Second Edition

VOLUME 1

CCNA® CERTIFICATION STUDY GUIDE

EXAM 200-301 v1.1

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TODD LAMMLE
DONALD ROBB

SYBEX®
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CCNA®

Certification

Study Guide

Volume 1

Exam 200-301 v1.1

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Acknowledgments

Many people helped us build the new CCNA books in 2024 and 2025. First, Kenyon Brown helped me put together the book direction and managed the internal editing at Wiley. Thank you, Ken, for working diligently for many months to keep these books moving along.

Thanks also to Kim Wimpsett, my most excellent and highly dependable development editor at Wiley for well over a decade. She always does an excellent job, and I refuse to work on a book without her now!

We'd also like to thank John Sleeva and Tiffany Tayler for their hard work and edits in books one and two, respectively. They really helped us create fine-tuned books.

In this book, I enjoyed collaborating with Donald Robb from Canada. He played a crucial role in crafting the new table of contents and was instrumental in writing, editing, and thoroughly addressing the latest exam topics across various chapters. His expertise is unparalleled, and he worked tirelessly alongside me daily to bring this book to life. I'm confident you'll appreciate his contributions as much as I do. You can connect with Donald through his well-known blog at `https://the-packet-thrower.com`. He also serves as a leading moderator and contributor on Reddit: `https://www.reddit.com/r/ccna`.

About the Authors

Todd Lammle is widely regarded as one of the foremost authorities on Cisco certification and internetworking, holding certifications across nearly every Cisco certification category. With a career spanning more than three decades, Todd has established himself as a globally recognized author, speaker, trainer, and consultant. His expertise extends across a broad range of technologies, including LANs, WANs, and large-scale enterprise wireless networks, both licensed and unlicensed. In recent years, he has specialized in implementing extensive Cisco security networks, particularly using Firepower/FTD and ISE.

What sets Todd apart is his deep, hands-on experience, which is evident in his writing and training materials. He's not just an author; he's a seasoned networking engineer with practical knowledge gained from working on some of the largest and most complex networks in the world. His experience includes significant contributions to companies such as Xerox, Hughes Aircraft, Texaco, AAA, Cisco, and Toshiba, among many others. This real-world experience allows Todd to bring a unique, practical perspective to his work, making his books and training sessions invaluable resources for IT professionals at all levels.

Todd has authored more than 120 books, solidifying his reputation as a leading voice in the industry. Some of his most popular titles include the *CCNA: Cisco Certified Network Associate Study Guide*, *CCNA Wireless Study Guide*, *CCNA Data Center Study Guide*, *CCNP SNCF (Firepower)*, and *CCNP Security*. All of these works are published by Sybex, a respected name in technical publishing.

In addition to his writing and speaking engagements, Todd runs an international consulting and training company based in Idaho. His company provides expert guidance and training to organizations around the world, helping them to navigate the complexities of modern networking technologies. Despite his busy professional life, Todd still finds time to enjoy the natural beauty of Idaho, often spending his free time at the lake in the mountains, where he enjoys the outdoors with his beloved golden retrievers.

For those looking to dive deeper into Todd Lammle's work, you can find his extensive range of books at `https://www.lammle.com/order-our-books`. Additionally, Todd is accessible to his readers and clients through his website at `www.lammle.com`, where you can find more resources, updates, and ways to connect with him directly.

Donald Robb, widely recognized online as "The Packet Thrower," brings over two decades of experience in the IT industry. His career has spanned a diverse array of roles, beginning with help desk support and evolving into a position as one of the most respected consultants in the field. Donald has honed expert-level skills across various IT domains, including networking, security, collaboration, data center management, wireless technologies, and service providers. His depth of knowledge and technical expertise have made him a sought-after professional in the industry.

Currently, Donald is a principal network architect for Walt Disney Studios. In this role, he serves as a subject matter expert on various technologies, playing a critical role in shaping the company's network architecture and ensuring its reliability and performance. His work involves leading the design and implementation of complex networks and guiding teams and stakeholders through the technical intricacies of modern IT infrastructures.

Over the years, Donald has collaborated with major industry vendors and smaller, specialized companies, earning many advanced certifications along the way. His achievements include becoming a double JNCIE and obtaining most of Cisco's professional-level certifications, demonstrating his deep technical proficiency and commitment to continuous learning. His expertise has also been recognized through his selection as a Cisco Champion for four consecutive years, an honor awarded to top influencers in the networking community.

In addition to his hands-on work in the field, Donald has made significant contributions to IT education. He has had the privilege of working alongside Todd Lammle, a legendary figure in the IT world, coauthoring several books and developing courses that have helped countless professionals advance their careers. Through his extensive experience, certifications, and educational efforts, Donald Robb has solidified his reputation as a leading authority in the IT industry.

Contents at a Glance

Contents

Introduction

Welcome to the exciting world of Cisco certification! If you've picked up this book because you want to improve yourself and your life with a better, more satisfying, and secure job, you've done the right thing. Whether your plan is to enter the thriving, dynamic IT sector or to enhance your skill set and advance your position within it, being Cisco certified can seriously stack the odds in your favor to help you attain your goals.

Cisco certifications are powerful instruments of success that also just happen to improve your grasp of all things internetworking. As you progress through this book, you'll gain a complete understanding of networking that reaches far beyond Cisco devices. By the end of this book, you'll comprehensively know how disparate network topologies and technologies work together to form the fully operational networks that are vital to today's very way of life in the developed world. The knowledge and expertise you'll gain here are essential for and relevant to every networking job. It's why Cisco certifications are in such high demand—even at companies with few Cisco devices!

For up-to-the-minute updates covering additions or modifications to the Cisco certification exams, as well as additional study tools, review questions, videos, and bonus materials, be sure to visit the Todd Lammle website and forum at www.lammle.com/ccna.

Cisco's Network Certifications

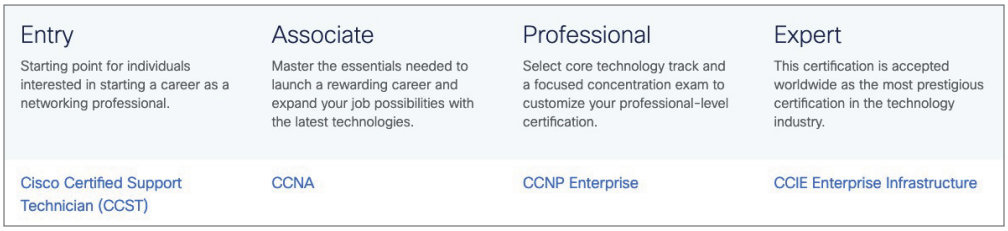
Way back in 1998, obtaining the Cisco Certified Network Associate (CCNA) certification was the first pitch in the Cisco certification climb. It was also the official prerequisite to each of the more advanced levels. But that changed in 2007, when Cisco announced the Cisco Certified Entry Network Technician (CCENT) certification. Then again, in May 2016, Cisco announced new updates to the CCENT and CCNA Routing and Switching (R/S) tests. Today, things have changed dramatically again.

In July 2019, Cisco switched up the certification process more than they have in the last 20 years! They announced all-new certifications that started in February 2020, and then again, an update and revision in the summer of 2024, which is probably why you're reading this book!

So what's changed? For starters, the CCENT course and exam (ICND1 and ICND2) no longer exist, nor do the terms Routing & Switching (rebranded to Enterprise). On top of that, the CCNA is no longer a prerequisite for any of the higher certifications at all, meaning that you'll be able to jump straight to CCNP without having to take the new CCNA exam if you have already achieved the CCNA or have enough background to skip the CCNA.

The new Cisco certification process will look like this:

FIGURE I.1 The Cisco certification path



First, the CCST entry-level certification was added, and you can find the Wiley Study Guide for the CCST Network book authored by Todd Lammle and Donald Robb, as well as this CCNA Study Guide, at `https://www.lammle.com/order-our-books`.

If you have an entry-level network background, you will want to head directly to CCNA, using this book and the abundant resources on `www.lammle.com/ccna`, of course!

The Todd Lammle CCNA program, beginning with this book, is a powerful tool to get you started in your CCNA studies, and it's vital to understand the material found in this book and at `www.lammle.com/ccna` before you go on to conquer any other certifications!

What Does This Book Cover?

This first book in the CCNA series covers everything you need to know regarding internetworking, Ethernet, switching, and routing. Volume II starts right where this first book in the series leaves off.

But regardless of which Cisco certification path you choose, as I've said, taking plenty of time to study and practice with routers or a router simulator is the real key to success.

You will learn the following information in this book:

Chapter 1: Network Fundamentals In Chapter 1, you will learn the basics of network fundamentals, the Cisco three-layer model, and wide area networks. Ethernet cabling including, fiber-optic, is discussed. The chapter ends with an overview of PoE. Review questions await you at the end to test your understanding of the material.

Chapter 2: Ethernet Networking Chapter 2 provides you with the Ethernet foundation you need in order to pass both the CCST and CCNA exams. Data encapsulation is discussed in detail in this chapter as well. As with the other chapters, this chapter includes written labs and review questions to help you.

Chapter 3: TCP/IP Chapter 3 covers the protocols of TCP/IP. I'll begin by exploring the DoD's version of TCP/IP, then compare that version and its protocols with the OSI reference model. Lastly, I'll dive into the world of IP addressing and the different classes of IP addresses used in networks today. Review questions are included at the end of the chapter to test your understanding of the material.

Chapter 4: Easy Subnetting Chapter 4 picks up right where we left off in the last chapter and continues to explore the world of IP addressing. The chapter opens by showing you how to subnet an IP network. Prepare yourself because being able to subnet quickly and accurately is pretty challenging. Use the review questions to test your ability to understand subnetting. You can also use the bonus tools found at `www.lammle.com/ccna`.

Chapter 5: Troubleshooting IP Addressing Chapter 5 covers IP address troubleshooting while focusing on the steps Cisco recommends following when troubleshooting an IP network. Working through this chapter will hone your knowledge of IP addressing and networking while refining the essential skills you've attained so far.

Chapter 6: Cisco's Internetworking Operating System (IOS) Chapter 6 introduces you to the Cisco Internetworking Operating System (IOS) and command-line interface (CLI). You'll learn how to turn on a router and configure the basics of the IOS, including setting passwords, banners, and more. Be sure to complete the written lab and review questions.

Chapter 7: Managing a Cisco Internetwork Chapter 7 covers the finer points of layer 2 switching to ensure that you know exactly how it works. You should already know that we rely on switching to break up large collision domains into smaller ones and that a collision domain is a network segment with two or more devices sharing the same bandwidth. Switches have changed the way networks are designed and implemented. If a pure switched design is implemented well, the result will be a clean, cost-effective, and resilient internetwork.

Chapter 8: Managing Cisco Devices Chapter 8 describes the boot process of Cisco routers, the configuration register, and how to manage Cisco IOS files. The chapter finishes with a section on Cisco's new licensing strategy for IOS. The written labs and review questions will help you build a strong foundation for the objectives covered in this chapter.

Chapter 9: IP Routing Chapter 9 focuses on the core topic of the ubiquitous IP routing process. It's integral to networking because it pertains to all routers and configurations that use it—easily the lion's share. IP routing is basically the process of moving packets from one network to another network using routers, and this chapter covers IP routing in depth.

Chapter 10: Open Shortest Path First Chapter 10 discusses Open Shortest Path First (OSPF), which is by far the most popular and important routing protocol in use today—so important that I'm devoting an entire chapter to it! The chapter begins with the basics by completely familiarizing you with key OSPF terminology.

Chapter 11: Enhanced IGRP Chapter 11 covers Enhanced IGRP (EIGRP), which is a Cisco-proprietary routing protocol that has been available for other companies to add to their router operating systems for a few years now. This advanced distance-vector routing protocol is covered in depth, including exam essentials, a written lab, and review questions.

Chapter 12: Layer 2 Switching Chapter 12 provides the solid background you need on layer two switching, how switches perform address learning, and how to make forwarding and filtering decisions. In addition, switch port security with MAC addresses is covered in detail. As always, go through the hands-on labs, written lab, and review questions to make sure you've really got layer two switching down!

Chapter 13: VLANs and Inter-VLAN Routing Chapter 13 discusses how we break up broadcast domains in a pure switched internetwork. We do this by creating virtual local area networks (VLANs). We'll also guide you through troubleshooting techniques in this all-important chapter. The written lab and review questions reinforce the VLAN material.

Chapter 14: Cloud and Virtual Private Networks Chapter 14 provides in-depth coverage of VPNs. You'll learn some smart solutions that will help you meet your company's off-site network access needs and dive deep into how these networks utilize IP security to provide secure communications over a public network via the Internet using VPNs with IPsec. This VPN section wraps up by demonstrating how to create a tunnel using GRE (Generic Routing Encapsulation). We'll then dive into on-premises and cloud technologies. "Private cloud" is simply a fancy term for hosting resources inside your physical environment, usually in a data center. You might have heard the saying that "cloud is just using someone else's data center," but this time, we are referring to yours! Generally speaking, the terms "private cloud" and "on-premises" are used interchangeably.

Chapter 15: Introduction to Artificial Intelligence and Machine Learning Chapter 15 dives into the new and exciting world of machine learning and generative AI. By the end of the chapter, you will understand how they work and why they are beneficial to understand as a networking professional. We will even get into practical examples!

Appendix A: Answers to the Written Labs This appendix provides the answers to the end-of-chapter written labs.

Appendix B: Answers to the Review Questions This appendix provides the answers to the end-of-chapter review questions.

Interactive Online Learning Environment and Test Bank

The interactive online learning environment that accompanies the *CCNA Certification Study Guide* provides a test bank with study tools to help you prepare for the certification exams and increase your chances of passing them the first time! The test bank includes the following elements:

Sample Tests All of the questions in this book are provided in the test bank, including the assessment test, which you'll find at the end of this introduction, and the review

questions at the end of each chapter. In addition, you'll find a bonus exam. Use these questions to test your knowledge of the study guide material. The online test bank runs on multiple devices.

Electronic Flashcards The flashcards are included for quick reference and are great tools for learning quick facts. You can even consider these as additional simple practice questions, which is essentially what they are.

PDF of Glossary of Terms There is a glossary included that covers the key terms used in this book.

The Sybex Interactive Online Test Bank, flashcards, and glossary can be accessed at `http://www.wiley.com/go/Sybextestprep`.

Todd Lammle Bonus Material and Labs Be sure to check `www.lammle.com/ccna` for directions on how to download all the latest bonus material created specifically to help you study for your CCNA exam.

Todd Lammle Videos I have created a full CCNA series of videos that can be purchased at `www.lammle.com/ccna`.

Like all exams, the CCNA certification is updated periodically and may eventually be retired or replaced. At some point after Cisco is no longer offering this exam, the old editions of our books and online tools will be retired. If you have purchased this book after the exam was retired, or you are attempting to register in the Sybex online learning environment after the exam was retired, please know that we make no guarantees that this exam's online Sybex tools will be available once the exam is no longer available.

CCNA Exam Overview

Cisco has designed the new CCNA program to prepare you for today's associate-level job roles in IT technologies. The CCNA now includes security and automation and programmability, and there is even a new CCNA DevNet certification. The new CCNA program has one certification that covers a broad range of fundamentals for IT careers.

The new CCNA certification covers a huge number of topics, including:

- Network fundamentals
- Network access
- IP connectivity
- IP services

- Security fundamentals
- Wireless
- Automation and programmability

Are There Any Prerequisites for Taking the CCNA Exam?

Not really, but having experience is really helpful. Cisco has no formal prerequisites for CCNA certification, but you should understand the exam topics before taking the exam.

CCNA candidates often also have:

- One or more years of experience implementing and administering Cisco solutions
- Knowledge of basic IP addressing
- A good understanding of network fundamentals

How to Use This Book

If you want a solid foundation for the serious effort of preparing for the new CCNA exam, then look no further. I've spent hundreds of hours putting together this book with the sole intention of helping you pass the Cisco exams, as well as really learning how to correctly configure Cisco routers and switches!

This book is loaded with valuable information, and you will get the most out of your study time if you understand the way in which the book is organized.

To maximize your benefit from this book, I recommend the following study method:

1. Take the assessment test that's provided at the end of this introduction. (The answers are at the end of the test.) It's okay if you don't know any of the answers; that's why you bought this book! Carefully read over the explanations for any questions you get wrong and note the chapters where the relevant material relevant is covered. This information should help you plan your study strategy.
2. Study each chapter carefully, making sure you fully understand the information and the test objectives listed at the beginning of each one. Pay extra-close attention to any chapter that includes material covered in questions you missed.
3. Answer all of the review questions related to each chapter. (The answers appear in Appendix A.) Note the questions that confuse you and study the topics they cover again until the concepts are crystal clear. And again—do not just skim these questions! Make sure you fully comprehend the reason for each correct answer. Remember, these will not be the exact questions you will find on the exam, but they're written to help you understand the chapter material and ultimately pass the exam!
4. Try your hand at the practice questions that are exclusive to this book. The questions can be found only at `http://www.wiley.com/go/sybextestprep`. Don't forget to

check out www.lammle.com/ccna for the most up-to-date Cisco exam prep questions, videos, hands-on labs, and Todd Lammle boot camps.

5. Test yourself using the flashcards, which are also found on the download link listed in step 4. These are brand-new and updated flashcards to help you prepare for the CCNA exam and a wonderful study tool!

To learn every bit of the material covered in this book, you'll have to apply yourself regularly and with discipline. Try to set aside the same time period every day to study, and select a comfortable and quiet place to do so. I'm confident that if you work hard, you'll be surprised at how quickly you will learn this material!

You can download bonus material and hands-on labs from www.Lammle.com/ccna, and by *doing hands-on labs every single day* in addition to using the review questions, the practice exams, the optional Todd Lammle video sections on Lammle.com, the electronic flashcards, and the written labs included with this book—it would actually be hard to fail the Cisco exams.

But understand that studying for the Cisco exams is a lot like getting in shape—if you do not go to the gym every day, it's not going to happen!

Where Do You Take the Exam?

You can take the CCNA Composite or any Cisco exam at any of the Pearson VUE authorized testing centers. For information, check www.vue.com or call 877-404-EXAM (3926).

To register for a Cisco exam, follow these steps:

1. Determine the number of the exam you want to take. (The CCNA exam number is 200-301.)
2. Register with the nearest Pearson VUE testing center. At this point, you will be asked to pay for the exam in advance. You can schedule exams up to six weeks in advance or as late as the day you want to take it—but if you fail a Cisco exam, you must wait five days before you will be allowed to retake it. If you need to cancel or reschedule your exam appointment, contact Pearson VUE at least 24 hours in advance.
3. When you schedule the exam, you'll get instructions regarding all appointment and cancellation procedures, the ID requirements, and information about the testing-center location.

Tips for Taking Your Cisco Exams

The Cisco exams contain approximately 50 questions and must be completed in about 90 minutes. It's difficult to provide exact details, as they frequently change. Typically, you need a score of around 85 percent to pass, but this can vary depending on the exam.

Many questions on the exam have answer choices that at first glance look identical—especially the syntax questions! So, remember to read through the choices carefully because

close just doesn't cut it. If you get commands in the wrong order or forget one measly character, you'll get the question wrong.

Also, never forget that the right answer is the Cisco answer. In many cases, more than one appropriate answer is presented, but the *correct* answer is the one that Cisco recommends. On the exam, you will always be told to pick one, two, or three options, never "choose all that apply." The Cisco exam may include the following test formats:

- Multiple-choice single answer
- Multiple-choice multiple answer
- Drag-and-drop
- Router simulations

Cisco proctored exams will not show the steps to follow in completing a router interface configuration, but they do allow partial command responses. For example, `show run`, `sho running`, or `sh running-config` would all be acceptable.

Here are some general tips for exam success:

- Arrive early at the exam center so you can relax and review your study materials.
- Read the questions *carefully*. Don't jump to conclusions. Make sure you're clear about *exactly* what each question asks. I always tell my students, "Read twice, answer once."
- When answering multiple-choice questions that you're not sure about, use the process of elimination to get rid of the obviously incorrect answers first. Doing this greatly improves your odds if you need to make an educated guess.
- You can no longer move forward and backward through the Cisco exams, so double-check your answer before clicking Next, as you can't change your mind.

After you complete an exam, you'll get immediate online notification of your pass or fail status, along with a printed examination score report detailing your results by section. (The test administrator will provide the printed score report.)

Test scores are automatically forwarded to Cisco within 5 working days after you take the test, so you don't need to send your score to them. If you pass the exam, you'll receive confirmation from Cisco, typically within 2–4 weeks, though sometimes a bit longer.

CCNA Certification Exam 200-301 Objectives

This table shows where each exam is covered in this book series.