debug eigrp neighbors** command in order to see what information is advertised to router R3.	

Trouble Ticket Hint List

On all routers, examine the EIGRP adjacency tables and write down the information.

Observe the messages that appear on routers R1, R2, and R4—they indicate that there is some kind of IP address mismatch and that the metric calculation is not in sync with all routers.

Verify how a secondary IP subnet is applied on the LAN segment on routers R2 and R4.

Verify IP connectivity toward router BBR1.

Enable EIGRP packet debugging and debugging for neighbor BBR1 to explore the problem toward that neighbor.

Examine the IP routing tables on routers in your pod and determine whether specific IP subnet information is present.

Verify the neighbor relationship between routers R1 and R3.

Examine the IP routing table and the EIGRP topology table on routers R1 and R3.

Enable EIGRP debugging for the neighbor and observe what information is advertised to router R3.

Configuration Sample After Trouble Tickets

```
On R1:
interface Serial0/0/0.1 multipoint
  no ip split-horizon eigrp 1
!
no key chain LAB24
!
key chain LAB24
 key 1
   key-string Cisco
   accept-lifetime 04:00:00 Jan 1 2003 infinite
   send-lifetime 04:00:00 Jan 1 2003 infinite
```

On R2:

```
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 ip address 172.30.42.2 255.255.255.0 secondary
```

On R4:

```
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 ip address 172.30.42.4 255.255.255.0 secondary
!
router eigrp 1
 no metric weights 0 1 1 1 1 1
```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Lab 3-1: Configure and Verify OSPF to Improve Routing Performance

Complete this lab activity to practice what you learned in the related module.

Activity Objective

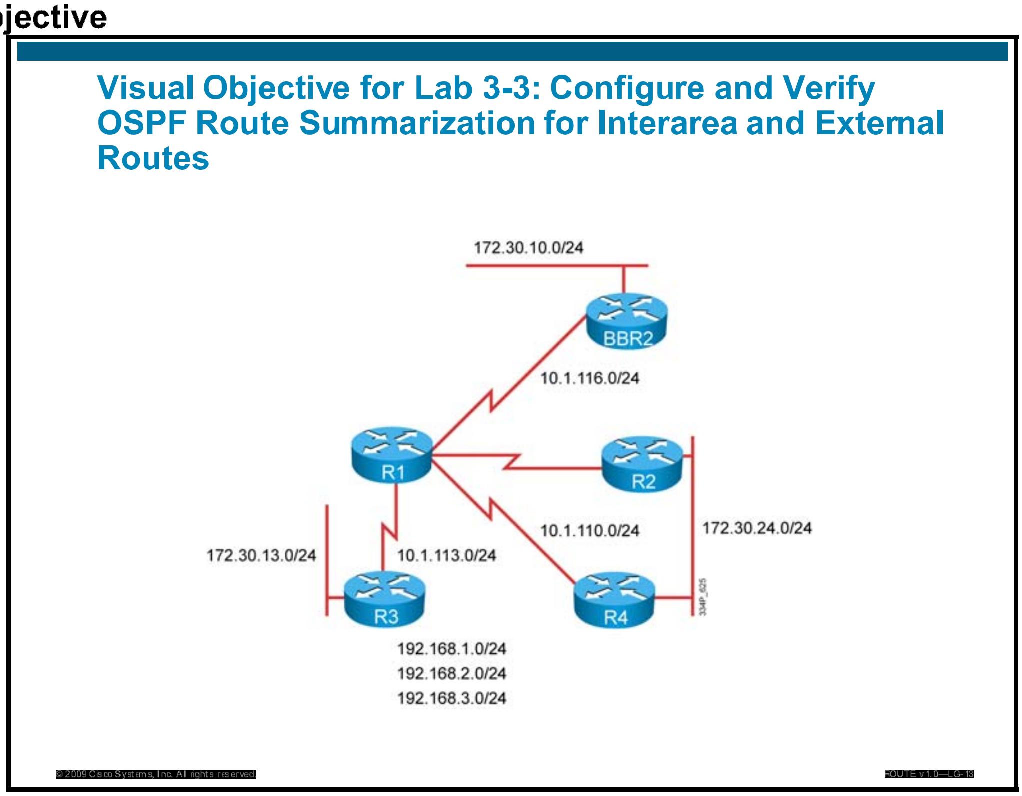
In this activity, you will use the correct commands, tools, and steps to configure and verify OSPF implementation. After completing this activity, you will be able to meet these objectives:

- Configure and verify OSPF operation over LAN interfaces
- Configure and verify OSPF operation over Frame Relay using a point-to-multipoint OSPF network type
- Configure and verify OSPF operation over Frame Relay using a point-to-point network type
- Select the required tools and commands to configure OSPF operations
- Make a list of configuration and implementation steps
- Write a verification and test plan to verify the proper implementation and operation according to the expected performance criteria
- Verify the configuration and operation by using the proper **show** and **debug** commands

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- In this task you, will configure OSPF on each of the routers in your network—routers R1, R2, R3, and R4. OSPF will be used to exchange routing information in order to achieve IP connectivity over the LAN interfaces. All of the routers should be members of the OSPF backbone area. The OSPF configuration should be so specific that if an additional network is added to the router, that network is not automatically advertised. The IP routing tables on all your routers should be populated with all of the specific IP subnets in your network.
- Verify that the proper OSPF adjacencies have been set up on the LAN segments between the routers in your pod (between routers R1 and R3 and between R2 and R4). Also examine how long the adjacencies have been set up and whether there is any problem in neighbor communications;, such as routing packets remaining in the queue. Verify whether the OSPF has been set up to advertise the IP subnets present on the loopback and LAN interfaces with the correct mask without examining the IP routing table and OSPF topology database. Verify the OSPF link-state database and compare it against the OSPF information that was put into the IP routing table on router R1. You should be able to see that the router R3 loopback network, acquired via OSPF, was put into the routing table, and that the metric related to the route corresponds to the value present in the link-state database.Verify that router R1 is the DR on the LAN segment between R1 and R3.
- As a next step, you will configure OSPF on the WAN segment between routers R3 and R4 to exchange IP routing information about the loopback and LAN. The OSPF configuration must reflect the point-to-point representation of the Frame Relay interface. Routers will be members of the same OSPF area as LAN segments. The OSPF configuration should be so specific that if an additional network is added to the router, that network is not automatically advertised. The IP routing tables on all your routers should be populated with all of the specific IP subnets in your network.
- Verify that the proper OSPF adjacencies have been set up on the WAN segment between routers R3 and R4 in your pod. Also examine how long the adjacencies have been set up and whether there is any problem with neighbor communications, such as routing packets remaining in the queue. Verify on the routers in your pod that OSPF has been set up to advertise the IP subnets present on the loopback, LAN interfaces, and the WAN segment from router R3 to R4 with the correct mask without examining the IP routing table and OSPF topology database.Verify the OSPF link-state database and compare it against the OSPF information that was put into the IP routing table on router R1. You should be able to see that the router R3 loopback network, acquired via OSPF, was put into the routing table, and that the metric related to the route corresponds to the value present in the link-state database.
- In the last step you will configure OSPF on a WAN segment between routers R1, R2, and R4 to exchange IP routing information. OSPF configuration must reflect the point-to-multipoint representation of the Frame Relay interface. Routers will be members of the same OSPF area as LAN segments. The OSPF configuration should be so specific that if an additional network is added to the router, that network is not automatically advertised. The IP routing tables on all of your routers should be populated with all of the specific IP subnets in your network.

- Verify that the proper OSPF adjacencies have been set up on the WAN segment between the routers R1, R2, and R4 in your pod. Examine also how long the adjacencies have been set up and whether there is any problem with neighbor communications, such as routing packets remaining in the queue. Verify for the routers in your pod that the OSPF is advertising all of the IP subnets on your routers and that the information is present in the OSPF link-state database as well as in the IP routing table.

Device Information

The table provides the information specific to each switch in the network:

Device Name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			

Command List

The table describes the commands that are used in this activity.

Command	Description
router ospf 1	Turns on OSPF; the process number is not communicated to other routers
interface s0/0/0.1 multipoint | point-to-point	Creates a subinterface (either point-to-multipoint or point-to-point)
ip ospf network point-to-multipoint	Forces OSPF to treat this interface as point-to-multipoint; the default is NBMA
network 172.31.x.0 0.0.0.255 area 0	Specifies the interfaces on which OSPF will run, in Area 0
show ip ospf interface	Displays information about interfaces configured for OSPF
show ip ospf neighbor	Displays a list of OSPF neighbors
show ip ospf database	Displays information about the OSPF database
show ip route [ospf]	Displays the entire IP routing table or OSPF routes only
ip ospf priority	Sets the router priority
log-adjacency-changes	Configures the router to send a syslog message when an OSPF neighbor goes up or down
ip ospf hello-interval	Specifies the interval between hello packets that are sent on the interface by the Cisco IOS software
clear ip ospf 1 process	Clears the Open Shortest Path First (OSPF) routing process

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	"Hints" section at the end of this lab
Implementation and verification plan hints	"Hints" section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, the device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirement list. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Device	Implementation Requirement

Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you gave collected all of the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and that it fulfills all of the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the "Hints" section at the end of this lab.

Student Notes:

Alternate Resources and Solutions

Other groups may have implemented a solution that is different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

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Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 3-1 Hint Sheet: Configure and Verify OSPF to Improve Routing Performance

Implementation Requirements

To facilitate the configuration of your network, Task 1 asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Define which specific subnets OSPF must announce	Visual Objective
ALL	Decide which OSPF area will be used	Implementation Policy

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load initial configuration.	All pod routers must be preloaded with the initial configuration for the lab.	Step 1
	R1, R3	2	Enable OSPF routing protocol on the LAN interface. Apply the configuration so that OSPF does not automatically advertise any additional network that is added to the router. Announce only LAN and loopback networks. Both routers should be members of the backbone area.	Verify that the proper OSPF adjacencies have been set up on LAN segments between the routers. Verify on each router that the OSPF has been set up to advertise the IP subnets present on the loopback and LAN interfaces with the correct mask, without examining the IP routing table and OSPF topology database. Verify the OSPF link-state database and compare it to the OSPF information that was put into the IP routing table. You should be able to see that the loopback network acquired via OSPF was put into the routing table, and that the metric related to the route corresponds to the value present in the link-state database.	Step 2

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R2, R4	3	Enable the OSPF routing protocol on the LAN interface. Apply the configuration so that OSPF does not automatically advertise any additional network that is added to the router. Announce only the LAN and loopback networks. Both routers should be members of the backbone area.	Verify that the proper OSPF adjacencies have been set up on the LAN segments between the routers. Verify on each router that OSPF has been set up to advertise the IP subnets present on the loopback and LAN interfaces with the correct mask, without examining the IP routing table and OSPF topology database. Verify the OSPF link-state database and compare it to the OSPF information that was put into the IP routing table. You should be able to see that the loopback network acquired via OSPF was put into the routing table, and that the metric related to the route corresponds to the value present in the link-state database.	Step 3
	R1, R3	4	Change the default OSPF DR/BDR selection on the LAN segment between routers R1 and R3, and force OSPF to choose R1 to become a DR.	Verify that router R1 is the DR on the LAN segment between R1 and R3.	Step 4
	R3	5	Change the OSPF configuration on router R3 and include the WAN segment that connects router R3 to router R4. The OSPF configuration that you add should be so specific that no additional networks are advertised. Place the segment in the OSPF area you have used for the LAN segment and loopbacks. The OSPF network representation for the WAN segment should reflect the Frame Relay network type.		Step 5

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R4	6	Change the OSPF configuration on router R3 and include the WAN segment that connects router R3 to router R4. The OSPF configuration that you add should be so specific that no additional networks are advertised. Place the segment in the OSPF area you have used for the LAN segment and loopbacks. The OSPF network representation for the WAN segment should reflect the Frame Relay network type.	Verify that the proper OSPF adjacencies have been set up on the WAN segment between routers R3 and R4 in your pod. Also examine how long the adjacencies have been set up and whether there is any problem with neighbor communications, such as routing packets remaining in the queue. On all of the pod routers, verify the OSPF link-state database and compare it against the OSPF information that was put into the IP routing table. You should be able to see that the loopback network acquired via OSPF was put into the routing table, and that the metric related to the route corresponds to the value present in the link-state database.	Step 5
	R1	7	Include the WAN segment on router R1 in OSPF and enable the OSPF adjacency over the serial interface toward routers R2 and R4. The OSPF configuration that you add should be so specific that no additional networks are advertised. Place the segment in the same OSPF area you have used so far. The OSPF network representation for the WAN segment should reflect the Frame Relay multipoint network type.		Step 6

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R2, R4		Add the OSPF configuration on routers R2 and R4. Include WAN segment toward router R1 in the OSPF. The OSPF configuration should also advertise any additional networks from a major network if added later. The OSPF interface network type should reflect the Frame Relay WAN segment representation.	Verify that the proper OSPF adjacencies have been set up on the WAN segment between routers R1, R2, and R4 in your pod. Examine how long the adjacencies have been set up and whether there is any problem with neighbor communications, such as routing packets remaining in the queue. Verify for the routers in your pod that OSPF is advertising all the IP subnets on your routers and that the information is present in the OSPF link-state database as well as in the IP routing table.	Step 6

Step-by-Step Procedure for Implementation and Verification

1. Load an initial configuration on all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Configure OSPF over the LAN interfaces on routers R1 and R3.

   2.1. Use the following example to configure the routers in this lab:

```
R1#
router ospf 1
 network 10.1.1.1 0.0.0.0 area 0
 network 172.30.13.0 0.0.0.255 area 0

R3#
router ospf 1
 network 10.3.3.3 0.0.0.0 area 0
 network 172.30.13.0 0.0.0.255 area 0
```

   2.2. Verify that the proper adjacencies are set up between neighbors on the LAN segment.

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State         Dead Time   Address         Interface
192.168.3.1       1   FULL/DR       00:00:32    172.30.13.3     FastEthernet0/0

R3#show ip ospf neighbor

Neighbor ID     Pri   State         Dead Time   Address         Interface
10.1.1.1          1   FULL/BDR      00:00:36    172.30.13.1     FastEthernet0/0
```

   2.3. Verify that the proper interfaces are involved in the OSPF process, and that networks are advertised.

```
R1#show ip ospf interface
Loopback0 is up, line protocol is up
  Internet Address 10.1.1.1/32, Area 0
  Process ID 1, Router ID 172.30.13.1, Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.13.1/24, Area 0
  Process ID 1, Router ID 172.30.13.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 172.30.13.1, Interface address 172.30.13.1
```

```
  Backup Designated router (ID) 192.168.3.1, Interface address 172.30.13.3
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:09
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.3.1  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)

R3#show ip ospf interface
Loopback0 is up, line protocol is up
  Internet Address 10.3.3.3/32, Area 0
  Process ID 1, Router ID 192.168.3.1, Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.13.3/24, Area 0
  Process ID 1, Router ID 192.168.3.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 172.30.13.1, Interface address 172.30.13.1
  Backup Designated router (ID) 192.168.3.1, Interface address 172.30.13.3
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:05
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 172.30.13.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
```

2.4. Examine the OSPF link-state database and verify that the loopback network acquired via OSPF was put into the routing table.

```
R1#show ip ospf database

            OSPF Router with ID (10.1.1.1) (Process ID 1)

                    Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        126         0x80000002 0x00EF56 2
192.168.3.1     192.168.3.1     127         0x80000002 0x006914 2

                    Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.13.3     192.168.3.1     127         0x80000001 0x00E195

R1#show ip route ospf
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O       10.3.3.3/32 [110/2] via 172.30.13.3, 00:02:07, FastEthernet0/0

R3#show ip ospf database

            OSPF Router with ID (192.168.3.1) (Process ID 1)

                    Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        178         0x80000002 0x00EF56 2
192.168.3.1     192.168.3.1     177         0x80000002 0x006914 2
```

```
                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.13.3     192.168.3.1     177         0x80000001 0x00E195
```

```
R3#show ip route ospf
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O       10.1.1.1/32 [110/2] via 172.30.13.1, 00:06:37, FastEthernet0/0
```

3. Configure OSPF over the LAN interfaces on routers R2 and R4.

3.1. Use the following example to configure the routers in this lab:

```
R2#
router ospf 1
 network 10.2.2.2 0.0.0.0 area 0
 network 172.30.24.0 0.0.0.255 area 0

R4#
router ospf 1
 network 10.4.4.4 0.0.0.0 area 0
 network 172.30.24.0 0.0.0.255 area 0
```

3.2. Verify that the proper adjacencies are set up between neighbors on the LAN segment.

```
R2#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.4.4.4          1   FULL/DR         00:00:30    172.30.24.4     FastEthernet0/0

R4#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.2.2.2          1   FULL/BDR        00:00:35    172.30.24.2     FastEthernet0/0
```

3.3. Verify that proper interfaces are involved in the OSPF process and that networks are advertised.

```
R2#show ip ospf interface
Loopback0 is up, line protocol is up
  Internet Address 10.2.2.2/32, Area 0
  Process ID 1, Router ID 172.30.24.2, Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.24.2/24, Area 0
  Process ID 1, Router ID 172.30.24.2, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 172.30.24.2, Interface address 172.30.24.2
  Backup Designated router (ID) 10.4.4.4, Interface address 172.30.24.4
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.4.4.4  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)

R4# show ip ospf interface
Loopback0 is up, line protocol is up
  Internet Address 10.4.4.4/32, Area 0
  Process ID 1, Router ID 10.4.4.4, Network Type LOOPBACK, Cost: 1
  Loopback interface is treated as a stub Host
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.24.4/24, Area 0
  Process ID 1, Router ID 10.4.4.4, Network Type BROADCAST, Cost: 1
```

```
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 172.30.24.2, Interface address 172.30.24.2
  Backup Designated router (ID) 10.4.4.4, Interface address 172.30.24.4
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:07
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 172.30.24.2  (Designated Router)
  Suppress hello for 0 neighbor(s)
```

3.4. Examine the OSPF link-state database and verify that the loopback network acquired via OSPF was put into the routing table.

```
R2#show ip ospf database

            OSPF Router with ID (10.2.2.2) (Process ID 1)

                          Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.2.2.2        10.2.2.2        169         0x80000002 0x000124 2
10.4.4.4        10.4.4.4        170         0x80000002 0x00FE12 2

                          Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        170         0x80000001 0x000116

R2#show ip route ospf
     10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O       10.4.4.4/32 [110/2] via 172.30.24.4, 00:04:40, FastEthernet0/0

R4#show ip ospf database

            OSPF Router with ID (10.4.4.4) (Process ID 1)

                          Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.2.2.2        10.2.2.2        214         0x80000002 0x000124 2
10.4.4.4        10.4.4.4        213         0x80000002 0x00FE12 2

                          Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        213         0x80000001 0x000116

R4#show ip route ospf
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O       10.2.2.2/32 [110/2] via 172.30.24.2, 00:07:34, FastEthernet0/0
```

4. Change the default OSPF DR/BDR selection on the LAN segment between routers R1 and R3.

4.1. Use the following example to configure the routers in this lab:

```
R1#
interface FastEthernet0/0
 ip ospf priority 10

R1#clear ip ospf 1 process
```

4.2. Verify that router R1 is the DR on the LAN segment between R1 and R3.

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.3.1       1   FULL/DR         00:00:32    172.30.13.3     FastEthernet0/0
```

5. Configure OSPF over Frame Relay using a point-to-point OSPF network type.

5.1. Use the following example to configure router R3 in this lab:

```
R3#
router ospf 1
 network 10.1.134.0 0.0.0.255 area 0
```

5.2. Use the following example to configure router R4 in this lab:

```
R4#
router ospf 1
 network 10.1.134.0 0.0.0.255 area 0
```

5.3. Verify the configuration on routers R1, R2, R3, and R4.

```
R1#show ip ospf database

            OSPF Router with ID (10.1.1.1) (Process ID 1)

                                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        78          0x80000003 0x00ED57 2
10.2.2.2        10.2.2.2        372         0x80000002 0x000124 2
10.4.4.4        10.4.4.4        11          0x80000004 0x007764 4
192.168.3.1     192.168.3.1     15          0x80000004 0x007030 4

                                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.13.3     192.168.3.1     662         0x80000001 0x00E195
172.30.24.4     10.4.4.4        371         0x80000001 0x000116

R1#show ip route ospf
     172.30.0.0/24 is subnetted, 2 subnets
O       172.30.24.0 [110/66] via 172.30.13.3, 00:01:26, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.2.2.2/32 [110/67] via 172.30.13.3, 00:01:26, FastEthernet0/0
O       10.3.3.3/32 [110/2] via 172.30.13.3, 00:01:26, FastEthernet0/0
O       10.4.4.4/32 [110/66] via 172.30.13.3, 00:01:26, FastEthernet0/0
O       10.1.134.0/24 [110/65] via 172.30.13.3, 00:01:26, FastEthernet0/0

R2#show ip ospf neighbor

Neighbor ID     Pri   State          Dead Time   Address         Interface
10.4.4.4          1   FULL/DR        00:00:35    172.30.24.4     FastEthernet0/0

R2#show ip ospf database

            OSPF Router with ID (10.2.2.2) (Process ID 1)

                                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        149         0x80000003 0x00ED57 2
10.2.2.2        10.2.2.2        437         0x80000002 0x000124 2
10.4.4.4        10.4.4.4        79          0x80000004 0x007764 4
192.168.3.1     192.168.3.1     83          0x80000004 0x007030 4

                                Net Link States (Area 0)
```

```
Link ID         ADV Router      Age         Seq#       Checksum
172.30.13.3     192.168.3.1     731         0x80000001 0x00E195
172.30.24.4     10.4.4.4        438         0x80000001 0x000116
```

R2#show ip route ospf

```
     172.30.0.0/24 is subnetted, 2 subnets
O       172.30.13.0 [110/66] via 172.30.24.4, 00:01:56, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.3.3.3/32 [110/66] via 172.30.24.4, 00:01:56, FastEthernet0/0
O       10.1.1.1/32 [110/67] via 172.30.24.4, 00:01:56, FastEthernet0/0
O       10.4.4.4/32 [110/2] via 172.30.24.4, 00:01:56, FastEthernet0/0
O       10.1.134.0/24 [110/65] via 172.30.24.4, 00:01:56, FastEthernet0/0
```

R3#show ip ospf neighbor

```
Neighbor ID     Pri   State       Dead Time   Address         Interface
10.4.4.4          0   FULL/  -    00:00:33    10.1.134.4      Serial0/0/0.2
10.1.1.1         10   FULL/BDR    00:00:31    172.30.13.1     FastEthernet0/0
```

R3#show ip ospf interface se0/0/0.2

```
Serial0/0/0.2 is up, line protocol is up
  Internet Address 10.1.134.3/24, Area 0
  Process ID 1, Router ID 192.168.3.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.4.4.4
  Suppress hello for 0 neighbor(s)
```

R3#show ip ospf database

```
            OSPF Router with ID (192.168.3.1) (Process ID 1)

                            Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        238         0x80000003 0x00ED57 2
10.2.2.2        10.2.2.2        529         0x80000002 0x000124 2
10.4.4.4        10.4.4.4        169         0x80000004 0x007764 4
192.168.3.1     192.168.3.1     173         0x80000004 0x007030 4

                            Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.13.3     192.168.3.1     820         0x80000001 0x00E195
172.30.24.4     10.4.4.4        528         0x80000001 0x000116
```

R3#show ip route ospf

```
     172.30.0.0/24 is subnetted, 2 subnets
O       172.30.24.0 [110/65] via 10.1.134.4, 00:02:47, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.2.2.2/32 [110/66] via 10.1.134.4, 00:02:47, Serial0/0/0.2
O       10.1.1.1/32 [110/2] via 172.30.13.1, 00:02:47, FastEthernet0/0
O       10.4.4.4/32 [110/65] via 10.1.134.4, 00:02:47, Serial0/0/0.2
```

R4#show ip ospf neighbor

```
Neighbor ID     Pri   State       Dead Time   Address         Interface
192.168.3.1       0   FULL/  -    00:00:35    10.1.134.3      Serial0/0/0.2
10.2.2.2          1   FULL/BDR    00:00:33    172.30.24.2     FastEthernet0/0
```

```
R4#show ip ospf interface serial0/0/0.2
Serial0/0/0.2 is up, line protocol is up
  Internet Address 10.1.134.4/24, Area 0
  Process ID 1, Router ID 10.4.4.4, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:07
  Supports Link-local Signaling (LLS)
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.3.1
  Suppress hello for 0 neighbor(s)

R4#show ip ospf database

            OSPF Router with ID (10.4.4.4) (Process ID 1)

                            Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        400         0x80000003 0x00ED57 2
10.2.2.2        10.2.2.2        690         0x80000002 0x000124 2
10.4.4.4        10.4.4.4        330         0x80000004 0x007764 4
192.168.3.1     192.168.3.1     335         0x80000004 0x007030 4

                            Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.13.3     192.168.3.1     982         0x80000001 0x00E195
172.30.24.4     10.4.4.4        689         0x80000001 0x000116

R4#show ip route ospf
     172.30.0.0/24 is subnetted, 2 subnets
O       172.30.13.0 [110/65] via 10.1.134.3, 00:03:26, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.2.2.2/32 [110/2] via 172.30.24.2, 00:03:26, FastEthernet0/0
O       10.3.3.3/32 [110/65] via 10.1.134.3, 00:03:26, Serial0/0/0.2
O       10.1.1.1/32 [110/66] via 10.1.134.3, 00:03:26, Serial0/0/0.2
```

6. Configure OSPF over Frame Relay using a point-to-multipoint OSPF network type.

6.1. Use the following example to configure router R1 in this lab:

```
R1#
interface Serial0/0/0.1 multipoint
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
!
router ospf 1
 network 10.1.110.0 0.0.0.255 area 0
```

6.2. Use the following example to configure routers R2 and R4 in this lab:

```
R2#
router ospf 1
 network 10.1.110.0 0.0.0.255 area 0

R4#
router ospf 1
 network 10.1.110.0 0.0.0.255 area 0
```

6.3. Verify the configuration on routers R1, R2, and R4.

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.2.2.2          0   FULL/  -        00:00:36    10.1.110.2      Serial0/0/0.1
10.4.4.4          0   FULL/  -        00:00:30    10.1.110.4      Serial0/0/0.1
192.168.3.1       1   FULL/DR         00:00:36    172.30.13.3     FastEthernet0/0

R1#show ip ospf int se0/0/0.1
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.1/24, Area 0
  Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_MULTIPOINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:02
  Supports Link-local Signaling (LLS)
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 2, Adjacent neighbor count is 2
    Adjacent with neighbor 10.2.2.2
    Adjacent with neighbor 10.4.4.4
  Suppress hello for 0 neighbor(s)

R1#show ip ospf database

            OSPF Router with ID (10.1.1.1) (Process ID 1)

                             Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        103         0x80000006 0x00D827 5
10.2.2.2        10.2.2.2        104         0x80000003 0x00CEB4 4
10.4.4.4        10.4.4.4        110         0x80000005 0x000434 6
192.168.3.1     192.168.3.1     517         0x80000004 0x007030 4

                             Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.13.3     192.168.3.1     1165        0x80000001 0x00E195
172.30.24.4     10.4.4.4        873         0x80000001 0x000116

R1#show ip route ospf
     172.30.0.0/24 is subnetted, 2 subnets
O       172.30.24.0 [110/65] via 10.1.110.4, 00:01:30, Serial0/0/0.1
                    [110/65] via 10.1.110.2, 00:01:30, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.2.2.2/32 [110/65] via 10.1.110.2, 00:01:30, Serial0/0/0.1
O       10.3.3.3/32 [110/2] via 172.30.13.3, 00:01:30, FastEthernet0/0
O       10.4.4.4/32 [110/65] via 10.1.110.4, 00:01:30, Serial0/0/0.1
O       10.1.134.0/24 [110/65] via 172.30.13.3, 00:01:30, FastEthernet0/0

R2#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.1.1.1          0   FULL/  -        00:00:34    10.1.110.1      Serial0/0/0.1
10.4.4.4          1   FULL/DR         00:00:39    172.30.24.4     FastEthernet0/0

R2#show ip ospf interface serial 0/0/0.1
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.2/24, Area 0
  Process ID 1, Router ID 10.2.2.2, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:05
  Supports Link-local Signaling (LLS)
```

```
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.1.1.1
  Suppress hello for 0 neighbor(s)
```

R2#show ip ospf database

```
            OSPF Router with ID (10.2.2.2) (Process ID 1)

                             Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        209         0x80000006 0x00D827 5
10.2.2.2        10.2.2.2        208         0x80000003 0x00CEB4 4
10.4.4.4        10.4.4.4        216         0x80000005 0x000434 6
192.168.3.1     192.168.3.1     623         0x80000004 0x007030 4

                             Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.13.3     192.168.3.1     1270        0x80000001 0x00E195
172.30.24.4     10.4.4.4        977         0x80000001 0x000116
```

R2#show ip route ospf

```
     172.30.0.0/24 is subnetted, 2 subnets
O       172.30.13.0 [110/65] via 10.1.110.1, 00:03:03, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O       10.3.3.3/32 [110/66] via 172.30.24.4, 00:03:03, FastEthernet0/0
                    [110/66] via 10.1.110.1, 00:03:03, Serial0/0/0.1
O       10.1.1.1/32 [110/65] via 10.1.110.1, 00:03:03, Serial0/0/0.1
O       10.4.4.4/32 [110/2] via 172.30.24.4, 00:03:03, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:03:03, Serial0/0/0.1
O       10.1.134.0/24 [110/65] via 172.30.24.4, 00:03:03, FastEthernet0/0
```

R4#show ip ospf neighbor

```
Neighbor ID     Pri   State           Dead Time   Address         Interface
10.1.1.1          0   FULL/  -        00:00:34    10.1.110.1      Serial0/0/0.1
192.168.3.1       0   FULL/  -        00:00:30    10.1.134.3      Serial0/0/0.2
10.2.2.2          1   FULL/BDR        00:00:31    172.30.24.2     FastEthernet0/0
```

R4#show ip ospf interface serial 0/0/0.1

```
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.4/24, Area 0
  Process ID 1, Router ID 10.4.4.4, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  Supports Link-local Signaling (LLS)
  Index 4/4, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.1.1.1
  Suppress hello for 0 neighbor(s)
```

R4#show ip ospf database

```
            OSPF Router with ID (10.4.4.4) (Process ID 1)

                             Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
```

```
10.1.1.1        10.1.1.1        300         0x80000006 0x00D827 5
10.2.2.2        10.2.2.2        300         0x80000003 0x00CEB4 4
10.4.4.4        10.4.4.4        305         0x80000005 0x000434 6
192.168.3.1     192.168.3.1     713         0x80000004 0x007030 4

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.13.3     192.168.3.1     1360        0x80000001 0x00E195
172.30.24.4     10.4.4.4        1067        0x80000001 0x000116
```

```
R4#show ip route ospf
     172.30.0.0/24 is subnetted, 2 subnets
O       172.30.13.0 [110/65] via 10.1.134.3, 00:04:12, Serial0/0/0.2
                    [110/65] via 10.1.110.1, 00:04:12, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O       10.2.2.2/32 [110/2] via 172.30.24.2, 00:04:12, FastEthernet0/0
O       10.3.3.3/32 [110/65] via 10.1.134.3, 00:04:12, Serial0/0/0.2
O       10.1.1.1/32 [110/65] via 10.1.110.1, 00:04:12, Serial0/0/0.1
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:04:12, Serial0/0/0.1
```


Lab 3-2: Implement and Verify OSPF Multiarea Routing

Complete this lab activity to practice what you learned in the related module.

Activity Objective

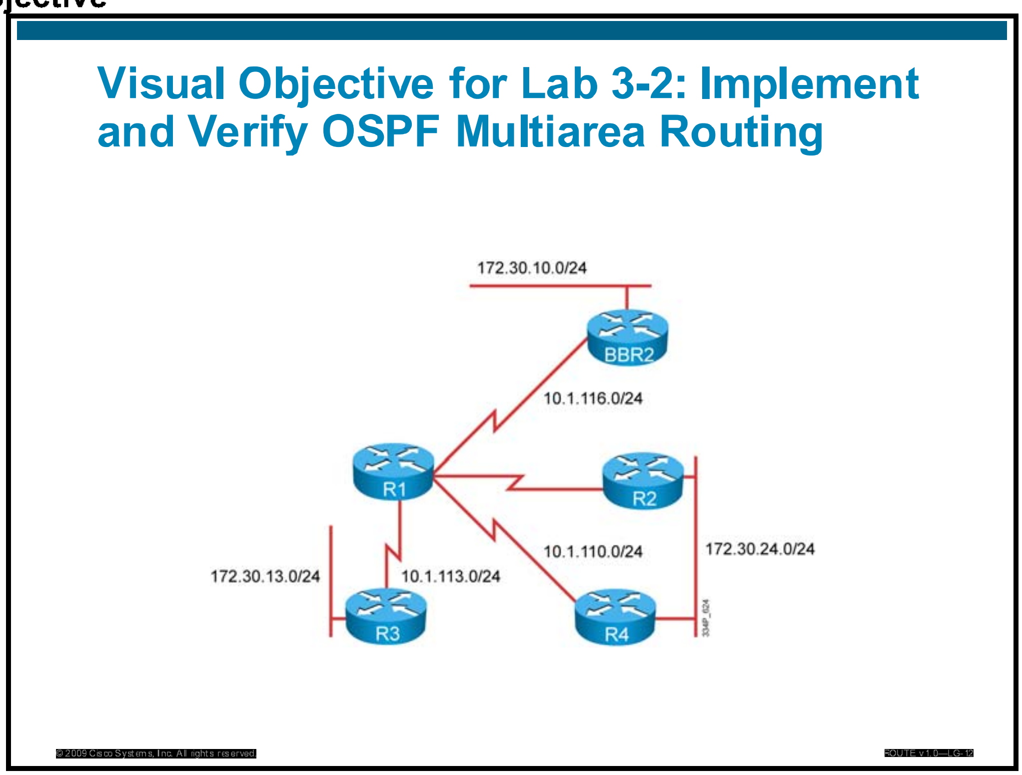
In this activity, you will use the correct commands, tools, and steps to configure and verify OSPF multiarea routing. After completing this activity, you will be able to meet these objectives:

- Configure and verify the OSPF operation over LAN and WAN interfaces
- Configure and verify the OSPF operation using multiple areas
- Select the required tools and commands to configure OSPF operations
- Influence the path selection for OSPF by changing the cost
- Optimize the OSPF operation to prevent the transmission of unnecessary hellos
- Make a list of configuration and implementation steps
- Write a verification and test plan to verify the proper implementation and operation according to the expected performance criteria
- Verify the configuration and operation by using the proper **show** and **debug** commands

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- First you will configure OSPF on the WAN segment between routers R1 and BBR2. BBR2 is preconfigured with OSPF routing in Area 0. Router R1 will be configured in OSPF Area 0 with a WAN interface toward router BBR2 and should receive IP routing information about network 172.30.10.0/24 from router BBR2.
- Verify that the OSPF adjacency has been set up on the WAN segment between routers R1 and BBR2. Examine the OSPF link-state database on router R1 and compare it to the IP routing table to verify the correctness of the received information. Examine the IP routing table on router R1 and verify that it is populated with the expected OSPF routes. Verify that you have connectivity to the BBR2 LAN segment 172.30.10.0/24.
- In this task you will complete the OSPF routing configuration in your pod. You will configure OSPF routing on routers R2, R3, and R4. Router R3 will be a member of OSPF Area 3 with all of its interfaces. Routers R2 and R4 will be members of Area 24. All of the router R2 and R4 interfaces will be part of that area. Routers in your pod should exchange and receive IP routing information about all of the subnets available.
- Verify that the OSPF adjacency has been set up between routers R1 and R3 in OSPF Area 3. Examine the OSPF link-state database on router R3 and compare it against its routing table to verify that the correct information was put into the IP routing table. Verify that router R3 has all the necessary IP subnets in its routing table and that it can access all the IP subnets in the network. Verify that the OSPF adjacency has been set up between routers R1 and R2 and between routers R1 and R4 in OSPF Area 24. Examine the OSPF link-state database on routers R2 and R4 and compare them against their routing tables to verify that the correct information was put into the IP routing table. Verify that routers R2 and R4 have all the necessary IP subnets in their routing tables and that they can access all the IP subnets in the network, including the subnets that have been announced by BBR2. Verify that you have connectivity to the BBR2 LAN segment 172.30.10.0/24 from all routers in your pod.
- In this task you will precisely adjust the OSPF operation on your routers. You will change the default path cost calculation in Area 24 and persuade router R1 to prefer the path via router R2 to the 172.30.24.0/24 LAN segment. Next you will have to make the OSPF routing in Area 0 more stable by forcing router R1 to administratively define the router ID. Finally, you will optimize the OSPF operation in Area 3 on router R3 to preserve CPU resources on that router by eliminating unnecessary OSPF traffic on the LAN segment.
- Verify that all the necessary OSPF adjacencies in the network are up and running. Router R1 should have an OSPF adjacency set up with BBR2 in Area 0, with router R3 in Area 3, and with routers R2 and R4 in Area 24. Verify that router R1 is using a stable router ID for the OSPF process you have configured. Examine the IP routing table on router R1 and confirm that it prefers the path via router R2 toward the 172.30.24.0/24 segment. Verify that R1 selects R2 as the next hop for IP packets destined to segment 172.30.24.0/24. Examine the OSPF adjacencies on router R3 and verify that the adjacency with router R1 is the only adjacency that is up and running. Verify that router R3 is not trying to set up an OSPF adjacency via the LAN segment.

Device Information

The table provides the information specific to each switch in the network:

Device Name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
router ospf 1	Turns on OSPF; the process number is not communicated to other routers
neighbor 10.1.110.2 cost 10	Assigns a cost to the neighbor
interface s0/0/0.1 multipoint | point-to-point	Creates a subinterface (either point-to-multipoint or point-to-point)
ip ospf network point-to-multipoint	Forces OSPF to treat this interface as point-to-multipoint; the default is NBMA
network 172.31.x.0 0.0.0.255 area 0	Specifies the interfaces on which OSPF will run, in Area 0
show ip ospf interface	Displays information about interfaces configured for OSPF
show ip ospf neighbor	Displays a list of OSPF neighbors
show ip ospf database	Displays information about the OSPF database
show ip route [**ospf**]	Displays a whole IP routing table or OSPF routes only
ip ospf priority	Sets the router priority
log-adjacency-changes	Configures the router to send a syslog message when an OSPF neighbor goes up or down
ip ospf hello-interval	Specifies the interval between hello packets that are sent on the interface by the Cisco IOS software
clear ip ospf 1 process	Clears the Open Shortest Path First (OSPF) routing process
router-id	Sets a fixed router ID
passive-interface	Disables the sending of routing updates on an interface
Ping	Diagnoses basic network connectivity
Trace	Discovers the routes that packets will actually take when traveling to their destination

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	"Hints" section at the end of this lab
Implementation and verification plan hints	"Hints" section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirement list. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Device	Implementation Requirement

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Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the "Hints" section at the end of this lab.

Student Notes:

Alternate Resources and Solutions

Other groups may have implemented a solution that is different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 3-2 Hint Sheet: Implement and Verify OSPF Multiarea Routing

Implementation Requirements

To facilitate the configuration of your network, Task 1 asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Define the interfaces and networks used in the network in order to correctly implement OSPF.	Visual Objective and lab
ALL	Observe the costs on the links.	Lab

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load the initial configuration.	All pod routers must be preloaded with the initial configuration for the lab.	Step 1

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1	2	Configure OSPF routing protocol on router R1. Enable the logging of OSPF neighbor changes on router R1. Include the router R1 WAN interface toward router BBR2 in the OSPF routing process. Remember that router BBR2 is already configured with the OSPF routing protocol toward router R1 in OSPF Area 0	Verify that the OSPF adjacency has been set up on the WAN segment between routers R1 and BBR2. Examine the OSPF link-state database on router R1 and compare it against the IP routing table to verify the correctness of the received information. Examine the IP routing table on router R1 and verify that it is populated with the expected OSPF routes. Verify that you have connectivity to the BBR2 LAN segment 172.30.10.0/24.	Step 2
	R3	3	Enable the OSPF routing protocol on router R3 and enable the logging of OSPF adjacency changes. Set up an OSPF adjacency with router R1. Configure router R3 to be part of Area 3 with all its interfaces.		Step 3
	R1	4	On router R1, add the OSPF configuration to enable adjacency with router R3. Router R1 should announce its networks and networks received via the backbone OSPF area to router R3.	Verify that the OSPF adjacency has been set up between routers R1 and R3 in OSPF Area 3.	Step 3
	R1, R2, R4	5	Configure the OSPF routing protocol on routers R2 and R4, and enable the logging of adjacency changes. Routers should set up an OSPF adjacency with router R1 and between each other. The LAN and WAN interfaces of routers R2 and R4 should be part of OSPF Area 24. Add a configuration on router R1 to allow the creation of OSPF adjacencies with routers R2 and R4. Router R1 should announce its network and networks received via the backbone area to routers R2 and R4.	Verify that the OSPF adjacency has been set up between routers R1 and R2 and between routers R1 and R4 in OSPF Area 24. Examine the OSPF link-state database on routers R2 and R4 and compare it to the router R2 and R4 routing tables to verify that the correct information was put into the IP routing table, including the subnets that were announced by BBR2.	Step 4

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1, R3, R4	7		Examine the OSPF link-state database on router R3 and compare it against its routing table to verify that the correct information was put into the IP routing table, including the subnets that were announced by BBR2. Verify that you have connectivity to the router BBR2 LAN segment 172.30.10.0/24 from routers R1 and R4.	Step 5
	R1	8	Examine the routing information for the LAN segment 172.30.24.0/24 on router R1 to verify which path is used to reach the destinations on that segment. Adjust the cost parameter used for OSPF path calculation on routers in Area 24 so that router R1 prefers the path via router R2 to the 172.30.24.0/24 destination subnet.	Examine the IP routing table on router R1 and confirm that it prefers the path via router R2 toward the 172.30.24.0/24 segment.	Step 6
	R1	9	Examine the OSPF configuration on router R1 to inspect what OSPF router ID is used for the OSPF process. Then change the OSPF router ID on router R1 and force the router to use the administratively defined value for the router ID.	Verify that router R1 is using a stable router ID for the OSPF process you have configured. Router R1 should have OSPF adjacency set up with BBR2 in Area 0, with router R3 in Area 3, and with routers R2 and R4 in Area 24.	Step 7
	R3	10	Examine the OSPF adjacencies on router R3. Verify that there are no neighbors seen on the LAN segment, but despite that, router R3 is constantly trying to set up OSPF adjacency. Change the OSPF configuration on router R3 so that it stops trying to set up OSPF adjacency via the LAN interface, which will preserve CPU cycles. The configuration should prevent the sending of OSPF hello packets out of that interface.	Verify that router R3 stopped trying to set up an OSPF adjacency via the LAN segment.	Step 8
		11			
		12			

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Configure the OSPF backbone area.

   2.1. Use the following example to configure the routers in this lab:

```
R1#
router ospf 1
 log-adjacency-changes
 network 10.1.116.0 0.0.0.255 area 0
```

   2.2. Verify OSPF configuration and reachability using different commands on router R1.

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
172.30.10.6       0   FULL/  -        00:00:32    10.1.116.6      Serial0/0/0.116

R1#show ip ospf interface
Serial0/0/0.116 is up, line protocol is up
  Internet Address 10.1.116.1/24, Area 0
  Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:02
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 172.30.10.6
  Suppress hello for 0 neighbor(s)

R1#show ip ospf database

            OSPF Router with ID (10.1.1.1) (Process ID 1)

                                 Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        75          0x80000002 0x00446A 2
172.30.10.6     172.30.10.6     72          0x80000003 0x002FC4 3

R1#show ip route ospf
     172.30.0.0/24 is subnetted, 2 subnets
O       172.30.10.0 [110/65] via 10.1.116.6, 00:01:05, Serial0/0/0.116

R1#ping 172.30.10.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.10.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/57/60 ms
```

3. Configure the OSPF nonbackbone areas.

   3.1. Use the following example to configure router R3 in this lab:

```
R3#
router ospf 1
 log-adjacency-changes
 network 10.1.113.0 0.0.0.255 area 3
```



```
 network 172.30.13.0 0.0.0.255 area 3
```

3.2. Use the following example to configure router R1 in this lab:

```
R1#
router ospf 1
 network 10.1.113.0 0.0.0.255 area 3
```

3.3. Verify the adjacency between routers R1 and R3:

```
R3#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.1.1.1          0   FULL/  -        00:00:36    10.1.113.1      Serial0/0/0.2
```

4. Configure OSPF nonbackbone areas.

4.1. Use the following example to configure routers R2 and R4 in this lab:

```
R2#
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24

R4#
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24
```

4.2. Use the following example to configure router R1 in this lab:

```
R1#
interface Serial0/0/0.1 multipoint
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
!
router ospf 1
 network 10.1.110.0 0.0.0.255 area 24
```

4.3. Verify the OSPF configuration on routers R1, R2, and R4.

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
172.30.10.6       0   FULL/  -        00:00:30    10.1.116.6      Serial0/0/0.116
192.168.3.1       0   FULL/  -        00:00:34    10.1.113.3      Serial0/0/0.2
10.4.4.4          0   FULL/  -        00:00:37    10.1.110.4      Serial0/0/0.1
10.2.2.2          0   FULL/  -        00:00:39    10.1.110.2      Serial0/0/0.1

R2#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.4.4.4          1   FULL/DR         00:00:33    172.30.24.4     FastEthernet0/0
10.1.1.1          0   FULL/  -        00:00:34    10.1.110.1      Serial0/0/0.1

R4#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.2.2.2          1   FULL/BDR        00:00:38    172.30.24.2     FastEthernet0/0
10.1.1.1          0   FULL/  -        00:00:38    10.1.110.1      Serial0/0/0.1

R1#show ip ospf interface
Serial0/0/0.116 is up, line protocol is up
  Internet Address 10.1.116.1/24, Area 0
  Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
```

```
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 1/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 172.30.10.6
  Suppress hello for 0 neighbor(s)
Serial0/0/0.2 is up, line protocol is up
  Internet Address 10.1.113.1/24, Area 3
  Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Index 1/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.3.1
  Suppress hello for 0 neighbor(s)
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.1/24, Area 24
  Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_MULTIPOINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 2, Adjacent neighbor count is 2
    Adjacent with neighbor 10.4.4.4
    Adjacent with neighbor 10.2.2.2
  Suppress hello for 0 neighbor(s)

R2#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.24.2/24, Area 24
  Process ID 1, Router ID 10.2.2.2, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 10.4.4.4, Interface address 172.30.24.4
  Backup Designated router (ID) 10.2.2.2, Interface address 172.30.24.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:09
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.4.4.4  (Designated Router)
  Suppress hello for 0 neighbor(s)
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.2/24, Area 24
  Process ID 1, Router ID 10.2.2.2, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
```

```
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.1.1.1
Suppress hello for 0 neighbor(s)
```

```
R4#show ip ospf interfaces
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.24.4/24, Area 24
  Process ID 1, Router ID 10.4.4.4, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 10.4.4.4, Interface address 172.30.24.4
  Backup Designated router (ID) 10.2.2.2, Interface address 172.30.24.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:04
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 2, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.2.2.2  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.4/24, Area 24
  Process ID 1, Router ID 10.4.4.4, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:08
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 2, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.1.1.1
  Suppress hello for 0 neighbor(s)
```

```
R1#show ip ospf database

            OSPF Router with ID (10.1.1.1) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        178         0x80000002 0x004766 2
172.30.10.6     172.30.10.6     184         0x80000006 0x00E30D 3

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.0      10.1.1.1        94          0x80000001 0x00D164
10.1.110.1      10.1.1.1        113         0x80000001 0x00C2F2
10.1.113.0      10.1.1.1        184         0x80000001 0x002E45
172.30.13.0     10.1.1.1        149         0x80000001 0x00E82E
172.30.24.0     10.1.1.1        84          0x80000001 0x006F9C

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        164         0x80000003 0x004ED1 2
192.168.3.1     192.168.3.1     157         0x80000002 0x00498D 3

                Summary Net Link States (Area 3)
```

```
Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.0      10.1.1.1        94          0x80000001 0x00D164
10.1.110.1      10.1.1.1        113         0x80000001 0x00C2F2
10.1.116.0      10.1.1.1        179         0x80000001 0x000D63
172.30.10.0     10.1.1.1        169         0x80000001 0x000A10
172.30.24.0     10.1.1.1        84          0x80000001 0x006F9C

                             Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        81          0x80000005 0x0037AA 3
10.2.2.2        10.2.2.2        36          0x80000003 0x00DFC4 3
10.4.4.4        10.4.4.4        36          0x80000003 0x00C3D0 3

                             Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        36          0x80000001 0x000116

                             Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      10.1.1.1        184         0x80000001 0x002E45
10.1.116.0      10.1.1.1        181         0x80000001 0x000D63
172.30.10.0     10.1.1.1        171         0x80000001 0x000A10
172.30.13.0     10.1.1.1        151         0x80000001 0x00E82E
```

R2#show ip ospf database

```
            OSPF Router with ID (10.2.2.2) (Process ID 1)

                             Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        202         0x80000005 0x0037AA 3
10.2.2.2        10.2.2.2        155         0x80000003 0x00DFC4 3
10.4.4.4        10.4.4.4        156         0x80000003 0x00C3D0 3

                             Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        156         0x80000001 0x000116

                             Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      10.1.1.1        305         0x80000001 0x002E45
10.1.116.0      10.1.1.1        300         0x80000001 0x000D63
172.30.10.0     10.1.1.1        290         0x80000001 0x000A10
172.30.13.0     10.1.1.1        270         0x80000001 0x00E82E
```

R4#show ip ospf database

```
            OSPF Router with ID (10.4.4.4) (Process ID 1)

                             Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        336         0x80000005 0x0037AA 3
10.2.2.2        10.2.2.2        290         0x80000003 0x00DFC4 3
10.4.4.4        10.4.4.4        289         0x80000003 0x00C3D0 3

                             Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        289         0x80000001 0x000116

                             Summary Net Link States (Area 24)
```

```
Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      10.1.1.1        438         0x80000001 0x002E45
10.1.116.0      10.1.1.1        433         0x80000001 0x000D63
172.30.10.0     10.1.1.1        423         0x80000001 0x000A10
172.30.13.0     10.1.1.1        403         0x80000001 0x00E82E
```

```
R1#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/65] via 10.1.110.4, 00:00:37, Serial0/0/0.1
                    [110/65] via 10.1.110.2, 00:00:37, Serial0/0/0.1
O       172.30.10.0 [110/65] via 10.1.116.6, 00:02:56, Serial0/0/0.116
O       172.30.13.0 [110/65] via 10.1.113.3, 00:02:36, Serial0/0/0.2
```

```
R2#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:02:42, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:02:42, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:02:42, Serial0/0/0.1
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:02:42, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:02:42, Serial0/0/0.1
```

```
R4#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:04:48, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:04:48, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:04:48, Serial0/0/0.1
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:04:48, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:04:48, Serial0/0/0.1
```

5. Verify the OSPF configuration on router R3 and connectivity to the BBR2 LAN segment 172.30.10.0/24 from routers R1 and R4.

```
R3#show ip ospf interfaces
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.13.3/24, Area 3
  Process ID 1, Router ID 192.168.3.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.3.1, Interface address 172.30.13.3
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:02
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Serial0/0/0.2 is up, line protocol is up
  Internet Address 10.1.113.3/24, Area 3
  Process ID 1, Router ID 192.168.3.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.1.1.1
  Suppress hello for 0 neighbor(s)
```

```
R3#show ip ospf database

            OSPF Router with ID (192.168.3.1) (Process ID 1)

                            Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        361         0x80000003 0x004ED1 2
192.168.3.1     192.168.3.1     352         0x80000002 0x00498D 3

                            Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.0      10.1.1.1        291         0x80000001 0x00D164
10.1.110.1      10.1.1.1        310         0x80000001 0x00C2F2
10.1.116.0      10.1.1.1        375         0x80000001 0x000D63
172.30.10.0     10.1.1.1        365         0x80000001 0x000A10
172.30.24.0     10.1.1.1        281         0x80000001 0x006F9C

R3#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.24.0 [110/129] via 10.1.113.1, 00:04:44, Serial0/0/0.2
O IA    172.30.10.0 [110/129] via 10.1.113.1, 00:05:49, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
O IA    10.1.110.1/32 [110/64] via 10.1.113.1, 00:05:12, Serial0/0/0.2
O IA    10.1.110.0/24 [110/192] via 10.1.113.1, 00:04:54, Serial0/0/0.2
O IA    10.1.116.0/24 [110/128] via 10.1.113.1, 00:05:49, Serial0/0/0.2

R1#ping 172.30.10.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.10.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/56/60 ms

R4#ping 172.30.10.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.10.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/113/116 ms
```

6. Tuning OSPF operation.

   6.1. Use the following example to configure router R1 in this lab:

```
R1#
router ospf 1
 neighbor 10.1.110.2 cost 10
```

   6.2. Verify that router R1 prefers the path via router R2 toward the 172.30.24.0/24 segment:

```
R1#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/11] via 10.1.110.2, 00:00:50, Serial0/0/0.1
O       172.30.10.0 [110/65] via 10.1.116.6, 00:00:50, Serial0/0/0.116
O       172.30.13.0 [110/65] via 10.1.113.3, 00:00:50, Serial0/0/0.2

R1#ping 172.30.24.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.24.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/56/60 ms

R1#ping 172.30.24.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.24.4, timeout is 2 seconds:
```



```
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/56/60 ms

R1#traceroute 172.30.24.4

Type escape sequence to abort.
Tracing the route to 172.30.24.4

  1 10.1.110.2 28 msec 28 msec 28 msec
  2 172.30.24.4 28 msec 28 msec *
```

7. Manipulate the router ID.

7.1. Use the following example to configure router R1 in this lab:

```
R1#
router ospf 1
 router-id 1.1.1.1

R1#clear ip ospf 1 process
```

7.2. Verify that router R1 prefers the path via router R2 toward the 172.30.24.0/24 segment:

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 10.1.1.1
 Start time: 5w2d, Time elapsed: 00:12:07.216
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 3. 3 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area BACKBONE(0)
            Number of interfaces in this area is 1
            Area has no authentication
            SPF algorithm last executed 00:02:56.724 ago
            SPF algorithm executed 3 times
            Area ranges are
            Number of LSA 7. Checksum Sum 0x04E292
            Number of opaque link LSA 0. Checksum Sum 0x000000
            Number of DCbitless LSA 0
            Number of indication LSA 0
            Number of DoNotAge LSA 0
            Flood list length 0
    Area 3
            Number of interfaces in this area is 1
            Area has no authentication
            SPF algorithm last executed 00:02:56.724 ago
            SPF algorithm executed 3 times
            Area ranges are
            Number of LSA 7. Checksum Sum 0x02B7FD
            Number of opaque link LSA 0. Checksum Sum 0x000000
            Number of DCbitless LSA 0
```

```
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
    Area 24
                Number of interfaces in this area is 1
                Area has no authentication
                SPF algorithm last executed 00:02:56.724 ago
                SPF algorithm executed 3 times
                Area ranges are
                Number of LSA 8. Checksum Sum 0x054B79
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0

R1#show ip ospf neighbor
Neighbor ID     Pri   State          Dead Time   Address         Interface
172.30.10.6       0   FULL/  -       00:00:34    10.1.116.6      Serial0/0/0.116
192.168.3.1       0   FULL/  -       00:00:38    10.1.113.3      Serial0/0/0.2
10.4.4.4          0   FULL/  -       00:00:31    10.1.110.4      Serial0/0/0.1
10.2.2.2          0   FULL/  -       00:00:33    10.1.110.2      Serial0/0/0.1

R1#show ip ospf interfaces
Serial0/0/0.116 is up, line protocol is up
  Internet Address 10.1.116.1/24, Area 0
  Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 1/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 2, maximum is 5
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 172.30.10.6
  Suppress hello for 0 neighbor(s)
Serial0/0/0.2 is up, line protocol is up
  Internet Address 10.1.113.1/24, Area 3
  Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 1/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 2, maximum is 5
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.3.1
  Suppress hello for 0 neighbor(s)
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.1/24, Area 24
  Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_MULTIPOINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 4
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 2, Adjacent neighbor count is 2
    Adjacent with neighbor 10.4.4.4
```

```
    Adjacent with neighbor 10.2.2.2, cost is 10
  Suppress hello for 0 neighbor(s)
```

```
R1#show ip ospf database

            OSPF Router with ID (10.1.1.1) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        56          0x80000003 0x004567 2
172.30.10.6     172.30.10.6     57          0x80000008 0x00DF0F 3

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.0      10.1.1.1        47          0x80000001 0x00B3B8
10.1.110.1      10.1.1.1        52          0x80000002 0x00C0F3
10.1.113.0      10.1.1.1        52          0x80000002 0x002C46
172.30.13.0     10.1.1.1        47          0x80000001 0x00E82E
172.30.24.0     10.1.1.1        47          0x80000001 0x0051F0

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        56          0x80000004 0x004CD2 2
192.168.3.1     192.168.3.1     57          0x80000004 0x00458F 3

                Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.0      10.1.1.1        47          0x80000001 0x00B3B8
10.1.110.1      10.1.1.1        52          0x80000002 0x00C0F3
10.1.116.0      10.1.1.1        52          0x80000002 0x000B64
172.30.10.0     10.1.1.1        47          0x80000001 0x000A10
172.30.24.0     10.1.1.1        47          0x80000001 0x0051F0

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        56          0x80000007 0x00D83D 3
10.2.2.2        10.2.2.2        447         0x80000003 0x00DFC4 3
10.4.4.4        10.4.4.4        448         0x80000003 0x00C3D0 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        448         0x80000001 0x000116

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      10.1.1.1        52          0x80000002 0x002C46
10.1.116.0      10.1.1.1        52          0x80000002 0x000B64
172.30.10.0     10.1.1.1        49          0x80000001 0x000A10
172.30.13.0     10.1.1.1        49          0x80000001 0x00E82E
```

8. Manipulation using OSPF adjacencies.

8.1. Use the following example to configure router R3 in this lab:

```
R3#
router ospf 1
 passive-interface FastEthernet0/0
```

8.2. Verify that router R3 did not establish adjacency, and that router R3 stopped trying to establish adjacency, on the LAN segment:

```
R3#show ip ospf interface FastEthernet0/0
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.13.3/24, Area 3
  Process ID 1, Router ID 192.168.3.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 192.168.3.1, Interface address 172.30.13.3
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    No Hellos (Passive interface)
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
```

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Lab 3-3: Configure and Verify OSPF Route Summarization for Interarea and External Routes

Complete this lab activity to practice what you learned in the related module.

Activity Objective

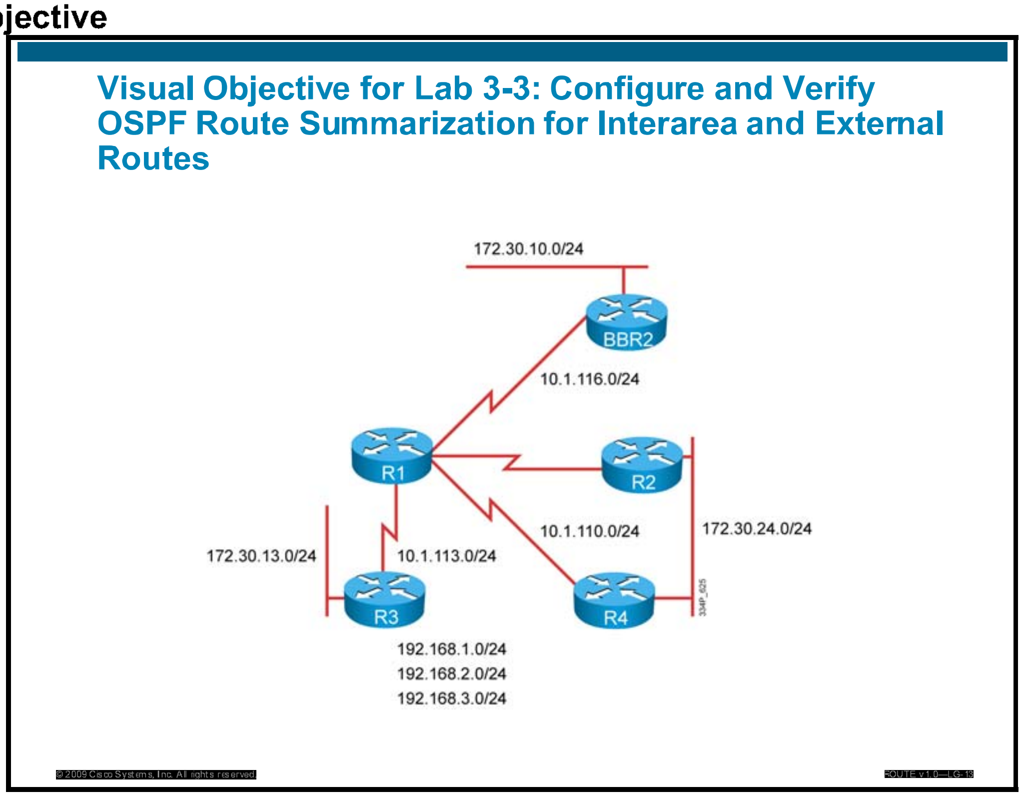
In this activity, you will use correct commands, tools, and steps to configure and verify OSPF multiarea routing and optimize OSPF routing by implementing summarization. After completing this activity, you will be able to meet these objectives:

- Configure and verify the OSPF operation over LAN and WAN interfaces
- Configure and verify the OSPF operation using multiple areas
- Select the required tools and commands to configure OSPF operations
- Optimize the OSPF operation by implementing route summarization for the internal OSPF routes
- Optimize the OSPF operation by implementing route summarization for the external OSPF routes
- Make a list of the configuration and implementation steps
- Write a verification and test plan to verify the proper implementation and operation according to the expected performance criteria.
- Verify the configuration and operation by using the proper **show** and **debug** commands

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- In this task you will examine IP routing information exchanged by routers configured with the OSPF routing protocol. Routers R1, R2, R3, and R4 are configured with the OSPF routing protocol and are announcing their directly attached networks. Router R4 is also announcing some external OSPF networks into the OSPF routing domain.
- Learn about the current OSPF configuration, which includes information about the networks that are included in the OSPF routing domain, interfaces where OSPF is enabled, OSPF adjacencies, link-state databases, and OSPF area design. Verify that all the routers have IP connectivity to the advertised networks. Examine the IP routing table, write down the IP networks that are advertised, and determine the IP addressing scheme.
- Use the information about the OSPF routing configuration and design that you collected in the previous task to optimize OSPF operation. You will optimize the OSPF link-state database, and consequently the IP routing table, by making them smaller using summarization of the 172.30.x.0/24 subnets from router BBR2.
- Verify that all relevant OSPF adjacencies are still up and running for routers R1, R2, R3, and R4. Router R1 should have running OSPF adjacencies to routers R2, R3, R4, and BBR2. Router R3 should have running OSPF adjacency with router R1 only, whereas routers R2 and R4 should have OSPF adjacency running between themselves and toward router R1. Examine the OSPF link-state databases on routers R1, R2, R3, and R4 and verify that the relevant information is in the databases. Verify that the best path information has been put into the router IP routing tables. Examine the OSPF link-state database and IP routing table on relevant routers to see that the OSPF internal route summarization for the pod IP subnets 172.30.x.0/24 has been applied.
- Further optimize OSPF routing operation by summarizing the OSPF external routes. Router R3 is redistributing certain 192.168.x.0/24 subnets into the OSPF routing domain. Because it is the only source of that IP routing information, there is no need for other routers to learn and keep information about individual 192.68.x.0/24 subnets. You also know that in the future, additional 192.168.x.0/24 subnets will be added.
- Verify that all relevant OSPF adjacencies are still up and running for routers R1, R2, R3, and R4. Router R1 should have running OSPF adjacencies to routers R2, R3, R4, and BBR2. Router R3 should have running OSPF adjacency with router R1 only, whereas routers R2 and R4 should have OSPF adjacency running between them and toward router R1. Examine the OSPF link-state databases on routers R1, R2, R3, and R4 and verify that the relevant information is in the databases. Verify that the best path information has been put into the router IP routing tables. Verify that the routing information for the external networks 192.168.x.0/24 is presented as summary information in the OSPF link-state database and in the IP routing tables on relevant routers; in other words, verify that the OSPF required information is really minimized. Verify that all the routers have IP connectivity to the pod external networks 192.268.x.0/24, which were redistributed on router R4.

Device Information

The table provides the information specific to each switch in the network:

Device Name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
router ospf 1	Turns on OSPF; the process number is not communicated to other routers
show ip ospf interface	Displays information about interfaces configured for OSPF
show ip ospf neighbor	Displays a list of OSPF neighbors
show ip ospf database	Displays information about the OSPF database
show ip route [**ospf**]	Displays the entire IP routing table or OSPF routes only
area range	Consolidates and summarizes routes at an area boundary
summary-address (OSPF)	Creates an aggregate address for OSPF
Ping	Diagnoses basic network connectivity

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	"Hints" section at the end of this lab
Implementation and verification plan hints	"Hints" section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirements list. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Device	Implementation Requirement

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Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the “Hints” section at the end of this lab.

Student Notes:

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Alternate Resources and Solutions

Other groups may have implemented a solution that is different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 3-3 Hint Sheet: Configure and Verify OSPF Route Summarization for Interarea and External Routes

Implementation Requirements

To facilitate the configuration of your network, Task 1 asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Identify the networks that are advertised by all routers.	Lab
ALL	Identify the existing OSPF configuration.	Lab
ALL	Identify the subnets that can be summarized and define a summary address.	Lab

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load the initial configuration.	All pod routers must be preloaded with the initial configuration for the lab.	Step 1
	R1–R4	2		Examine the OSPF routing configuration on all routers. First explore the OSPF adjacencies to gain insight into how OSPF is deployed in the network. Also observe the OSPF area configuration in order to learn the OSPF architecture and topology.	Step 2.1
	R1–R4			Verify the router R1, R2, R3, and R4 IP routing tables to see whether the correct information was put into the routing tables.	2.2

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1		Apply OSPF internal route summarization for the IP subnet 172.30.10.0/24 received from router BBR1. Summarize the networks in summary route 172.30.0.0/16, which is announced into nonbackbone OSPF areas.	Examine the OSPF link-state databases on all routers and verify that the relevant information is in the databases. Verify that the OSPF internal route summarization is applied for the pod IP 172.30.x.0/24 subnets.	Step 3
	R3		Apply the appropriate OSPF configuration to summarize the external 192.168.x.0/24 subnets, which are redistributed and injected into the OSPF domain. Because you know that additional 192.168.x.0/24 subnets will be added in the future, apply the summarization so that all 192.168.x.0/24 subsets are summarized with one command only and that the OSPF routing optimization is maximized.	Examine the OSPF link-state database and IP routing table on all routers to verify that the relevant information is present. The routing information for the external 192.168.x.0/24 networks is presented as summary information in the OSPF link-state database and therefore in the IP routing tables on relevant routers. Verify that all the external 192.268.x.0/24 networks, which are redistributed on router R3, are reachable from router R4.	Step 4

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Examine the OSPF routing information.

   2.1. Examine the OSPF adjacencies and OSPF link-state database to gain insight into how OSPF is deployed in the network.

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
172.30.10.6       0   FULL/  -        00:00:38    10.1.116.6      Serial0/0/0.116
192.168.3.1       0   FULL/  -        00:00:32    10.1.113.3      Serial0/0/0.2
10.4.4.4          0   FULL/  -        00:00:35    10.1.110.4      Serial0/0/0.1
10.2.2.2          0   FULL/  -        00:00:37    10.1.110.2      Serial0/0/0.1

R1#show ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1408        0x80000005 0x0008B4 2
```

```
172.30.10.6     172.30.10.6     1430        0x800009AD 0x00CD7B 3

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         1403        0x80000001 0x0014AA
10.1.110.2      1.1.1.1         83          0x80000001 0x006E45
10.1.110.4      1.1.1.1         64          0x80000001 0x00644C
10.1.113.0      1.1.1.1         1383        0x80000001 0x007FFC
172.30.13.0     1.1.1.1         1373        0x80000001 0x003AE5
172.30.24.0     1.1.1.1         83          0x80000001 0x00A2A8

                Summary ASB Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         1373        0x80000001 0x000387

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1383        0x80000006 0x000F20 2
192.168.3.1     192.168.3.1     1408        0x80000004 0x009F3C 3

                Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         1424        0x80000001 0x0014AA
10.1.110.2      1.1.1.1         103         0x80000001 0x006E45
10.1.110.4      1.1.1.1         85          0x80000001 0x00644C
10.1.116.0      1.1.1.1         1429        0x80000001 0x005E1B
172.30.10.0     1.1.1.1         1429        0x80000001 0x005BC7
172.30.24.0     1.1.1.1         103         0x80000001 0x00A2A8

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         88          0x80000006 0x00A187 3
10.2.2.2        10.2.2.2        106         0x80000005 0x00E9FF 3
10.4.4.4        10.4.4.4        86          0x80000005 0x0012C5 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        473         0x80000001 0x000116

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         1405        0x80000001 0x007FFC
10.1.116.0      1.1.1.1         1431        0x80000001 0x005E1B
172.30.10.0     1.1.1.1         1431        0x80000001 0x005BC7
172.30.13.0     1.1.1.1         1395        0x80000001 0x003AE5

                Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         1395        0x80000001 0x000387

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     1501        0x80000001 0x0004C4 0
192.168.2.0     192.168.3.1     1501        0x80000001 0x00F8CE 0
192.168.3.0     192.168.3.1     1502        0x80000001 0x00EDD8 0

R2#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
```

```
10.4.4.4          1   FULL/DR       00:00:38    172.30.24.4     FastEthernet0/0
1.1.1.1           0   FULL/  -      00:00:30    10.1.110.1      Serial0/0/0.1
```

R2#show ip ospf database

```
            OSPF Router with ID (10.2.2.2) (Process ID 1)

                                 Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         859         0x80000003 0x00A784 3
10.2.2.2        10.2.2.2        836         0x80000005 0x00307B 3
10.4.4.4        10.4.4.4        750         0x80000005 0x001487 3

                                 Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        1527        0x80000002 0x00FE17

                                 Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         859         0x80000002 0x007DFD
10.1.116.0      1.1.1.1         858         0x80000002 0x005C1C
172.30.10.0     1.1.1.1         858         0x80000002 0x0059C8
172.30.13.0     1.1.1.1         858         0x80000002 0x0038E6

                                 Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         605         0x80000002 0x000188

                                 Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     585         0x80000002 0x0002C5 0
192.168.2.0     192.168.3.1     585         0x80000002 0x00F6CF 0
192.168.3.0     192.168.3.1     584         0x80000002 0x00EBD9 0
```

R3#show ip ospf neighbor

```
Neighbor ID     Pri   State         Dead Time   Address         Interface
1.1.1.1           0   FULL/  -      00:00:39    10.1.113.1      Serial0/0/0.2
```

R3#show ip ospf database

```
            OSPF Router with ID (192.168.3.1) (Process ID 1)

                                 Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1516        0x80000006 0x000F20 2
192.168.3.1     192.168.3.1     1519        0x80000004 0x009F3C 3

                                 Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         1536        0x80000001 0x0014AA
10.1.110.2      1.1.1.1         216         0x80000001 0x006E45
10.1.110.4      1.1.1.1         198         0x80000001 0x00644C
10.1.116.0      1.1.1.1         1541        0x80000001 0x005E1B
172.30.10.0     1.1.1.1         1541        0x80000001 0x005BC7
172.30.24.0     1.1.1.1         216         0x80000001 0x00A2A8

                                 Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     1611        0x80000001 0x0004C4 0
```

```
192.168.2.0     192.168.3.1     1611        0x80000001 0x00F8CE 0
192.168.3.0     192.168.3.1     1629        0x80000001 0x00EDD8 0
```

R4#show ip ospf neighbor

```
Neighbor ID     Pri   State         Dead Time   Address         Interface
10.2.2.2          1   FULL/BDR      00:00:38    172.30.24.2     FastEthernet0/0
1.1.1.1           0   FULL/  -      00:00:39    10.1.110.1      Serial0/0/0.1
```

R4#show ip ospf database

```
            OSPF Router with ID (10.4.4.4) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         900         0x80000003 0x00A784 3
10.2.2.2        10.2.2.2        879         0x80000005 0x00307B 3
10.4.4.4        10.4.4.4        790         0x80000005 0x001487 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        1567        0x80000002 0x00FE17

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         900         0x80000002 0x007DFD
10.1.116.0      1.1.1.1         900         0x80000002 0x005C1C
172.30.10.0     1.1.1.1         900         0x80000002 0x0059C8
172.30.13.0     1.1.1.1         900         0x80000002 0x0038E6

                Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         646         0x80000002 0x000188

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     626         0x80000002 0x0002C5 0
192.168.2.0     192.168.3.1     626         0x80000002 0x00F6CF 0
192.168.3.0     192.168.3.1     626         0x80000002 0x00EBD9 0
```

2.2. Verify that the correct information was added to the router R1, R2, R3, and R4 IP routing tables.

R1#show ip route ospf

```
     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/11] via 10.1.110.2, 00:04:59, Serial0/0/0.1
O       172.30.10.0 [110/65] via 10.1.116.6, 00:27:27, Serial0/0/0.116
O       172.30.13.0 [110/65] via 10.1.113.3, 00:26:57, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/11] via 10.1.110.2, 00:04:59, Serial0/0/0.1
O       10.1.110.2/32 [110/10] via 10.1.110.2, 00:04:59, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.113.3, 00:04:59, Serial0/0/0.2
O E2 192.168.2.0/24 [110/20] via 10.1.113.3, 00:04:59, Serial0/0/0.2
O E2 192.168.3.0/24 [110/20] via 10.1.113.3, 00:04:59, Serial0/0/0.2
```

R2#show ip route ospf

```
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:05:45, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:05:45, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:05:45, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:05:45, Serial0/0/0.1
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:05:45, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:05:45, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:05:45, Serial0/0/0.1
```



```
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:05:45, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:05:45, Serial0/0/0.1
```

```
R3#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.24.0 [110/75] via 10.1.113.1, 00:06:39, Serial0/0/0.2
O IA    172.30.10.0 [110/129] via 10.1.113.1, 00:28:14, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.1.110.4/32 [110/75] via 10.1.113.1, 00:06:21, Serial0/0/0.2
O IA    10.1.110.1/32 [110/64] via 10.1.113.1, 00:28:14, Serial0/0/0.2
O IA    10.1.110.2/32 [110/74] via 10.1.113.1, 00:06:39, Serial0/0/0.2
O IA    10.1.116.0/24 [110/128] via 10.1.113.1, 00:28:14, Serial0/0/0.2
```

```
R4#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:06:30, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:06:30, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:06:30, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:06:30, FastEthernet0/0
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:06:30, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:06:30, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:06:30, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:06:30, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:06:30, Serial0/0/0.1
```

3. Summarizing the OSPF internal routes.

3.1. Use the following example to configure router R1 in this lab:

```
R1#
router ospf 1
 area 0 range 172.30.0.0 255.255.0.0
```

3.2. Verify the OSPF link-state databases and IP routing tables.

```
R1#show ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)

                        Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1785        0x80000005 0x0008B4 2
172.30.10.6     172.30.10.6     1807        0x800009AD 0x00CD7B 3

                        Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         1781        0x80000001 0x0014AA
10.1.110.2      1.1.1.1         461         0x80000001 0x006E45
10.1.110.4      1.1.1.1         442         0x80000001 0x00644C
10.1.113.0      1.1.1.1         1760        0x80000001 0x007FFC
172.30.13.0     1.1.1.1         1750        0x80000001 0x003AE5
172.30.24.0     1.1.1.1         461         0x80000001 0x00A2A8

                        Summary ASB Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         1750        0x80000001 0x000387

                        Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1760        0x80000006 0x000F20 2
192.168.3.1     192.168.3.1     1788        0x80000004 0x009F3C 3

                        Summary Net Link States (Area 3)
```

```
Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         1804        0x80000001 0x0014AA
10.1.110.2      1.1.1.1         483         0x80000001 0x006E45
10.1.110.4      1.1.1.1         465         0x80000001 0x00644C
10.1.116.0      1.1.1.1         1809        0x80000001 0x005E1B
172.30.0.0      1.1.1.1         33          0x80000001 0x00C963
172.30.24.0     1.1.1.1         483         0x80000001 0x00A2A8

                             Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         468         0x80000006 0x00A187 3
10.2.2.2        10.2.2.2        486         0x80000005 0x00E9FF 3
10.4.4.4        10.4.4.4        466         0x80000005 0x0012C5 3

                             Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        853         0x80000001 0x000116

                             Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         1799        0x80000001 0x007FFC
10.1.116.0      1.1.1.1         1824        0x80000001 0x005E1B
172.30.0.0      1.1.1.1         48          0x80000001 0x00C963
172.30.13.0     1.1.1.1         1789        0x80000001 0x003AE5

                             Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         1789        0x80000001 0x000387

                             Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     1894        0x80000001 0x0004C4 0
192.168.2.0     192.168.3.1     1894        0x80000001 0x00F8CE 0
192.168.3.0     192.168.3.1     1896        0x80000001 0x00EDD8 0

R1#show ip route ospf
     172.30.0.0/16 is variably subnetted, 4 subnets, 2 masks
O       172.30.24.0/24 [110/11] via 10.1.110.2, 00:01:42, Serial0/0/0.1
O       172.30.0.0/16 is a summary, 00:01:42, Null0
O       172.30.10.0/24 [110/65] via 10.1.116.6, 00:01:42, Serial0/0/0.116
O       172.30.13.0/24 [110/65] via 10.1.113.3, 00:01:42, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/11] via 10.1.110.2, 00:01:42, Serial0/0/0.1
O       10.1.110.2/32 [110/10] via 10.1.110.2, 00:01:42, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.113.3, 00:01:42, Serial0/0/0.2
O E2 192.168.2.0/24 [110/20] via 10.1.113.3, 00:01:42, Serial0/0/0.2
O E2 192.168.3.0/24 [110/20] via 10.1.113.3, 00:01:42, Serial0/0/0.2

R2#show ip ospf database

            OSPF Router with ID (10.2.2.2) (Process ID 1)

                             Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1392        0x80000003 0x00A784 3
10.2.2.2        10.2.2.2        1369        0x80000005 0x00307B 3
10.4.4.4        10.4.4.4        1282        0x80000005 0x001487 3

                             Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        20          0x80000003 0x00FC18
```

```
                         Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         1392        0x80000002 0x007DFD
10.1.116.0      1.1.1.1         1391        0x80000002 0x005C1C
172.30.0.0      1.1.1.1         99          0x80000001 0x00C963
172.30.13.0     1.1.1.1         175         0x80000001 0x003AE5

                         Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         1138        0x80000002 0x000188

                         Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     1118        0x80000002 0x0002C5 0
192.168.2.0     192.168.3.1     1118        0x80000002 0x00F6CF 0
192.168.3.0     192.168.3.1     1117        0x80000002 0x00EBD9 0

R2#show ip route ospf
     172.30.0.0/16 is variably subnetted, 3 subnets, 2 masks
O IA    172.30.0.0/16 [110/129] via 10.1.110.1, 00:02:29, Serial0/0/0.1
O IA    172.30.13.0/24 [110/129] via 10.1.110.1, 00:09:32, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:09:32, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:09:32, Serial0/0/0.1
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:09:32, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:09:32, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:02:24, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:02:24, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:02:24, Serial0/0/0.1

R3#show ip ospf database

            OSPF Router with ID (192.168.3.1) (Process ID 1)

                         Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1933        0x80000006 0x000F20 2
192.168.3.1     192.168.3.1     6           0x80000005 0x009D3D 3

                         Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         1952        0x80000001 0x0014AA
10.1.110.2      1.1.1.1         633         0x80000001 0x006E45
10.1.110.4      1.1.1.1         614         0x80000001 0x00644C
10.1.116.0      1.1.1.1         1957        0x80000001 0x005E1B
172.30.0.0      1.1.1.1         182         0x80000001 0x00C963
172.30.24.0     1.1.1.1         633         0x80000001 0x00A2A8

                         Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     6           0x80000002 0x0002C5 0
192.168.2.0     192.168.3.1     6           0x80000002 0x00F6CF 0
192.168.3.0     192.168.3.1     13          0x80000002 0x00EBD9 0

R3#show ip route ospf
     172.30.0.0/16 is variably subnetted, 3 subnets, 2 masks
O IA    172.30.24.0/24 [110/75] via 10.1.113.1, 00:11:05, Serial0/0/0.2
O IA    172.30.0.0/16 [110/129] via 10.1.113.1, 00:03:34, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.1.110.4/32 [110/75] via 10.1.113.1, 00:10:46, Serial0/0/0.2
O IA    10.1.110.1/32 [110/64] via 10.1.113.1, 00:32:39, Serial0/0/0.2
```

```
O IA    10.1.110.2/32 [110/74] via 10.1.113.1, 00:11:05, Serial0/0/0.2
O IA    10.1.116.0/24 [110/128] via 10.1.113.1, 00:32:39, Serial0/0/0.2
```

```
R4#show ip ospf database

            OSPF Router with ID (10.4.4.4) (Process ID 1)

                                 Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1445        0x80000003 0x00A784 3
10.2.2.2        10.2.2.2        1424        0x80000005 0x00307B 3
10.4.4.4        10.4.4.4        1335        0x80000005 0x001487 3

                                 Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        73          0x80000003 0x00FC18

                                 Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         1445        0x80000002 0x007DFD
10.1.116.0      1.1.1.1         1445        0x80000002 0x005C1C
172.30.0.0      1.1.1.1         152         0x80000001 0x00C963
172.30.13.0     1.1.1.1         228         0x80000001 0x003AE5

                                 Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         1191        0x80000002 0x000188

                                 Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     1171        0x80000002 0x0002C5 0
192.168.2.0     192.168.3.1     1171        0x80000002 0x00F6CF 0
192.168.3.0     192.168.3.1     1171        0x80000002 0x00EBD9 0
```

```
R4#show ip route ospf
     172.30.0.0/16 is variably subnetted, 3 subnets, 2 masks
O IA    172.30.0.0/16 [110/129] via 10.1.110.1, 00:04:22, Serial0/0/0.1
O IA    172.30.13.0/24 [110/129] via 10.1.110.1, 00:11:25, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:11:25, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:11:25, FastEthernet0/0
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:11:25, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:11:25, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:04:17, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:04:17, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:04:17, Serial0/0/0.1
```

4. Summarizing OSPF external routes.

4.1. Use the following example to configure router R3 in this lab:

```
R3#
router ospf 1
 summary-address 192.168.0.0 255.255.0.0
```

4.2. Verify the OSPF link-state databases and IP routing tables.

```
R1#show ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)

                                 Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
```

```
1.1.1.1         1.1.1.1         129         0x80000006 0x0006B5 2
172.30.10.6     172.30.10.6     298         0x800009AE 0x00CB7C 3

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         129         0x80000002 0x0012AB
10.1.110.2      1.1.1.1         792         0x80000001 0x006E45
10.1.110.4      1.1.1.1         773         0x80000001 0x00644C
10.1.113.0      1.1.1.1         129         0x80000002 0x007DFD
172.30.13.0     1.1.1.1         129         0x80000002 0x0038E6
172.30.24.0     1.1.1.1         792         0x80000001 0x00A2A8

                Summary ASB Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         129         0x80000002 0x000188

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         129         0x80000007 0x000D21 2
192.168.3.1     192.168.3.1     175         0x80000005 0x009D3D 3

                Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         137         0x80000002 0x0012AB
10.1.110.2      1.1.1.1         800         0x80000001 0x006E45
10.1.110.4      1.1.1.1         782         0x80000001 0x00644C
10.1.116.0      1.1.1.1         137         0x80000002 0x005C1C
172.30.0.0      1.1.1.1         350         0x80000001 0x00C963
172.30.24.0     1.1.1.1         800         0x80000001 0x00A2A8

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         785         0x80000006 0x00A187 3
10.2.2.2        10.2.2.2        803         0x80000005 0x00E9FF 3
10.4.4.4        10.4.4.4        783         0x80000005 0x0012C5 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        1170        0x80000001 0x000116

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         140         0x80000002 0x007DFD
10.1.116.0      1.1.1.1         140         0x80000002 0x005C1C
172.30.0.0      1.1.1.1         352         0x80000001 0x00C963
172.30.13.0     1.1.1.1         140         0x80000002 0x0038E6

                Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         140         0x80000002 0x000188

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.0.0     192.168.3.1     23          0x80000001 0x000FBA 0

R1#show ip route ospf
     172.30.0.0/16 is variably subnetted, 4 subnets, 2 masks
O       172.30.24.0/24 [110/11] via 10.1.110.2, 00:06:36, Serial0/0/0.1
O       172.30.0.0/16 is a summary, 00:06:36, Null0
```

```
O       172.30.10.0/24 [110/65] via 10.1.116.6, 00:06:36, Serial0/0/0.116
O       172.30.13.0/24 [110/65] via 10.1.113.3, 00:06:36, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/11] via 10.1.110.2, 00:06:36, Serial0/0/0.1
O       10.1.110.2/32 [110/10] via 10.1.110.2, 00:06:36, Serial0/0/0.1
O E2 192.168.0.0/16 [110/20] via 10.1.113.3, 00:01:06, Serial0/0/0.2

R2#show ip ospf database

            OSPF Router with ID (10.2.2.2) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         852         0x80000006 0x00A187 3
10.2.2.2        10.2.2.2        867         0x80000005 0x00E9FF 3
10.4.4.4        10.4.4.4        848         0x80000005 0x0012C5 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        1235        0x80000001 0x000116

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         204         0x80000002 0x007DFD
10.1.116.0      1.1.1.1         204         0x80000002 0x005C1C
172.30.0.0      1.1.1.1         416         0x80000001 0x00C963
172.30.13.0     1.1.1.1         203         0x80000002 0x0038E6

                Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         203         0x80000002 0x000188

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.0.0     192.168.3.1     89          0x80000001 0x000FBA 0

R2#show ip route ospf
     172.30.0.0/16 is variably subnetted, 3 subnets, 2 masks
O IA    172.30.0.0/16 [110/129] via 10.1.110.1, 00:07:18, Serial0/0/0.1
O IA    172.30.13.0/24 [110/129] via 10.1.110.1, 00:14:21, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:14:21, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:14:21, Serial0/0/0.1
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:14:21, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:14:21, Serial0/0/0.1
O E2 192.168.0.0/16 [110/20] via 10.1.110.1, 00:01:48, Serial0/0/0.1

R3#show ip ospf database

            OSPF Router with ID (192.168.3.1) (Process ID 1)

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         247         0x80000007 0x000D21 2
192.168.3.1     192.168.3.1     283         0x80000005 0x009D3D 3

                Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         247         0x80000002 0x0012AB
10.1.110.2      1.1.1.1         910         0x80000001 0x006E45
10.1.110.4      1.1.1.1         892         0x80000001 0x00644C
```

```
10.1.116.0      1.1.1.1         247         0x80000002 0x005C1C
172.30.0.0      1.1.1.1         460         0x80000001 0x00C963
172.30.24.0     1.1.1.1         910         0x80000001 0x00A2A8

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.0.0     192.168.3.1     129         0x80000001 0x000FBA 0

R3#show ip route ospf
     172.30.0.0/16 is variably subnetted, 3 subnets, 2 masks
O IA    172.30.24.0/24 [110/75] via 10.1.113.1, 00:15:34, Serial0/0/0.2
O IA    172.30.0.0/16 [110/129] via 10.1.113.1, 00:08:03, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.1.110.4/32 [110/75] via 10.1.113.1, 00:15:15, Serial0/0/0.2
O IA    10.1.110.1/32 [110/64] via 10.1.113.1, 00:37:08, Serial0/0/0.2
O IA    10.1.110.2/32 [110/74] via 10.1.113.1, 00:15:34, Serial0/0/0.2
O IA    10.1.116.0/24 [110/128] via 10.1.113.1, 00:37:08, Serial0/0/0.2
O    192.168.0.0/16 is a summary, 00:02:33, Null0

R4#show ip ospf database

            OSPF Router with ID (10.4.4.4) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         938         0x80000006 0x00A187 3
10.2.2.2        10.2.2.2        955         0x80000005 0x00E9FF 3
10.4.4.4        10.4.4.4        934         0x80000005 0x0012C5 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        1321        0x80000001 0x000116

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         290         0x80000002 0x007DFD
10.1.116.0      1.1.1.1         290         0x80000002 0x005C1C
172.30.0.0      1.1.1.1         503         0x80000001 0x00C963
172.30.13.0     1.1.1.1         290         0x80000002 0x0038E6

                Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         290         0x80000002 0x000188

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.0.0     192.168.3.1     175         0x80000001 0x000FBA 0

R4#show ip route ospf
     172.30.0.0/16 is variably subnetted, 3 subnets, 2 masks
O IA    172.30.0.0/16 [110/129] via 10.1.110.1, 00:08:45, Serial0/0/0.1
O IA    172.30.13.0/24 [110/129] via 10.1.110.1, 00:15:47, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:15:47, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:15:47, FastEthernet0/0
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:15:47, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:15:47, Serial0/0/0.1
O E2 192.168.0.0/16 [110/20] via 10.1.110.1, 00:03:14, Serial0/0/0.1

R4#ping 192.168.1.1

Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/116 ms

R4#ping 192.168.2.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/114/120 ms

R4#ping 192.168.3.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/112 ms
```


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Lab 3-4: Configure and Verify OSPF Special Area Types

Complete this lab activity to practice what you learned in the related module.

Activity Objective

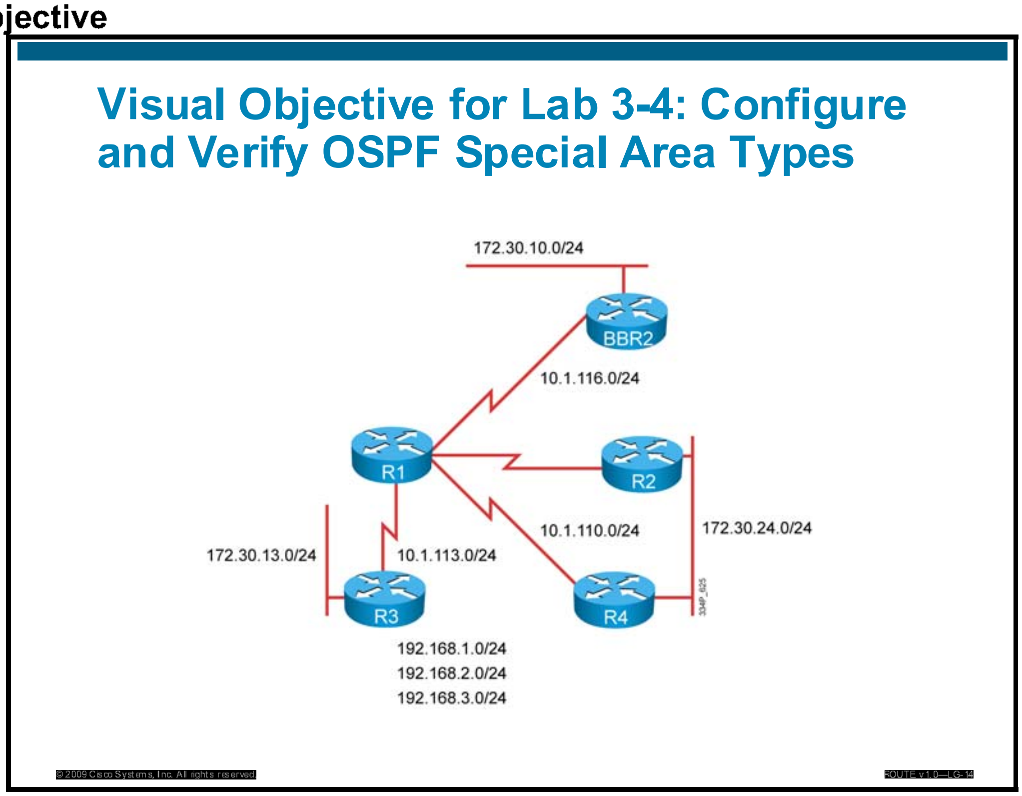
In this activity, you will use the correct commands, tools, and steps to configure and verify OSPF multiarea routing and optimize OSPF routing by implementing different OSPF special area types. After completing this activity, you will be able to meet these objectives:

- Configure and verify the OSPF operation over LAN and WAN interfaces in multiple OSPF areas
- Optimize the OSPF operation by implementing OSPF database optimization using special OSPF area types.
- Select the required tools and commands to configure OSPF operations
- Make a list of configuration and implementation steps
- Write a verification and test plan to verify the proper implementation and operation according to the expected performance criteria.
- Verify the configuration and operation by using the proper **show** and **debug** commands

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- In this task you will examine IP routing information exchanged by routers configured with the OSPF routing protocol. Routers R1, R2, R3, and R4 are configured with the OSPF routing protocol and announce their directly attached networks. Router R4 also announces some external OSPF networks into the OSPF routing domain.
- Learn about the current OSPF configuration, which includes the information about the networks that are included in the OSPF routing domain, interfaces where OSPF is enabled, OSPF adjacencies, link-state databases, and OSPF area design. Verify that all the routers have IP connectivity to the advertised networks. Examine the IP routing table, write down the IP networks that are advertised, and determine the IP addressing scheme.
- In this task, you must optimize OSPF routing inside Area 24. Routers R2 and R4 have insufficient CPU and memory resources to cope with the amount of routing information that is advertised in the OSPF domain. You must reduce the size of the OSPF link-state database on routes R2 and R4 to preserve their resources.
- Verify that OSPF adjacencies in the OSPF domain are operational. Router R1 should have OSPF adjacency with routers R2, R3, R4, and BBR2. Routers R2 and R4 should also have adjacency set between them. Examine the OSPF database on routers R1 and R3 and verify that they still have all the specific information about OSPF internal and external routes of your OSPF domain. Also verify that the IP routing tables are populated with the best paths to all destination networks. Examine the OSPF database on routers R2 and R4 and verify that the size of the database is smaller because they do not hold the specific information about the IP subnets that are external to the OSPF domain; in other words, those that are redistributed somewhere in the OSPF domain. Verify that routers R2 and R4 have the information necessary to reach the external networks. Verify that routers R2 and R4 have IP connectivity to the destinations from the IP subnets that are external to the OSPF domain.
- In this task you must minimize OSPF link-state database information inside Area 24. Although you optimized OSPF Area 24 operation in the previous task to preserve R2 and R4 resources, you have seen that they still cannot hold all the information that is advertised in the OSPF domain. Therefore, you must further reduce the amount of OSPF information on those routers while preserving the IP connectivity to the destinations located on all networks that are not attached to routers R2 and R4.
- Verify that OSPF adjacencies in the OSPF domain are operational. Router R1 should have OSPF adjacency with routers R2, R3, R4, and BBR2. Routers R2 and R4 should have additional adjacency set between them. Examine the OSPF database on routers R1 and R3 and verify that they still have all the specific information about OSPF internal and external routes of your OSPF domain. Also verify that the IP routing tables are populated with the best paths to all destination networks. Examine the OSPF databases on routers R2 and R4 and verify that the size of the databases is smaller because they do not hold the specific information about the IP subnets that are external to OSPF Area 24; in other words, those IP networks that are redistributed somewhere in the OSPF domain and those IP networks that are internal to OSPF but are part of other OSPF areas. Verify that routers R2 and R4 have the information necessary to reach all the networks. Verify that routers R2 and R4 have IP connectivity to the destinations from all the IP subnets that are announced in the OSPF domain.

- In this task you will have to minimize the OSPF and IP routing information inside Area 3. You have noticed that router R3 does not have sufficient memory capacity to store all the OSPF an IP routing information. In other words, the OSPF link-state database, and consequently the IP routing table, cannot store all the dynamically acquired IP routing information.
- Verify that OSPF adjacencies in the OSPF domain are operational. Router R1 should have an OSPF adjacency with routers R2, R3, R4, and BBR2. Routers R2 and R4 should have an additional adjacency set between them. Examine the OSPF database on router R1 and verify that it still has all the specific information about the OSPF internal and external routes of your OSPF domain. Also verify that the IP routing table is populated with the best paths to all destination networks. Verify that router R1 can access all the networks that are announced in the OSPF domain. Examine the OSPF databases on routers R2 and R4 and verify that they still have all the specific information about the OSPF internal routes from Area 24, while the information about the other networks is not present, and external routes of your OSPF domain. Also verify that the IP routing table is populated with the proper IP routing information. Verify that routers R2 and R4 can access all the networks that are advertised in the OSPF domain. Examine the OSPF database on router R3 and verify that the database size has been reduced. Verify that the router has the information about all the OSPF Area 3 internal router as well as the external routes that are redistributed in the area. At the same time, the router should not have any information about the routes that are external to OSPF Area 3. Verify that you still have IP connectivity to all networks announced that are announced by OSPF from router R3.

Device Information

The table provides the information specific to each switch in the network:

Device name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
router ospf 1	Turns on OSPF; the process number is not communicated to other routers
show ip ospf database	Displays information about OSPF database
show ip route [**ospf**]	Displays whole IP routing table or OSPF routes only
show ip ospf	Displays general information about OSPF routing processes
area stub	Defines an area as a stub area
area nssa	Configures an area as a not-so-stubby area (NSSA)
Ping	Diagnoses basic network connectivity

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	"Hints" section at the end of this lab
Implementation and verification plan hints	"Hints" section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, the device names and trunk encapsulation types. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirements list. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Device	Implementation Requirement

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Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you can use the information provided in the “Hints” section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the "Hints" section at the end of this lab.

Student Notes:

Alternate Resources and Solutions

Other groups may have implemented a solution that is different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 3-4 Hint Sheet: Configure and Verify OSPF Special Area Types

Implementation Requirements

To facilitate the configuration of your network, Task 1 asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Identify the networks that are advertised by all routers. Find internal as well as external networks.	Lab
ALL	Identify the existing OSPF configuration.	Lab

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load the initial configuration.	All pod routers must be preloaded with the initial configuration for the lab.	Step 1
	R1–R4	2		Examine the OSPF routing configuration on all routers. First explore the OSPF link-state database to gain insight into how OSPF is deployed in the network. Also observe the OSPF area configuration to learn the OSPF architecture and topology.	Step 2.1
	R1–R4	3		Verify the IP routing tables for routers R1, R2, R3, and R4 to see whether the correct information was put into the routing tables and that external networks are in the IP routing table.	Step 2.2

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1, R2, R4	4	Prevent OSPF from announcing information about the OSPF external routers into Area 24. Connectivity to external routes 192.168.x.0/24 should be preserved and routers R2 and R4 should still be able to access those networks. Remember that routers R2 and R4 should have specific information about those networks that are internal to the OSPF domain regardless of where they are injected into the OSPF domain.	Examine the OSPF database on routers R2 and R4 and verify that the size of the database is smaller than before because they do not hold specific information about the IP subnets that are external to the OSPF domain; that is, those that are redistributed somewhere in the OSPF domain. Verify that routers R2 and R4 have the necessary information on how to reach the external networks. Verify that routers R2 and R4 have IP connectivity to the destinations from the IP subnets that are external to the OSPF domain.	Step 3
	R1, R2, R4	5	Prevent OSPF from announcing information about the OSPF internal routers from other OSPF areas into Area 24. Connectivity to all external routes 192.168.x.0/24 and internal routes from other areas should be preserved; that is,routers R2 and R4 should still be able to access those networks. Remember that routers R2 and R4 should have specific information about those networks that are internal to the OSPF Area 24.	Examine the OSPF database on routers R2 and R4 and verify that the size of the database is smaller than before because they do not hold the specific information about the IP subnets that are interarea and external to the OSPF domain. Verify that routers R2 and R4 have the necessary information on how to reach the interarea and external networks. Verify that routers R2 and R4 have IP connectivity to the destinations from the IP subnets that are external to the OSPF domain.	Step 4

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1, R3	6	Minimize the OSPF link-state database and IP routing table on router R3 inside Area 3. The router R3 OSPF database, and consequently the IP routing table, should have information only about the OSPF Area 3 announced routes, whether internal or external. Preserve the redistribution of external routes 192.1658.x.0/24 on router R3; that is, the router should still announce those networks into the OSPF domain. Remember that router R3 should also preserve connectivity to all subsets announced by OSPF.	Examine the OSPF database on router R1 and verify that it still has all the specific information about the internal and external OSPF routes of your OSPF domain. Also verify that the IP routing table is populated with the best paths to all destination networks. Examine the OSPF database and IP routing table on router R3 and verify that the database size and the size of the IP routing table have been reduced. The router should not have any information about the routes that are external to OSPF Area 3. Verify that you still have IP connectivity from router R3 to the LAN segment between routers R2 and R4.	Step 5

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Examine the OSPF routing information.

   2.1. Examine the OSPF link-state database to gain insight into how OSPF is deployed in the network.

```
R1#show ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         202         0x80000005 0x000EAC 2
172.30.10.6     172.30.10.6     203         0x800009B5 0x00BD83 3

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         168         0x80000001 0x0014AA
10.1.110.2      1.1.1.1         118         0x80000002 0x006C46
10.1.110.4      1.1.1.1         118         0x80000002 0x00624D
10.1.113.0      1.1.1.1         194         0x80000004 0x0079FF
172.30.13.0     1.1.1.1         189         0x80000001 0x003AE5
172.30.24.0     1.1.1.1         118         0x80000002 0x00A0A9

                Summary ASB Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         189         0x80000001 0x000387

                Router Link States (Area 3)
```

```
Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         193         0x80000005 0x001717 2
192.168.3.1     192.168.3.1     194         0x80000004 0x009F3C 3

                Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         169         0x80000001 0x0014AA
10.1.110.2      1.1.1.1         119         0x80000002 0x006C46
10.1.110.4      1.1.1.1         119         0x80000002 0x00624D
10.1.116.0      1.1.1.1         205         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         200         0x80000001 0x005BC7
172.30.24.0     1.1.1.1         119         0x80000002 0x00A0A9

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         124         0x80000007 0x00A580 3
10.2.2.2        10.2.2.2        125         0x80000007 0x00E502 3
10.4.4.4        10.4.4.4        133         0x80000005 0x0012C5 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        137         0x80000001 0x000116

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         200         0x80000001 0x007FFC
10.1.116.0      1.1.1.1         205         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         200         0x80000001 0x005BC7
172.30.13.0     1.1.1.1         190         0x80000001 0x003AE5

                Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         190         0x80000001 0x000387

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     286         0x80000001 0x0004C4 0
192.168.2.0     192.168.3.1     286         0x80000001 0x00F8CE 0
192.168.3.0     192.168.3.1     286         0x80000001 0x00EDD8 0
192.168.4.0     1.1.1.1         226         0x80000001 0x00EB43 0

R2#show ip ospf database

            OSPF Router with ID (10.2.2.2) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         30          0x80000007 0x00A580 3
10.2.2.2        10.2.2.2        29          0x80000007 0x00E502 3
10.4.4.4        10.4.4.4        39          0x80000005 0x0012C5 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        43          0x80000001 0x000116

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         107         0x80000001 0x007FFC
```

```
10.1.116.0      1.1.1.1         112         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         107         0x80000001 0x005BC7
172.30.13.0     1.1.1.1         97          0x80000001 0x003AE5

                Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         97          0x80000001 0x000387

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     201         0x80000001 0x0004C4 0
192.168.2.0     192.168.3.1     201         0x80000001 0x00F8CE 0
192.168.3.0     192.168.3.1     201         0x80000001 0x00EDD8 0
192.168.4.0     1.1.1.1         141         0x80000001 0x00EB43 0
R3#show ip ospf database

            OSPF Router with ID (192.168.3.1) (Process ID 1)

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         249         0x80000005 0x001717 2
192.168.3.1     192.168.3.1     248         0x80000004 0x009F3C 3

                Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         225         0x80000001 0x0014AA
10.1.110.2      1.1.1.1         175         0x80000002 0x006C46
10.1.110.4      1.1.1.1         175         0x80000002 0x00624D
10.1.116.0      1.1.1.1         260         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         255         0x80000001 0x005BC7
172.30.24.0     1.1.1.1         175         0x80000002 0x00A0A9

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     340         0x80000001 0x0004C4 0
192.168.2.0     192.168.3.1     340         0x80000001 0x00F8CE 0
192.168.3.0     192.168.3.1     342         0x80000001 0x00EDD8 0
192.168.4.0     1.1.1.1         282         0x80000001 0x00EB43 0
R4#show ip ospf database

            OSPF Router with ID (10.4.4.4) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         208         0x80000007 0x00A580 3
10.2.2.2        10.2.2.2        208         0x80000007 0x00E502 3
10.4.4.4        10.4.4.4        215         0x80000005 0x0012C5 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        220         0x80000001 0x000116

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         283         0x80000001 0x007FFC
10.1.116.0      1.1.1.1         288         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         283         0x80000001 0x005BC7
172.30.13.0     1.1.1.1         273         0x80000001 0x003AE5
```



```
                              Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         273         0x80000001 0x000387

                              Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     371         0x80000001 0x0004C4 0
192.168.2.0     192.168.3.1     371         0x80000001 0x00F8CE 0
192.168.3.0     192.168.3.1     371         0x80000001 0x00EDD8 0
192.168.4.0     1.1.1.1         311         0x80000001 0x00EB43 0
```

2.2. Verify the IP routing table.

```
R1#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/11] via 10.1.110.2, 00:04:10, Serial0/0/0.1
O       172.30.10.0 [110/65] via 10.1.116.6, 00:05:30, Serial0/0/0.116
O       172.30.13.0 [110/65] via 10.1.113.3, 00:05:20, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/11] via 10.1.110.2, 00:04:10, Serial0/0/0.1
O       10.1.110.2/32 [110/10] via 10.1.110.2, 00:04:10, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.113.3, 00:04:10, Serial0/0/0.2
O E2 192.168.2.0/24 [110/20] via 10.1.113.3, 00:04:10, Serial0/0/0.2
O E2 192.168.3.0/24 [110/20] via 10.1.113.3, 00:04:10, Serial0/0/0.2

R2#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:04:35, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:04:35, Serial0/0/0.1
O E2 192.168.4.0/24 [110/20] via 10.1.110.1, 00:04:35, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:04:35, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:04:35, Serial0/0/0.1
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:04:35, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:04:35, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:04:35, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:04:35, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:04:35, Serial0/0/0.1

R3#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.24.0 [110/75] via 10.1.113.1, 00:04:54, Serial0/0/0.2
O IA    172.30.10.0 [110/129] via 10.1.113.1, 00:06:02, Serial0/0/0.2
O E2 192.168.4.0/24 [110/20] via 10.1.113.1, 00:04:59, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.1.110.4/32 [110/75] via 10.1.113.1, 00:04:54, Serial0/0/0.2
O IA    10.1.110.1/32 [110/64] via 10.1.113.1, 00:05:44, Serial0/0/0.2
O IA    10.1.110.2/32 [110/74] via 10.1.113.1, 00:04:54, Serial0/0/0.2
O IA    10.1.116.0/24 [110/128] via 10.1.113.1, 00:06:02, Serial0/0/0.2

R4#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:05:14, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:05:14, Serial0/0/0.1
O E2 192.168.4.0/24 [110/20] via 10.1.110.1, 00:05:14, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:05:14, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:05:14, FastEthernet0/0
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:05:14, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:05:14, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:05:14, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:05:14, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:05:14, Serial0/0/0.1
```

3. Optimize OSPF routing for Area 24 using stub area type.

3.1. Use the following example to configure routers R1, R2, and R4 in this lab:

```
R1#
router ospf 1
 area 24 stub

R2#
router ospf 1
 area 24 stub

R4#
router ospf 1
 area 24 stub
```

3.2. Verify the OSPF database, IP routing table, and check for connectivity to external networks.

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 1.1.1.1
 Start time: 5w2d, Time elapsed: 01:34:17.468
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 It is an area border and autonomous system boundary router
 Redistributing External Routes from,
    static, includes subnets in redistribution
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 4. Checksum Sum 0x02D6AD
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 3. 2 normal 1 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area BACKBONE(0)
              Number of interfaces in this area is 1
              Area has no authentication
              SPF algorithm last executed 00:02:27.320 ago
              SPF algorithm executed 10 times
              Area ranges are
                 172.30.0.0/16 Active(65) Advertise
              Number of LSA 8. Checksum Sum 0x0467C1
              Number of opaque link LSA 0. Checksum Sum 0x000000
              Number of DCbitless LSA 0
              Number of indication LSA 0
              Number of DoNotAge LSA 0
              Flood list length 0
    Area 3
              Number of interfaces in this area is 1
              Area has no authentication
              SPF algorithm last executed 00:02:27.320 ago
              SPF algorithm executed 11 times
              Area ranges are
              Number of LSA 7. Checksum Sum 0x0315B9
              Number of opaque link LSA 0. Checksum Sum 0x000000
              Number of DCbitless LSA 0
              Number of indication LSA 0
```

```
                Number of DoNotAge LSA 0
                Flood list length 0
    Area 24
                Number of interfaces in this area is 1
                It is a stub area
                  generates stub default route with cost 1
                Area has no authentication
                SPF algorithm last executed 00:01:54.696 ago
                SPF algorithm executed 14 times
                Area ranges are
                Number of LSA 9. Checksum Sum 0x076B2D
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
```

```
R2#show ip ospf
 Routing Process "ospf 1" with ID 10.2.2.2
 Start time: 5w2d, Time elapsed: 01:33:28.784
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 0 normal 1 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area 24
                Number of interfaces in this area is 2
                It is a stub area
                Area has no authentication
                SPF algorithm last executed 00:02:15.864 ago
                SPF algorithm executed 13 times
                Area ranges are
                Number of LSA 9. Checksum Sum 0x0421D9
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
```

```
R4#show ip ospf
 Routing Process "ospf 1" with ID 10.4.4.4
 Start time: 5w2d, Time elapsed: 01:33:51.592
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
```

```
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 0 normal 1 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area 24
                Number of interfaces in this area is 2
                It is a stub area
                Area has no authentication
                SPF algorithm last executed 00:02:56.556 ago
                SPF algorithm executed 14 times
                Area ranges are
                Number of LSA 9. Checksum Sum 0x0421D9
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0

R1#show ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)

                         Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         579         0x80000005 0x000EAC 2
172.30.10.6     172.30.10.6     581         0x800009B5 0x00BD83 3

                         Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         546         0x80000001 0x0014AA
10.1.110.2      1.1.1.1         106         0x80000001 0x006E45
10.1.110.4      1.1.1.1         96          0x80000002 0x00624D
10.1.113.0      1.1.1.1         571         0x80000004 0x0079FF
172.30.13.0     1.1.1.1         566         0x80000001 0x003AE5
172.30.24.0     1.1.1.1         106         0x80000002 0x00A0A9

                         Summary ASB Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         566         0x80000001 0x000387

                         Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         570         0x80000005 0x001717 2
192.168.3.1     192.168.3.1     573         0x80000004 0x009F3C 3

                         Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         548         0x80000001 0x0014AA
10.1.110.2      1.1.1.1         108         0x80000001 0x006E45
10.1.110.4      1.1.1.1         98          0x80000002 0x00624D
10.1.116.0      1.1.1.1         583         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         578         0x80000001 0x005BC7
172.30.24.0     1.1.1.1         108         0x80000002 0x00A0A9

                         Router Link States (Area 24)
```



```
Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         113         0x8000000A 0x00B76F 3
10.2.2.2        10.2.2.2        106         0x8000000B 0x00FBE9 3
10.4.4.4        10.4.4.4        107         0x80000008 0x002AAC 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        107         0x80000003 0x001BFB

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         1.1.1.1         149         0x80000001 0x0093A6
10.1.113.0      1.1.1.1         149         0x80000002 0x009BE1
10.1.116.0      1.1.1.1         149         0x80000002 0x007AFF
172.30.10.0     1.1.1.1         149         0x80000002 0x0077AC
172.30.13.0     1.1.1.1         149         0x80000002 0x0056CA

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     666         0x80000001 0x0004C4 0
192.168.2.0     192.168.3.1     666         0x80000001 0x00F8CE 0
192.168.3.0     192.168.3.1     666         0x80000001 0x00EDD8 0
192.168.4.0     1.1.1.1         605         0x80000001 0x00EB43 0

R2#show ip ospf database

            OSPF Router with ID (10.2.2.2) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         160         0x8000000A 0x00B76F 3
10.2.2.2        10.2.2.2        152         0x8000000B 0x00FBE9 3
10.4.4.4        10.4.4.4        154         0x80000008 0x002AAC 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        154         0x80000003 0x001BFB

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         1.1.1.1         194         0x80000001 0x0093A6
10.1.113.0      1.1.1.1         194         0x80000002 0x009BE1
10.1.116.0      1.1.1.1         194         0x80000002 0x007AFF
172.30.10.0     1.1.1.1         194         0x80000002 0x0077AC
172.30.13.0     1.1.1.1         194         0x80000002 0x0056CA

R4#show ip ospf database

            OSPF Router with ID (10.4.4.4) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         179         0x8000000A 0x00B76F 3
10.2.2.2        10.2.2.2        172         0x8000000B 0x00FBE9 3
10.4.4.4        10.4.4.4        172         0x80000008 0x002AAC 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        172         0x80000003 0x001BFB
```

```
                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         1.1.1.1         214         0x80000001 0x0093A6
10.1.113.0      1.1.1.1         214         0x80000002 0x009BE1
10.1.116.0      1.1.1.1         214         0x80000002 0x007AFF
172.30.10.0     1.1.1.1         214         0x80000002 0x0077AC
172.30.13.0     1.1.1.1         214         0x80000002 0x0056CA

R1#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/11] via 10.1.110.2, 00:03:10, Serial0/0/0.1
O       172.30.10.0 [110/65] via 10.1.116.6, 00:04:00, Serial0/0/0.116
O       172.30.13.0 [110/65] via 10.1.113.3, 00:04:00, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/11] via 10.1.110.2, 00:03:10, Serial0/0/0.1
O       10.1.110.2/32 [110/10] via 10.1.110.2, 00:03:10, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.113.3, 00:03:10, Serial0/0/0.2
O E2 192.168.2.0/24 [110/20] via 10.1.113.3, 00:03:10, Serial0/0/0.2
O E2 192.168.3.0/24 [110/20] via 10.1.113.3, 00:03:10, Serial0/0/0.2

R2#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:03:35, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:03:35, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:03:35, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:03:35, Serial0/0/0.1
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:03:35, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:03:35, Serial0/0/0.1
O*IA 0.0.0.0/0 [110/65] via 10.1.110.1, 00:03:35, Serial0/0/0.1

R4#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:03:50, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:03:50, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:03:50, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:03:50, FastEthernet0/0
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:03:50, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:03:50, Serial0/0/0.1
O*IA 0.0.0.0/0 [110/65] via 10.1.110.1, 00:03:50, Serial0/0/0.1

R2#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/116 ms

R4#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/116 ms
```

4. Optimize OSPF routing for Area 24 using stub area type.

   4.1. Use the following example to configure router R1 in this lab:

```
R1#
router ospf 1
 area 24 stub no-summary
```

   4.2. Verify the OSPF database, IP routing table, and check for connectivity to external networks.

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 1.1.1.1
```

```
 Start time: 5w2d, Time elapsed: 01:38:20.940
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 It is an area border and autonomous system boundary router
 Redistributing External Routes from,
    static, includes subnets in redistribution
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 4. Checksum Sum 0x04C018
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 3. 2 normal 1 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area BACKBONE(0)
                Number of interfaces in this area is 1
                Area has no authentication
                SPF algorithm last executed 00:00:09.816 ago
                SPF algorithm executed 4 times
                Area ranges are
                   172.30.0.0/16 Active(65) Advertise
                Number of LSA 8. Checksum Sum 0x039389
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
    Area 3
                Number of interfaces in this area is 1
                Area has no authentication
                SPF algorithm last executed 00:00:09.816 ago
                SPF algorithm executed 4 times
                Area ranges are
                Number of LSA 7. Checksum Sum 0x03A6FC
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
    Area 24
                Number of interfaces in this area is 1
                It is a stub area, no summary LSA in this area
                  generates stub default route with cost 1
                Area has no authentication
                SPF algorithm last executed 00:00:12.192 ago
                SPF algorithm executed 4 times
                Area ranges are
                Number of LSA 5. Checksum Sum 0x05A408
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0

R2#show ip ospf
 Routing Process "ospf 1" with ID 10.2.2.2
 Start time: 5w2d, Time elapsed: 01:37:21.236
```

```
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 0 normal 1 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area 24
            Number of interfaces in this area is 2
            It is a stub area
            Area has no authentication
            SPF algorithm last executed 00:00:48.900 ago
            SPF algorithm executed 15 times
            Area ranges are
            Number of LSA 5. Checksum Sum 0x01D1E5
            Number of opaque link LSA 0. Checksum Sum 0x000000
            Number of DCbitless LSA 0
            Number of indication LSA 0
            Number of DoNotAge LSA 0
            Flood list length 0

R4#show ip ospf
 Routing Process "ospf 1" with ID 10.4.4.4
 Start time: 5w2d, Time elapsed: 01:37:37.268
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 0 normal 1 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area 24
            Number of interfaces in this area is 2
            It is a stub area
            Area has no authentication
            SPF algorithm last executed 00:01:26.240 ago
            SPF algorithm executed 16 times
            Area ranges are
            Number of LSA 5. Checksum Sum 0x01D1E5
            Number of opaque link LSA 0. Checksum Sum 0x000000
```

```
            Number of DCbitless LSA 0
            Number of indication LSA 0
            Number of DoNotAge LSA 0
            Flood list length 0
```

```
R2#show ip ospf database

            OSPF Router with ID (10.2.2.2) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         59          0x80000009 0x00B96E 3
10.2.2.2        10.2.2.2        377         0x80000009 0x004663 3
10.4.4.4        10.4.4.4        381         0x80000009 0x002A6F 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        376         0x80000005 0x0017FD

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         1.1.1.1         60          0x80000003 0x008FA8

R4#show ip ospf database

            OSPF Router with ID (10.4.4.4) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         94          0x80000009 0x00B96E 3
10.2.2.2        10.2.2.2        413         0x80000009 0x004663 3
10.4.4.4        10.4.4.4        416         0x80000009 0x002A6F 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        411         0x80000005 0x0017FD

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         1.1.1.1         95          0x80000003 0x008FA8

R2#show ip route ospf
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:06:44, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:06:44, Serial0/0/0.1
O*IA 0.0.0.0/0 [110/65] via 10.1.110.1, 00:01:55, Serial0/0/0.1

R4#show ip route ospf
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:06:12, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:06:12, FastEthernet0/0
O*IA 0.0.0.0/0 [110/65] via 10.1.110.1, 00:01:27, Serial0/0/0.1

R2#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/116 ms

R4#ping 192.168.1.1
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/116 ms
```

5. Reduce the OSPF information in Area 3.

5.1. Use the following example to configure router R1 in this lab:

```
R1#
router ospf 1
 area 3 nssa no-summary

R3#
router ospf 1
 area 3 nssa
```

5.2. Verify the OSPF database, IP routing table, and check for connectivity to the external networks.

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 1.1.1.1
 Start time: 5w2d, Time elapsed: 01:49:41.980
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 It is an area border and autonomous system boundary router
 Redistributing External Routes from,
    static, includes subnets in redistribution
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 4. Checksum Sum 0x04D4AF
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 3. 1 normal 1 stub 1 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area BACKBONE(0)
                Number of interfaces in this area is 1
                Area has no authentication
                SPF algorithm last executed 00:00:43.736 ago
                SPF algorithm executed 7 times
                Area ranges are
                   172.30.0.0/16 Active(65) Advertise
                Number of LSA 7. Checksum Sum 0x039002
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
    Area 3
                Number of interfaces in this area is 1
                It is a NSSA area
        Perform type-7/type-5 LSA translation
                Area has no authentication
                SPF algorithm last executed 00:00:43.740 ago
                SPF algorithm executed 9 times
                Area ranges are
                Number of LSA 7. Checksum Sum 0x032655
                Number of opaque link LSA 0. Checksum Sum 0x000000
```



```
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
    Area 24
                Number of interfaces in this area is 1
                It is a stub area, no summary LSA in this area
                  generates stub default route with cost 1
                Area has no authentication
                SPF algorithm last executed 00:00:46.040 ago
                SPF algorithm executed 7 times
                Area ranges are
                Number of LSA 5. Checksum Sum 0x05A408
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
```

R3#show ip ospf

```
 Routing Process "ospf 1" with ID 192.168.3.1
 Start time: 5w2d, Time elapsed: 01:49:49.824
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 It is an autonomous system boundary router
 Redistributing External Routes from,
    connected, includes subnets in redistribution
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 0 normal 0 stub 1 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area 3
                Number of interfaces in this area is 2
                It is a NSSA area
                Area has no authentication
                SPF algorithm last executed 00:08:12.260 ago
                SPF algorithm executed 14 times
                Area ranges are
                Number of LSA 7. Checksum Sum 0x01FFF9
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
```

R1#show ip ospf database

```
            OSPF Router with ID (1.1.1.1) (Process ID 1)

                                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         977         0x80000005 0x000EAC 2
```

```
172.30.10.6     172.30.10.6     979         0x800009B5 0x00BD83 3

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         943         0x80000001 0x0014AA
10.1.110.2      1.1.1.1         503         0x80000001 0x006E45
10.1.110.4      1.1.1.1         493         0x80000002 0x00624D
10.1.113.0      1.1.1.1         969         0x80000004 0x0079FF
172.30.13.0     1.1.1.1         18          0x80000001 0x003AE5
172.30.24.0     1.1.1.1         503         0x80000002 0x00A0A9

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         27          0x80000007 0x00B86D 2
192.168.3.1     192.168.3.1     29          0x80000006 0x004192 3

                Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         1.1.1.1         49          0x80000001 0x001B17

                Type-7 AS External Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     40          0x80000001 0x0018CB 0
192.168.2.0     192.168.3.1     40          0x80000001 0x000DD5 0
192.168.3.0     192.168.3.1     40          0x80000001 0x0002DF 0
192.168.4.0     1.1.1.1         48          0x80000001 0x00CF5D 0

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         514         0x8000000A 0x00B76F 3
10.2.2.2        10.2.2.2        508         0x8000000B 0x00FBE9 3
10.4.4.4        10.4.4.4        509         0x80000008 0x002AAC 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        509         0x80000003 0x001BFB

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         1.1.1.1         221         0x80000002 0x0091A7

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     1.1.1.1         20          0x80000001 0x00B5A1 0
192.168.2.0     1.1.1.1         20          0x80000001 0x00AAAB 0
192.168.3.0     1.1.1.1         20          0x80000001 0x009FB5 0
192.168.4.0     1.1.1.1         1009        0x80000001 0x00EB43 0

R3#show ip ospf database

            OSPF Router with ID (192.168.3.1) (Process ID 1)

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         506         0x80000008 0x00B66E 2
192.168.3.1     192.168.3.1     505         0x8000000C 0x003598 3

                Summary Net Link States (Area 3)
```

```
Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         1.1.1.1         66          0x80000001 0x001B17

                                Type-7 AS External Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     509         0x80000001 0x0018CB 0
192.168.2.0     192.168.3.1     509         0x80000001 0x000DD5 0
192.168.3.0     192.168.3.1     509         0x80000001 0x0002DF 0
192.168.4.0     1.1.1.1         532         0x80000001 0x00CF5D 0


R1#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/11] via 10.1.110.2, 00:01:55, Serial0/0/0.1
O       172.30.10.0 [110/65] via 10.1.116.6, 00:01:55, Serial0/0/0.116
O       172.30.13.0 [110/65] via 10.1.113.3, 00:01:30, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/11] via 10.1.110.2, 00:01:55, Serial0/0/0.1
O       10.1.110.2/32 [110/10] via 10.1.110.2, 00:01:55, Serial0/0/0.1
O N2 192.168.1.0/24 [110/20] via 10.1.113.3, 00:01:30, Serial0/0/0.2
O N2 192.168.2.0/24 [110/20] via 10.1.113.3, 00:01:30, Serial0/0/0.2
O N2 192.168.3.0/24 [110/20] via 10.1.113.3, 00:01:30, Serial0/0/0.2


R3#show ip route ospf
O N2 192.168.4.0/24 [110/20] via 10.1.113.1, 00:01:05, Serial0/0/0.2
O*IA 0.0.0.0/0 [110/65] via 10.1.113.1, 00:01:10, Serial0/0/0.2

R3#ping 172.30.24.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.24.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/116 ms
```

Lab 3-5: Configure and Verify OSPF Authentication

Complete this lab activity to practice what you learned in the related module.

Activity Objective

Complete this lab activity to practice what you learned in the related module.

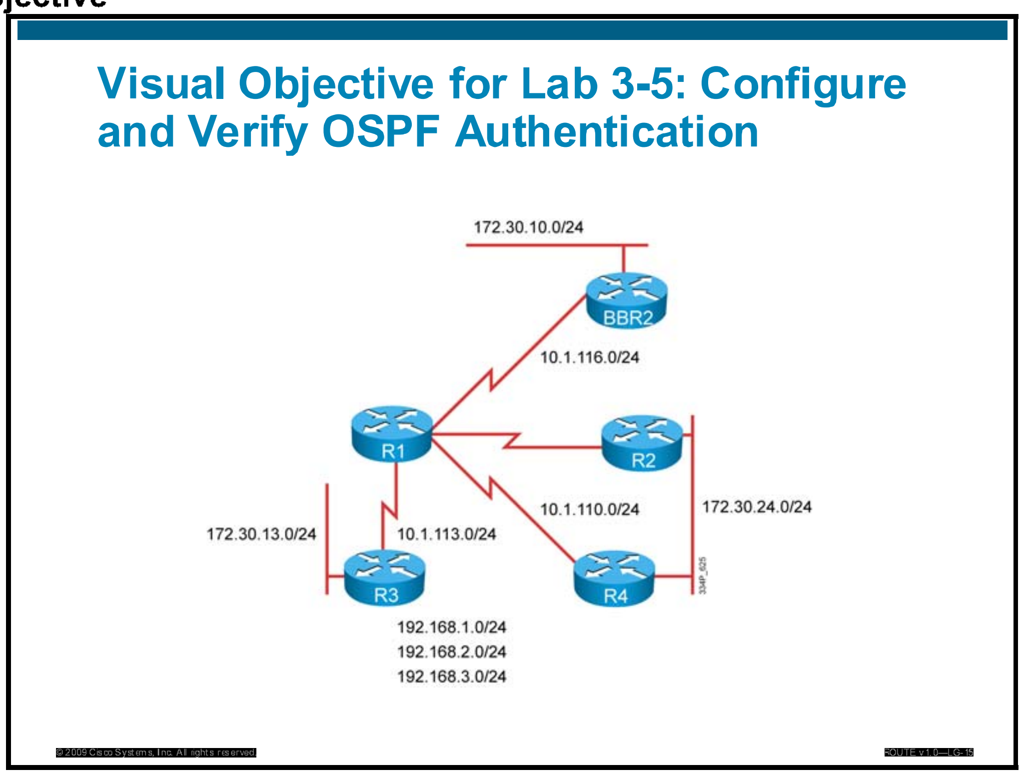
In this activity, you will use correct commands, tools, and steps to configure and verify basic OSPF authentication implementation. After completing this activity, you will be able to meet these objectives:

- Select the required tools and commands to configure basic OSPF authentication
- Organize the tasks into an implementation plan to implement OSPF authentication
- Implement the identified OSPF solution to configure basic OSPF authentication in the provided network according to the implementation plan, using Cisco IOS commands and applications in the correct order to the selected devices and portions of the network
- Write a verification and test plan to verify correct implementation and operation according to the expected performance criteria
- Verify the implementation according to the verification plan, using the appropriate **show** and **debug** commands and applications to verify correct operation document implementation, operations, and maintenance

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- Set proper initial configuration on all devices in your lab. The instructor will provide the necessary information on how to set the initial configuration on all devices.
- When an existing topology needs to be fine tuned, the administrator first needs to review the existing routing configuration and policy. This requires that you review the router configuration and examine the routing behavior. Examine IP routing information exchanged by routers configured with OSPF routing protocol. Routers R1, R2, R3, and R4 are configured with the OSPF routing protocol and announce their directly attached networks. Router R4 also announces some external OSPF networks into the OSPF routing domain.
- Once the existing topology and operation is discovered, the administrator can address and adjust the operation so that it is more precise. The security of the routing information must be properly addressed. The administrator should deploy a configuration that prevents traffic hijacking and black-hole routing caused by counterfeit routing information that is injected into the routing domain by a malicious attacker. This is achieved by deploying routing authentication, and OSPF can be affected. OSPF authentication offers very granular authentication, which is deployed on a per-interface basis. Address the OSPF routing security in OSPF Areas 3 and 24. You have decided to apply simple OSPF authentication between routers R3 and R1 to examine how authentication is working. At the same time you are concerned with the LAN segment between routers R2 and R4 and have decided to implement link authentication on that segment also. The most secure OSPF authentication should be deployed.
- OSPF authentication configuration and deployment can be eased by deploying area-based authentication. The area-based authentication mechanism utilizes the OSPF deployment specific – the routing topology deployed in areas. In this task you will address the OSPF routing security in OSPF Area 24. You have decided to scale the authentication in that area by deploying authentication on the LAN segment between routers R2 and R4 and on other Area 24 interfaces and segments.
- Verify the IP routing table, OSPF routing domain, interfaces where OSPF is enabled, OSPF adjacencies, link-state databases, and OSPF area design after each task in order to verify proper configuration.

Device Information

The table provides the information specific to each switch in the network:

Device Name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
ip ospf authentication	Specifies the authentication type for an interface
ip ospf authentication-key	Assigns a password to be used by neighboring routers that use Open Shortest Path First (OSPF) simple password authentication
ip ospf message-digest-key md5	Enables Open Shortest Path First (OSPF) Message Digest 5 (MD5) authentication
area authentication	Enables authentication for an OSPF area
show ip ospf	Displays general information about Open Shortest Path First (OSPF) routing processes
show ip ospf database	Displays lists of information related to the Open Shortest Path First (OSPF) database for a specific router
show ip route [**ospf**]	Displays whole IP routing table or OSPF routes only
show ip ospf neighbor	Displays Open Shortest Path First (OSPF) neighbor information on a per-interface basis
show ip ospf interface	Displays Open Shortest Path First (OSPF)-related interface information

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	“Hints” section at the end of this lab
Implementation and verification plan hints	“Hints” section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirements list. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Device	Implementation Requirement

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Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you can use the information provided in the “Hints” section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the "Hints" section at the end of this lab.

Student Notes:

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Alternate Resources and Solutions

Other groups may have implemented a solution different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 3-5 Hint Sheet: Configure and Verify OSPF Authentication

Implementation Requirements

To facilitate the configuration of your network, Task 1 asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Interfaces involved in OSPF authentication	Visual Objective
ALL	Authentication type used on the interface	Implementation Policy
ALL	Authentication key used for authentication	Implementation Policy

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load the initial configuration.	All pod routers must be preloaded with the initial configuration for the lab.	Step 1
	R1–R4			Examine the OSPF routing configuration on all routers. First explore the OSPF link-state database to gain insight into how OSPF is deployed in the network. Also observe the OSPF area configuration to determine the OSPF architecture and topology. Verify the IP routing tables for routers R1, R2, R3, and R4 to see whether the correct information was put into the routing tables and that external networks are inside the IP routing table.	Step 2

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1, R3		Deploy OSPF link authentication between routers R1 and R3 on the WAN segment. Remember that router R3 should not use encrypted keys for the OSPF authentication.		Step 3
	R2, R4		Deploy OSPF link authentication between routers R2 and R4 on the LAN segment. Deploy the most secure OSPF authentication.	Examine OSPF adjacencies and verify that all the adjacencies that were up before implementing OSPF link authentication are still up and running. Router R1 should have OSPF adjacencies to routers R2, R3, R4, and BBR2. Routers R2 and R4 should have an additional adjacency between them.	Step 3
	R2, R4		Change the OSPF authentication on routers R2 and R4 so that they enforce the OSPF authentication on all OSPF-enabled interfaces. Remember that the configuration must be implemented with a minimum number of commands, and that if an additional interface is added to Area 24, the OSPF authentication should automatically be enforced on that interface also without having to apply additional commands.		Step 4
	R1		Deploy OSPF authentication on router R1 for Area 24 also. The authentication should use the most secure method available.	Examine OSPF adjacencies and interfaces in order to verify that all the adjacencies that were up before implementing OSPF link authentication are still up and running. Router R1 should have OSPF adjacencies to routers R2, R3, R4, and BBR2. Routers R2 and R4 should have an additional adjacency between them.	Step 4

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

    1.1. The instructor will provide guidelines for changing the initial configuration.

2. Examine the OSPF routing information by verifying the OSPF link-state database to gain insight into how OSPF is deployed in the network, and to check the OSPF process and IP routing table.

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 1.1.1.1
 Start time: 5w2d, Time elapsed: 01:54:01.424
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 It is an area border and autonomous system boundary router
 Redistributing External Routes from,
    static, includes subnets in redistribution
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 4. Checksum Sum 0x04C018
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 3. 3 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area BACKBONE(0)
                Number of interfaces in this area is 1
                Area has no authentication
                SPF algorithm last executed 00:01:57.292 ago
                SPF algorithm executed 9 times
                Area ranges are
                   172.30.0.0/16 Active(65) Advertise
                Number of LSA 8. Checksum Sum 0x039389
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
    Area 3
                Number of interfaces in this area is 1
                Area has no authentication
                SPF algorithm last executed 00:01:08.224 ago
                SPF algorithm executed 13 times
                Area ranges are
                Number of LSA 7. Checksum Sum 0x039B02
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
    Area 24
                Number of interfaces in this area is 1
                Area has no authentication
                SPF algorithm last executed 00:00:58.224 ago
                SPF algorithm executed 12 times
                Area ranges are
                Number of LSA 9. Checksum Sum 0x0768BE
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
```

```
R2#show ip ospf
 Routing Process "ospf 1" with ID 10.2.2.2
 Start time: 5w2d, Time elapsed: 01:53:16.904
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 4. Checksum Sum 0x02D4AE
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area 24
                Number of interfaces in this area is 2
                Area has no authentication
                SPF algorithm last executed 00:01:24.016 ago
                SPF algorithm executed 20 times
                Area ranges are
                Number of LSA 9. Checksum Sum 0x03969B
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0

R3#show ip ospf
 Routing Process "ospf 1" with ID 192.168.3.1
 Start time: 5w2d, Time elapsed: 01:54:33.812
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 It is an autonomous system boundary router
 Redistributing External Routes from,
    connected, includes subnets in redistribution
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 4. Checksum Sum 0x02D4AE
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area 3
                Number of interfaces in this area is 2
                Area has no authentication
                SPF algorithm last executed 00:01:48.556 ago
```

```
                SPF algorithm executed 17 times
                Area ranges are
                Number of LSA 7. Checksum Sum 0x0274A6
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
```

R4#show ip ospf

```
 Routing Process "ospf 1" with ID 10.4.4.4
 Start time: 5w2d, Time elapsed: 01:53:25.576
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 4. Checksum Sum 0x02D4AE
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
    Area 24
                Number of interfaces in this area is 2
                Area has no authentication
                SPF algorithm last executed 00:01:50.844 ago
                SPF algorithm executed 20 times
                Area ranges are
                Number of LSA 9. Checksum Sum 0x03969B
                Number of opaque link LSA 0. Checksum Sum 0x000000
                Number of DCbitless LSA 0
                Number of indication LSA 0
                Number of DoNotAge LSA 0
                Flood list length 0
```

R1#show ip ospf database

```
            OSPF Router with ID (1.1.1.1) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         162         0x8000000D 0x00FDB4 2
172.30.10.6     172.30.10.6     159         0x800009C6 0x009B94 3

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         171         0x80000001 0x0014AA
10.1.110.2      1.1.1.1         123         0x80000001 0x006E45
10.1.110.4      1.1.1.1         93          0x80000001 0x00644C
10.1.113.0      1.1.1.1         141         0x80000001 0x007FFC
172.30.13.0     1.1.1.1         113         0x80000001 0x003AE5
172.30.24.0     1.1.1.1         123         0x80000001 0x00A2A8

                Summary ASB Link States (Area 0)
```

```
Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         113         0x80000001 0x000387

                            Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         127         0x8000000F 0x000321 2
192.168.3.1     192.168.3.1     137         0x80000010 0x008748 3

                            Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         184         0x80000001 0x0014AA
10.1.110.2      1.1.1.1         136         0x80000001 0x006E45
10.1.110.4      1.1.1.1         106         0x80000001 0x00644C
10.1.116.0      1.1.1.1         184         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         164         0x80000001 0x005BC7
172.30.24.0     1.1.1.1         136         0x80000001 0x00A2A8

                            Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         28          0x8000000E 0x009787 3
10.2.2.2        10.2.2.2        117         0x80000011 0x00D10C 3
10.4.4.4        10.4.4.4        29          0x8000000F 0x00FDCF 3

                            Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        118         0x80000001 0x000116

                            Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         156         0x80000001 0x007FFC
10.1.116.0      1.1.1.1         186         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         166         0x80000001 0x005BC7
172.30.13.0     1.1.1.1         127         0x80000001 0x003AE5

                            Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         127         0x80000001 0x000387

                            Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     1264        0x8000000B 0x00EFCE 0
192.168.2.0     192.168.3.1     1264        0x8000000B 0x00E4D8 0
192.168.3.0     192.168.3.1     1266        0x8000000B 0x00D9E2 0
192.168.4.0     1.1.1.1         191         0x80000001 0x00EB43 0

R2#show ip ospf database

            OSPF Router with ID (10.2.2.2) (Process ID 1)

                            Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         71          0x8000000E 0x009787 3
10.2.2.2        10.2.2.2        158         0x80000011 0x00D10C 3
10.4.4.4        10.4.4.4        71          0x8000000F 0x00FDCF 3

                            Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        159         0x80000001 0x000116
```

```
                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.113.0      1.1.1.1         196         0x80000001 0x007FFC
10.1.116.0      1.1.1.1         226         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         206         0x80000001 0x005BC7
172.30.13.0     1.1.1.1         168         0x80000001 0x003AE5

                Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         168         0x80000001 0x000387

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     1306        0x8000000B 0x00EFCE 0
192.168.2.0     192.168.3.1     1306        0x8000000B 0x00E4D8 0
192.168.3.0     192.168.3.1     1306        0x8000000B 0x00D9E2 0
192.168.4.0     1.1.1.1         232         0x80000001 0x00EB43 0

R3#show ip ospf database

            OSPF Router with ID (192.168.3.1) (Process ID 1)

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         211         0x8000000F 0x000321 2
192.168.3.1     192.168.3.1     206         0x80000010 0x008748 3

                Summary Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.110.1      1.1.1.1         255         0x80000001 0x0014AA
10.1.110.2      1.1.1.1         207         0x80000001 0x006E45
10.1.110.4      1.1.1.1         177         0x80000001 0x00644C
10.1.116.0      1.1.1.1         255         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         235         0x80000001 0x005BC7
172.30.24.0     1.1.1.1         207         0x80000001 0x00A2A8

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     1332        0x8000000B 0x00EFCE 0
192.168.2.0     192.168.3.1     1332        0x8000000B 0x00E4D8 0
192.168.3.0     192.168.3.1     1333        0x8000000B 0x00D9E2 0
192.168.4.0     1.1.1.1         260         0x80000001 0x00EB43 0

R4#show ip ospf database

            OSPF Router with ID (10.4.4.4) (Process ID 1)

                Router Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         129         0x8000000E 0x009787 3
10.2.2.2        10.2.2.2        217         0x80000011 0x00D10C 3
10.4.4.4        10.4.4.4        128         0x8000000F 0x00FDCF 3

                Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        216         0x80000001 0x000116

                Summary Net Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
```

```
10.1.113.0      1.1.1.1         255         0x80000001 0x007FFC
10.1.116.0      1.1.1.1         285         0x80000001 0x005E1B
172.30.10.0     1.1.1.1         265         0x80000001 0x005BC7
172.30.13.0     1.1.1.1         227         0x80000001 0x003AE5

                Summary ASB Link States (Area 24)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.3.1     1.1.1.1         227         0x80000001 0x000387

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.0     192.168.3.1     1366        0x8000000B 0x00EFCE 0
192.168.2.0     192.168.3.1     1366        0x8000000B 0x00E4D8 0
192.168.3.0     192.168.3.1     1366        0x8000000B 0x00D9E2 0
192.168.4.0     1.1.1.1         292         0x80000001 0x00EB43 0

R1#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/11] via 10.1.110.2, 00:03:40, Serial0/0/0.1
O       172.30.10.0 [110/65] via 10.1.116.6, 00:06:01, Serial0/0/0.116
O       172.30.13.0 [110/65] via 10.1.113.3, 00:05:22, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/11] via 10.1.110.2, 00:03:40, Serial0/0/0.1
O       10.1.110.2/32 [110/10] via 10.1.110.2, 00:03:40, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.113.3, 00:03:40, Serial0/0/0.2
O E2 192.168.2.0/24 [110/20] via 10.1.113.3, 00:03:40, Serial0/0/0.2
O E2 192.168.3.0/24 [110/20] via 10.1.113.3, 00:03:40, Serial0/0/0.2

R2#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:04:57, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:04:57, Serial0/0/0.1
O E2 192.168.4.0/24 [110/20] via 10.1.110.1, 00:04:57, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:04:57, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:04:57, Serial0/0/0.1
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:04:57, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:04:57, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:04:57, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:04:57, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:04:57, Serial0/0/0.1

R3#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.24.0 [110/75] via 10.1.113.1, 00:07:02, Serial0/0/0.2
O IA    172.30.10.0 [110/129] via 10.1.113.1, 00:07:02, Serial0/0/0.2
O E2 192.168.4.0/24 [110/20] via 10.1.113.1, 00:06:37, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.1.110.4/32 [110/75] via 10.1.113.1, 00:06:42, Serial0/0/0.2
O IA    10.1.110.1/32 [110/64] via 10.1.113.1, 00:07:02, Serial0/0/0.2
O IA    10.1.110.2/32 [110/74] via 10.1.113.1, 00:07:02, Serial0/0/0.2
O IA    10.1.116.0/24 [110/128] via 10.1.113.1, 00:07:02, Serial0/0/0.2

R4#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:05:35, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:05:35, Serial0/0/0.1
O E2 192.168.4.0/24 [110/20] via 10.1.110.1, 00:05:35, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:05:35, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:05:35, FastEthernet0/0
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:05:35, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:05:35, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:05:35, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:05:35, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:05:35, Serial0/0/0.1
```

3. Enable OSPF link authentication.

3.1. Use the following example to configure the routers in this lab:

```
R1#
interface Serial0/0/0.2 point-to-point
 ip ospf authentication
 ip ospf authentication-key CISCO

R2#
interface FastEthernet0/0
 ip ospf authentication message-digest
 ip ospf message-digest-key 1 md5 CISCO

R3#
interface Serial0/0/0.2 point-to-point
 ip ospf authentication
 ip ospf authentication-key CISCO

R4#
interface FastEthernet0/0
 ip ospf authentication message-digest
 ip ospf message-digest-key 1 md5 CISCO
```

3.2. Verify that the authentication is successfully configured.

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
172.30.10.6       0   FULL/  -        00:00:32    10.1.116.6      Serial0/0/0.116
192.168.3.1       0   FULL/  -        00:00:36    10.1.113.3      Serial0/0/0.2
10.4.4.4          0   FULL/  -        00:00:39    10.1.110.4      Serial0/0/0.1
10.2.2.2          0   FULL/  -        00:00:31    10.1.110.2      Serial0/0/0.1

R2#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.4.4.4          1   FULL/DR         00:00:30    172.30.24.4     FastEthernet0/0
1.1.1.1           0   FULL/  -        00:00:37    10.1.110.1      Serial0/0/0.1

R3#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           0   FULL/  -        00:00:32    10.1.113.1      Serial0/0/0.2

R4#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.2.2.2          1   FULL/BDR        00:00:36    172.30.24.2     FastEthernet0/0
1.1.1.1           0   FULL/  -        00:00:32    10.1.110.1      Serial0/0/0.1

R1#show ip ospf interface serial 0/0/0.2
Serial0/0/0.2 is up, line protocol is up
  Internet Address 10.1.113.1/24, Area 3
  Process ID 1, Router ID 1.1.1.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:09
  Supports Link-local Signaling (LLS)
  Index 1/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 5
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.3.1
  Suppress hello for 0 neighbor(s)
  Simple password authentication enabled
```

```
R2#show ip ospf interface fa0/0
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.24.2/24, Area 24
  Process ID 1, Router ID 10.2.2.2, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 10.4.4.4, Interface address 172.30.24.4
  Backup Designated router (ID) 10.2.2.2, Interface address 172.30.24.2
  Flush timer for old DR LSA due in 00:02:46
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:07
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 2
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.4.4.4  (Designated Router)
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1

R3#show ip ospf interface serial 0/0/0.2
Serial0/0/0.2 is up, line protocol is up
  Internet Address 10.1.113.3/24, Area 3
  Process ID 1, Router ID 192.168.3.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:09
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 3
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 1.1.1.1
  Suppress hello for 0 neighbor(s)
Simple password authentication enabled

R4#show ip ospf interface fastethernet 0/0
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.24.4/24, Area 24
  Process ID 1, Router ID 10.4.4.4, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 10.4.4.4, Interface address 172.30.24.4
  Backup Designated router (ID) 10.2.2.2, Interface address 172.30.24.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 3
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.2.2.2  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
```

4. Enable OSPF area authentication.

   4.1. Use the following example to configure routers R2 and R4 in this lab:

```
R2#
interface FastEthernet0/0
```



```
 no ip ospf authentication message-digest
 ip ospf message-digest-key 1 md5 CISCO
!
interface Serial0/0/0.1 multipoint
 ip ospf message-digest-key 1 md5 CISCO
!
router ospf 1
 area 24 authentication message-digest

R4#
interface FastEthernet0/0
 no ip ospf authentication message-digest
 ip ospf message-digest-key 1 md5 CISCO
!
interface Serial0/0/0.1 multipoint
 ip ospf message-digest-key 1 md5 CISCO
!
router ospf 1
 area 24 authentication message-digest
```

4.2. Use the following example to configure router R1 in this lab:

```
R1#
interface Serial0/0/0.1 multipoint
 ip ospf message-digest-key 1 md5 CISCO
!
router ospf 1
 area 24 authentication message-digest
```

4.3. Verify that the authentication is successfully configured.

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State         Dead Time   Address         Interface
172.30.10.6       0   FULL/  -     00:00:35    10.1.116.6      Serial0/0/0.116
192.168.3.1       0   FULL/  -      00:00:39    10.1.113.3      Serial0/0/0.2
10.4.4.4          0   FULL/  -      00:00:32    10.1.110.4      Serial0/0/0.1
10.2.2.2          0   FULL/  -      00:00:34    10.1.110.2      Serial0/0/0.1

R2#show ip ospf neighbor

Neighbor ID     Pri   State         Dead Time   Address         Interface
10.4.4.4          1   FULL/DR       00:00:36    172.30.24.4     FastEthernet0/0
1.1.1.1           0   FULL/  -      00:00:33    10.1.110.1      Serial0/0/0.1

R3#show ip ospf neighbor

Neighbor ID     Pri   State         Dead Time   Address         Interface
1.1.1.1           0   FULL/  -      00:00:31    10.1.113.1      Serial0/0/0.2

R4#show ip ospf neighbor

Neighbor ID     Pri   State         Dead Time   Address         Interface
10.2.2.2          1   FULL/BDR      00:00:34    172.30.24.2     FastEthernet0/0
1.1.1.1           0   FULL/  -      00:00:30    10.1.110.1      Serial0/0/0.1

R1#show ip ospf interface serial 0/0/0.1
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.1/24, Area 24
  Process ID 1, Router ID 1.1.1.1, Network Type POINT_TO_MULTIPOINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:07
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 5
  Last flood scan time is 0 msec, maximum is 4 msec
```

```
  Neighbor Count is 2, Adjacent neighbor count is 2
    Adjacent with neighbor 10.4.4.4
    Adjacent with neighbor 10.2.2.2, cost is 10
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1

R2#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.24.2/24, Area 24
  Process ID 1, Router ID 10.2.2.2, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 10.4.4.4, Interface address 172.30.24.4
  Backup Designated router (ID) 10.2.2.2, Interface address 172.30.24.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:04
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 2
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.4.4.4  (Designated Router)
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.2/24, Area 24
  Process ID 1, Router ID 10.2.2.2, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:08
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 1.1.1.1
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1

R3#show ip ospf interface serial0/0/0.2
Serial0/0/0.2 is up, line protocol is up
  Internet Address 10.1.113.3/24, Area 3
  Process ID 1, Router ID 192.168.3.1, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:02
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 2, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 1.1.1.1
  Suppress hello for 0 neighbor(s)
  Simple password authentication enabled

R4#show ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet Address 172.30.24.4/24, Area 24
  Process ID 1, Router ID 10.4.4.4, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
```

```
  Designated Router (ID) 10.4.4.4, Interface address 172.30.24.4
  Backup Designated router (ID) 10.2.2.2, Interface address 172.30.24.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:07
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 3
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.2.2.2  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
Serial0/0/0.1 is up, line protocol is up
  Internet Address 10.1.110.4/24, Area 24
  Process ID 1, Router ID 10.4.4.4, Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 1.1.1.1
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
R1#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/11] via 10.1.110.2, 00:05:46, Serial0/0/0.1
O       172.30.10.0 [110/65] via 10.1.116.6, 00:19:32, Serial0/0/0.116
O       172.30.13.0 [110/65] via 10.1.113.3, 00:18:53, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/11] via 10.1.110.2, 00:05:46, Serial0/0/0.1
O       10.1.110.2/32 [110/10] via 10.1.110.2, 00:05:46, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.113.3, 00:05:46, Serial0/0/0.2
O E2 192.168.2.0/24 [110/20] via 10.1.113.3, 00:05:46, Serial0/0/0.2
O E2 192.168.3.0/24 [110/20] via 10.1.113.3, 00:05:46, Serial0/0/0.2

R2#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:05:55, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:05:55, Serial0/0/0.1
O E2 192.168.4.0/24 [110/20] via 10.1.110.1, 00:05:55, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:05:55, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:05:55, Serial0/0/0.1
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:05:55, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:05:55, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:05:55, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:05:55, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:05:55, Serial0/0/0.1
     172.30.0.0/16 is variably subnetted, 3 subnets, 2 masks

R3#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.24.0 [110/75] via 10.1.113.1, 00:07:04, Serial0/0/0.2
O IA    172.30.10.0 [110/129] via 10.1.113.1, 00:20:12, Serial0/0/0.2
O E2 192.168.4.0/24 [110/20] via 10.1.113.1, 00:19:47, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O IA    10.1.110.4/32 [110/75] via 10.1.113.1, 00:07:04, Serial0/0/0.2
O IA    10.1.110.1/32 [110/64] via 10.1.113.1, 00:20:12, Serial0/0/0.2
O IA    10.1.110.2/32 [110/74] via 10.1.113.1, 00:07:04, Serial0/0/0.2
```

```
O IA    10.1.116.0/24 [110/128] via 10.1.113.1, 00:20:12, Serial0/0/0.2
```

R4#show ip route ospf

```
R4#show ip route ospf
     172.30.0.0/24 is subnetted, 3 subnets
O IA    172.30.10.0 [110/129] via 10.1.110.1, 00:07:24, Serial0/0/0.1
O IA    172.30.13.0 [110/129] via 10.1.110.1, 00:07:24, Serial0/0/0.1
O E2 192.168.4.0/24 [110/20] via 10.1.110.1, 00:07:24, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:07:24, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:07:24, FastEthernet0/0
O IA    10.1.113.0/24 [110/128] via 10.1.110.1, 00:07:24, Serial0/0/0.1
O IA    10.1.116.0/24 [110/128] via 10.1.110.1, 00:07:24, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:07:24, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:07:24, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:07:24, Serial0/0/0.1
```

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Lab 4-1: Configure Route Redistribution Between Multiple IP Routing Protocols

Complete this lab activity to practice what you learned in the related module.

Activity Objective

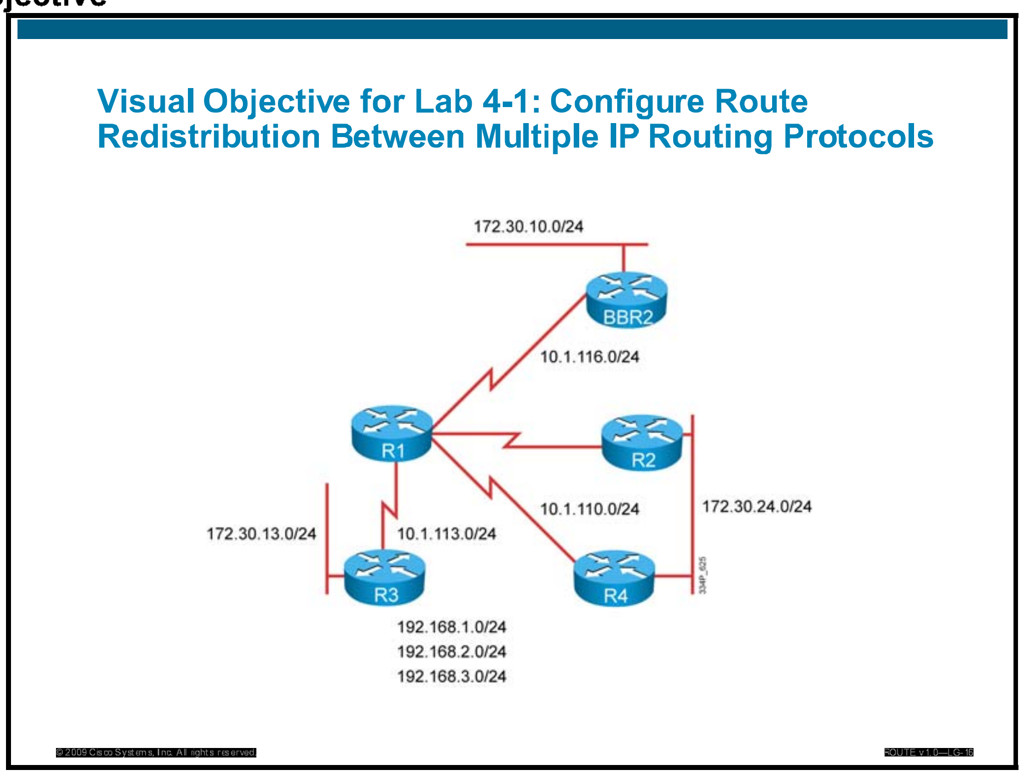
In this activity, you will use correct commands, tools, and steps to configure and verify route redistribution between multiple IP routing protocols. After completing this activity, you will be able to meet these objectives:

- Configure and verify different routing protocols in the network
- Select the required tools and commands to configure redistribution between different routing protocols
- Make a list of configuration and implementation steps
- Write a verification and test plan to verify the proper implementation and operation according to the expected performance criteria.
- Verify the configuration and operation by using the proper **show** and **debug** commands

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- Set proper initial configuration on all devices in your lab. The instructor will provide the necessary information on how to set initial the configuration on all devices.
- Multiple routing protocols must be deployed in your network. RIPv2, EIGRP, and OSPF must be configured in order to start the redistribution. Routers R3 and R1 will use the RIPv2 routing protocol to exchange routing information. Routers R1, R2, and R4 will use the OSPF routing protocol to exchange routing information, and router R1 will use EIGRP to exchange routing information with router BBR2.
- Configuration must be verified in order to proceed to the next step. Verify that the RIPv2 protocol is running between routers R1 and R3. Make sure that router R1 can access the RIPv2-announced routes from router R1. Verify that the EIGRP routing protocol is up and running between routers R1 and BBR2. Make sure that router R1 receives routes announced by BBR2 and that these routes are accessible. Examine and verify that the OSPF routing protocol is up and running between routers R1, R2, and R4. Make sure that routers have established the adjacencies and that R1has received the IP subnet from the LAN segment between routers R2 and R4. Verify that R1 has connectivity to the networks.
- After successful configuration of the routing protocols, redistribution must take place. Redistribute connected loopback interfaces in RIP to announce them to router R1. Configure the RIP-to-EIGRP redistribution with filtering to allow access to only one of the loopback interfaces. Because the RIP-to-EIGRP redistribution will be in one direction only (one way), you must configure a static default route on router R3 to provide connectivity to selected RIPv2 routing domain routes.
- Examine the RIPv2 database on routers R1 and R3 and verify that the R3 loopback networks are present in the RIP table as a result of redistribution. Add an additional loopback network to router R3 and verify that the network is not redistributed into RIPv2, and that router R1 does not receive that information. Verify that you have connectivity from router R3 to the BBR2 LAN segment.
- The next task to be preformed is the configuration of the redistribution between the OSPF and EIGRP domains. You will deploy two-way redistribution to achieve full IP connectivity between the routing domains. Additionally you will configure two-way redistribution between the OSPF and RIP routing domains.
- Examine the RIP routing information on router R3 and verify that the routes from the OSPF routing domain are present in the RIP database and IP routing table. The EIGRP topology table on router R1 must contain routes that originated in OSPF. Verify that the OSPF database and IP routing table on routers R2 and R4 hold the information about the RIP and EIGRP redistributed routes. Verify that you have connectivity from the R2 LAN segment to the BBR2 LAN segment, and that there is connectivity from the R3 LAN segment to the R2 LAN segment.

Device Information

The table provides the information specific to each switch in the network:

Device name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
router rip	Configures the RIP routing process
version	Specifies a RIP version used globally by the router
network (RIP)	Specifies a list of networks for the RIP routing process
[**no**] **auto-summary** (RIP)	Restores the default behavior of automatic summarization of subnet routes into network-level routes
show ip rip database	Displays summary address entries in the RIP routing database entries; if relevant, displays whether routes are being summarized based upon a summary address
show ip route	Displays whole IP routing table
Router ospf	Configures an OSPF routing process
ip ospf network point-to-multipoint	Configures the OSPF network type to a type other than the default for a given medium
ip ospf hello-interval	Specifies the interval between hello packets that the Cisco IOS software sends on the interface
log-adjacency-changes	Configures the router to send a syslog message when an OSPF neighbor goes up or down
network area	Defines the interfaces on which OSPF runs and defines the area ID for those interfaces
Show ip ospf database	Display lists of information related to the OSPF database for a specific router
Show ip ospf neighbor	Displays OSPF neighbor information on a per-interface basis
Router eigrp	Configures the EIGRP process
network (EIGRP)	Specifies the network for an EIGRP routing process
Show ip eigrp neighbors	Displays neighbors discovered by EIGRP
Show ip eigrp topology	Displays entries in the EIGRP topology table
redistribute (IP)	Redistributes routes from one routing domain into another routing domain
distribute-list in (IP)	Filters networks received in updates
distribute-list out (IP)	Suppresses networks from being advertised in updates
ip prefix-list	Creates a prefix list or adds a prefix list entry
route-map	Defines the conditions for redistributing routes from one routing protocol into another, or enables policy routing
default-metric (eigrp)	Sets metrics for the EIGRP
ip route	Establishes static routes
ping	Diagnoses basic network connectivity
router ospf 1	Configures an OSPF routing process

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	“Hints” section at the end of this lab
Implementation and verification plan hints	“Hints” section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

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Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirements list. If you are unsure, you can use the information provided in the “Hints” section at the end of this lab.

Device	Implementation Requirement

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Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you can use the information provided in the “Hints” section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the "Hints" section at the end of this lab.

Student Notes:

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Alternate Resources and Solutions

Other groups may have implemented a solution that is different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 4-1 Hint Sheet: Configure Route Redistribution Between Multiple IP Routing Protocols

Implementation Requirements

To facilitate the configuration of your network, Task 1 asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Interfaces involved in routing protocol configuration	Visual Objective
ALL	Where redistribution takes place	Implementation Policy
ALL	What needs to be redistributed	Implementation Policy

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load the initial configuration.	All pod routers must be preloaded with the initial configuration for the lab.	Step 1
		2	Configure the RIPv2 routing protocol on routers R1 and R3 and advertise the R3 LAN segment. Routers should exchange RIPv2 only over the WAN segment that interconnects them.	Examine and verify that the RIPv2 protocol is running between routers R1 and R3. Make sure that router R1 can access the RIPv2-announced routes from router R1.	Step 2
			Configure routers R1, R2, and R4 to exchange routing information using OSPF. On router R1, the process should include only the WAN segment that connects router R1 to routers R2 and R4. Routers R2 and R4 should also include the LAN segment in the OSPF process. Only a single area should be deployed.	Examine and verify that the EIGRP routing protocol is up and running between routers R1 and BBR2. Make sure that router R1 receives routes announced by BBR2 and that these routes are accessible.	Step 3

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
			Configure the EIGRP routing protocol on router R1 and include only the interface that connects router R1 to router BBR2. BBR2 is preconfigured with EIGRP AS 1.	Examine and verify that the OSPF routing protocolsis up and running between routers R1, R2, and R4. Make sure that the routers have established adjacencies and that R1 has received the IP subnet from the LAN segment between routers R2 and R4. Verify that R1 has connectivity to the networks.	Step 4
			Redistribute the IP subnets configured on the loopback interfaces on router R3 into the RIPv2 routing domain. Only IP subnets that are currently configured on the existing loopback interfaces should be redistributed, even if new subnets are added in the future. Do not use an access list or route maps to accomplish filtering.	Examine the RIPv2 database on routers R1 and R3 and verify that R3 loopback networks are present in the RIP table as a result of redistribution.	Step 5
			Redistribute RIPv2 routes to the EIGRP routing domain on router R1. Make sure that after the redistribution, only the 192.168.1.0/24 loopback networks is redistributed into the EIGRP routing domain and not any other R3-deployed loopback network. You cannot use distribute lists to provide filtering upon redistribution.	Add an additional loopback network to router R3 and verify that the network is not redistributed into RIPv2 and that router R1 does not receive that information. Examine the IP routing tables on routers R1 and R3 and confirm that the requested routes are present.	Step 6
			Configure a static route on router R3 to establish connectivity in the opposite direction.	Verify that you have connectivity from router R3 to the router BBR2 LAN segment.	Step 7
			Redistribute routing information from OSPF to the EIGRP routing domain and vice versa on router R1.	Examine the EIGRP topology table on router R1 and confirm that OSPF-originated routes are present.	Step 8

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
			Redistribute from the OSPF to the RIP routing domain and vice versa. Make sure that only RIP-originated routes are redistributed into the OSPF domain and that only OSPF-originated routes are redistributed into the RIP routing domain.	Examine the RIP routing information on router R3 and verify that routes from the OSPF routing domain are present in the RIP database and IP routing table. Verify that the OSPF database and IP routing table on routers R2 and R4 contain the information about the RIP and EIGRP redistributed routes. Verify that you have connectivity from the R2 LAN segment to the BBR2 LAN segment. Verify that you have connectivity from the R3 LAN segment to the R2 LAN segment.	Step 9

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Enable the RIP routing protocol.

   2.1. Use the following example to configure the routers in this lab:

```
R1#
router rip
 version 2
 network 10.0.0.0
 no auto-summary

R3#
router rip
 version 2
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
```

   2.2. Verify that RIP is successfully configured.

```
R1#show ip rip database
10.0.0.0/8    auto-summary
10.1.1.1/32    directly connected, Loopback0
10.1.110.0/24    directly connected, Serial0/0/0.1
10.1.113.0/24    directly connected, Serial0/0/0.2
10.1.116.0/24    directly connected, Serial0/0/0.116
10.3.3.3/32
    [1] via 10.1.113.3, 00:00:06, Serial0/0/0.2
172.30.0.0/16    auto-summary
172.30.13.0/24
    [1] via 10.1.113.3, 00:00:06, Serial0/0/0.2
```

```
R3#show ip rip database
10.0.0.0/8    auto-summary
10.1.1.1/32
    [1] via 10.1.113.1, 00:00:20, Serial0/0/0.2
10.1.110.0/24
    [1] via 10.1.113.1, 00:00:20, Serial0/0/0.2
10.1.113.0/24    directly connected, Serial0/0/0.2
10.1.116.0/24
    [1] via 10.1.113.1, 00:00:20, Serial0/0/0.2
10.3.3.3/32    directly connected, Loopback0
172.30.0.0/16    auto-summary
172.30.13.0/24    directly connected, FastEthernet0/0

R1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
R       172.30.13.0 [120/1] via 10.1.113.3, 00:00:03, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
R       10.3.3.3/32 [120/1] via 10.1.113.3, 00:00:03, Serial0/0/0.2
C       10.1.1.1/32 is directly connected, Loopback0
C       10.1.110.0/24 is directly connected, Serial0/0/0.1
C       10.1.113.0/24 is directly connected, Serial0/0/0.2
C       10.1.116.0/24 is directly connected, Serial0/0/0.116

R3#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
C       172.30.13.0 is directly connected, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C       10.3.3.3/32 is directly connected, Loopback0
R       10.1.1.1/32 [120/1] via 10.1.113.1, 00:00:22, Serial0/0/0.2
R       10.1.110.0/24 [120/1] via 10.1.113.1, 00:00:22, Serial0/0/0.2
C       10.1.113.0/24 is directly connected, Serial0/0/0.2
R       10.1.116.0/24 [120/1] via 10.1.113.1, 00:00:22, Serial0/0/0.2
C    192.168.1.0/24 is directly connected, Loopback31
C    192.168.2.0/24 is directly connected, Loopback32
C    192.168.3.0/24 is directly connected, Loopback33
```

3. Enable the OSPF routing protocol.

   3.1. Use the following example to configure the routers in this lab:

```
R1#
interface Serial0/0/0.1 multipoint
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
!
router ospf 1
 log-adjacency-changes
```

```
 network 10.1.110.0 0.0.0.255 area 0
```

```
R2#
interface Serial0/0/0.1 multipoint
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 0
 network 172.30.24.0 0.0.0.255 area 0
```

```
R4#
interface Serial0/0/0.1 multipoint
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 0
 network 172.30.24.0 0.0.0.255 area 0
```

3.2. Verify that OSPF is successfully configured.

```
R1#show ip ospf database

            OSPF Router with ID (10.1.1.1) (Process ID 1)

                          Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        890         0x80000004 0x0036AD 3
10.2.2.2        10.2.2.2        963         0x80000003 0x00DFC4 3
10.4.4.4        10.4.4.4        892         0x80000004 0x00EEA4 3

                          Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        964         0x80000001 0x000116

R1#show ip ospf neighbor

Neighbor ID     Pri   State         Dead Time   Address         Interface
10.4.4.4          0   FULL/  -      00:00:31    10.1.110.4      Serial0/0/0.1
10.2.2.2          0   FULL/  -      00:00:31    10.1.110.2      Serial0/0/0.1

R1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 2 subnets
O       172.30.24.0 [110/65] via 10.1.110.4, 00:03:51, Serial0/0/0.1
                    [110/65] via 10.1.110.2, 00:03:51, Serial0/0/0.1
R       172.30.13.0 [120/1] via 10.1.113.3, 00:00:14, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
R       10.3.3.3/32 [120/1] via 10.1.113.3, 00:00:14, Serial0/0/0.2
C       10.1.1.1/32 is directly connected, Loopback0
O       10.1.110.4/32 [110/64] via 10.1.110.4, 00:03:51, Serial0/0/0.1
C       10.1.110.0/24 is directly connected, Serial0/0/0.1
O       10.1.110.2/32 [110/64] via 10.1.110.2, 00:03:51, Serial0/0/0.1
C       10.1.113.0/24 is directly connected, Serial0/0/0.2
```

```
C       10.1.116.0/24 is directly connected, Serial0/0/0.116

R2#show ip ospf database

            OSPF Router with ID (10.2.2.2) (Process ID 1)

                                 Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        919         0x80000004 0x0036AD 3
10.2.2.2        10.2.2.2        988         0x80000003 0x00DFC4 3
10.4.4.4        10.4.4.4        918         0x80000004 0x00EEA4 3

                                 Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        989         0x80000001 0x000116

R2#show ip ospf neighbor

Neighbor ID     Pri   State         Dead Time   Address         Interface
10.4.4.4          1   FULL/DR       00:00:37    172.30.24.4     FastEthernet0/0
10.1.1.1          0   FULL/  -      00:00:39    10.1.110.1      Serial0/0/0.1

R2#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
C       172.30.24.0 is directly connected, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.2.2.2/32 is directly connected, Loopback0
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:05:59, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:05:59, Serial0/0/0.1
C       10.1.110.0/24 is directly connected, Serial0/0/0.1

R4#show ip ospf database

            OSPF Router with ID (10.4.4.4) (Process ID 1)

                                 Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.1.1.1        10.1.1.1        961         0x80000004 0x0036AD 3
10.2.2.2        10.2.2.2        1033        0x80000003 0x00DFC4 3
10.4.4.4        10.4.4.4        960         0x80000004 0x00EEA4 3

                                 Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.30.24.4     10.4.4.4        1032        0x80000001 0x000116

R4#show ip ospf neighbor

Neighbor ID     Pri   State         Dead Time   Address         Interface
10.2.2.2          1   FULL/BDR      00:00:31    172.30.24.2     FastEthernet0/0
10.1.1.1          0   FULL/  -      00:00:34    10.1.110.1      Serial0/0/0.1

R4#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
C       172.30.24.0 is directly connected, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.4.4.4/32 is directly connected, Loopback0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:08:06, Serial0/0/0.1
C       10.1.110.0/24 is directly connected, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:08:06, FastEthernet0/0
```

4. Enable the EIGRP routing protocol.

4.1. Use the following example to configure the routers in this lab:

```
R1#
router eigrp 1
 network 10.1.116.0 0.0.0.255
```

4.2. Verify that EIGRP is successfully configured.

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   10.1.116.6              Se0/0/0.116       13 00:13:50 1220   5000  0  60

R1#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(10.1.1.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.116.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.116
P 172.30.10.0/24, 1 successors, FD is 2172416
        via 10.1.116.6 (2172416/28160), Serial0/0/0.116

R1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/65] via 10.1.110.4, 00:12:00, Serial0/0/0.1
                    [110/65] via 10.1.110.2, 00:12:00, Serial0/0/0.1
D       172.30.10.0 [90/2172416] via 10.1.116.6, 00:12:00, Serial0/0/0.116
R       172.30.13.0 [120/1] via 10.1.113.3, 00:00:23, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
R       10.3.3.3/32 [120/1] via 10.1.113.3, 00:00:23, Serial0/0/0.2
C       10.1.1.1/32 is directly connected, Loopback0
C       10.1.110.0/24 is directly connected, Serial0/0/0.1
C       10.1.113.0/24 is directly connected, Serial0/0/0.2
C       10.1.116.0/24 is directly connected, Serial0/0/0.116
```

5. Enable redistribution into the RIP routing protocol.

5.1. Use the following example to configure the routers in this lab:

```
R3#
router rip
 redistribute connected
 distribute-list prefix PL-RIP out connected
!
ip prefix-list PL-RIP seq 5 permit 192.168.1.0/24
ip prefix-list PL-RIP seq 10 permit 192.168.2.0/24
ip prefix-list PL-RIP seq 15 permit 192.168.3.0/24
```

5.2. Verify that redistribution is successfully configured.

```
R1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 3 subnets
O       172.30.24.0 [110/65] via 10.1.110.4, 00:12:57, Serial0/0/0.1
                    [110/65] via 10.1.110.2, 00:12:57, Serial0/0/0.1
D       172.30.10.0 [90/2172416] via 10.1.116.6, 00:02:25, Serial0/0/0.116
R       172.30.13.0 [120/1] via 10.1.113.3, 00:00:08, Serial0/0/0.2
     10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
R       10.3.3.3/32 [120/1] via 10.1.113.3, 00:00:08, Serial0/0/0.2
C       10.1.1.1/32 is directly connected, Loopback0
O       10.1.110.4/32 [110/64] via 10.1.110.4, 00:12:57, Serial0/0/0.1
C       10.1.110.0/24 is directly connected, Serial0/0/0.1
O       10.1.110.2/32 [110/64] via 10.1.110.2, 00:12:57, Serial0/0/0.1
C       10.1.113.0/24 is directly connected, Serial0/0/0.2
C       10.1.116.0/24 is directly connected, Serial0/0/0.116
R    192.168.1.0/24 [120/1] via 10.1.113.3, 00:00:10, Serial0/0/0.2
R    192.168.2.0/24 [120/1] via 10.1.113.3, 00:00:10, Serial0/0/0.2
R    192.168.3.0/24 [120/1] via 10.1.113.3, 00:00:10, Serial0/0/0.2
```

6. Enable redistribution into the EIGRP routing protocol.

6.1. Use the following example to configure the routers in this lab:

```
R1#
router eigrp 1
 redistribute rip route-map RM-RIP
 default-metric 1500 100 255 1 1500
!
ip access-list standard ACL-RIP
 permit 192.168.2.0 0.0.0.255
 permit 192.168.3.0 0.0.0.255
!
route-map RM-RIP deny 10
 match ip address ACL-RIP
!
route-map RM-RIP permit 99
```

6.2. Verify that redistribution is successfully configured.

```
R1#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(10.1.1.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.3.3.3/32, 1 successors, FD is 1732096
```

```
        via Redistributed (1732096/0)
P 10.1.1.1/32, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 10.1.110.0/24, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 192.168.1.0/24, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 10.1.113.0/24, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 10.1.116.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.116
P 172.30.10.0/24, 1 successors, FD is 2172416
        via 10.1.116.6 (2172416/28160), Serial0/0/0.116
P 172.30.13.0/24, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
```

7. Enable additional connectivity.

7.1. Use the following example to configure router R3 in this lab:

```
R3#
ip route 0.0.0.0 0.0.0.0 10.1.113.1
```

7.2. Verify that redistribution is successfully configured.

```
R3#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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 10.1.113.1 to network 0.0.0.0

     172.30.0.0/24 is subnetted, 1 subnets
C       172.30.13.0 is directly connected, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C       10.3.3.3/32 is directly connected, Loopback0
R       10.1.1.1/32 [120/1] via 10.1.113.1, 00:00:16, Serial0/0/0.2
R       10.1.110.0/24 [120/1] via 10.1.113.1, 00:00:16, Serial0/0/0.2
C       10.1.113.0/24 is directly connected, Serial0/0/0.2
R       10.1.116.0/24 [120/1] via 10.1.113.1, 00:00:16, Serial0/0/0.2
C    192.168.1.0/24 is directly connected, Loopback31
C    192.168.2.0/24 is directly connected, Loopback32
C    192.168.3.0/24 is directly connected, Loopback33
S*   0.0.0.0/0 [1/0] via 10.1.113.1

R3#ping 172.30.10.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.10.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/119/140 ms

R3#ping 172.30.10.6 source 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.10.6, 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 = 112/115/124 ms

R3#ping 172.30.10.6 source 192.168.2.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.10.6, timeout is 2 seconds:
```

```
Packet sent with a source address of 192.168.2.1
.....
Success rate is 0 percent (0/5)
```

8. Configure redistribution between OSPF and EIGRP.

   8.1. Use the following example to configure router R1 in this lab:

```
R1#
router eigrp 1
 redistribute ospf 1
!
router ospf 1
redistribute eigrp 1 subnets
```

   8.2. Verify that redistribution is successfully configured.

```
R1#show ip eigrp topology
IP-EIGRP Topology Table for AS(1)/ID(10.1.1.1)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.3.3.3/32, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 10.1.1.1/32, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 10.1.110.4/32, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 10.1.110.0/24, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 10.1.110.2/32, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 192.168.1.0/24, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 10.1.113.0/24, 1 successors, FD is 1732096
        via Redistributed (1732096/0)
P 10.1.116.0/24, 1 successors, FD is 2169856
        via Connected, Serial0/0/0.116
P 172.30.24.0/24, 1 successors, FD is 1732096
        via Redistributed (1732096/0)

Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.30.10.0/24, 1 successors, FD is 2172416
        via 10.1.116.6 (2172416/28160), Serial0/0/0.116
P 172.30.13.0/24, 1 successors, FD is 1732096
        via Redistributed (1732096/0)

R4#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 2 subnets
C       172.30.24.0 is directly connected, FastEthernet0/0
O E2    172.30.10.0 [110/20] via 10.1.110.1, 00:03:39, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C       10.4.4.4/32 is directly connected, Loopback0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:03:39, Serial0/0/0.1
C       10.1.110.0/24 is directly connected, Serial0/0/0.1
O       10.1.110.2/32 [110/1] via 172.30.24.2, 00:03:39, FastEthernet0/0
```

```
O E2    10.1.116.0/24 [110/20] via 10.1.110.1, 00:03:39, Serial0/0/0.1
```

9. Configure redistribution between OSPF and RIP.

9.1. Use the following example to configure router R1 in this lab:

```
R1#
router ospf 1
 redistribute rip subnets
!
router rip
redistribute ospf 1
```

9.2. Verify that redistribution is successfully configured.

```
R2#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 3 subnets
C       172.30.24.0 is directly connected, FastEthernet0/0
O E2    172.30.10.0 [110/20] via 10.1.110.1, 00:06:11, Serial0/0/0.1
O E2    172.30.13.0 [110/20] via 10.1.110.1, 00:00:07, Serial0/0/0.1
     10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
C       10.2.2.2/32 is directly connected, Loopback0
O E2    10.3.3.3/32 [110/20] via 10.1.110.1, 00:00:07, Serial0/0/0.1
O E2    10.1.1.1/32 [110/20] via 10.1.110.1, 00:00:07, Serial0/0/0.1
O       10.1.110.4/32 [110/1] via 172.30.24.4, 00:06:11, FastEthernet0/0
O       10.1.110.1/32 [110/64] via 10.1.110.1, 00:06:11, Serial0/0/0.1
C       10.1.110.0/24 is directly connected, Serial0/0/0.1
O E2    10.1.113.0/24 [110/20] via 10.1.110.1, 00:00:07, Serial0/0/0.1
O E2    10.1.116.0/24 [110/20] via 10.1.110.1, 00:06:11, Serial0/0/0.1
O E2 192.168.1.0/24 [110/20] via 10.1.110.1, 00:00:10, Serial0/0/0.1
O E2 192.168.2.0/24 [110/20] via 10.1.110.1, 00:00:10, Serial0/0/0.1
O E2 192.168.3.0/24 [110/20] via 10.1.110.1, 00:00:10, Serial0/0/0.1

R3#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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 10.1.113.1 to network 0.0.0.0

     172.30.0.0/24 is subnetted, 1 subnets
C       172.30.13.0 is directly connected, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C       10.3.3.3/32 is directly connected, Loopback0
R       10.1.1.1/32 [120/1] via 10.1.113.1, 00:00:00, Serial0/0/0.2
R       10.1.110.0/24 [120/1] via 10.1.113.1, 00:00:00, Serial0/0/0.2
C       10.1.113.0/24 is directly connected, Serial0/0/0.2
R       10.1.116.0/24 [120/1] via 10.1.113.1, 00:00:00, Serial0/0/0.2
C    192.168.1.0/24 is directly connected, Loopback31
C    192.168.2.0/24 is directly connected, Loopback32
C    192.168.3.0/24 is directly connected, Loopback33
S*   0.0.0.0/0 [1/0] via 10.1.113.1

R2#ping 172.30.10.6
```



```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.10.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/112 ms

R2#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/112 ms

R2#ping 192.168.2.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/116 ms

R3#ping 172.30.10.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.10.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/115/120 ms

R3#ping 172.30.24.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.24.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/116 ms

R3#ping 172.30.24.2 source 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.24.2, 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 = 112/112/116 ms

R3#ping 172.30.10.6 source 192.168.2.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.10.6, timeout is 2 seconds:
Packet sent with a source address of 192.168.2.1
.....
Success rate is 0 percent (0/5)

R3#ping 172.30.24.2 source 192.168.2.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.24.2, timeout is 2 seconds:
Packet sent with a source address of 192.168.2.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/112/116 ms
```

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Lab 5-1: Configure and Verify Path Control Between Multiple IP Routing Protocols

Complete this lab activity to practice what you learned in the related module.

Activity Objective

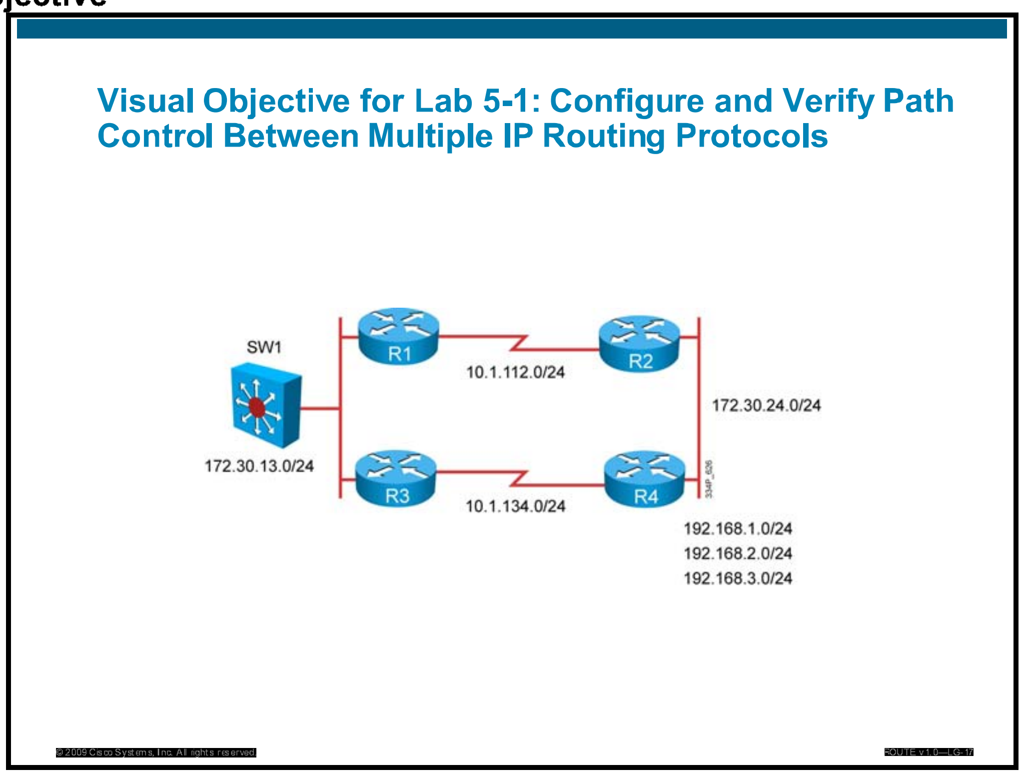
In this activity, you will use correct commands, tools, and steps to configure and verify path control between multiple routing protocols. After completing this activity, you will be able to meet these objectives:

- Configure and verify policy-based routing
- Select the required tools and commands to configure PBR operations
- Make a list of configuration and implementation steps
- Write a verification and test plan to verify the proper implementation and operation according to the expected performance criteria.
- Verify the configuration and operation by using the proper **show** and **debug** commands

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- Begin by deploying the EIGRP routing protocol in your network to achieve full IP connectivity. Routers R1, R2, R3, and R4 will form EIGRP adjacencies and exchange IP routing information to achieve a converged IP routing topology.
- Examine and verify that the EIGRP routing protocol is up and running between routers R1, R2, R3, and R4. Verify that the router R1, R2, R3, and R4 routing tables are populated with the required networks. Examine the path of IP packets sourced from SW1 destined to networks 192.168.1.0/24 and 192.168.2.0/24. Examine the path of IP packets sourced locally from router R2 destined to network 192.168.3.0/24.
- The destination-based forwarding and reachability provided by EIGRP is not sufficient for all traffic. You will deploy source-based IP routing using policy-based routing. You will change default IP routing decisions based on the EIGRP-acquired routing information for selected IP source to IP destination flows and apply a different next hop router. Change the policy on router R3 so that IP traffic that is sourced from switch SW1 IP address 172.30.13.11 and sent to networks 192.168.1.0/24 and 192.168.2.0/24 will select R1 as a next hop. Change the policy on router R1 so that locally originated traffic sent to network 192.168.3.0/24 will select router R3 as the next hop rather than router R2.
- Examine and verify that traffic originated from switch SW1 that is sent to networks 192.168.1.0/24 and 192.168.2.0/24 takes the path R3-R1-R2-R4 using policy-based routing.
- Examine and verify that policy-based routing is in effect on router R3. Verify that traffic originated from switch SW1 that is sent to other networks is not policy routed and takes the path governed by the EIGRP-selected best path. Verify that locally originated traffic on router R1 that is sent to 192.168.3.0/24 travels on the path R3-R4 instead of the path R2-R4. Verify that policy-based routing is in effect on router R1 for locally originated traffic sent to network 192.168.3.0/24 only, and that for the other type of traffic, the normal EIGRP-governed path is selected.

Device Information

The table provides the information specific to each switch in the network:

Device name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
show ip route	Displays whole IP routing table
Router eigrp	Configures the EIGRP process
network (EIGRP)	Specifies the network for an EIGRP routing process
[no] auto-summary (EIGRP)	Allows automatic summarization of subnet routes into network-level routes
debug ip policy	Displays IP policy routing packet activity
route-map	Defines the conditions for redistributing routes from one routing protocol into another, or enables policy routing
ip policy route-map	Identifies a route map to use for policy routing on an interface
trace (privileged)	Discovers the routes that packets will actually take when traveling to their destination
ping	Diagnoses basic network connectivity

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	"Hints" section at the end of this lab
Implementation and verification plan hints	"Hints" section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

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Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirements list. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Device	Implementation Requirement

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Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you can use the information provided in the “Hints” section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the "Hints" section at the end of this lab.

Student Notes:

Alternate Resources and Solutions

Other groups may have implemented a solution different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 5-1 Hint Sheet: Configure and Verify Path Control Between Multiple IP Routing Protocols

Implementation Requirements

To facilitate the configuration of your network, Task 1 asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Define the EIGRP autonomous system number and the interfaces that must be part of the EIGRP	Implementation Policy
ALL	Define networks advertised	Implementation Policy
ALL	Define the preferred path for the packets	Implementation Policy

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load the initial configuration.	All pod routers must be preloaded with the initial configuration for the lab.	Step 1
	R1–R4	2	Configure the EIGRP routing protocol on routers R1, R2, R3, and R4, and on all WAN, LAN, and loopback interfaces.	Examine and verify that the EIGRP routing protocol is up and running between routers R1, R2, R3, and R4 by verifying that the routers have their IP routing tables populated with the required networks.	Step 2
				Examine the path of IP packets sourced from SW1 that are sent to networks 192.168.1.0/24 and 192.168.2.0/24. Verify reachability. Examine the path of IP packets sourced locally from router R2 that are sent to network 192.168.3.0/24.	Step 3

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R3		Change the routing policy on router R3 for the IP traffic sourced from switch SW1 IP address 172.30.13.11 that is sent to networks 192.168.1.0/24 and 192.168.2.0/24 so that router R1 is selected as a next hop.	Examine and verify that traffic originated from switch SW1 that is sent to networks 192.168.1.0/24 and 192.168.2.0/24 takes the path R3-R1-R2-R4 and uses policy-based routing. Examine and verify that policy-based routing is in effect on router R3.	Step 4
	R1		Change the routing policy on router R1 to force the locally originated traffic that is sent to network 192.168.3.0/24 to select router R3 as a next hop instead of router R2.	Examine and verify that locally originated traffic on router R1 that is sent to network 192.168.3.0/24 travels via router path R3-R4 instead of path R2-R4. Verify that policy-based routing is in effect on router R1 for locally originated traffic destined to network 192.168.3.0/24 only, and that for the other type of traffic, the normal EIGRP-governed path is selected.	Step 5

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Implement EIGRP routing.

   2.1. Use the following example to configure the EIGRP routing protocol in the lab.

```
R1#
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary

R2#
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary

R3#
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary

R4#
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 network 192.168.0.0 0.0.255.255
 no auto-summary
```


2.2. Verify that the EIGRP routing protocol is up and running between routers.

```
R1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.24.0 [90/2044416] via 10.1.112.2, 00:01:52, Serial0/0/0.1
C       172.30.13.0 is directly connected, FastEthernet0/0
     10.0.0.0/24 is subnetted, 3 subnets
C       10.1.115.0 is directly connected, Serial0/0/0.4
C       10.1.112.0 is directly connected, Serial0/0/0.1
D       10.1.134.0 [90/2172416] via 172.30.13.3, 00:01:52, FastEthernet0/0
D    192.168.1.0/24 [90/2172416] via 10.1.112.2, 00:01:52, Serial0/0/0.1
D    192.168.2.0/24 [90/2172416] via 10.1.112.2, 00:01:52, Serial0/0/0.1
D    192.168.3.0/24 [90/2172416] via 10.1.112.2, 00:01:52, Serial0/0/0.1

R2#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 2 subnets
C       172.30.24.0 is directly connected, FastEthernet0/0
D       172.30.13.0 [90/2172416] via 10.1.112.1, 00:01:33, Serial0/0/0.1
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.115.0 [90/2681856] via 10.1.112.1, 01:46:07, Serial0/0/0.1
C       10.1.112.0 is directly connected, Serial0/0/0.1
D       10.1.134.0 [90/2172416] via 172.30.24.4, 00:02:07, FastEthernet0/0
D    192.168.1.0/24 [90/156160] via 172.30.24.4, 01:46:47, FastEthernet0/0
D    192.168.2.0/24 [90/156160] via 172.30.24.4, 01:46:47, FastEthernet0/0
D    192.168.3.0/24 [90/156160] via 172.30.24.4, 01:46:47, FastEthernet0/0

R3#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 2 subnets
D       172.30.24.0 [90/2172416] via 10.1.134.4, 00:01:52, Serial0/0/0.3
C       172.30.13.0 is directly connected, FastEthernet0/0
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.115.0 [90/2172416] via 172.30.13.1, 01:46:17, FastEthernet0/0
D       10.1.112.0 [90/2172416] via 172.30.13.1, 00:01:52, FastEthernet0/0
C       10.1.134.0 is directly connected, Serial0/0/0.3
D    192.168.1.0/24 [90/2297856] via 10.1.134.4, 00:01:52, Serial0/0/0.3
D    192.168.2.0/24 [90/2297856] via 10.1.134.4, 00:01:52, Serial0/0/0.3
D    192.168.3.0/24 [90/2297856] via 10.1.134.4, 00:01:52, Serial0/0/0.3
```

```
R4#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 2 subnets
C       172.30.24.0 is directly connected, FastEthernet0/0
D       172.30.13.0 [90/2172416] via 10.1.134.3, 00:02:11, Serial0/0/0.3
     10.0.0.0/24 is subnetted, 3 subnets
D       10.1.115.0 [90/2684416] via 172.30.24.2, 00:02:11, FastEthernet0/0
                   [90/2684416] via 10.1.134.3, 00:02:11, Serial0/0/0.3
D       10.1.112.0 [90/2172416] via 172.30.24.2, 00:02:11, FastEthernet0/0
C       10.1.134.0 is directly connected, Serial0/0/0.3
C    192.168.1.0/24 is directly connected, Loopback31
C    192.168.2.0/24 is directly connected, Loopback32
C    192.168.3.0/24 is directly connected, Loopback33
```

3. Examine the path of the IP packets.

```
sw1#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 58/58/59 ms

sw1#ping 192.168.2.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 58/58/59 ms

sw1#traceroute 192.168.1.1

Type escape sequence to abort.
Tracing the route to 192.168.1.1

  1 172.30.13.3 0 msec 0 msec 0 msec
  2 10.1.134.4 25 msec 25 msec *

sw1#traceroute 192.168.2.1

Type escape sequence to abort.
Tracing the route to 192.168.2.1

  1 172.30.13.3 0 msec 0 msec 0 msec
  2 10.1.134.4 25 msec 25 msec *

R1#ping 192.168.3.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/57/60 ms

R1#trace 192.168.3.1

Type escape sequence to abort.
Tracing the route to 192.168.3.1

  1 10.1.112.2 28 msec 28 msec 28 msec
  2 172.30.24.4 28 msec 28 msec *
```


4. Implement PBR on router R3.

4.1. Use the following example to configure PBR on router R3 in the lab.

```
R3#
interface FastEthernet0/0
 ip policy route-map RM-PBR
!
ip access-list extended ACL-PBR
 permit ip host 172.30.13.11 192.168.1.0 0.0.0.255
 permit ip host 172.30.13.11 192.168.2.0 0.0.0.255
!
route-map RM-PBR permit 10
 match ip address ACL-PBR
 set ip next-hop 172.30.13.1
```

4.2. Verify the traffic flow from switch SW1 and PBR on R3.

```
sw1#trace 192.168.1.1

Type escape sequence to abort.
Tracing the route to 192.168.1.1

  1 172.30.13.3 0 msec 0 msec 0 msec
  2 172.30.13.1 0 msec 0 msec 0 msec
  3 10.1.112.2 25 msec 25 msec 25 msec
  4 172.30.24.4 34 msec 25 msec *

R3#debug ip policy
Policy routing debugging is on
```

Note	Enable debugging in order to see the policy macth following the **ping** commands on pod switch SW1.

```
sw1#ping 192.168.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 51/58/67 ms

R3#
*May 24 14:14:49.025: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.1.1, len
100, FIB policy match
*May 24 14:14:49.025: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.1.1, len
100, policy match
*May 24 14:14:49.025: IP: route map RM-PBR, item 10, permit
*May 24 14:14:49.025: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.1.1
(FastEthernet0/0), len 100, policy routed
*May 24 14:14:49.025: IP: FastEthernet0/0 to FastEthernet0/0 172.30.13.1
*May 24 14:14:49.085: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.1.1, len
100, FIB policy match
*May 24 14:14:49.085: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.1.1,
g=172.30.13.1, len 100, FIB policy routed
*May 24 14:14:49.145: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.1.1, len
100, FIB policy match
*May 24 14:14:49.145: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.1.1,
g=172.30.13.1, len 100, FIB policy routed

sw1#ping 192.168.3.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 50/57/59 ms

R3#
*May 24 14:15:16.645: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.3.1, len
100, FIB policy rejected(no match) - normal forwarding
```

```
*May 24 14:15:16.645: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.3.1
(FastEthernet0/0), len 100, policy rejected -- normal forwarding
*May 24 14:15:16.705: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.3.1, len
100, FIB policy rejected(no match) - normal forwarding
*May 24 14:15:16.765: IP: s=172.30.13.11 (FastEthernet0/0), d=192.168.3.1, len
100, FIB policy rejected(no match) - normal forwarding
```

5. Implement PBR on router R1.

5.1. Use the following example to configure PBR on router R1 in the lab.

```
R1#
ip local policy route-map RM-LOCAL-PBR
!
ip access-list extended ACL-LOCAL-PBR
 permit ip any 192.168.3.0 0.0.0.255
!
route-map RM-LOCAL-PBR permit 10
 match ip address ACL-LOCAL-PBR
 set ip next-hop 172.30.13.3
```

5.2. Verify the traffic flow and PBR on R1.

```
R1#ping 192.168.3.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/57/60 ms

R1#traceroute 192.168.3.1
Type escape sequence to abort.
Tracing the route to 192.168.3.1

  1 172.30.13.3 0 msec 0 msec 0 msec
  2 172.30.13.1 36 msec 32 msec 32 msec
  3 10.1.112.2 28 msec 28 msec 28 msec
  4 172.30.24.4 28 msec 28 msec *

R1#debug ip policy
Policy routing debugging is on
```

Note	Enable debugging in order to see the policy match following the **ping** commands on pod router R1.

```
R1#ping 192.168.3.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/58/60 ms

R1#
*May 24 14:28:08.341: IP: s=10.1.112.1 (local), d=192.168.3.1, len 100, policy
match
*May 24 14:28:08.341: IP: route map RM-LOCAL-PBR, item 10, permit
*May 24 14:28:08.341: IP: s=10.1.112.1 (local), d=192.168.3.1
(FastEthernet0/0), len 100, policy routed
*May 24 14:28:08.341: IP: local to FastEthernet0/0 172.30.13.3
*May 24 14:28:08.401: IP: s=10.1.112.1 (local), d=192.168.3.1, len 100, policy
match
*May 24 14:28:08.401: IP: route map RM-LOCAL-PBR, item 10, permit
*May 24 14:28:08.401: IP: s=10.1.112.1 (local), d=192.168.3.1
(FastEthernet0/0), len 100, policy routed
*May 24 14:28:08.401: IP: local to FastEthernet0/0 172.30.13.3
```



```
*May 24 14:28:08.457: IP: s=10.1.112.1 (local), d=192.168.3.1, len 100, policy
match
*May 24 14:28:08.457: IP: route map RM-LOCAL-PBR, item 10, permit
*May 24 14:28:08.457: IP: s=10.1.112.1 (local), d=192.168.3.1
(FastEthernet0/0), len 100, policy routed
*May 24 14:28:08.457: IP: local to FastEthernet0/0 172.30.13.3
*May 24 14:28:08.517: IP: s=10.1.112.1 (local), d=192.168.3.1, len 100, policy
match

R1#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/56/60 ms

R1#
*May 24 14:28:18.977: IP: s=10.1.112.1 (local), d=192.168.1.1, len 100, policy
rejected -- normal forwarding
*May 24 14:28:19.033: IP: s=10.1.112.1 (local), d=192.168.1.1, len 100, policy
rejected -- normal forwarding
*May 24 14:28:19.093: IP: s=10.1.112.1 (local), d=192.168.1.1, len 100, policy
rejected -- normal forwarding
*May 24 14:28:19.149: IP: s=10.1.112.1 (local), d=192.168.1.1, len 100, policy
rejected -- normal forwarding
*May 24 14:28:19.205: IP: s=10.1.112.1 (local), d=192.168.1.1, len 100, policy
rejected -- normal forwarding
```

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Lab 6-1: Configure BGP Operations

Complete this lab activity to practice what you learned in the related module.

Activity Objective

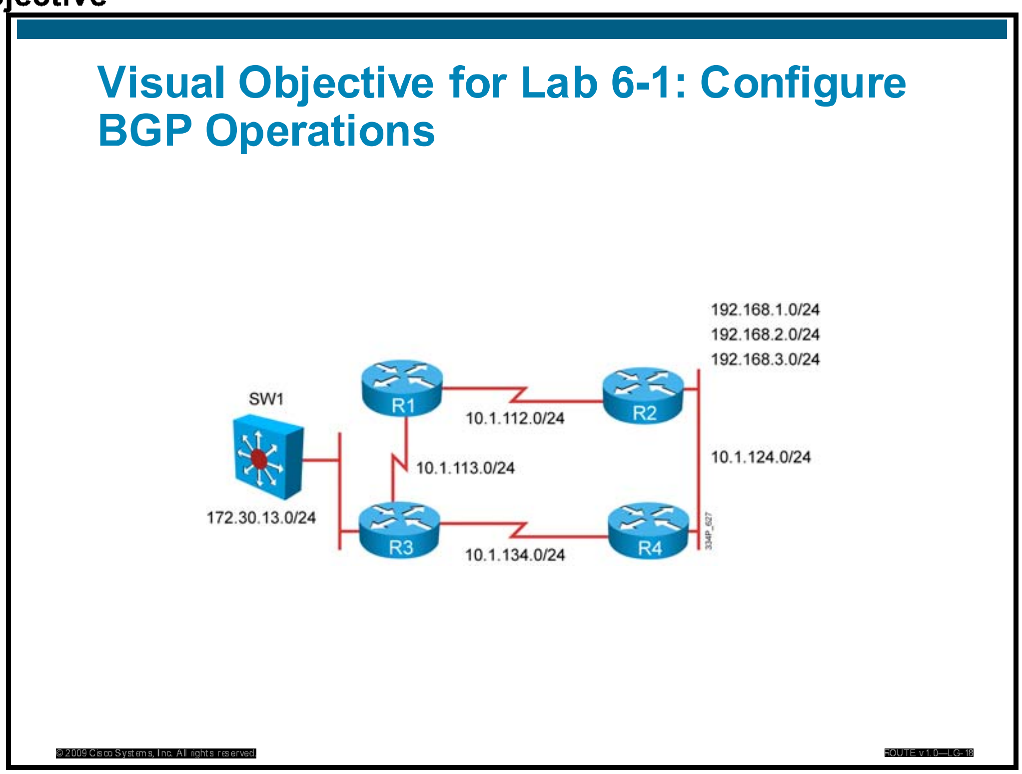
In this activity, you will use correct commands, tools, and steps to configure and verify BGP operations. After completing this activity, you will be able to meet these objectives:

- Configure and verify multihomed ISP connections
- Configure EBGP on the enterprise router to connect to the two ISPs
- Select the required tools and commands to configure EBGP operations
- Make a list of configuration and implementation steps
- Write a verification and test plan to verify the proper implementation and operation according to the expected performance criteria
- Verify the configuration and operation by using the proper **show** and **debug** commands

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- Your first task will be to deploy the EBGP routing protocol in your pod. The network topology should consist of the following BGP autonomous systems:
  - AS 130 with router R3 and switch SW1 as members
  - AS 100 with router R1 as a member
  - AS 200 with router R2 as a member
  - AS 400 with router R4 as a member

  AS 130 will have EBGP sessions to AS 100 and AS 200 in order to receive IP information about the networks in AS 200.
- Examine and verify that EBGP sessions have been set up and that the neighbors are ready to exchange IP routing information. Examine and verify that the EBGP session between router R3, R1, and R4 uses strong authentication.
- Configure the routers to announce selected networks via the BGP routing protocol to exchange IP routing information. The following should be done in order to announce the required routing information:
  - Announce the 172.30.13.0/24 network from router R3
  - Announce the 10.3.3.3/32 network from router R3
  - Announce the 192.168.1.0/24, 192.168.2.0/24, and 192.168.3.0/24 networks from router R2

Device Information

The table provides the information specific to each switch in the network:

Device name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
router bgp	Configures the BGP routing process
[no] synchronization	Enables the synchronization between BGP and the Interior Gateway Protocol (IGP) system
bgp log-neighbor-changes	Enables logging of BGP neighbor resets
[no]auto-summary (BGP)	Configures automatic summarization of subnet routes into network-level routes
neighbor remote-as	Adds an entry to the BGP or multiprotocol BGP neighbor table
neighbor password	Enables Message Digest 5 (MD5) authentication on a TCP connection between two BGP peers
Show ip bgp summary	Displays the status of all BGP connections
show ip bgp neighbors	Displays information about BGP and TCP connections to neighbors
show ip bgp	Displays entries in the Border Gateway Protocol (BGP) routing table
network (BGP and multiprotocol BGP)	Specifies the networks to be advertised by the BGP and multiprotocol BGP routing processes
redistribute (IP)	Redistributes routes from one routing domain into another routing domain
route-map	Defines the conditions for redistributing routes from one routing protocol into another, or enables policy routing
aggregate-address	Creates an aggregate entry in a BGP database

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	"Hints" section at the end of this lab
Implementation and verification plan hints	"Hints" section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirement list. If you are unsure, you can use the information provided in the “Hints” section at the end of this lab.

Device	Implementation Requirement

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Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the "Hints" section at the end of this lab.

Student Notes:

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Alternate Resources and Solutions

Other groups may have implemented a solution different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 6-1 Hint Sheet: Configure BGP Operations

Implementation Requirements

To facilitate the configuration of your network, Task 1 asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Define BGP autonomous system numbers and assign them to routers	Implementation Policy
ALL	Define the networks that will be advertised	Implementation Policy Visual Objective

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load the initial configuration.	All pod routers must be preloaded with the initial configuration for the lab.	Step 1

Complete √	Device	Order	Values and items to Implement	Verification Method and Expected Results	Step
	R1–R4		Enable BGP routing protocol on routers R1, R2, R3, and R4 and configure the following EBGP sessions: ■ AS 130 to AS 100 between routers R3 and R1 ■ AS 130 to AS 400 between routers R3 and R4 ■ AS 200 to AS 100 between routers R2 and R1 ■ AS 200 to AS 400 between routers R2 and R4 The BGP sessions between AS 130, AS 100, and AS 400 should be authenticated using the strongest possible authentication.	Examine and verify that EBGP sessions have been set up and that the neighbors are ready to exchange IP routing information. Examine and verify that the EBGP session between router R3, R1, and R4 uses strong authentication.	Step 2
	R3		Enable router R3 to announce the connected network 172.30.13.0/24 to the neighboring autonomous systems via the EBGP sessions you set up in the previous task. The network should not be redistributed into BGP. Configure router R3 to announce the loopback network 10.3.3.3/32 to the neighboring autonomous systems 100 and 200 via the EBGP network. The network should be redistributed into BGP.		Step 3
	R2		Configure router R2 to announce the 192.168.x.0/24 subnets to the neighboring autonomous systems via BGP. Instead of announcing individual 192.168.x.0/24 subnets, announce the 192.168.0.0/16 major network. The summary route should be advertised if at least one of the 192.168.x.0/24 subnets are present in the IP routing table of router R2.	Verify that routers R1, R2, and R4 have information about the 172.30.13.0/24 and 10.3.3.3/32 networks in their BGP and IP routing tables. Verify that routers R1, R3, and R4 have information about the 192.168.0.0/16 summary route in their BGP and IP routing tables.	Step 3

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration on all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Configure EBGP.

   2.1. Use the following example to configure the routers in this lab:

```
R1#
router bgp 100
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.112.2 remote-as 200
 neighbor 10.1.113.3 remote-as 130
 neighbor 10.1.113.3 password cisco
 no auto-summary

R2#
router bgp 200
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.112.1 remote-as 100
 neighbor 10.1.124.4 remote-as 400
 no auto-summary

R3#
router bgp 130
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.113.1 remote-as 100
 neighbor 10.1.113.1 password cisco
 neighbor 10.1.134.4 remote-as 400
 neighbor 10.1.134.4 password cisco
 no auto-summary

R4#
router bgp 400
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.124.2 remote-as 200
 neighbor 10.1.134.3 remote-as 130
 neighbor 10.1.134.3 password cisco
 no auto-summary
```

   2.2. Verify that EBGP sessions have been set up.

```
R1#show ip bgp summary
BGP router identifier 10.1.113.1, local AS number 100
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.112.2      4   200       4       4        1    0    0 00:00:35        0
10.1.113.3      4   130      13      13        1    0    0 00:05:29        0

R2#show ip bgp summary
BGP router identifier 192.168.3.1, local AS number 200
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.112.1      4   100       5       5        1    0    0 00:01:14        0
10.1.124.4      4   400      10      10        1    0    0 00:07:19        0

R3#show ip bgp summary
```

```
BGP router identifier 10.3.3.3, local AS number 130
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.113.1      4   100      14      14        1    0    0 00:06:36        0
10.1.134.4      4   400      14      14        1    0    0 00:06:36        0

R4#show ip bgp summary
BGP router identifier 10.1.134.4, local AS number 400
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.124.2      4   200      11      11        1    0    0 00:08:22        0
10.1.134.3      4   130      15      15        1    0    0 00:07:11        0

R1#show ip bgp neighbors
BGP neighbor is 10.1.112.2,  remote AS 200, external link
  BGP version 4, remote router ID 192.168.3.1
  BGP state = Established, up for 00:03:03
  Last read 00:00:03, last write 00:00:03, hold time is 180, keepalive
interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  1          1
    Notifications:          0          0
    Updates:                0          0
    Keepalives:             6          6
    Route Refresh:          0          0
    Total:                  7          7
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 1, neighbor version 1/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                                 Sent       Rcvd
  Prefix activity:               ----       ----
    Prefixes Current:               0          0
    Prefixes Total:                 0          0
    Implicit Withdraw:              0          0
    Explicit Withdraw:              0          0
    Used as bestpath:             n/a          0
    Used as multipath:            n/a          0

                                   Outbound    Inbound
  Local Policy Denied Prefixes:    --------    -------
    Total:                                0          0
  Number of NLRIs in the update sent: max 0, min 0

  Connections established 1; dropped 0
  Last reset never
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.112.1, Local port: 11663
Foreign host: 10.1.112.2, Foreign port: 179

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

Event Timers (current time is 0xCF33BF5C):
Timer          Starts    Wakeups            Next
```

```
Retrans           7         0            0x0
TimeWait          0         0            0x0
AckHold           5         1            0x0
SendWnd           0         0            0x0
KeepAlive         0         0            0x0
GiveUp            0         0            0x0
PmtuAger          0         0            0x0
DeadWait          0         0            0x0

iss: 2989442931  snduna: 2989443091  sndnxt: 2989443091     sndwnd:  16225
irs: 1800635018  rcvnxt: 1800635178  rcvwnd:      16225  delrcvwnd:    159

SRTT: 182 ms, RTTO: 1073 ms, RTV: 891 ms, KRTT: 0 ms
minRTT: 28 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: active open, nagle
IP Precedence value : 6

Datagrams (max data segment is 1460 bytes):
Rcvd: 10 (out of order: 0), with data: 5, total data bytes: 159
Sent: 9 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion:
0), with data: 6, total data bytes: 159

BGP neighbor is 10.1.113.3,  remote AS 130, external link
  BGP version 4, remote router ID 10.3.3.3
  BGP state = Established, up for 00:08:00
  Last read 00:00:59, last write 00:00:59, hold time is 180, keepalive
interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  2          2
    Notifications:          0          0
    Updates:                0          0
    Keepalives:            13         13
    Route Refresh:          0          0
    Total:                 15         15
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 1, neighbor version 1/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                                 Sent       Rcvd
  Prefix activity:               ----       ----
    Prefixes Current:               0          0
    Prefixes Total:                 0          0
    Implicit Withdraw:              0          0
    Explicit Withdraw:              0          0
    Used as bestpath:             n/a          0
    Used as multipath:            n/a          0

                                   Outbound    Inbound
  Local Policy Denied Prefixes:    --------    -------
    Total:                                0          0
  Number of NLRIs in the update sent: max 0, min 0

  Connections established 2; dropped 1
  Last reset 00:08:02, due to Peer closed the session
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.113.1, Local port: 179
Foreign host: 10.1.113.3, Foreign port: 41736
```

```
Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

Event Timers (current time is 0xCF33D1E8):
Timer          Starts    Wakeups            Next
Retrans            11          0             0x0
TimeWait            0          0             0x0
AckHold            11          9             0x0
SendWnd             0          0             0x0
KeepAlive           0          0             0x0
GiveUp              0          0             0x0
PmtuAger            0          0             0x0
DeadWait            0          0             0x0

iss: 3696661118  snduna: 3696661373  sndnxt: 3696661373     sndwnd:  16130
irs: 2118041417  rcvnxt: 2118041672  rcvwnd:      16130  delrcvwnd:    254

SRTT: 231 ms, RTTO: 769 ms, RTV: 538 ms, KRTT: 0 ms
minRTT: 40 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: passive open, nagle, gen tcbs, md5
IP Precedence value : 6

Datagrams (max data segment is 1440 bytes):
Rcvd: 22 (out of order: 0), with data: 11, total data bytes: 254
Sent: 20 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion:
0), with data: 10, total data bytes: 254

R2#show ip bgp neihbors
BGP neighbor is 10.1.112.1,  remote AS 100, external link
  BGP version 4, remote router ID 10.1.113.1
  BGP state = Established, up for 00:03:10
  Last read 00:00:10, last write 00:00:10, hold time is 180, keepalive
interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  1          1
    Notifications:          0          0
    Updates:                0          0
    Keepalives:             6          6
    Route Refresh:          0          0
    Total:                  7          7
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 1, neighbor version 1/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                                 Sent       Rcvd
  Prefix activity:               ----       ----
    Prefixes Current:               0          0
    Prefixes Total:                 0          0
    Implicit Withdraw:              0          0
    Explicit Withdraw:              0          0
    Used as bestpath:             n/a          0
    Used as multipath:            n/a          0

                                   Outbound    Inbound
  Local Policy Denied Prefixes:    --------    -------
    Total:                                0          0
  Number of NLRIs in the update sent: max 0, min 0

  Connections established 1; dropped 0
  Last reset never
```



```
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.112.2, Local port: 179
Foreign host: 10.1.112.1, Foreign port: 11663

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

Event Timers (current time is 0xCF337EE4):
Timer          Starts    Wakeups            Next
Retrans             6          0             0x0
TimeWait            0          0             0x0
AckHold             6          4             0x0
SendWnd             0          0             0x0
KeepAlive           0          0             0x0
GiveUp              0          0             0x0
PmtuAger            0          0             0x0
DeadWait            0          0             0x0

iss: 1800635018  snduna: 1800635178  sndnxt: 1800635178     sndwnd:  16225
irs: 2989442931  rcvnxt: 2989443091  rcvwnd:      16225  delrcvwnd:    159

SRTT: 165 ms, RTTO: 1172 ms, RTV: 1007 ms, KRTT: 0 ms
minRTT: 28 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: passive open, nagle, gen tcbs
IP Precedence value : 6

Datagrams (max data segment is 1460 bytes):
Rcvd: 9 (out of order: 0), with data: 6, total data bytes: 159
Sent: 10 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion:
0), with data: 5, total data bytes: 159
```

BGP neighbor is 10.1.124.4, remote AS 400, external link

```
  BGP version 4, remote router ID 10.1.134.4
  BGP state = Established, up for 00:09:18
  Last read 00:00:18, last write 00:00:18, hold time is 180, keepalive
interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  1          1
    Notifications:          0          0
    Updates:                0          0
    Keepalives:            11         11
    Route Refresh:          0          0
    Total:                 12         12
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 1, neighbor version 1/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                                 Sent       Rcvd
  Prefix activity:               ----       ----
    Prefixes Current:               0          0
    Prefixes Total:                 0          0
    Implicit Withdraw:              0          0
    Explicit Withdraw:              0          0
    Used as bestpath:             n/a          0
    Used as multipath:            n/a          0

                                   Outbound    Inbound
  Local Policy Denied Prefixes:    --------    -------
    Total:                                0          0
```

```
  Number of NLRIs in the update sent: max 0, min 0

  Connections established 1; dropped 0
  Last reset never
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.124.2, Local port: 16876
Foreign host: 10.1.124.4, Foreign port: 179

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

Event Timers (current time is 0xCF339128):
Timer          Starts    Wakeups            Next
Retrans            13          0             0x0
TimeWait            0          0             0x0
AckHold            11          0             0x0
SendWnd             0          0             0x0
KeepAlive           0          0             0x0
GiveUp              0          0             0x0
PmtuAger            0          0             0x0
DeadWait            0          0             0x0

iss: 1923157603  snduna: 1923157858  sndnxt: 1923157858     sndwnd:  16130
irs: 3896442338  rcvnxt: 3896442593  rcvwnd:      16130  delrcvwnd:    254

SRTT: 247 ms, RTTO: 663 ms, RTV: 416 ms, KRTT: 0 ms
minRTT: 0 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: active open, nagle
IP Precedence value : 6

Datagrams (max data segment is 1460 bytes):
Rcvd: 23 (out of order: 0), with data: 11, total data bytes: 254
Sent: 14 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion:
0), with data: 12, total data bytes: 254

R3#show ip bgp neighbors
BGP neighbor is 10.1.113.1,  remote AS 100, external link
  BGP version 4, remote router ID 10.1.113.1
  BGP state = Established, up for 00:08:10
  Last read 00:00:09, last write 00:00:09, hold time is 180, keepalive
interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                        Sent       Rcvd
    Opens:                 2          2
    Notifications:         0          0
    Updates:               0          0
    Keepalives:           14         14
    Route Refresh:         0          0
    Total:                16         16
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 1, neighbor version 1/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                                Sent       Rcvd
  Prefix activity:              ----       ----
    Prefixes Current:              0          0
    Prefixes Total:                0          0
    Implicit Withdraw:             0          0
    Explicit Withdraw:             0          0
    Used as bestpath:            n/a          0
```

```
    Used as multipath:           n/a         0

                                  Outbound    Inbound
  Local Policy Denied Prefixes:    --------    -------
    Total:                              0          0
  Number of NLRIs in the update sent: max 0, min 0

  Connections established 2; dropped 1
  Last reset 00:08:10, due to User reset
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.113.3, Local port: 41736
Foreign host: 10.1.113.1, Foreign port: 179

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

Event Timers (current time is 0xCF329F18):
Timer          Starts    Wakeups            Next
Retrans            12          0             0x0
TimeWait            0          0             0x0
AckHold            10          9             0x0
SendWnd             0          0             0x0
KeepAlive           0          0             0x0
GiveUp              0          0             0x0
PmtuAger            0          0             0x0
DeadWait            0          0             0x0

iss: 2118041417  snduna: 2118041672  sndnxt: 2118041672     sndwnd:  16130
irs: 3696661118  rcvnxt: 3696661373  rcvwnd:      16130  delrcvwnd:    254

SRTT: 239 ms, RTTO: 712 ms, RTV: 473 ms, KRTT: 0 ms
minRTT: 40 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: active open, nagle, md5
IP Precedence value : 6

Datagrams (max data segment is 1440 bytes):
Rcvd: 20 (out of order: 0), with data: 10, total data bytes: 254
Sent: 22 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion:
0), with data: 11, total data bytes: 254

BGP neighbor is 10.1.134.4,  remote AS 400, external link
  BGP version 4, remote router ID 10.1.134.4
  BGP state = Established, up for 00:08:11
  Last read 00:00:11, last write 00:00:11, hold time is 180, keepalive
interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  2          2
    Notifications:          0          0
    Updates:                0          0
    Keepalives:            14         14
    Route Refresh:          0          0
    Total:                 16         16
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 1, neighbor version 1/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                                 Sent       Rcvd
  Prefix activity:               ----       ----
    Prefixes Current:               0          0
```

```
    Prefixes Total:                0         0
    Implicit Withdraw:             0         0
    Explicit Withdraw:             0         0
    Used as bestpath:            n/a         0
    Used as multipath:           n/a         0

                                 Outbound    Inbound
  Local Policy Denied Prefixes:    --------    -------
    Total:                               0          0
  Number of NLRIs in the update sent: max 0, min 0

  Connections established 2; dropped 1
  Last reset 00:08:15, due to User reset
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.134.3, Local port: 60976
Foreign host: 10.1.134.4, Foreign port: 179

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

Event Timers (current time is 0xCF32B158):
Timer          Starts    Wakeups            Next
Retrans            12          0             0x0
TimeWait            0          0             0x0
AckHold            10          0             0x0
SendWnd             0          0             0x0
KeepAlive           0          0             0x0
GiveUp              0          0             0x0
PmtuAger            0          0             0x0
DeadWait            0          0             0x0

iss: 4003509121  snduna: 4003509376  sndnxt: 4003509376     sndwnd:  16130
irs:  489762982  rcvnxt:  489763237  rcvwnd:      16130  delrcvwnd:    254

SRTT: 239 ms, RTTO: 712 ms, RTV: 473 ms, KRTT: 0 ms
minRTT: 40 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: active open, nagle, md5
IP Precedence value : 6

Datagrams (max data segment is 1440 bytes):
Rcvd: 20 (out of order: 0), with data: 10, total data bytes: 254
Sent: 13 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion:
0), with data: 11, total data bytes: 254

R4#show ip bgp neighbors
BGP neighbor is 10.1.124.2,  remote AS 200, external link
  BGP version 4, remote router ID 192.168.3.1
  BGP state = Established, up for 00:09:25
  Last read 00:00:25, last write 00:00:25, hold time is 180, keepalive
interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  1          1
    Notifications:          0          0
    Updates:                0          0
    Keepalives:            11         11
    Route Refresh:          0          0
    Total:                 12         12
  Default minimum time between advertisement runs is 30 seconds

 For address family: IPv4 Unicast
  BGP table version 1, neighbor version 1/0
 Output queue size : 0
```

```
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                               Sent       Rcvd
  Prefix activity:             ----       ----
    Prefixes Current:             0          0
    Prefixes Total:               0          0
    Implicit Withdraw:            0          0
    Explicit Withdraw:            0          0
    Used as bestpath:           n/a          0
    Used as multipath:          n/a          0

                                 Outbound    Inbound
  Local Policy Denied Prefixes:  --------    -------
    Total:                              0          0
  Number of NLRIs in the update sent: max 0, min 0

  Connections established 1; dropped 0
  Last reset never
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.124.4, Local port: 179
Foreign host: 10.1.124.2, Foreign port: 16876

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

Event Timers (current time is 0xCF32B9B4):
Timer          Starts    Wakeups            Next
Retrans            12          0             0x0
TimeWait            0          0             0x0
AckHold            12         11             0x0
SendWnd             0          0             0x0
KeepAlive           0          0             0x0
GiveUp              0          0             0x0
PmtuAger            0          0             0x0
DeadWait            0          0             0x0

iss: 3896442338  snduna: 3896442593  sndnxt: 3896442593     sndwnd:  16130
irs: 1923157603  rcvnxt: 1923157858  rcvwnd:      16130  delrcvwnd:    254

SRTT: 239 ms, RTTO: 712 ms, RTV: 473 ms, KRTT: 0 ms
minRTT: 0 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: passive open, nagle, gen tcbs
IP Precedence value : 6

Datagrams (max data segment is 1460 bytes):
Rcvd: 14 (out of order: 0), with data: 12, total data bytes: 254
Sent: 23 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion:
0), with data: 11, total data bytes: 254

BGP neighbor is 10.1.134.3,  remote AS 130, external link
  BGP version 4, remote router ID 10.3.3.3
  BGP state = Established, up for 00:08:16
  Last read 00:00:15, last write 00:00:15, hold time is 180, keepalive
interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  2          2
    Notifications:          0          0
    Updates:                0          0
    Keepalives:            14         14
    Route Refresh:          0          0
    Total:                 16         16
  Default minimum time between advertisement runs is 30 seconds
```

```
 For address family: IPv4 Unicast
  BGP table version 1, neighbor version 1/0
 Output queue size : 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                               Sent       Rcvd
  Prefix activity:             ----       ----
    Prefixes Current:             0          0
    Prefixes Total:               0          0
    Implicit Withdraw:            0          0
    Explicit Withdraw:            0          0
    Used as bestpath:           n/a          0
    Used as multipath:          n/a          0

                                 Outbound    Inbound
  Local Policy Denied Prefixes:    --------    -------
    Total:                              0          0
  Number of NLRIs in the update sent: max 0, min 0

  Connections established 2; dropped 1
  Last reset 00:08:18, due to Peer closed the session
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 1
Local host: 10.1.134.4, Local port: 179
Foreign host: 10.1.134.3, Foreign port: 60976

Enqueued packets for retransmit: 0, input: 0  mis-ordered: 0 (0 bytes)

Event Timers (current time is 0xCF32CBF8):
Timer          Starts    Wakeups            Next
Retrans            11          0             0x0
TimeWait            0          0             0x0
AckHold            11          9             0x0
SendWnd             0          0             0x0
KeepAlive           0          0             0x0
GiveUp              0          0             0x0
PmtuAger            0          0             0x0
DeadWait            0          0             0x0

iss:  489762982  snduna:  489763237  sndnxt:  489763237     sndwnd:  16130
irs: 4003509121  rcvnxt: 4003509376  rcvwnd:      16130  delrcvwnd:    254

SRTT: 231 ms, RTTO: 769 ms, RTV: 538 ms, KRTT: 0 ms
minRTT: 40 ms, maxRTT: 300 ms, ACK hold: 200 ms
Flags: passive open, nagle, gen tcbs, md5
IP Precedence value : 6

Datagrams (max data segment is 1440 bytes):
Rcvd: 13 (out of order: 0), with data: 11, total data bytes: 254
Sent: 20 (retransmit: 0, fastretransmit: 0, partialack: 0, Second Congestion:
0), with data: 10, total data bytes: 254
```

3. Announce networks into BGP.

3.1. Use the following example to configure router R3 in this lab:

```
R3#
router bgp 130
 network 172.30.13.0 mask 255.255.255.0
 redistribute connected route-map RM-BGP
!
ip access-list standard ACL-BGP
 permit 10.3.3.3
!
!
route-map RM-BGP permit 10
 match ip address ACL-BGP
```

3.2. Use the following example to configure router R2 in this lab.

```
R2#
router bgp 200
 network 192.168.1.0
 network 192.168.2.0
 network 192.168.3.0
 aggregate-address 192.168.0.0 255.255.0.0 summary-only
```

3.3. Verify the BGP table in order to see announced routes.

```
R1#show ip bgp
BGP table version is 4, local router ID is 10.1.113.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  10.3.3.3/32      10.1.112.2                             0 200 400 130 ?
*>                  10.1.113.3               0             0 130 ?
*  172.30.13.0/24   10.1.112.2                             0 200 400 130 i
*>                  10.1.113.3               0             0 130 i
*  192.168.0.0/16   10.1.113.3                             0 130 400 200 i
*>                  10.1.112.2               0             0 200 i

R2#show ip bgp
BGP table version is 10, local router ID is 192.168.3.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  10.3.3.3/32      10.1.112.1                             0 100 130 ?
*>                  10.1.124.4                             0 400 130 ?
*  172.30.13.0/24   10.1.112.1                             0 100 130 i
*>                  10.1.124.4                             0 400 130 i
*> 192.168.0.0/16   0.0.0.0                            32768 i
s> 192.168.1.0      0.0.0.0                  0         32768 i
s> 192.168.2.0      0.0.0.0                  0         32768 i
s> 192.168.3.0      0.0.0.0                  0         32768 i

R3#show ip bgp
BGP table version is 4, local router ID is 10.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i -
              internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 10.3.3.3/32      0.0.0.0                  0         32768 ?
*> 172.30.13.0/24   0.0.0.0                  0         32768 i
*  192.168.0.0/16   10.1.113.1                             0 100 200 i
*>                  10.1.134.4                             0 400 200 i

R4#show ip bgp
BGP table version is 22, local router ID is 10.1.134.4
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  10.3.3.3/32      10.1.124.2                             0 200 100 130 ?
*>                  10.1.134.3               0             0 130 ?
*  172.30.13.0/24   10.1.124.2                             0 200 100 130 i
*>                  10.1.134.3               0             0 130 i
*> 192.168.0.0/16   10.1.124.2               0             0 200 i
```

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Lab 6-2: Manipulate EBGP Path Selections

Complete this lab activity to practice what you learned in the related module.

Activity Objective

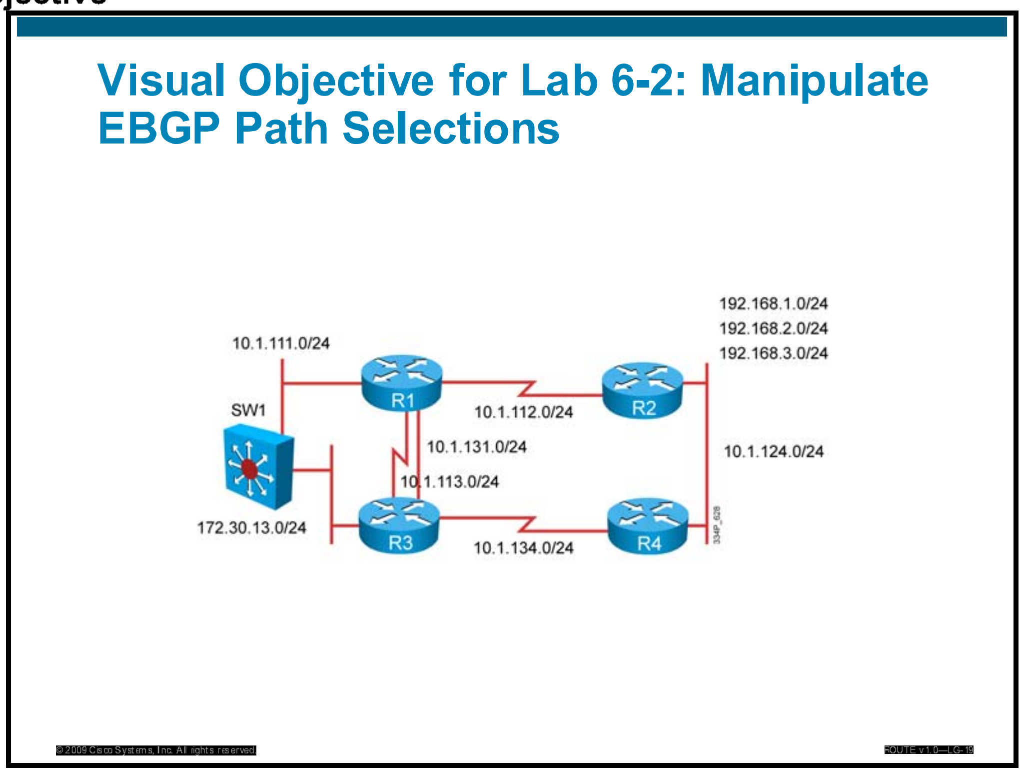
In this activity, you will use correct commands, tools, and steps to manipulate EBGP path selections. After completing this activity, you will be able to meet these objectives:

- Configure and verify policy-based routing
- Select the required tools and commands to configure PBR operations
- Make a list of configuration and implementation steps
- Write a verification and test plan to verify the proper implementation and operation according to the expected performance criteria.
- Verify the configuration and operation by using the proper **show** and **debug** commands

Information Packet

The figure illustrates what you will accomplish in this activity.

Visual Objective



Implementation Policy

The following list details the configuration requirements for all devices in the company network:

- In this task you will deploy the EBGP routing protocol in your pod. The network topology should consist of the following BGP autonomous systems:

— AS 130 with router R3 and switch SW1 as members

— AS 100 with router R1 as a member

— AS 200 with router R2 as a member

— AS 400 with router R4 as a member

AS 130 will have EBGP sessions to AS 100 in order to receive IP information about the networks in AS 200. AS 200 should have EBGP sessions to AS 100 and AS 400 to exchange IP routing information. Change the default BGP path selection for the traffic from AS 103 that are sent to networks originated from AS 200. Change the primary path for the traffic that is returning to AS 130.

- Examine the EBGP adjacencies and verify that adjacencies are set up between the routers R1, R2, R3, and R4. Verify that the router IP routing tables are populated with the required networks. Examine the path of IP packets sourced from AS 130 that are sent to networks in AS 200. Examine the path of IP packets returning to AS 130 from AS 200.
- Deploy additional EBGP sessions in your pod. Establish the following additional EBGP adjacencies:

— AS 130 to AS 100 between switch SW1 and router R1

— AS 130 to AS 400 between routers R3 and R4

— AS 130 between router R3 and switch SW1

Delete the following EBGP sessions:

— AS 130 to AS 100 between routers R3 and R1

Influence AS 130 path selection to select the primary path out of the AS via router R4 in AS 400. Influence the path of the traffic coming into AS 130 from AS 200. The path via router R1 should be preferred.

- Examine the EBGP adjacencies and verify they are set up between the routers. Verify that the routers have their IP routing tables populated with the required networks. Examine the primary path out of AS 130. Examine and verify the path of IP packets coming into AS 130.

Device Information

The table provides the information specific to each switch in the network:

Device name	Role			
R1	POD router			
R2	POD router			
R3	POD router			
R4	POD router			
BBR2	Backbone router			

Command List

The table describes the commands that are used in this activity.

Command	Description
router bgp	Configures the BGP routing process
[no] synchronization	Enables the synchronization between BGP and your Interior Gateway Protocol (IGP) system
bgp log-neighbor-changes	Enables logging of BGP neighbor resets
[no]auto-summary (BGP)	Configures automatic summarization of subnet routes into network-level routes
neighbor remote-as	Adds an entry to the BGP or multiprotocol BGP neighbor table
show ip bgp summary	Displays the status of all BGP connections
show ip bgp	Displays entries in the Border Gateway Protocol (BGP) routing table
network (BGP and multiprotocol BGP)	Specifies the networks to be advertised by the BGP and multiprotocol BGP routing processes
show ip route	Displays whole IP routing table
neighbor route-map	Applys a route map to incoming or outgoing routes
route-map	Defines the conditions for redistributing routes from one routing protocol into another, or enables policy routing

Required Resources

These are the resources and equipment that are required to complete this activity:

- A PC that is connected to an on-site laboratory or a PC with an Internet connection if remote laboratory equipment must be accessed
- A terminal server that is connected to the console port of each laboratory device, if using a remote laboratory
- Core and access switches in your pod

Job Aids

These are the job aids for this lab activity:

Value	Location
Blank implementation requirements list	Task 1
Blank implementation and verification plan form	Task 2
Blank verification notes form	Task 3
Alternate resources and solutions form	End of this lab
Implementation requirements hints	“Hints” section at the end of this lab
Implementation and verification plan hints	“Hints” section at the end of this lab
Solution configuration answer key (step-by-step procedure)	Configuration section at the end of this lab

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Task 1: Establish an Implementation Requirements List

The first step in your configuration deployment is to establish a list of what is needed in order for you to configure each device; for example, device names, trunk encapsulation types, and so on. Use the following table, the visual objective at the beginning of this lab, the implementation policy, and the device information to create your implementation requirements list. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Device	Implementation Requirement

Task 2: Create an Implementation and Verification Plan

The second step in your configuration deployment is to establish a task list of the items that must be configured on each device, and in what order. Use the following table and the visual objective at the beginning of this lab to create your implementation and verification plan. If you are unsure, you can use the information provided in the "Hints" section at the end of this lab.

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results

Task 3: Implement and Verify

Now that you have collected all the requirements and planned your implementation, you are ready to connect to the remote lab and implement your solution. Do not forget to save.

Once your solution is implemented, you need to verify that your configuration is working and fulfills all the requirements specified by the customer. Keep in mind that once you leave the company, a network specialist will verify your configuration. Your ability to implement the solution according to the customer specifications will determine whether you get the job or not. Use the following area to record your notes and document the verifications you conducted to ensure that your solution is complete. If you are unsure about the verification steps, use the information provided in the "Hints" section at the end of this lab.

Student Notes:

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Alternate Resources and Solutions

Other groups may have implemented a solution different from yours. These will be discussed during the debriefing period that will follow this lab. Use the following space to document other possible solutions for your reference.

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Hints

You are encouraged to complete the labs using your knowledge. However, this section contains a series of hints to aid your completion of the lab.

Lab 6-2 Hint Sheet: Manipulate EBGP Path Selections

Implementation Requirements

To facilitate the configuration of your network, Task 1 asks you to create an implementation requirements list. This list details the elements you need in order to develop an implementation plan. The following is an example of such a list:

Device	Implementation Requirement	Hint
ALL	Define BGP autonomous system numbers and assign them to routers	Implementation Policy
ALL	Define the networks that will be advertised	Implementation Policy Visual Objective
ALL	Define path manipulation rules	Implementation Policy

Implementation and Verification Plan

In Task 2, you will create an implementation and verification plan. Although there are several ways to set up this plan, the following tasks must be completed:

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
	R1–R4	1	Load the initial configuration.	All pod routers must be preloaded with the initial configuration for the lab.	Step 1
	R1–R4		Establish the following EBGP adjacencies: ■ AS 130 to AS 100 – two EBGP sessions between routers R3 and R1 ■ AS 100 to AS 200 between routers R1 and R2 ■ AS 400 to AS 200 between routers R4 and R2	Examine the EBGP adjacencies and verify they are set up correctly between the routers.	Step 2

Complete √	Device	Order	Values and Items to Implement	Verification Method and Expected Results	Step
			The following networks should be announced: ■ Announce the 172.30.13.0/24 network from router R3. ■ Announce the 192.168.1.0/24, 192.168.2.0/24, and 192.168.3.0/24 networks from router R2.	Verify the BGP table to verify that all networks are announced.	Step 3
			Change the default BGP path selection for the traffic from AS 103 that is sent to networks originated from AS 200. The path via 10.1.131.1 should be preferred over the second option, via 10.1.113.1. For the traffic that is returning to AS 130, the path via 10.1.131.1 should be the primary path.	Verify the IP routing table and BGP table in order to see the advertised networks and the preferred path for the packets.	Step 4
			Establish the following additional EBGP adjacencies: ■ AS 130 to AS 100 between switch SW1 and router R1 ■ AS 130 to AS 400 between routers R3 and R4 ■ AS 130 between router R3 and switch SW1 Delete the following EBGP sessions: ■ AS 130 to AS 100 between routers R3 and R1	Examine the EBGP adjacencies and verify that they are set up correctly between the routers.	Step 5
			Influence AS 130 path selection to select the primary path out of the AS via router R4 in AS 400. Influence the path of the traffic coming into AS 130 from AS 200. The path via router R1 should be preferred.	Verify the IP routing table and BGP table in order to see the advertised networks and the preferred path for the packets.	Step 6

Step-by-Step Procedure for Implementation and Verification

1. Load the initial configuration to all devices in your lab.

   1.1. The instructor will provide guidelines for changing the initial configuration.

2. Establish EBGP adjacencies.

2.1. Use the following example to configure the routers in this lab:

```
R1#
router bgp 100
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.112.2 remote-as 200
 neighbor 10.1.113.3 remote-as 130
 neighbor 10.1.131.3 remote-as 130
 no auto-summary

R2#
router bgp 200
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.112.1 remote-as 100
 neighbor 10.1.124.4 remote-as 400
 no auto-summary

R3#
router bgp 130
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.113.1 remote-as 100
 neighbor 10.1.131.1 remote-as 100
 no auto-summary

R4#
router bgp 400
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.124.2 remote-as 200
 no auto-summary
```

2.2. Verify that the adjacencies are established.

```
R1#show ip bgp summary
BGP router identifier 10.1.131.1, local AS number 100
BGP table version is 5, main routing table version 5
4 network entries using 468 bytes of memory
5 path entries using 260 bytes of memory
4/2 BGP path/bestpath attribute entries using 496 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1272 total bytes of memory
BGP activity 16/12 prefixes, 29/24 paths, scan interval 5 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.112.2      4   200      69      73        5    0    0 00:04:28        3
10.1.113.3      4   130     102     102        5    0    0 00:04:23        1
10.1.131.3      4   130      95     102        5    0    0 00:04:28        1

R2#show ip bgp summary
BGP router identifier 192.168.3.1, local AS number 200
BGP table version is 19, main routing table version 19
4 network entries using 468 bytes of memory
4 path entries using 208 bytes of memory
3/2 BGP path/bestpath attribute entries using 372 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1072 total bytes of memory
BGP activity 8/4 prefixes, 11/7 paths, scan interval 60 secs
```

```
Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.112.1      4   100      74      70       19    0    0 00:05:02        1
10.1.124.4      4   400      40      56       19    0    0 00:36:34        0

R3#show ip bgp summary
BGP router identifier 10.3.3.3, local AS number 130
BGP table version is 23, main routing table version 23
4 network entries using 468 bytes of memory
7 path entries using 364 bytes of memory
3/2 BGP path/bestpath attribute entries using 372 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1228 total bytes of memory
BGP activity 32/28 prefixes, 74/67 paths, scan interval 5 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.113.1      4   100     103     103       23    0    0 00:05:15        3
10.1.131.1      4   100     103      97       23    0    0 00:05:20        3

R4#show ip bgp summary
BGP router identifier 10.1.134.4, local AS number 400
BGP table version is 19, main routing table version 19
4 network entries using 468 bytes of memory
4 path entries using 208 bytes of memory
3/2 BGP path/bestpath attribute entries using 372 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1096 total bytes of memory
BGP activity 11/7 prefixes, 11/7 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.124.2      4   200      57      41       19    0    0 00:37:09        4
```

3. Announce the networks in BGP.

3.1. Use the following example to configure the routers in this lab:

```
R2#
router bgp 200
 network 192.168.1.0
 network 192.168.2.0
 network 192.168.3.0

R3#
router bgp 130
 network 172.30.13.0 mask 255.255.255.0
```

3.2. Verify the BPG table for the announced networks:

```
R1#show ip bgp
BGP table version is 5, local router ID is 10.1.131.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  172.30.13.0/24   10.1.113.3            1000             0 130 i
*>                  10.1.131.3               0             0 130 i
*> 192.168.1.0      10.1.112.2               0             0 200 i
*> 192.168.2.0      10.1.112.2               0             0 200 i
*> 192.168.3.0      10.1.112.2               0             0 200 i

R2#show ip bgp
```

```
BGP table version is 19, local router ID is 192.168.3.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.30.13.0/24   10.1.112.1                             0 100 130 i
*> 192.168.1.0      0.0.0.0                  0         32768 i
*> 192.168.2.0      0.0.0.0                  0         32768 i
*> 192.168.3.0      0.0.0.0                  0         32768 i

R3#show ip bgp
BGP table version is 23, local router ID is 10.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.30.13.0/24   0.0.0.0                  0         32768 i
*  192.168.1.0      10.1.113.1                             0 100 200 i
*>                  10.1.131.1                          1000 100 200 i
*  192.168.2.0      10.1.113.1                             0 100 200 i
*>                  10.1.131.1                          1000 100 200 i
*  192.168.3.0      10.1.113.1                             0 100 200 i
*>                  10.1.131.1                          1000 100 200 i

R4#show ip bgp
BGP table version is 19, local router ID is 10.1.134.4
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.30.13.0/24   10.1.124.2                             0 200 100 130 i
*> 192.168.1.0      10.1.124.2               0             0 200 i
*> 192.168.2.0      10.1.124.2               0             0 200 i
*> 192.168.3.0      10.1.124.2               0             0 200 i
```

4. Change the default BGP path selection.

4.1. Use the following example to configure the routers in this lab:

```
R3#
router bgp 130
 neighbor 10.1.113.1 route-map RM-MED out
 neighbor 10.1.131.1 route-map RM-WEIGHT in
!
route-map RM-WEIGHT permit 10
 set weight 1000
!
route-map RM-MED permit 10
 set metric 1000
```

4.2. Verify the routing table for the preferred path of the packets.

```
R1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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
```

```
     172.30.0.0/24 is subnetted, 1 subnets
B       172.30.13.0 [20/0] via 10.1.131.3, 00:04:25
     10.0.0.0/24 is subnetted, 4 subnets
C       10.1.111.0 is directly connected, FastEthernet0/0
C       10.1.113.0 is directly connected, Serial0/0/0.2
C       10.1.112.0 is directly connected, Serial0/0/0.1
C       10.1.131.0 is directly connected, FastEthernet0/1
B    192.168.1.0/24 [20/0] via 10.1.112.2, 00:04:25
B    192.168.2.0/24 [20/0] via 10.1.112.2, 00:04:25
B    192.168.3.0/24 [20/0] via 10.1.112.2, 00:04:25

R2#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
B       172.30.13.0 [20/0] via 10.1.112.1, 00:04:59
     10.0.0.0/24 is subnetted, 2 subnets
C       10.1.124.0 is directly connected, FastEthernet0/0
C       10.1.112.0 is directly connected, Serial0/0/0.1
C    192.168.1.0/24 is directly connected, Loopback30
C    192.168.2.0/24 is directly connected, Loopback31
C    192.168.3.0/24 is directly connected, Loopback32

R3#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
C       172.30.13.0 is directly connected, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.3.3.3/32 is directly connected, Loopback0
C       10.1.113.0/24 is directly connected, Serial0/0/0.2
C       10.1.131.0/24 is directly connected, FastEthernet0/1
C       10.1.134.0/24 is directly connected, Serial0/0/0.3
B    192.168.1.0/24 [20/0] via 10.1.131.1, 00:05:14
B    192.168.2.0/24 [20/0] via 10.1.131.1, 00:05:14
B    192.168.3.0/24 [20/0] via 10.1.131.1, 00:05:14

R4#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
B       172.30.13.0 [20/0] via 10.1.124.2, 00:05:01
     10.0.0.0/24 is subnetted, 2 subnets
```

```
C       10.1.124.0 is directly connected, FastEthernet0/0
C       10.1.134.0 is directly connected, Serial0/0/0.3
B    192.168.1.0/24 [20/0] via 10.1.124.2, 00:37:14
B    192.168.2.0/24 [20/0] via 10.1.124.2, 00:37:14
B    192.168.3.0/24 [20/0] via 10.1.124.2, 00:37:14
```

5. Establish additional adjacencies and remove a few of them.

5.1. Use the following example to configure the routers in this lab:

```
R1#
router bgp 100
 no neighbor 10.1.113.3 remote-as 130
 no neighbor 10.1.131.3 remote-as 130
 neighbor 10.1.111.11 remote-as 130

R3#
router bgp 130
 neighbor 10.1.134.4 remote-as 400
 neighbor 172.30.13.11 remote-as 130
 no neighbor 10.1.113.1 remote-as 100
 no neighbor 10.1.131.1 remote-as 100

R4#
router bgp 400
 neighbor 10.1.134.3 remote-as 130

SW1#
router bgp 130
 no synchronization
 neighbor 10.1.111.1 remote-as 100
 neighbor 172.30.13.3 remote-as 130
 network 172.30.13.0 mask 255.255.255.0
 no auto-summary
```

5.2. Verify the preferred path of the packets.

```
R1#show ip bgp summary
BGP router identifier 10.1.131.1, local AS number 100
BGP table version is 5, main routing table version 5
4 network entries using 468 bytes of memory
7 path entries using 364 bytes of memory
4/2 BGP path/bestpath attribute entries using 496 bytes of memory
3 BGP AS-PATH entries using 72 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1400 total bytes of memory
BGP activity 29/25 prefixes, 62/55 paths, scan interval 5 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.1.111.11     4   130      70      91        5    0    0 00:02:59        4
10.1.112.2      4   200     140     152        5    0    0 00:02:58        3

Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

R2#show ip bgp summary
BGP router identifier 192.168.3.1, local AS number 200
BGP table version is 7, main routing table version 7
4 network entries using 468 bytes of memory
5 path entries using 260 bytes of memory
4/2 BGP path/bestpath attribute entries using 496 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1272 total bytes of memory
BGP activity 5/1 prefixes, 6/1 paths, scan interval 60 secs
```

```
Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.1.112.1      4   100      48      46        7    0    0 00:22:22        1
10.1.124.4      4   400      36      41        7    0    0 00:32:58        1

R3#show ip bgp summary
BGP router identifier 10.3.3.3, local AS number 130
BGP table version is 7, main routing table version 7
4 network entries using 468 bytes of memory
5 path entries using 260 bytes of memory
5/2 BGP path/bestpath attribute entries using 620 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1372 total bytes of memory
BGP activity 62/58 prefixes, 145/140 paths, scan interval 5 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.1.134.4      4   400      85      82        7    0    0 00:06:48        3
172.30.13.11    4   130      89     108        7    0    0 00:06:49        1

R4#show ip bgp summary
BGP router identifier 10.1.134.4, local AS number 400
BGP table version is 40, main routing table version 40
4 network entries using 468 bytes of memory
5 path entries using 260 bytes of memory
4/2 BGP path/bestpath attribute entries using 496 bytes of memory
3 BGP AS-PATH entries using 72 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1296 total bytes of memory
BGP activity 12/8 prefixes, 41/36 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.124.2      4   200     118     111       40    0    0 01:27:16        4
10.1.134.3      4   130      83      86       40    0    0 00:07:25        1

sw1#show ip bgp summary
BGP router identifier 172.30.13.11, local AS number 130
BGP table version is 19, main routing table version 19
4 network entries using 468 bytes of memory
8 path entries using 416 bytes of memory
7/2 BGP path/bestpath attribute entries using 980 bytes of memory
2 BGP AS-PATH entries using 48 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1912 total bytes of memory
BGP activity 20/16 prefixes, 73/65 paths, scan interval 5 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down
State/PfxRcd
10.1.111.1      4   100      96      75       19    0    0 00:07:41        3
172.30.13.3     4   130     110      91       19    0    0 00:08:58        4
```

6. Manipulate BGP path selection with local preference and AS path prepending.

6.1. Use the following example to configure the routers in this lab:

```
R3#
router bgp 130
 neighbor 10.1.134.4 route-map RM-LP in
 neighbor 10.1.134.4 route-map RM-APP out
!
route-map RM-LP permit 10
 set local-preference 200
!
route-map RM-APP permit 10
 set as-path prepend 130 130
```

6.2. Verify the preferred path of the packets.

```
R1#show ip bgp
BGP table version is 5, local router ID is 10.1.131.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.30.13.0/24   10.1.111.11              0             0 130 i
*> 192.168.1.0      10.1.112.2               0             0 200 i
*> 192.168.2.0      10.1.112.2               0             0 200 i
*> 192.168.3.0      10.1.112.2               0             0 200 i

R2#show ip bgp
BGP table version is 30, local router ID is 192.168.3.1
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.30.13.0/24   10.1.112.1                             0 100 130 i
*> 192.168.1.0      0.0.0.0                  0         32768 i
*> 192.168.2.0      0.0.0.0                  0         32768 i
*> 192.168.3.0      0.0.0.0                  0         32768 i

R3#show ip bgp
BGP table version is 7, local router ID is 10.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.30.13.0/24   0.0.0.0                  0         32768 i
* i                 172.30.13.11             0    100      0 i
*> 192.168.1.0      10.1.134.4                    200      0 400 200 i
* i                 10.1.111.1               0    100      0 100 200 i
*> 192.168.2.0      10.1.134.4                    200      0 400 200 i
* i                 10.1.111.1               0    100      0 100 200 i
*> 192.168.3.0      10.1.134.4                    200      0 400 200 i
* i                 10.1.111.1               0    100      0 100 200 i

R4#show ip bgp
BGP table version is 40, local router ID is 10.1.134.4
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  172.30.13.0/24   10.1.134.3               0             0 130 130 130 i
*>                  10.1.124.2                             0 200 100 130 i
*> 192.168.1.0      10.1.124.2               0             0 200 i
*> 192.168.2.0      10.1.124.2               0             0 200 i
*> 192.168.3.0      10.1.124.2               0             0 200 i

R1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
B       172.30.13.0 [20/0] via 10.1.111.11, 00:02:51
     10.0.0.0/24 is subnetted, 4 subnets
C       10.1.111.0 is directly connected, FastEthernet0/0
C       10.1.113.0 is directly connected, Serial0/0/0.2
C       10.1.112.0 is directly connected, Serial0/0/0.1
C       10.1.131.0 is directly connected, FastEthernet0/1
B    192.168.1.0/24 [20/0] via 10.1.112.2, 00:02:51
B    192.168.2.0/24 [20/0] via 10.1.112.2, 00:02:51
B    192.168.3.0/24 [20/0] via 10.1.112.2, 00:02:51

sw1#show ip bgp
BGP table version is 19, local router ID is 172.30.13.11
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
* i172.30.13.0/24   172.30.13.3              0    100      0 i
*>                  0.0.0.0                  0         32768 i
* i192.168.1.0      10.1.134.4               0    200      0 400 200 i
*>                  10.1.111.1                             0 100 200 i
* i192.168.2.0      10.1.134.4               0    200      0 400 200 i
*>                  10.1.111.1                             0 100 200 i
* i192.168.3.0      10.1.134.4               0    200      0 400 200 i
*>                  10.1.111.1                             0 100 200 i

R2#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
B       172.30.13.0 [20/0] via 10.1.112.1, 00:03:34
     10.0.0.0/24 is subnetted, 2 subnets
C       10.1.124.0 is directly connected, FastEthernet0/0
C       10.1.112.0 is directly connected, Serial0/0/0.1
C    192.168.1.0/24 is directly connected, Loopback30
C    192.168.2.0/24 is directly connected, Loopback31
C    192.168.3.0/24 is directly connected, Loopback32

R3#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
C       172.30.13.0 is directly connected, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C       10.3.3.3/32 is directly connected, Loopback0
S       10.1.111.0/24 [1/0] via 172.30.13.11
C       10.1.113.0/24 is directly connected, Serial0/0/0.2
C       10.1.131.0/24 is directly connected, FastEthernet0/1
```

```
C       10.1.134.0/24 is directly connected, Serial0/0/0.3
B    192.168.1.0/24 [20/0] via 10.1.134.4, 00:06:23
B    192.168.2.0/24 [20/0] via 10.1.134.4, 00:06:23
B    192.168.3.0/24 [20/0] via 10.1.134.4, 00:06:23

R4#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
B       172.30.13.0 [20/0] via 10.1.124.2, 00:04:32
     10.0.0.0/24 is subnetted, 2 subnets
C       10.1.124.0 is directly connected, FastEthernet0/0
C       10.1.134.0 is directly connected, Serial0/0/0.3
B    192.168.1.0/24 [20/0] via 10.1.124.2, 00:04:32
B    192.168.2.0/24 [20/0] via 10.1.124.2, 00:04:32
B    192.168.3.0/24 [20/0] via 10.1.124.2, 00:04:32

sw1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

     172.30.0.0/24 is subnetted, 1 subnets
C       172.30.13.0 is directly connected, Vlan113
     10.0.0.0/24 is subnetted, 1 subnets
C       10.1.111.0 is directly connected, Vlan111
B    192.168.1.0/24 [20/0] via 10.1.111.1, 00:05:14
B    192.168.2.0/24 [20/0] via 10.1.111.1, 00:05:14
B    192.168.3.0/24 [20/0] via 10.1.111.1, 00:05:14
```

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Answer Key

The correct answers and expected solutions for the activities that are described in this guide appear here.

Lab 1-1 Answer Key: Assess Skills for Implementing Complex Networks

When you complete this activity, your lab configuration will be similar to the results in the "Hints" section of Lab 1-1.

Lab 2-1 Answer Key: Configure and Verify EIGRP Operations

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1247 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.13.1 255.255.255.0
 delay 100
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
```

```
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 point-to-point
 description Link to R2
 ip address 10.1.112.1 255.255.255.0
 ip summary-address eigrp 1 192.168.0.0 255.255.0.0 5
 frame-relay interface-dlci 112
!
interface Serial0/0/0.4 point-to-point
 description Link to BBR1
 ip address 10.1.115.1 255.255.255.0
 frame-relay interface-dlci 115
!
router eigrp 1
 passive-interface FastEthernet0/0
 network 10.1.112.0 0.0.0.255
 network 10.1.115.0 0.0.0.255
 network 172.30.13.0 0.0.0.255
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R2#show running-configuration
Building configuration...

Current configuration : 1016 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
```

```
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.112.2 255.255.255.0
 frame-relay interface-dlci 121
!
router eigrp 1
 network 10.1.112.0 0.0.0.255
 network 10.0.0.0
 network 172.30.24.0 0.0.0.255
 network 172.30.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end

R3#show running-configuration
Building configuration...

Current configuration : 1024 bytes
!
version 12.4
service timestamps debug datetime msec
```

```
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 delay 100
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.3 point-to-point
 description Link to R4
 ip address 10.1.134.3 255.255.255.0
 frame-relay interface-dlci 134
!
router eigrp 1
 passive-interface FastEthernet0/0
 network 10.1.134.0 0.0.0.255
 network 172.30.13.0 0.0.0.255
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
```

```
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R4#show running-configuration

```
Building configuration...

Current configuration : 978 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.3 point-to-point
 description Link to R3
 ip address 10.1.134.4 255.255.255.0
 frame-relay interface-dlci 143
!
router eigrp 1
 network 10.1.134.0 0.0.0.255
 network 172.30.24.0 0.0.0.255
 no auto-summary
```

```
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 2-2 Answer Key: Configure and Verify EIGRP Circuit Emulation and Frame Relay Operations

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1305 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 no ip address
 shutdown
 duplex auto
```

```
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 multipoint
 description Link to R2, R3, R4
 ip address 10.1.110.1 255.255.255.0
 no ip split-horizon eigrp 1
 frame-relay map ip 10.1.110.2 112 broadcast
 frame-relay map ip 10.1.110.3 113 broadcast
 frame-relay map ip 10.1.110.4 114 broadcast
!
interface Serial0/0/0.4 point-to-point
 description Link to BBR1
 ip address 10.1.115.1 255.255.255.0
 frame-relay interface-dlci 115
!
interface Serial0/0/0.5 point-to-point
 description Link to BBR2
 ip address 10.1.116.1 255.255.255.0
 frame-relay interface-dlci 116
!
router eigrp 1
 network 10.0.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R2#show running-configuration

```
Building configuration...

Current configuration : 927 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
```

```
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.2 255.255.255.0
 frame-relay interface-dlci 121
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
```



```
end

R3#show running-configuration
Building configuration...

Current configuration : 1137 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 10.255.255.1 255.255.255.0 secondary
 ip address 172.30.13.3 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.3 255.255.255.0
 frame-relay interface-dlci 131
!
interface Serial0/0/0.3 point-to-point
 description Link to R4
 ip address 10.1.134.3 255.255.255.0
 delay 3000
 frame-relay interface-dlci 134
!
router eigrp 1
 variance 2
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
```

```
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R4#show running-configuration
Building configuration...

Current configuration : 1076 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
```

```
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.4 255.255.255.0
 frame-relay interface-dlci 141
!
interface Serial0/0/0.3 point-to-point
 description Link to R3
 ip address 10.1.134.4 255.255.255.0
 delay 3000
 frame-relay interface-dlci 143
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 2-3 Answer Key: Configure and Verify EIGRP Authentication

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1383 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
```

```
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
key chain LAB23-LAN
 key 1
   key-string CiscoLAN
   accept-lifetime 04:00:00 Jan 1 2009 infinite
   send-lifetime 04:00:00 Jan 1 2009 infinite
key chain LAB23-WAN
 key 1
   key-string CiscoWAN
   accept-lifetime 04:00:00 Jan 1 2009 infinite
   send-lifetime 04:00:00 Jan 1 2009 infinite
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.13.1 255.255.255.0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-LAN
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R2
 ip address 10.1.112.1 255.255.255.0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-WAN
 frame-relay interface-dlci 112
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
```



```
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R2#show running-configuration
Building configuration...

Current configuration : 1383 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
key chain LAB23-LAN
 key 1
   key-string CiscoLAN
   accept-lifetime 04:00:00 Jan 1 2009 infinite
   send-lifetime 04:00:00 Jan 1 2009 infinite
key chain LAB23-WAN
 key 1
   key-string CiscoWAN
   accept-lifetime 04:00:00 Jan 1 2009 infinite
   send-lifetime 04:00:00 Jan 1 2009 infinite
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-LAN
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
```

```
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.112.2 255.255.255.0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-WAN
 frame-relay interface-dlci 121
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R3#show running-configuration
Building configuration...

Current configuration : 1383 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
key chain LAB23-LAN
 key 1
   key-string CiscoLAN
   accept-lifetime 04:00:00 Jan 1 2009 infinite
```



```
   send-lifetime 04:00:00 Jan 1 2009 infinite
key chain LAB23-WAN
 key 1
   key-string CiscoWAN
   accept-lifetime 04:00:00 Jan 1 2009 infinite
   send-lifetime 04:00:00 Jan 1 2009 infinite
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-LAN
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.3 point-to-point
 description Link to R4
 ip address 10.1.134.3 255.255.255.0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-WAN
 frame-relay interface-dlci 134
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R4#show running-configuration

```
Building configuration...
```

```
Current configuration : 1383 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
key chain LAB23-LAN
 key 1
   key-string CiscoLAN
   accept-lifetime 04:00:00 Jan 1 2009 infinite
   send-lifetime 04:00:00 Jan 1 2009 infinite
key chain LAB23-WAN
 key 1
   key-string CiscoWAN
   accept-lifetime 04:00:00 Jan 1 2009 infinite
   send-lifetime 04:00:00 Jan 1 2009 infinite
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-LAN
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.3 point-to-point
 description Link to R3
 ip address 10.1.134.4 255.255.255.0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB23-WAN
 frame-relay interface-dlci 143
!
router eigrp 1
```

```
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 2-4 Answer Key: Implement and Troubleshoot EIGRP Operations

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1541 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
key chain LAB24
 key 1
   key-string Cisco
   accept-lifetime 04:00:00 Jan 1 2003 infinite
   send-lifetime 04:00:00 Jan 1 2003 infinite
!
!
!
```

```
!
!
!
!
!
interface FastEthernet0/0
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R2, R3, R4
 ip address 10.1.110.1 255.255.255.0
 no ip split-horizon eigrp 1
 frame-relay map ip 10.1.110.2 112 broadcast
 frame-relay map ip 10.1.110.3 113 broadcast
 frame-relay map ip 10.1.110.4 114 broadcast
!
interface Serial0/0/0.4 point-to-point
 description Link to BBR1
 ip address 10.1.115.1 255.255.255.0
 ip authentication mode eigrp 1 md5
 ip authentication key-chain eigrp 1 LAB24
 frame-relay interface-dlci 115
!
interface Serial0/0/0.5 point-to-point
 description Link to BBR2
 ip address 10.1.116.1 255.255.255.0
 frame-relay interface-dlci 116
!
router eigrp 1
 network 10.0.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R2#show running-configuration
Building configuration...

Current configuration : 1000 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.42.2 255.255.255.0 secondary
 ip address 172.30.24.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.2 255.255.255.0
 frame-relay interface-dlci 121
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
```

```
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R3#show running-configuration
Building configuration...

Current configuration : 1207 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.3 255.255.255.0
```

```
 frame-relay interface-dlci 131
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R4#show running-configuration
Building configuration...

Current configuration : 1000 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.42.4 255.255.255.0 secondary
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
```

```
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.4 255.255.255.0
 frame-relay interface-dlci 141
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
sched.30.13.3 not on common s
end
```

Lab 3-1 Answer Key: Configure and Verify OSPF to Improve Routing Performance

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1201 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
```

```
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.13.1 255.255.255.0
 ip ospf priority 10
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 multipoint
 description Link to R2, R4
 ip address 10.1.110.1 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay map ip 10.1.110.2 112 broadcast
 frame-relay map ip 10.1.110.4 114 broadcast
!
router ospf 1
 log-adjacency-changes
 network 10.1.1.1 0.0.0.0 area 0
 network 10.1.110.0 0.0.0.255 area 0
 network 172.30.13.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
```

```
 login
!
scheduler allocate 20000 1000
end
```

```
R2#show running-configuration
Building configuration...

Current configuration : 1061 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.2 255.255.255.0
 frame-relay interface-dlci 121
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 0
 network 10.2.2.2 0.0.0.0 area 0
 network 172.30.24.0 0.0.0.255 area 0
!
```

```
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R3#show running-configuration
Building configuration...

Current configuration : 1381 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface Loopback31
 ip address 192.168.1.1 255.255.255.0
!
interface Loopback32
 ip address 192.168.2.1 255.255.255.0
!
interface Loopback33
 ip address 192.168.3.1 255.255.255.0
!
interface FastEthernet0/0
```

```
 ip address 172.30.13.3 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.3 255.255.255.0
 frame-relay interface-dlci 131
!
interface Serial0/0/0.2 point-to-point
 description Link to R4
 ip address 10.1.134.3 255.255.255.0
 frame-relay interface-dlci 134
!
router ospf 1
 log-adjacency-changes
 network 10.1.134.0 0.0.0.255 area 0
 network 10.3.3.3 0.0.0.0 area 0
 network 172.30.13.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R4#show running-configuration
Building configuration...

Current configuration : 1235 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
```

```
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.4 255.255.255.0
 frame-relay interface-dlci 141
!
interface Serial0/0/0.2 point-to-point
 description Link to R3
 ip address 10.1.134.4 255.255.255.0
 frame-relay interface-dlci 143
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 0
 network 10.1.134.0 0.0.0.255 area 0
 network 10.4.4.4 0.0.0.0 area 0
 network 172.30.24.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
```

```
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 3-2 Answer Key: Implement and Verify OSPF Multiarea Routing

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1487 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
```

```
interface Serial0/0/0.1 multipoint
 description Link to R2, R4
 ip address 10.1.110.1 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay map ip 10.1.110.2 112 broadcast
 frame-relay map ip 10.1.110.4 114 broadcast
!
interface Serial0/0/0.2 point-to-point
 description Link to R3
 ip address 10.1.113.1 255.255.255.0
 frame-relay interface-dlci 113
!
interface Serial0/0/0.116 point-to-point
 description Link to BBR2
 ip address 10.1.116.1 255.255.255.0
 frame-relay interface-dlci 116
!
router ospf 1
 router-id 1.1.1.1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 24
 network 10.1.113.0 0.0.0.255 area 3
 network 10.1.116.0 0.0.0.255 area 0
 neighbor 10.1.110.2 cost 10
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R2#show running-configuration

```
Building configuration...

Current configuration : 1030 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
```

```
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.2 255.255.255.0
 frame-relay interface-dlci 121
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end

R3#show running-configuration
Building configuration...

Current configuration : 1246 bytes
```

```
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface Loopback31
 ip address 192.168.1.1 255.255.255.0
!
interface Loopback32
 ip address 192.168.2.1 255.255.255.0
!
interface Loopback33
 ip address 192.168.3.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.2 point-to-point
 description Link to R1
 ip address 10.1.113.3 255.255.255.0
 frame-relay interface-dlci 131
!
router ospf 1
 log-adjacency-changes
 passive-interface FastEthernet0/0
 network 10.1.113.0 0.0.0.255 area 3
 network 172.30.13.0 0.0.0.255 area 3
!
```

```
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R4#show running-configuration
Building configuration...

Current configuration : 1030 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
```

```
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.110.4 255.255.255.0
 frame-relay interface-dlci 141
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 3-3 Answer Key: Configure and Verify OSPF Route Summarization for Interarea and External Routes

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1524 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
```

```
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 multipoint
 description Link to R2, R4
 ip address 10.1.110.1 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay map ip 10.1.110.2 112 broadcast
 frame-relay map ip 10.1.110.4 114 broadcast
!
interface Serial0/0/0.2 point-to-point
 description Link to R3
 ip address 10.1.113.1 255.255.255.0
 frame-relay interface-dlci 113
!
interface Serial0/0/0.116 point-to-point
 description Link to BBR2
 ip address 10.1.116.1 255.255.255.0
 frame-relay interface-dlci 116
!
router ospf 1
 router-id 1.1.1.1
 log-adjacency-changes
 area 0 range 172.30.0.0 255.255.0.0
 network 10.1.110.0 0.0.0.255 area 24
 network 10.1.113.0 0.0.0.255 area 3
 network 10.1.116.0 0.0.0.255 area 0
 neighbor 10.1.110.2 cost 10
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
```



```
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R2#show running-configuration
Building configuration...

Current configuration : 1087 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 multipoint
 description Link to R1
 ip address 10.1.110.2 255.255.255.0
 ip ospf network point-to-multipoint
```

```
 ip ospf hello-interval 10
 frame-relay interface-dlci 121
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R3#show running-configuration
Building configuration...

Current configuration : 1519 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface Loopback31
 ip address 192.168.1.1 255.255.255.0
```

```
!
interface Loopback32
 ip address 192.168.2.1 255.255.255.0
!
interface Loopback33
 ip address 192.168.3.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.2 point-to-point
 description Link to R1
 ip address 10.1.113.3 255.255.255.0
 frame-relay interface-dlci 131
!
router ospf 1
 log-adjacency-changes
 summary-address 192.168.0.0 255.255.0.0
 redistribute connected subnets route-map RM-LOOP
 passive-interface FastEthernet0/0
 network 10.1.113.0 0.0.0.255 area 3
 network 172.30.13.0 0.0.0.255 area 3
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
ip access-list standard ACL-LOOP
 permit 192.168.1.0 0.0.0.255
 permit 192.168.2.0 0.0.0.255
 permit 192.168.3.0 0.0.0.255
!
!
route-map RM-LOOP permit 10
 match ip address ACL-LOOP
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R4#show running-configuration
Building configuration...
```

```
Current configuration : 1087 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 multipoint
 description Link to R1
 ip address 10.1.110.4 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay interface-dlci 141
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
```

```
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 3-4 Answer Key: Configure and Verify OSPF Special Area Types

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1639 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
```

```
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R2, R4
 ip address 10.1.110.1 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay map ip 10.1.110.2 112 broadcast
 frame-relay map ip 10.1.110.4 114 broadcast
!
interface Serial0/0/0.2 point-to-point
 description Link to R3
 ip address 10.1.113.1 255.255.255.0
 frame-relay interface-dlci 113
!
interface Serial0/0/0.116 point-to-point
 description Link to BBR2
 ip address 10.1.116.1 255.255.255.0
 frame-relay interface-dlci 116
!
router ospf 1
 router-id 1.1.1.1
 log-adjacency-changes
 area 3 nssa no-summary
 area 24 stub no-summary
 redistribute static subnets
 network 10.1.110.0 0.0.0.255 area 24
 network 10.1.113.0 0.0.0.255 area 3
 network 10.1.116.0 0.0.0.255 area 0
 neighbor 10.1.110.2 cost 10
!
ip forward-protocol nd
ip route 192.168.4.0 255.255.255.0 10.1.116.6
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end

R2#show running-configuration
Building configuration...

Current configuration : 1129 bytes
!
version 12.4
service timestamps debug datetime msec
```

```
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R1
 ip address 10.1.110.2 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay interface-dlci 121
!
router ospf 1
 log-adjacency-changes
 area 24 stub
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
```

```
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R3#show running-configuration

```
Building configuration...

Current configuration : 1519 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface Loopback31
 ip address 192.168.1.1 255.255.255.0
!
interface Loopback32
 ip address 192.168.2.1 255.255.255.0
!
interface Loopback33
 ip address 192.168.3.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
```



```
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.2 point-to-point
 description Link to R1
 ip address 10.1.113.3 255.255.255.0
 frame-relay interface-dlci 131
!
router ospf 1
 log-adjacency-changes
 area 3 nssa
 redistribute connected subnets route-map RM-LOOP
 passive-interface FastEthernet0/0
 network 10.1.113.0 0.0.0.255 area 3
 network 172.30.13.0 0.0.0.255 area 3
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
ip access-list standard ACL-LOOP
 permit 192.168.1.0 0.0.0.255
 permit 192.168.2.0 0.0.0.255
 permit 192.168.3.0 0.0.0.255
!
!
route-map RM-LOOP permit 10
 match ip address ACL-LOOP
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R4#show running-configuration

```
Building configuration...

Current configuration : 1129 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
```

```
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R1
 ip address 10.1.110.4 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay interface-dlci 141
!
router ospf 1
 log-adjacency-changes
 area 24 stub
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
```



```
end
```

Lab 3-5 Answer Key: Configure and Verify OSPF Authentication

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1727 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R2, R4
 ip address 10.1.110.1 255.255.255.0
 ip ospf message-digest-key 1 md5 CISCO
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay map ip 10.1.110.2 112 broadcast
 frame-relay map ip 10.1.110.4 114 broadcast
```

```
!
interface Serial0/0/0.2 point-to-point
 description Link to R3
 ip address 10.1.113.1 255.255.255.0
 ip ospf authentication
 ip ospf authentication-key CISCO
 frame-relay interface-dlci 113
!
interface Serial0/0/0.116 point-to-point
 description Link to BBR2
 ip address 10.1.116.1 255.255.255.0
 frame-relay interface-dlci 116
!
router ospf 1
 router-id 1.1.1.1
 log-adjacency-changes
 area 24 authentication message-digest
 redistribute static subnets
 network 10.1.110.0 0.0.0.255 area 24
 network 10.1.113.0 0.0.0.255 area 3
 network 10.1.116.0 0.0.0.255 area 0
 neighbor 10.1.110.2 cost 10
!
ip forward-protocol nd
ip route 192.168.4.0 255.255.255.0 10.1.116.6
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R2#show running-configuration
Building configuration...

Current configuration : 1234 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
```

```
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 ip ospf message-digest-key 1 md5 CISCO
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R1
 ip address 10.1.110.2 255.255.255.0
 ip ospf message-digest-key 1 md5 CISCO
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay interface-dlci 121
!
router ospf 1
 log-adjacency-changes
 area 24 authentication message-digest
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R3#show running-configuration
Building configuration...

Current configuration : 1564 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface Loopback31
 ip address 192.168.1.1 255.255.255.0
!
interface Loopback32
 ip address 192.168.2.1 255.255.255.0
!
interface Loopback33
 ip address 192.168.3.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.2 point-to-point
 description Link to R1
 ip address 10.1.113.3 255.255.255.0
 ip ospf authentication
 ip ospf authentication-key CISCO
 frame-relay interface-dlci 131
```

```
!
router ospf 1
 log-adjacency-changes
 redistribute connected subnets route-map RM-LOOP
 passive-interface FastEthernet0/0
 network 10.1.113.0 0.0.0.255 area 3
 network 172.30.13.0 0.0.0.255 area 3
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
ip access-list standard ACL-LOOP
 permit 192.168.1.0 0.0.0.255
 permit 192.168.2.0 0.0.0.255
 permit 192.168.3.0 0.0.0.255
!
!
route-map RM-LOOP permit 10
 match ip address ACL-LOOP
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R4#show running-configuration
Building configuration...

Current configuration : 1234 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
```

```
!
!
!
interface Loopback0
 ip address 10.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 ip ospf message-digest-key 1 md5 CISCO
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R1
 ip address 10.1.110.4 255.255.255.0
 ip ospf message-digest-key 1 md5 CISCO
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay interface-dlci 141
!
router ospf 1
 log-adjacency-changes
 area 24 authentication message-digest
 network 10.1.110.0 0.0.0.255 area 24
 network 172.30.24.0 0.0.0.255 area 24
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 4-1 Answer Key: Configure Route Redistribution Between Multiple IP Routing Protocols

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

R1#show running-configuration

```
Building configuration...

Current configuration : 1857 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.1.1.1 255.255.255.255
!
interface FastEthernet0/0
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R2, R4
 ip address 10.1.110.1 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay map ip 10.1.110.2 112 broadcast
 frame-relay map ip 10.1.110.4 114 broadcast
!
interface Serial0/0/0.2 point-to-point
 description Link to R3
 ip address 10.1.113.1 255.255.255.0
 frame-relay interface-dlci 113
!
interface Serial0/0/0.116 point-to-point
 description Link to BBR2
 ip address 10.1.116.1 255.255.255.0
```

```
 frame-relay interface-dlci 116
!
router eigrp 1
 redistribute rip route-map RM-RIP
 redistribute ospf 1
 network 10.1.116.0 0.0.0.255
 default-metric 1500 100 255 1 1500
 auto-summary
!
router ospf 1
 log-adjacency-changes
 redistribute rip subnets
 redistribute eigrp 1 subnets
 network 10.1.110.0 0.0.0.255 area 0
!
router rip
 version 2
 redistribute ospf 1
 network 10.0.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
ip access-list standard ACL-RIP
 permit 192.168.2.0 0.0.0.255
 permit 192.168.3.0 0.0.0.255
!
!
route-map RM-RIP deny 10
 match ip address ACL-RIP
!
route-map RM-RIP permit 99
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end

R2#show running-configuration
Building configuration...

Current configuration : 1113 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
```

```
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R1
 ip address 10.1.110.2 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay interface-dlci 121
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 0
 network 172.30.24.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
```

```
scheduler allocate 20000 1000
end
```

```
R3#show running-configuration
Building configuration...

Current configuration : 1463 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface Loopback31
 ip address 192.168.1.1 255.255.255.0
!
interface Loopback32
 ip address 192.168.2.1 255.255.255.0
!
interface Loopback33
 ip address 192.168.3.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.2 point-to-point
 description Link to R1
 ip address 10.1.113.3 255.255.255.0
```



```
 frame-relay interface-dlci 131
!
router rip
 version 2
 redistribute connected
 network 10.0.0.0
 network 172.30.0.0
 distribute-list prefix PL-RIP out connected
 no auto-summary
!
ip forward-protocol nd
ip route 0.0.0.0 0.0.0.0 10.1.113.1
!
!
ip http server
no ip http secure-server
!
!
ip prefix-list PL-RIP seq 5 permit 192.168.1.0/24
ip prefix-list PL-RIP seq 10 permit 192.168.2.0/24
ip prefix-list PL-RIP seq 15 permit 192.168.3.0/24
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R4#show running-configuration

```
Building configuration...

Current configuration : 1113 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
```

```
!
!
interface Loopback0
 ip address 10.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R1
 ip address 10.1.110.4 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay interface-dlci 141
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 0
 network 172.30.24.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 5-1 Answer Key: Configure and Verify Path Control Between Multiple IP Routing Protocols

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1113 bytes
!
```

```
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.4.4.4 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 multipoint
 description Link to R1
 ip address 10.1.110.4 255.255.255.0
 ip ospf network point-to-multipoint
 ip ospf hello-interval 10
 frame-relay interface-dlci 141
!
router ospf 1
 log-adjacency-changes
 network 10.1.110.0 0.0.0.255 area 0
 network 172.30.24.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
```

```
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R2#show running-configuration
Building configuration...

Current configuration : 955 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.24.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.112.2 255.255.255.0
 frame-relay interface-dlci 121
```

```
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R3#show running-configuration
Building configuration...

Current configuration : 1179 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 ip policy route-map RM-PBR
 duplex auto
 speed auto
!
interface FastEthernet0/1
```

```
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.2 point-to-point
 ip address 10.1.134.3 255.255.255.0
 frame-relay interface-dlci 134
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
ip access-list extended ACL-PBR
 permit ip host 172.30.13.11 192.168.1.0 0.0.0.255
 permit ip host 172.30.13.11 192.168.2.0 0.0.0.255
!
!
route-map RM-PBR permit 10
 match ip address ACL-PBR
 set ip next-hop 172.30.13.1
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R4#show running-configuration

```
Building configuration...

Current configuration : 1171 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
```

```
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback31
 ip address 192.168.1.1 255.255.255.0
!
interface Loopback32
 ip address 192.168.2.1 255.255.255.0
!
interface Loopback33
 ip address 192.168.3.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 172.30.24.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.3 point-to-point
 description Link to R3
 ip address 10.1.134.4 255.255.255.0
 frame-relay interface-dlci 143
!
router eigrp 1
 network 10.0.0.0
 network 172.30.0.0
 network 192.168.0.0 0.0.255.255
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
```

```
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 6-1 Answer Key: Configure BGP Operations

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1165 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.1 point-to-point
 description Link to R2
 ip address 10.1.112.1 255.255.255.0
 frame-relay interface-dlci 112
!
interface Serial0/0/0.2 point-to-point
```

```
 description link to R3
 ip address 10.1.113.1 255.255.255.0
 frame-relay interface-dlci 113
!
router bgp 100
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.112.2 remote-as 200
 neighbor 10.1.113.3 remote-as 130
 neighbor 10.1.113.3 password cisco
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R2#show running-configuration

```
Building configuration...

Current configuration : 1334 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback30
```

```
 ip address 192.168.1.1 255.255.255.0
!
interface Loopback31
 ip address 192.168.2.1 255.255.255.0
!
interface Loopback32
 ip address 192.168.3.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 10.1.124.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.112.2 255.255.255.0
 frame-relay interface-dlci 121
!
router bgp 200
 no synchronization
 bgp log-neighbor-changes
 network 192.168.1.0
 network 192.168.2.0
 network 192.168.3.0
 aggregate-address 192.168.0.0 255.255.0.0 summary-only
 neighbor 10.1.112.1 remote-as 100
 neighbor 10.1.124.4 remote-as 400
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R3#show running-configuration
Building configuration...

Current configuration : 1460 bytes
!
```



```
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.2 point-to-point
 description link to R1
 ip address 10.1.113.3 255.255.255.0
 frame-relay interface-dlci 131
!
interface Serial0/0/0.3 point-to-point
 description link to R4
 ip address 10.1.134.3 255.255.255.0
 frame-relay interface-dlci 134
!
router bgp 130
 no synchronization
 bgp log-neighbor-changes
 network 172.30.13.0 mask 255.255.255.0
 redistribute connected route-map RM-BGP
 neighbor 10.1.113.1 remote-as 100
 neighbor 10.1.113.1 password cisco
 neighbor 10.1.134.4 remote-as 400
 neighbor 10.1.134.4 password cisco
 no auto-summary
!
```

```
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
ip access-list standard ACL-BGP
 permit 10.3.3.3
!
!
route-map RM-BGP permit 10
 match ip address ACL-BGP
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R4#show running-configuration

```
Building configuration...

Current configuration : 1040 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 10.1.124.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
```



```
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
!
interface Serial0/0/0.3 point-to-point
 description Link to R3
 ip address 10.1.134.4 255.255.255.0
 frame-relay interface-dlci 143
!
router bgp 400
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.124.2 remote-as 200
 neighbor 10.1.134.3 remote-as 130
 neighbor 10.1.134.3 password cisco
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

Lab 6-2 Answer Key: Manipulate EBGP Path Selections

When you complete this activity, your lab configuration will be similar to the results here, with differences that are specific to your device or workgroup:

```
R1#show running-configuration
Building configuration...

Current configuration : 1182 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
```

```
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 10.1.111.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 ip address 10.1.131.1 255.255.255.0
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 point-to-point
 description Link to R2
 ip address 10.1.112.1 255.255.255.0
 frame-relay interface-dlci 112
!
interface Serial0/0/0.2 point-to-point
 description link to R3
 ip address 10.1.113.1 255.255.255.0
 frame-relay interface-dlci 113
!
router bgp 100
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.111.11 remote-as 130
 neighbor 10.1.112.2 remote-as 200
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
```

```
end

R2#show running-configuration
Building configuration...

Current configuration : 1278 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback30
 ip address 192.168.1.1 255.255.255.0
!
interface Loopback31
 ip address 192.168.2.1 255.255.255.0
!
interface Loopback32
 ip address 192.168.3.1 255.255.255.0
!
interface FastEthernet0/0
 ip address 10.1.124.2 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.1 point-to-point
 description Link to R1
 ip address 10.1.112.2 255.255.255.0
 frame-relay interface-dlci 121
!
router bgp 200
 no synchronization
```

```
 bgp log-neighbor-changes
 network 192.168.1.0
 network 192.168.2.0
 network 192.168.3.0
 neighbor 10.1.112.1 remote-as 100
 neighbor 10.1.124.4 remote-as 400
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

R3#show running-configuration

```
Building configuration...

Current configuration : 1572 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface FastEthernet0/0
 ip address 172.30.13.3 255.255.255.0
```

```
 duplex auto
 speed auto
!
interface FastEthernet0/1
 ip address 10.1.131.3 255.255.255.0
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.2 point-to-point
 description link to R1
 ip address 10.1.113.3 255.255.255.0
 frame-relay interface-dlci 131
!
interface Serial0/0/0.3 point-to-point
 description link to R4
 ip address 10.1.134.3 255.255.255.0
 frame-relay interface-dlci 134
!
router bgp 130
 no synchronization
 bgp log-neighbor-changes
 network 172.30.13.0 mask 255.255.255.0
 neighbor 10.1.134.4 remote-as 400
 neighbor 10.1.134.4 route-map RM-LP in
 neighbor 10.1.134.4 route-map RM-APP out
 neighbor 172.30.13.11 remote-as 130
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
!
route-map RM-LP permit 10
 set local-preference 200
!
route-map RM-WEIGHT permit 10
 set weight 1000
!
route-map RM-APP permit 10
 set as-path prepend 130 130
!
route-map RM-MED permit 10
 set metric 1000
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
R4#show running-configuration
Building configuration...

Current configuration : 1032 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip cef
!
!
!
!
ip auth-proxy max-nodata-conns 3
ip admission max-nodata-conns 3
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 10.1.124.4 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0/0
 no ip address
 encapsulation frame-relay
 no fair-queue
 frame-relay lmi-type cisco
!
interface Serial0/0/0.3 point-to-point
 description Link to R3
 ip address 10.1.134.4 255.255.255.0
 frame-relay interface-dlci 143
!
router bgp 400
 no synchronization
 bgp log-neighbor-changes
 neighbor 10.1.124.2 remote-as 200
 neighbor 10.1.134.3 remote-as 130
 no auto-summary
!
ip forward-protocol nd
!
!
ip http server
no ip http secure-server
!
```

```
!
!
!
!
control-plane
!
!
!
line con 0
line aux 0
line vty 0 4
 login
!
scheduler allocate 20000 1000
end
```

```
sw1#show running-config
Building configuration...

Current configuration : 3836 bytes
!
version 12.2
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname sw1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
system mtu routing 1500
ip subnet-zero
ip routing
!
!
!
!
crypto pki trustpoint TP-self-signed-2041166592
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-2041166592
 revocation-check none
 rsakeypair TP-self-signed-2041166592
!
!
crypto pki certificate chain TP-self-signed-2041166592
 certificate self-signed 01
  3082023C 308201A5 A0030201 02020101 300D0609 2A864886 F70D0101 04050030
  31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D 43657274
  69666963 6174652D 32303431 31363635 3932301E 170D3933 30333031 30303030
  35315A17 0D323030 31303130 30303030 305A3031 312F302D 06035504 03132649
  4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D32 30343131
  36363539 3230819F 300D0609 2A864886 F70D0101 01050003 818D0030 81890281
  8100A59B D9B34BB0 6778FF10 1E84887D 8E02E881 DDE5048A BBAD99CC 728DEC8F
  0349147C 31477BF2 3892E139 E12E126B 0C66F95C 55CB2337 DBC74315 2D00FA7B
  55C82BDB A162CAF1 D6E7B675 C59A5237 6F1E9356 CFA8C68E 7E1C4268 DA1CA1D8
  7020D432 20395273 33DBC301 C2D27D04 95FB8793 922A09AC 109373C9 FB66E909
  8CD90203 010001A3 64306230 0F060355 1D130101 FF040530 030101FF 300F0603
  551D1104 08300682 04737731 2E301F06 03551D23 04183016 8014A120 BCDEF6CB
  D773C393 E0FDDE7F 16C388BB A7E2301D 0603551D 0E041604 14A120BC DEF6CBD7
  73C393E0 FDDE7F16 C388BBA7 E2300D06 092A8648 86F70D01 01040500 03818100
  68EFD060 CD0CC462 4EE25687 D4551382 5CE1137B CAA1C332 03F0B512 219D22E2
  31852861 704DB587 B1976F85 1B45BC36 48CA364F 08115AD1 DB02838F 323EDE08
  49898FEE C102DB22 6E3040E7 4E25CEC6 8FCE0230 570364A9 8ADCB160 781E83BA
  B1E77A9A 4126F517 86C1449A 08041F5D 85C70453 686FD11A C5AF09D4 63D8016A
```

```
  quit
!
!
!
!
!
!
spanning-tree mode pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 53248
!
vlan internal allocation policy ascending
!
!
!
!
interface FastEthernet0/1
 switchport access vlan 111
 switchport mode access
!
interface FastEthernet0/2
 switchport access vlan 124
 switchport mode access
!
interface FastEthernet0/3
 switchport access vlan 113
 switchport mode access
!
interface FastEthernet0/4
 switchport access vlan 124
 switchport mode access
!
interface FastEthernet0/5
 switchport access vlan 100
 switchport mode access
!
interface FastEthernet0/6
 switchport trunk encapsulation dot1q
 switchport mode trunk
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface FastEthernet0/13
!
interface FastEthernet0/14
!
interface FastEthernet0/15
!
interface FastEthernet0/16
!
interface FastEthernet0/17
!
interface FastEthernet0/18
!
interface FastEthernet0/19
!
interface FastEthernet0/20
!
```



```
interface FastEthernet0/21
!
interface FastEthernet0/22
!
interface FastEthernet0/23
!
interface FastEthernet0/24
!
interface GigabitEthernet0/1
 switchport trunk encapsulation dot1q
 switchport mode trunk
!
interface GigabitEthernet0/2
 switchport trunk encapsulation dot1q
 switchport mode trunk
!
interface Vlan1
 no ip address
!
interface Vlan111
 ip address 10.1.111.11 255.255.255.0
!
interface Vlan113
 ip address 172.30.13.11 255.255.255.0
!
router bgp 130
 no synchronization
 bgp log-neighbor-changes
 network 172.30.13.0 mask 255.255.255.0
 neighbor 10.1.111.1 remote-as 100
 neighbor 10.1.111.1 transport path-mtu-discovery
 neighbor 172.30.13.3 remote-as 130
 neighbor 172.30.13.3 transport path-mtu-discovery
 no auto-summary
!
ip default-gateway 10.2.160.1
ip classless
ip http server
ip http secure-server
!
!
!
control-plane
!
!
line con 0
line vty 0 4
 login
line vty 5 15
 login
!
end
```

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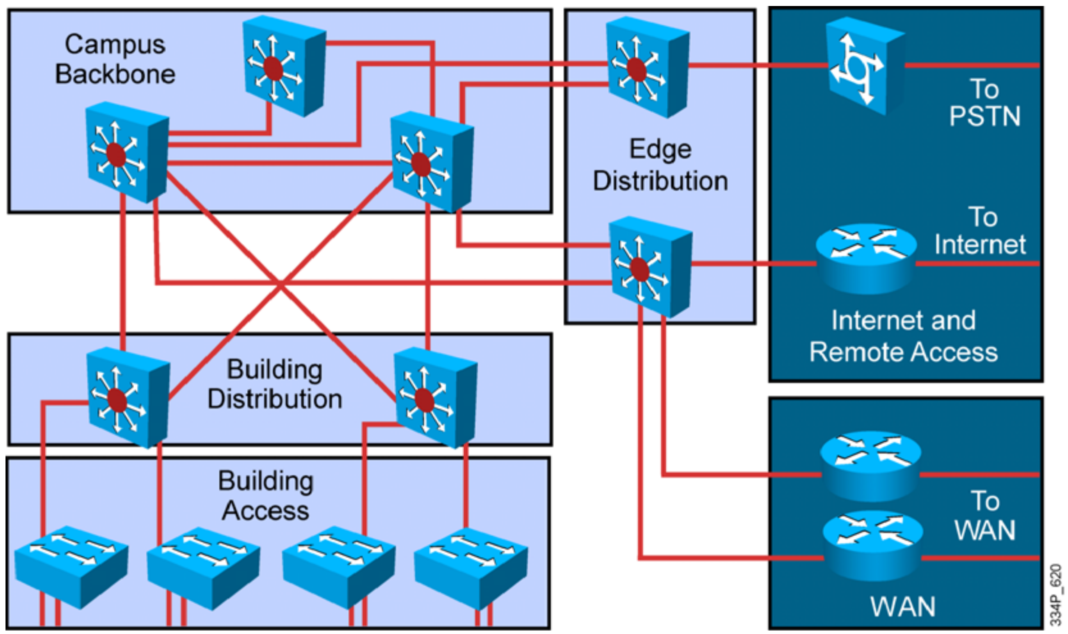
Visual Objective for Lab 1-1: Assess Skills for Implementing Complex Networks



ROUTE v1.0—LG-4

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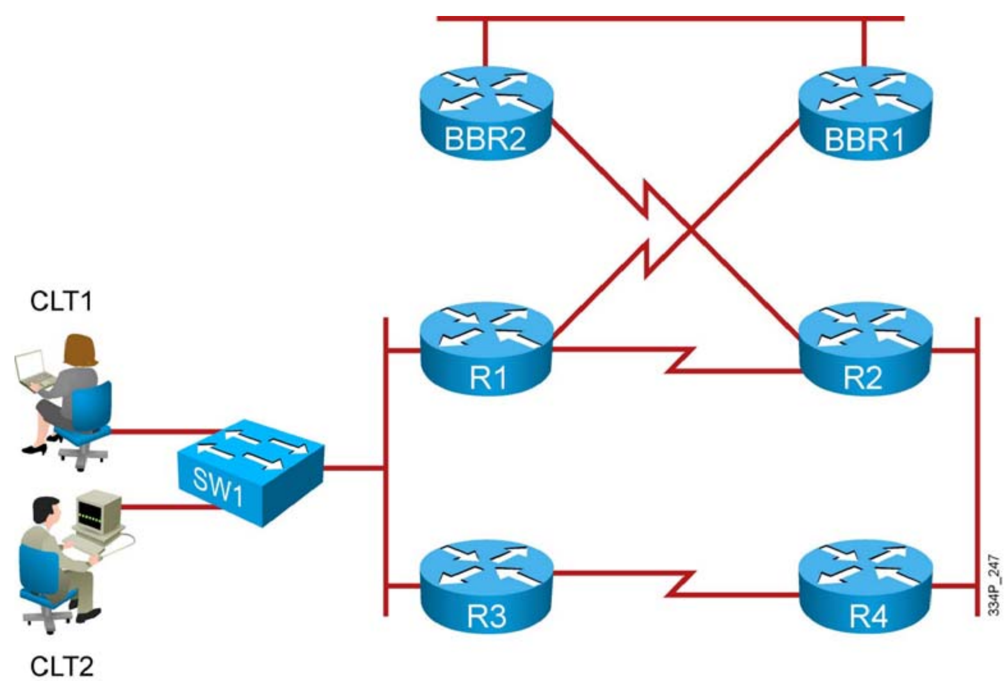
Visual Objective for Lab 1-1: Campus Network To Be Implemented



 ROUTE v1.0—LG-5

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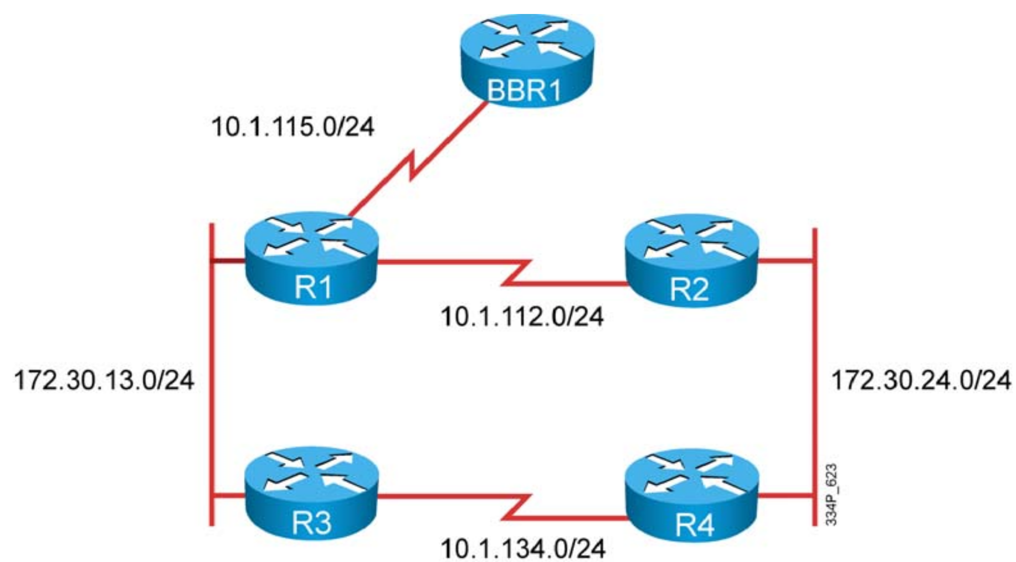
Visual Objective for Lab 2-1: Configure and Verify Basic EIGRP Operations



 ROUTE v1.0—LG-7

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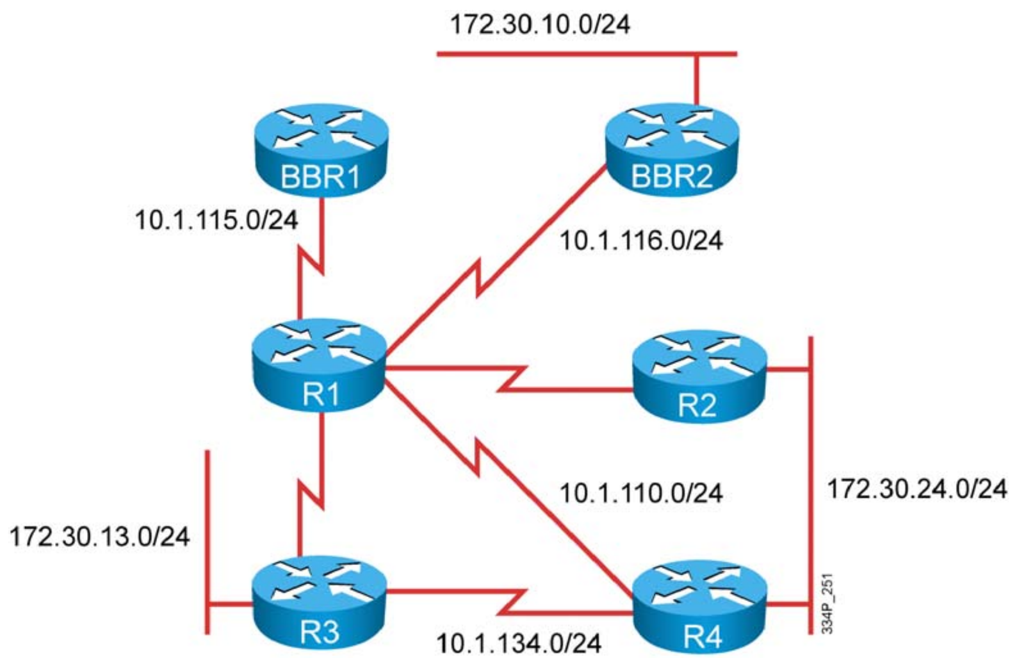
Visual Objective for Lab 2-2: Configure and Verify EIGRP Circuit Emulation and Frame Relay Operations



ROUTE v1.0—LG-8

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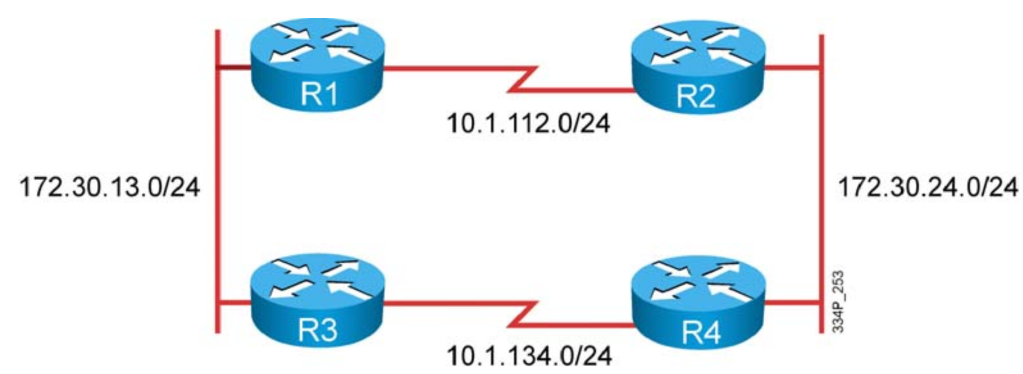
Visual Objective for Lab 2-3: Configure and Verify EIGRP Authentication



ROUTE v1.0—LG-9

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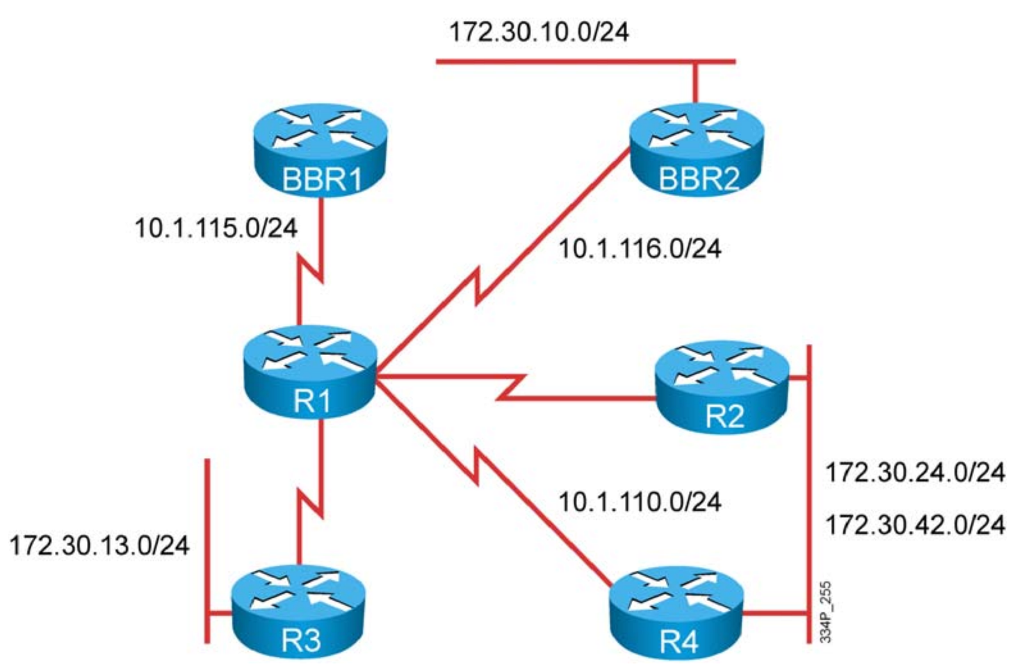
Visual Objective for Lab 2-4: Verify EIGRP Operations



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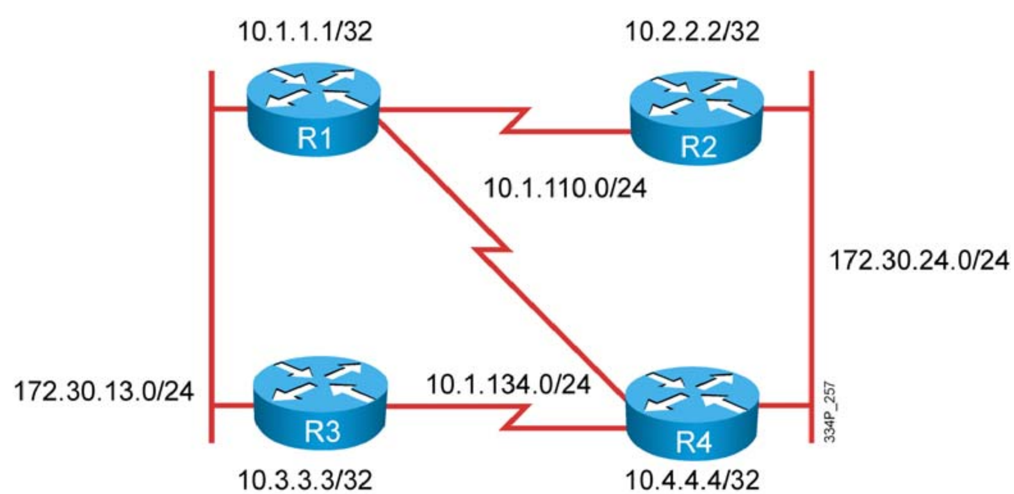
Visual Objective for Lab 3-1: Configure and Verify OSPF to Improve Routing Performance



ROUTE v1.0—LG-11

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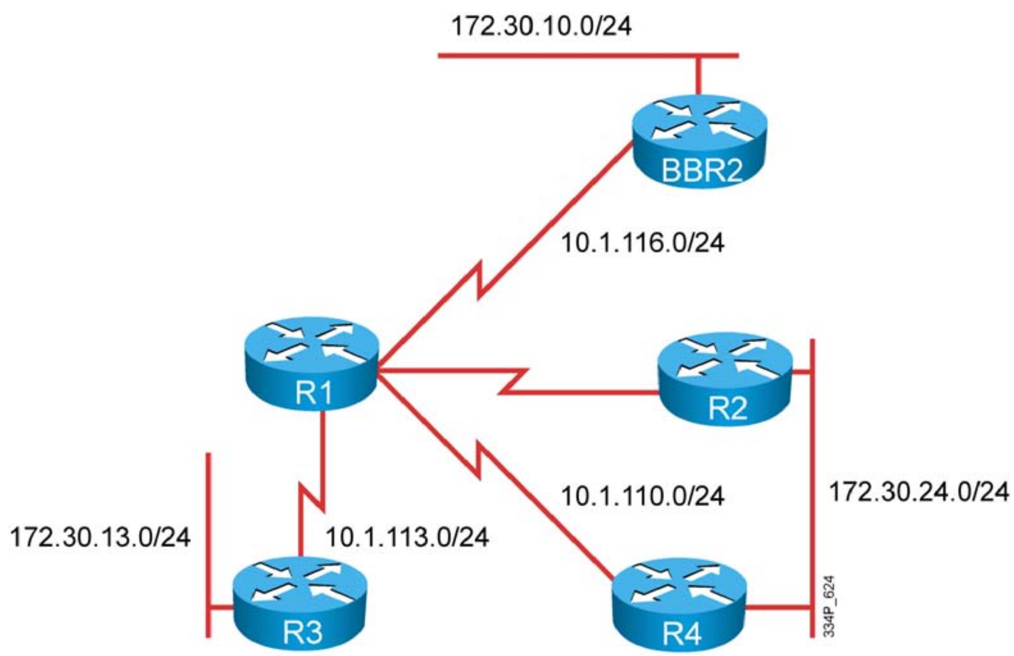
Visual Objective for Lab 3-2: Implement and Verify OSPF Multiarea Routing



ROUTE v1.0—LG-12

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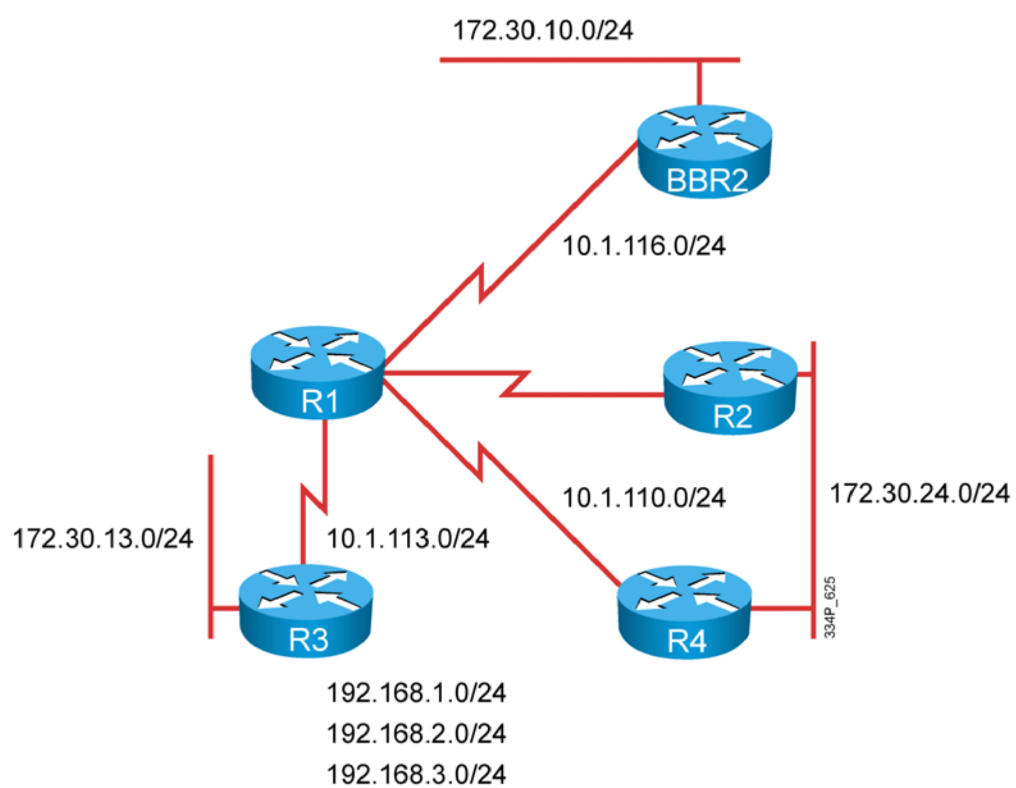
Visual Objective for Lab 3-3: Configure and Verify OSPF Route Summarization for Interarea and External Routes



ROUTE v1.0—LG-13

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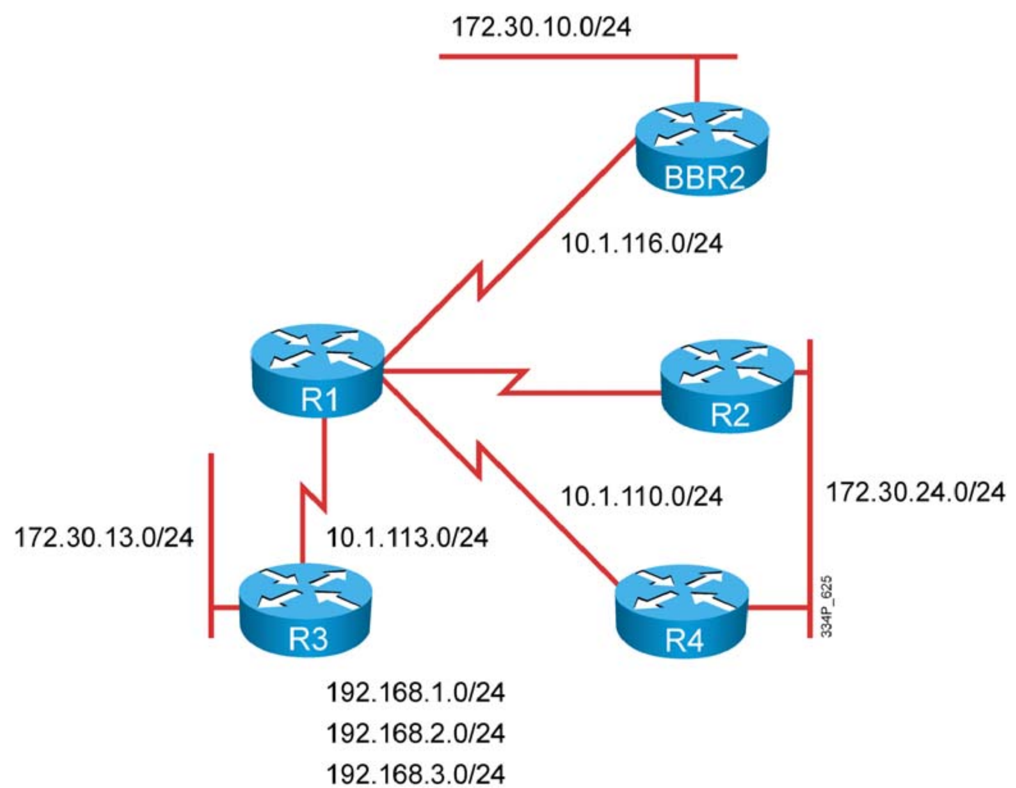
Visual Objective for Lab 3-4: Configure and Verify OSPF Special Area Types



ROUTE v1.0—LG-14

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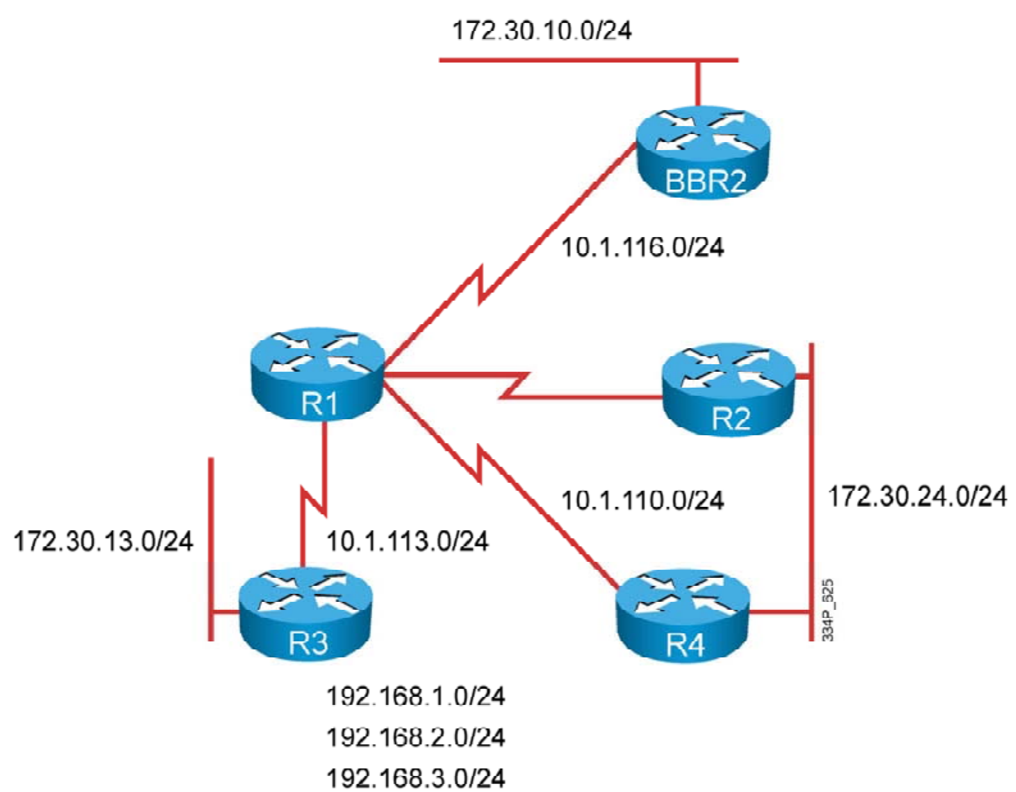
Visual Objective for Lab 3-5: Configure and Verify OSPF Authentication



ROUTE v1.0—LG-15

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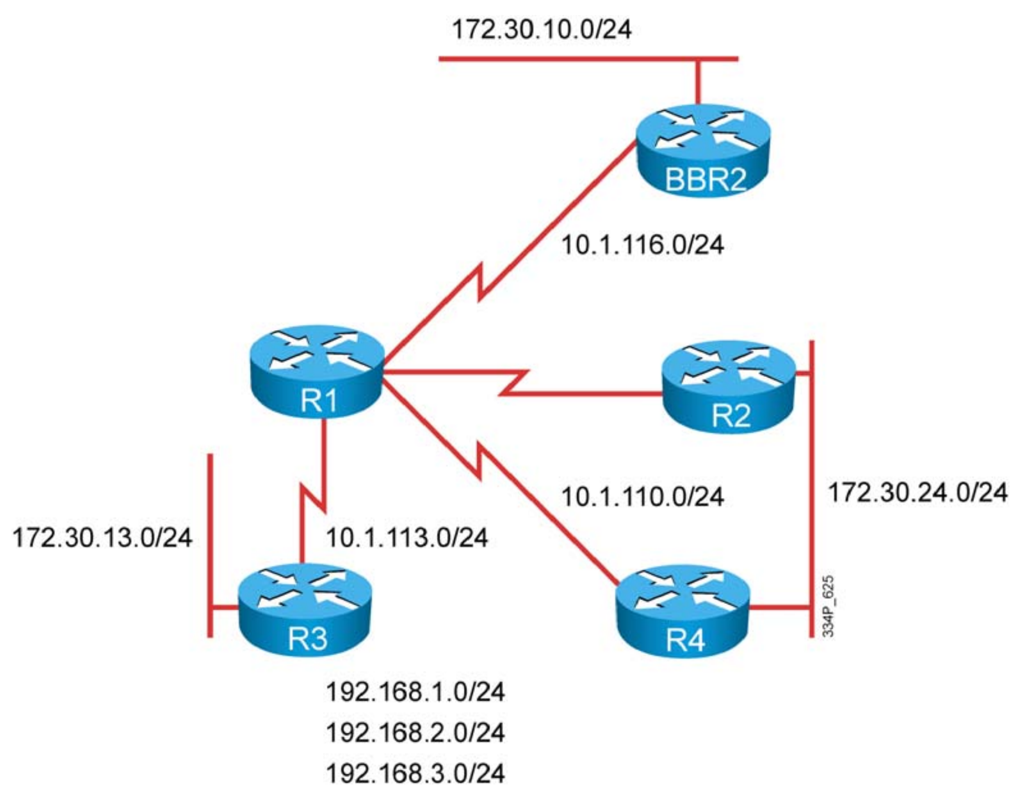
Visual Objective for Lab 4-1: Configure Route Redistribution Between Multiple IP Routing Protocols



 ROUTE v1.0—LG-16

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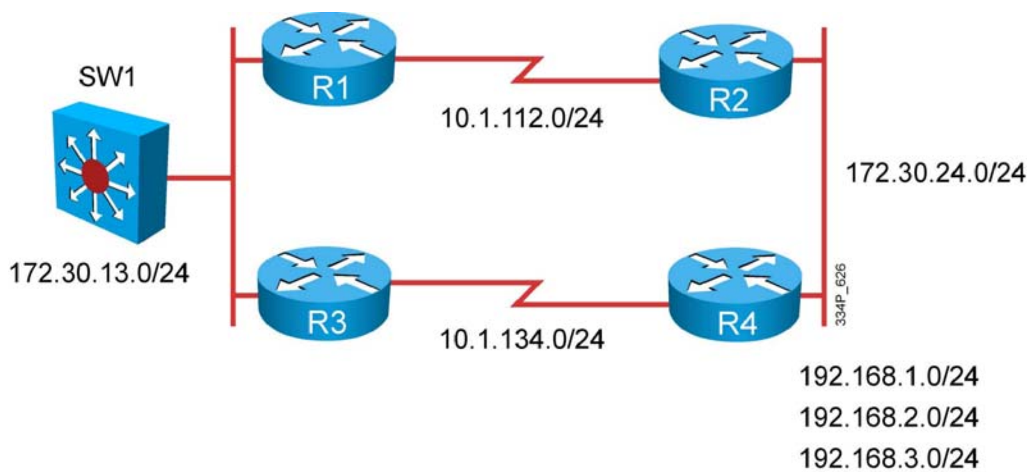
Visual Objective for Lab 5-1: Configure and Verify Path Control Between Multiple IP Routing Protocols



ROUTE v1.0—LG-17

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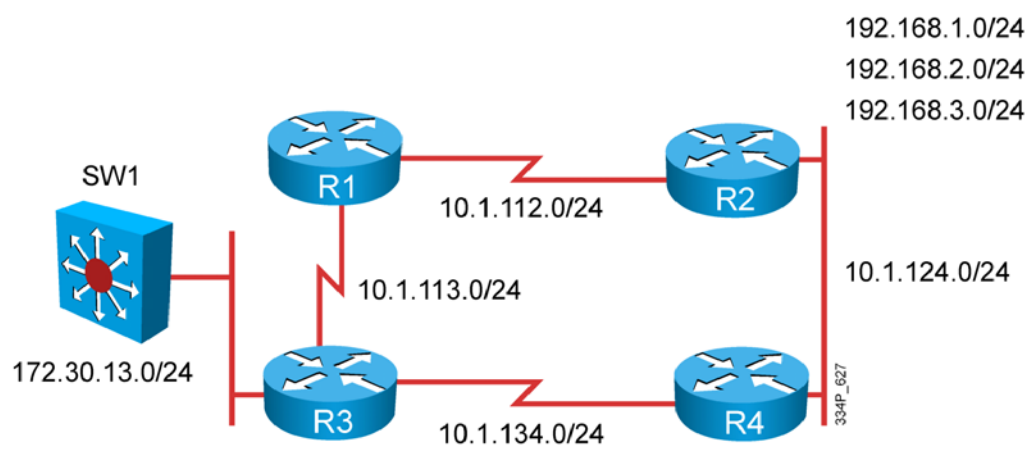
Visual Objective for Lab 6-1: Configure BGP Operations



ROUTE v1.0—LG-18

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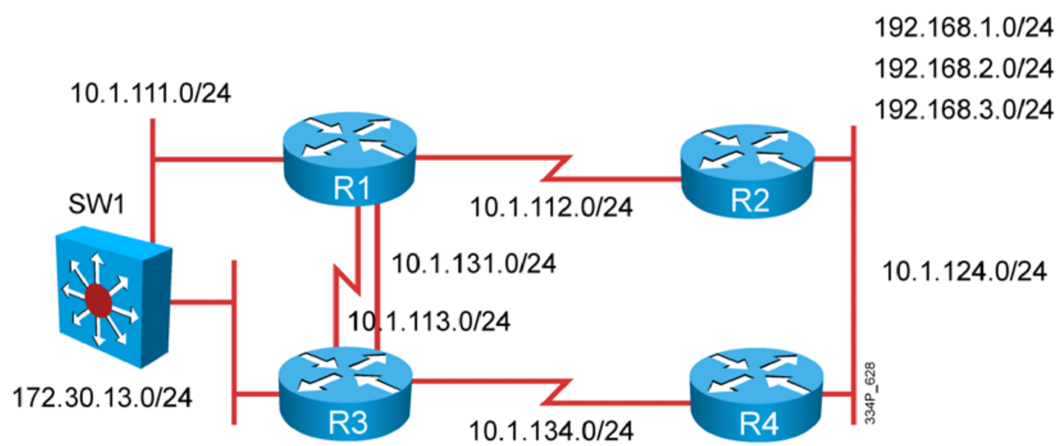
Visual Objective for Lab 6-2: Manipulate EBGP Path Selections



 ROUTE v1.0—LG-19

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