Principles of Computer Security: CompTIA Security+™ and Beyond

(Exam SY0-301)

Third Edition

About the Authors

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He has a Bachelor of Science degree in computer information systems from Excelsior College and two Associates in Applied Science degrees from the Community College of the Air Force. Bobby's professional IT certifications include A+, Security+, ACP, CCNA, CCAI, CIW, CIWSA, MCP+I, MCSA (Windows 2000 & 2003), MCSE (Windows NT4, 2000 & 2003), MCSE: Security (Windows 2000 & 2003), CISSP, CIFI, CEH, CHFI, and CPTS, and he is also a certified trainer.

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New York Chicago San Francisco
Lisbon London Madrid Mexico City Milan
New Delhi San Juan Seoul Singapore Sydney Toronto

The McGraw-Hill Companies

Cataloging-in-Publication Data is on file with the Library of Congress

Principles of Computer Security: CompTIA Security+™ and Beyond, Third Edition (Exam SY0-301)

1 2 3 4 5 6 7 8 9 0 QDB QDB 1 0 9 8 7 6 5 4 3 2

ISBN: Book p/n 978-0-07-178616-4 and CD p/n 978-0-07-178617-1 of set 978-0-07-178619-5

MHID: Book p/n 0-07-178616-3 and CD p/n 0-07-178617-1 of set 0-07-178619-8

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This book is dedicated to the many security professionals who daily work to ensure the safety of our nation's critical infrastructures. We want to recognize the thousands of dedicated individuals who strive to protect our national assets but who seldom receive praise and often are only noticed when an incident occurs. To you, we say thank you for a job well done!

Acknowledgments

We, the authors of *Principles of Computer Security: CompTIA Security+™ and Beyond, Third Edition*, have many individuals who we need to acknowledge—individuals without whom this effort would not have been successful. This third edition would not have been possible without Tim Green, who navigated a myriad of problems and made life easier for the author team. He brought together an all-star production team that made this book more than just a new edition, but a complete learning system.

The list needs to start with those folks at McGraw-Hill who worked tirelessly with the project's multiple authors and contributors and lead us successfully through the minefield that is a book schedule and who took our rough chapters and drawings and turned them into a final, professional product we can be proud of. We thank all the good people from the Acquisitions team, Tim Green and Stephanie Evans; from the Editorial Services team, Janet Walden and LeeAnn Pickrell; from the Illustration and Production teams, Jean Bodeaux and Amarjeet Kumar and the composition team at Cenveo Publisher Services. We also thank the technical editor, Bobby Rogers; the copy editors, Bill McManus and LeeAnn Pickrell; the proofreader, Paul Tyler; and the indexer, Rebecca Plunkett; for all their attention to detail that made this a finer work after they finished with it.

We also need to acknowledge our current employers who, to our great delight, have seen fit to pay us to work in a career field that we all find exciting and rewarding. There is never a dull moment in security, because it is constantly changing.

We would like to thank Art Conklin for herding the cats on this one.

Finally, we would each like to individually thank those people who—on a personal basis—have provided the core support for us individually. Without these special people in our lives, none of us could have put this work together.

Successful cat herders have many behind them helping them succeed. I owe thanks to many friends, their friendship and support makes efforts such as this possible. And to Susan, my lovely wife and friend, thank you for your sacrifices that enable me to do the things I do.

—Art Conklin, Ph.D.

I would like to thank my wife, Charlan, for the tremendous support she has always given me. It doesn't matter how many times I have sworn that I'll never get involved with another book project only to return within months to yet another one; through it all, she has remained supportive.

I would also like to publicly thank the United States Air Force, which provided me numerous opportunities since 1986 to learn more about security than I ever knew existed.

To whoever it was who decided to send me as a young captain—fresh from completing my master's degree in artificial intelligence—to my first assignment in computer security: thank you, it has been a great adventure!

—Gregory B. White, Ph.D.

For Macon.

—Chuck Cothren

Geena, thanks for being my best friend and my greatest support. Anything I am is because of you. Love to my kids and grandkids!

—Roger L. Davis

To my wife and best friend Leah for your love, energy, and support—thank you for always being there. Here's to many more years together.

—Dwayne Williams

ABOUT THIS BOOK

Important Technology Skills

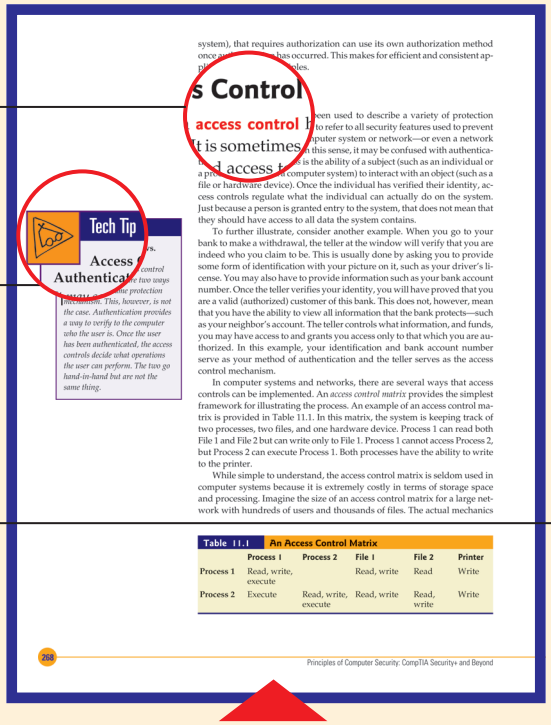
Information technology (IT) offers many career paths and information security is one of the fastest-growing tracks for IT professionals. This book provides coverage of the materials you need to begin your exploration of information security.

In addition to covering all of the CompTIA Security+ exam objectives, additional material is included to help you build a solid introductory knowledge of information security.

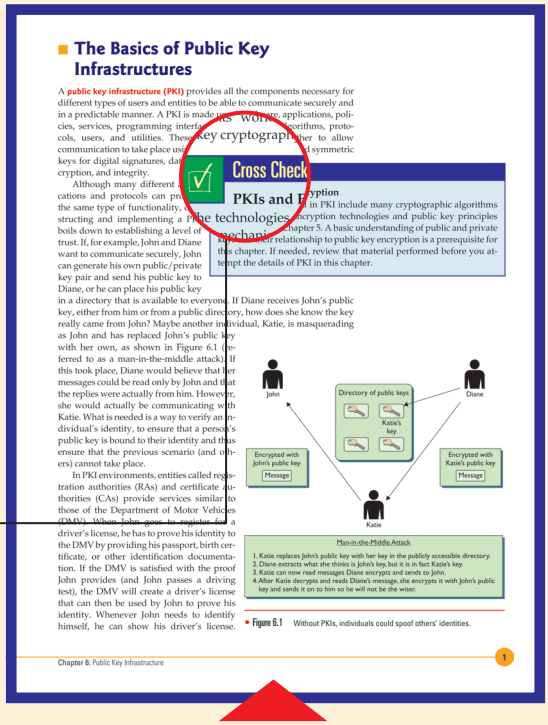
***Key Terms**, identified in red, point out important vocabulary and definitions that you need to know.*

***Tech Tip** sidebars provide inside information from experienced information security professionals.*

***Cross Check** questions develop reasoning skills: ask, compare, contrast, and explain.*



***Engaging and Motivational** — Using a conversational style and proven instructional approach, the authors explain technical subjects in a clear, interesting way using real-world examples.*



***Makes Learning Fun!** — Rich, colorful text and illustrations bring technical concepts to life.*

Proven Learning Method Keeps You on Track

Designed for classroom use and written by instructors for use in their own classes, Principles of Computer Security: CompTIA Security+ and Beyond *is structured to give you comprehensive knowledge of information security. The textbook's active learning methodology guides you beyond mere recall and—through thought-provoking activities, labs, and sidebars—helps you develop critical-thinking, diagnostic, and communication skills.*

Effective Learning Tools

This feature-rich textbook is designed to make learning easy and enjoyable and to help you develop the skills and critical thinking abilities that will enable you to adapt to different job situations and to troubleshoot problems. Written by instructors with decades of combined information security experience, this book conveys even the most complex issues in an accessible, easy-to-understand format.

Chapter Review *sections provide concept summaries, key terms lists, and lots of questions and projects.*

Try This! *exercises apply core skills in a new setting.*

Notes, Tips, Warnings, *and* ***Exam Tips*** *create a road map for success.*

Key Terms List *presents the important terms identified in the chapter.*

Offers Practical Experience— *Tutorials and lab assignments develop essential hands-on skills and put concepts in real-world contexts.*

Robust Learning Tools— *Summaries, key term lists, quizzes, essay questions, and lab projects help you practice skills*

Each chapter includes:

- **Learning Objectives** that set measurable goals for chapter-by-chapter progress
- **Illustrations** that give you a clear picture of the concepts and technologies
- **Try This!**, **Cross Check**, and **Tech Tip** sidebars that encourage you to practice and apply concepts in real-world settings
- **Notes**, **Tips**, and **Warnings** that guide you, and **Exam Tips** that give you advice or provide information specifically related to preparing for the exam
- **Chapter Summaries** and **Key Terms Lists** that provide you with an easy way to review important concepts and vocabulary
- **Challenging End-of-Chapter Tests** that include vocabulary-building exercises, multiple-choice questions, essay questions, and on-the-job lab projects

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PREFACE

Information and computer security has moved from the confines of academia to mainstream America in the last decade. The Code Red, Nimda, and Slammer attacks were heavily covered in the media and broadcast into the average American's home. Today, the Internet has turned 40, and with its maturing, the threats are increasing. Botnets and cyber-criminals are making news regularly. It has become increasingly obvious to everybody that something needs to be done to secure not only our nation's critical infrastructure but also the businesses we deal with on a daily basis. The question is, "Where do we begin?" What can the average information technology professional do to secure the systems that he or she is hired to maintain? One immediate answer is education and training. If we want to secure our computer systems and networks, we need to know how to do this and what security entails.

Complacency is not an option in today's hostile network environment. While we once considered the insider to be the major threat to corporate networks, and the "script kiddie" to be the standard external threat (often thought of as only a nuisance), the highly interconnected network world of today is a much different place. The U.S. government identified eight critical infrastructures a few years ago that were thought to be so critical to the nation's daily operation that if one were to be lost, it would have a catastrophic impact on the nation. To this original set of eight sectors, more have recently been added. A common thread throughout all of these, however, is technology—especially technology related to computers and communication. Thus, an individual, organization, or nation who wanted to cause damage to this nation could attack it not just with traditional weapons but with computers through the Internet. It is not surprising to hear that among the other information seized in raids on terrorist organizations, computers and Internet information are usually seized as well. While the insider can certainly still do tremendous damage to an organization, the external threat is again becoming the chief concern among many.

So, where do you, the IT professional seeking more knowledge on security, start your studies? The IT world is overflowing with certifications that can be obtained by those attempting to learn more about their chosen profession. The security sector is no different, and the CompTIA Security+ exam offers a basic level of certification for security. In the pages of this book you will find not only material that can help you prepare for taking the CompTIA Security+ exam but also the basic information that you will need in order to understand the issues involved in securing your computer systems and networks today. In no way is this book the final source for learning all about protecting your organization's systems, but it serves as a point from which to launch your security studies and career.

One thing is certainly true about this field of study—it never gets boring. It constantly changes as technology itself advances. Something else you will find as you progress in your security studies is that no matter how much technology advances and no matter how many new security devices are developed, at its most basic level, the human is still the weak link in the security chain. If you are looking for an exciting area to delve into, then you have certainly chosen wisely. Security offers a challenging blend of technology and people issues. We, the authors of this book, wish you luck as you embark on an exciting and challenging career path.

Wm. Arthur Conklin, Ph.D.
Gregory B. White, Ph.D.

INTRODUCTION

Computer security is becoming increasingly important today as the number of security incidents steadily climbs. Many corporations are now spending significant portions of their budget on security hardware, software, services, and personnel. They are spending this money not because it increases sales or enhances the product they provide, but because of the possible consequences should they not take protective actions.

Why Focus on Security?

Security is not something that we want to have to pay for; it would be nice if we didn't have to worry about protecting our data from disclosure, modification, or destruction from unauthorized individuals, but that is not the environment we find ourselves in today. Instead, we have seen the cost of recovering from security incidents steadily rise along with the rise in the number of incidents themselves. Since September 11, 2001, this has taken on an even greater sense of urgency as we now face securing our systems not just from attack by disgruntled employees, juvenile hackers, organized crime, or competitors; we now also have to consider the possibility of attacks on our systems from terrorist organizations. If nothing else, the events of September 11, 2001, showed that anybody is a potential target. You do not have to be part of the government or a government contractor; being an American is sufficient reason to make you a target to some, and with the global nature of the Internet, collateral damage from cyber attacks on one organization could have a worldwide impact.

A Growing Need for Security Specialists

To protect our computer systems and networks, we will need a significant number of new security professionals trained in the many aspects of computer and network security. This is not an easy task as the systems connected to the Internet become increasingly complex, with software whose lines of code number in the millions. Understanding why this is such a difficult problem to solve is not hard if you consider how many errors might be present in a piece of software that is several million lines long. When you add the additional factor of how fast software is being developed—from necessity as the market is constantly moving—understanding how errors occur is easy.

Not every "bug" in the software will result in a security hole, but it doesn't take many to affect the Internet community drastically. We can't just blame the

vendors for this situation, because they are reacting to the demands of government and industry. Most vendors are fairly adept at developing patches for flaws found in their software, and patches are constantly issued to protect systems from bugs that may introduce security problems. This introduces a whole new problem for managers and administrators—patch management. How important this has become is easily illustrated by how many of the most recent security events have occurred as a result of a security bug for which a patch was available months prior to the security incident; members of the community had not correctly installed the patch, however, thus making the incident possible. One of the reasons this happens is that many of the individuals responsible for installing the patches are not trained to understand the security implications surrounding the hole or the ramifications of not installing the patch. Many of these individuals simply lack the necessary training.

Because of the need for an increasing number of security professionals who are trained to some minimum level of understanding, certifications such as the Security+ have been developed. Prospective employers want to know that the individual they are considering hiring knows what to do in terms of security. The prospective employee, in turn, wants to have a way to demonstrate his or her level of understanding, which can enhance the candidate's chances of being hired. The community as a whole simply wants more trained security professionals.

Preparing Yourself for the Security+ Exam

Principles of Computer Security: CompTIA Security+ and Beyond, Third Edition is designed to help prepare you to take the Security+ certification exam. When you pass it, you will demonstrate you have that basic understanding of security that employers are looking for. Passing this certification exam will not be an easy task, for you will need to learn many things to acquire that basic understanding of computer and network security.

How This Book Is Organized

The book is divided into chapters to correspond with the objectives of the exam itself. Some of the chapters are more technical than others—reflecting the nature of the security environment where you will be forced to deal with not only technical details but also other issues such as security policies and procedures as well as training and education. Although many individuals involved in computer and network security have advanced degrees in math, computer science, information systems, or computer or electrical engineering, you do not need this technical background to address security effectively in your organization. You do not need to develop your own cryptographic algorithm, for example; you simply need to be able to understand how cryptography is used, along with its strengths and weaknesses.

As you progress in your studies, you will learn that many security problems are caused by the human element. The best technology in the world still ends up being placed in an environment where humans have the opportunity to foul things up—and all too often do.

Onward and Upward

At this point, we hope that you are now excited about the topic of security, even if you weren't in the first place. We wish you luck in your endeavors and welcome you to the exciting field of computer and network security.

CompTIA Security+

- Designed for IT professionals focused on system security.
- Covers network infrastructure, cryptography, assessments, and audits.
- Security+ is mandated by the U.S. Department of Defense and is recommended by top companies such as Microsoft, HP, and Cisco.

It Pays to Get Certified

In a digital world, digital literacy is an essential survival skill. Certification proves you have the knowledge and skill to solve business problems in virtually any business environment. Certifications are highly valued credentials that qualify you for jobs, increased compensation, and promotion.

Security is one of the highest-demand job categories—growing in importance as the frequency and severity of security threats continue to be a major concern for organizations around the world.

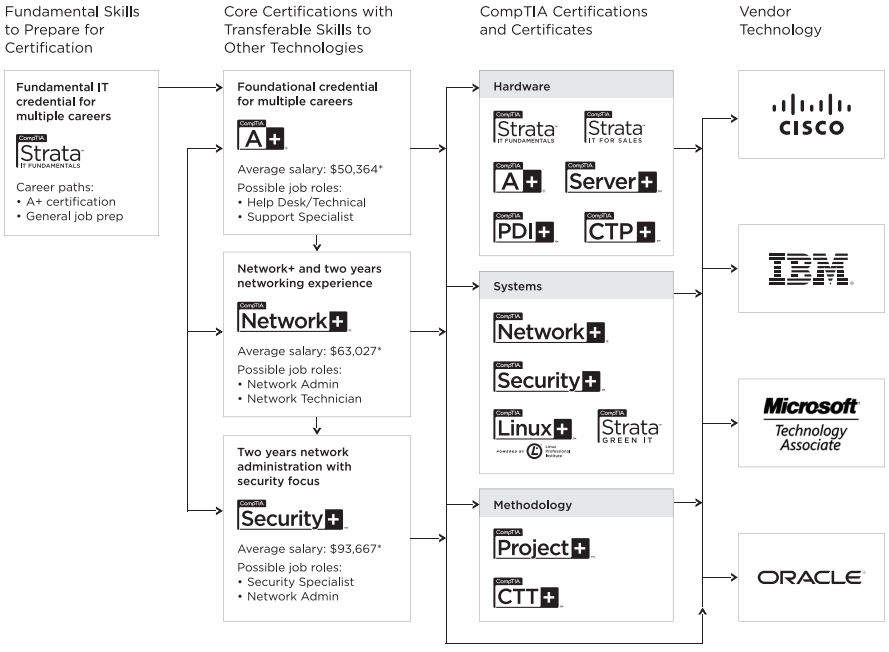
- Jobs for security administrators are expected to increase by 18 percent; the skill set required for these types of jobs map to CompTIA Security+ certification.
- Network security administrators can earn as much as $106,000 per year.
- CompTIA Security+ is the first step in starting your career as a network security administrator or systems security administrator.
- CompTIA Security+ is regularly used in organizations such as Hitachi Information Systems, Trendmicro, the McAfee Elite Partner program, the U.S. State Department, and U.S. government contractors such as EDS, General Dynamics, and Northrop Grumman.

How Certification Helps Your Career

Learn new skills to get a job	Retain your job and salary	Want to change jobs	Stick out from the resume pile	IT is everywhere
Certifications are essential credentials that prove you have the knowledge and skills to perform.	Make your expertise stand above the rest. Competence is usually retained during times of change.	Certifications qualify you for new opportunities, whether locked into a current job, see limited advancement or need to change careers.	Hiring managers can demand the strongest skill set.	IT is needed in most companies across the industries. There aren't enough trained professionals to fill jobs.

CompTIA Career Pathway

CompTIA offers a number of credentials that form a foundation for your career in technology and that allow you to pursue specific areas of concentration. Depending on the path you choose, CompTIA certifications help you build upon your skills and knowledge, supporting learning throughout your career.



*Source: *Computerworld* Salary Survey 2010—U.S. salaries only

Steps to Getting Certified and Staying Certified

1. **Review exam objectives.** Review the certification objectives to make sure you know what is covered in the exam: www.comptia.org/certifications/testprep/examobjectives.aspx
2. **Practice for the exam.** After you have studied for the certification, take a free assessment and sample test to get an idea what type of questions might be on the exam: www.comptia.org/certifications/testprep/practicetests.aspx
3. **Purchase an exam voucher.** Purchase exam vouchers on the CompTIA Marketplace, which is located at: www.comptiastore.com
4. **Take the test!** Select a certification exam provider, and schedule a time to take your exam. You can find exam providers at the following link: www.comptia.org/certifications/testprep/testingcenters.aspx
5. **Stay Certified! Meet the Continuing Education Requirement.** Effective January 1, 2011, new CompTIA Security+ certifications are valid for three years from the date of your certification. There are a number of ways the certification can be renewed. For more information go to: http://certification.comptia.org/getCertified/steps_to_certification/stayCertified.aspx

Join the Professional Community

The free online IT Pro Community provides valuable content to students and professionals.

Career IT job resources include

- Where to start in IT
- Career assessments
- Salary trends
- U.S. job board

Join the IT Pro Community and get access to:

- Forums on networking, security, computing, and cutting-edge technologies
- Access to blogs written by industry experts

- Current information on cutting-edge technologies
- Access to various industry resource links and articles related to IT and IT careers

OFFICIAL

MULTI-LAYERED LEARNING TOOLS INCLUDED

Content Seal of Quality

This courseware bears the seal of CompTIA Approved Quality Content. This seal signifies this content covers 100 percent of the exam objectives and implements important instructional design principles. CompTIA recommends multiple learning tools to help increase coverage of the learning objectives.

Why CompTIA?

- **Global recognition** CompTIA is recognized globally as the leading IT nonprofit trade association and has enormous credibility. Plus, CompTIA's certifications are vendor-neutral and offer proof of foundational knowledge that translates across technologies.
- **Valued by hiring managers** Hiring managers value CompTIA certification because it is vendor- and technology-independent validation of your technical skills.
- **Recommended or required by government and businesses** Many government organizations and corporations (for example, Dell, Sharp, Ricoh, the U.S. Department of Defense, and many more) either recommend or require technical staff to be CompTIA certified.
- **Three CompTIA certifications ranked in the top 10** In a study by DICE of 17,000 technology professionals, certifications helped command higher salaries at all experience levels.

How to Obtain More Information

- **Visit CompTIA online** Go to www.comptia.org to learn more about getting CompTIA certified.
- **Contact CompTIA** Please call 866-835-8020, ext. 5 or e-mail questions@comptia.org.
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The contents of this training material were created for the CompTIA Security+ exam covering CompTIA certification objectives that were current as of the date of publication.

CompTIA has not reviewed or approved the accuracy of the contents of this training material and specifically disclaims any warranties of merchantability or fitness for a particular purpose. CompTIA makes no guarantee concerning the success of persons using any such "Approved" or other training material in order to prepare for any CompTIA certification exam.

INSTRUCTOR AND STUDENT WEB SITE

For instructor and student resources, check out www.PrinciplesSecurity3e.com. Students will find chapter quizzes that will help them learn more about computer security, and teachers can access support materials (ask your sales representative for details).

Additional Resources for Teachers

The Principles of Computer Security: CompTIA Security+ and Beyond Online Learning Center (www.PrinciplesSecurity3e.com) provides many resources for instructors:

- Answer keys to the end-of-chapter activities in the textbook
- Answer keys to the lab manual activities
- Access to testbank files and software that allows you to generate a wide array of paper- or network-based tests, and that features automatic grading
- Hundreds of practice questions and a wide variety of question types and difficulty levels, enabling you to customize each test to maximize student progress
- Blackboard cartridges and other formats may also be available upon request; contact your sales representative
- Engaging PowerPoint slides on the lecture topics (including full-color artwork from the book)