



Introducing Routing and Switching in the Enterprise, CCNA Discovery Learning Guide (Companion Guide)

By Allan Reid, Jim Lorenz, Cheryl A. Schmidt

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Introducing Routing and Switching in the Enterprise, CCNA Discovery Learning Guide is the official supplemental textbook for the Introducing Routing and Switching in the Enterprise course in the Cisco® Networking Academy® CCNA® Discovery curriculum version 4. The course, the third of four in the new curriculum, familiarizes you with the equipment applications and protocols installed in enterprise networks, with a focus on switched networks, IP Telephony requirements, and security. It also introduces advanced routing protocols such as Enhanced Interior Gateway Routing Protocol (EIGRP) and Open Shortest Path First (OSPF) Protocol. Hands-on exercises include configuration, installation, and troubleshooting.

The *Learning Guide's* features help you focus on important concepts to succeed in this course:

- Chapter Objectives—Review core concepts by answering the focus questions listed at the beginning of each chapter.
- Key Terms—Refer to the lists of networking vocabulary introduced and highlighted in context in each chapter. The Glossary defines each key term.
- Summary of Activities and Labs—Maximize your study time with this complete list of all associated exercises at the end of each chapter.
- Check Your Understanding—Evaluate your readiness with the end-of-chapter questions that match the style of questions you see in the online course quizzes. The answer key explains each answer.
- Challenge Questions and Activities—Apply a deeper understanding of the concepts with these challenging end-of-chapter questions and activities. The answer key explains each answer.
- Hands-on Labs— Master the practical, hands-on skills of the course by

performing all the tasks in the course labs and additional challenge labs included in Part II of the Learning Guide.

This book is part of the Cisco Networking Academy Series from Cisco Press®. Books in this series support and complement the Cisco Networking Academy curriculum.

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- Sales Rank: #2136153 in eBooks
- Published on: 2008-04-25
- Released on: 2008-04-25
- Format: Kindle eBook

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Introduction

Cisco Networking Academy is a comprehensive e-learning program that delivers information technology skills to students around the world. The Cisco CCNA Discovery curriculum consists of four courses that provide a comprehensive overview of networking, from fundamentals to advanced applications and services. The curriculum emphasizes real-world practical application, while providing opportunities for you to gain the skills and hands-on experience needed to design, install, operate, and maintain networks in small to medium-sized businesses and in enterprise and Internet service provider environments. The *Introducing Routing and Switching in the Enterprise* course is the third course in the curriculum.

Introducing Routing and Switching in the Enterprise, CCNA Discovery Learning Guide is the official supplemental textbook for the third course in v4.x of the CCNA Discovery online curriculum of the Networking Academy. As a textbook, this book provides a ready reference to explain the same networking concepts, technologies, protocols, and devices as the online curriculum. In addition, it contains all the interactive activities, Packet Tracer activities, and hands-on labs from the online curriculum and bonus labs.

This book emphasizes key topics, terms, and activities and provides many alternative explanations and examples as compared with the course. You can use the online curriculum as directed by your instructor and then also use this *Learning Guide's* study tools to help solidify your understanding of all the topics. In addition, the book includes the following:

- Expanded coverage of CCNA exam material
- Additional key Glossary terms
- Bonus labs
- Additional Check Your Understanding and Challenge questions and activities
- Interactive activities and Packet Tracer activities on the CD-ROM

Goal of This Book

First and foremost, by providing a fresh, complementary perspective of the online content, this book helps you learn all the required materials of the third course in the Networking Academy CCNA Discovery curriculum. As a secondary goal, individuals who do not always have Internet access can use this text as a mobile replacement for the online curriculum. In those cases, you can read the appropriate sections of this book, as directed by your instructor, and learn the topics that appear in the online curriculum. Another secondary goal of this book is to serve as your offline study material to help prepare you for the CCNA exams.

Audience for This Book

This book's main audience is anyone taking the third CCNA Discovery course of the Networking Academy curriculum. Many Networking Academies use this textbook as a required tool in the course, whereas other Networking Academies recommend the learning 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 *Learning 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, the text 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 short sidebars 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 300 computer and networking terms.

Practice

Practice makes perfect. This new *Learning 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. Appendix A, "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. Appendix A provides the answers.
- **Packet Tracer activities:** Interspersed throughout the chapters, you'll find many activities to work with the Cisco Packet Tracer tool. Packet Tracer enables 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.
- **Interactive activities:** These activities provide an interactive learning experience to reinforce the material

presented in the chapter.

- **Labs:** Part II of this book contains all the hands-on labs from the curriculum plus additional labs for further practice. Part I includes references to the hands-on labs, as denoted by the lab icon, and Part II of the book contains each lab in full. You may perform each lab when it is referenced in the chapter or wait until you have completed the entire 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.

A Word About the Discovery Server CD

The CCNA Discovery series of courses is designed to provide a hands-on learning approach to networking. Many of the CCNA Discovery labs are based on Internet services. Because it is not always possible to allow students access to these services on a live network, the Discovery Server has been developed to provide them.

The Discovery Server CD is a bootable CD that transforms a regular PC into a Linux server running several preconfigured services for use with Discovery labs. Your instructor can download the CD files, burn a CD, and show you how to use the server. Hands-on labs that use the Discovery Server are identified within the labs themselves.

Once booted, the server provides many services to clients, including the following:

- Domain Name Services
- Web services
- FTP
- TFTP
- Telnet
- SSH
- DHCP
- Streaming video

How This Book Is Organized

This book covers the major topics in the same sequence as the online curriculum for the CCNA Discovery Introducing Routing and Switching in the Enterprise course. The online curriculum has ten chapters for this course, so this book has ten chapters, with the same names and numbers as the online course chapters.

To make it easier to use this book as a companion to the course, the major topic headings in each chapter match, with just a few exceptions, the major sections of the online course chapters. However, the *Learning*

Guide presents many topics in slightly different order inside each major heading. In addition, the book occasionally uses different examples than the course. As a result, students get more detailed explanations, a second set of examples, and different sequences of individual topics, all to aid the learning process. This new design, based on research into the needs of the Networking Academies, helps typical students lock in their understanding of all the course topics.

Chapters and Topics

Part I of this book has ten chapters, as follows:

- **Chapter 1, "Networking in the Enterprise,"** describes the goals of the enterprise network and compares enterprise LANs, WANs, intranets, and extranets. Types of enterprise applications are identified, including traffic flow patterns and prioritization. This chapter also focuses on the needs of teleworkers and the use of virtual private networks to support them.
- **Chapter 2, "Exploring the Enterprise Network Infrastructure,"** describes the network operations center (NOC), telecommunications rooms, and network documentation used in the enterprise. Requirements for supporting the enterprise edge are introduced, including external service delivery and security considerations. This chapter also provides a good review of switch and router hardware. It reinforces the basic commands necessary to configure switches and routers and verify their operation.
- **Chapter 3, "Switching in an Enterprise Network,"** focuses on the characteristics of switches and issues associated with supporting them in an enterprise environment. These include redundancy and Spanning Tree Protocol (STP). You learn to configure VLANs, trunking, and multiswitch inter-VLAN routing. The chapter also covers the VLAN Trunking Protocol (VTP), support for IP telephony, and wireless and VLAN implementation best practices.
- **Chapter 4, "Addressing in an Enterprise Network,"** compares flat and hierarchical network design with a focus on the structure and advantages of hierarchical IP addressing. This chapter provides a review of subnet masks and basic subnetting and introduces variable-length subnet masks (VLSM) and their benefits. It provides instruction on how to implement VLSM addressing in hierarchical network design. The use and importance of classless routing, classless interdomain routing (CIDR), and route summarization are explained, along with subnetting best practices. This chapter also provides a review of private IP addressing, Network Address Translation (NAT), and Port Address Translation (PAT), with examples of implementation.
- **Chapter 5, "Routing with a Distance Vector Protocol,"** describes common network topologies and provides a review of static and dynamic routing and default routes. The chapter also provides a review of distance vector routing protocols. The advantages and disadvantages of using Routing Information Protocol (RIP) and Enhanced Interior Gateway Routing Protocol (EIGRP) are discussed. Instructions are provided for the configuration and implementation of the RIPv2 and EIGRP dynamic routing protocols.
- **Chapter 6, "Routing with a Link-State Protocol,"** focuses on link-state routing protocols, specifically the Open Shortest Path First (OSPF) Protocol. OSPF characteristics are described, as are advantages and issues involved with implementing OSPF. Instructions are provided for configuring single-area OSPF. In addition, issues associated with using multiple routing protocols in a network are addressed.
- **Chapter 7, "Implementing Enterprise WAN Links,"** focuses on devices and technology options for connecting the enterprise WAN. Packet- and circuit-switching technologies are compared, as are last-mile and long-range technologies. WAN encapsulations, such as High-Level Data Link Control (HDLC) and PPP, are described. You learn how to configure PPP on a WAN link, including authentication. The chapter also provides an overview of the popular Frame Relay WAN technology.
- **Chapter 8, "Filtering Traffic Using Access Control Lists,"** emphasizes the importance of using access control lists (ACL) in network security and traffic flow control. This chapter describes the various types of Cisco IOS ACLs and how they are configured, including the use of the wildcard mask. Standard, extended, and named ACLs are compared, with suggestions for when to use them and placement in specific

scenarios. Details are provided on how to create, edit, and apply various ACLs. Filtering traffic based on specific fields in the IP packet is covered. The use of ACLs with NAT and PAT and inter-VLAN routing is discussed. In addition, ACL logging (and the use of syslog servers) is introduced.

- **Chapter 9, "Troubleshooting an Enterprise Network,"** emphasizes the impact of network failure on an organization and the concept of a failure domain. This chapter describes network monitoring tools and techniques and reviews the troubleshooting process. This chapter identifies common problems associated with switching and connectivity, routing, WAN configurations and ACLs, and ways to troubleshoot these problems.
- **Chapter 10, "Putting It All Together,"** In this summary activity, you use what you have learned about the enterprise network infrastructure, switching technologies, hierarchical IP addressing, routing protocols, WAN technologies, and ACLs to build and configure a multiswitch, multirouter simulated enterprise network.

Part I: Concepts also includes the following:

- **Appendix A, "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, plus additional computer and networking terms.

Part II of this book includes the labs that correspond to each chapter. Part II also includes the following:

- **Appendix B, "Lab Equipment Interfaces and Initial Configuration Restoration,"** provides a table listing the proper interface designations for various routers. Procedures are included for erasing and restoring routers and switches to clear previous configurations. In addition, the steps necessary to restore an SDM router are provided.

About the CD-ROM

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

- **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.
- **Interactive activities:** The CD-ROM contains the interactive activities referenced throughout the book.
- **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 for not only learning and studying the material, but for on-the-job success, too. 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*: "Communication Skills" and "Technical Skills."
- **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.

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