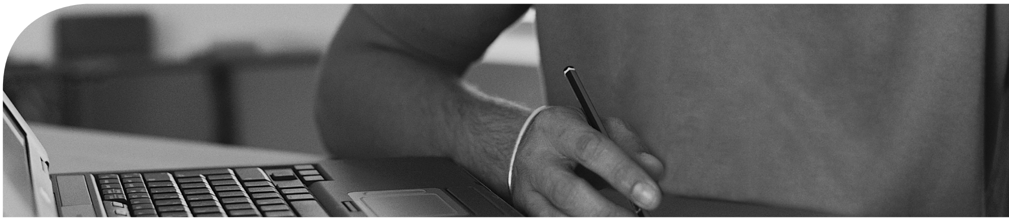

31 Days Before Your
CCNA Routing & Switching Exam

A Day-By-Day Review Guide for the ICND1/CCENT (100-105), ICND2 (200-105), and CCNA (200-125) Certification Exam

Allan Johnson

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31 Days Before Your CCNA Routing & Switching Exam

Allan Johnson

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About the Author

Allan Johnson entered the academic world in 1999 after 10 years as a business owner/operator to follow his passion for teaching. He holds both an MBA and an M.Ed. in Occupational Training and Development. Allan taught CCNA courses at the high school level for 7 years and has taught both CCNA and CCNP courses at Del Mar College in Corpus Christi, Texas. In 2003, Allan began to commit much of his time and energy to the CCNA Instructional Support Team, providing services to Networking Academy instructors worldwide and creating training materials. He now works full time for Cisco Networking Academy as a Learning Systems Developer.

About the Technical Reviewer

Rick McDonald teaches computer and networking courses via distance from the University of Alaska–Fairbanks campus, where he is a Professor of Information Systems. He holds a BA in English and an M.Ed. in Educational Technology from Gonzaga University in Spokane, Washington. His current academic focus is developing methods for delivering hands-on training in Alaska using web-based teaching tools.

Dedications

For my wife, Becky. Thank you for all your support during this crazy whirlwind of a year. You are the stabilizing force that keeps me grounded.

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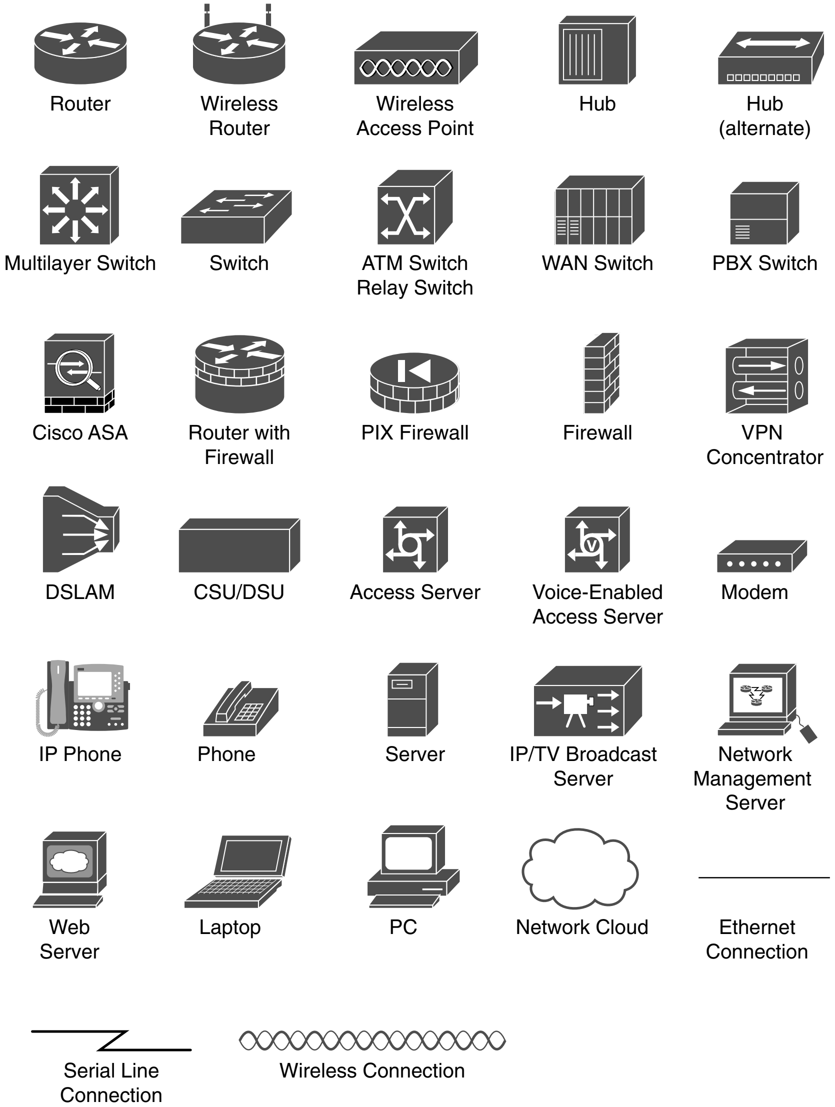

Command Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in the IOS Command Reference. The Command Reference describes these conventions as follows:

- **Boldface** indicates commands and keywords that are entered literally as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a **show** command).
- *Italic* indicates arguments for which you supply actual values.
- Vertical bars (|) separate alternative, mutually exclusive elements.
- Square brackets ([ ]) indicate an optional element.
- Braces ({ }) indicate a required choice.
- Braces within brackets ([{ }]) indicate a required choice within an optional element.

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Introduction

If you're reading this introduction, you've probably already spent a considerable amount of time and energy pursuing your CCNA certification. You're taking one of two paths. Either you are planning on taking the two exams, Interconnecting Cisco Network Devices, Part 1 (ICND1 100-105) and ICND2 200-105, or you are planning on taking the full Cisco Certified Network Associate Exam (CCNA 200-125). Regardless of how you got to this point in your travels through your CCNA studies, *31 Days Before Your CCNA Routing & Switching Exam* most likely represents the last leg of your journey on your way to the destination: to become a Cisco Certified Network Associate. However, if you are like me, you might be reading this book at the *beginning* of your studies. If so, this book provides an excellent overview of the material you must now spend a great deal of time studying and practicing. But I must warn you: unless you are extremely well versed in networking technologies and have considerable experience configuring and troubleshooting Cisco routers and switches, this book will *not* serve you well as the sole resource for your exam preparations. Therefore, let me spend some time discussing my recommendations for study resources.

Study Resources

Cisco Press and Pearson IT Certification offer an abundance of CCNA-related books to serve as your primary source for learning how to install, configure, operate, and troubleshoot small to medium-size routed and switched networks.

Safari Books Online

All the resources I reference in the book are available with a subscription to Safari Books Online (https://www.safaribooksonline.com). If you don't have an account, you can try it free for ten days.

Primary Resources

First on the list must be Wendell Odom's *CCNA Routing and Switching 200-125 Official Cert Guide and Network Simulator Library* (ISBN: 9781587206108). If you do not buy any other books, buy this one. Wendell's method of teaching, combined with his technical expertise and down-to-earth style, is unsurpassed in our industry. As you read through his books, you sense that he is sitting right there next to you walking you through the material. The practice exams and study materials on the DVD in the back of the book, plus the online resources, are worth the price of the book. There is no better resource on the market for a CCNA candidate.

If you are a Cisco Networking Academy student, you are blessed with access to the online version of the CCNA Routing and Switching curriculum and the wildly popular Packet Tracer network simulator. The Cisco Network Academy curriculum has four courses. To learn more about CCNA Routing and Switching courses and to find an Academy near you, visit http://www.netacad.com.

However, if you are not an Academy student but want to benefit from the extensive authoring done for these courses, you can buy any or all of CCNA Routing and Switching Companion Guides (CGs) and Labs & Study Guides (LSGs) of the Academy's popular online curriculum. Although you will not have access to the Packet Tracer files, you will have access to the tireless work of an outstanding team of Cisco Academy instructors dedicated to providing students with comprehensive and engaging CCNA preparation course material. The titles and ISBNs for the CCNA Routing and Switching CGs and LSGs follow:

- *Introduction to Networks v6 Companion Guide* (ISBN: 9781587133602)
- *Introduction to Networks v6 Labs & Study Guide* (ISBN: 9781587133619)
- *Routing and Switching Essentials v6 Companion Guide* (ISBN: 9781587134289)
- *Routing and Switching Essentials v6 Labs & Study Guide* (ISBN: 9781587134265)
- *Scaling Networks v6 Companion Guide* (ISBN: 9781587134340)
- *Scaling Networks v6 Labs & Study Guide* (ISBN: 9781587134333)
- *Connecting Networks v6 Companion Guide* (ISBN: 9781587134326)
- *Connecting Networks v6 Labs & Study Guide* (ISBN: 9781587134296)

You can find these books at http://www.ciscopress.com by clicking the Cisco Networking Academy link.

Supplemental Resources

In addition to the book you hold in your hands, I recommend three supplemental resources to augment your final 31 days of review and preparation.

First is Scott Empson's very popular *CCNA Routing and Switching Portable Command Guide* (ISBN: 9781587205880). This guide is much more than just a listing of commands and what they do. Yes, it summarizes all the CCNA certification-level IOS commands, keywords, command arguments, and associated prompts. But it also provides you with tips and examples of how to apply the commands to real-world scenarios. Configuration examples throughout the book provide you with a better understanding of how these commands are used in simple network designs.

Second, Kevin Wallace's *CCNA Routing and Switching 200-125 Premium Edition Complete Video Course* (ISBN: 9780134580708) is a comprehensive training course that brings Cisco CCNA exam topics to life through the use of real-world demonstrations, animations, live instruction, and configurations, making learning these foundational networking topics easy and fun. Kevin's engaging style and love for the technology is infectious. The course contains more than 25 hours of instruction in more than 300 videos. The course also includes excellent practice tests.

Third, Wendell Odom and Sean Wilkins have created more than 400 structured labs that are available in the *CCNA Routing and Switching 200-125 Network Simulator* (ISBN: 9780789757760). These simulations map precisely to chapters in Wendell's book, but they are also a great practice resource for anyone.

The Cisco Learning Network

Finally, if you have not done so already, you should register with The Cisco Learning Network at https://learningnetwork.cisco.com. Sponsored by Cisco, The Cisco Learning Network is a free social learning network where IT professionals can engage in the common pursuit of enhancing and advancing their IT careers. Here you can find many resources to help you prepare for your CCNA exam, in addition to a community of like-minded people ready to answer your questions, help you with your struggles, and share in your triumphs.

So which resources should you buy? The answer to that question depends largely on how deep your pockets are or how much you like books. If you're like me, you must have it all! I admit it; my bookcase is a testament to my Cisco "geekness." But if you are on a budget, choose one of the primary study resources and one of the supplemental resources (such as Wendell Odom's certification library and Scott Empson's command guide). Whatever you choose, you will be in good hands. Any or all of these authors will serve you well.

Goals and Methods

The main goal of this book is to provide you with a clear and succinct review of the CCNA objectives. Each day's exam topics are grouped into a common conceptual framework and use the following format:

- A title for the day that concisely states the overall topic
- A list of one or more CCNA 200-125 exam topics to be reviewed
- A "Key Topics" section to introduce the review material and quickly orient you to the day's focus
- An extensive review section consisting of short paragraphs, lists, tables, examples, and graphics
- A "Study Resources" section to give you a quick reference for locating more in-depth treatment of the day's topics

The book counts down starting with Day 31 and continues through exam day to provide post-test information. Inside this book is also a calendar and checklist that you can tear out and use during your exam preparation.

Use the calendar to enter each actual date beside the countdown day and the exact day, time, and location of your CCNA exam. The calendar provides a visual for the time you can dedicate to each CCNA exam topic.

The checklist highlights important tasks and deadlines leading up to your exam. Use it to help you map out your studies.

Who Should Read This Book?

The audience for this book is anyone finishing preparation for taking the CCNA 200-125 exam. A secondary audience is anyone needing a refresher review of CCNA exam topics—possibly before attempting to recertify or sit for another certification for which the CCNA is a prerequisite.

Getting to Know the CCNA 200-125 Exam

For the current certifications (announced in May 2016), Cisco created the ICND1 (100-105) and ICND2 (200-105) exams, along with the CCNA (200-125) exam. To become CCENT certified, you need to pass just the ICND1 exam. To become CCNA Routing and Switching certified, you must pass both the ICND1 and ICND2 exams, or just the CCNA exam. The CCNA exam simply covers all the topics on the ICND1 and ICND2 exams, giving you two options for gaining your CCNA Routing and Switching certification. The two-exam path gives people with less experience a chance to study for a smaller set of topics at one time. The one-exam option provides a more cost-effective certification path for those who want to prepare for all the topics at once. This book focuses on the entire list of topics published for the CCNA 200-125 exam.

Currently for the CCNA exam, you are allowed 90 minutes to answer 50–60 questions**.** Use the following steps to access a tutorial at home that demonstrates the exam environment before you go to take the exam:

Step 1. Visit http://www.vue.com/cisco.

Step 2. Look for a link to the certification tutorial. Currently, it appears on the right side of the web page under the heading "Related Links."

Step 3. Click the Certification Tutorial link.

When you get to the testing center and check in, the proctor verifies your identity, gives you some general instructions, and then takes you into a quiet room containing a PC. When you're at the PC, you have a few things to do before the timer starts on your exam. For instance, you can take the tutorial to get accustomed to the PC and the testing engine. Every time I sit for an exam, I go through the tutorial even though I know how the test engine works. It helps me settle my nerves and get focused. Anyone who has user-level skills in getting around a PC should have no problems with the testing environment.

When you start the exam, you are asked a series of questions. Each question is presented one at a time and must be answered before moving on to the next question. The exam engine does not let you go back and change your answer. The exam questions can be in one of the following formats:

- Multiple choice
- Fill in the blank
- Drag and drop
- Testlet
- Simlet
- Simulation

The multiple-choice format simply requires that you point and click a circle or check box next to the correct answer(s). Cisco traditionally tells you how many answers you need to choose, and the testing software prevents you from choosing too many or too few.

Fill-in-the-blank questions usually require you only to type numbers. However, if words are requested, the case does not matter unless the answer is a command that is case sensitive (such as passwords and device names, when configuring authentication).

Drag-and-drop questions require you to click and hold, move a button or icon to another area, and release the mouse button to place the object somewhere else—usually in a list. For some questions, to get the question correct, you might need to put a list of five things in the proper order.

Testlets contain one general scenario and several multiple-choice questions about the scenario. These are ideal if you are confident in your knowledge of the scenario's content because you can leverage your strength over multiple questions.

A simlet is similar to a testlet, in that you are given a scenario with several multiple-choice questions. However, a simlet uses a network simulator to allow you access to a simulation of the command line of Cisco IOS Software. You can then use **show** commands to examine a network's current behavior and answer the question.

A simulation also uses a network simulator, but you are given a task to accomplish, such as implementing a network solution or troubleshooting an existing network implementation. You do this by configuring one or more routers and switches. The exam then grades the question based on the configuration you changed or added. A newer form of the simulation question is the GUI-based simulation, which simulates a graphical interface such as that found on a Linksys router or the Cisco Security Device Manager.

What Topics Are Covered on the CCNA Exam

Table I-1 summarizes the seven domains of the CCNA 200-125 exam:

Table I-1 CCNA 200-125 Exam Domains and Weightings

Domain	% of Examination
1.0 Network Fundamentals	15%
2.0 LAN Switching Technologies	21%
3.0 Routing Technologies	23%
4.0 WAN Technologies	10%
5.0 Infrastructure Services	10%
6.0 Infrastructure Security	11%
7.0 Infrastructure Management	10%

Although Cisco outlines general exam topics, not all topics might appear on the CCNA exam; likewise, topics that are not specifically listed might appear on the exam. The exam topics that Cisco provides and this book covers are a general framework for exam preparation. Be sure to check Cisco's website for the latest exam topics.

Registering for the CCNA 200-125 Exam

If you are starting your *31 Days Before Your CCNA Routing & Switching Exam* today, register for the exam right now. In my testing experience, there is no better motivator than a scheduled test date staring me in the face. I'm willing to bet the same holds true for you. Don't worry about unforeseen circumstances. You can cancel your exam registration for a full refund up to 24 hours before taking the exam. So if you're ready, gather the following information in Table I-1 and register right now!

- Legal name
- Social Security or passport number
- Company name
- Valid email address
- Method of payment

You can schedule your exam at any time by visiting www.pearsonvue.com/cisco/. I recommend that you schedule it for 31 days from now. The process and available test times vary based on the local testing center you choose.

Remember, there is no better motivation for study than an actual test date. *Sign up today*.

Digital Study Guide

Cisco Press offers this book in an online digital format that includes enhancements such as interactive activities and Check Your Understanding questions, plus Packet Tracer activities and a full-length exam.

> *31 Days Before Your CCNA Routing & Switching Exam Digital Study Guide* is available for a discount for anyone who purchases this book. Details about redeeming this offer are found in the back of the book.

- **Read** the complete text of the book on any web browser that supports HTML5, including mobile.
- **Reinforce** key concepts with more than 31 dynamic and interactive hands-on exercises, and see the results with the click of a button. Also included are more than 25 Packet Tracer activities.
- **Test** your understanding of the material at the end of each day with more than 300 fully interactive online quiz questions. You also get a full-length final quiz of 60 questions that mimic the type of questions you will see in the CCNA Routing and Switching Composite certification exam.

To get your copy of Packet Tracer software, go to the companion website for instructions. To access this companion website, follow these steps:

Step 1. Go to http://www.ciscopress.com/register and log in or create a new account.

Step 2. Enter the ISBN 9781587205903.

Step 3. Answer the challenge question as proof of purchase.

Step 4. Click the Access Bonus Content link in the Registered Products section of your account page, to be taken to the page where your downloadable content is available.

This book contains references to the Digital Study Guide enhancements that look like this:

Activity: Identify the Encapsulation Layer

Refer to the Digital Study Guide to complete this activity.

Packet Tracer Activity: Configure Routing Protocol Authentication

Refer to the Digital Study Guide to access the PKA file for this activity. You must have Packet Tracer software to run this activity.

Check Your Understanding

Refer to the Digital Study Guide to take a 10-question quiz covering the content of this day.

When you are at these points in the Digital Study Guide, you can start the enhancement.

Day 24

Basic Router Configuration

CCNA 200-125 Exam Topics

- Configure, verify, and troubleshoot IPv4 addressing and subnetting
- Configure, verify, and troubleshoot IPv6 addressing

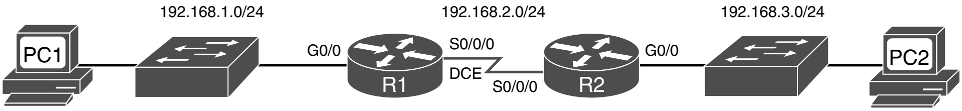
Key Topic

Today we review basic router configuration. First, we focus on configuring and verifying initial settings, including IPv4 addressing. Then we review IPv6 addressing and network connectivity verification. Most of this should be very familiar at this point in your studies because these skills are fundamental to all other router configuration tasks.

Basic Router Configuration with IPv4

Figure 24-1 shows the topology and IPv4 addressing scheme that we use to review basic router configuration and verification tasks.

Figure 24-1 IPv4 Example Topology



Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0	192.168.2.1	255.255.255.0	N/A
R2	G0/0	192.168.3.1	255.255.255.0	N/A
	S0/0/0	192.168.2.2	255.255.255.0	N/A
PC1	N/A	192.168.1.10	255.255.255.0	192.168.1.1
PC2	N/A	192.168.3.10	255.255.255.0	192.168.3.1

When configuring a router, certain basic tasks are performed:

- Naming the router
- Setting passwords
- Configuring interfaces
- Configuring a banner
- Saving changes on a router
- Verifying basic configuration and router operations

Command Syntax

Table 24-1 shows the basic router configuration command syntax used to configure R1 in the following example.

Table 24-1 Basic Router Configuration Command Syntax

Configuration Task	Commands
Naming the router	`Router(config)# hostname name`
Setting passwords	`Router(config)# enable secret password`
	`Router(config)# line console 0`
	`Router(config-line)# password password`
	`Router(config-line)# login`
	`Router(config)# line vty 0 15`
	`Router(config-line)# transport input ssh`
	`Router(config-line)# login local`
	`Router(config)# username name password password`
Configuring a message-of-the-day banner	`Router(config)# banner motd # message #`
Configuring an interface	`Router(config)# interface type number`
	`Router(config-if)# ip address address mask`
	`Router(config-if)# description description`
	`Router(config-if)# no shutdown`
Saving changes on a router	`Router# copy running-config startup-config`
Examining the output of **show** commands	`Router# show running-config`
	`Router# show ip route`
	`Router# show ip interface brief`
	`Router# show interfaces`

Configuration Example

Let's walk through a basic configuration for R1. First, enter privileged EXEC mode and then global configuration mode:

```
Router> enable
Router# config t
```

Next, name the router and enter the encrypted password for entering privileged EXEC mode. This command overrides the older **enable password** *password* command, so we are not entering that one:

```
Router(config)# hostname R1
R1(config)# enable secret class
```

Next, configure the console password and require that it be entered with the login password:

```
R1(config)# line console 0
R1(config-line)# password cisco
R1(config-line)# login
```

Configuring SSH and disabling Telnet are security best practices, so configure the vty lines to use only SSH.

NOTE: SSH configuration is not shown here; assume that it is already configured. To review SSH configuration, refer to Day 12, "LAN Security."

```
R1(config)# line vty 0 15
R1(config-line)# transport input ssh
R1(config-line)# login local
R1(config-line)# exit
R1(config)# username admin password cisco
```

Encrypt all the clear-text passwords in the running configuration using the **service-password encryption** command:

```
R1(config)# service-password encryption
```

Configure the message-of-the-day (MOTD) banner. A delimiting character such as a # is used at both the beginning and the end of the message. At a minimum, a banner should warn against unauthorized access. A good security policy prohibits configuring a banner that welcomes an unauthorized user:

```
R1(config)# banner motd #
Enter TEXT message.  End with the character '#'.
******************************************
WARNING!! Unauthorized Access Prohibited!!
******************************************
#
```

Now configure the individual router interfaces with IP addresses and other information. First, enter interface configuration mode by specifying the interface type and number. Next, configure the IP address and subnet mask:

```
R1(config)# interface Serial0/0/0
R1(config-if)# ip address 192.168.2.1 255.255.255.0
```

It is good practice to configure a description on each interface to help document the network information:

```
R1(config-if)# description Ciruit#VBN32696-123 (help desk:1-800-555-1234)
```

Activate the interface:

```
R1(config-if)# no shutdown
```

Assuming that the other side of the link is activated on R2, the serial interface is now up. Finish R1 by configuring the GigabitEthernet 0/0 interface:

```
R1(config-if)# interface GigabitEthernet0/0
R1(config-if)# ip address 192.168.1.1 255.255.255.0
R1(config-if)# description R1 LAN
R1(config-if)# no shutdown
```

Assume that R2 is fully configured and can route back to the 192.168.1.0/24 LAN attached to R1. We need to add a static route to R1 to ensure connectivity to R2's LAN. Static routing is reviewed in more detail on Day 25, "Basic Routing Concepts." For now, enter the following command to configure a directly attached static route to R2's LAN:

```
R1(config)# ip route 192.168.3.0 255.255.255.0 Serial 0/0/0
```

To save the configuration, enter the **copy running-config startup-config** command or the **copy run start** command.

Verification Example

You can use the **show running-config** command to verify the full current configuration on the router. However, a few other basic commands can help you not only verify your configuration, but also begin troubleshooting any potential problems.

First, make sure that the networks for your interfaces are now in the routing table by using the **show ip route** command (see Example 24-1).

Example 24-1 The show ip route Command

```
R1# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
        o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, GigabitEthernet0/0
L        192.168.1.1/32 is directly connected, GigabitEthernet0/0
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.2.0/24 is directly connected, Serial0/0/0
L        192.168.2.1/32 is directly connected, Serial0/0/0
S     192.168.3.0/24 is directly connected, Serial0/0/0
R1#
```

If a network is missing, check your interface status with the **show ip interface brief** command (see Example 24-2).

Example 24-2 The show ip interface brief Command

```
R1# show ip interface brief
Interface                   IP-Address      OK? Method   Status                 Protocol
Embedded-Service-Engine0/0  unassigned      YES unset    administratively  down down down
GigabitEthernet0/0          192.168.1.1     YES manual   up                     up
GigabitEthernet0/1          unassigned      YES unset    administratively  down down
Serial0/0/0                 192.168.2.1     YES manual   up                     up
Serial0/0/1                 unassigned      YES unset    administratively  down down
R1#
```

The output from the **show ip interface brief** command provides you with three important pieces of information:

- IP address
- Line status (column 5)
- Protocol status (column 6)

The IP address should be correct, and the status codes should be up and up. Table 24-2 summarizes the two status codes and their meanings.

Table 24-2 Interface Status Codes

Name	Location	General Meaning
Line status	First status code	Refers to the Layer 1 status—for example, is the cable installed, is it the right/wrong cable, is the device on the other end powered on?
Protocol status	Second status code	Refers generally to the Layer 2 status. It is always down if the line status is down. If the line status is up, a protocol status of down is usually caused by mismatched data link layer configuration.

Four combinations of settings are possible for the status codes when troubleshooting a network. Table 24-3 lists the four combinations, along with an explanation of the typical reasons why an interface is in that state.

Table 24-3 Combinations of Interface Status Codes

Line and Protocol Status	Typical Reasons
Administratively down, down	The interface has a **shutdown** command configured on it.
down, down	The interface has a **no shutdown** command configured, but the physical layer has a problem. For example, no cable has been attached to the interface (or with Ethernet), the switch interface on the other end of the cable is shut down, or the switch is powered off.

Line and Protocol Status	Typical Reasons
up, down	This almost always refers to data link layer problems, most often configuration problems. For example, serial links have this combination when one router was configured to use PPP and the other defaults to use HDLC. However, a clocking or hardware issue can also be to blame.
up, up	All is well and the interface is functioning.

If necessary, use the more verbose **show interface** command if you need to track down a problem with an interface, to get the output for every physical and virtual interface. You can also specify one interface. Example 24-3 shows the output for GigabitEthernet 0/0.

Example 24-3 The show interface gigabitethernet 0/0 Command

```
R1# show interface gigabitethernet 0/0
GigabitEthernet0/0 is up, line protocol is up
  Hardware is CN Gigabit Ethernet, address is 30f7.0da3.0da0 (bia 30f7.0da3.0da0)
  Description: R1 LAN
  Internet address is 192.168.1.1/24
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full Duplex, 100Mbps, media type is RJ45
  output flow-control is unsupported, input flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:00, output 00:00:01, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     387 packets input, 59897 bytes, 0 no buffer
     Received 252 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog, 86 multicast, 0 pause input
     281 packets output, 35537 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     56 unknown protocol drops
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier, 0 pause output
     0 output buffer failures, 0 output buffers swapped out
R1#
```

This command has a lot of output. However, sometimes this is the only way to find a problem.

Table 24-4 parses and explains each important part of the **show interface** output.

Table 24-4 show interface Output Explanation

Output	Description
GigabitEthernet…is {up | down | administratively down}	Whether the interface hardware is currently active or down, or whether an administrator has taken it down.
line protocol is {up | down}	Whether the software processes that handle the line protocol consider the interface usable (that is, whether keepalives are successful). If the interface misses three consecutive keepalives, the line protocol is marked as down.
Hardware	Hardware type (for example, MCI Ethernet, serial communications interface [SCI], cBus Ethernet) and address.
Description	Text string description configured for the interface (max 240 characters).
Internet address	IP address followed by the prefix length (subnet mask).
MTU	Maximum transmission unit (MTU) of the interface.
BW	Bandwidth of the interface, in kilobits per second. The bandwidth parameter is used to compute routing protocol metrics and other calculations.
DLY	Delay of the interface, in microseconds.
rely	Reliability of the interface as a fraction of 255 (255/255 is 100 percent reliability), calculated as an exponential average over 5 minutes.
load	Load on the interface as a fraction of 255 (255/255 is completely saturated), calculated as an exponential average over 5 minutes.
Encapsulation	Encapsulation method assigned to an interface.
Loopback	Whether loopback is set. Can indicate a problem with the carrier.
Keepalive	Whether keepalives are set.
ARP type	Type of Address Resolution Protocol (ARP) assigned.
Last input	Number of hours, minutes, and seconds since the last packet was successfully received by an interface. Useful for knowing when a dead interface failed.
output	Number of hours, minutes, and seconds since the last packet was successfully transmitted by an interface. Useful for knowing when a dead interface failed.
output hang	Number of hours, minutes, and seconds (or never) since the interface was last reset because of a transmission that took too long. When the number of hours in any of the previous fields exceeds 24 hours, the number of days and hours is printed. If that field overflows, asterisks are printed.
Last clearing	Time at which the counters that measure cumulative statistics shown in this report (such as number of bytes transmitted and received) were last reset to 0. Note that variables that might affect routing (for example, load and reliability) are not cleared when the counters are cleared. Asterisks indicate elapsed time too large to be displayed. Reset the counters with the **clear interface** command.

Output	**Description**
Output queue, input queue, drops queue	Number of packets in output and input queues. Each number is followed by a slash (/), the maximum size of the queue, and the number of packets dropped because of a full queue.
Five minute input rate, Five minute output rate	Average number of bits and packets transmitted per second in the last 5 minutes. If the interface is not in promiscuous mode, it senses network traffic that it sends and receives (instead of all network traffic). The 5-minute input and output rates should be used only as an approximation of traffic per second during a given 5-minute period. These rates are exponentially weighted averages with a time constant of 5 minutes. A period of four time constants must pass before the average will be within 2 percent of the instantaneous rate of a uniform stream of traffic over that period.
packets input	Total number of error-free packets the system received.
bytes input	Total number of bytes, including data and MAC encapsulation, in the error-free packets received by the system.
no buffers	Number of received packets discarded because the main system had no buffer space. Compare with ignored count. Broadcast storms on Ethernet are often responsible for no input buffer events.
Received…broadcasts	Total number of broadcast or multicast packets received by the interface. The number of broadcasts should be kept as low as practicable. An approximate threshold is less than 20 percent of the total number of input packets.
runts	Number of Ethernet frames that are discarded because they are smaller than the minimum Ethernet frame size. Any Ethernet frame that is less than 64 bytes is considered a runt. Runts are usually caused by collisions. If more than one runt per million bytes is received, it should be investigated.
giants	Number of Ethernet frames that are discarded because they exceed the maximum Ethernet frame size. Any Ethernet frame that is larger than 1518 bytes is considered a giant.
input error	Runts, giants, no buffer, cyclic redundancy check (CRC), frame, overrun, and ignored counts. Other input-related errors can also increase the input error count, and some datagrams can have more than one error. Therefore, this sum might not balance with the sum of enumerated input error counts.
CRC	CRC generated by the originating LAN station or far-end device not matching the checksum calculated from the data received. On a LAN, this usually indicates noise or transmission problems on the LAN interface or the LAN bus itself. A high number of CRCs is usually the result of collisions or a station transmitting bad data.

Output	Description
frame	Number of packets received as incorrectly having a CRC error and a noninteger number of octets. On a LAN, this is usually the result of collisions or a malfunctioning Ethernet device.
overrun	Number of times the receiver hardware could not hand-receive data to a hardware buffer because the input rate exceeded the capability of the receiver to handle the data.
ignored	Number of received packets ignored by the interface because the interface hardware ran low on internal buffers. These buffers are different from the system buffers mentioned in the buffer description. Broadcast storms and bursts of noise can cause the ignored count to increase.
input packets with dribble condition detected	Dribble bit error indicates that a frame is slightly too long. This frame error counter is incremented just for informational purposes; the router accepts the frame.
packets output	Total number of messages transmitted by the system.
bytes	Total number of bytes, including data and MAC encapsulation, transmitted by the system.
underruns	Number of times that the transmitter has been running faster than the router can handle. This might never be reported on some interfaces.
output errors	Sum of all errors that prevented the final transmission of datagrams out of the interface being examined. Note that this might not balance with the sum of the enumerated output errors because some datagrams might have more than one error and others might have errors that do not fall into any of the specifically tabulated categories.
collisions	Number of messages retransmitted because of an Ethernet collision. This is usually the result of an overextended LAN (too-long Ethernet or transceiver cable, more than two repeaters between stations, or too many cascaded multiport transceivers). A packet that collides is counted only once in output packets.
interface resets	Number of times an interface has been completely reset. This can happen if packets queued for transmission were not sent within several seconds. On a serial line, this can be caused by a malfunctioning modem that is not supplying the transmit clock signal, or it can be caused by a cable problem. If the system notices that the carrier detect line of a serial interface is up but the line protocol is down, it periodically resets the interface in an effort to restart it. Interface resets can also occur when an interface is looped back or shut down.

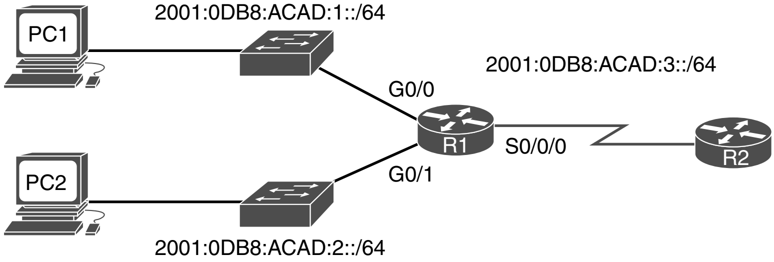
✓ Activity: Order the Steps for IPv4 Router Configuration

Refer to the Digital Study Guide to complete this activity.

Basic Router Configuration with IPv6

In this section, we use the topology in Figure 24-2 to review the basic commands for enabling IPv6 on a router.

Figure 24-2 IPv6 Example Topology



Command Syntax

First, you must enable IPv6 routing using the following command in global configuration mode:

```
R1(config)# ipv6 unicast-routing
```

Among other actions, this command configures the router to begin listening for and responding to Neighbor Discovery (ND) messages on all active IPv6 interfaces.

To configure an IPv6 address on a router's interface, you have one of several options:

- Configure the interface to use the EUI-64 method of addressing:

  ```
  Router(config)# ipv6 address ipv6-prefix/prefix-length eui-64
  ```

- Configure the full global unicast address. To manually configure a full IPv6 address, use the following command syntax:

  ```
  Router(config)# ipv6 address ipv6-address/prefix-length
  ```

- Configure the interface as unnumbered (see Day 26, "IPv6 Addressing").
- Configure the interface as a DHCPv6 client (see Day 7, "DHCP and DNS").

NOTE: To manually configure an interface's link-local address, use the following command syntax:

```
Router(config)# ipv6 address ipv6-address/prefix-length link-local
```

Configuration Example

The preferred method often is to manually configure the full IPv6 address because you can control the number of hexadecimal digits you must type when testing connectivity or troubleshooting a problem. You can see this by comparing the EUI-64 method to a full configuration. In Example 24-4, the interfaces on R1 are all configured using the EUI-64 method.

Example 24-4 Configuring Interfaces Using the EUI-64 Method

```
R1(config)# interface g0/0
R1(config-if)# ipv6 address 2001:db8:acad:1::/64 eui-64
R1(config-if)# interface g0/1
R1(config-if)# ipv6 address 2001:db8:acad:2::/64 eui-64
R1(config-if)# interface s0/0/0
R1(config-if)# ipv6 address 2001:db8:acad:3::/64 eui-64
R1(config-if)# do show ipv6 interface brief
GigabitEthernet0/0          [up/up]
    FE80::2D0:97FF:FE20:A101
    2001:DB8:ACAD:1:2D0:97FF:FE20:A101
GigabitEthernet0/1          [up/up]
    FE80::2D0:97FF:FE20:A102
    2001:DB8:ACAD:2:2D0:97FF:FE20:A102
Serial0/0/0                  [down/down]
    FE80::20C:CFFF:FE77:A401
    2001:DB8:ACAD:3:20C:CFFF:FE77:A401
<output omitted>
```

Notice the number of hexadecimal digits in the IPv6 addresses highlighted in the output from the **show ipv6 interface brief** command. Imagine having to ping the GigabitEthernet 0/0 address 2001:DB8:ACAD:1:2D0:97FF:FE20:A101.

Furthermore, notice that the link-local addresses are also rather complex. To reduce the complexity of the router's configuration, verification, and troubleshooting, it is a good practice to manually configure the link-local address as well as the IPv6 global unicast address. In Example 24-5, R1 is reconfigured with simpler IPv6 addresses and with FE80::1 as the link-local address on all interfaces. Remember, the link-local address needs to be unique only on that interface's link.

Example 24-5 Full IPv6 Address and Link-Local Address Configuration

```
R1(config-if)# interface g0/0
R1(config-if)# no ipv6 address 2001:db8:acad:1::/64 eui-64
R1(config-if)# ipv6 address 2001:db8:acad:1::1/64
R1(config-if)# ipv6 address fe80::1 link-local
R1(config-if)# interface g0/1
R1(config-if)# no ipv6 address 2001:db8:acad:2::/64 eui-64
R1(config-if)# ipv6 address 2001:db8:acad:2::1/64
R1(config-if)# ipv6 address fe80::1 link-local
R1(config-if)# interface s0/0/0
R1(config-if)# no ipv6 address 2001:db8:acad:3::/64 eui-64
R1(config-if)# ipv6 address 2001:db8:acad:3::1/64
R1(config-if)# ipv6 address fe80::1 link-local
R1(config-if)# do show ipv6 interface brief
```

```
GigabitEthernet0/0          [up/up]
    FE80::1
    2001:DB8:ACAD:1::1
GigabitEthernet0/1          [up/up]
    FE80::1
    2001:DB8:ACAD:2::1
Serial0/0/0                  [down/down]
    FE80::1
    2001:DB8:ACAD:3::1
<output omitted>
```

NOTE: If you do not remove the previous IPv6 address configuration, each interface will have two IPv6 global unicast addresses. This is different than in IPv4, where simply configuring another IPv4 address with the **ip address** command overwrites any previous configuration. However, only one link-local address can exist per interface.

Compare the highlighted output from the **show ipv6 interface brief** command in Example 24-5 with the output in Example 24-4. You can see that simplifying the IPv6 addressing implementation can make your verification and troubleshooting job much easier.

To verify the full configuration of an interface, use the **show ipv6 interface** command. Example 24-6 shows the output for R1's GigabitEthernet 0/0 interface.

Example 24-6 The show ipv6 interface gigabitethernet 0/0 Command

```
R1# show ipv6 interface gigabitethernet 0/0
GigabitEthernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::1
  No Virtual link-local address(es):
  Global unicast address(es):
    2001:DB8:ACAD:1::1, subnet is 2001:DB8:ACAD:1::/64
  Joined group address(es):
    FF02::1
    FF02::1:FF00:1
  MTU is 1500 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
  ICMP unreachables are sent
  ND DAD is enabled, number of DAD attempts: 1
  ND reachable time is 30000 milliseconds
  ND advertised reachable time is 0 milliseconds
  ND advertised retransmit interval is 0 milliseconds
  ND router advertisements are sent every 200 seconds
  ND router advertisements live for 1800 seconds
  ND advertised default router preference is Medium
  Hosts use stateless autoconfig for addresses.
```

Focus on the highlighted output. IPv6 is enabled on this interface with a nice, short link-local address. The global unicast address and its subnet are listed, as is the address of multicast groups that this interface automatically joined. Do you remember what the FF02::1 and FF02::1:FF00:1 addresses are used for? If not, revisit Day 26.

That's all the IPv6 configurations for today. As we continue to review the exam topics in the upcoming days, we will incorporate IPv6 topics.

Activity: Order the Steps for IPv6 Router Configuration

Refer to the Digital Study Guide to complete this activity.

Verifying IPv4 and IPv6 Network Connectivity

As reviewed on Day 29, "Switch Configuration Basics," ping and traceroute are helpful tools for verifying network connectivity. Example 24-7 demonstrates successful ping output on the router.

Example 24-7 Successful ping Output on a Router

```
R1# ping 192.168.3.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
!Pinging an IPv6 destination
R1# ping 2001:db8:acad:1:290:dff:fee5:8095

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:1:290:CFF:FEE5:8095, timeout is
2   seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/9/46 ms

R1#
```

Unsuccessful ping output shows periods (.) instead of exclamation points (!), as Example 24-8 demonstrates. The output would be the same in IPv6.

Example 24-8 Unsuccessful ping Output on a Router

```
R1# ping 192.168.3.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.3.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R1#
```

Example 24-9 shows output from a successful **traceroute** command.

Example 24-9 Successful traceroute Output on a Router

```
R1# traceroute 192.168.3.10
Type escape sequence to abort.
Tracing the route to 192.168.3.10

  1   192.168.2.2      71 msec   70 msec   72 msec
  2   192.168.3.10     111 msec  133 msec  115 msec
R1#
!Tracing to an IPv6 destination.
R2# traceroute 2001:db8:acad:1:290:cff:fee5:8095
Type escape sequence to abort.
Tracing the route to 2001:DB8:ACAD:1:290:CFF:FEE5:8095

  1   2001:DB8:ACAD:3::11 msec    1 msec    1 msec
  2   2001:DB8:ACAD:1:290:CFF:FEE5:80951 msec    1 msec    0 msec
R2#
```

Unsuccessful traces show the last successful hop and the asterisks for each attempt until the user cancels. To cancel the **traceroute** command on a router, use the key combination **Ctrl-Shift-6** and then press the **x** key. Example 24-10 shows unsuccessful **traceroute** output. The output would be the same with IPv6.

Example 24-10 Unsuccessful traceroute Output on a Router

```
R1# traceroute 192.168.3.2
Type escape sequence to abort.
Tracing the route to 192.168.3.2

  1   192.168.2.2      71 msec   70 msec   72 msec
  2   *      *      *
  3   *      *      *
  4   *      *      *
  5   *
R1#
```

Using Telnet or SSH to remotely access another device also tests connectivity. More important, these remote access methods test whether a device has been correctly configured so that you can access it for management purposes. This can be important when a device is truly remote (for example, across town or in another city). Day 12 reviews SSH configuration and verification in greater detail.

During the basic configuration tasks earlier, we entered the commands to properly configure the vty lines for SSH remote access. If you are accessing a device configured with SSH from a PC, you use the SSH setting in your terminal client. However, you can use the **ssh** command on a router or switch to access another device configured with SSH. Example 24-11 shows how to use SSH to remotely access R2 from R1.

Example 24-11 Remote Access Using SSH

```
R1# ssh?
  -c     Select encryption algorithm
  -l     Log in using this user name
  -m     Select HMAC algorithm
  -o     Specify options
  -p     Connect to this port
  -v     Specify SSH Protocol Version
  -vrf   Specify vrf name
  WORD   IP address or hostname of a remote system

R1# ssh -l?
  WORD   Login name

R1# ssh -l admin?
  -c     Select encryption algorithm
  -m     Select HMAC algorithm
  -o     Specify options
  -p     Connect to this port
  -v     Specify SSH Protocol Version
  -vrf   Specify vrf name
  WORD   IP address or hostname of a remote system

R1# ssh -l admin 192.168.2.2
Password:

******************************************
WARNING!! Unauthorized Access Prohibited!!
******************************************

R2>
```

NOTE: During your CCNA studies and lab practice, you most likely used a Telnet configuration to remotely access your lab equipment. Although Telnet is easier to use than SSH, remember that SSH is considered best practice. Therefore, during the CCNA exam, be ready to use SSH to remotely access devices on simulation questions because Telnet might not be configured or allowed.

Packet Tracer Activity: Dual-Stack Router Address Configuration

Refer to the Digital Study Guide to access the PKA file for this activity. You must have Packet Tracer software to run this activity. See the Introduction for details.

Basic IP Addressing Troubleshooting

If you are sure you manually configured the correct IP address and subnet mask (IPv4) or network prefix (IPv6), then basic IP addressing issues are usually the result of a misconfigured default gateway or duplicate addresses.

Default Gateway

A misconfigured default gateway is one of the most common problems in either a static or dynamically assigned IP addressing scheme. For a device to communicate across multiple networks, it must be configured with an IP address, a subnet mask or network prefix, and a default gateway.

The default gateway is used when the host wants to send a packet to a device on another network. The default gateway address is generally the router interface address attached to the local network to which the host is connected.

To resolve a default gateway that was manually configured incorrectly, consult the topology and addressing documentation to verify what the device's default gateway should be—normally, a router attached to the same LAN.

NOTE: A misconfigured DHCP server can also cause a default gateway issue. Some DHCP server configurations, such as the Easy IP IOS feature, might require the administrator to manually configure the default gateway address. If this is configured incorrectly, no devices will have access beyond the LAN. DHCP is reviewed on Day 7.

Duplicate IP Addresses

Under some circumstances, duplicate IP address conflicts can occur between a statically configured network device and a PC obtaining automatic IP addressing information from the DHCP server. To resolve such an IP addressing conflict, you can do one of the following:

- Convert the network device with the static IP address to a DHCP client
- On the DHCP server, exclude the static IP address of the end device from the DHCP pool of addresses

The first solution is a quick fix that you can do in the field. However, the device more than likely needs a static configuration. The second solution might be the better long-term choice. However, it requires that you have administrative privileges to configure the DHCP server.

You might also encounter IP addressing conflicts when manually configuring IP on an end device in a network that uses only static IP addresses. In this case, you must determine which IP addresses are available on the particular IP subnet and configure accordingly. This case illustrates why it is so important for a network administrator to maintain detailed documentation, including IP address assignments and topologies, for end devices.

Study Resources

For today's exam topics, refer to the following resources for more study.

Resource	Location	Topic
Primary Resources		
Routing and Switching Essentials	1	Router Initial Configuration
ICND1 Official Cert Guide	17	Enabling IPv4 Support on Cisco Router Interfaces
	30	Implementing Unicast IPv6 Addresses on Routers
Supplemental Resources		
CCNA Portable Command Guide	11	All
CCNA Video Series	3	Lesson 2: Basic Router Configuration and Verification
CCNA Network Simulator	ICND1	Chapter 17: New Job I
		Chapter 17: Rebuild a Configuration
		Chapter 17: Router CLI Exec Mode I–II
		Chapter 17: Router CLI Configuration Process
		Chapter 17: Setting Router Passwords
		Chapter 30: IPv6 Configuration I–II
		Chapter 30: IPv6 Address Configuration I–IX
		Chapter 30: IPv6 EUI-64 Calculation Drills I–X
		Chapter 30: IPv6 Addressing Troubleshooting

Check Your Understanding

Refer to the Digital Study Guide to take a short quiz covering the content of this day.

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