31 Days Before Your CCNA Security Exam

A Day-By-Day Review Guide for the IINS 210-260 Certification Exam

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Patrick Gargano

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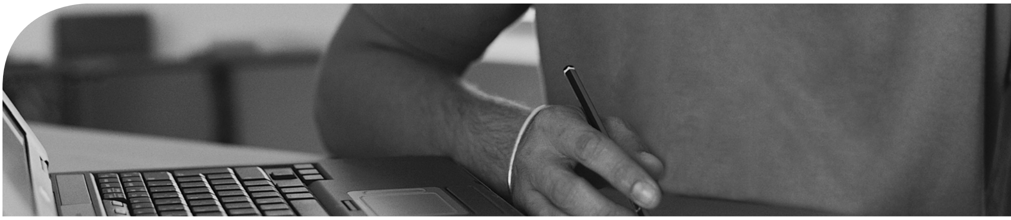

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Patrick Gargano

Cisco Press • 800 East 96th Street • Indianapolis, Indiana 46240 USA

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About the Author

Patrick Gargano has been an educator since 1996 and a Cisco Networking Academy Instructor since 2000. He currently heads the Networking Academy program at Collège La Cité in Ottawa, Canada, where he teaches CCNA/CCNP-level courses. Patrick has twice led the Cisco Networking Academy student Dream Team deploying the wired and wireless networks supporting the U.S. Cisco Live conferences. In 2014 he co-authored *CCNP Routing and Switching Portable Command Guide*. Recognitions of his teaching include prizes from Collège La Cité for innovation and excellence and from the Ontario Association of Certified Engineering Technicians and Technologists for excellence in technology education. Previously, Patrick was a Cisco Networking Academy instructor at Cégep de l'Outaouais (Gatineau, Canada) and Louis-Riel High School (Ottawa, Canada) and a Cisco instructor (CCSI) for Fast Lane UK (London). His certifications include CCNA (R&S), CCNA Wireless, CCNA Security, and CCNP (R&S). He holds Bachelor of Education and Bachelor of Arts degrees from the University of Ottawa. Find him on Twitter @PatrickGargano.

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Dedications

To my wife Kathryn, who is always happy to explain that when in doubt, “that” is always better than “which,” and to our son Samuel who, at age 7, already knows that (not which) Mummy is usually right but Daddy is usually more fun.

To my father, who can’t read this.

To my mother, who has devoted everything to our family.

To Albert, who has endured with courage.

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Alongside the Cisco Press team, I want to offer my sincere gratitude to my colleagues at La Cité, especially Georges Absi, who has been generous with advice, moral support, and his wife's authentic tabbouleh.

My past, present, and future students at La Cité are the inspiration for this book. I had them in mind with every word that I wrote, and if I've produced something that they'll find useful and easy to understand, then I've met my loftiest goal.

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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.

Introduction

If you're reading this Introduction, you've probably already spent a considerable amount of time and energy pursuing your CCNA Security certification. Regardless of how you got to this point in your travels through your networking studies, *31 Days Before Your CCNA Security Exam* most likely represents the last leg of your journey on your way to the destination: to become CCNA Security certified.

However, if you happen to be reading this book at the beginning of your studies, then this book provides you with 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 network security technologies and have considerable experience as a network technician or administrator, this book will not serve you well as the sole resource for CCNA Security exam preparation. I know this first hand. I recently took the CCNA Security exam and was impressed with both the breadth and depth of knowledge required to pass. I have been teaching, writing about, and implementing networks for almost two decades. And yet, there was a moment during the CCNA Security exam where I thought, "Wow, this is really a tough exam!"

You see, Cisco states that for the CCNA Security exam, you must "demonstrates the skills required to develop a security infrastructure, recognize threats and vulnerabilities to networks, and mitigate security threats." You simply cannot just study this content. You must practice it. Although I have a solid understanding of network security concepts and technologies, I also have extensive experience implementing and troubleshooting network security. That's why I was able to successfully pass the exam. There really is no other way to correctly answer the many scenario-based questions a candidate will receive during the exam than to have experienced the same or similar scenario in the real world or a lab simulation.

Now that I've sufficiently challenged you, let me spend some time discussing my recommendations for study resources.

Study Resources

Cisco Press offers an abundance of network security books and resources to serve you well as you learn how to install, troubleshoot, and monitor network devices to maintain the integrity, confidentiality, and availability of data and devices. Most of the resources can be purchased in book form or as eBooks for your tablet reader or mobile device by visiting www.ciscopress.com.

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 is the *CCNA Security 210-260 Official Cert Guide*, written by Omar Santos and John Stuppi. The authors have done an outstanding job of gathering together and organizing all the material you need to study for the CCNA Security certification exam. It is available in print (ISBN: 978158720568) and Premium Edition eBook (ISBN: 9780134077895) versions. The print version comes with the Pearson IT Certification Practice Test engine and two practice exams, as well as 90 minutes of video training. The Premium Edition eBook version comes with four practice exams, multiplatform accessibility, and performance tracking.

If you are a Cisco Networking Academy student, you are blessed with access to the online version of the CCNA Security curriculum and the wildly popular Packet Tracer network simulator. The course provides an introduction to the core security concepts and skills needed for the installation, troubleshooting, and monitoring of network devices to maintain the integrity, confidentiality, and availability of data and devices. The course helps students learn how to secure Cisco routers, implement AAA, configure ACLs, mitigate common Layer 2 attacks, implement Cisco IOS firewall features, implement site-to-site VPNs, and implement remote-access VPNs. To learn more about the CCNA Security course and to find an Academy near you, visit http://www.netacad.com. Cisco Press also produces a printed course booklet (ISBN: 9781587133510) and lab manual (ISBN: 9781587133503) to accompany the CCNA Security Networking Academy course.

Supplemental Resources

In addition to the book you hold in your hands and to those mentioned previously, there are three more supplemental resources I would recommend to augment your final 31 days of review and preparation.

Omar Santos, Aaron Woland, and Mason Haris recorded more than 13 hours of video in their *CCNA Security 210-260 Complete Video Course* (ISBN: 9780134499314), which is available free with your Safari Books Online account. You can also purchase it separately from Cisco Press. The authors talk you through the full range of topics on the CCNA Security exam using a variety of presentation styles, including live instructor whiteboarding, real-world demonstrations, animations of network activity, dynamic KeyNote presentations, and doodle videos. They also demonstrate router, switch, and ASA CLI/ASDM configuration and troubleshooting in real lab environments, enabling you to learn both the concepts and the hands-on application.

Cisco Press has recently published the second edition of the very popular *CCNA Security Portable Command Guide* (ISBN: 9781587205750), by Bob Vachon. This book summarizes all the relevant Cisco IOS Software security commands, keywords, command arguments, and associated prompts, and offers tips and examples for applying these commands to real-world security challenges. Bob also includes ASDM screenshots to help when configuring the Cisco ASA.

The second book I would suggest is *Cisco ASA: All-in-One Next-Generation Firewall, IPS, and VPN Services*, Third Edition (ISBN: 9781587143076), written by Jazib Frahim, Omar Santos, and Andrew Ossipov. This is an amazingly detailed resource (1248 pages!) on configuring, monitoring, and troubleshooting the entire Cisco ASA firewall family. True, it goes beyond the CCNA Security exam topics, but if you're a geek like me, you'll enjoy delving more deeply into the ASA with this book.

I occasionally reference other Cisco Press books for more specific topics. The simplest way to access this extra content is with a Safari Books Online subscription.

So, which resources should you buy? That question is largely up to how deep your pockets are or how much you like books. If you're like me, you want it all...online access for mobile and tablet reading, as well as hard copies for intensive study sessions with a pencil in hand. I admit it; my bookcase is a testament to my "geekness." But that's not practical for most students. So if you are on a budget, then choose one of the primary study resources and one of the supplemental resources, such as the *CCNA Security 210-260 Official Cert Guide* and the *CCNA Security Portable*

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 Security exam objectives. Each day's exam topics are grouped into a common conceptual framework and uses the following format:

- A title for the day that concisely states the overall topic
- A list of one or more CCNA Security IINS 210-260 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 provide you a quick reference for locating more in-depth treatment of the day's topics (as introduced in the previous section)

The book counts down starting with Day 31 and continues through exam day to provide post-test information. You will also find a calendar and checklist inside the book 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 Security exam. The calendar provides a visual for the time that you can dedicate to each CCNA Security exam topic.

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

Who Should Read This Book?

The audience for this book is anyone finishing their preparation for taking the CCNA Security IINS 210-260 exam. A secondary audience is anyone who needs a refresher review of CCNA Security exam topics, perhaps before attempting to recertify.

Getting to Know the CCNA Security IINS 210-260 Exam

Cisco launched the newest version of the CCNA Security exam, numbered 210-260, on September 1, 2015. The exam tests the candidate's knowledge of secure network infrastructure, core security concepts, managing secure access, VPN encryption, firewalls, intrusion prevention, web and email content security, and endpoint security. It also validates skills for installation, troubleshooting, and monitoring of a secure network to maintain integrity, confidentiality, and availability of data and devices. As a prerequisite, Cisco states that a candidate must be CCENT or CCNA Routing and Switching certified before attempting the exam.

Currently for the CCNA Security exam, you are allowed 90 minutes to answer 60 to 70 questions. Most recently, a passing score is 860 on a scale of 300 to 1000, but the passing score often rises as the exam matures. If you've never taken a certification exam before with Pearson VUE, there is a 2 minute 45 second video titled What to Expect in a Pearson VUE Test Center that nicely summarizes the experience: https://home.pearsonvue.com/test-taker/security.aspx. You can also search for it on YouTube.

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.

What Topics Are Covered on the CCNA Security

Table I-1 summarizes the seven domains of the CCNA Security exam.

Table I-1 CCNA Security IINS 210-260 Exam Domains and Weightings

Domain	% of Examination
1.0 Security Concepts	12%
2.0 Secure Access	14%
3.0 VPN	17%
4.0 Secure Routing and Switching	18%
5.0 Cisco Firewall Technologies	18%
6.0 IPS	9%
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Video: Data Encapsulation Summary

Refer to the Digital Study Guide to view this video.

Activity: Identify the Encapsulation Layer

Refer to the Digital Study Guide to complete this activity.

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

Cryptographic Technologies

CCNA Security 210-260 IINS Exam Topics

- 1.3.a Describe key exchange
- 1.3.b Describe hash algorithm
- 1.3.c Compare and contrast symmetric and asymmetric encryption
- 1.3.d Describe digital signatures, certificates, and PKI

Key Topics

Today we will review cryptographic technologies and terminology. In particular, we will look at understanding the challenges of secure key management within a network environment. As well, we will review the different types of hashing algorithms in use today for data integrity. We will compare and contrast symmetric and asymmetric encryption algorithms, and finally delve into digital signatures and certificates. We will review PKI tomorrow.

CIA Triad

Before looking at the different cryptographic technologies in use today, it is important to understand the basic premise of cryptography itself. *Cryptography* is the practice and study of techniques to secure communications in the presence of third parties. Historically, cryptography was synonymous with encryption. Its goal was to keep messages private. Today, cryptography includes other responsibilities:

- **Confidentiality:** Uses encryption algorithms to encrypt and hide data
- **Data integrity:** Uses hashing algorithms to ensure that data is unaltered during any operation
- **Authentication:** Ensures that any messages received were actually sent from the perceived origin

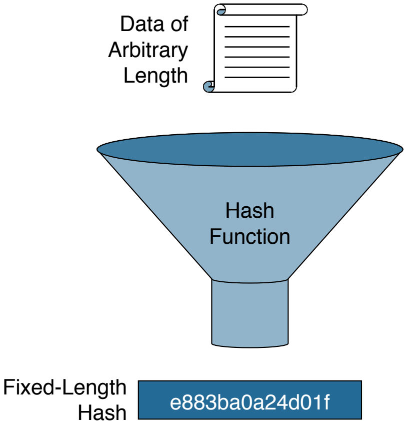
Key Exchange and Management

Key management deals with the secure generation, verification, exchange, storage, and destruction of keys. It is extremely important to have secure methods of key management. Key exchange and management are often considered the most difficult part of designing a cryptosystem. Many cryptosystems have failed because of mistakes in their key management, and all modern cryptographic algorithms require key management procedures. The basic components of any key management system include (1) automated and randomized key generation, (2) key strength verification, (3) encrypted key storage, (4) secure key exchange, (5) short key lifetimes, and (6) revocation and destruction of compromised or expired keys.

Hash Algorithms

Hashing is a mechanism that is used for data integrity assurance. Hashing is based on a one-way mathematical function that is relatively easy to compute but significantly difficult to reverse. Figure 29-1 illustrates how hashing is performed. Data of an arbitrary length is input into the hash function, and the result of the hash function is the fixed-length hash, which is known as the "digest" or "fingerprint."

Figure 29-1 Hash Function



Well-known Hash Functions

Hash functions are helpful when ensuring data is not changed accidentally, such as by a communication error. Although hashing can be used to detect *accidental* changes, it cannot be used to guard against deliberate changes. There is no unique identifying information from the sender in the hashing procedure. Therefore, hashing is vulnerable to man-in-the-middle attacks and does not provide security to transmitted data.

The following are the three most commonly used cryptographic hash functions:

- **Message Digest 5 (MD5):** MD5 is a one-way function that makes it easy to compute a hash from the given input data but makes it very difficult to compute input data given only a hash value. MD5 produces a 128-bit hash and is now considered a legacy algorithm that should be avoided.

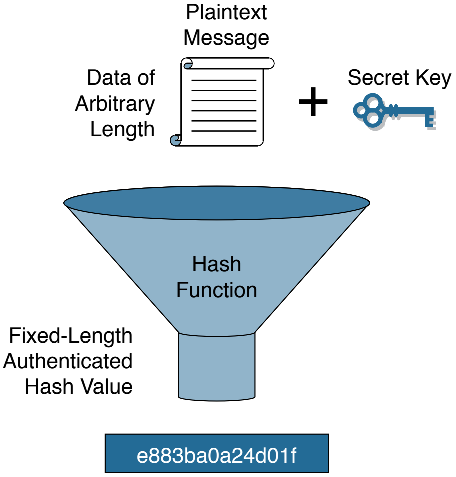
- **Secure Hash Algorithm 1 (SHA-1):** SHA-1 takes a message of up to 2^64 bits in length and produces a 160-bit message digest. The algorithm is slightly slower than MD5, but the larger message digest makes it more secure against brute-force collision and inversion attacks. It is now considered legacy and should be avoided when possible.
- **Secure Hash Algorithm 2 (SHA-2):** SHA-2 algorithms are the secure hash algorithms that the U.S. government requires by law for use in certain applications. The SHA-2 family includes 224-bit, 256-bit, 384-bit, and 512-bit functions. When choosing a hashing algorithm, use SHA-256 or higher, as they are currently the most secure.

CAUTION: Security flaws were discovered in SHA-1 and MD5. Therefore, it is now recommended that these algorithms be avoided.

Authentication Using Hashing

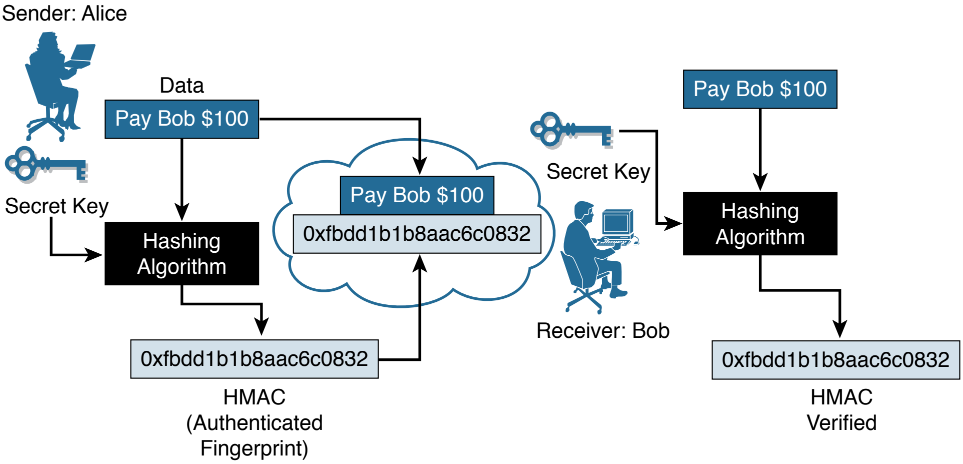
Two systems that have agreed on a secret key can use the key along with a hash function to verify data integrity of communication between them by using a keyed hash. A message authentication code is produced by passing the message data along with the secret key through a hash algorithm. Only the sender and the receiver know the secret key, and the output of the hash function now depends on the message data and the secret key. Figure 29-2 illustrates how the message authentication code is created. Data of an arbitrary length is input into the hash function, together with a secret key. The result is the fixed-length hash that depends on the data and the secret key. This type of authentication is referred to as keyed-hash message authentication code (HMAC) and adds authentication to integrity assurance.

Figure 29-2 HMAC Hashing



HMAC functions can be used with MD5 (HMAC-MD5) or SHA-1 (HMAC-SHA-1).
Figure 29-3 illustrates cryptographic authentication in action. The sender, Alice, wants to ensure that the message is not altered in transit and wants to provide a way for the receiver, Bob, to authenticate the origin of the message.

Figure 29-3 HMAC in Action



Alice inputs data and the secret key into the hashing algorithm and calculates the fixed-length message authentication code, or fingerprint. This authenticated fingerprint is then attached to the message and sent to Bob. Bob removes the fingerprint from the message and uses the received message with his copy of the secret key as input to the same hashing function. If the fingerprint that is calculated is identical to the fingerprint that was received, then data integrity has been verified. Also, the origin of the message is authenticated, because only Alice possesses a copy of the shared secret key.

Hashing in Cisco Products

Cisco products use hashing for entity authentication, data integrity, and data authenticity purposes such as

- IPsec gateways and clients use hashing algorithms to verify packet integrity and authenticity.
- Cisco IOS routers use keyed hashing with secret keys to add authentication information to routing protocol updates.
- Cisco software images that you can download from Cisco.com have MD5 and SHA-512 based checksums available, so that customers can check the integrity of downloaded images.

Symmetric and Asymmetric Encryption

Before diving into the differences between symmetric and asymmetric encryption algorithms, let's first start by reviewing the basic concepts of encryption itself.

Encryption Overview

Encryption is the process of disguising a message in such a way as to hide its original contents. With encryption, the plaintext readable message is converted to ciphertext, which is the unreadable, "disguised" message. Decryption reverses this process. Encryption is used to guarantee confidentiality so that only authorized entities can read the original message.

Encryption can provide confidentiality at different network layers, such as the following:

- Encrypting application layer data, such as encrypting email messages with Pretty Good Privacy (PGP)
- Encrypting session layer data using a protocol such as Secure Sockets Layer (SSL) or Transport Layer Security (TLS)
- Encrypting network layer data using protocols such as those provided in the IP security (IPsec) protocol suite
- Encrypting data link layer data using proprietary link-encrypting devices

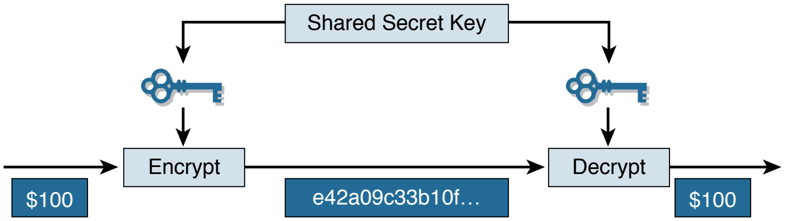
A good cryptographic algorithm is designed in such a way that it resists common cryptographic attacks. Variable key lengths and scalability are also desirable attributes of a good encryption algorithm. A key is a required parameter for encryption algorithms to encrypt and decrypt a message. The key is the link between the plaintext and ciphertext. There are two classes of encryption algorithms, which differ in their use of keys:

- **Symmetric encryption algorithms:** Use the same key to encrypt and decrypt data
- **Asymmetric encryption algorithms:** Use different keys to encrypt and decrypt data

Symmetric Encryption Algorithms

Symmetric, or secret key, encryption is the most commonly used form of cryptography because the shorter key length increases the speed of execution. The typical key-length range of symmetric encryption algorithms is 40 to 256 bits. Figure 29-4 illustrates an example of symmetric encryption in action.

Figure 29-4 Symmetric Encryption Example



In this example, the same key is used to encrypt the data by the sender and decrypt the data by the recipient.

With symmetric encryption, key management can be a challenge. The encryption and decryption keys are the same. The sender and the receiver must exchange the symmetric, secret key using a secure channel before any encryption can occur.

Table 29-1 provides a summary of the types of symmetric encryption algorithms in use today and their respective key lengths.

Table 29-1 Symmetric Encryption Algorithms

Symmetric Encryption Algorithm	Key Length (in bits)
DES	56
3DES	112 and 168
AES	128, 192, and 256
SEAL	160
RC	RC2 (40 and 64)
	RC4 (1 to 256)
	RC5 (0 to 2040)
	RC6 (128, 192, and 256)

DES is considered a legacy algorithm and is vulnerable to brute-force attacks. One way to increase the effectiveness of DES, without changing the well-analyzed algorithm itself, is to use the same algorithm with different keys several times in a row. The technique of applying DES three times in a row to a plaintext block is called *3DES*. Brute-force attacks on 3DES are considered unfeasible today. Because the basic algorithm has been well tested in the field for more than 35 years, it is considered very trustworthy. For several years, it was recognized that DES would eventually reach the end of its usefulness. In 1997, the *AES* initiative was announced. AES was chosen to replace DES and 3DES, because the key length of AES is much stronger than that of DES, and AES runs faster than 3DES on comparable hardware.

Video: Symmetric Encryption Demonstration

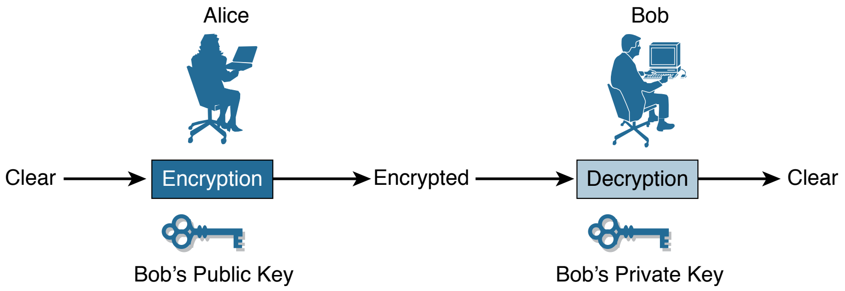
Refer to the Digital Study Guide to view this video.

Asymmetric Encryption Algorithms

Asymmetric encryption algorithms use a pair of keys to encrypt and decrypt data. Secure messages can be exchanged without having to have a pre-shared key. Because neither party has a shared secret, very long key lengths must be used. These algorithms are resource intensive and slower to execute. Most commonly, an entity with a key pair will share one of the keys (the public key) and keep the other key in complete secrecy (the private key). The private key cannot, in any reasonable amount of time, be calculated from the public key. Data that is encrypted with the private key requires the public key to decrypt. Vice versa, data that is encrypted with the public key requires the private key to decrypt. Asymmetric encryption is also known as public key encryption.

Here is one possible scenario of asymmetric encryption in action. In Figure 29-5, imagine that Bob has generated a public/private key pair. Bob keeps the private key totally secret but publishes the public key so it is available to everyone. Alice has a message that she wants to send to Bob in private. If Alice encrypts the message using Bob's public key, only Bob has the private key that is required to decrypt the message, providing confidentiality.

Figure 29-5 Asymmetric Encryption Example



The following table provides a detailed comparison between symmetric and asymmetric encryption algorithms:

Asymmetric Encryption Algorithm	Key Length (in bits)
DH	512, 1024, 2048, 3072, 4096
DSS and DSA	512–1024
RSA	512–2048
ElGamal	512–1024
Elliptical curve techniques	160

Four protocols that use asymmetric encryption algorithms are

- **Internet Key Exchange (IKE):** A fundamental component of IPsec VPNs
- **Secure Sockets Layer (SSL):** Now implemented as IETF standard TLS
- **Secure Shell (SSH):** Provides a secure remote-access connection to network devices
- **Pretty Good Privacy (PGP):** A computer program that provides cryptographic privacy and authentication

Video: Asymmetric Encryption Demonstration

Refer to the Digital Study Guide to view this video.

Activity: Compare Symmetric and Asymmetric Encryption Algorithms

Refer to the Digital Study Guide to complete this activity.

Digital Signatures and RSA Certificates

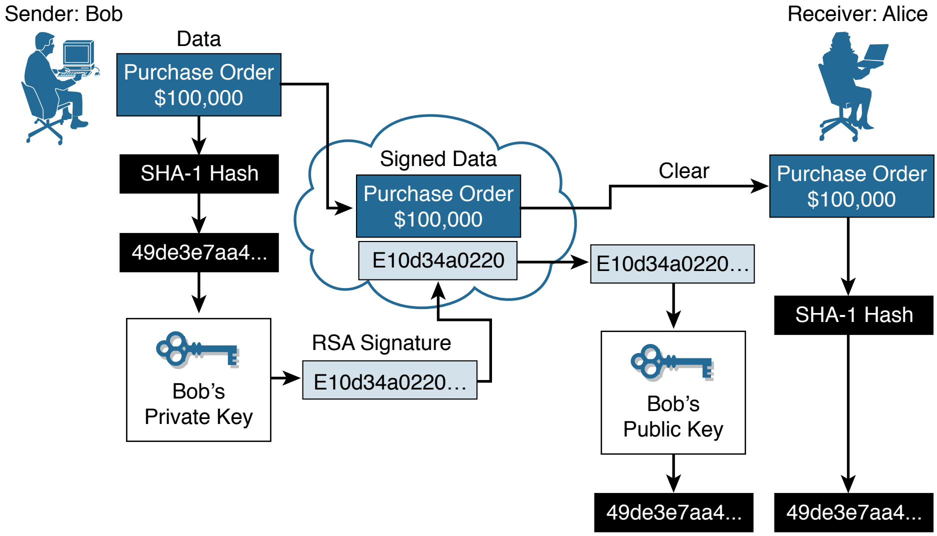
Digital signatures provide the same functionality as handwritten signatures. Specifically, they are a mathematical technique used to provide three basic security services: authenticates a source, proving that a certain party has seen and signed the data in question; guarantees that the data has not changed from the time it was signed; proves to a third party that the data exchange did take place.

Digital signatures are commonly used in code signing (to verify the integrity of downloaded files) and digital certificates (to verify the identity of an organization or individual). The basic four properties of digital signatures are that (1) the signature is authentic, (2) the signature is not forgeable, (3) the signature is not reusable, and (4) the signer cannot claim later that they did not sign it.

Digital certificates are used to authenticate and verify that a user sending a message is who they claim to be. Figure 29-6 shows how an RSA digital certificate or signature is used. RSA is an asymmetric algorithm that is commonly used for generating and verifying digital signatures. In this scenario, Bob is confirming an order with Alice. The steps are as follows:

1. Bob makes a hash, or fingerprint, of the document, which uniquely identifies the document and all its contents.
2. Bob encrypts the hash with only the private key of the signer (i.e., Bob's private key).

Figure 29-6 Using RSA Digital Signatures



3. The encrypted hash, which is known as the signature, is appended to the document.
4. Alice obtains Bob's public key.
5. Alice decrypts the signature using Bob's public key. This step reveals the hash value initially calculated by Bob.
6. Alice makes a hash of the received document, without its signature, and compares this hash to the decrypted signature hash sent by Bob. If the hashes match, the document is authentic. The match means that the document has been signed by Bob and has not changed since it was signed.

Study Resources

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

Resource	**Location**	**Topic**
CCNA Security Official Cert Guide	5	Fundamentals of VPN Technology and Cryptography
CCNA Security (Networking Academy Curriculum)	7	Cryptographic Systems
Supplemental Resources		
CCNA Security Complete Video Course	3	Fundamentals of VPN Technology and Cryptography
CCNA Security Portable Command Guide	14	VPNs and Cryptology
	15	Asymmetric Encryption and PKI

Check Your Understanding

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

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