CCNP Routing and Switching
Portable Command Guide

All the CCNP ROUTE 300-101 and SWITCH 300-115 commands in one compact, portable resource

Scott Empson
Patrick Gargano
Hans Roth

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Contents at a Glance

Table of Contents

Part II: SWITCH

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Diane Teare, P.Eng, CCNP, CCDP, CCSI, PMP, is a professional in the networking, training, project management, and e-learning fields. She has more than 25 years of experience in designing, implementing, and troubleshooting network hardware and software and has been involved in teaching, course design, and project management. She has extensive knowledge of network design and routing technologies. Diane is a Cisco Certified Systems Instructor (CCSI) and holds her Cisco Certified Network Professional (CCNP), Cisco Certified Design Professional (CCDP), and Project Management Professional (PMP) certifications. She is an instructor, and the course director for the CCNA and CCNP Routing and Switching curriculum with one of the largest authorized Cisco Learning Partners. She was the director of e-learning for the same company, where she was responsible for planning and supporting all of the company's e-learning offerings in Canada, including Cisco courses. Diane has a bachelor's degree in applied science in electrical engineering and a master's degree in applied science in management science. Diane has authored, co-authored, and served as a technical reviewer on multiple Cisco Press titles.

Dedications

As always, this book is dedicated to Trina, Zach, and Shae. —Scott Empson

To my wife, Kathryn, for her patience, encouragement, love and understanding. I am a much better person thanks to her (or so she says. She also says there should be a comma after "love."). —Patrick Gargano

I'd like to again thank my wife, Carol, for her constant support and understanding during those times I've spent writing in the basement. —Hans Roth

Acknowledgments

Anyone who has ever had anything to do with the publishing industry knows that it takes many, many people to create a book. Our names may be on the cover, but there is no way that we can take credit for all that occurred to get this book from idea to publication. Therefore, we must thank the following:

Scott: The team at Cisco Press. Once again, you amaze me with your professionalism and the ability to make me look good. Mary Beth, Chris, and Tonya—thank you for your continued support and belief in my little engineering journal.

To my technical reviewer, Diane Teare, thanks for keeping me on track and making sure that what I wrote was correct and relevant. I have read and used Diane's books for many years, and now I finally have a chance to work with you. Hopefully, I live up to your standards.

A big thank you goes to my co-authors, Hans Roth and Patrick Gargano, for helping me through this with all of your technical expertise and willingness to assist in trying to make my ideas a reality. I am truly honored to have you as part of the Portable Command Guide family.

Patrick: I feel I must also echo some of Scott's acknowledgments. As the "new guy" on the team, I would have been lost had it not been for Mary Beth's advice, Vanessa's patience, Chris' direction, and Diane's eagle eyes. Thank you for making me feel part of the gang. As well, massive thanks to Scott for bringing me on board for this revision of the *CCNP Portable Command Guide*. It was a pleasure working with him and Hans on this project. I hope I've managed to uphold the level of excellence these books have achieved over the years.

Hans: The overall effort is large and the involvement is wide to get any book completed. Working with you folks at Cisco Press has again been a wonderful partnership. Your ongoing professionalism, understanding, and patience have consistently helped me to do a little better each time I sit down to write.

To our technical reviewer, Diane Teare: Wow, thanks for making me go deep.

Scott and Patrick: Thanks for your help, positive approach, and expertise. It was a very great pleasure.

Command Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in the IOS Command Reference. The Command Reference describes these conventions as follows:

- **Boldface** indicates commands and keywords that are entered literally as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a **show** command).
- *Italic* indicates arguments for which you supply actual values.
- Vertical bars (|) separate alternative, mutually exclusive elements.
- Square brackets ([ ]) indicate an optional element.
- Braces ({ }) indicate a required choice.
- Braces within brackets ([{ }]) indicate a required choice within an optional element.

Introduction

Welcome to *CCNP Routing and Switching Portable Command Guide*! This book is the result of a redesign by Cisco of their professional-level certification exams to more closely align with the industry's need for networking talent as we enter the era of "the Internet of Everything." The previous success of the last editions of both the ROUTE and SWITCH books prompted Cisco Press to approach me with a request to update the book with the necessary new content to help both students and IT professionals in the field study and prepare for the new CCNP ROUTE and SWITCH exams. This time around, after many long talks with Hans and Patrick, Cisco Press, and other trusted IT colleagues, the decision was made to combine both ROUTE and SWITCH into a single volume. Hopefully, you will find value in having both exams' content in a single (albeit slightly thicker) volume. For someone who originally thought that a Portable Command Guide would be fewer than 100 pages in length and limited to the Cisco Academy program for its complete audience, I am continually amazed that my little engineering journal has caught on with such a wide range of people throughout the IT community.

For those of you who have worked with these books before, thank you for looking at this one. I hope that it will help you as you prepare for the vendor exam, or assist you in your daily activities as a Cisco network administrator/manager. For those of you new to the Portable Command Guides, you are reading what is essentially a cleaned-up version of my own personal engineering journals—a small notebook that I carry around with me that contains little nuggets of information; commands that I use but then forget; IP address schemes for the parts of the network I work with only on occasion; and those little reminders for those concepts that you only work with once or twice a year, but still need to know when those times roll around. As an educator who teaches these topics to post-secondary students, the classes I teach sometime occur only once a year; all of you out there can attest to the fact that it is extremely difficult to remember all those commands all the time. Having a journal of commands at your fingertips, without having to search the Cisco website (or if the network is down and you are the one responsible for getting it back online) can be a real timesaver.

With the creation of the new CCNP exam objectives, there is always something new to read, or a new podcast to listen to, or another slideshow from Cisco Live that you missed or that you just want to review again. The engineering journal can be that central repository of information that will not weigh you down as you carry it from the office or cubicle to the server and infrastructure rooms in some remote part of the building or some branch office.

To make this guide a more realistic one for you to use, the folks at Cisco Press have decided to continue with an appendix of blank pages—pages that are there for you to put your own personal touches (your own configurations, commands that are not in this book but are needed in your world, and so on). That way, this book will hopefully look less like the authors' journals and more like your own.

Who Should Read This Book?

This book is for those people preparing for the CCNP ROUTE and/or SWITCH exams, whether through self-study, on-the-job training and practice, study within the Cisco Academy Program, or study through the use of a Cisco Training Partner. There are also some handy hints and tips along the way to make life a bit easier for you in this endeavor. It is small enough that you will find it easy to carry around with you. Big, heavy textbooks might look impressive on your bookshelf in your office, but can you really carry them all around with you when you are working in some server room or equipment closet somewhere?

Strategies for Exam Preparation

The strategy you use for CCNP ROUTE and SWITCH might differ slightly from strategies used by other readers, mainly based on the skills, knowledge, and experience you already have obtained. For instance, if you have attended a ROUTE or SWITCH course, you might take a different approach than someone who learned routing via on-the-job training. Regardless of the strategy you use or the background you have, this book is designed to help you get to the point where you can pass the exam with the least amount of time required. For instance, there is no need for you to practice or read about EIGRP, OSPF, HSRP, or VLANs if you fully understand it already. However, many people like to make sure that they truly know a topic and therefore read over material that they already know. Several book features will help you gain the confidence that you need to be convinced that you know some material already, and to also help you know what topics you need to study more.

How This Book Is Organized

Although this book could be read cover to cover, I strongly advise against it, unless you really are having problems sleeping at night. The book is designed to be a simple listing of those commands needed to be understood to pass the ROUTE and SWITCH exams. Portable Command Guides contain very little theory; it has been designed to list out commands needed at this level of study.

This book follows the list of objectives for the CCNP ROUTE and SWITCH exams:

Part I: ROUTE

- **Chapter 1, "Basic Networking and Routing Concepts"**: This chapter shows the Cisco Hierarchical Model of Network Design; the Cisco Enterprise Composite Network Model; static and default Routes; Administrative Distances; IPv6 Addresses; and RIPng.
- **Chapter 2, "EIGRP Implementation"**: This chapter deals with EIGRP—the design, implementation, verification, and troubleshooting of this protocol in both IPv4 and IPv6.
- **Chapter 3, "Implementing a Scalable Multiarea Network OSPF Based Solution"**: This chapter deals with OSPF; a review of configuring OSPF, both

single area (as a review) and multiarea. Topics again include the design, implementation, verification, and troubleshooting of the protocol in both IPv4 and IPv6.

- **Chapter 4, "Configuration of Redistribution"**: This chapter show how to manipulate routing information. Topics include prefix lists, distribution lists, route maps, route redistribution, and static routes in both IPv4 and IPv6.
- **Chapter 5, "Path Control Implementation"**: This chapter deals those tools and commands that you can use to help evaluate network performance issues and control the path. Topics include CEF, Cisco IOS IP SLAs, and policy-based routing using route maps in both IPv4 and IPv6.
- **Chapter 6, "Enterprise Internet Connectivity"**: This chapter starts with DHCP and NAT and then deals with the use of BGP to connect an enterprise network to a service provider. Topics include the configuration, verificiation, and troubleshooting of a BGP-based solution, BGP attributes, regular expressions, and BGP route filtering using access lists.
- **Chapter 7, "Routers and Router Protocol Hardening"**: This chapter starts with checklists to follow when securing Cisco routers and the components of a router security policy. It then moves into topics such as password encryption, SSH, secure SNMP, backups, logging, and Network Time Protocol (NTP), and finishes with authentication of EIGRP, OSPF, and BGP.

Part II: SWITCH

- **Chapter 8, "Basic Concepts and Network Design"**: This chapter covers topics such as SDM templates, LLDP, PoE, and switch verification commands.
- **Chapter 9, "Campus Network Architecture"**: This chapter provides information on virtual LANs—creating, verifying, and troubleshooting them, along with EtherChannel, DHCPv4 and DHCPv6, and configuring and verifying voice VLANs.
- **Chapter 10, "Implementing Spanning Tree"**: This chapter provides information on the configuration of spanning tree, along with commands used to verify the protocol and to configure enhancements to spanning tree, such as Rapid Spanning Tree and Multiple Spanning Tree. The Cisco STP Toolkit is also shown here, along with FlexLinks.
- **Chapter 11, "Implementing Inter-VLAN Routing"**: This chapter shows the different ways to enable inter-VLAN communication—using an external router or using SVIs on a multilayer switch.
- **Chapter 12, "Implementing High-Availability Networks"**: This chapter covers topics such as IP service level agreements, port mirroring, and switch virtualization.
- **Chapter 13, "First-Hop Redundancy Implementation"**: This chapter provides information needed to ensure that you have first-hop redundancy; HSRP, VRRP, and GLBP are shown here in both IPv4 and IPv6.
- **Chapter 14, "Campus Network Security"**: Security is the focus of this chapter. Topics covered include switch security recommended practices, static MAC addresses, port security, 802.1x authentication, mitigating VLAN hopping, DHCP snooping, DAI, and private VLANs.

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CHAPTER 4

Configuration of Redistribution

This chapter provides information about the following redistribution topics:

- Defining seed and default metrics
- Redistributing connected networks
- Redistributing static routes
- Redistributing subnets into OSPF
- Assigning E1 or E2 routes in OSPF
- Redistributing OSPF internal and external routes
- Configuration example: route redistribution for IPv4
- Configuration example: route redistribution for IPv6
- Verifying route redistribution
- Route filtering using the **distribute-list** command
    - Configuration example: inbound and outbound distribute list route filters
    - Configuration example: controlling redistribution with outbound distribute lists
    - Verifying route filters
- Route filtering using prefix lists
    - Configuration example: using a distribute list that references a prefix list to control redistribution
    - Verifying prefix lists
- Using route maps with route redistribution
    - Configuration example: route maps
- Manipulating redistribution using route tagging
- Changing administrative distance for internal and external routes
- Passive interfaces

Defining Seed and Default Metrics

`Router(config)#router eigrp 100`	Starts the EIGRP routing process.
`Router(config-router)#network 172.16.0.0`	Specifies which network to advertise in EIGRP.

`Router(config-router)#` **`redistribute rip`** `Router(config-router)#`**`default-metric 1000 100 250 1 1500`** Or `Router(config-router)#` **`redistribute rip metric 1000 100 250 1 1500`**	Redistributes routes learned from RIP into EIGRP. The metrics assigned to these learned routes will be calculated using the following components: 1000 = Bandwidth in Kbps 100 = Delay in tens of microseconds 255 = Reliability out of 255 1 = Load out of 255 1500 = Maximum transmission unit (MTU) size The **metric** keyword in the second option assigns a starting EIGRP metric that is calculated using the following components: 1000, 100, 255, 1 1500.

NOTE: The values used in this command constitute the seed metric for these RIP routes being redistributed into EIGRP. The seed metric is the initial value of an imported route and it must be consistent with the destination protocol.

NOTE: The default seed metrics are as follows:

- Connected: 1
- Static: 1
- RIP: Infinity
- EIGRP: Infinity
- OSPF: 20 for all except for BGP, which is 1
- BGP: BGP metric is set to IGP metric value

NOTE: If both the **metric** keyword in the **redistribute** command and the **default-metric** command are used, the value of the **metric** keyword in the **redistribute** command takes precedence.

TIP: If a value is not specified for the **metric** option, and no value is specified using the **default-metric** command, the default metric value is 0, except for Open Shortest Path First (OSPF) Protocol, where the default cost is 20. Routing Information Protocol (RIP) and Enhanced Interior Gateway Routing Protocol (EIGRP) must have the appropriate metrics assigned to any redistributed routes; otherwise, redistribution will not work. Border Gateway Protocol (BGP) will use the Internal Gateway Protocol (IGP) metric, while both connected networks and static routes will receive an initial default value of 1.

TIP: The **default-metric** command is useful when routes are being redistributed from more than one source because it eliminates the need for defining the metrics separately for each redistribution.

TIP: Redistributed routes between EIGRP processes do not need metrics configured. Redistributed routes are tagged as EIGRP external routes and will appear in the routing table with a code of D EX.

Redistributing Connected Networks

`Router(config)#router ospf 1`	Starts the OSPF routing process.
`Router(config-router)#` `redistribute connected`	Redistributes all directly connected networks.
	NOTE: It is not necessary to redistribute networks that are already configured under the routing protocol.
	NOTE: The **connected** keyword refers to routes that are established automatically by virtue of having enabled IP on an interface. For routing protocols such as OSPF, Intermediate System-to-Intermediate System (IS-IS), and EIGRP, these routes are redistributed as external to the autonomous system.

`Router(config-router)#`
`redistribute connected`
`metric 50`
	Redistributes all directly connected networks and assigns them a starting metric of 50.

	NOTE: The **redistribute connected** command is *not* affected by the **default-metric** command.

Redistributing Static Routes

`Router(config)#ip route 10.1.1.0` `255.255.255.0 serial 0/0/0`	Creates a static route for network 10.1.1.0/24 exiting out of interface Serial 0/0/0
`Router(config)#router eigrp 10`	Starts the EIGRP routing process
`Router(config-router)#` `redistribute static`	Redistributes static routes on this router into the EIGRP routing process

Redistributing Subnets into OSPF

`Router(config)#router ospf 1`	Starts the OSPF routing process.

`Router(config-router)#`
`redistribute eigrp 10`
`metric 100 subnets`
	Redistributes routes learned from EIGRP autonomous system 10. A metric of 100 is assigned to all routes. Subnets will also be redistributed.

	NOTE: Without the **subnets** keyword, no subnets will be redistributed into the OSPF domain. (Only routes that are in the routing table with the default classful mask will be redistributed.)

Assigning E1 or E2 Routes in OSPF

`Router(config)#router ospf 1`	Starts the OSPF routing process.
`Router(config-router)#` `redistribute eigrp 1 metric-type 1`	Redistributes routes learned from EIGRP autonomous system 1. Routes will be advertised as E1 routes.
	NOTE: If the **metric-type** argument is not used, routes will be advertised by default in OSPF as E2 routes. E2 routes have a default fixed cost of 20 associated with them, but this value can be changed with the **metric** keyword. The metric will not change as the route is propagated throughout the OSPF area. E1 routes will have internal area costs added to the seed metric.

TIP: Use external type 1 (E1) routes when there are multiple Autonomous System Border Routers (ASBRs) advertising an external route to the same autonomous system to avoid suboptimal routing (see Figure 4-1).

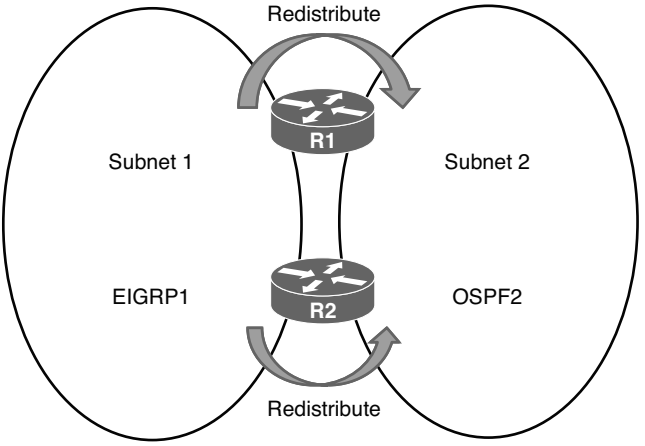

Figure 4-1 Network Topology with Two ASBRs

TIP: Use external type 2 (E2) routes if only one ASBR is advertising an external route to the AS (see Figure 4-2).

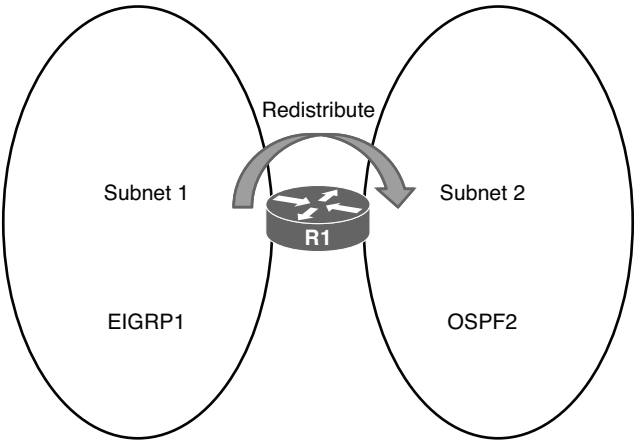

Figure 4-2 Network Topology with One ASBR

Redistributing OSPF Internal and External Routes

`Router(config)#router eigrp 10`	Starts the EIGRP routing process for autonomous system 10.
`Router(config-router)#` **`redistribute ospf 1 match internal external 1 external 2`**	Redistributes routes learned from OSPF process ID 1. The keywords **match internal external 1** and **external 2** instruct EIGRP to only redistribute internal, external type 1 and type 2 OSPF routes.
	NOTE: The default behavior when redistributing OSPF routes is to redistribute all routes—internal, external 1, and external 2. The keywords **match internal external 1** and **external 2** are required only if router behavior is to be modified.

Configuration Example: Route Redistribution for IPv4

Figure 4-3 shows the network topology for the configuration that follows, which demonstrates how to configure single point two-way basic redistribution between EIGRP and OSPF for IPv4, using the commands covered in this chapter. For this configuration example, assume that EIGRP and OSPF routing has been configured correctly on all four routers.

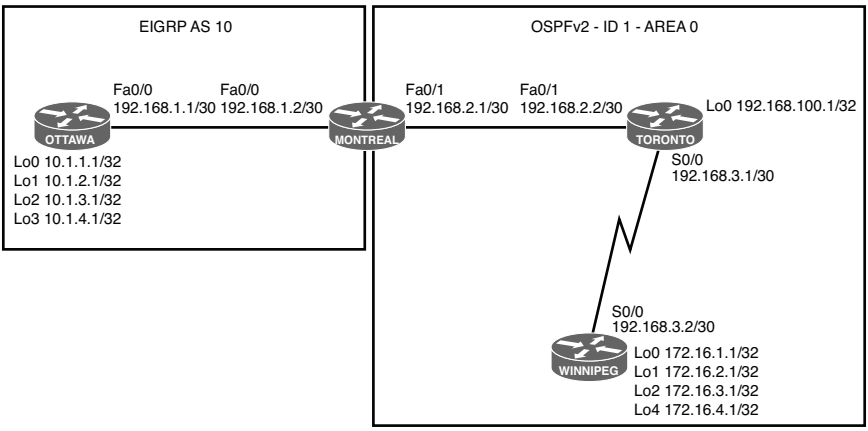

Figure 4-3 Network Topology for IPv4 Route Redistribution

`MONTREAL(config)#router eigrp 10`	Enters EIGRP configuration mode.
`MONTREAL(config-router)#` **`redistribute ospf 1 metric 1500 10 255 1 1500`**	Redistributes routes from OSPF process ID 1 into EIGRP AS 10 and assigns a seed metric to these routes.
`MONTREAL(config-router)#exit`	Returns to global configuration mode.
`MONTREAL(config)#router ospf 1`	Enters OSPF configuration mode.
`MONTREAL(config-router)#` **`redistribute eigrp 10 subnets`**	Redistributes classless routes from EIGRP autonomous system 10 into OSPF process ID 1 as external type 2 (E2) with a metric of 20, which is fixed and does not change across the OSPF domain.
	NOTE: Omitting the **subnets** keyword is a common configuration error. Without this keyword, only networks in the routing table with a classful mask will be redistributed. Subnets will not be redistributed, and subnets will not be automatically summarized and redistributed.
`MONTREAL(config-router)#` **`redistribute eigrp 10 metric-type 1 subnets`**	Redistributes classless routes from EIGRP autonomous system 10 into OSPF process ID 1 as external type 1 (E1). Type 1 external routes calculate the cost by adding the external cost (20) to the internal cost of each link that the packet crosses.

Configuration Example: Route Redistribution for IPv6

Figure 4-4 shows the network topology for the configuration that follows, which demonstrates how to configure single point two-way basic redistribution between EIGRP and OSPF for IPv6, using the commands covered in this chapter. For this configuration example, assume that EIGRP and OSPF routing for IPv6 has been configured correctly on all four routers.

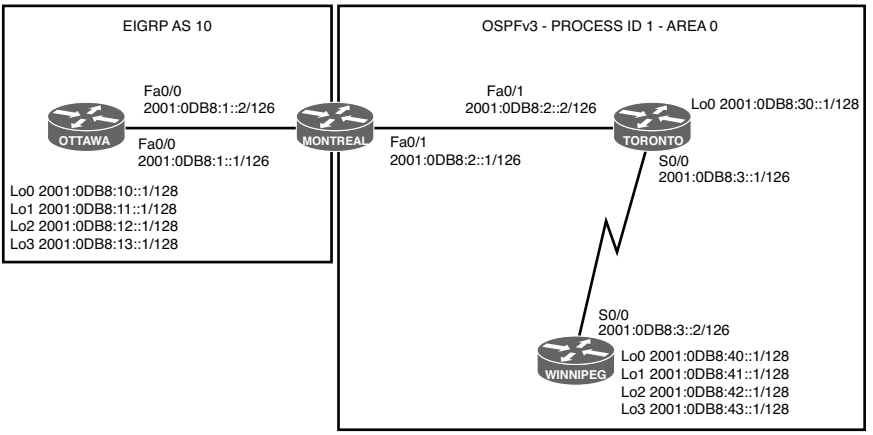

Figure 4-4 Network Topology for IPv6 Route Redistribution

`MONTREAL(config)#`**`ipv6 router eigrp 10`**	Enters IPv6 EIGRP configuration mode.
`MONTREAL(config-router)#` **`redistribute ospf 1 metric 1500 10 255 1 1500 include-connected`**	Redistributes IPv6 routes from OSPF process ID 1 into EIGRP autonomous system 10 and assigns a seed metric to these routes.
	NOTE: With the **include-connected** command, you instruct the target routing protocol to redistribute the routes that are learned by the source protocol and also the connected interfaces if the source routing protocol is running on them.
`MONTREAL(config-router)#`**`exit`**	Returns to global configuration mode.
`MONTREAL(config)#`**`ipv6 router ospf 1`**	Enters IPv6 OSPF configuration mode.
`MONTREAL(config-router)#` **`redistribute eigrp 10 include-connected`**	Redistributes IPv6 routes from EIGRP autonomous system 10 into OSPF process ID 1 as external type 2 (E2) with a metric of 20, which is fixed and does not change across the OSPF domain.

`MONTREAL(config-router)#` **`redistribute eigrp 10 metric-type 1 include-connected`**	Redistributes IPv6 routes from EIGRP autonomous system 10 into OSPF process ID 1 as external type 1 (E1). Type 1 external routes calculate the cost by adding the external cost (20) to the internal cost of each link that the packet crosses.
	NOTE: The **subnets** keyword does not exist in OSPFv3 redistribution configuration.

Verifying Route Redistribution

`Router#`**`show ip route`** `Router#`**`show ipv6 route`**	Displays the current state of the routing table
`Router#`**`show ip eigrp topology`** `Router#`**`show ipv6 eigrp topology`**	Displays the EIGRP topology table
`Router#`**`show ip protocols`** `Router#`**`show ipv6 protocols`**	Displays parameters and the current state of any active routing process
`Router#`**`show ip rip database`** `Router#`**`show ipv6 rip database`**	Displays summary address entries in the RIP routing database
`Router#`**`show ip ospf database`** `Router#`**`show ipv6 ospf database`**	Displays the link-state advertisement (LSA) types within the link-state database (LSDB)

Route Filtering Using the distribute-list Command

`Router(config)#`**`router eigrp 10`**	Starts the EIGRP routing process for autonomous system 10
`Router(config-router)#`**`distribute-list 1 in`**	Creates an incoming global distribute list that refers to access control list (ACL) 1
`Router(config-router)#`**`distribute-list 2 out`**	Creates an outgoing global distribute list that refers to ACL 2
`Router(config-router)#`**`distribute-list 3 in fastethernet0/0`**	Creates an incoming distribute list for interface FastEthernet0/0 and refers to ACL 3
`Router(config-router)#`**`distribute-list 4 out serial0/0/0`**	Creates an outgoing distribute list for interface Serial0/0/0 and refers to ACL 4
`Router(config-router)#`**`distribute-list 5 out ospf 1`**	Filters updates advertised from OSPF process ID 1 into EIGRP autonomous system 10 according to ACL 5

Configuration Example: Inbound and Outbound Distribute List Route Filters

Figure 4-5 shows the network topology for the configuration that follows, which demonstrates how to configure inbound and outbound route filters to control routing updates using the commands covered in this chapter. Assume that all basic configurations and EIGRP routing have been configured correctly.

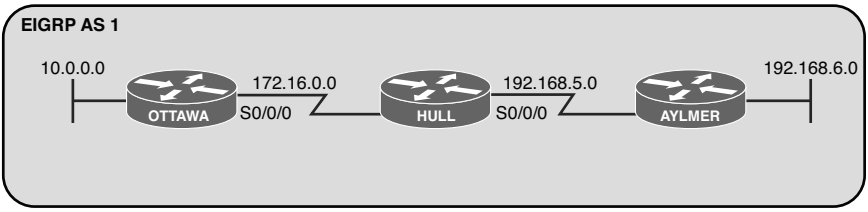

Figure 4-5 Network Topology for Inbound and Outbound Distribute List Route Filters

The first objective is to prevent router AYLMER from learning the 10.0.0.0/8 network using an outbound distribute list on router HULL.

`HULL(config)#access-list 10 deny 10.0.0.0 0.255.255.255`	Creates a standard ACL number 10 and explicitly denies the 10.0.0.0/8 network
`HULL(config)#access-list 10 permit any`	Adds a second line to ACL 10 which permits all other networks
`HULL(config)#router eigrp 1`	Enters EIGRP autonomous system 1 routing process

`HULL(config-router)#distribute-list 10 out`
Or
`HULL(config-router)#distribute-list 10 out serial0/0/0`
	Creates an outbound global distribute list that refers to ACL 10
	Creates an outgoing distribute list for interface Serial0/0/0 that refers to ACL 10

The second objective is to prevent router OTTAWA from learning the 192.168.6.0/24 network using an inbound distribute list on router OTTAWA.

`OTTAWA(config)#access-list 20 deny 192.168.6.0 0.0.0.255`	Creates a standard ACL number 20 and explicitly denies the 192.168.6.0/24 network
`OTTAWA(config)#access-list 20 permit any`	Adds a second line to ACL 20 which permits all other networks
`OTTAWA (config)#router eigrp 1`	Enters EIGRP autonomous system 1 routing process

`OTTAWA(config-router)# distribute-list 20 in`
Or
`OTTAWA(config-router)# distribute-list 20 in serial0/0/0`
	Creates an inbound global distribute list that refers to ACL 20
	Creates an inbound distribute list for interface Serial0/0/0 that refers to ACL 20

Configuration Example: Controlling Redistribution with Outbound Distribute Lists

Figure 4-6 shows the network topology for the configuration that follows, which demonstrates how to control redistribution with an outbound distribute list using the commands covered in this chapter. Assume that all basic configurations and EIGRP and OSPF routing have been configured correctly.

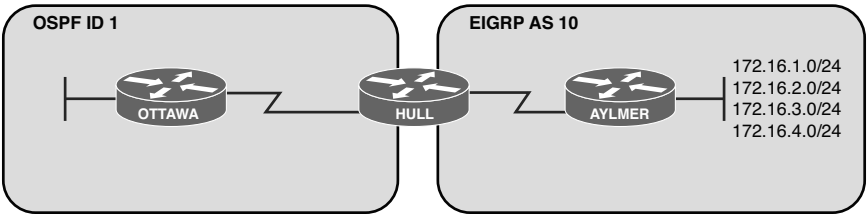

Figure 4-6 Network Topology for Controlling Redistribution with Outbound Distribute Lists

The objective is to prevent networks 172.16.3.0/24 and 172.16.4.0/24 from being redistributed into the OSPF domain.

`HULL(config)#access-list 30 permit 172.16.1.0 0.0.0.255`	Creates a standard ACL number 30 and explicitly permits the 172.16.1.0/24 network.
`HULL (config)#access-list 30 permit 172.16.2.0 0.0.0.255`	Adds a second line to ACL 30 that explicitly permits the 172.16.2.0/24 network.
`HULL(config)#router ospf 1`	Enters OSPF process ID 1 routing process.
`HULL(config-router)#redistribute eigrp 10 subnets`	Redistributes all EIGRP networks into OSPF.
`HULL(config-router)#distribute-list 30 out eigrp 10`	Creates an outbound distribute list to filter routes being redistributed from EIGRP into OSPF.
	NOTE: The implicit "deny any" statement at the end of the access list prevents routing updates about any other network from being advertised. As a result, networks 172.16.3.0/24 and 172.16.4.0/24 will not be redistributed into OSPF.

Verifying Route Filters

`Router#show ip protocols`	Displays the parameters and current state of active routing protocols

```
Routing Protocol is "eigrp 10"
  Outgoing update filter list for all interfaces is 2
   Redistributed ospf 1 filtered by 5
    Serial 0/0/0 filtered by 4
  Incoming update filter list for all interfaces is 1
    FastEthernet0/0 filtered by 3
```

NOTE: For each interface and routing process, Cisco IOS permits the following:

- One incoming global distribute list
- One outgoing global distribute list
- One incoming interface distribute list
- One outgoing interface distribute list
- One outgoing redistribution distribute list

CAUTION: Route filters have *no* effect on LSAs or the LSDB. A basic requirement of link-state routing protocols is that routers in an area must have identical LSDBs.

NOTE: OSPF routes *cannot* be filtered from entering the OSPF database. The **distribute-list in** command filters routes only from entering the routing table, but it doesn't prevent link-state packets (LSP) from being propagated.

The command **distribute-list out** works only on the routes being redistributed by the ASBR into OSPF. It can be applied to external type 2 and external type 1 routes but *not* to intra-area and interarea routes.

Route Filtering Using Prefix Lists

The general syntax for configuring a prefix list is as follows:

```
Router(config)#ip prefix-list list-name [seq seq-value] deny | permit
network/len [ge ge-value] [le le-value]
```

The table that follows describes the parameters for this command.

Parameter	Description
list-name	The name of the prefix list
seq	(Optional) Applies a sequence number to the entry being created or deleted
seq-value	(Optional) Specifies the sequence number
deny	Denies access to matching conditions
permit	Permits access for matching conditions
network/len	(Mandatory) The network number and length (in bits) of the netmask
ge	(Optional) Applies *ge-value* to the range specified

Parameter	Description
ge-value	(Optional) Specifies the lesser value of a range (the "from" portion of the range description)
le	(Optional) Applies *le-value* to the range specified
le-value	(Optional) Specifies the greater value of a range (the "to" portion of the range description)

TIP: You must define a prefix list before you can apply it as a route filter.

TIP: There is an implicit deny statement at the end of each prefix list.

TIP: The range of sequence numbers that can be entered is from 1 to 4,294,967,294. If a sequence number is not entered when configuring this command, a default sequence numbering is applied to the prefix list. The number 5 is applied to the first prefix entry, and subsequent unnumbered entries are incremented by 5.

A router tests for prefix list matches from the lowest sequence number to the highest.

By numbering your **prefix-list** statements, you can add new entries at any point in the list.

The following examples show how you can use the **prefix-list** command to filter networks using some of the more commonly used options.

`Router(config)#ip prefix-list ROSE permit 192.0.0.0/8 le 24`	Creates a prefix list that will accept a netmask of up to 24 bits (**le** meaning less than or equal to) in routes with the prefix 192.0.0.0/8. Because no sequence number is identified, the default number of 5 is applied.
`Router(config)#ip prefix-list ROSE deny 192.0.0.0/8 ge 25`	Creates a prefix list that will deny routes with a netmask of 25 bits or greater (**ge** meaning greater than or equal to) in routes with the prefix 192.0.0.0/8. Because no sequence number is identified, the number 10 is applied—an increment of 5 over the previous statement.
	NOTE: This configuration will permit routes such as 192.2.0.0/16 or 192.2.20.0/24, but will deny a more specific subnet such as 192.168.10.128/25.
`Router(config)#ip prefix-list TOWER permit 10.0.0.0/8 ge 16 le 24`	Creates a prefix list that permits all prefixes in the 10.0.0.0/8 address space that have a netmask of between 16 and 24 bits (greater than or equal to 16 bits, and less than or equal to 24 bits).

`Router(config)#ip prefix-list TEST seq 5 permit 0.0.0.0/0`	Creates a prefix list and assigns a sequence number of 5 to a statement which permits only the default route 0.0.0.0/0.
`Router(config)#ip prefix-list TEST seq 10 permit 0.0.0.0/0 ge 30 le 30`	Creates a prefix list and assigns a sequence number of 10 to a statement that permits any prefix with a netmask of exactly 30 bits.
`Router(config)#ip prefix-list TEST seq 15 permit 0.0.0.0/0 le 32`	Creates a prefix list and assigns a sequence number of 15 to a statement that permits any address or subnet (permit any).
`Router(config)#no ip prefix-list TEST seq 10`	Removes sequence number 10 from the prefix list.

Configuration Example: Using a Distribute List That References a Prefix List to Control Redistribution

Figure 4-7 shows the network topology for the configuration that follows, which demonstrates how to control redistribution with a prefix list using the commands covered in this chapter. Assume that all basic configurations and EIGRP and OSPF routing have been configured correctly.

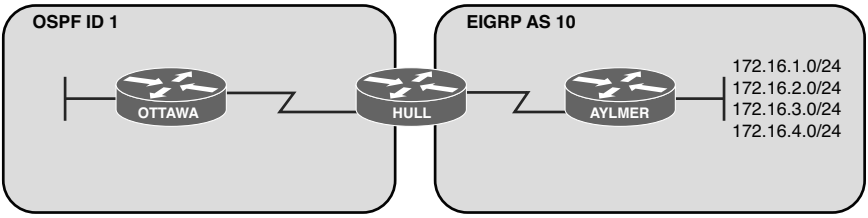

Figure 4-7 Network Topology for Distribute List Configuration with Prefix Lists

The objective is to prevent networks 172.16.3.0/24 and 172.16.4.0/24 from being redistributed into the OSPF domain.

`HULL(config)#ip prefix-list FILTER seq 5 permit 172.16.1.0/24`	Creates a prefix list called FILTER with a first sequence number of 5 that explicitly permits the 172.16.1.0/24 network.
`HULL (config)#ip prefix-list FILTER seq 10 permit 172.16.2.0/24`	Adds a second line to the FILTER prefix list that explicitly permits the 172.16.2.0/24 network.
`HULL(config)#router ospf 1`	Enters OSPF process ID 1 routing process.
`HULL(config-router)# redistribute eigrp 10 subnets`	Redistributes all EIGRP networks into OSPF.

`HULL(config-router)#` **`distribute-list prefix FILTER out eigrp 10`**	Creates an outbound distribute list to filter routes being redistributed from EIGRP into OSPF that references the prefix list.
	NOTE: The implicit deny any statement at the end of the prefix list prevents routing updates about any other network from being advertised. As a result, networks 172.16.3.0/24 and 172.16.4.0/24 will not be redistributed into OSPF.

TIP: You can attach prefix lists to the redistribution process either via a distribute list or via a route map.

Verifying Prefix Lists

`show ip prefix-list` `[` **`detail`** `|` **`summary`**`]`	Displays information on all prefix lists. Specifying the **detail** keyword includes the description and the hit count (the number of times the entry matches a route) in the display.
`clear ip prefix-list` *`prefix-list-name`*`[network/length]`	Resets the hit count shown on prefix list entries.

Using Route Maps with Route Redistribution

`Router(config)#` **`route-map MY_MAP permit 10`**	Creates a route map called MY_MAP. This **route-map** statement will permit redistribution based on subsequent criteria. A sequence number of 10 is assigned.
`Router(config-route-map)#` **`match ip address 5`**	Specifies the match criteria (the conditions that should be tested); in this case, match addresses filtered using a standard access list number 5.
`Router(config-route-map)#` **`set metric 500`**	Specifies the set action (what action is to be performed if the match criteria is met); in this case, set the external metric to 500 (instead of the default value of 20).
`Router(config-route-map)#` **`set metric-type type-1`**	Specifies a second set action for the same match criteria. In this case, set the external OSPF network type to E1.

`Router(config-route-map)#route-map MY_MAP deny 20`	Adds a second statement to the MY_MAP route map that will deny redistribution based on subsequent criteria.
`Router(config-route-map)#match ip address prefix-list MY_PFL`	Specifies the match criteria (the conditions that should be tested); in this case, match addresses filtered using a prefix list named MY_PFL.
`Router(config-route-map)#route-map MY_MAP permit 30`	Adds a third statement to the MY_MAP route map that will permit redistribution based on subsequent criteria.
	NOTE: No "match" criteria are explicitly specified; all other routes will be redistributed with the following "set" criteria applied.
`Router(config-route-map)#set metric 5000`	Specifies the set action (what action is to be performed if the match criteria is met); in this case, set the external metric to 5000 (instead of the default value of 20)
`Router(config-route-map)#set metric-type type 2`	Specifies a second set action for the same match criteria; in this case, set the external OSPF network type to E2. This is optional since the default type for redistributed routes into OSPF is external type 2.
`Router(config-route-map)#router ospf 10`	Enters OSPF process ID 10 routing process.
`Router(config-router)#redistribute eigrp 1 route-map MY_MAP subnets`	Redistributes only EIGRP routes that are permitted by route map MY_MAP into OSPF.

NOTE: When used to filter redistribution, route map **permit** or **deny** statements determine whether the route will be redistributed. Routes without a match will not be redistributed. The route map stops processing at the first match (similar to an access list or prefix list). There is always an implicit deny statement at the end of a route map.

Configuration Example: Route Maps

Figure 4-8 shows the network topology for the configuration that follows, which demonstrates how to control redistribution with a route map using the commands covered in this chapter. Assume that all basic configurations and EIGRP and OSPF routing have been configured correctly.

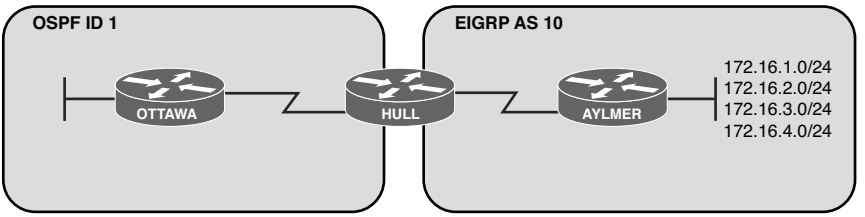

Figure 4-8 Network Topology for Route Map Configuration

The objective is to only redistribute networks 172.16.1.0/24 and 172.16.2.0/24 into OSPF and advertise them as external type 1 (E1) routes with an external metric of 50.

`HULL(config)#access-list 5 permit 172.16.1.0 0.0.0.255`	Creates a standard ACL number 5 and explicitly permits the 172.16.1.0/24 network.
`HULL (config)#access-list 5 permit 172.16.2.0 0.0.0.255`	Adds a second line to ACL 5 that explicitly permits the 172.16.2.0/24 network.
`HULL(config)#route-map FILTER permit 10`	Creates a route map called FILTER. This route map will permit traffic based on subsequent criteria. A sequence number of 10 is assigned.
`HULL(config-route-map)#match ip address 5`	Specifies the match criteria; match addresses filtered from ACL 5.
`HULL(config-route-map)#set metric 50` `HULL(config-route-map)#set metric-type type-1`	Specifies the set actions (what actions are to be performed if the match criterion is met); in this case, sets the external metric to 50 *and* sets the type to external type 1 (E1).
`HULL(config)#router ospf 1`	Enters OSPF process ID 1 routing process.
`HULL(config)#redistribute eigrp 10 subnets route-map FILTER`	Redistributes only those EIGRP networks into OSPF which match the route map.
	NOTE: Networks 172.16.2.0/24 and 172.16.3.0/24 will not be redistributed because of the implicit deny any at the end of the route map.

Manipulating Redistribution Using Route Tagging

Two-way multipoint redistribution can introduce routing loops in the network. One option to prevent redistribution of already redistributed routes is to use route tagging. In two-way multipoint redistribution scenarios, route tags must be applied and filtered in both direction and on both routers performing redistribution.

Figure 4-9 shows the network topology for the configuration that follows, which demonstrates how to control redistribution with route tags using the commands covered in this chapter. Assume that all basic configurations and EIGRP and OSPF routing have been configured correctly. A tag number of 11 is used to identify OSPF routes, and a tag of 22 is used to identify EIGRP routes.

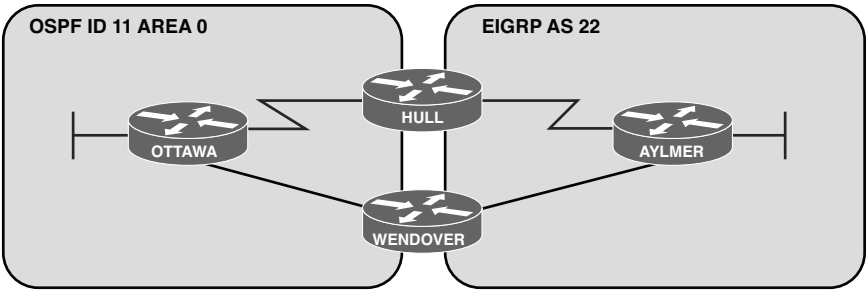

Figure 4-9 Network Topology for Redistribution Using Route Tagging

The following configuration needs to be entered on both the HULL and WENDOVER routers.

`HULL(config)#route-map EIGRPtoOSPF deny 10` `HULL(config-route-map)#match tag 11`	Creates a route map named EIGRPtoOSPF and denies redistribution for all routes tagged with the value 11.
`HULL(config-route-map)#route-map EIGRPtoOSPF permit 20` `HULL(config-route-map)#set tag 22`	Creates a second statement for route map EIGRPtoOSPF permitting all other routes to be redistributed with a tag of 22.
`HULL(config-route-map)#route-map OSPFtoEIGRP deny 10` `HULL(config-route-map)#match tag 22`	Creates a route map names OSPFtoEIGRP and denies redistribution for all routes tagged with the value 22.
`HULL(config-route-map)#route-map OSPFtoEIGRP permit 20` `HULL(config-route-map)#set tag 11`	Creates a second statement for route map OSPFtoEIGRP permitting all other routes to be redistributed with a tag of 11.
`HULL(config-route-map)#router ospf 11`	Enters OSPF configuration mode.
`HULL(config-router)#redistribute eigrp 22 subnets route-map EIGRPtoOSPF`	Redistributes all EIGRP routes with a tag of 22 into the OSPF domain.
`HULL(config-router)#router eigrp 22`	Enters EIGRP configuration mode.

`HULL(config-router)#redistribute ospf 11 metric 1500 1 255 1 1500 route-map OSPFtoEIGRP`	Redistributes all OSPF routes with a tag of 11 into the EIGRP domain.
	NOTE: The result here is to ensure only routes originating in the OSPF domain are redistributed into EIGRP, while only routes originating in the EIGRP domain are redistributed into the OSPF domain.

Changing Administrative Distance for Internal and External Routes

The commands to change the administrative distance (AD) for internal and external routes are as follows.

`Router(config)#router ospf 1`	Starts the OSPF routing process
`Router(config-router)#distance ospf intra-area 105 inter-area 105 external 125`	Changes the AD to 105 for intra-area and interarea routes, and changes the AD to 125 for external routes
`Router(config)#router eigrp 100`	Starts the EIGRP routing process
`Router(config-router)#distance eigrp 80 105`	Changes the AD to 80 for internal EIGRP routes and changes the AD to 105 for EIGRP external routes
`Router(config)#router bgp 65001`	Starts the BGP routing process
`Router(config-router)#distance bgp 30 200 220`	Changes the AD to 30 for external BGP routes, 200 for internal BGP routes and 220 for local BGP routes

Passive Interfaces

`Router(config)#router rip`	Starts the RIP routing process.
`Router(config-router)#passive-interface serial0/0/0`	Sets the interface as passive, meaning that routing updates will not be sent out this interface.
	NOTE: For RIP, the **passive-interface** command will prevent the interface from sending out routing updates but will allow the interface to receive updates.
`Router(config)#router rip`	Starts the RIP routing process.

`Router(config-router)#passive-interface default`	Sets all interfaces as passive.
	TIP: The **passive-interface default** command is useful for Internet service provider (ISP) and large enterprise networks, where a distribution router may have as many as 200 interfaces.
`Router(config-router)#no passive-interface fastethernet0/0`	Activates the FastEthernet0/0 interface to send and receive updates.

CAUTION: For OSPF, a passive interface does not send or process received Hellos. This prevents routers from becoming neighbors on that interface. A better way to control OSPF routing updates is to create a stub area, a totally stubby area, or a not-so-stubby area (NSSA).

CAUTION: When the **passive-interface** command is used with EIGRP, inbound and outbound hello packets are not sent. This prevents routers from becoming EIGRP neighbors. A passive interface cannot send EIGRP hellos, which prevents adjacency relationships with link partners. An administrator can create a "pseudo" passive EIGRP interface by using a route filter that suppresses all routes from the EIGRP routing update. An example of this is shown in Chapter 2, "EIGRP Implementation."

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Index

Numbers

A

B

C

D

E

F

I

L

M

N

O

P

R

S

T

U

V

W - X - Y - Z