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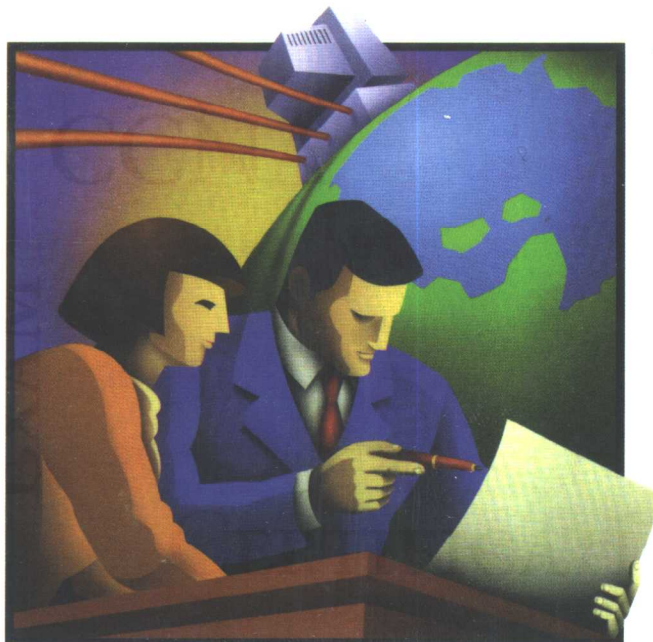
CISCO CAREER CERTIFICATIONS
CISCO CERTIFIED NETWORK ASSOCIATE

Wendell Odom
CCIE#1624

CCNA Exam
Certification Guide
CCNA资格认证考试及培训
必　　读

The official study guide for

CCNA Exam #640-407

CISCO SYSTEMS

CISCO PRESS

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CCNA Exam Certification Guide

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CISCO SYSTEMS

清 华 大 学 出 版 社

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出 版 前 言

    21 世纪将会是一个信息高速公路四通八达的时代,信息产业发展的水平亦将是评估一个国家综合国力的重要依据。世界各国将会在信息技术的研究开发和信息产业的发展方面展开激烈的竞争。这既是一种挑战也是一种机遇。有鉴于此,我国已经开始全面快速地发展网络技术和因特网。

    Cisco Systems 公司是世界领先的全球 Internet,Intranet 以及电信网络设备及解决方案的供应商,1996 年名列世界十大电信公司之一。Cisco Systems 的联网操作系统(IOS)是支持网络服务和网络应用的坚实基础。该公司与麦克米伦计算机出版公司合作创立了 Cisco Press,出版了一系列关于最新的网络技术的权威著作。这些著作不仅兼顾建网与网际互联的基础理论和实际应用,为网络专业人员和用户提供必要的技术支持,还有一部分是为 Cisco CCIE 考试和 CCNA,CCNP,CCDA 及 CCDP 职业考试认证准备的自学和培训教材。Cisco 公司早于 1994 年就进入中国,已为国内信息产业界所熟悉。我们引进其中部分著作组成"CISCO 系列丛书(影印版)"影印出版,以祈对我国信息产业的发展稍尽绵薄之力,并衷心希望这套丛书对从事建网,网际互联的专业人员;有志于我国信息产业发展的读者,以及参加 Cisco 培训和准备 Cisco 考试认证的人员有所裨益。

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About the Author

Wendell Odom, CCIE, is the Technology Director of Lacidar Unlimited, Inc., a networking consulting and training company in Atlanta, Georgia. In this role, Wendell provides both expert advice about many aspects of building networks, and full design and implementation assistance for large projects. Wendell is CCIE #1624 and a Certified Cisco Systems Instructor and has taught various Cisco certification courses including Introduction to Cisco Router Configuration (ICRC), Advanced Cisco Router Configuration (ACRC), Cisco SNA for Multiprotocol Administrators (SNAM), Cisco Channel Interface Processor (CIP), and Cisco ATM (CATM). Wendell is one of the first Cisco instructors certified without a probationary testing period and is the first non-Cisco instructor in the United States to teach Cisco's SNAM, CIP, and DLSw courses.

About the Technical Reviewers

Thomas M. Thomas II, a member of the OSPF Working Group, is Cisco Certified and a Course Designer in Cisco Systems' Worldwide Training Division. Prior to his duties at Cisco, Tom was a Senior Network Engineer and Group Leader of the Advanced Systems Solutions Engineering Team for MCI's Managed Network Services. His responsibilities included network support and design consulting. Tom has also worked as a technical team leader at AT&T Solutions, for which he provided technical support and network management for Cisco routers over ATM and Frame Relay, configured various networking protocols, and developed custom training programs. He has also performed network management and troubleshooting duties for many years as a member of the United States Air Force. Tom is the author of *OSPF Network Design Solutions*, published by Cisco Press.

Henry Benjamin, CCNA, is a Senior Network Consultant for a large organization specializing in IP routing protocols and SNA. He is a Cisco Certified Network Associate and has planned, designed, and implemented large networks including IGRP, EIGRP, and OSPF. Over the past two years he has focused on large SNA networks including the largest Cisco DLSw+ network in the world. Henry also holds a Bachelor of Engineering degree from Sydney University.

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Kevin Downes is a Senior Network Systems Consultant with International Network Services (INS). His network certifications include the Cisco CCIE, Bay Networks CRS, Certified Network Expert (CNX) Ethernet, Novell CNE, and Banyan Systems CBE. He has published several articles on the subjects of network infrastructure design, network operating systems (NOS), and Internet Protocol (IP). He completed his B.S. in Computer Information Systems from Strayer University in 1993. Kevin is the coauthor of *Internetworking Troubleshooting Handbook* and *Internetworking Technologies Handbook, Second Edition*, both published by Cisco Press.

Dedications

First, to my loving wife, Kris, whose support and tolerance during our first year of marriage allowed me to write this book. Also, to Kris's now deceased, longtime companion, Sterling the cat, who kept Kris company for 17 years before we met, and who kept me company during my first month of writing this book at home.

Acknowledgments

Chris Cleveland, development editor for Cisco Press, deserves a great deal of credit for making this book much better. When one person tells you someone is the best at what he does, you might at least pay attention. When everyone does, it's impressive. All the accolades are true—great job!

John Kane of Cisco Press was a great help as we set the tone for the Cisco Press Certification series. John, our many talks together, refining what the books should and should not be, were of great help. Your infinite patience working with a first-time author helped as well.

Amy Lewis of Cisco Press helped greatly by taking care of many details. Amy, in five years of running a business, I have never had business transactions taken care of with such ease and professionalism. And thanks for getting those advance checks to me in a timely fashion!

Tom Thomas and Henry Benjamin provided excellent technical review for the book chapters. Tom, your insight and interest in all aspects of Cisco certification helped beyond the call of duty, and your thoroughness absolutely made the book better. Henry, your specific suggestions for how to fix problematic parts of the book were particularly helpful, as well as your Aussie sense of humor! I saw from your comments that you have what it takes to succeed as a writer, as Tom has already shown with his OSPF book.

Clare Gough was also very helpful with technical discussions, as was Margo Lindenmayer of Network Associates. James Deoglaer of Convergent Communications was generous enough to give me the keys to their lab, which was very helpful for some of the lab scenarios. And Mike Zanotto of Skyline Computer provided some timely but flexible business, so I could write and pay my bills. Thanks!

To my good friends Greg and Lance, whose prayers in the midst of several nagging illnesses helped get me through the process. And to my wife, Kris, who has been a blessing beyond compare, both by doing more of my share of the work at home, and with emotional support. And finally, and most important, to Jesus Christ, my savior, whose joy gives me strength.

Introduction: Overview of Certification and How to Succeed

Professional certifications have been an important part of the computing industry for many years and will continue to become more and more important. Many reasons exist for these certifications, but the most popularly cited reason is that of credibility. All other considerations held equal, the certified employee/consultant/job candidate is considered more valuable than one who is not.

Cisco Certifications: Training Paths and Exams

The *Cisco Certified Internetwork Expert (CCIE)* certification program has been available since the early '90s. This long-standing certification has maintained a high degree of credibility and is recognized as a certification that lives up to the name "expert." The CCIE certification process requires passing a computer based test and then a two-day hands-on lab. Recertification is required every two years to ensure that the individual has kept skills up-to-date.

Many problems were created by having one highly credible, but difficult to pass, certification. One problem was that there was no way to distinguish between someone who is almost ready to pass CCIE and a novice. The CCIE lab test is meant to prove that the individual not only has mastery of many topics, but the ability to learn and unravel situations quickly and under pressure. Many highly respected engineers have failed the CCIE lab on the first try. Employers wanting to reward employees based on certification, employers looking at prospective new employees, and network managers trying to choose between competing consulting companies have had too few Cisco-related certifications on which they could base their decisions.

In an effort to solve these problems, Cisco Systems has created several new "Cisco Career Certifications." Included in these new certifications is a series of certifications related to routing and switching. The *Cisco Certified Network Associate (CCNA)* certification, accomplished by passing a computer-based exam, is one of these new certifications oriented toward routing and switching. CCNA is the first certification in this series. If you understand the protocols listed in the table of contents, plus how they apply to the network diagramed in Figure I–1, then you are a candidate who should be ready for the CCNA exam.

**Figure I–1**   *Typical Network Used for the CCNA Exam*
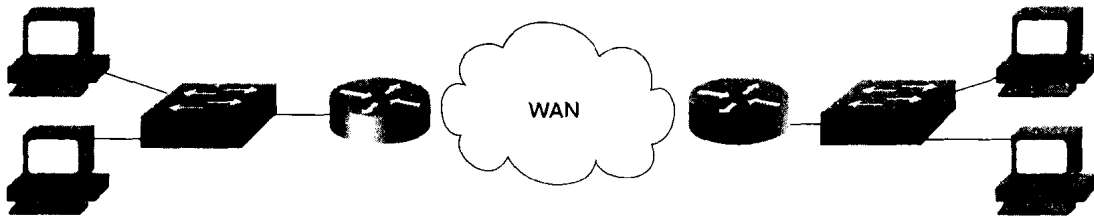
The WAN links in the Figure I-1 are Frame Relay, point-to-point serial, and ISDN links. The LANs are typically Ethernet, with LAN switches in some cases.

The CCNA exam is used to prove mastery of the features used in typical small networks. CCNA certification is required before attempting CCNA and CCDP certifications. Figure I–2 lists the various Cisco certifications relating to routing and switching, along with the exams required.

Some reasons for taking the CCNA exam are as follows:

1. To prove your mastery of basic internetwork concepts.

2. To create a more impressive entry in your résumé.

3. To prove that beyond simply taking a Cisco certified course, you understand the topics in the class.

4. To demonstrate that you have equivalent experience and expertise to those who have taken the Cisco certified courses.

5. To obtain a Cisco certification while you gain the experience needed to pass the CCIE Routing and Switching or CCIE ISP Dial certifications. (Unless you want to shoot for the stars and take a CCIE test now, **CCNA is the only first step** toward certification involving routing and LAN switching.)

6. To encourage self-discipline in your study as you try to become CCIE certified.

7. As a stepping stone to the CCNP and CCDP certifications.

8. For consultants, to provide a marketing edge compared to your competitors by asserting that a Cisco certified individual will be working with a particular prospective client.

Two suggested training paths are outlined on Cisco's Web site and include suggested courses that will prepare you to pass the exam. These paths are also described later in this chapter, along with two other training paths.

Figure I–2   *Cisco Certifications and Exams on the Routing and Switching Career Path*
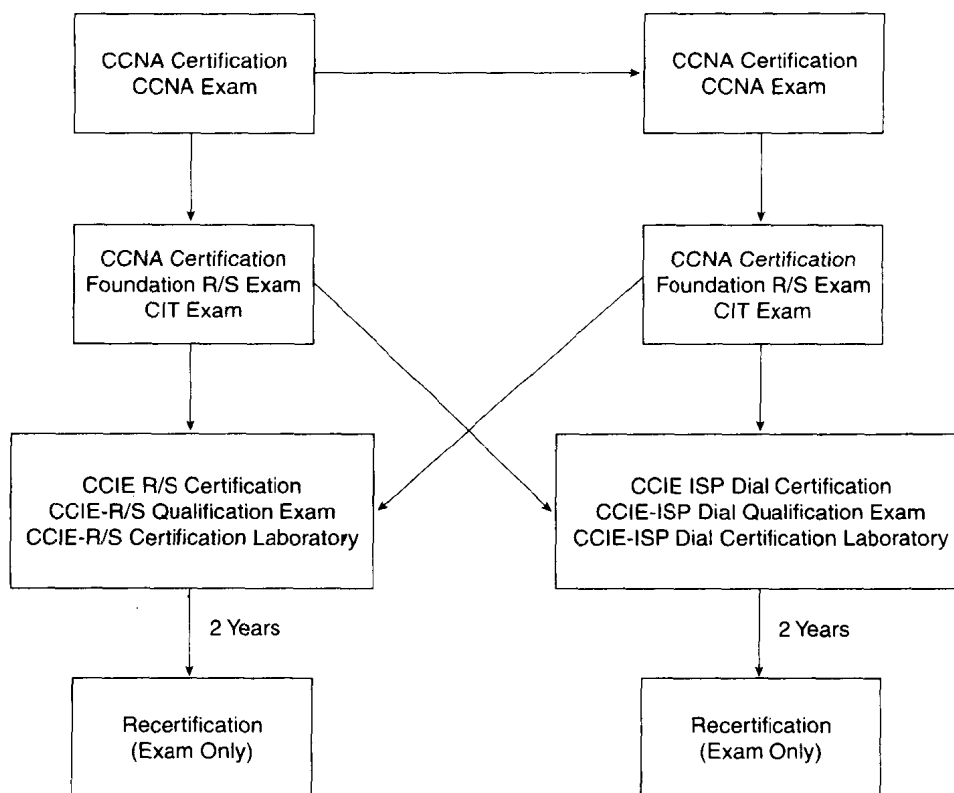
The *Cisco Certified Networking Professional (CCNP)* exam is used to prove mastery of more complex networks. In this case, complex means topics covered in the prerequisite courses. Like CCNA, the CCNP certification is oriented toward proving the skills needed to implement internetworks. Most of the same reasons for wanting to become CCNA certified are also true for CCNP. **CCNA certification is a prerequisite to taking the CCNP exam.**

When this book went to press, the courses suggested in the training path defined by Cisco for CCNP were as follows:

1. A training path leading to CCNA certification

2. The Advanced Cisco Router Configuration (ACRC) course

3. The Cisco LAN Switching Course (CLSC) course

4. The Configuring, Monitoring, and Troubleshooting Dial-up Services (CMTD) course

5. The Cisco Internetwork Troubleshooting (CIT) course

The *Cisco Certified Design Associate (CCDA)* exam is used to prove mastery over network design issues for basic networks. It is similar to CCNA but is focused on design issues. This certification is particularly important for those with presales oriented jobs.

When this book went to press, the courses suggested in the training path defined by Cisco for CCDA were as follows:

1. The Internetworking Technology Multimedia (ITM) CD-based course

2. The Designing Cisco Networks (DCN) course

The *Cisco Certified Design Professional (CCDP)* exam is used to prove mastery over design issues for more advanced networks. This certification proves mastery of design issues in complex networks. In this case, complex means topics covered in the prerequisite courses. This certification is particularly important for those with presales oriented jobs. **CCDA and CCNA certification are prerequisites to taking the CCDP exam.**

When this book went to press, the courses suggested in the training path defined by Cisco for CCDP were as follows:

1. A training path leading to CCDA and CCNA certification

2. The Advanced Cisco Router Configuration (ACRC) course

3. The Cisco LAN Switching Course (CLSC) course

4. The Configuring, Monitoring, and Troubleshooting Dial-up Services (CMTD) course

5. The Cisco Internetwork Design (CID) course

A Few Words on the Various Cisco Certifications

You should note the following when considering CCNA, CCNP, CCDA, and CCDP Cisco routing and switching certifications:

Most people will not pursue all four of these certifications: CCNA, CCNP, CCDA, and CCDP—Most people will follow a track of getting CCNA and then either focus on the design certifications or the implementation certifications.

Certification exams cover the content taught in Cisco Systems Certified Courses— There is a definite benefit to taking the courses suggested by Cisco before taking the exam. The courses are not required for certification, however.

The old CCIE is now CCIE-R/S—Cisco added the designation R/S for "routing and switching," which includes both LAN and ATM switching. This is the CCIE of old. CCIE-ISP covers dial issues in more depth, as well as exterior routing protocols. CCIE-WAN, which entails a separate career path of recommended courses and exams, covers WAN switching and voice.

Only the CCIE certifications require a hands-on lab exam—CCIE-R/S, CCIE-ISP, and CCIE-WAN all require passing a hands-on lab exam after passing a written (computer-based) exam. Recertification for CCIE of any kind currently does not require a hands-on lab, but rather a more detailed written test on an area of specialization.

Recertification is not (yet) required for CCNA, CCNP, CCDA, and CCDP—Because these certifications were announced in early 1998, there is not yet a need for recertification rules. In my opinion, Cisco will eventually require recertification for these, probably with a written (computer-based) test.

In the future, CCNA might be required before taking CCIE—Today, you can take the CCIE written exam at any time. In my opinion, the reason these new certifications are not required before taking the CCIE exam today is that there would be complaints from people who have prepared for CCIE, but would have then to back up and take other tests. If my theory is true, it seems reasonable to assume that one day Cisco will require CCDP or CCNP certification before taking the CCIE written and lab exams. Of course, the CCNP and CCDP certifications require CCNA certification first. It will be interesting to see if my predictions come true!

There is also a WAN Switching Career Certifications path—There is a whole other set of certifications with the acronym WAN in the title, which refer to the WAN switching topics and the functions of what was once the Stratacom product line (which was bought by Cisco). CCNA-WAN, CCNP-WAN, CCDP-WAN, and CCIE-WAN are the certifications; only a CCDA-WAN is missing as compared to the routing/switching certifications. These certifications are similar in concept to the others, but because the technology concerned is WAN switching, there are different exams and courses for the Career Certification levels. Please see Cisco's Web site for more details.

Objectives

The objective of this book is to help you fully understand, remember, and recall all the details of the topics covered on the CCNA exam. When that objective is reached, passing the CCNA exam should follow. The CCNA exam will be a foundation for most people as they progress through the other Cisco certifications; passing the exam because of a thorough understanding and recall of the topics will be incredibly valuable at the next steps.

This book will help you **pass the CCNA exam**, by doing the following:

- Helping you discover which test topics you have not mastered

- Providing explanations and information to fill in your knowledge gaps

- Supplying exercises and scenarios which enhance your ability to recall and deduce the answers to test questions

- Providing practice exercises on the topics and the testing process via online test questions (delivered on the CD)

Who Should Read This Book?

This book is not designed to be a general networking topics book, although it can be used for that purpose. This book is intended to tremendously increase your chances of passing the CCNA exam. Although others may benefit from using this book, the book is written assuming you want to pass the exam.

So why should you want to pass CCNA? To get a raise. To show your manager you are working hard to increase your skills. As a requirement from your manager before he will spend money on another course. As a résumé enhancer. Because you work in a presales job at a reseller and want to become CCDA and CCDP certified. To prove you know the topic, if you learned via on-the-job training (OJT) rather than from taking the prerequisite classes. Or one of many other reasons.

Others who may want to use this book are those considering moving beyond Cisco's ICRC (Introduction to Cisco Router Configuration) course to take Cisco's ACRC (Advanced Cisco Router Configuration) or CLSC (Cisco LAN Switch Configuration) courses. If you can answer a high percentage of the questions in this book, you are ready for those courses!

Have You Mastered All the Exam Objectives?

The exam will test you on a wide variety of topics; most people will not remember all the topics on the exam. Because some study will be required, this book focuses on helping you obtain the maximum benefit from the time you spend preparing for the exam. There are many sources for the information covered in the exam; for example, you could read the Cisco Documentation CD. However, this book is the most effective way to prepare for the exam.

You should begin your exam preparation by reading Chapter 1 and spending ample time reviewing the exam objectives listed there. Check out Cisco's "Cisco Connection Online" Web Site (http://www.cisco.com) for any future changes to the list of objectives.

# Preparation Before Using This Book

This book assumes that you fit into one of four general categories relating to your preparation before using this book. These categories, or training paths, are outlined in Table I-1.

Table I-1 *Four Possible CCNA Training Paths*

Training Path	What Is Involved
1. CCNA Path 1	As defined by Cisco Systems, this involves taking two courses: Internetworking Technology Multimedia (ITM) (CD-based). Cisco Routing and LAN Switching (CRLS) (instructor led).
2. CCNA Path 2	As defined by Cisco Systems, this involves taking three courses: Internetworking Technology Multimedia (ITM) (CD-based). Intro to Cisco Router Configuration (ICRC) (instructor led). High Performance Solutions for Desktop Connectivity (HPSDC) (CD-based).
3. Cisco Networking Academy	Cisco's Networking Academies are designed for high school and university students, with a goal of providing a learning path that provides the students with valuable Cisco skills, ready to use in the marketplace.
4. "OJT"	As defined by this book, on-the-job training, without the previous courses.

If you fall into Training Path 1, you happened to have taken the path that most closely matches what is covered on the exam. Many, however, have already taken Training Path 2, or at least the ICRC part of it. If that is the case, you will need to learn about LAN switching. The HPSDC CD course, and/or this book, can fill the gap. If you are in Training Path 3, this book will help you decide what pieces are missing from your skill set, and direct you in how to prepare. If you followed Training Path 4, you probably have lots of knowledge, but possibly not all the knowledge about the topics that are covered on the exam. This book will help you find the additional topics you need to study before taking the exam.

This book is designed with features that help CCNA candidates from each of these four preparation tracks complete their mastery of basic networks and pass the exam. Figure I-3 outlines the basic approach that you should use, depending on which training path you have followed. The details about which topics you should pay attention to during your preparation time are contained in Chapter 1.

Figure I–3   *Achieving Mastery through the Training Paths*
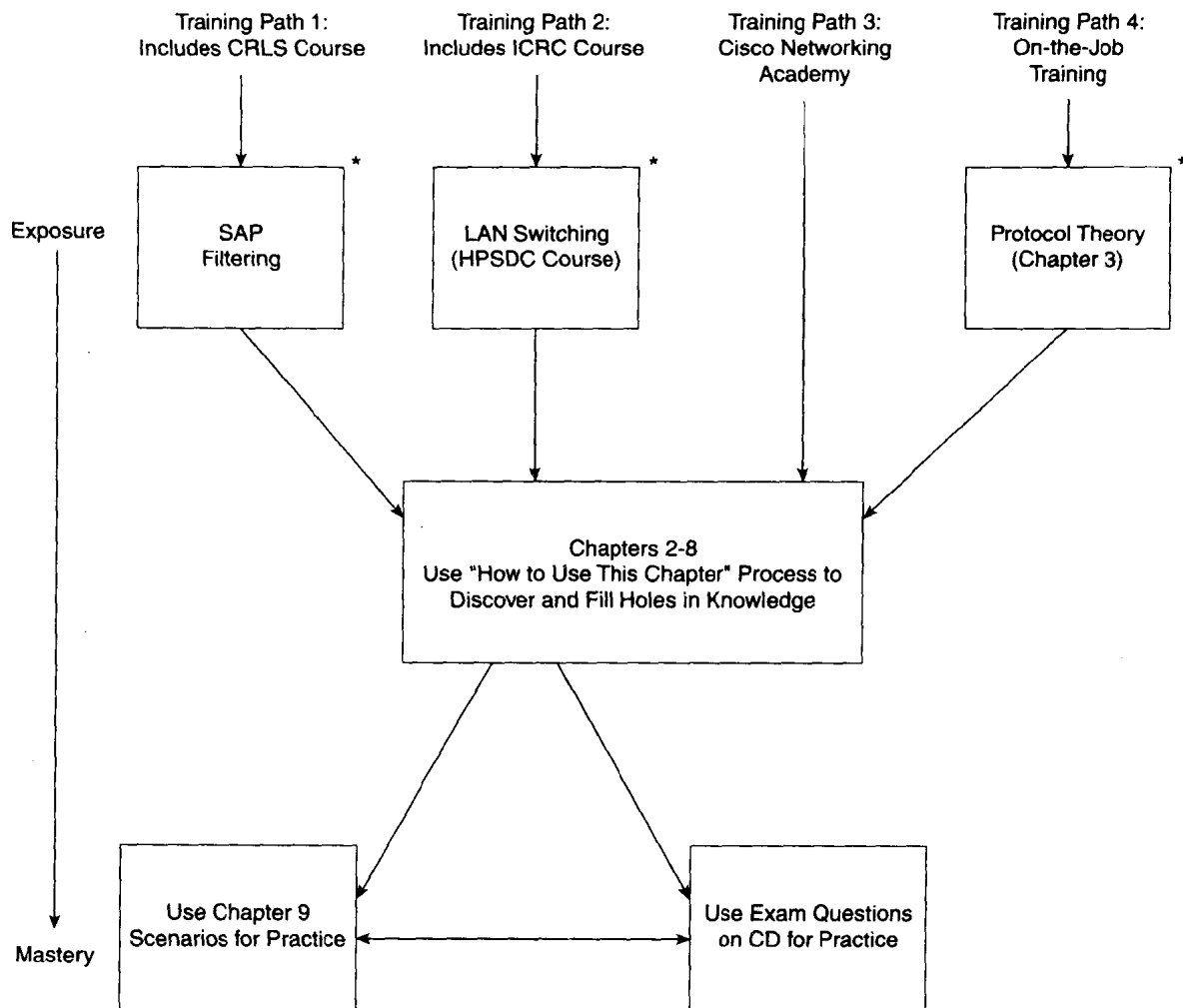
How This Book Is Organized

The book begins with a chapter definition of the topics that will be covered by the CCNA exam. Before studying for any exam, knowing the topics that could be covered is vitally important. With the CCNA exam, knowing what is on the exam is seemingly straightforward; Cisco publishes a list of 60 CCNA objectives. However, the objectives are certainly open to interpretation. Many topics may be considered on the fringe of what an objective implies; Chapter 1 attempts to clarify what is definitely on the exam, what is not, and it also lists which topics may be on the exam.

Chapters 2–8 match directly to Cisco's CCNA exam objectives. Each chapter begins with a quiz so that you can quickly determine your current level of readiness. The chapters are as follows:

2. Understanding Cisco's Internetwork Operating System (IOS) Software

3. Understanding the OSI Reference Model

4. Understanding LANs and LAN Switching

5. Network Protocols: Understanding the TCP/IP Suite and Novell NetWare Protocols

6. Understanding Routing

7. Understanding Network Security

8. WAN Protocols: Understanding Point-to-Point, Frame Relay, and ISDN

Additional scenarios in Chapter 9, "Scenarios for Final Preparation," provide a method of final preparation with more questions and exercises. Also, example test questions and the testing engine on the CD allow simulated exams for final practice.

Approach

Retention and recall are the two features of human memory most closely related to performance on tests. This exam preparation guide focuses on increasing both the retention and recall of the topics on the exam. The other human characteristic involved in successfully passing the exam is intelligence; this book does not address that issue!

Adult retention is typically less than that of children. It is common for four year olds to pick up basic language skills in a new country faster than their parents. Children retain facts as an end unto itself; adults typically need either a stronger reason to remember a fact, or must have a reason to think about that fact several times to retain that fact in memory. For these reasons, a student who attends a typical Cisco course, and retains 50 percent of the material, is actually quite an amazing student!

Memory recall is based on connectors to the information that needs to be recalled. For example, if the exam asks what ARP stands for, we automatically add information to the question. We know the topic is networking, because of the test. We may recall the term "ARP Broadcast,"

which implies it is the name of something that flows in a network. Maybe we do not recall all three words in the acronym, but we recall that it has something to do with Addressing. Of course, because the test is multiple choice, if only one answer begins with Address, we have a pretty good guess. Having read the answer "Address Resolution Protocol," then we may even have the infamous "aha" experience, in which we are then sure that our answer is correct (and possibly a brightly lit light bulb is hovering over our head). All these added facts and assumptions are the connectors that eventually lead our brains to the fact needed to be recalled.

Of course, recall and retention work together. If you do not retain the knowledge, it will be difficult to recall it!

This book is designed with features to help you increase retention and recall. It does this in the following ways:

- Providing succinct and complete methods of helping you decide what you already know and what you do not know.

- Giving references to the exact passages in this book that review those concepts you did not recall, so you can quickly be reminded about a fact or concept.

- Including exercise questions that supply fewer "connectors" than multiple choice questions. This helps you exercise recall and avoids giving you a false sense of confidence, as a multiple-choice only exercise might do. For example, fill-in-the-blank questions require you to have better recall than a multiple choice question.

- Pulling the entire breadth of subject matter together. A separate, larger chapter (Chapter 9) containing scenarios and several related questions, covering every topic on the exam, gives you the chance to prove that you have gained a mastery over the subject matter. This reduces the "connectors" implied by questions residing in a particular chapter and requires you to exercise other connectors to remember the details!

- Finally, accompanying this book is a CD-ROM that has exam-like, multiple-choice questions. These are useful for you to practice taking the exam and to get accustomed to the time restrictions imposed during the exam.

Features and Conventions of This Book

The various features of this book are listed as follows:

Cross Reference to CCNA Objectives—Cisco lists the objectives of the CCNA exam on their Web site. That list is included in Chapter 1, "What Is CCNA?" of this book. A section of each core chapter will include a reference to the CCNA objectives discussed in that chapter.

"Do I Know This Already?" Quiz—This beginning section of each chapter is designed to thoroughly quiz you on all topics in that chapter. Use your score on these questions to determine your relative need to study this topic further.

Foundation Topics—This section in each chapter explains and reviews topics that will be covered in the exam. If you feel the need for some review of the topics listed in that chapter, read through the explanations in this section. If you do not feel as much need to review these topics, review the charts and lists in each chapter and then proceed directly to the exercises at the end of the chapter.

Charts and Tables—Most of the facts learned in the prerequisite courses are summarized in tables and charts in each chapter. This enables you to review a chapter quickly, focusing on these charts and tables, without having to read the text. If you want to learn more, pause, and read the paragraphs leading up to the chart or paragraph. This is just one of the methods used in this book to enable you to make maximum use of you preparation time!

Q&A— Thinking about the same fact in many different ways increases recall; during a timed test, recall is a very important factor. During study time, increasing retention is most important, so there is something in memory you can recall in the future. These end-of-the-chapter questions focus on recall, covering topics in the Foundation Topics section by using several types of questions. And because the "Do I Know This Already?" quiz questions can help increase your recall as well, they are restated in the Q&A sections. Restating these questions, along with new questions, provides a larger set of practice questions for when you finish a chapter and for final review when your exam date is approaching.

Scenarios—Chapter 9, "Scenarios for Final Preparation," presents several scenarios with a battery of questions on each scenario. These scenarios are intended for use after you have reviewed the chapters and are ready to validate your mastery of all CCNA topics. If you get a high percentage of these questions correct, you should feel very confident about the CCNA exam!

Test Questions—Using the test engine on the CD, you can take simulated exams, as well as choose to be presented with several questions on a topic you need to work on more. The online testing tool will provide you with practice that will make you more comfortable when you actually take the CCNA exam.