

TODD LAMMLE

CCNA[®]

Routing and Switching

COMPLETE REVIEW GUIDE

Second Edition

- + 2 custom practice tests
- + Over 100 electronic flashcards
- + Searchable key term glossary

EXAM 100-105
EXAM 200-105
EXAM 200-125

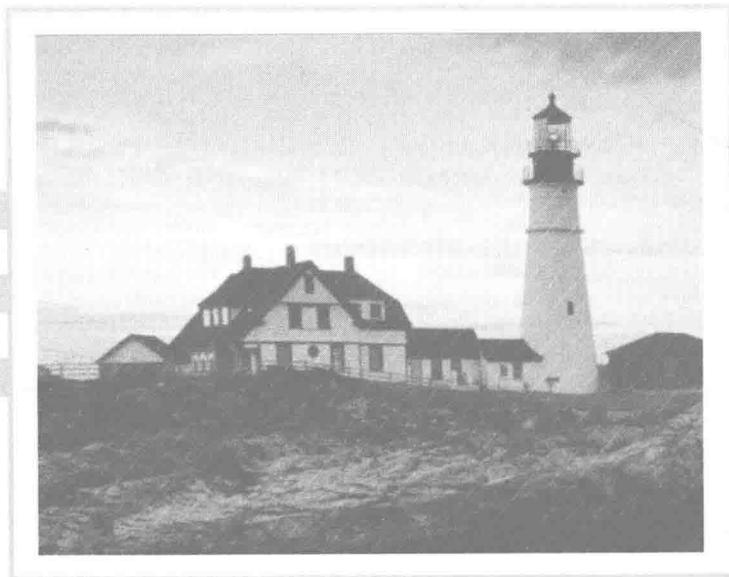
CCNA[®]

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Review Guide

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Todd Lammle

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Acknowledgments

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Thanks to Ken Brown, who always keeps me working hard and makes sure I am headed in the right direction. This is no easy task for Ken!

And thanks to my production editor, Christine O'Connor, for keeping the book on track, and Amy Breguet, for keeping all the edits in order and on time. And I can't forget Judy Flynn, the backbone of all my books, who reads every word over and over until the chapters are nearly flawless!

Thank you all!

About the Author

Todd Lammle Cisco certified in almost every category, is *the* authority on Cisco networking and certification. His three decades of real-world experience is prevalent in his writing. He is an experienced networking engineer with very practical experience working on the largest bounded and unbounded networks in the world at such companies as Xerox, Hughes Aircraft, Texaco, AAA, Cisco, and Toshiba, among many others. Todd has published over 60 books, including the very popular and bestselling *CCNA: Cisco Certified Network Associate Study Guide* and *Cisco Firepower NGIPS*. Todd runs an international training company from Texas and a large-scale consulting business out of Colorado. You can reach Todd through his forum and blog at www.lammle.com/ccna.

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 you're striving to enter the thriving, dynamic IT sector or seeking 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 markedly 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 is essential for and relevant to every networking job and is why Cisco certifications are in such high demand—even at companies with few Cisco devices!

Although it's now common knowledge that Cisco rules routing and switching, the fact that it also rocks the voice, data center, and service provider worlds is also well recognized. And Cisco certifications reach way beyond the popular but less extensive certifications like those offered by CompTIA and Microsoft to equip you with indispensable insight into today's vastly complex networking realm. Essentially, by deciding to become Cisco certified, you're proudly announcing that you want to become an unrivaled networking expert—a goal that this book will get you well on your way to achieving. Congratulations in advance on the beginning of your brilliant future!



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

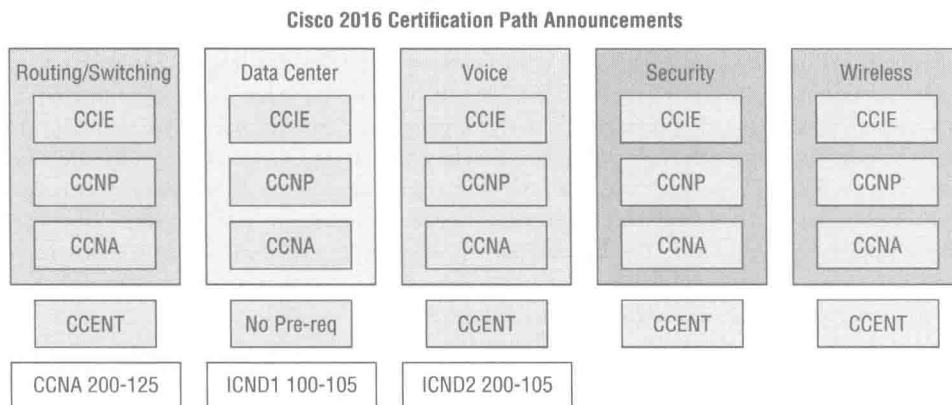
Cisco's Network Certifications

It used to be that to secure the holy grail of Cisco certifications—the CCIE—you passed only one written test before being faced with a grueling, formidable hands-on lab. This intensely daunting, all-or-nothing approach made it nearly impossible to succeed and predictably didn't work out too well for most people. Cisco responded to this issue by creating a series of new certifications, which not only made it easier to eventually win the highly coveted CCIE prize, it gave employers a way to accurately rate and measure the skill levels of prospective and current employees. This exciting paradigm shift in Cisco's certification path truly opened doors that few were allowed through before!

Beginning in 1998, obtaining the Cisco Certified Network Associate (CCNA) certification was the first milestone in the Cisco certification climb, as well as 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. And then in May 2016, Cisco once again proclaimed updates to the CCENT and CCNA Routing and Switching (R/S) tests. Now the Cisco certification process looks like Figure I.1.

FIGURE I.1 The Cisco certification path



The Cisco R/S path is by far the most popular and could very well remain so, but soon you'll see the Data Center path become more and more of a focus as companies migrate to data center technologies. The Security track also actually does provide a good job opportunity as well. Still, understanding the foundation of R/S before attempting any other certification track is something I highly recommend.

Even so, and as the figure shows, you only need your CCENT certification to get underway for most of the tracks.

Cisco Certified Entry Network Technician (CCENT)

Don't be fooled by the oh-so-misleading name of this first certification because it absolutely isn't entry level! Okay—maybe entry level for Cisco's certification path, but definitely not for someone without experience trying to break into the highly lucrative yet challenging IT job market! For the uninitiated, the CompTIA A+ and Network+ certifications aren't official prerequisites, but know that Cisco does expect you to have that type and level of experience before embarking on your Cisco certification journey.

All of this gets us to 2016, when the climb to Cisco supremacy just got much harder again. The innocuous-sounding siren's call of the CCENT can lure you to some serious trouble if you're not prepared, because it's actually much harder than the old CCNA ever was. This will rapidly become apparent once you start studying, but be encouraged! The fact that the certification process is getting harder really works better for you in the long run, because that which is harder to obtain only becomes that much more valuable when you finally do, right? Yes, indeed!

Another important factor to keep in mind is that the Interconnection Cisco Network Devices Part 1 (ICND1) exam, which is the required exam for the CCENT certification, costs \$150 per attempt, and it's anything but easy to pass! The good news is that this book will guide you step-by-step in building a strong foundation in routing and switching technologies. You really need to build on a strong technical foundation and stay away from exam cram type books, suspicious online material, and the like. They can help somewhat, but understand that you'll pass the Cisco certification exams only if you have a strong foundation and that you'll get that solid foundation only by reading as much as you can and practicing the review questions in this book. Additional practice exam questions, videos, and labs are offered on my website, and what seems like a million other sites offer additional material that can help you study.

However, there is one way to skip the CCENT exam and still meet the prerequisite before moving on to any other certification track, and that path is through the CCNA R/S Composite exam. First, I'll discuss the Interconnecting Cisco Network Devices Part 2 (ICND2) exam, and then I'll tell you about the CCNA Composite exam, which will provide you, when you're successful, with both the CCENT and the CCNA R/S certification.

Cisco Certified Network Associate Routing and Switching (CCNA R/S)

Once you have achieved your CCENT certification, you can take the ICND2 (200-105) exam in order to achieve your CCNA R/S certification, which is the most popular certification Cisco has by far because it's the most sought-after certification by all employers.

As with the CCENT, the ICND2 exam is also \$150 per attempt—although thinking you can just skim a book and pass any of these exams would probably be a really expensive mistake! The CCENT/CCNA exams are extremely hard and cover a lot of material, so you have to really know your stuff. Taking a Cisco class or spending months with hands-on experience is definitely a requirement to succeed when faced with this monster!

And once you have your CCNA, you don't have to stop there—you can choose to continue and achieve an even higher certification, called the Cisco Certified Network Professional (CCNP). There are various ones, as shown in Figure I.1. The CCNP R/S is still the most popular, with Security certifications coming in at a close second. And I've got to tell you that the Data Center certification will be catching up fast. Also good to know is that anyone with a CCNP R/S has all the skills and knowledge needed to attempt the notoriously dreaded but coveted CCIE R/S lab. But just becoming a CCNA R/S can land you that job you've dreamed about, and that's what this book is all about: helping you to get and keep a great job!

Still, why take two exams to get your CCNA if you don't have to? Cisco still has the CCNA Composite (200-125) exam that, if passed, will land you with your CCENT and your CCNA R/S via only one test, priced accordingly at \$300. Some people like the one-test approach, and some people like the two-test approach.

Why Become a CCENT and CCNA R/S?

Cisco, like Microsoft and other vendors that provide certification, has created the certification process to give administrators a set of skills and to equip prospective employers with a way to measure those skills or match certain criteria. And as you probably know, becoming a CCNA R/S is certainly the initial, key step on a successful journey toward a new, highly rewarding, and sustainable networking career.

The CCNA program was created to provide a solid introduction not only to the Cisco Internetwork Operating System (IOS) and Cisco hardware but also to internetworking in general, making it helpful to you in areas that are not exclusively Cisco's. And regarding today's certification process, it's not unrealistic that network managers—even those without Cisco equipment—require Cisco certifications for their job applicants.

Rest assured that if you make it through the CCNA and are still interested in Cisco and internetworking, you're headed down a path to certain success!

What Skills Do You Need to Become a CCNA R/S?

This ICND1 exam (100-105) tests a candidate for the knowledge and skills required to successfully install, operate, and troubleshoot a small branch office network. The exam includes questions on the operation of IP data networks, LAN switching technologies, IPv6, IP routing technologies, IP services, network device security, and basic troubleshooting. The ICND2 exam (exam 200-105) tests a candidate for the knowledge and skills required to successfully install, operate, and troubleshoot a small- to medium-size enterprise branch network. The exam includes questions on LAN switching technologies, IP routing technologies, IP services (FHRP, SNMP v2 and v3), the cloud, and ACI as well as troubleshooting and WAN technologies.

How Do You Become a CCNA R/S?

If you want to go straight for our CCNA R/S and take only one exam, all you have to do is pass the CCNA Composite exam (200-125). Oh, but don't you wish it were that easy? True, it's just one test, but it's a whopper, and to pass it you must possess enough knowledge to understand what the test writers are saying, and you need to know everything I mentioned previously, in the discussions of the ICND1 and ICND2 exams! Hey, it's hard, but it can be done!

What does the CCNA Composite exam (200-125) cover? Pretty much the same topics covered in the ICND1 and ICND2 exams. Candidates can prepare for this exam by taking the Todd Lammle authorized Cisco boot camps. Exam 200-125 tests a candidate's knowledge and skills required to install, operate, and troubleshoot a small to medium-size enterprise branch network.

While you can take the Composite exam to get your CCNA, it's good to know that Cisco offers the two-step process I discussed earlier in this introduction. And this book

covers both those exams too! It may be easier than taking that one ginormous exam for you, but don't think the two-test method is easy. It takes work! However, it can be done; you just need to stick with your studies.

The two-test method involves passing the following:

- **Exam 100-105:** Interconnecting Cisco Networking Devices Part 1 (ICND1)
- **Exam 200-105:** Interconnecting Cisco Networking Devices Part 2 (ICND2)

I can't stress this point enough: It's critical that you have some hands-on experience with Cisco routers. If you can get a hold of some basic routers and switches, you're set, but if you can't, I've worked hard to provide hundreds of configuration examples throughout this book to help network administrators, or people who want to become network administrators, learn the skills they need to pass the CCENT and CCNA R/S exams.



For Cisco certification hands-on training, which includes CCNA videos and practice test questions all from CCSI Todd Lammle, please see www.lammle.com/ccna.

What Does This Book Cover?

This book covers everything you need to know to pass the CCNA Composite exam (200-125). The composite CCNA book is available on Amazon. But regardless of which 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 the Open Systems Interconnection (OSI) model the way Cisco wants you to learn it. There are plenty of review questions to help you.

Chapter 2: LAN Switching Fundamentals This chapter will provide you with the Ethernet foundation you need in order to pass the composite exam. Data encapsulation is discussed in detail in this chapter as well. And as with the other chapters, this chapter includes review questions to help you.

Chapter 3: Routing Technologies In this chapter, I will discuss routing concepts. This will include a discussion of the routing table, routing protocols, and static routing. I will also cover the configuration of RIP and single-area OSPF and the process of troubleshooting end-to-end connectivity at layer 3. Don't skip the 10 review questions.

Chapter 4: WAN Technologies In this chapter, I will cover wide area network (WAN) technologies. This will include a discussion of multilink Point-to-Point Protocol interfaces, PPP over Ethernet (PPoE), and Generic Routing Encapsulation tunnels. I will also cover the configuration of Border Gateway Protocol (BGP). And you'll find plenty of help in this chapter as long as you don't skip the review questions at the end.

Chapter 5: Infrastructure Services Here, you'll find out all about infrastructure services. These services include DNS, DHCP, HSRP, and NAT. It will cover the configuration, verification, and troubleshooting of these vital network services. As with Chapter 4, plenty of help is there for you if you don't skip the review questions.

Chapter 6: Infrastructure Security This chapter introduces you to port security and the common access layer attacks it can help prevent. It will also include the configuration, verification, and troubleshooting of access lists and the proper hardening of network devices. Be sure to complete the review questions.

Chapter 7: Infrastructure Management This chapter provides you with the management skills needed to run a Cisco IOS network. The topics will include device maintenance and the monitoring of devices. I'll also describe the tools used to troubleshoot and resolve issues, and I will close the chapter with a discussion of network programmability. As always, complete the review questions.

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



Be sure to check the announcements section of my forum at www.lammle.com/ccna to find out how to download bonus material I created specifically for this book.

Interactive Online Learning Environment and Test Bank

I've worked hard to provide some really great tools to help you with your certification process. The interactive online learning environment that accompanies the *CCNA Routing and Switching Complete Review Guide, Second Edition*, provides a test bank with study tools to help you prepare for the certification exam—and increase your chances of passing it the first time! The test bank includes the following:

Sample tests All of the questions in this book are provided, including the assessment test, which you'll find at the end of this introduction, and the chapter tests that include the review questions at the end of each chapter. In addition, there are two practice exams with 50 questions each. Use these questions to test your knowledge of the study guide material. The online test bank runs on multiple devices.

Flashcards The online text bank includes 100 flashcards specifically written to hit you hard, so don't get discouraged if you don't ace your way through them at first! They're there to ensure that you're really ready for the exam. And no worries—armed with the review questions, practice exams, and flashcards, you'll be more than prepared when exam day comes! Questions are provided in digital flashcard format (a question followed by a

single correct answer). You can use the flashcards to reinforce your learning and provide last-minute test prep before the exam.

Other study tools A glossary of key terms from this book and their definitions are available as a fully searchable PDF.



Go to www.wiley.com/go/sybextestprep to register and gain access to this interactive online learning environment and test bank with study tools.

In addition to the online test bank, I have provided additional study material that'll help you get the most out of your exam preparation:

Todd Lammle Bonus Material and Labs Be sure to check the 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.

How to Use This Book

If you want a solid foundation for the serious effort of preparing for the CCNA Routing and Switching exam, then look no further. I've spent hundreds of hours putting together this book with the sole intention of helping you to pass the Cisco exam, as well as really learn 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 why the book is organized the way it is.

So 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 in which the material relevant to them 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 the Appendix.) 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 that 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 bonus practice questions that are exclusive to this book. The questions can be found only at <http://sybextestbanks.wiley.com>. And be sure to

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

5. Test yourself using all the flashcards, which are also found on the download link. These are brand-new and updated flashcards to help you prepare for the CCNA and are 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 learn this material!

If you follow these steps and really study using the review questions, the practice exams, the Todd Lammle video sections, and the electronic flashcards,—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 Exams?

You may take the ICND1, ICND2, or CCNA R/S 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 ICND1 exam number is 100-105, ICND2 is 200-105, and CCNA R/S Composite is 200-125.)
2. Register with the nearest Pearson VUE testing center. At this point, you will be asked to pay in advance for the exam. At the time of this writing, the ICND1 and ICND2 exams are \$150, and the CCNA R/S Composite exam is \$300. The exams must be taken within one year of payment. 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 something comes up and 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 about 40 to 50 questions and must be completed in about 90 minutes or less. This information can change per exam. You must get a score of about 85 percent to pass this exam, but again, each exam can be different.

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`, `show running`, or `show running-config` would 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. "Read twice, answer once," is what I always tell my students.
- 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 since you can't change your mind.

After you complete an exam, you'll get immediate, online notification of your pass or fail status, a printed examination score report that indicates your pass or fail status, and your exam results by section. (The test administrator will give you the printed score report.) Test scores are automatically forwarded to Cisco within five 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 two to four weeks, sometimes a bit longer.

Objective Map for CCNA Routing and Switching Certification Exam 200-125

We've provided this objective map to help you locate where the objectives for the CCNA Routing and Switching certification Exam 200-125 are covered in each chapter. Please refer to it when you want to find an objective quickly.

Exam objectives are subject to change at any time without prior notice and at Cisco's sole discretion. Please visit Cisco's certification website (www.cisco.com/web/learning) for the latest information on the CCNA Routing and Switching certification.

NETWORKING FUNDAMENTALS	Chapter(s)
Compare and contrast OSI and TCP/IP models.	1
Compare and contrast TCP and UDP protocols.	1
Describe the impact of infrastructure components in an enterprise network.	1
Describe the effects of cloud resources on enterprise network architecture.	1
Compare and contrast collapsed core and three-tier architectures.	1
Compare and contrast network topologies.	1
Select the appropriate cabling type based on implementation requirements.	1
Apply troubleshooting methodologies to resolve problems.	1
Configure, verify, and troubleshoot IPv4 addressing and subnetting.	1
Compare and contrast IPv4 address types.	1
Describe the need for private IPv4 addressing.	1
Identify the appropriate IPv6 addressing scheme to satisfy addressing requirements in a LAN/WAN environment.	1
Configure, verify, and troubleshoot IPv6 addressing.	1
Configure and verify IPv6 Stateless Address Auto Configuration.	1
Compare and contrast IPv6 address types.	1
LAN SWITCHING TECHNOLOGIES	
Describe and verify switching concepts.	2
Interpret Ethernet frame format.	2
Troubleshoot interface and cable issues (collisions, errors, duplex, speed).	2
Configure, verify, and troubleshoot VLANs (normal/extended range) spanning multiple switches.	2

NETWORKING FUNDAMENTALS	Chapter(s)
Configure, verify, and troubleshoot interswitch connectivity.	2
Configure, verify, and troubleshoot STP protocols.	2
Configure, verify and troubleshoot STP-related optional features.	2
Configure and verify layer 2 protocols.	2
Configure, verify, and troubleshoot (layer 2/layer 3) EtherChannel.	2
Describe the benefits of switch stacking and chassis aggregation.	2
ROUTING TECHNOLOGIES	
Describe the routing concepts.	3
Interpret the components of a routing table.	3
Describe how a routing table is populated by different routing information sources.	3
Configure, verify, and troubleshoot inter-VLAN routing.	3
Compare and contrast static routing and dynamic routing.	3
Compare and contrast distance-vector and link-state routing protocols.	3
Compare and contrast interior and exterior routing protocols.	3
Configure, verify, and troubleshoot IPv4 and IPv6 static routing.	3
Configure, verify, and troubleshoot single-area and multi-area OSPFv2 for IPv4 (excluding authentication, filtering, manual summarization, redistribution, stub, virtual-link, and LSAs).	3
Configure, verify, and troubleshoot single-area and multi-area OSPFv3 for IPv6 (excluding authentication, filtering, manual summarization, redistribution, stub, virtual-link, and LSAs).	3
Configure, verify, and troubleshoot EIGRP for IPv4 (excluding authentication, filtering, manual summarization, redistribution, stub).	3
Configure, verify, and troubleshoot EIGRP for IPv6 (excluding authentication, filtering, manual summarization, redistribution, stub).	3

NETWORKING FUNDAMENTALS	Chapter(s)
Configure, verify, and troubleshoot RIPv2 for IPv4 (excluding authentication, filtering, manual summarization, redistribution).	3
Troubleshoot basic layer 3 end-to-end connectivity issues.	3
WAN TECHNOLOGIES	
Configure and verify PPP and MLPPP on WAN interfaces using local authentication.	4
Configure, verify, and troubleshoot PPPoE client-side interfaces using local authentication.	4
Configure, verify, and troubleshoot GRE tunnel connectivity.	4
Describe WAN topology options.	4
Describe WAN access connectivity options.	4
Configure and verify single-homed branch connectivity using eBGP IPv4 (limited to peering and route advertisement using Network command only).	4
Describe basic QoS concepts.	4
INFRASTRUCTURE SERVICES	
Describe DNS lookup operation.	5
Troubleshoot client connectivity issues involving DNS.	5
Configure and verify DHCP on a router (excluding static reservations).	5
Troubleshoot client- and router-based DHCP connectivity issues.	5
Configure, verify, and troubleshoot basic HSRP.	5
Configure, verify, and troubleshoot inside source NAT.	5
Configure and verify NTP operating in a client/server mode.	5
INFRASTRUCTURE SECURITY	
Configure, verify, and troubleshoot port security.	6
Describe common access layer threat mitigation techniques.	6