

What Is the CCIE Certification?

This chapter will cover:

- Steps in becoming a CCIE
- CCIE qualification exam structure
- Chapter format
- How to prepare for the exam

Introduction

The Cisco Certified Internetwork Expert (CCIE) certification is the *crème de la crème* of networking certifications. It is recognized throughout the industry as being the most valued and difficult to obtain of all network certifications. The aim of the program is to make you a Cisco expert.

In today's business world, whether you're on the IS staff of a corporation, an Internet service provider (ISP), or a network integrator, people are asking more and more of you. More network use is the norm. More bandwidth is the constant want. More reliability is expected. Companies are putting their most valuable commodity, information, in your hands.

The CCIE program is well named, because you will be an expert in the multitude of internetworking technologies in use today. Armed with knowledge gained from this book and on-the-job training, you will provide benefits to your superiors or your customers because you will be able to design, implement, and evolve networks more intelligently and efficiently than your colleagues.

Besides the recognition that accompanies your CCIE status, other benefits will come your way. CCIEs have the option to jump to second-level Cisco tech support for any

case of technical questions or problems. You can also participate in a special CCIE chat forum, and answer questions on a CCO open forum.

Thinking of Becoming a CCIE?

As stated earlier, the CCIE is an advanced certification program. The Cisco entry and intermediate certifications such as Cisco Certified Network Associate (CCNA), Cisco Certified Network Professional (CCNP), Cisco Certified Design Associate (CCDA), and Cisco Certified Design Professional (CCDP) can provide you with a Cisco certification career path towards the ultimate goal: becoming a CCIE. Cisco recommends that you complete the appropriate course work and obtain significant work experience before continuing on your journey to certification.

If you're looking for rough rules of thumb, Cisco recommends that you have two or more years of internetworking experience. A good understanding of Transmission Control Protocol/Internet Protocol (TCP/IP), local area network (LAN) and wide area network (WAN) protocols, the Open Systems Interconnection (OSI) reference model, the Internet, security, and client/server architecture is essential. The company also recommends you have experience with packet-level diagnosis, plus real-world experience with Cisco and non-Cisco products. Again, the goal of the CCIE certification is for you to become a networking expert, not to be introduced to intermediate networking subjects.

Steps in Becoming a CCIE

So what are the steps to becoming a CCIE? The CCIE exam consists of two parts: a qualification exam and a laboratory exam. The qualification exam is two hours long and consists of 100 multiple-choice questions. The student must score at least 65 percent on this test in order to pass and be eligible for the two-day hands-on lab exam. Immediately after your test is completed, you know whether or not you passed. In addition, your score of each section is broken down, giving you a good feedback tool for revisiting weaker areas before taking the lab exam.

The second part of the certification process is a two-day hands-on laboratory exam. During the hands-on exam each test candidate receives his or her own rack of equipment, cables, and patch panels. The candidate is also provided with a full set of Cisco documentation to use throughout the exam. No other material is allowed in the exam room.

Your first task will be to create a network to specification. This will take up all of the first day and half of the second day. Halfway through the second day, while you are out

of the room, the exam proctor will insert faults into your network, and you will have to find and fix them—as well as be able to document the problems and their resolutions.

The exam has a total of 100 possible points. To pass, you must achieve a score of 80 points or better. You must achieve a passing score on each section of the exam to be allowed to progress to the next. For example, a perfect score on the first day would be 45 points. You have to earn at least 30 points to be allowed to return for the first part of day two. Table 1-1 shows the scoring breakdown.

The lab starting time varies depending upon location, but will be somewhere between 8:00 A.M. and 9:00 A.M. each day and run for 7½ hours. You will have a half-hour break for lunch. A proctor will be in the room to clarify questions and handle any emergencies that may arise, but basically you are on your own.

The failure rate for this exam is high. According to Cisco, only about 20 percent of the candidates pass it on the first attempt. On average, CCIE candidates require two to three lab exams before they earn a passing score. Think of your first time as a learning experience, and if you manage to pass, that is a bonus. The number of times you can retake the exam is unlimited.

As with all certification exams, lab exam content and structure are subject to change, so when you are ready to consider taking the lab exam, it's best to get the latest information from Cisco. Cisco's Web site contains specific instructions about how to prepare for the CCIE lab and qualification exams. It cannot be stressed enough that you must have lots of hands-on practice if you hope to pass this exam. If you do not have equipment to practice on at work, you will have to set up a home lab or find another way to gain access to the equipment.

Qualification tests are administered via Sylvan Prometric, and are graded on a pass/fail basis. Each test costs \$300; if you don't pass the first time, there is no limit (other than your pocketbook) to the number of times you can take the test. The lab exam is given on site at Cisco locations. You must score 80 percent or higher on the hands-on lab test to pass. The lab tests cost \$1,200 each. If you do not pass the first lab test, you must wait 30 days until trying it again.

Table 1-1 CCIE Lab Exam Scoring

Day	Task	Points	Total So Far	Minimum Score to Continue
One	Build	45	45	30
Two (part I)	Build	30	75	55
Two (part II)	Troubleshooting	25	100	80 or better to pass

CCIE Qualification Exam Structure

The qualification exam is computer based and administered at one of the Cisco authorized testing centers listed in this chapter. The exam consists of 100 multiple-choice questions and is a closed-book exam; no reference materials are allowed in the exam room. The student is given two hours to complete the exam and must score at least 65 percent to pass. The passing score will be given on the Examination Score Sheet at the end of the exam along with your score. A grading of either pass or fail will also be given.

CCIE Qualification Exam Blueprint

The CCIE Routing and Switching exam covers IP and IP routing, non-IP desktop protocols such as Internetwork Packet Exchange (IPX), and bridging- and switching-related technologies. The exam will cover the following areas:

- **Cisco device operation** The student should understand the architecture and operation of the router. The student should also know router commands and be able to interpret the output from these commands.
- **General networking theory** The student should have an understanding of the OSI model with a detailed understanding of the functions provided by each layer.
- **General routing concepts** The student should have an understanding of basic routing concepts. The student should also understand the differences between switching and routing, various summarization techniques, and the differences between link state and distance vector protocols.
- **Protocol comparisons** The student should have an understanding of various networking protocols and differences between them. An example of this would be IP versus IPX or TCP versus User Datagram Protocol (UDP).
- **Protocol mechanics** The student should have a detailed understanding of protocol mechanics such as Windowing/Acknowledgements (ACK), fragmentation, maximum transmission unit (MTU), handshaking, and termination.
- **Bridging and LAN switching** The student should have a working knowledge of various bridging technologies such as
 - **Transparent bridging** IEEE/DEC spanning tree, translational bridging, bridging protocol data unit (BPDU), integrated routed and bridging (IRB), and concurrent routing and bridging (CRB)
 - **Source-route bridging** Source-route translational bridging (SRTB), source-route transparent bridging (SRT), data-link switching (DLSw), and remote source-route bridging (RSRB)

The student should also be responsible for understanding LAN switching and trunking technologies such as VLAN Trunk Protocol (VTP), inter-switch link (ISL), virtual LAN (VLAN), Fast Ether Channel (FEC), Cisco Discovery Protocol (CDP), and Cisco Group Management Protocol (CGMP).

- **IP** The student should have a working knowledge of IP addressing, classless interdomain routing (CIDR), subnetting, Address Resolution Protocol (ARP), network address translation (NAT), Hot Standby Router Protocol (HSRP), Domain Name System (DNS), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP), and Internet Control Message Protocol (ICMP).
- **IP routing protocols** The student should have a working knowledge of the architecture and design of today's most popular routing protocols, including Open Shortest Path First (OSPF), Routing Information Protocol (RIP), RIPv2, Intermediate System to Intermediate System (IS-IS), Enhanced Interior Gateway Routing Protocol (EIGRP), Interior Gateway Routing Protocol (IGRP), and Border Gateway Protocol (BGP).
- **Desktop protocols** The student should have a working knowledge of desktop protocols, with a focus towards IPX, such as NetWare Link Services Protocol (NLSP), IPX-RIP, IPX-Service Advertising Protocol (SAP), IPX-EIGRP, Sequenced Packet Exchange (SPX), Network Control Protocol (NCP), IPXWAN, IPX addressing, Get Nearest Server (GNS), and Novell Directory Services (NDS) (routing and mechanisms).
- **Performance management** The student should have a working knowledge of the various traffic management mechanics used on a router, including all queuing techniques, Resource Reservation Protocol (RSVP), traffic shaping, and load balancing.
- **WAN (addressing, signaling, and framing)** The student should have a working knowledge of the addressing, signaling, and framing used by today's most popular wide area protocols. The exam will cover Integrated Services Digital Network (ISDN), frame relay, Asynchronous Transfer Mode (ATM), X25, High-level Data Link Control (HDLC), and Point-to-Point Protocol (PPP). The student will also be responsible for understanding the physical layer framing techniques and encoding.
- **LAN** The student should have working knowledge of data link layer addressing, Media Access Control (MAC), and Logical Link Control (LLC) techniques for all Ethernet and Token Ring technologies.
- **Security** The student should have an understanding of the security techniques used by a router. The student should know the general concepts and differences

between Remote Access Dial-In User Service (RADIUS) and Terminal Access Controller Access Control System (TACACS).

Chapter Format

The book is broken into multiple practice exams given one per chapter. The exams cover key areas that the student must master in order to pass the CCIE Routing and Switching qualification exam. The areas include networking fundamentals, routing and switching fundamentals, Cisco-specific technology, and bridging and desktop protocols.

The exam questions are multiple-choice with an answer sheet provided at the end of the questions as a quick reference. A detailed answer and analysis section follows each 100 question multiple-choice test. In this section each question is reviewed and answered in detailed. We not only tell you why a particular answer is correct, but we also explain the technology and review why the other answers are incorrect. We believe this is the most effective study format, allowing you to learn not only from getting the correct answer, but also from understanding why the answer is correct and why the other answers are incorrect.

Chapter 2 (Networking Fundamentals)

Chapter 2 focuses on the OSI model, circuit- and packet-switched technologies, wide area protocols, TCP/IP fundamentals, and protocol mechanics. The exam contains questions on the OSI model, namely the features provided by each layer and a comparison between layers. The exam also contains questions on the addressing, signaling, and framing used by today's most popular WAN protocols, including frame relay, ATM, PPP, and ISDN. Questions are also given on IP addressing, subnetting, and basic operation of TCP/IP. The goal is to test the user's aptitude of basic networking protocols, mechanics, and technologies. The following is a detailed breakdown of the topics covered in this chapter:

- **OSI model** Layer comparisons and functions
- **Protocol comparisons** IP versus IPX and TCP versus UDP
- **Protocol mechanics** Windowing/Acknowledgements, fragmentation, MTU, handshaking, and termination
- **Addressing** CIDR, subnetting, and ARP
- **Services** DNS, DHCP, and ICMP
- **Transport** IP fragmentation, sockets, and ports

- **ISDN** Link Access Procedure on the D channel (LAPD), Basic Rate Interface (BRI)/Primary Rate Interface (PRI) framing, signaling, mapping, dialer map, interface types, B/D channels, and Multilink PPP
- **Frame relay** Local Management Interface (LMI), Data Link Connection Identifier (DLCI), permanent virtual circuit (PVC), framing, traffic shaping, forward explicit congestion notification (FECN), backward explicit congestion notification (BECN), committed information rate (CIR), discard eligible (DE), mapping, and compression
- **ATM** Switched virtual connection (SVC)/PVC, ATM Adaptation Layer (AAL), user-network interface (UNI)/network-network interface (NNI), Interim Local Management Interface (ILMI), cell format, and private network-network interface (PNNI)
- **Leased-line protocols** HDLC, PPP, asynchronous modems, and compression

Chapter 3 (Routing Fundamentals)

Chapter 3 focuses on routing fundamentals and routing protocols. The goal of this practice exam is to test the user's aptitude on design fundamentals and operation of today's most popular routing protocols. The exam includes questions on OSPF, IS-IS, EIGRP, IGRP, and BGP. The following is a detailed breakdown of the topics covered in this chapter:

- **OSPF** Areas, virtual links, stub, not so stubby areas (NSSA), area border router (ABR)/autonomous system boundary router (ASBR) redistributions, media dependencies, external versus internal, and summarization
- **OSPF operation** Designated router (DR), backup designated router (BDR), adjacencies, link state advertisement (LSA) types, link state database, shortest path first (SPF) algorithm, and authentication
- **BGP** Peer groups, route reflectors, confederations, clusters, attributes, autonomous system (AS) operation, which includes route maps, filters, neighbors, decision algorithm, Interior Border Gateway Protocol (IBGP), and Exterior Border Gateway Protocol (EBGP)
- **EIGRP** Metrics, route types, and protocol mechanics
- **IS-IS** Metrics, route types, and protocol mechanics
- **RIP and RIPv2** Metrics, mechanics, and design

Chapter 4 (Cisco-Specific Technology)

Chapter 4 focuses on Cisco-specific topics including device operation, router commands, router components, performance management, and security. The exam contains questions on nonvolatile random access memory (NVRAM), flash memory, CPU, file system management, and configuration register settings. The exam also contains questions on the queuing techniques, traffic management techniques, command-line knowledge, and LAN switching basics. The goal is to test the user's aptitude on Cisco device operation and architecture as well as the student's knowledge of router commands and his or her ability to interpret the output of those commands. The following is a detailed breakdown of the topics covered in this chapter:

- **Commands** Show and debug
- **Infrastructure** NVRAM, flash memory, CPU, file system, and configuration register settings
- **Operations** File transfers, password recovery, Simple Network Management Protocol (SNMP), accessing devices, and security (passwords)
- **Traffic management** Queuing, weighted fair queuing (WFQ), traffic shaping, and load balancing
- **Authentication, authorization, and accounting (AAA), TACACS, and RADIUS** General concepts and usage comparisons
- **LAN switching** Trunking, VTP, ISL, VLAN, FEC, CDP, and CGMP

Chapter 5 (Desktop Protocols and Bridging)

Chapter 5 focuses on desktop protocols, bridging techniques, and LAN technologies. The exam contains questions on transparent bridging, BPDUs, DLSw, routing information field (RIF) format, IPX, and LAN technologies. The goal is to test the user's aptitude on bridging technologies and concepts, data link addressing, MAC, and LLC. The following is a detailed breakdown of the topics covered in this chapter:

- **Transparent bridging** IEEE/DEC spanning tree, translational bridging, configuration BPDU, IRB, CRB, and access lists
- **Source-route bridging** SRTB, SRT, DLSw, RSRB, and access lists
- **IPX** NLSP, IPX-RIP, SAP, IPX-EIGRP, IPXWAN, and IPX addressing
- **Data Link layer addressing**
- **Ethernet/Fast Ethernet/Gigabit Ethernet** Encapsulation, carrier sense multiple access collision detect (CSMA/CD), topology, speed, controller errors, limitations, and 802.3

- **Token Ring** Token passing, beaconing, active monitor, ring insertion, soft and hard errors, encapsulation, topology, MTU, speed, and limitations

CD-ROM

The CD-ROM included with this book contains interactive software from FastTrak Express. The testing software provides standard and adaptive simulated exams with detailed score analysis, similar to what the student will see on test day.

How to Prepare for the Exam

You realize the need for training of some sort. (Proper training will help you gain the expertise needed to complete your certification goal.) So where do you go, and whom do you talk to about obtaining the proper training? Training comes in many forms and from several sources. For example, you may learn more in an hour of hands-on training than you could ever learn in the classroom. In essence, the type of training you choose depends on your job, goals, and study habits.

Hands-On Training

Hands-on training is just a broader term for on-the-job training. Whenever you think about hands-on training, remember that it involves some type of physical participation by you with the software for which you plan to get certified. On-the-job training is the easiest way to get hands-on training, but it's a little limiting because you don't get to explore the full range of software features and it is difficult to work on a production network. You can also get directed hands-on training using a number of Internet-based remote preparation labs, third-party aids, and sample configurations at the end of each chapter.

Hands-on training could also be the most time-consuming method of learning new skills. Although this type of training will supply you with the most real-world way of performing a task, the amount of time you must invest before you have enough information to become certified might take years. However, no matter how much knowledge you obtain from other sources, nothing will replace the knowledge acquired from on-the-job experience. There's something special about going through all of the procedures for installing, configuring, maintaining, and troubleshooting software and hardware yourself that makes the learning experience more complete.

The best place to acquire on-the-job training is on a live system at an existing company or prototyping labs that offer all the software and hardware necessary to design, install, and configure internetworks without disrupting production networks. All you need to do is find a job that's related to your education requirements. Of course, actually getting hired by a company that can offer on-the-job training before you have a certification in hand is a lot harder than it might seem. Unfortunately, most companies

will require you to have the same skills that you are trying to learn before they'll hire you. If this is the case, you may have to work out an arrangement with the prospective employer to work as an entry-level person or to work at a reduced rate. Other times you may be able to work out an arrangement to help out and assist on projects free of charge in return for the hands-on experience. Although this is not putting any money into your pocket, you'll be getting the necessary training that you are looking for. Consider it as a payment toward your education.

Instructor-Led Training

Enroll in a professional education program. The courses will present you with a lot of information in a relatively short amount of time (three to five days for most classes). The instructor will normally present you with a series of lectures, along with oral or written question-and-answer periods, lab exercises, and hands-on experience.

Instructor-led courses are available from a variety of different sources. These sources include Cisco Authorized Training Partners (CATPs), colleges, universities, and different third-party educational facilities. Each of these different educational facilities provides a myriad of services. The services offered by these institutions range from the very general to the very specific. The lengths of classes also range from just a few hours to four or more years. The cost of the different educational services will range from nothing to thousands of dollars.

Because the educational facilities will vary in class size, materials offered, length, cost, and types of services, you'll need to discuss your educational needs with them.

The best place to obtain the required information for the Cisco certifications would be from a CATP education center. Cisco provides excellent training for its certifications as well as for its line of products. Although Cisco does offer some training directly, most of the training comes from the CATPs. Cisco authorizes the partners to teach its courses at a strict quality level. Cisco inspects the centers for proper hardware and software, as well as for the general overall condition of the facility. Each center must use a Certified Cisco Systems Instructor (CCSI) to teach its courses. The instructors have passed a series of competency exams and have attended special courses designed to make sure that they meet the Cisco standards for teaching the course.

CATPs are located worldwide, with the largest concentration being in Europe. Some of the partners are quite large, with upwards of ten classrooms in one location. CATPs are usually smaller. A few partner companies have education centers in different parts of the country. The centers are all basically the same, because Cisco must authorize each one and each center must meet the Cisco guidelines.

What distinguishes the different partners from each other is the quality of the instructors. Although each instructor is Cisco certified, many of the instructors teach

only what is in the Cisco course manual. Although this is the base information required for the Cisco certifications, it may not always lend itself to real-world experiences. The extras that the better instructors include usually come from years in the field practicing what they teach. We all have had instructors or professors who really knew the book material that they taught, but if you asked them a question about something that didn't appear in the manual, they did not have a clue. When selecting the center that you want to attend, be sure to ask for references from former students. Talk to these people and get a feel about how the instructor handled the class, subject matter, and questions about related topics not included in the course material. You'll find that most of the instructors will get good reviews.

Cisco has been recognized for a long time by the industry for its proactive approach to training its resellers, users, and systems engineers. You can always count on the course materials written for Cisco software to be current with what's on the market. You can look at Cisco's Web site at www.cisco.com. This Web site contains a complete list of courses, current certification requirements, and listing of CATPs.

Self-Study Training

Cisco offers self-study programs, as do other sources. The self-study programs are good for self-starters who have both the time and the attitude to study on their own. By using the self-study programs offered by Cisco and authorized partners, you can save yourself a few dollars. The courses are designed to supply you with the course manuals offered by Cisco and usually include some form of lab training. Most training partners will sell you all the self-study course manuals so that you can study them at a convenient time.

The self-study programs are an excellent way to get some form of training, hands-on experience, and knowledge needed to obtain the Cisco certification. The biggest disadvantage of the self-study program is that you don't receive the instructor-student interaction used in instructor-led courses. If you decide to participate in the self-study program, you'll need to spend the time required to really learn the material.

Other Types of Training

At times, the standard approaches to training, like on-the-job or instructor-led training, won't fit into your schedule or don't meet some personal need (you may not study well on your own). For this reason, alternative forms of education are very popular. The alternative forms of education may include books, audiotapes, videotapes, Web-based training (WBT), and computer-based training (CBT) programs. These are all excellent sources of information that will help to augment your training process. This form of learning is available from a number of vendors providing lab supplements for those requiring hands-on equipment with lab exercises to assist not only in the preparation

for Cisco's certifications, but also to provide just-in-time learning for on-the-job project requirements.

From the experienced computer technician down to the beginner, a bookcase with a wide variety of computer books will be a necessity. The library will prove to be a great asset in your quest for advancement in the computer industry. With a well-rounded library, you'll be able to reference the topics and subjects that you may not know very well. You'll find that your library will grow immensely in a short time. Many of the books that you get will have just a few pages on the subject that concerns you right now, but will provide a source of reference on other material in the future.

Many books are available about the Cisco Internetworking Operating Systems (IOSs) on the shelves of bookstores. As a Cisco expert, you'll need to know about the early versions of Cisco IOSs and how they work. You should also know the different commands and terminology that was a part of old versions of Cisco. The versions of Cisco IOSs have many differences. Don't ignore the general networking books. Many of these books have a lot of practical information about how to administer and troubleshoot your internetwork. Although these books may not provide Cisco-specific information, they will help you gain a better understanding of networks in general. Even if you don't use this information immediately, you'll find it essential later.

As you've seen, many different approaches to training are available for becoming a CCIE and for general knowledge of the internetworking computer industry. It's normal to feel a bit overwhelmed because of the vast amount of information that you'll receive in preparation for your certification exams. The secret to making this process work and passing the exams will be to find the style, type of training, and studying techniques that best stimulate your mind.

How to Schedule the Written Exam

CCIE candidates can take the Routing and Switching qualification exam (350-001) through Prometric or VUE. In order to register for the exam you will need an ID number. For candidates in the United States or Canada, a social security number or a social insurance number will be used as your ID. For candidates outside the United States and Canada, the ID number used will be assigned by the testing center. Once assigned, this ID is the identification to the CCIE database record for all certifications and for all recertification exams.

VUE Scheduling Information

Candidates can schedule an exam through VUE online at www.vue.com/cisco or via telephone through one of the following registration numbers:

Americas 952-995-8844
Asia—Pacific 61-2-9323-5586
Australia 1-800-356-022
Austria 0800-292150
Belgium—Dutch 0800-74174
Belgium—French 0800-74175
Canada (877) 404-EXAM (3926)
Europe, Middle East, or Africa 31-348-484-632
France 0800-904757
Germany 0800-0826499
Hong Kong 800-930-988
Ireland 1-800-552131
Israel 1-800-9453797
Italy 800-790521
Malaysia 1800-808-578
Netherlands 0800-0235323
New Zealand 0800-445-884
Philippines 1800-1611-0155
Portugal 800-831429
Singapore 800-6161-888
South Africa 0800-995044
South Korea 00308-610-021
Spain 900-993190
Sweden 020-798690
Switzerland 0800-837550
Taiwan 0 0080-611-289
Turkey 0080031929149
United Kingdom 0800-7319905
United States (877) 404-EXAM (3926)

Prometric Scheduling Information

Candidates can schedule an exam through Prometric online at www.2test.com/index.jsp or via telephone through one of the registration numbers listed on their Web site.