

Introduction

The Cisco Networking Academy is a comprehensive e-learning program that provides students with Internet technology skills. A Networking Academy delivers web-based content, online assessment, student performance tracking, and hands-on labs to prepare students for industry-standard certifications. The CCNA curriculum includes four courses oriented around the topics of the Cisco Certified Network Associate (CCNA) certification.

Routing Protocols and Concepts, CCNA Exploration Companion Guide is the official supplement textbook to be used with v4 of the CCNA Exploration Routing Protocols and Concepts online curriculum of the Networking Academy.

This book goes beyond earlier editions of the Cisco Press *Companion Guides* by providing many alternate explanations and examples as compared to the course. You can use the online curriculum as normal and use this companion guide to help solidify your understanding of all the topics through the alternate examples.

The basis for this book as well as the online curriculum is to provide you with a thorough understanding of routing protocols and concepts beyond that necessary for the CCNA certification exam. The commands used for configuring routing protocols are not very difficult. The challenge is to understand the operation of those protocols and their effect upon the network.

The objective of this book is to explain routing protocols and concepts. Every concept is methodically explained with no assumptions made of the reader's knowledge of routing protocols. The only exceptions are, if a concept is beyond the scope of this course or is covered in CCNP, it is noted within the text.

Readers are welcome to use the resources on Rick Graziani's website: <http://www.cabrillo.edu/~rgraziani>. You can e-mail Rick Graziani at graziani@cabrillo.edu to obtain the username and password to access his resources for this course and all other CCNA and CCNP courses, including PowerPoint presentations.

Goal of This Book

First and foremost, by providing a fresh, complementary perspective on the content, this book is intended to help you learn all the required materials of the Routing Protocols and Concepts course in the Networking Academy CCNA Exploration curriculum. As a secondary goal, the text is intended as a mobile replacement for the online curriculum for individuals who do not always have Internet access. In those cases, you can instead read the appropriate sections of the book, as directed by your instructor, and learn the same material that is covered in the online curriculum. Another secondary goal is to serve as your offline study material to prepare for the CCNA exam.

Audience for This Book

This book's main audience is anyone taking the CCNA Exploration Routing Protocols and Concepts course of the Cisco Networking Academy curriculum. Many Academies use this textbook as a required tool in the course, while other Academies recommend the *Companion Guides* as an additional source of study and practice materials.

Book Features

The educational features of this book focus on supporting topic coverage, readability, and practice of the course material to facilitate your full understanding of the course material.

Topic Coverage

The following features give you a thorough overview of the topics covered in each chapter so that you can make constructive use of your study time:

- **Objectives**—Listed at the beginning of each chapter, the objectives reference the core concepts covered in the chapter. The objectives match the objectives stated in the corresponding chapters of the online curriculum; however, the question format in the *Companion Guide* encourages you to think about finding the answers as you read the chapter.
- **“How-to” feature:** When this book covers a set of steps that you need to perform for certain tasks, it lists the steps as a how-to list. When you are studying, the icon helps you easily refer to this feature as you skim through the book.
- **Notes, tips, cautions, and warnings:** These are short sidebars that point out interesting facts, timesaving methods, and important safety issues.
- **Chapter summaries:** At the end of each chapter is a summary of the chapter's key concepts. It provides a synopsis of the chapter and serves as a study aid.



Readability

The authors have compiled, edited, and in some cases, rewritten the material so that it has a more conversational tone that follows a consistent and accessible reading level. In addition, the following features have been updated to assist your understanding of the networking vocabulary:

- **Key terms:** Each chapter begins with a list of key terms, along with a page-number reference from inside the chapter. The terms are listed in the order in which they are explained in the chapter. This handy reference allows you to find a term, flip to the page where the term appears, and see the term used in context. The Glossary defines all the key terms.
- **Glossary:** This book contains an all-new Glossary, with more than 150 terms.

Practice

Practice makes perfect. This new *Companion Guide* offers you ample opportunities to put what you learn to practice. You will find the following features valuable and effective in reinforcing the instruction that you receive:

- **Check Your Understanding questions and answer key:** Updated review questions are presented at the end of each chapter as a self-assessment tool. These questions match the style of questions that you see in the online course. The appendix, “Check Your Understanding and Challenge Questions Answer Key,” provides an answer key to all the questions and includes an explanation of each answer.
- **(NEW) Challenge questions and activities:** Additional—and more challenging—review questions and activities are presented at the end of chapters. These questions are purposefully designed to be similar to the more complex styles of questions you might see on the CCNA exam. This section might also include activities to help prepare you for the exams. The appendix provides the answers.
- **Packet Tracer Activities:** Interspersed throughout the chapters, you’ll find many activities that allow you to work with the Cisco Packet Tracer tool. Packet Tracer allows you to create networks, visualize how packets flow in the network, and use basic testing tools to determine whether the network would work. When you see this icon, you can use Packet Tracer with the listed file to perform a task suggested in this book. The activity files are available on this book’s CD-ROM; Packet Tracer software, however, is available through the Academy Connection website. Ask your instructor for access to Packet Tracer.

Packet Tracer
□ Activity

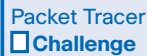
Labs and Study Guide

The supplementary book *Routing Protocols and Concepts, CCNA Exploration Labs and Study Guide*, by Cisco Press (ISBN 1-58713-204-4), contains all the labs from the curriculum plus additional challenge labs and study guide material. The end of each chapter of this *Companion Guide* indicates with icons what labs, activities, and Packet Tracer Activities are available in the Labs and Study Guide.



- **Lab and Activity references:** This icon notes the hands-on labs and other activities created for this chapter in the online curriculum. Within *Routing Protocols and Concepts, CCNA Exploration Labs and Study Guide*, you will also find additional labs and study guide material created by the author of that book.
- **(NEW) Packet Tracer Companion activities:** Many of the hands-on labs include Packet Tracer Companion activities, where you can use Packet Tracer to complete a simulation of the lab. Look for this icon in *Routing Protocols and Concepts, CCNA Exploration Labs and Study Guide*, by Cisco Press (ISBN 1-58713-204-4), for hands-on labs that have a Packet Tracer Companion.

Packet Tracer
□ Companion



- **(NEW) Packet Tracer Skills Integration Challenge activities:** These activities require you to pull together several skills learned from the chapter to successfully complete one comprehensive exercise. Look for this icon in *Routing Protocols and Concepts*, *CCNA Exploration Labs and Study Guide*, by Cisco Press (ISBN 1-58713-204-4) for instructions on how to perform the Packet Tracer Skills Integration Challenge for this chapter.

A Word About Packet Tracer Software and Activities

Packet Tracer is a self-paced, visual interactive teaching and learning tool developed by Cisco. Lab activities are an important part of networking education. However, lab equipment can be a scarce resource. Packet Tracer provides a visual simulation of equipment and network processes to offset the challenge of limited equipment. Students can spend as much time as they like completing standard lab exercises through Packet Tracer, and have the option to work from home. Although Packet Tracer is not a substitute for real equipment, it allows students to practice using a command-line interface. This “e-doing” capability is a fundamental component of learning how to configure routers and switches from the command line.

Packet Tracer v4.x is available only to Cisco Networking Academies through the Academy Connection website. Ask your instructor for access to Packet Tracer.

The course includes essentially three different types of Packet Tracer activities. This book uses an icon system to indicate which type of Packet Tracer activity is available. The icons are intended to give you a sense of the purpose of the activity and the amount of time you need to allot to complete it. The three types of Packet Tracer activities follow:



- **Packet Tracer Activity:** This icon identifies straightforward exercises interspersed throughout the chapters where you can practice or visualize a specific topic. The activity files for these exercises are available on this book’s CD-ROM. These activities take less time to complete than the Packet Tracer Companion and Challenge activities.



- **Packet Tracer Companion:** This icon identifies exercises that correspond to the hands-on labs of the course. You can use Packet Tracer to complete a simulation of the hands-on lab or complete a similar “lab.” The Companion Guide points these out at the end of each chapter, but look for this icon and the associated exercise file in *Routing Protocols and Concepts CCNA Exploration Labs and Study Guide* for hands-on labs that have a Packet Tracer Companion.



- **Packet Tracer Skills Integration Challenge:** This icon identifies activities that require you to pull together several skills learned from the chapter to successfully complete one comprehensive exercise. The *Companion Guide* points these out at the end of each

chapter, but look for this icon in *Routing Protocols and Concepts CCNA Exploration Labs and Study Guide* for instructions on how to perform the Packet Tracer Skills Integration Challenge for this chapter.

How This Book Is Organized

The book covers the major topic headings in the same sequence as the online curriculum for the CCNA Exploration Routing Protocols and Concepts course. This book has 11 chapters, with the same numbers and similar names as the online course chapters.

Each routing protocol chapter and the static routing chapter begin with a single topology that is used throughout the chapter. The single topology per chapter allows better continuity and easier understanding of routing commands, operations, and outputs.

- **Chapter 1, “Introduction to Routing and Packet Forwarding,”** provides an overview of the router hardware and software, along with an introduction to directly connected networks, static routing, and dynamic routing protocols. The process of packet forwarding is also reviewed, including the path determination and switching functions.
- **Chapter 2, “Static Routing,”** examines static routing in detail. The use of static routes and the role they play in modern networks are discussed. This chapter describes the advantages, uses, and configuration of static routes using next-hop IP addresses and/or exit interfaces. Basic Cisco IOS commands are reviewed, along with an introduction to the Cisco IP routing table.
- **Chapter 3, “Introduction to Dynamic Routing Protocols,”** provides an overview of dynamic routing protocols and the various methods used to classify them. The terms *metrics* and *administrative distance* are introduced. This chapter serves as an introduction to terms and concepts that are examined more fully in later chapters.
- **Chapter 4, “Distance Vector Routing Protocols,”** covers the theory behind distance vector routing protocols. The algorithm used by distance vector routing protocols, along with the process of network discovery and routing table maintenance, is discussed.
- **Chapter 5, “RIP Version 1,”** examines the distance vector routing protocol RIPv1. Although it is the oldest IP routing protocol, RIPv1 is the ideal candidate for discussing distance vector technology and classful routing protocols. This chapter includes the configuration, verification, and troubleshooting of RIPv1.
- **Chapter 6, “VLSM and CIDR,”** discusses VLSM (variable-length subnet masks) and CIDR (classless interdomain routing), including how to allocate IP addresses according to need rather than by class, and how IP addresses can be summarized as a single address, which is known as *supernetting*.

- **Chapter 7, “RIPv2,”** discusses RIPv2, a distance vector routing protocol. RIPv2 is a classless routing protocol as compared to RIPv1, which is a classful routing protocol. This chapter examines the benefits of using a classless routing protocol and describes how it supports both VLSM and CIDR. This chapter includes the configuration, verification, and troubleshooting of RIPv2.
- **Chapter 8, “The Routing Table: A Closer Look,”** examines the Cisco IPv4 routing table in detail. Understanding the structure and lookup process of the routing table provides a valuable tool in verifying and troubleshooting networks.
- **Chapter 9, “EIGRP,”** discusses the classless routing protocol EIGRP. EIGRP is a Cisco-proprietary, advanced distance vector routing protocol. This chapter examines DUAL (Diffusing Update Algorithm) and describes how DUAL determines best paths and loop-free backup paths. This chapter includes the configuration, verification, and troubleshooting of EIGRP.
- **Chapter 10, “Link-State Routing Protocols,”** provides an introduction to link-state terms and concepts. This chapter compares link-state and distance vector routing protocols, discussing the benefits and requirements of using a link-state routing protocol.
- **Chapter 11, “OSPF,”** examines the classless, link-state routing protocol OSPF. OSPF operations are discussed, including link-state updates, adjacency, and the DR/BDR election process. This chapter includes the configuration, verification, and troubleshooting of OSPF.
- **Appendix, “Check Your Understanding and Challenge Questions Answer Key,”** provides the answers to the Check Your Understanding questions that you find at the end of each chapter. It also includes answers for the Challenge Questions and Activities that conclude most chapters.
- The **Glossary** provides a compiled list of all the key terms that appear throughout this book.

About the CD-ROM

The CD-ROM included with this book provides many useful tools and information to support your education:

Packet Tracer
□ Activity

- **Packet Tracer Activity files:** These are files to work through the Packet Tracer Activities referenced throughout the book, as indicated by the Packet Tracer Activity icon.
- **Taking Notes:** This section includes a .txt file of the chapter objectives to serve as a general outline of the key topics of which you need to take note. The practice of taking clear, consistent notes is an important skill not only for learning and studying the material but for on-the-job success as well. Also included in this section is “A Guide to Using a Networker’s Journal” PDF booklet providing important insight into the value

of the practice of using a journal, how to organize a professional journal, and some best practices on what, and what not, to take note of in your journal.

- **IT Career Information:** This section includes a student guide to applying the toolkit approach to your career development. Learn more about entering the world of Information Technology as a career by reading two informational chapters excerpted from *The IT Career Builder's Toolkit*: “Defining Yourself: Aptitudes and Desires” and “Making Yourself Indispensable.”
- **Lifelong Learning in Networking:** As you embark on a technology career, you will notice that it is ever-changing and evolving. This career path provides new and exciting opportunities to learn new technologies and their applications. Cisco Press is one of the key resources to plug into on your quest for knowledge. This section of the CD-ROM provides an orientation to the information available to you and tips on how to tap into these resources for lifelong learning.