EXAM CRAM

CCNA

Routing and Switching

200-125

Fifth Edition

PEARSON IT CERTIFICATION

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EXAM CRAM

CCNA Routing and Switching 200-125 Exam Cram

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Preface

Why is this book so valuable? Why is it an excellent last resource prior to your exam? Let me outline that for you here:

- This book balances the two potential areas of expertise you need for each exam topic. You either need to focus on the theory of a technology or you need to be able to demonstrate mastery of configuration, verification, and troubleshooting. You can trust this text to guide you through the precise knowledge you need, topic by topic.
- As alluded to above, this text remains tightly in scope with the exam. Although larger texts might provide background or peripheral information about a topic, this book is laser-focused on just those topics you need to master for success in the exam environment. We certainly encourage the reading and study of larger works for those that require it.
- Your author and technical reviewer have specialized in writing about and training candidates in all things CCNA since the inception of the certification in 1998.
- Your author and technical reviewer take the actual CCNA exam as many times as Cisco permits them in a constant effort to be intimately familiar with the exam itself and Cisco's testing techniques.
- This book is filled with valuable resources to assist you immediately in your passing score—these resources include CramSavers, CramQuizzes, Review Questions, Final Exams, a Command Reference, and even CramSheets.

About the Author

Anthony Sequeira (CCIE No. 15626) began his IT career in 1994 with IBM in Tampa, Florida. He quickly formed his own computer consultancy, Computer Solutions, and then discovered his true passion—teaching and writing about Microsoft and Cisco technologies. Anthony has lectured to massive audiences around the world while working for Mastering Computers. Anthony has never been happier in his career than he is now as a full-time trainer for CBT Nuggets. He is an avid tennis player, a private pilot, a semi-professional poker player, and enjoys getting beaten up by women and children at the martial arts school he attends with his daughter. Follow Anthony today on Twitter @compsolv or Facebook at facebook.com/compsolv.

Dedication

This book is dedicated to my beautiful daughter Annabella (Bella) Joy Sequeira. This was my first book of many where you were old enough to help write it! Thank you, my Bell!

Acknowledgments

I cannot thank Keith Barker enough! He helped me acquire this incredible opportunity, and he improved the book dramatically as its technical editor. Keith, I am so lucky to have you as a friend and brother from another Mother!

About the Technical Reviewer

Keith Barker began as a network technician for Electronic Data Systems (EDS) in 1985 and has had experience in IT and networking for more than 30 years. Keith creates training for CBT Nuggets, is a Cisco CCIE in Route/Switch and Security, and has also earned certifications associated with VMware, Palo Alto, Check Point, ITIL, CCISP, and others. He can be reached through his Facebook page: Keith Barker Networking, on YouTube at Keith6783, or on Twitter @KeithBarkerCCIE.

We Want to Hear from You!

As the reader of this book, you are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

We welcome your comments. You can email or write to let us know what you did or didn't like about this book—as well as what we can do to make our books better.

Please note that we cannot help you with technical problems related to the topic of this book.

When you write, please be sure to include this book's title and author as well as your name and email address. We will carefully review your comments and share them with the author and editors who worked on the book.

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Register your copy of CCNA *Routing and Switching 200-125 Exam Cram* at www.pearsonitcertification.com for convenient access to downloads, updates, and corrections as they become available. To start the registration process, go to www.pearsonitcertification.com/register and log in or create an account*. Enter the product ISBN 9780789756749 and click **Submit**. When the process is complete, you will find any available bonus content under Registered Products.

*Be sure to check the box that you would like to hear from us to receive exclusive discounts on future editions of this product.

Introduction

Welcome to *CCNA Routing and Switching 200–125 Exam Cram*! This book covers the accelerated CCNA certification exam. Whether this is your first or your fifteenth *Exam Cram*, you'll find information here that will ensure your success as you pursue knowledge, experience, and certification. This introduction covers how the *Exam Cram* series can help you prepare for the CCNA exam.

This book is one of the *Exam Cram* series of books and will help by getting you on your way to becoming a CCNA.

This introduction discusses the basics of the CCNA exam. Included are sections covering preparation, how to take an exam, a description of this book's contents, how this book is organized, and, finally, author contact information.

Each chapter in this book contains practice questions. There are also two full-length practice exams at the end of the book. Practice exams in this book should provide an accurate assessment of the level of expertise you need to obtain to pass the test. Answers and explanations are included for all test questions. It is best to obtain a level of understanding equivalent to a consistent pass rate of at least 90 percent or more on the practice questions and exams in this book before you attempt the real exam.

Let's begin by looking at preparation for the exam.

How to Prepare for the Exam

This text follows the official exam objectives letter for letter. These official objectives from Cisco Systems can be found here:

> https://learningnetwork.cisco.com/community/certifications/ccna/ccna-exam/exam-topics

Following the exam topics item by item and in their original order allows you to ensure you are ready for the real exam questions that will come your way on your actual test date.

Practice Tests

This book is filled with practice exam questions to get you ready! Enjoy the following:

- **CramSaver questions before each and every section**: These difficult, open-ended questions ensure you really know the material. Some readers use these questions in order to "test out" of a particular section.
- **CramQuizzes to end each section**: Another chance to demonstrate your knowledge after completing a section.
- **Review Questions to end each chapter**: Your final pass through the material for that chapter.
- **Two full final exams**: These exams include explanations and tips for approaching each final exam question.

In addition, the book includes two additional full practice tests in the Pearson Test Prep software available to you either online or as an offline Windows application. To access the practice exams, please see the instructions in the card inserted in the sleeve in the back of the book. This card includes a unique access code that enables you to activate your exams in the Pearson Test Prep software.

If you are interested in more practice exams than are provided with this book, Pearson IT Certification publishes a Premium Edition eBook and Practice Test product. In addition to providing you with three eBook files (EPUB, PDF, and Kindle) this product provides you with two additional exams' worth of questions. The Premium Edition version also offers you a link to the specific section in the book that presents an overview of the topic covered in the question, allowing you to easily refresh your knowledge. The insert card in the back of the book includes a special offer for a 70 percent discount off of this Premium Edition eBook and Practice Test product, which is an incredible deal.

Taking a Certification Exam

When you have prepared for the exam, you must register with Cisco Systems to take the exam. The CCNA exam is given at Pearson VUE testing centers. Check the Pearson VUE website at http://www.pearsonvue.com/ to get specific details.

You can register for an exam online or by phone. After you register, you will receive a confirmation notice. Some locations may have limited test centers

available, which means you should schedule your exam in advance to make sure you can get the specific date and time you would like.

Arriving at the Exam Location

As with any examination, arrive at the testing center early. Be prepared! You need to bring two forms of identification (one with a picture). The testing center staff requires proof that you are who you say you are and that someone else is not taking the test for you. Arrive early, because if you are late, you will be barred from entry and will not receive a refund for the cost of the exam.

ExamAlert

You'll be spending a lot of time in the exam room. Plan on using the full two hours of time allotted for your exam and surveys. Policies differ from location to location regarding bathroom breaks—check with the testing center before beginning the exam.

In the Testing Center

You will not be allowed to take into the examination room study materials or anything else that could raise suspicion that you're cheating. This includes practice test material, books, exam prep guides, or other test aids. The Testing Center will provide you with scratch paper and a pen or pencil. These days, this often comes in the form of an erasable whiteboard.

After the Exam

Examination results are available after the exam. If you pass the exam, you will simply receive a passing grade—your exact score will not be provided. Candidates who do not pass will receive a complete breakdown on their score by domain. This allows those individuals to see what areas they are weak in.

About This Book

The ideal reader for an *Exam Cram* book is someone seeking certification. However, it should be noted that an *Exam Cram* book is a very easily readable, rapid presentation of facts. Therefore, an *Exam Cram* book is also extremely useful as a quick reference manual.

Most people seeking certification use multiple sources of information. Check out the links at the end of each chapter to get more information about subjects you're weak in.

This book includes other helpful elements in addition to the actual logical, step-by-step learning progression of the chapters themselves. *Exam Cram* books use elements such as ExamAlerts, tips, notes, and practice questions to make information easier to read and absorb. This text also includes a very helpful command reference and glossary to assist you.

> **Note**
>
> Reading this book from start to finish is not necessary; this book is set up so that you can quickly jump back and forth to find sections you need to study.

Use the *CramSheet* to remember last-minute facts immediately before the exam. Use the practice questions to test your knowledge. You can always brush up on specific topics in detail by referring to the table of contents and the index. Even after you achieve certification, you can use this book as a rapid-access reference manual.

The Exam Blueprint

The table that follows outlines the CCNA exam domains and objectives and maps the objectives to the chapter(s) in the book that cover them in detail.

Exam Domain	Objective	Chapter in Book That Covers It
Network Fundamentals	Compare and contrast OSI and TCP/IP models	Chapter 1
Network Fundamentals	Compare and contrast TCP and UDP protocols	Chapter 1
Network Fundamentals	Describe the impact of infrastructure components in an enterprise network	Chapter 1
Network Fundamentals	Describe the effects of cloud resources on enterprise network architecture	Chapter 1
Network Fundamentals	Compare and contrast collapsed core and three-tier architectures	Chapter 1
Network Fundamentals	Compare and contrast network topologies	Chapter 1

Exam Domain	Objective	Chapter in Book That Covers It
Network Fundamentals	Select the appropriate cabling type based on implementation requirements	Chapter 1
Network Fundamentals	Apply troubleshooting methodologies to resolve problems	Chapter 1
Network Fundamentals	Configure, verify, and troubleshoot IPv4 addressing and subnetting	Chapter 2
Network Fundamentals	Compare and contrast IPv4 address types	Chapter 2
Network Fundamentals	Describe the need for private IPv4 addressing	Chapter 2
Network Fundamentals	Identify the appropriate IPv6 addressing scheme to satisfy addressing requirements in a LAN/WAN environment	Chapter 3
Network Fundamentals	Configure, verify, and troubleshoot IPv6 addressing	Chapter 3
Network Fundamentals	Configure and verify IPv6 Stateless Address Auto Configuration	Chapter 3
Network Fundamentals	Compare and contrast IPv6 address types	Chapter 3
LAN Switching Technologies	Describe and verify switching concepts	Chapter 4
LAN Switching Technologies	Interpret Ethernet frame format	Chapter 4
LAN Switching Technologies	Troubleshoot interface and cable issues (collisions, errors, duplex, speed)	Chapter 4
LAN Switching Technologies	Configure, verify, and troubleshoot VLANs (normal/extended range) spanning multiple switches	Chapter 5
LAN Switching Technologies	Configure, verify, and troubleshoot interswitch connectivity	Chapter 5
LAN Switching Technologies	Configure, verify, and troubleshoot STP protocols	Chapter 5
LAN Switching Technologies	Configure, verify, and troubleshoot STP-related optional features	Chapter 5
LAN Switching Technologies	Configure and verify Layer 2 protocols	Chapter 5

Exam Domain	Objective	Chapter in Book That Covers It
LAN Switching Technologies	Configure, verify, and troubleshoot (Layer 2/Layer 3) EtherChannel	Chapter 6
LAN Switching Technologies	Describe the benefits of switch stacking and chassis aggregation	Chapter 6
Routing Technologies	Describe the routing concepts	Chapter 7
Routing Fundamentals	Interpret the components of a routing table	Chapter 7
Routing Technologies	Describe how a routing table is populated by different routing information sources	Chapter 7
Routing Technologies	Configure, verify, and troubleshoot inter-VLAN routing	Chapter 8
Routing Technologies	Compare and contrast static routing and dynamic routing	Chapter 9
Routing Technologies	Compare and contrast distance vector and link state routing protocols	Chapter 9
Routing Technologies	Compare and contrast interior and exterior routing protocols	Chapter 9
Routing Technologies	Configure, verify, and troubleshoot IPv4 and IPv6 static routing	Chapter 10
Routing Technologies	Configure, verify, and troubleshoot single area and multi-area OSPFv2 for IPv4 (excluding authentication, filtering, manual summarization, redistribution, stub, virtual-link, and LSAs)	Chapter 10
Routing Technologies	Configure, verify, and troubleshoot single area and multi-area OSPFv3 for IPv6 (excluding authentication, filtering, manual summarization, redistribution, stub, virtual-link, and LSAs)	Chapter 10
Routing Technologies	Configure, verify, and troubleshoot EIGRP for IPv4 (excluding authentication, filtering, manual summarization, redistribution, stub)	Chapter 10
Routing Technologies	Configure, verify, and troubleshoot EIGRP for IPv6 (excluding authentication, filtering, manual summarization, redistribution, stub)	Chapter 10

Exam Domain	Objective	Chapter in Book That Covers It
Routing Technologies	Configure, verify, and troubleshoot RIPv2 for IPv4 (excluding authentication, filtering, manual summarization, redistribution)	Chapter 10
Routing Technologies	Troubleshoot basic Layer 3 end-to-end connectivity issues	Chapter 10
WAN Technologies	Configure and verify PPP and MLPPP on WAN interfaces using local authentication	Chapter 11
WAN Technologies	Configure, verify, and troubleshoot PPPoE client-side interfaces using local authentication	Chapter 11
WAN Technologies	Configure, verify, and troubleshoot GRE tunnel connectivity	Chapter 11
WAN Technologies	Describe WAN topology options	Chapter 11
WAN Technologies	Describe WAN access connectivity options	Chapter 11
WAN Technologies	Configure and verify single-homed branch connectivity using eBGP IPv4 (limited to peering and route advertisement using Network command only)	Chapter 12
WAN Technologies	Describe basic QoS concepts	Chapter 13
Infrastructure Services	Describe DNS lookup operation	Chapter 14
Infrastructure Services	Troubleshoot client connectivity issues involving DNS	Chapter 14
Infrastructure Services	Configure and verify DHCP on a router (excluding static reservations)	Chapter 14
Infrastructure Services	Troubleshoot client- and router-based DHCP connectivity issues	Chapter 14
Infrastructure Services	Configure, verify, and troubleshoot basic HSRP	Chapter 14
Infrastructure Services	Configure and verify NTP operating in a client/server mode	Chapter 14
Infrastructure Services	Configure, verify, and troubleshoot inside source NAT	Chapter 15
Infrastructure Security	Configure, verify, and troubleshoot port security	Chapter 16
Infrastructure Security	Describe common access layer threat mitigation techniques	Chapter 16

Exam Domain	Objective	Chapter in Book That Covers It
Infrastructure Security	Describe device security using AAA with TACACS+ and RADIUS	Chapter 16
Infrastructure Security	Configure, verify, and troubleshoot IPv4 and IPv6 standard, extended, and named access list for traffic filtering	Chapter 17
Infrastructure Security	Verify ACLs using the APIC-EM Path Trace ACL analysis tool	Chapter 17
Infrastructure Security	Configure, verify, and troubleshoot basic device hardening	Chapter 18
Infrastructure Management	Configure and verify device-monitoring protocols	Chapter 19
Infrastructure Management	Troubleshoot network connectivity issues using ICMP echo-based IP SLA	Chapter 19
Infrastructure Management	Configure and verify device management	Chapter 20
Infrastructure Management	Configure and verify initial device configuration	Chapter 21
Infrastructure Management	Perform device maintenance	Chapter 22
Infrastructure Management	Use Cisco IOS tools to troubleshoot and resolve problems	Chapter 23
Infrastructure Management	Describe network programmability in enterprise network architecture	Chapter 24

The Chapter Elements

Each *Exam Cram* book has chapters that follow a predefined structure. This structure makes *Exam Cram* books easy to read and provides a familiar format for all *Exam Cram* books. The following elements typically are used:

- Chapter topics
- Essential Terms and Components
- CramSavers
- CramQuizzes
- ExamAlerts
- Notes

- Exam preparation practice questions and answers
- An "Additional Resources" section at the end of each chapter

> **Note**
>
> Bulleted lists, numbered lists, tables, and graphics are also used where appropriate. A picture can paint a thousand words sometimes, and tables can help to associate different elements with each other visually.

Now let's look at each of the elements in detail.

- **Chapter topics**—Each chapter contains details of all subject matter listed in the table of contents for that particular chapter. The objective of an *Exam Cram* book is to cover all the important facts without giving too much detail; it is an exam cram. When examples are required, they are included.
- **Essential Terms and Components**—The start of every chapter contains a list of terms and concepts you should understand. These are all defined in the book's accompanying Glossary.
- **CramSavers**—Each major section in the chapter kicks off with a brief short answer question quiz to help you assess your knowledge of the section topic. This chapter element is designed to help you determine if you need to read the whole section in detail or merely skim the material and skip ahead to the CramQuiz at the end of the section.
- **CramQuizzes**—Each major section in the chapter concludes with a multiple choice question quiz to help ensure that you have gained a familiarity with the section content.
- **ExamAlerts**—ExamAlerts address exam-specific, exam-related information. An ExamAlert addresses content that is particularly important, tricky, or likely to appear on the exam. An ExamAlert looks like this:

> **ExamAlert**
>
> Make sure you remember the different ways in which you can access a router remotely. Know which methods are secure, and which are not.

- **Notes**—Notes typically contain useful information that is not directly related to the current topic under consideration. To avoid breaking up the flow of the text, they are set off from the regular text.

> **Note**
>
> This is a note. You have already seen several notes.

- **Review Questions**—At the end of every chapter is a battery of exam practice questions similar to those in the actual exam. Each chapter contains a list of questions relevant to that chapter, including answers and explanations. Test your skills as you read.
- **Additional Resources section**—This section at the end of each chapter describes other relevant sources of information related to the chapter topics covered.

Other Book Elements

Most of this *Exam Cram* book on CCNA follows the consistent chapter structure already described. However, there are various, important elements that are not part of the standard chapter format. These elements apply to the entire book as a whole.

- **Practice exams**—In addition to exam-preparation questions at the end of each chapter, two full practice exams are included at the end of the book.
- **Answers and explanations for practice exams**—These follow each practice exam, providing answers and explanations to the questions in the exams.
- **Command reference**—This valuable study guide appears at the end of the text.
- **Glossary**—The glossary contains a listing of important terms used in this book with explanations.
- **CramSheet**—The CramSheet is a quick-reference, tear-out cardboard sheet of important facts useful for last-minute preparation. CramSheets often include a simple summary of the facts that are most difficult to remember.
- **Companion website**—The companion website for your book allows you to access several digital assets that come with your book, including:

- Pearson Test Prep software (both online and Windows desktop versions)
- Key Terms Flash Cards application
- A PDF version of the command reference
- A PDF version of the CramSheet

To access the book's companion website, simply follow these steps:

1. Register your book by going to: PearsonITCertification.com/register and entering the ISBN: 9780789756749.
2. Respond to the challenge questions.
3. Go to your account page and select the **Registered Products** tab.
4. Click on the **Access Bonus Content** link under the product listing.

Pearson Test Prep Practice Test Software

As noted previously, this book comes complete with the Pearson Test Prep practice test software containing four full exams (the two from the back of the book as well as two additional tests). These practice tests are available to you either online or as an offline Windows application. To access the practice exams that were developed with this book, please see the instructions in the card inserted in the sleeve in the back of the book. This card includes a unique access code that enables you to activate your exams in the Pearson Test Prep software.

Accessing the Pearson Test Prep Software Online

The online version of this software can be used on any device with a browser and connectivity to the Internet, including desktop machines, tablets, and smartphones. To start using your practice exams online, simply follow these steps:

1. Go to: http://www.PearsonTestPrep.com.
2. Select **Pearson IT Certification** as your product group.
3. Enter your email/password for your account. If you don't have an account on PearsonITCertification.com or CiscoPress.com, you will need to establish one by going to PearsonITCertification.com/join.

4. In the **My Products** tab, click the **Activate New Product** button.
5. Enter the access code printed on the insert card in the back of your book to activate your product.
6. The product will now be listed in your My Products page. Click the **Exams** button to launch the exam settings screen and start your exam.

Accessing the Pearson Test Prep Software Offline

If you wish to study offline, you can download and install the Windows version of the Pearson Test Prep software. There is a download link for this software on the book's companion website, or you can just enter this link in your browser:

http://www.pearsonitcertification.com/content/downloads/pcpt/engine.zip

To access the book's companion website and the software, simply follow these steps:

1. Register your book by going to: PearsonITCertification.com/register and entering the ISBN: 9780789756749.
2. Respond to the challenge questions.
3. Go to your account page and select the **Registered Products** tab.
4. Click on the **Access Bonus Content** link under the product listing.
5. Click the **Install Pearson Test Prep Desktop Version** link under the Practice Exams section of the page to download the software.
6. After the software finishes downloading, unzip all the files on your computer.
7. Double-click the application file to start the installation, and follow the on-screen instructions to complete the registration.
8. When the installation is complete, launch the application and select **Activate Exam** button on the My Products tab.
9. Click the **Activate a Product** button in the Activate Product Wizard.
10. Enter the unique access code found on the card in the sleeve in the back of your book and click the **Activate** button.

11. Click **Next** and then the **Finish** button to download the exam data to your application.
12. You can now start using the practice exams by selecting the product and clicking the **Open Exam** button to open the exam settings screen.

Note that the offline and online versions will synch together, so saved exams and grade results recorded on one version will be available to you on the other as well.

Customizing Your Exams

Once you are in the exam settings screen, you can choose to take exams in one of three modes:

- Study Mode
- Practice Exam Mode
- Flash Card Mode

Study Mode allows you to fully customize your exams and review answers as you are taking the exam. This is typically the mode you would use first to assess your knowledge and identify information gaps. Practice Exam Mode locks certain customization options, as it is presenting a realistic exam experience. Use this mode when you are preparing to test your exam readiness. Flash Card Mode strips out the answers and presents you with only the question stem. This mode is great for late stage preparation when you really want to challenge yourself to provide answers without the benefit of seeing multiple choice options. This mode will not provide the detailed score reports that the other two modes will, so it should not be used if you are trying to identify knowledge gaps.

In addition to these three modes, you will be able to select the source of your questions. You can choose to take exams that cover all of the chapters or you can narrow your selection to just a single chapter or the chapters that make up specific parts in the book. All chapters are selected by default. If you want to narrow your focus to individual chapters, simply deselect all the chapters then select only those on which you wish to focus in the Objectives area.

You can also select the exam banks on which to focus. Each exam bank comes complete with a full exam of questions that cover topics in every chapter. The two exams printed in the book are available to you as well as two additional exams of unique questions. You can have the test engine serve up exams from all four banks or just from one individual bank by selecting the desired banks in the exam bank area.

There are several other customizations you can make to your exam from the exam settings screen, such as the time of the exam, the number of questions served up, whether to randomize questions and answers, whether to show the number of correct answers for multiple answer questions, or whether to serve up only specific types of questions. You can also create custom test banks by selecting only questions that you have marked or questions on which you have added notes.

Updating Your Exams

If you are using the online version of the Pearson Test Prep software, you should always have access to the latest version of the software as well as the exam data. If you are using the Windows desktop version, every time you launch the software, it will check to see if there are any updates to your exam data and automatically download any changes that were made since the last time you used the software. This requires that you are connected to the Internet at the time you launch the software.

Sometimes, due to many factors, the exam data may not fully download when you activate your exam. If you find that figures or exhibits are missing, you may need to manually update your exams.

To update a particular exam you have already activated and downloaded, simply select the **Tools** tab and select the **Update Products** button. Again, this is only an issue with the desktop Windows application.

If you wish to check for updates to the Pearson Test Prep exam engine software, Windows desktop version, simply select the **Tools** tab and select the **Update Application** button. This will ensure you are running the latest version of the software engine.

Contacting the Author

Hopefully, this book provides you with the tools you need to pass the CCNA exam. Feedback is appreciated. You can contact the author at compsolv@me.com.

Thank you for selecting my book; I have worked to apply the same concepts in this book that I have used in the hundreds of training classes I have taught. Spend your study time wisely and you, too, can become a CCNA. Good luck for the exam, although if you carefully work through this text, you will certainly minimize the amount of luck required!

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PART V

Infrastructure Services

This part of the text deals with one of the seven overall sections you must master for the CCNA exam. There are two chapters total that make up Part 5.

These chapters prove critical for your success in production networks. If you cannot successfully manage your infrastructure services in your complex network, you are in for big trouble, especially when things inevitably go wrong. Part 5 includes the following chapters:

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CHAPTER 14

Infrastructure Services: DNS, DHCP, NTP, HSRP

This chapter covers the following official CCNA 200-125 exam topics:

- Describe DNS lookup operation
- Troubleshoot client connectivity issues involving DNS
- Configure and verify DHCP on a router (excluding static reservations)
- Troubleshoot client- and router-based DHCP connectivity issues
- Configure and verify NTP operating in client/server mode
- Configure, verify, and troubleshoot basic HSRP

This chapter ensures you are ready for the preceding topics from the Infrastructure Services section of the overall exam blueprint from Cisco Systems. Remember, this is just a section of the Infrastructure Services area. Chapter Fifteen, which deals with NAT, also exists in this grouping.

Essential Terms and Components

- DNS
- DNS Lookups
- Client DNS Configurations
- DHCP
- DHCP Server
- DHCP Relay
- DHCP Client
- Other DHCP Assigned Parameters
- NTP Server
- NTP Client

- Stratum
- FHRP
- HSRP
- Priority
- Preemption
- Version

Topic: Describe DNS lookup operation

CramSaver

If you can correctly answer these CramSaver questions, save time by skimming the ExamAlerts in this chapter and then completing the CramQuiz at the end of each section and the Review Questions at the end of the chapter. Notice the CramSaver is also broken down by section, so perhaps you just need to review a certain area. If you are in doubt at all—read EVERYTHING in this chapter!

1. What service resolves "friendly names" like www.cbtnuggets.com to an IP address?

   _____

2. Name two types of DNS records.

   _____

Answers

1. The Domain Name System (DNS) resolves friendly names to IP addresses.
2. Common record types include:
   - Start of Authority (SOA)
   - IP addresses (A and AAAA)
   - SMTP mail exchangers (MX)
   - Name servers (NS)
   - Pointers for reverse DNS lookups (PTR)
   - Domain name aliases (CNAME)

Imagine a world where we would need to communicate with devices on the Internet (or our company's intranet) using the IP addresses of systems. This would be nearly impossible since IP addresses are so difficult to memorize for the many devices. The Domain Name System (DNS) prevents this nightmare.

DNS resolves "friendly" names like www.cbtnuggets.com to the IP address that devices truly need to reach the remote system. We use DNS every day, as you might guess. The system can refer to a private RFC 1918 address space inside your organization or to the public, globally routable IPv4 address space on the Internet. You can also have your internal private DNS servers interact with public DNS servers.

The Domain Name System delegates the responsibility of assigning domain names and mapping those names to Internet resources by designating *authoritative* name servers for each domain. Network administrators may delegate authority over sub-domains of their allocated name space to other name servers. This approach gives us a fault-tolerant design and eliminates the need for everyone to rely on one single huge database.

Remember, when you hear DNS, you are talking about this structure of naming as well as the technical details of the protocol itself (for example, what messages are exchanged and how data is processed in the system).

The Internet maintains the domain name hierarchy and the Internet Protocol (IP) address spaces. DNS maintains the domain name hierarchy and provides translation services between it and the address spaces. A DNS name server is a server that stores the DNS records for a domain; a DNS name server responds with answers to queries against its database.

The most common types of records stored in the DNS database are as follows:

- Start of Authority (SOA)
- IP Addresses (A and AAAA)
- SMTP Mail Exchangers (MX)
- Name Servers (NS)
- Pointers for Reverse DNS Lookups (PTR)
- Domain Name Aliases (CNAME)

DNS databases are traditionally stored in structured zone files.

CramQuiz

1. Which statement about DNS is false?
   - ❍ **A.** DNS operates thanks to one central master database.
   - ❍ **B.** DNS resolves domain names to IP addresses.
   - ❍ **C.** DNS uses many types of records to do its job.
   - ❍ **D.** Multiple DNS servers are typically available for a client.

2. What device is responsible for each DNS domain?
   - ❍ **A.** Master DNS
   - ❍ **B.** Authoritative name server
   - ❍ **C.** Zone file server
   - ❍ **D.** DNS client

CramQuiz Answers

1. **A** is correct. The DNS system creates a distributed database so that one central master database does not need to be relied upon.
2. **B** is correct. Each domain has an authoritative name server that helps manage the domain.

Topic: Troubleshoot client connectivity issues involving DNS

CramSaver

1. What Windows CLI command allows you to see the IP address information configured as well as the DNS server IP address?

   _____

2. What Windows CLI tool allows you to learn information regarding the DNS lookup including the DNS server name, address, non-authoritative response, and resolved addresses and aliases?

   _____

3. What is the command that specifies one or more DNS servers for a Cisco device to use?

   _____

Answers

1. **ipconfig /all**
2. **nslookup**
3. **ip name-server**

Ensuring your clients are properly configured to use DNS is important for full functionality on the Internet today.

On a Windows client system, you can check the DNS settings using **ipconfig**, as shown in Example 14.1.

EXAMPLE 14.1 **Examining DNS Settings on a Windows Client**

```
C:\Users\terry>ipconfig /all

Windows IP Configuration

   Host Name . . . . . . . . . . . . : DESKTOP-ABC123
   Primary Dns Suffix  . . . . . . . :
   Node Type . . . . . . . . . . . . : Hybrid
   IP Routing Enabled. . . . . . . . : No
```

```
   WINS Proxy Enabled. . . . . . . . : No
   DNS Suffix Search List. . . . . . : my-router.home

Ethernet adapter Ethernet:

   Connection-specific DNS Suffix  . : my-router.home
   Description . . . . . . . . . . . : Realtek PCIe GBE Family
                                       Controller
   Physical Address. . . . . . . . . : 84-8F-69-F5-5F-3D
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes
   Link-local IPv6 Address . . . . . : fe80::bc5e:a448:8dcc:72ce%3
                                       (Preferred)
   IPv4 Address. . . . . . . . . . . : 192.168.1.191(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Lease Obtained. . . . . . . . . . : Monday3:33:08 AM
   Lease Expires . . . . . . . . . . : Friday 3:33:19 AM
   Default Gateway . . . . . . . . . : 192.168.1.1
   DHCP Server . . . . . . . . . . . : 192.168.1.1
   DHCPv6 IAID . . . . . . . . . . . : 59019113
   DHCPv6 Client DUID. . . . . . . . : 00-01-00-01-1E-72-89-C7-84-8F-
                                       69-F5-5F-3D
   DNS Servers . . . . . . . . . . . : 192.168.1.1
   NetBIOS over Tcpip. . . . . . . . : Enabled
C:\Users\terry>
```

Notice from the output in Example 14.1 that this client will send DNS requests to 192.168.1.1. This is, of course, a private-use-only address inside our network. This router receives public DNS server addresses automatically from our ISP so that it can resolve public website names that we want to visit.

Figure 14.1 shows the actual configuration for this Windows client in the graphical user interface of the Control Panel. Notice that the DNS information of 192.168.1.1 is being learned by this client automatically.

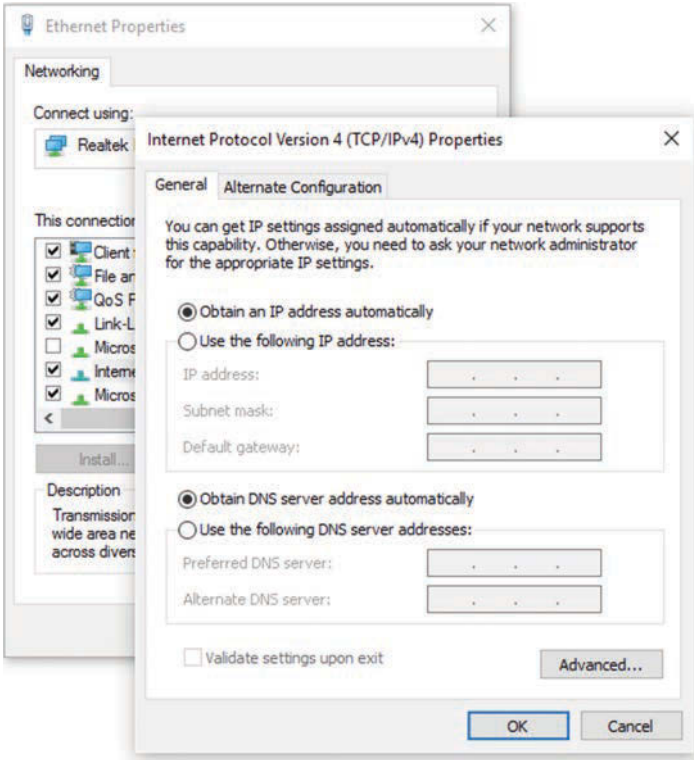


FIGURE 14.1 **The DNS Settings Inside of Windows**

What about verifying the Windows client is fine from a DNS perspective? One approach is to ping a known and reachable Web server using the friendly name. Example 14.2 demonstrates this approach.

EXAMPLE 14.2 **Checking DNS Functionality by Using PING**

```
C:\Users\terry>ping www.cisco.com

Pinging e144.dscb.akamaiedge.net [23.202.192.170] with 32 bytes of data:
Reply from 23.202.192.170: bytes=32 time=35ms TTL=54
Reply from 23.202.192.170: bytes=32 time=37ms TTL=54
Reply from 23.202.192.170: bytes=32 time=36ms TTL=54
Reply from 23.202.192.170: bytes=32 time=35ms TTL=54

Ping statistics for 23.202.192.170:
     Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
     Minimum = 35ms, Maximum = 37ms, Average = 35ms

C:\Users\terry>
```

ExamAlert

You can also configure a Cisco router or switch as a DNS client. We cover this later in this chapter. Do not ignore the Windows client information, however.

If you would like to receive even more information, however, use the NSLOOKUP command. Example 14.3 demonstrates this powerful tool.

EXAMPLE 14.3 **Using NSLOOKUP to Verify DNS**

```
C:\Users\terry>nslookup www.cisco.com
Server:  ACME_Quantum_Gateway.my-router.home
Address:  192.168.1.1

Non-authoritative answer:
Name:    e144.dscb.akamaiedge.net
Addresses:  2600:1408:10:18c::90
          2600:1408:10:181::90
          23.202.192.170
Aliases:  www.cisco.Com
          www.cisco.com.akadns.net
          wwwds.cisco.com.edgekey.net
          wwwds.cisco.com.edgekey.net.globalredir.akadns.net
C:\Users\terry>
```

Just as it can be convenient for your Windows client to use DNS, it can also be beneficial for your Cisco routers and switches. Table 14.1 provides commands available on these devices.

TABLE 14.1 **DNS Related Commands on Cisco Devices**

Cisco Command	Description
ip domain-lookup	This command enables DNS-based host name-to-address translation; note this command is enabled by default on many Cisco devices.
ip name-server	This command specifies the address of one or more name servers for the device to use for DNS resolution.
ip domain-name	This command defines a default domain name that the Cisco IOS software uses to complete unqualified host names (names without a dotted-decimal domain name).

CramQuiz

1. What is a common Windows client setting for IPv4 DNS?
   - ❍ **A.** The use of only Google DNS public servers
   - ❍ **B.** To acquire the DNS settings automatically via DHCP
   - ❍ **C.** To use the public IP address of the ISP's router
   - ❍ **D.** To use a local loopback address

2. What command enables DNS-based host name translations on a Cisco router and is enabled by default on many Cisco routers?
   - ❍ **A. ip domain-name**
   - ❍ **B. ip name-server**
   - ❍ **C. ip domain-list**
   - ❍ **D. ip domain-lookup**

CramQuiz Answers

1. **B** is correct. A very common approach for Windows client's DNS is to acquire this information dynamically.
2. **D** is correct. The **ip domain-lookup** command enables DNS-based host name resolution. This command is a default setting.

Topic: Configure and verify DHCP on a router (excluding static reservations)

CramSaver

1. What is the default lease duration on a Cisco DHCP server?

   _____

2. Which feature allows a router to forward a client's DHCP request to a remote DHCP server?

   _____

Answers

1. The default lease duration is 1 day, which is 86,400 seconds.
2. The DHCP Relay-Agent feature permits this.

Figure 14.2 shows the simple topology we use to configure a Dynamic Host Configuration Protocol (DHCP) server using a Cisco router (R1), and to configure a Cisco router (R2) as a DHCP client.

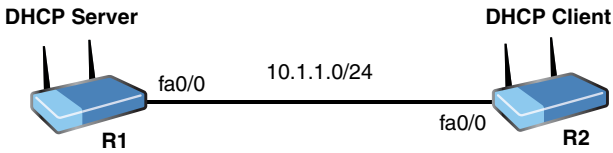


FIGURE 14.2 **The DHCP Server and Client Topology**

Example 14.4 shows the configuration of R1, the DHCP Server.

EXAMPLE 14.4 **The Configuration of the DHCP Server**

```
R1#
R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#interface fa0/0
R1(config-if)#ip address 10.1.1.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#exit
```

```
R1(config)#
%LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
R1(config)#ip dhcp excluded-address 10.1.1.1 10.1.1.10
R1(config)#ip dhcp pool CCNAEXAMCRAM
R1(dhcp-config)#default-router 10.1.1.1
R1(dhcp-config)#dns-server 8.8.8.8 4.2.2.2
R1(dhcp-config)#option 150 ip 10.10.10.2
R1(dhcp-config)#network 10.1.1.0 /24
R1(dhcp-config)#end
R1#
```

The commands directly involving DHCP are as follows:

- **ip dhcp excluded-address 10.1.1.1 10.1.1.10**: This command tells the DHCP server *not* to assign the addresses from 10.1.1.1 to 10.1.1.10 to DHCP clients. For example, the 10.1.1.1 address is the static router interface address configured on R1's fa0/0 interface.
- **ip dhcp pool CCNAEXAMCRAM**: This command creates our DHCP pool on R1. This pool will contain the specific parameters we want to hand out to clients who lease addresses from the DHCP server.
- **default-router 10.1.1.1**: This command assigns the default gateway to clients of this DHCP pool.
- **dns-server 8.8.8.8 4.2.2.2**: This command sets a primary and backup DNS server for the clients.
- **option 150 ip 10.10.10.2**: This command provides clients with the IP address of a TFTP server.
- **network 10.1.1.0 /24**: This command specifies the IP address assignments for the pool. Remember, we excluded a small portion of this network address space. As a result, we expect the first leased address to be 10.1.1.11/24.

ExamAlert

The **network** command used in DHCP configuration accepts a subnet mask or prefix notation in its syntax.

Example 14.5 shows the configuration of a DHCP client function on a Cisco router.

EXAMPLE 14.5 **The Configuration of the DHCP Client**

```
R2#
R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#interface fa0/0
R2(config-if)#ip address dhcp
R2(config-if)#no shutdown
R2(config-if)#end
R2#
%SYS-5-CONFIG_I: Configured from console by console
R2#
%LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
R2#
```

Notice here the very simple configuration. The command **ip address dhcp** gets the job done for the client interface.

Next, let's begin our verification on the server. Example 14.6 shows the use of the **show ip dhcp binding** command to verify the server's operation.

EXAMPLE 14.6 **Verifying the DHCP Server**

```
R1#
R1#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/           Lease expiration     Type
                    Hardware address/
                    User name
10.1.1.11           0063.6973.636f.2d63. 08:10 PM _______ Automatic
                    6130.332e.3066.6330.
                    2e30.3030.302d.4661.
                    302f.30
R1#
```

ExamAlert

Notice that the default lease duration for Cisco DHCP servers is one day. To see any IP address conflicts in your Cisco DHCP environment, you can use the command **show ip dhcp conflict**.

Example 14.7 shows a simple verification on the client. The **show ip interface brief** command allows us to quickly view the DHCP learned address on Fa0/0.

EXAMPLE 14.7 **Verifying the DHCP Client**

```
R2#
R2#show ip interface brief
Interface        IP-Address  OK? Method Status                Protocol
FastEthernet0/0  10.1.1.11   YES DHCP   up                    up
FastEthernet1/0  unassigned  YES unset  administratively down down
FastEthernet1/1  unassigned  YES unset  administratively down down
R2#
```

What happens if your DHCP server is not on the same subnet with the clients that need it? One option is to configure a DHCP relay-agent. This is a router that hears the DHCP requests from clients and forwards them to the appropriate DHCP server. It is very simple to configure this relay agent. Figure 14.3 and Example 14.8 show a sample topology and configuration. Note that the powerful **ip helper-address** *dhcp-server-ip* command gets the job done. The relay agent knows the address of the DHCP server, so it can successfully forward local DHCP traffic to the DHCP server.

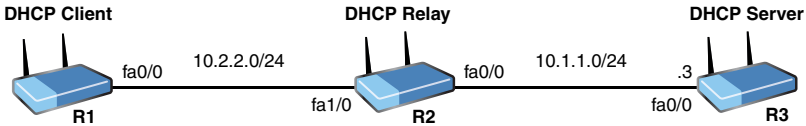


FIGURE 14.3 The DHCP Relay-Agent

EXAMPLE 14.8 **Configuring the DHCP Relay-Agent**

```
R2#
R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#interface fa1/0
R2(config-if)#ip helper-address 10.1.1.3
R2(config-if)#end
R2#
```

CramQuiz

1. What command ensures your DHCP server does not lease out addresses you have statically configured elsewhere?
   - ❍ **A. no dhcp-server assign-address**
   - ❍ **B. no dhcp-lease address**
   - ❍ **C. ip dhcp no-lease address**
   - ❍ **D. ip dhcp excluded-address**

2. What command configures a default gateway in a DHCP server pool?
   - ❍ **A. ip default-gateway**
   - ❍ **B. gateway-of-last-resort**
   - ❍ **C. ip domain-server**
   - ❍ **D. default-router**

3. What command configures a Cisco device as a DHCP client?
   - ❍ **A. ip address auto**
   - ❍ **B. ip address dhcp**
   - ❍ **C. ip address learn**
   - ❍ **D. ip address dynamic**

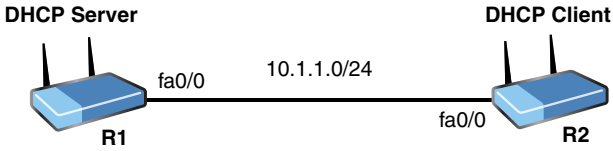
CramQuiz Answers

1. **D** is correct. Use the **ip dhcp excluded-address** command to create a range of excluded addresses from your pool.
2. **D** is correct. Use the **default-router** command in the DHCP pool to set the default gateway address.
3. **B** is correct. **ip address dhcp**, used in interface configuration mode, sets the Cisco device as a DHCP client.

Topic: Troubleshoot client- and router-based DHCP connectivity issues

CramSaver

1. Examine the figure and the example configurations. Why is the DHCP client failing to acquire IP address information?




```
R1#
R1#show running-config
Building configuration...

Current configuration : 1343 bytes
!
! Last configuration change at 08:30:24 UTC Fri Aug 26 2016
!
upgrade fpd auto
version 15.0
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
!
!
!
ip source-route
no ip icmp rate-limit unreachable
ip cef
!
!
ip dhcp excluded-address 10.1.1.1 10.1.1.10
!
```

```
ip dhcp pool CCNAEXAMCRAM
   network 10.1.2.0 255.255.255.0
   default-router 10.1.1.1
   dns-server 8.8.8.8 4.2.2.2
   option 150 ip 10.10.10.2
!
!
no ip domain lookup
no ipv6 cef
!
multilink bundle-name authenticated
!
!
!
redundancy
!
!
ip tcp synwait-time 5
!
!
!
interface FastEthernet0/0
 ip address 10.1.1.1 255.255.255.0
 duplex half
!
!
interface FastEthernet1/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
!
interface FastEthernet1/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
no cdp log mismatch duplex
!
!
!
```

```
control-plane
!
!
!
mgcp fax t38 ecm
mgcp behavior g729-variants static-pt
!
!
!
gatekeeper
 shutdown
!
!
line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line vty 0 4
 login
!
ntp master 2
end

R1#


R2#
R2#show running-config
Building configuration...

Current configuration : 1165 bytes
!
! Last configuration change at 08:49:30 UTC Fri Aug 26 2016
!
upgrade fpd auto
version 15.0
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
```

```
no aaa new-model
!
!
!
ip source-route
no ip icmp rate-limit unreachable
ip cef
!
!
!
no ip domain lookup
no ipv6 cef
!
multilink bundle-name authenticated
!
!
!
redundancy
!
!
ip tcp synwait-time 5
!
!
!
interface FastEthernet0/0
 ip address dhcp
 duplex half
!
!
interface FastEthernet1/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
!
interface FastEthernet1/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
```

```
no cdp log mismatch duplex
!
!
!
control-plane
!
!
!
mgcp fax t38 ecm
mgcp behavior g729-variants static-pt
!
!
!
gatekeeper
 shutdown
!
!
line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line vty 0 4
 login
!
ntp server 10.1.1.1
end

R2#
```

_____

2. What command allows you to easily verify the lease assignments from the DHCP server?

_____

Answers

1. The subnet for lease assignments is incorrect for the DHCP server pool; the correct subnet should be configured with **network 10.1.1.0 /24.**
2. **show ip dhcp server bindings**

There can be many issues to prevent proper DHCP connectivity. Here are just some issues you should be aware of:

- Errors in router or switch configurations
- DHCP server configuration
- DHCP relay-agent configuration
- DHCP server scope configuration or software defect

ExamAlert

Although there are many possible errors in your CCNA exam, watch out for server or client misconfigurations because these will be the most common.

The four steps of the DHCP process that must succeed for a successful DHCP lease are as follows:

1. Discover (from the client)
2. Offer (from the server)
3. Request (from the client)
4. Acknowledgement (from the server)

Remember the key verification commands for DHCP. **show ip dhcp binding** is critical for the server, and **show ip interface brief** works well for the client.

CramQuiz

1. Examine the configuration shown. DHCP clients in the 10.1.1.0/24 subnet are complaining that they cannot access Internet resources. What is the most likely issue?

```
R1#show running-config
Building configuration...

Current configuration : 1312 bytes
!
! Last configuration change at 08:57:10 UTC Fri Aug 26 2016
!
upgrade fpd auto
version 15.0
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
```

```
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
!
!
!
ip source-route
no ip icmp rate-limit unreachable
ip cef
!
!
ip dhcp excluded-address 10.1.1.1 10.1.1.10
!
ip dhcp pool CCNAEXAMCRAM
   network 10.1.1.0 255.255.255.0
   default-router 10.1.1.1
   option 150 ip 10.10.10.2
!
!
no ip domain lookup
no ipv6 cef
!
multilink bundle-name authenticated
!
!
redundancy
!
!
ip tcp synwait-time 5
!
!
!
interface FastEthernet0/0
 ip address 10.1.1.1 255.255.255.0
 duplex half
!
!
interface FastEthernet1/0
 no ip address
 shutdown
 duplex auto
 speed auto
```

```
!
!
interface FastEthernet1/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
no cdp log mismatch duplex
!
!
!
control-plane
!
!
!
mgcp fax t38 ecm
mgcp behavior g729-variants static-pt
!
!
!
gatekeeper
 shutdown
!
!
line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line vty 0 4
 login
!
ntp master 2
end

R1#
```

- ❍ **A.** The scope of addresses in the pool is not correct.
- ❍ **B.** There is no lease duration set.
- ❍ **C.** There are no DNS servers assigned to the clients.
- ❍ **D.** The default gateway is incorrect.

2. What is the second step of the four steps of the DHCP process?

- ❍ **A.** Acknowledgement
- ❍ **B.** Request
- ❍ **C.** Offer
- ❍ **D.** Discover

CramQuiz Answers

1. **C** is correct. This configuration is missing the assignment of DNS servers for the clients.
2. **C** is correct. The second step of the process is an offer.

Topic: Configure and verify NTP operating in client/server mode

CramSaver

1. What command configures your Cisco router to be an authoritative reference clock source with a stratum of 3?

   _____

2. What command confirms your NTP client to server relationship in tabular form?

   _____

Answers

1. **ntp master 3**
2. **show ntp association**

It is critical for many reasons to have accurate time on your network devices. To automate this process, we have Network Time Protocol (NTP). NTP uses the transport layer protocol of UDP and port 123. NTP uses the concept of a stratum value to gauge the accuracy of time values carried by NTP. A lower stratum value is preferred. You can think of stratum like a hop count from the authoritative reference clock source. Ideally, this time source should be an atomic clock, or at least linked to one. Example 14.9 configures R1 to act as a reference clock source for the network. Notice we select a stratum value of 2.

EXAMPLE 14.9 **Configuring the NTP Master in the Network**

```
R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ntp master ?
  <1-15> Stratum number
  <cr>

R1(config)#ntp master 2
R1(config)#end
R1#
```

ExamAlert

The default stratum value for the **ntp master** command is **8**.

How do you configure an NTP client to receive the correct time from your NTP server (master)? The command is **ntp server** *ntp-server-ip-address*. Example 14.10 shows this configuration.

EXAMPLE 14.10 **Configuring the NTP Client**

```
R2#
R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#ntp server 10.1.1.1
R2(config)#end
R2#
```

ExamAlert

There are several other NTP configuration options available (such as broadcasting NTP updates), but these are not required at the CCNA level.

There are two key commands for verifying NTP. Example 14.11 shows one of them, the **show ntp associations** command. Note how this allows us to easily verify our association with the configured NTP master device.

EXAMPLE 14.11 **Verifying the NTP Configuration with Show NTP Associations**

```
R2#show ntp associations

  address      ref clock      st   when poll reach  delay  offset   disp
 *~10.1.1.1    127.127.1.1    2      0   64   275 19.784 40129.7 68.951
 * sys.peer, # selected, + candidate, - outlyer, x falseticker,
 ~ configured
R2#
```

Example 14.12 shows another frequently used verification option of **show ntp status**.

EXAMPLE 14.12 **Using Show NTP Status to Verify NTP**

```
R2#show ntp status
Clock is synchronized, stratum 3, reference clock is 10.1.1.1
nominal freq is 250.0000 Hz, actual freq is 250.0000 Hz, precision is
2**24
reference time is DA5E7147.56CADEA7 (19:54:31.339 EST Thu Feb 4 2016)
clock offset is 0.0986 msec, root delay is 2.46 msec
root dispersion is 16.27 msec, peer dispersion is 5.33 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is
0.000000009 s/s
system poll interval is 64, last update was 530 sec ago.
R2#
```

CramQuiz

1. What is a stratum in NTP?
   - ❍ **A.** A measure of the proximity to the reference clock
   - ❍ **B.** A key value for authentication
   - ❍ **C.** The number of total NTP clients
   - ❍ **D.** A measurement for the number of NTP queries per minute

2. What command configures your Cisco device as an NTP client of 10.1.1.1?
   - ❍ **A. ntp client 10.1.1.1**
   - ❍ **B. ntp master 10.1.1.1**
   - ❍ **C. ntp server 10.1.1.1**
   - ❍ **D. ntp 10.1.1.1**

CramQuiz Answers

1. **A** is correct. The stratum indicates how far a device is from the reference clock.
2. **C** is correct. The **ntp server** command is used on a client.

Topic: Configure, verify, and troubleshoot basic HSRP

CramSaver

1. What command configures HSRP under an interface for group 10 with a virtual IP address of 10.10.10.1?

   _____

2. What feature would you use along with interface tracking in HSRP?

   _____

Answers

1. **standby 10 ip 10.10.10.1**
2. Preemption

The Hot Standby Router Protocol (HSRP) allows multiple default gateways to respond to clients and permit them access off of their LAN segment. This technology was invented by Cisco Systems and is known as a First Hop Redundancy Protocol (FHRP).

HSRP has each router (or even more than two devices) present a virtual IP address to the LAN segment. The active router can respond to this virtual IP address and forward traffic. The device that forwards traffic is called the *active router*, and the others in the group are called *standby routers*.

The HSRP routers communicate with each other every three seconds by default to ensure they are up. There is a dead timer of ten seconds. Example 14.13 demonstrates the HSRP configuration on two routers connected to a LAN segment.

EXAMPLE 14.13 **Configuring HSRP**

```
R1#
R1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#interface gi0/1
R1(config-if)#standby 10 ip 10.10.10.100
R1(config-if)#end
R1#

R2#
R2#configure terminal
```

```
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#interface gi0/1
R2(config-if)#standby 10 ip 10.10.10.100
R2(config-if)#end
R2#
```

Verification is also simple. Example 14.14 demonstrates the use of the **show standby** command on R1.

EXAMPLE 14.14 **Verifying HSRP**

```
R1#
R1#show standby
GigabitEthernet0/1 - Group 10
  State is Active
    2 state changes, last state change 00:02:03
  Virtual IP address is 10.10.10.100
  Active virtual MAC address is 0000.0c07.ac0a
    Local virtual MAC address is 0000.0c07.ac0a (v1 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.304 secs
  Preemption disabled
  Active router is local
  Standby router is 10.10.10.2, priority 100 (expires in 9.552 sec)
  Priority 100 (default 100)
  Group name is "hsrp-Gi0/1-10" (default)
R1#
```

Notice that R1 is the active router. The virtual IP address is our assignment of 10.10.10.100. The actual IP addresses on R1 and R2 are 10.10.10.1 and 10.10.10.2, respectively. Notice the default priority is in place of 100. The greater the priority number, the higher the priority is. This directly controls the active router assignment. Example 14.15 demonstrates setting preemption (disabled by default) and setting the priority to immediately win the active role.

EXAMPLE 14.15 **Setting Preemption and Adjusting HSRP Priority**

```
R2#
R2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#interface gi0/1
R2(config-if)#standby 10 preempt
R2(config-if)#standby 10 priority 120
R2(config-if)#end
R2#
*%HSRP-5-STATECHANGE: GigabitEthernet0/1 Grp 10 state Standby -> Active
```

```
R2#
R2#show standby
GigabitEthernet0/1 - Group 10
  State is Active
    2 state changes, last state change 00:00:10
  Virtual IP address is 10.10.10.100
  Active virtual MAC address is 0000.0c07.ac0a
    Local virtual MAC address is 0000.0c07.ac0a (v1 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.640 secs
  Preemption enabled
  Active router is local
  Standby router is 10.10.10.1, priority 100 (expires in 9.552 sec)
  Priority 120 (configured 120)
  Group name is "hsrp-Gi0/1-10" (default)
R2#
```

ExamAlert

Remember that HSRP is a Cisco proprietary FHRP! There are other standards-based protocols, such as VRRP and GLBP.

CramQuiz

1. What does FHRP stand for?
   - ❍ **A.** First Hop Redundancy Protocol
   - ❍ **B.** First HSRP Router Protocol
   - ❍ **C.** First Hop Routing Protocol
   - ❍ **D.** Final Hop Routing Protocol

2. What command permits the verification of your HSRP configuration?
   - ❍ **A. show standby**
   - ❍ **B. show router hsrp**
   - ❍ **C. show hsrp**
   - ❍ **D. show fhrp hsrp**

CramQuiz Answers

1. **A** is correct. HSRP is an example of a First Hop Redundancy Protocol.
2. **A** is correct. Use **show standby** for the HSRP verification.

Review Questions

1. What type of record is used in DNS for a mail server?
   - ❍ **A.** SOA
   - ❍ **B.** MX
   - ❍ **C.** NS
   - ❍ **D.** CNAME

2. Your junior network admin issues a ping to www.cisco.com, which is successful. What has been verified?
   - ❍ **A.** WINS
   - ❍ **B.** DNS
   - ❍ **C.** NTP
   - ❍ **D.** DHCP

3. What command sets the DHCP scope to 192.168.1.0/24?
   - ❍ **A. scope 192.168.1.0 /24**
   - ❍ **B. network 192.168.1.0 255.255.255.0**
   - ❍ **C. subnet 192.168.1.0 /24**
   - ❍ **D. addresses 192.168.1.0**

4. What command configures a DHCP relay-agent?
   - ❍ **A. ip dhcp relay-agent**
   - ❍ **B. ip dhcp relay-agent enable**
   - ❍ **C. ip forward-address**
   - ❍ **D. ip helper-address**

5. What command configures HSRP preemption for group 10?
   - ❍ **A. standby 10 preempt**
   - ❍ **B. standby preempt group 10**
   - ❍ **C. hsrp 10 preempt**
   - ❍ **D. hsrp preempt group 10**

Answers to Review Questions

1. **B** is correct. The MX record is for a mail server.
2. **B** is correct. DNS name resolution has been verified.
3. **B** is correct. The **network** command sets this.
4. **D** is correct. To configure a relay agent, we use **ip helper-address**.
5. **A** is correct. The simple command is **standby 10 preempt**.

Additional Resources

Configuring a Cisco Router as a DHCP Server— http://www.ajsnetworking.com/dhcp-server

Network Time Protocol—http://www.ajsnetworking.com/network-time-protocol

HSRP Configuration—http://www.ajsnetworking.com/hsrp

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