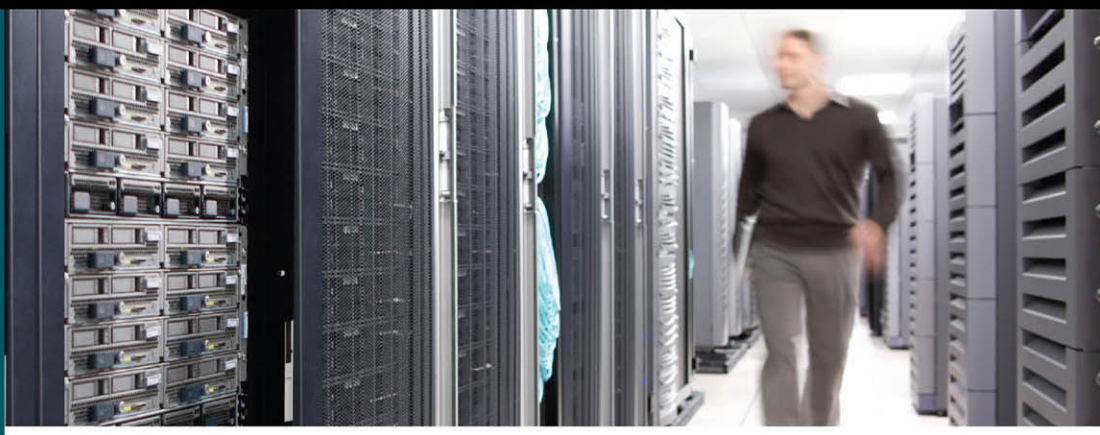

CCNA Routing and Switching

Portable Command Guide

Fourth Edition

All the CCNA Routing and Switching commands in one compact, portable resource

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Scott Empson

CCNA Routing and Switching Portable Command Guide

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Scott Empson is the chair of the Bachelor of Applied Information Systems Technology degree program at the Northern Alberta Institute of Technology in Edmonton, Alberta, Canada, where he has taught Cisco routing, switching, network design, and leadership courses in a variety of different programs (certificate, diploma, and applied degree) at the postsecondary level. Scott is also the program coordinator of the Cisco Networking Academy Program at NAIT, an Area Support Centre for the province of Alberta. He has a master of education degree along with three undergraduate degrees: a bachelor of arts, with a major in English; a bachelor of education, again with a major in English/language arts; and a bachelor of applied information systems technology, with a major in network management. He currently holds several industry certifications, including CCNP, CCDP, C|EH and Network+. Before instructing at NAIT, he was a junior/senior high school English/language arts/computer science teacher at different schools throughout northern Alberta. Scott lives in Edmonton, Alberta, with his wife, Trina, and two children, Zachariah and Shaelyn.

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Dedications

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

Acknowledgments

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

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

To my technical reviewer, Brian: Thanks for keeping me on track and making sure that what I wrote was correct and relevant.

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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 *CCNA Routing and Switching Portable Command Guide*! The success of the previous editions of this book 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 CCNA Routing and Switching exam. For someone who originally thought that this book would be less than 100 pages in length and limited to the Cisco Networking 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.

I have long been a fan of what I call the "engineering journal," a small notebook that can be carried around and that contains little nuggets of information—commands that you forget, the IP addressing scheme of some remote part of the network, little reminders about how to do something you only have to do once or twice a year (but is vital to the integrity and maintenance of your network). This journal has been a constant companion by my side for the past 15 years; I only teach some of these concepts every second or third year, so I constantly need to refresh commands and concepts and learn new commands and ideas as Cisco releases them. My journals are the best way for me to review because they are written in my own words (words that I can understand). At least, I had better understand them because if I can't, I have only myself to blame.

My first published engineering journal was the *CCNA Quick Command Guide*; it was organized to match the (then) order of the Cisco Networking Academy program. That book then morphed into the *Portable Command Guide*, the fourth edition of which you are reading right now. This book is my "industry" edition of the engineering journal. It contains a different logical flow to the topics, one more suited to someone working in the field. Like topics are grouped together: routing protocols, switches, troubleshooting. More complex examples are given. IPv6 has now been integrated directly into the content chapters themselves. IPv6 is not something new that can be introduced in a separate chapter; it is part of network designs all around the globe, and we need to be as comfortable with it as we are with IPv4. The popular "Create Your Own Journal" appendix is still here (blank pages for you to add in your own commands that you need in your specific job). We all recognize the fact that no network administrator's job can be so easily pigeonholed as to just working with CCNA topics; you all have your own specific jobs and duties assigned to you. That is why you will find those blank pages at the end of the book. Make this book your own; personalize it with what you need to make it more effective. This way your journal will not look like mine.

Networking Devices Used in the Preparation of This Book

To verify the commands in this book, I had to try them out on a few different devices. The following is a list of the equipment I used when writing this book:

- C2821 ISR with PVDM2, CMME, a WIC-2T, FXS and FXO VICs, running 12.4(10a) IPBase IOS
- WS-C2960-24TT-L Catalyst switch, running 12.2(25)SE IOS
- WS-C2950-12 Catalyst switch, running Version C2950-C3.0(5.3)WC(1) Enterprise Edition software
- C1941 ISRG2 router with WIC 2T and HWIC-4ESW, running Version 15.1(1)T Cisco IOS with a technology package of IPBaseK9

Those of you familiar with Cisco devices will recognize that a majority of these commands work across the entire range of the Cisco product line. These commands are not limited to the platforms and Cisco IOS Software versions listed. In fact, these devices are in most cases adequate for someone to continue his or her studies into the CCNP level.

Private Addressing Used in This Book

This book uses RFC 1918 addressing throughout. Because I do not have permission to use public addresses in my examples, I have done everything with private addressing. Private addressing is perfect for use in a lab environment or in a testing situation because it works exactly like public addressing, with the exception that it cannot be routed across a public network.

Who Should Read This Book

This book is for those people preparing for the CCNA Routing and Switching exam, whether through self-study, on-the-job training and practice, or study within the Cisco Networking Academy program. There are also some handy hints and tips along the way to make life a bit easier for you in this endeavor. This book 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 around with you when you are working in some server room or equipment closet somewhere?

Optional Sections

A few sections in this book have been marked as optional. These sections cover topics that are not on the CCNA Routing and Switching certification exam, but they are valuable topics that should be known by someone at a CCNA level. Some of the optional topics might also be concepts that are covered in the Cisco Networking Academy program courses.

Organization of This Book

This book follows a logical approach to configuring a small to mid-size network. It is an approach that I give to my students when they invariably ask for some sort of outline to plan and then configure a network. Specifically, this approach is as follows:

Part I: Network Fundamentals

- **Chapter 1, "How to Subnet"**—An overview of how to subnet, examples of subnetting (both a Class B and a Class C address), the use of the binary AND operation, the Enhanced Bob Maneuver to Subnetting
- **Chapter 2, "VLSM"**—An overview of VLSM, an example of using VLSM to make your IP plan more efficient
- **Chapter 3, "Route Summarization"**—Using route summarization to make your routing updates more efficient, an example of how to summarize a network, necessary requirements for summarizing your network
- **Chapter 4, "Cables and Connections"**—An overview of how to connect to Cisco devices, which cables to use for which interfaces, and the differences between the TIA/EIA 568A and 568B wiring standards for UTP
- **Chapter 5, "The Command-Line Interface"**—How to navigate through Cisco IOS Software: editing commands, keyboard shortcuts, and help commands

Part II: LAN Switching Technologies

- **Chapter 6, "Configuring a Switch"**—Commands to configure Catalyst 2960 switches: names, passwords, IP addresses, default gateways, port speed and duplex, configuring static MAC addresses
- **Chapter 7, "VLANs"**—Configuring static VLANs, troubleshooting VLANs, saving and deleting VLAN information, Voice VLAN configuration with and without trust
- **Chapter 8, "VLAN Trunking Protocol and Inter-VLAN Communication"**—Configuring a VLAN trunk link, configuring VTP, verifying VTP, inter-VLAN communication, router-on-a-stick, subinterfaces, and SVIs
- **Chapter 9, "Spanning Tree Protocol"**—Verifying STP, setting switch priorities, working with the STP Toolkit, enabling Rapid Spanning Tree
- **Chapter 10, "EtherChannel"**—Creating and verifying Layer 2 and Layer 3 EtherChannel groups between switches

Part III: Routing Technologies: IPv4 and IPv6

- **Chapter 11, "Configuring a Cisco Router"**—Commands needed to configure a single router: names, passwords, configuring interfaces, MOTD and login banners, IP host tables, saving and erasing your configurations
- **Chapter 12, "Static Routing"**—Configuring IPv4 and IPv6 static routes in your internetwork

- **Chapter 13, "RIP Next Generation (RIPng)"**—Implementing, verifying, and troubleshooting RIPng
- **Chapter 14, "EIGRP and EIGRPv6"**—Configuring and verifying EIGRP and EIGRPv6
- **Chapter 15, "OSPFv2 and OSPFv3"**—Configuring and verifying OSPFv2 and OSPFv3 in both single-area and multiarea networks

Part IV: WAN Technologies

- **Chapter 16, "Understanding Point-to-Point Protocols"**—Configuring PPP, authenticating PPP using CHAP, compressing in PPP, Multilink PPP, troubleshooting PPP, returning to HDLC encapsulation, configuring a DSL connection using PPPoE
- **Chapter 17, "External Border Gateway Protocol (eBGP)"**—Configuring and verifying eBGP, multihop
- **Chapter 18, "Configuring Generic Routing Encapsulation (GRE) Tunnels"**—Configuring and verifying GRE tunnels
- **Chapter 19, "Quality of Service (QoS)"**—Configuring and verifying basic QoS, configuring and verifying auto-QoS

Part V: Infrastructure Services

- **Chapter 20, "DHCP"**—Configuring and verifying DHCP on a Cisco IOS router, using Cisco IP phones with a DHCP server
- **Chapter 21, "First Hop Redundancy Protocols (FHRP): Hot Standby Router Protocol (HSRP)"**—Configuring and verifying Hot Standby Routing Protocol (HSRP) on a Cisco device
- **Chapter 22, "Network Address Translation (NAT)"**—Configuring and verifying NAT and PAT

Part VI: Infrastructure Security

- **Chapter 23, "Switch Port Security"**—Setting passwords on a switch, switch port security, sticky MAC addresses
- **Chapter 24, "Managing Traffic Using Access Control Lists (ACL)"**—Configuring standard ACLs, wildcard masking, creating extended ACLs, creating named ACLs, using sequence numbers in named ACLs, verifying and troubleshooting ACLs, IPv6 ACLs
- **Chapter 25, "Device Hardening"**—Configuring and encrypting passwords, configuring and verifying SSH, restricting virtual terminal access, disabling unused services

Part VII: Infrastructure Management

- **Chapter 26, "Backing Up and Restoring Cisco IOS Software and Configurations"**—Boot commands for Cisco IOS Software, backing up and restoring Cisco IOS Software using TFTP, Xmodem, and ROMmon environmental variables, Secure Copy
- **Chapter 27, "Password-Recovery Procedures and the Configuration Register"**—The configuration register, password recovery procedure for routers and switches
- **Chapter 28, "Cisco Discovery Protocol (CDP) and Link Layer Discovery Protocol (LLDP)"**—Customizing and verifying CDP, configuring and verifying LLDP
- **Chapter 29, "IOS Tools"**—Commands for both **ping** and extended **ping**, the **traceroute** command
- **Chapter 30, "Device Monitoring"**—Configuring SNMP, working with syslog, severity levels, configuring NetFlow, Network Time Protocol (NTP), using the clock and time stamps
- **Chapter 31, "Cisco IOS Licensing"**—Differences between licensing pre- and post-Cisco IOS Version 15, installing permanent and evaluation licenses, backing up and uninstalling licenses, Cisco Smart Software Manager
- **Chapter 32, "Basic Troubleshooting"**—Various **show** commands used to view the routing table, interpreting the **show** interface command, verifying your IP settings using different operating systems

Part VIII: Appendixes

- **Appendix A, "Binary/Hex/Decimal Chart"**—A chart showing numbers 0 through 255 in the three numbering systems of binary, hexadecimal, and decimal
- **Appendix B, "Create Your Own Journal Here"**—Some blank pages for you to add in your own specific commands that might not be in this book

Did I Miss Anything?

I am always interested to hear how my students, and now readers of my books, do on both certification exams and future studies. If you would like to contact me and let me know how this book helped you in your certification goals, please do so. Did I miss anything? Let me know. Contact me at ccnaguide@empson.ca or through the Cisco Press website, http://www.ciscopress.com.

CHAPTER 13

RIP Next Generation (RIPng)

This chapter provides information and commands concerning the following topics:

- Implementing RIP Next Generation
- Verifying and troubleshooting RIPng
- Configuration example: RIPng

NOTE For an excellent overview of IPv6, I strongly recommend you read Rick Graziani's book from Cisco Press: *IPv6 Fundamentals: A Straightforward Approach to Understanding IPv6*.

Implementing RIP Next Generation

This section shows how to implement RIP Next Generation (RIPng) on a router.

`Router(config)#ipv6 unicast-routing`	Enables the forwarding of IPv6 unicast datagrams globally on the router.
`Router(config)#interface serial0/0/0`	Moves to interface configuration mode.
`Router(config-if)#ipv6 rip TOWER enable`	Creates the RIPng process named TOWER and enables RIPng on the interface.
	NOTE Unlike RIPv1 and RIPv2, where you needed to create the RIP routing process with the **router rip** command and then use the **network** command to specify the interfaces on which to run RIP, the RIPng process is created automatically when RIPng is enabled on an interface with the **ipv6 rip** *name* **enable** command.
	TIP Be sure that you do not misspell your process name. If you do misspell the name, you will inadvertently create a second process with the misspelled name.
	NOTE Cisco IOS Software automatically creates an entry in the configuration for the RIPng routing process when it is enabled on an interface.
	NOTE The **ipv6 router rip** *process-name* command is still needed when configuring optional features of RIPng.
	NOTE The routing process name does not need to match between neighbor routers.
`Router(config)#ipv6 router rip TOWER`	Creates the RIPng process named TOWER if it has not already been created and moves to router configuration mode.

`Router(config-rtr)#maximum-paths 2`	Defines the maximum number of equal-cost routes that RIPng can support.
	NOTE The number of paths that can be used is a number from 1 to 64. The default is 4.
`Router(config-if)#ipv6 rip tower default-information originate`	Announces the default route along with all other RIPng routes.
`Router(config-if)#ipv6 rip tower default-information only`	Announces only the default route. Suppresses all other RIPng routes.

Verifying and Troubleshooting RIPng

CAUTION Using the **debug** command may severely affect router performance and might even cause the router to reboot. Always exercise caution when using the **debug** command. Do not leave **debug** on. Use it long enough to gather needed information, and then disable debugging with the **undebug all** command.

TIP Send your **debug** output to a syslog server to ensure you have a copy of it in case your router is overloaded and needs to reboot.

`Router#clear ipv6 rip`	Deletes routes from the IPv6 RIP routing table and, if installed, routes in the IPv6 routing table.
`Router#clear ipv6 route *`	Deletes all routes from the IPv6 routing table.
	NOTE Clearing all routes from the routing table causes high CPU utilization rates as the routing table is rebuilt.
`Router#clear ipv6 route 2001:db8:c18:3::/64`	Clears this specific route from the IPv6 routing table.
`Router#clear ipv6 traffic`	Resets IPv6 traffic counters.
`Router#debug ipv6 packet`	Displays debug messages for IPv6 packets.
`Router#debug ipv6 rip`	Displays debug messages for IPv6 RIP routing transactions.
`Router#debug ipv6 routing`	Displays debug messages for IPv6 routing table updates and route cache updates.
`Router#show ipv6 interface`	Displays the status of interfaces configured for IPv6.
`Router#show ipv6 interface brief`	Displays a summarized status of all interfaces along with assigned IPv6 addresses.
`Router#show ipv6 neighbors`	Displays IPv6 neighbor discovery cache information.
`Router#show ipv6 protocols`	Displays the parameters and the current state of the active IPv6 routing protocol processes.

`Router#show ipv6 rip`	Displays information about the current IPv6 RIPng process.
`Router#show ipv6 rip database`	Displays the RIPng process database. If more than one RIPng process is running, all are displayed with this command.
`Router#show ipv6 rip next-hops`	Displays RIPng processes and, under each process, all next-hop addresses.
`Router#show ipv6 route`	Displays the current IPv6 routing table.
`Router#show ipv6 route rip`	Displays the current RIPng routes in the IPv6 routing table
`Router#show ipv6 route summary`	Displays a summarized form of the current IPv6 routing table.
`Router#show ipv6 routers`	Displays IPv6 router advertisement information received from other routers.
`Router#show ipv6 traffic`	Displays statistics about IPv6 traffic.

Configuration Example: RIPng

Figure 13-1 illustrates the network topology for the configuration that follows, which shows how to configure IPv6 and RIPng using the commands covered in this chapter.

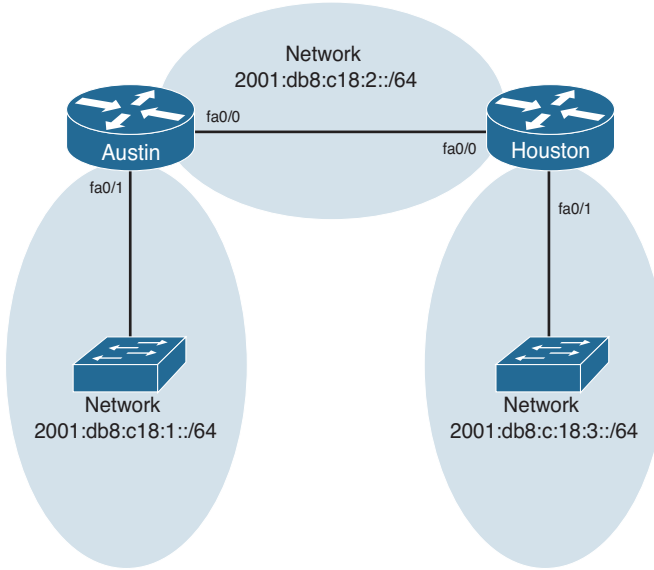

Figure 13-1 Network Topology for IPv6/RIPng Configuration Example

Austin Router

`Router>enable`	Moves to privileged mode
`Router#configure terminal`	Moves to global configuration mode
`Router(config)#hostname Austin`	Assigns a hostname to the router
`Austin(config)#ipv6 unicast-routing`	Enables the forwarding of IPv6 unicast datagrams globally on the router
`Austin(config)#interface fastethernet0/0`	Enters interface configuration mode
`Austin(config-if)#ipv6 address 2001:db8:c18:2::/64 eui-64`	Configures a global IPv6 address with an EUI-64 interface identifier in the low-order 64 bits of the IPv6 address
`Austin(config-if)#ipv6 rip TOWER enable`	Creates the RIPng process named TOWER and enables RIPng on the interface
`Austin(config-if)#no shutdown`	Activates the interface
`Austin(config-if)#interface fastethernet0/1`	Enters interface configuration mode
`Austin(config-if)#ipv6 address 2001:db8:c18:1::/64 eui-64`	Configures a global IPv6 address with an EUI-64 interface identifier in the low-order 64 bits of the IPv6 address
`Austin(config-if)#ipv6 rip TOWER enable`	Creates the RIPng process named TOWER and enables RIPng on the interface
`Austin(config-if)#no shutdown`	Activates the interface
`Austin(config-if)#exit`	Moves to global configuration mode
`Austin(config)#exit`	Moves to privileged mode
`Austin#copy running-config startup-config`	Saves the configuration to NVRAM

Houston Router

`Router>enable`	Moves to privileged mode
`Router#configure terminal`	Moves to global configuration mode
`Router(config)#hostname Houston`	Assigns a hostname to the router
`Houston(config)#ipv6 unicast-routing`	Enables the forwarding of IPv6 unicast datagrams globally on the router
`Houston(config)#interface fastethernet0/0`	Enters interface configuration mode
`Houston(config-if)#ipv6 address 2001:db8:c18:2::/64 eui-64`	Configures a global IPv6 address with an EUI-64 interface identifier in the low-order 64 bits of the IPv6 address
`Houston(config-if)#ipv6 rip TOWER enable`	Creates the RIPng process named TOWER and enables RIPng on the interface
`Houston(config-if)#no shutdown`	Activates the interface
`Houston(config-if)#interface fastethernet 0/1`	Enters interface configuration mode
`Houston(config-if)#ipv6 address 2001:db8:c18:3::/64 eui-64`	Configures a global IPv6 address with an EUI-64 interface identifier in the low-order 64 bits of the IPv6 address
`Houston(config-if)#ipv6 rip TOWER enable`	Creates the RIPng process named TOWER and enables RIPng on the interface
`Houston(config-if)#no shutdown`	Activates the interface
`Houston(config-if)#exit`	Moves to global configuration mode
`Houston(config)#exit`	Moves to privileged mode
`Houston#copy running-config startup-config`	Saves the configuration to NVRAM

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