

NETWORKING

CCNA Guide to  
**Cisco Networking**

Fourth Edition

Kelly Cannon  
Kelly Caudle  
Anthony Chiarella



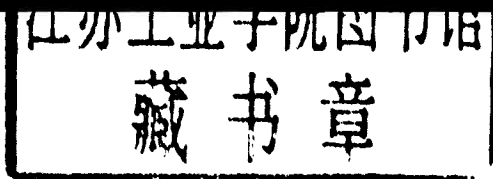
# CCNA Guide to Cisco Networking

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**Kelly Cannon**

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Australia • Brazil • Japan • Korea • Mexico • Singapore • Spain • United Kingdom • United States



**CCNA Guide to Cisco Networking,  
Fourth Edition**

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## **Cisco Certification Exam Objectives**

### **Exam # 640-802: Cisco Certified Network Associate**

This table maps the Cisco CCNA exam topics with the book chapter in which these topics are covered. There are eight categories of objectives assigned by Cisco.

Appendix A, CCNA Certification Objectives, provides a detailed exam objectives mapping grid.

Exam Topic	Chapter
Describe how a network works	1, 2, 3, 7, 8
Configure, verify, and troubleshoot a switch with VLANs and interswitch communications	2, 12, 13
Implement an IP addressing scheme and IP services to meet network requirements in a medium-size enterprise branch office network	4, 9
Configure, verify, and troubleshoot basic router operation and routing on Cisco devices	5, 6, 7, 8, 10, 14
Explain and select the appropriate administrative tasks required for a WLAN	2
Identify security threats to a network and describe general methods to mitigate those threats	14
Implement, verify, and troubleshoot NAT and ACLs in a medium-size enterprise branch office network	9, 10
Implement and verify WAN links	6, 11, 14

# Preface

**The undisputed worldwide leader in networking equipment, Cisco** manufactures routers, switches, access servers, and network management software designed to interconnect LANs and WANs around the globe. The proliferation of networks in the workplace and the popularity of the Internet have contributed to an increasing need for networking professionals with both LAN and WAN configuration skills. Employers are looking for qualified people to fill the demand for these networking jobs, and certification is a great way to prove you have what it takes. The primary objective of this book is to help you prepare for and pass the Cisco Certified Network Associate Exam (CCNA). This certification (Exam 640-802), is the foundation certification upon which other Cisco certifications are built. It validates the ability to install, configure, operate, monitor, and troubleshoot routed and switched Cisco networks. The CCNA certification can also be obtained by taking two exams rather than one (640-822 then 640-816). Passage of the exam 640-822 earns the Cisco Certified Entry Network Technician (CCENT) certification. This relatively new certification provides recognition of certain networking knowledge and router configuration skills at a slightly lower level than the CCNA designation. This book can be used to prepare for any of the three exams listed above.

Hands-on learning is the best way to master the networking skills necessary for both the CCENT and CCNA certifications and a career in wide-area networking. This book contains more than 50 hands-on exercises that apply networking concepts, such as IP addressing, routing, and switching, as they would be applied on Cisco equipment in the real world and on CCENT and CCNA exams. In addition, each chapter offers multiple review questions and case projects to reinforce mastery of the CCNA topics.

The inclusion of the lab manual at the end of this text provides a substantial and effective learning experience. In addition, the appendices provide crucial test-taking information such as a list of essential commands, as well as troubleshooting techniques and references.

This book is suitable for use in any Cisco CCNA course. As a prerequisite, students should have basic networking knowledge, such as the skills learned in an introductory networking course.

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## Intended Audience

*CCNA Guide to Cisco Networking, Fourth Edition* serves as a comprehensive guide for anyone who wants to obtain a solid background in basic Cisco networking concepts, and is an ideal tool to use to prepare for CCENT/CCNA certification. This book guides you through the basics of networking, configuration, and troubleshooting of Cisco routers and switches. To best understand the material in this book, you should have a background in basic networking concepts and have worked with PC hardware. This book is intended for use in a classroom or an instructor-led training environment with access to Cisco routers and switches. When you finish the book, you should understand and be able to perform all objectives covered on the CCNA Exam #640-802.

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## Chapter Descriptions

Here is a summary of the topics covered in each chapter of this book:

**Chapter 1, “Introducing Networks,”** introduces the OSI reference model and identifies why the industry uses this layered approach to networking. It also explores the five steps of data encapsulation, the function of a MAC address, and the difference between connection-oriented and connectionless network service.

In **Chapter 2, “Network Devices,”** you learn all about the different devices used on a network and the advantages and disadvantages of using particular devices. The devices include hubs and repeaters, bridges and switches, wireless access points, routers and gateways. Devices are discussed in the context of network segmentation, because it is important to understand which devices segment the network and which do not. You will also be introduced to Ethernet, Fast Ethernet, and Gigabit Ethernet operations.

In **Chapter 3, “TCP/IP,”** you learn about TCP/IP—the language of the Internet. TCP/IP is a suite of many protocols, including ICMP, UDP, TCP, ARP, and RARP. It is important to be able to describe the functions performed by these protocols. You will also learn about the benefits of using ping and trace to troubleshoot IP and how IP packets are transmitted. Finally, you learn the Cisco three-layer hierarchical model used for network design by Cisco professionals.

In **Chapter 4, “IP Addressing,”** you learn the different classes of IP addresses, how to configure and subdivide an IP network, and advanced routing concepts such as CIDR, summarization, and VLSM. You will convert between decimal, binary, and hexadecimal numbering systems. Finally, you learn the differences between IPv4, which is in use now on most networks, and IPv6, which is the future of IP.

In **Chapter 5, “Router and IOS Basics,”** you learn about the components of the router and the basic configuration commands. This includes various configuration modes and prompts, passwords, context-sensitive help, and enhanced editing features. It also includes instructions on how to configure the HyperTerminal program in Windows to access the router, and how to configure the router using the system configuration dialog.

**Chapter 6, “Router Startup and Configuration,”** explains the boot process in a Cisco router and how to manipulate the process. You are introduced to CDP, a proprietary protocol of Cisco, which is enabled by default on all Cisco routers and switches. In addition, configuration of IP on the router is discussed. This chapter also details troubleshooting connection problems using show commands, ping, trace, and telnet. Finally, you are introduced to Cisco’s new Security Device Manager, which is a web-based tool for configuring Cisco routers.

In **Chapter 7, “Routing Protocols,”** you learn to differentiate among routable, non-routable, and routing protocols. Routing protocols are categorized as either Exterior Gateway Protocols or Interior Gateway Protocols. The focus of this chapter is Interior Gateway Protocols and the two categories therein, which include distance-vector and link-state. You learn about the count-to-infinity problem with distance-vector routing protocols, along with different ways to combat this problem. This chapter also details how to configure the most popular distance-vector routing protocol-RIP. Finally, you learn how to configure static routing and default routes.

**Chapter 8**, “Advanced Routing Protocols,” introduces several advanced routing concepts on the 640-802 exam. Classful and classless routing are described in detail. The chapter introduces RIPv2, Enhanced Interior Gateway Routing Protocol (EIGRP), and Open Shortest Path First (OSPF). Controlling routing traffic is also covered.

**Chapter 9**, “Network Services,” discusses the various services used on a network and explains how to use a Cisco router to implement these services. Included in the discussion is Network Address Translation (NAT), Dynamic Host Configuration Protocol (DHCP), and Domain Name Service (DNS). You learn how to configure these services using both the command line interface as well as the new Security Device Manager.

**Chapter 10**, “Access Lists,” covers the dual purpose of access lists, which are flow control and security. You learn the syntax of the two types of lists found on the CCNA exam. These include standard IP and extended IP lists. You learn the usage and rules of access lists and how to configure and apply them. You also learn how to control access to the VTY line with access lists and how to monitor your lists on the router. Finally, you learn how to create named access lists and how to use the Security Device Manager to create access lists, as well as a firewall.

In **Chapter 11**, “PPP and Frame Relay,” you learn about PPP encapsulation and how to configure PPP and its options on a Cisco router. You also learn about PPP multilink and how to enable it. In addition to PPP configuration, you also learn about Frame Relay standards and equipment, and about the role of virtual circuits and performance parameters in Frame Relay. This chapter covers the various Frame Relay topologies and explains how to configure and monitor Frame Relay on Cisco routers.

**Chapter 12**, “Basic Switching and Switch Configuration,” covers the features and benefits of Fast Ethernet, as well as the guidelines and distance limitations governing its use. In addition, it discusses network segmentation and introduces basic traffic management concepts. In this chapter, you also study basic concepts relating to Cisco switches and learn how to operate them. Finally, you learn how to perform and verify switch configuration tasks, and how to implement basic switch security.

In **Chapter 13**, “Advanced Switching Concepts,” you gain experience with the Spanning Tree Protocol and learn about its benefits. You also learn about the usefulness of virtual LANS and practice configuring a VLAN. Finally, you study the VLAN trunking protocol (VTP) and learn how to configure it.

**Chapter 14**, “Network Security,” explains the distinction between the various types of network threats and discusses ways to mitigate these threats. In this chapter, you also learn how to implement SSH on Cisco routers and switches. Finally, you practice configuring a VPN using the Cisco Security Device manager.

**Appendix A**, “CCNA Certification Objectives,” lists each CCNA certification objective and the chapter in which it is covered.

**Appendix B**, “Additional Resources,” provides additional sources of information on subjects covered in this course.

**Appendix C**, “A Networking Professional’s Toolkit,” provides pictures of networking tools, along with their proper names and uses.

**Appendix D**, “Command Summary,” provides a list of the commands presented in this course. You should review these commands before you attempt the CCNA certification examination.



**Appendix E**, “Troubleshooting Summary,” provides a list of commonly used troubleshooting commands and a description of their output. You should review these commands before you attempt the CCNA certification examination.

The **Lab Manual** chapters map to the main text chapters and provide necessary hands-on skills for working with networking equipment in general, and for configuring Cisco routers and switches. The Cisco CCNA certification Exam #640-802, as well as the two other exams leading to the CCNA (640-822 and 640-816), includes simulation questions that mirror actual router and switch configuration. Configuration of the routers and switches in the lab is essential to performing successfully on these exams. Even students who are not interested in becoming a CCNA still need to master the equipment if they will configure it on the job. In addition, working with the networking equipment enhances students’ understanding of the material presented in their lectures. Finally, students work on the labs in teams. They help each other and learn from each other’s successes and mistakes.

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## Book Features

To aid you in fully understanding Cisco networking concepts, this book includes many features designed to enhance your learning experience:

- **Chapter Objectives**—Each chapter begins with a detailed list of the concepts to be mastered. This list gives you a quick reference to the chapter’s contents, and is a useful study aid.
- **Chapter Summary**—Each chapter’s text is followed by a bulleted summary of the concepts introduced in that chapter. These summaries provide a helpful way to revisit the major ideas covered in each chapter.
- **Key Terms**—All the terms within the chapter that were introduced with boldfaced text are collected in the Key Terms list at the end of the chapter. This list helps you check your understanding of all major terms.
- **Review Questions**—The end-of-chapter assessment begins with a set of review questions that reinforce the ideas introduced in each chapter. Answering these questions ensures that you have mastered the important concepts. The review questions can also be used to help prepare for the CCNA exam.
- **Case Projects**—At the end of each chapter, there are several Case Projects. In these extensive examples, you implement the skills and knowledge gained in the chapter through real design and implementation scenarios.

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## Lab Manual Features

To ensure a successful experience for instructors and students alike, this book includes the following sections for each lab:

- **Lab Objectives**—Every lab has a brief description and list of learning objectives.
- **Materials Required**—Every lab includes information on hardware, software, and other materials you need to complete the lab.
- **Estimated Completion Time**—Every lab has an estimated completion time, so that you can plan your activities accurately.



- **Activity**—The actual lab activity is presented in this section. Logical and precise step-by-step instructions guide you through the lab.
- **Certification Objectives**—Each chapter lists the relevant objectives from Cisco's CCNA Exam #640-802.
- **Review Questions**—Every lab provides follow-up questions to help reinforce concepts presented in the lab.

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## Text and Graphic Conventions

Additional information and exercises have been added to this book to help you better understand what is being discussed. Icons throughout the text alert you to these additional materials. The icons used in this book are described below.



Notes present additional helpful material related to the subject being discussed.



Tips offer extra information on resources, how to attack problems, and time-saving shortcuts.



Case Projects are more involved, scenario-based assignments. In these extensive case project examples, you are asked to independently apply what you have learned in the chapter.

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## Instructor's Materials

The following supplemental materials are available when this book is used in a classroom setting. All of the supplements available with this book are provided to the instructor on a single CD-ROM (ISBN: 1423925750).

**Electronic Instructor's Manual**—The Instructor's Manual that accompanies this textbook includes additional instructional material to assist in class preparation, including suggestions for classroom activities, discussion topics, and additional projects.

**Solutions**—This supplement provides answers to all end-of-chapter materials, including Review Questions, Case Projects, and the Activity projects in the Lab Manual.

**ExamView®**—This textbook is accompanied by ExamView, a powerful testing software package that allows instructors to create and administer printed, computer (LAN-based), and Internet exams. ExamView includes hundreds of questions that correspond to the topics covered in this text, enabling students to generate detailed study guides that include page references for further review. The computer-based and Internet testing components allow students to take exams at their computers, and they save the instructor time by grading each exam automatically.

**PowerPoint Presentations**—This book comes with Microsoft PowerPoint slides for each chapter. They can be used as a teaching aid for classroom presentation, can be made available to students on the network for chapter review, or can be printed for classroom distribution. Instructors, please feel at liberty to add your own slides for additional topics that you introduce to the class.

**Figure Files**—All of the figures in the book are reproduced on the Instructor Resources CD, in bitmap format. Similar to the PowerPoint presentations, these can be used as a teaching aid for classroom presentation, can be made available to students for review, or can be printed for classroom distribution.

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## Test Prep Software

Two kinds of exam preparation software are included on the CD-ROM at the back of this book:

**CoursePrep** software from MeasureUp provides hundreds of sample exam questions that mirror the look and feel of the CCNA 640-802 exam. For more information about MeasureUp test prep products, or to order the complete version of this software, visit their Web site at [www.measureup.com](http://www.measureup.com).

**CertBlaster** software from dti Publishing Corp. also offers hundreds of sample exam questions in a variety of testing modes: Study, Certification, Assessment, Flash Drill, and Adaptive. For more information about CertBlaster and other dti Publishing products, visit their Web site at [www.certblaster.com](http://www.certblaster.com). The unlock code for the CertBlaster questions is: `c_ccna` (case sensitive).

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## Acknowledgments

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### Kelly Caudle

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### Kelly Cannon

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## **Anthony Chiarella**

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## **Hardware Requirements**

The following is a list of hardware required to complete all the labs in the book. Many of the individual labs do not have all of these requirements. In terms of routers and switches, if you have a Cisco Academy CCNA lab setup, you have the necessary equipment for the routing and switching labs in Chapter 5 through the end of the book. The hardware required for Chapters 1 through 4 is minimal. The routing and switching lab setup, in addition to any other hardware required, is as follows:

- Four 2600 series routers with power cables (could substitute a different series but must have two serial interfaces and one Fast Ethernet interface)
- One 2600 series router with power cable (could substitute a different series but must have two serial interfaces and two Fast Ethernet interfaces)
- Two Cisco series 2950 switches (or other appropriate series switch) with power cord
- Five hubs with power cables (can substitute switches)
- Three V.35 DTE cables (male) with serial end to match serial interface on routers
- Three V.35 DCE cables (female) with serial end to match serial interface on routers
- Rollover cables for the routers and switches
- Five RJ-45 to DB-9 connectors (do not need these if rollover cables have a DB-9 end)
- Six computers running Microsoft Windows Vista or XP2, with NICs installed
- HyperTerminal installed on all Windows computers
- One Windows Internet computer with a NIC configured and the TCP/IP protocol configured
- Transceivers for the router Ethernet ports, if these ports use an AUI connection instead of RJ-45
- TFTP server software on a CD or USB drive (preferably Cisco's, which is TFTPSEXE)
- Power strips

- Nineteen UTP patch cables
- One CSU/DSU (can substitute a router if necessary, and it does not have to work; it is for simulation purposes only, and is only used in Lab 2.1)
- One bridge (does not have to work; it is for simulation purposes only, and is only used in Lab 2.1)
- Transceivers for the bridge connections if the bridge uses AUI connections instead of RJ-45 (only used in Lab 2.1)
- Three hubs (do not have to work; they are for simulation purposes only, and are only used in Lab 2.1)
- Nine NICs with RJ-45 transceivers to simulate nine host computers (do not have to work; they are for simulation purposes only, and are only used in Lab 2.1)
- One serial cable with a compatible connector for a serial interface on a router on one end and a V.35 connector on the other end to attach to the CSU/DSU. If another router will be used instead of the CSU/DSU, the cable connector should match the serial interface on the additional router (does not have to work; it is for simulation purposes only, and is only used in Lab 2.1)

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