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思科网络技术学院教程 (第三、四学期) (第三版) (英文版)

Cisco Networking Academy Program
CCNA 3 and 4
Companion Guide
Third Edition

The only authorized textbook for the
Cisco Networking Academy Program

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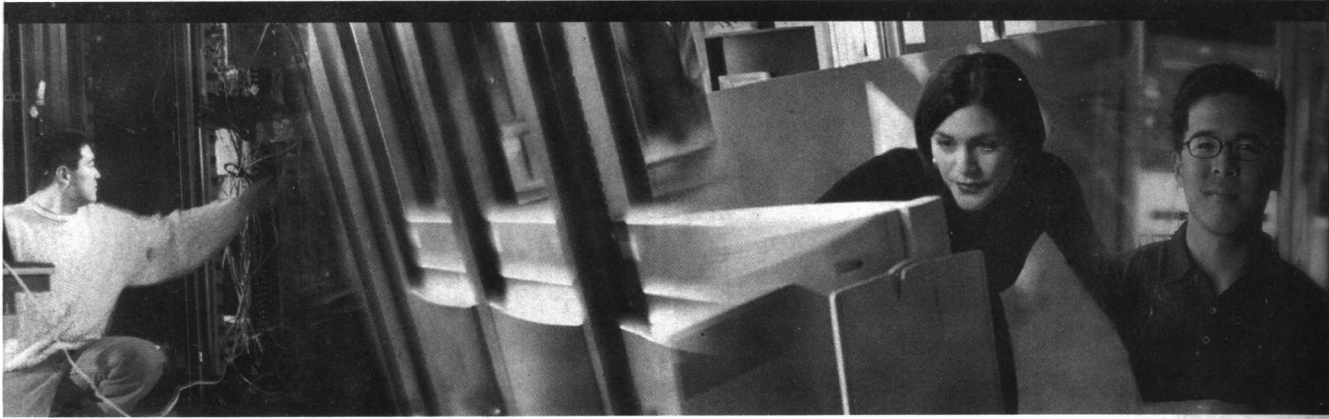
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Cisco Networking Academy Program

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内容提要

思科网络技术学院项目（*Cisco Networking Academy Program*）是Cisco Systems公司在全世界范围推出的一个主要面向初级网络工程技术人员的培训项目，其培训内容与CCNA类似。

本书为思科网络技术学院第三、四季期的配套书面教程，主要内容包括：OSI参考模型和路由选择、无级路由选择、单区域OSPF、增强内部网关路由选择协议、交换概念与局域网设计、交换机、交换机配置、生成树协议、虚拟局域网、VLAN中继协议、扩展的IP地址、广域网技术、点到点协议、ISDN和DDR、帧中继、网络管理介绍、光网络基础、网络管理、网络认证考试复习、Network+认证考试概览、CCNA认证考试复习、关于融合网络技术的介绍、制定网络安全和网络管理策略、虚拟专用网。每章的最后还提供了复习题。附录A包含了本书中使用的所有关键词的术语表；附录B是每章结尾复习题的答案。

本书为新的思科网络技术学院教学计划的第三、四季期的书面教材，编写本书的目的是为了帮助学生准备CCNA认证考试，并帮助他们掌握必要的网络知识。

为实施人才强国战略贡献力量(代序言)

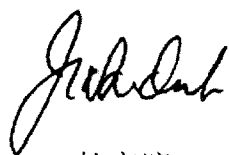
在《思科网络技术学院教程》(第三版)影印版出版之际,我谨代表思科系统网络技术有限公司,感谢各位学员朋友对思科网络技术学院的厚爱,感谢人民邮电出版社长期以来的合作与支持,感谢编辑及所有人为此付出的努力。

思科公司总裁兼首席执行官钱伯斯认为,互联网和教育,作为推动社会经济发展的两个核心动力,将深刻改变国家、企业和个人在未来时代的核心竞争力。现在,这一理念已经得到越来越多的认同和支持。

回首1997年,作为互联网和教育相结合的产物,思科系统公司启动了思科网络技术学院这一非赢利性的全球网络技术教育项目。到目前为止,思科公司为该项目的投入已达2亿美元,在全球150多个国家建立了1万余所思科网络技术学院。来自全球大学、职业技术学校、中学、团体机构和其他教育组织的45万学员正在学习。在中国,第一所思科网络技术学院1998年于复旦大学成立。短短6年时间,已经在全国建立了200所思科网络技术学院,培养超过2万名毕业生。最近,思科公司又与教育部签署协议,面向全国35所示范性软件学院提供全面的基于思科网络技术学院的网络技术课程体系,以帮助中国培养一大批兼通网络技术的复合型软件人才。

在思科网络技术学院,参加学习的学员不仅来自经济发达省份,也来自西部欠发达地区;既有在校的大学生甚至中学生,也有已经处于重要岗位的在职人员。2000年6月,钱伯斯第三次访华之际,思科向30所西部高校捐建了思科网络技术学院,希望网络能为东西部地区协调发展做出贡献,得到了西部地区的热烈响应。2001年10,江泽民主席在第九界亚太经合组织会议(APEC)上宣布发起“人力资源能力建设促进项目”。作为该计划的积极参与者,思科系统公司在此后的三年中,为APEC各成员国选派的400名学员提供思科CCNA、CCNP培训及认证。此外,联合国开发计划署(UNDP)、国际电信联盟(ITU)也分别与思科合作,在贫困和欠发达地区成立思科网络技术学院,用以缩小地区间的数字鸿沟。

展望未来,网络还有更大的潜能等待着我们一起发掘。在国家高瞻远瞩地提出人才强国战略之今天,思科将一如继往地发挥自己特有的网络技术优势,尤其是通过思科网络技术学院这一非盈利性的全球教育项目,帮助中国的人才资源能力建设,最终发动更多的人投身到网络经济大潮去,为消除数字鸿沟、发展国民经济贡献力量!



杜家滨

思科系统公司全球 副总裁
思科系统(中国)网络技术有限公司 总裁

2004年12月

About the Technical Reviewers

Ronald Bodtcher has been involved with computer networking since college, where he implemented a primitive version of SneakerNet while programming an IBM-360 with punched cards. After graduating from BYU with bachelor's and master's degrees in accounting, Ron actually became a computer and worked as a manager and tax computer specialist for KPMG Peat Marwick. Today, Ron is a consultant for CPAide, a company that provides web services for accounting professionals. Ron is a certified public accountant, and his IT certifications include A+, Network+, and CCNA. He is also a member of the Internet Society, the Association for Computing Machinery, and the IEEE. As a graduate of the Cisco Networking Academy Program at College of the Canyons in Santa Clarita, California, Ron has first-hand experience in mastering basic Cisco Networking and passed the CCNA with flying colors. Ron spends his free time recovering and restoring Ice Age fossils in the paleontology lab at the LaBrea Tar Pits and hiking in Waterton National Park with his wife, Sara, and their three daughters Sara Jr., Alice, and Ronaleah.

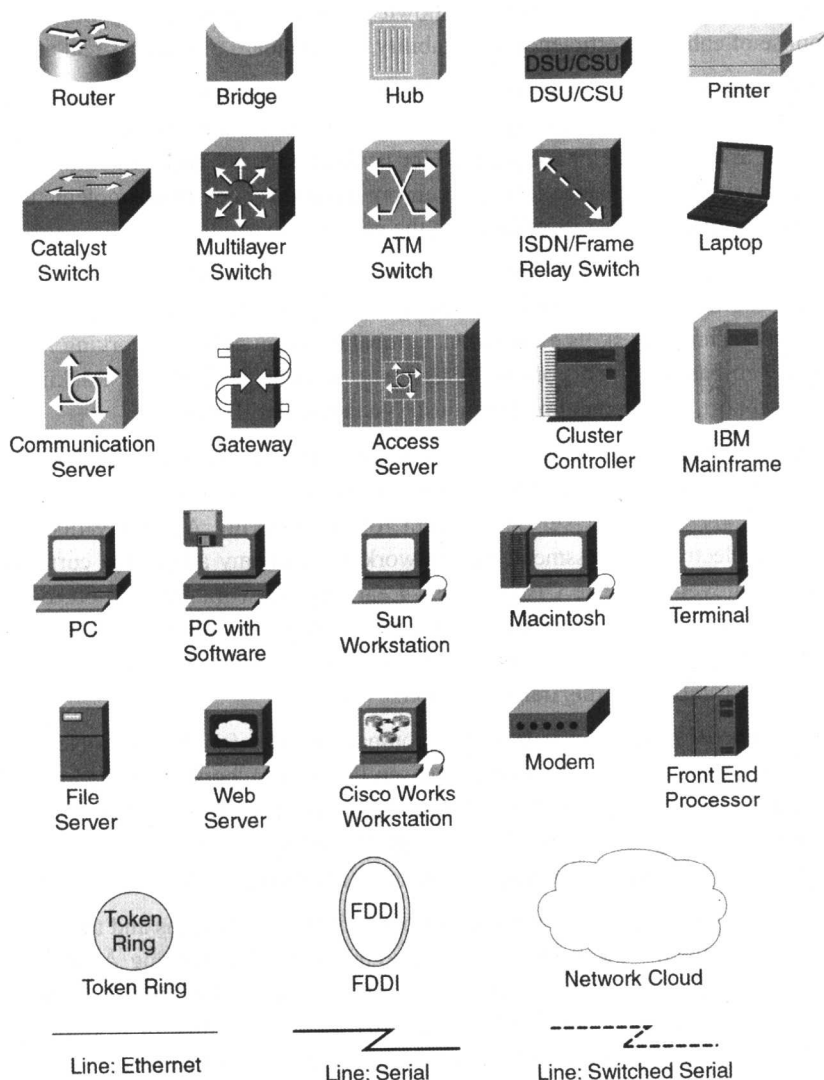
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Rick McDonald earned his CCNP in 2002 and currently teaches CCNP and other computer classes at Central Piedmont Community College in Charlotte, North Carolina. He holds a B.A. degree in English and an M.A. degree in computer education from Gonzaga University in Spokane, Washington. Rick is an avid cyclist who also enjoys reading, but his preferred hobby is travel with his wife, Becky, and his sons, Greg, Paul, and Sam.

Cisco Systems Networking Icon Legend

Cisco Systems, Inc. uses a standardized set of icons to represent devices in network topology illustrations. The icon legend that follows shows the most commonly used icons that you might encounter throughout this book.



Command Syntax Conventions

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

- Vertical bars (|) separate alternative, mutually exclusive elements.
- Square brackets ([]) indicate optional elements.
- Braces ({ }) indicate a required choice.
- Braces within brackets ([{ }]) indicate a required choice within an optional element.
- **Boldface** indicates commands and keywords that are entered exactly as shown.
- *Italic* indicates arguments for which you supply values.

Foreword

Throughout the world, the Internet has brought tremendous new opportunities for individuals and their employers. Companies and other organizations are seeing dramatic increases in productivity by investing in robust networking capabilities. Some studies have shown measurable productivity improvements in entire economies. The promise of enhanced efficiency, profitability, and standard of living is real and growing.

Such productivity gains aren't achieved by simply purchasing networking equipment. Skilled professionals are needed to plan, design, install, deploy, configure, operate, maintain, and troubleshoot today's networks. Network managers must assure that they have planned for network security and for continued operation. They need to design for the required performance level in their organization. They must implement new capabilities as the demands of their organization, and its reliance on the network, expands.

To meet the many educational needs of the internetworking community, Cisco Systems established the Cisco Networking Academy Program. The Networking Academy is a comprehensive learning program that provides students with the Internet technology skills essential in a global economy. The Networking Academy integrates face-to-face teaching, web-based content, online assessment, student performance tracking, hands-on labs, instructor training and support, and preparation for industry-standard certifications.

The Networking Academy continually raises the bar on blended learning and educational processes. The Internet-based assessment and instructor support systems are some of the most extensive and validated ever developed, including a 24/7 customer service system for Networking Academy instructors. Through community feedback and electronic assessment, the Networking Academy adapts the curriculum to improve outcomes and student achievement. The Cisco Global Learning Network infrastructure designed for the Networking Academy delivers a rich, interactive, and personalized curriculum to students worldwide. The Internet has the power to change the way people work, live, play, and learn, and the Cisco Networking Academy Program is in the forefront of this transformation.

This Cisco Press title is one of a series of best-selling companion titles for the Cisco Networking Academy Program. Designed by Cisco Worldwide Education and Cisco Press, these books provide integrated support for the online learning content that is made available to Academies all over the world. These Cisco Press books are the only authorized books for the Networking Academy by Cisco Systems, and provide print and CD-ROM materials that ensure the greatest possible learning experience for Networking Academy students.

I hope you are successful as you embark on your learning path with Cisco Systems and the Internet. I also hope that you will choose to continue your learning after you complete the Networking Academy curriculum. In addition to its Cisco Networking Academy Program titles, Cisco Press also publishes an extensive list of networking technology and certification publications that provide a wide range of resources. Cisco Systems has also established a network of professional training companies—the Cisco Learning Partners—who provide a full range of Cisco training courses. They offer training in many formats, including e-learning, self-paced, and instructor-led classes. Their instructors are Cisco certified, and Cisco creates their materials. When you are ready, please visit the Learning & Events area on Cisco.com to learn about all the educational support that Cisco and its partners have to offer.

Thank you for choosing this book and the Cisco Networking Academy Program.

Kevin Warner

Senior Director, Marketing

Worldwide Education

Cisco Systems, Inc.

Introduction

Cisco Networking Academy Program CCNA 3 and 4 Companion Guide, Third Edition, supplements your classroom and laboratory experience with the Cisco Networking Academy Program, whose curriculum empowers you to enter employment or further education and training in the computer networking field.

This book is designed to train you beyond the online materials that you have already used in this program. It also covers topics that pertain to the Cisco Certified Network Associate (CCNA) certification exam. This book closely follows the style and format that Cisco has incorporated into the curriculum. Finally, this book is complemented by a CD-ROM, which contains instructional Videos, e-Lab Activities, PhotoZooms, and exam preparation practice questions, all presented in an interactive multimedia format as learning reference materials.

This book introduces and extends your knowledge and practical experience with the design, configuration, and maintenance of switches, local-area networks (LANs), and virtual local-area networks (VLANs). The concepts that are covered in this book enable you to develop practical experience in skills that are related to configuring LANs, widearea networks (WANs), Interior Gateway Routing Protocol (IGRP), Enhanced Interior

Gateway Routing Protocol (EIGRP), and network troubleshooting. In addition, this book extends your knowledge of and practical experience with WANs, Integrated Services Data Network (ISDN), Point-to-Point Protocol (PPP), and Frame Relay design, configuration, and maintenance.

This book not only prepares you for the CCNA certification exam, but it also prepares you for the CompTIA Network+ certification exam.

The Goal of This Book

The goal of this book is to educate you about Cisco-supported networking technologies and to help you understand how to design and build networks and to configure Cisco routers. This book is designed for use in conjunction with the Cisco Networking Academy Program curriculum or as a standalone reference.

The Audience for This Book

This book's main audience is students who are interested in networking technologies. In particular, this book is targeted toward students who are in the Cisco Networking Academy Program. In the classroom, this book can serve as a supplement to the online curriculum.

This book is also appropriate for corporate training faculty and staff members, as well as general users. The book's user-friendly, nontechnical approach is ideal for readers who prefer to stay away from manuals that require a vast amount of technical knowledge.

Book Features

This book contains many helpful features that help facilitate your understanding of computer systems and troubleshooting system problems:

- **Objectives**—Each chapter starts with a list of objectives that should be mastered by the end of the chapter. The objectives provide a reference for the concepts that are covered in the chapter.
- **Figures, Examples, and Tables**—This book contains figures, configuration examples, and tables that help explain theories, concepts, and commands that reinforce concepts and help visualize the content that the chapter covers. In addition, the specific examples provide real-life situations that detail the problem and the solution.
- **Chapter Summaries**—At the end of each chapter is a summary of the concepts that were covered in the chapter. The summary provides a synopsis of the chapter and serves as a study aid. Use it to gauge your mastery of the topics covered in that chapter.

- **Key Terms**—The Key Terms section provides a summary of the most important terms that are covered in the chapter. These terms serve as a study aid. They also reinforce the concepts that were introduced in the chapter. As you read the chapter, any terms that appear in blue are defined in the Key Terms section.
- **Check Your Understanding Questions**—Review questions are presented at the end of Chapters 1–17 to serve as a further assessment. These questions reinforce the concepts introduced in the chapter and help test your understanding before you move on to new chapters.
- **Skill Builders**—Throughout this book are references to worksheet and lab activities that are found in *Cisco Networking Academy Program CCNA 3 and 4 Lab Companion*, Third Edition. These labs allow you to make a connection between theory and practice.

How This Book Is Organized

This book is divided into 23 chapters and two appendixes. Chapter 1 is a review, Chapters 2–10 apply to the CCNA 3 online curriculum, and Chapters 11–16 apply to the CCNA 4 online curriculum. Chapters 17–23 are additional materials that are written to help you prepare for exams, such as the CCNA and CompTIA Network+ exams, and to gain knowledge on emerging technologies. The following provides a summary of each element:

- Chapter 1, “The Review: The OSI Reference Model and Routing”—This chapter presents a review of the Open System Interconnection (OSI) reference model and an overview of network planning and design considerations that are related to routing.
- Chapter 2, “Introduction to Classless Routing”—This chapter presents the fundamentals of variable length subnet mask (VLSM) along with how and why to use it. This chapter describes how to configure VLSM. It also delves into the history of the Routing Information Protocol (RIP) and the basic components of RIPv2. Finally, this chapter covers how to configure, verify, and troubleshoot RIPv2.
- Chapter 3, “Single-Area OSPF”—This chapter discusses the fundamentals of link-state routing protocols, single-area OSPF concepts, and single-area OSPF configuration.
- Chapter 4, “Enhanced Interior Gateway Routing Protocol”—This chapter presents the basic concepts of EIGRP and compares it to IGRP. The steps for configuring, verifying, and troubleshooting are described as well.
- Chapter 5, “Switching Concepts and LAN Design”—This chapter discusses problems in LANs and possible solutions that can improve LAN performance. In addition, this chapter covers the advantages and disadvantages of using bridges, switches, and routers for LAN segmentation and the effects of switching, bridging, and routing on network throughput. Finally, this chapter presents Ethernet, Fast Ethernet, and VLANs and the benefits of these technologies.
- Chapter 6, “Switches”—This chapter presents 802.3 LANs and the pros and cons of LAN segmentation with LAN design. In addition, this chapter describes basic Layer 2 bridging and switching functions.
- Chapter 7, “Switch Configuration”—This chapter describes the processes of LAN switching. It covers the steps for configuring and verifying switch configuration and describes password recovery and firm upgrade procedures.
- Chapter 8, “Spanning Tree Protocol”—This chapter provides an overview of the Spanning Tree Protocol and redundant topologies.
- Chapter 9, “Virtual LANs”—This chapter discusses the basic concepts of VLANs and their benefits. It also describes how to configure, verify, save, delete, and troubleshoot VLANs.
- Chapter 10, “VLAN Trunking Protocol”—This chapter provides an overview of trunking. In addition, it describes the concepts, operation, and configuration of VTP. Finally, it covers the fundamentals of

inter-VLAN routing.

- Chapter 11, “Scaling IP Addresses”—This chapter describes the components of scaling networks with NAT and PAT. It also discusses DHCP, its operation, configuration, and steps for troubleshooting.
- Chapter 12, “WAN Technologies”—This chapter presents the various protocols and technologies that are used in WAN environments. It describes the basics of WANs, including common WAN technologies, types of wide-area services, encapsulation formats, and link options. Finally, this chapter discusses point-to-point links, circuit switching, packet switching, virtual circuits, dial-up services, and WAN devices.
- Chapter 13, “Point-to-Point Protocol” —This chapter discusses the basic components, processes, and operations that define PPP communication. In addition, this chapter describes how to configure and verify the configuration of PPP along with PPP authentication.
- Chapter 14, “ISDN and DDR” —This chapter presents the services, standards, components, operation, and configuration of ISDN communication.
- Chapter 15, “Frame Relay” —This chapter discusses Frame Relay services, standards, components, and operation. In addition, this chapter covers the configuration tasks for Frame Relay service, along with the commands for monitoring and maintaining a Frame Relay connection.
- Chapter 16, “Introduction to Network Administration” —This chapter provides an overview of the methodologies that are used to design WANs. It includes a description of WAN communication and the processes and considerations for designing a WAN. It also covers the process for gathering user requirements for WAN design and the benefits of using a hierarchical design model. This chapter discusses basic components of different types of workstations and servers, including Microsoft, UNIX, and Apple systems. In addition, this chapter introduces network management tools, the OSI and network management models, as well as how management software gathers information and records problems.
- Chapter 17, “Optical Networking Fundamentals” —This chapter describes how optical networks provide speed, data transportation, capacity, and scalability. This chapter also discusses the optical network function, the enhanced scalability provided by dense wavelength division multiplexing (DWDM), and the solutions that optical networks provide.
- Chapter 18, “Network Management” —This chapter discusses the basic fundamentals of managing a network. It covers network documentation, network security, network maintenance, data recovery, server administration, server maintenance, and network troubleshooting.
- Chapter 19, “Network Certification Exam Review”—This chapter provides a review of the topics you need to know to successfully pass the Network+ certification exam.
- Chapter 20, “CCNA Certification Exam Review” —This chapter assists in your preparation for the CCNA certification exam by presenting a review of the topics that are covered on the exam.
- Chapter 21, “Introduction to Converged Networking”—This chapter describes how traditional voice, video, and data networks are implemented and explains various types of voice-over-data technologies. This chapter also covers the need for converged voice, video, and data networks. In addition, this chapter introduces Cisco Architecture for Voice, Video and Integrated Data (AVVID) and new applications for converged networks.
- Chapter 22, “Developing Network Security and Network Management Strategies”—This chapter helps you work with your network design customer in the development of effective security strategies. It helps you select the right tools and products to implement the strategies.
- Chapter 23, “Virtual Private Networks” —This chapter establishes virtual private networking as a clear

case for security. It covers the basic mechanism for using public networks for private communications.

- Appendix A, “Glossary of Key Terms” —The glossary contains definitions of all the key terms that are used throughout the book.
- Appendix B, “Check Your Understanding Answer Key” —This appendix provides the answers to the “Check Your Understanding” questions that are at the end of each chapter.

About the CD-ROM

A CD-ROM accompanies this book to further enhance your learning experience. The CD-ROM contains a test engine with CCNA practice exam questions, interactive e-Lab Activities, PhotoZooms of networking equipment and hardware, and instructional Videos and animations that highlight potentially difficult concepts. These materials support self-directed study by allowing you to engage in learning and skill-building exercises outside of the classroom. The CD-ROM also provides the following:

- An easy-to-use graphical user interface
- Chapter-by-chapter activities and resources
- Information and activities that are not found online
- Accurate and concise feedback on practice exam questions
- Learner-directed practice and study
- Flexibility for learners of all levels

Finally, these learning tools emphasize not only conceptual material, but also the importance of practicing what you have learned. The CD-ROM helps you understand networking technologies and make the connection between theory and practice.

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