5th Edition

Systems Security Certified Practitioner

An (ISC)² Certification

The Official (ISC)² SSCP CBK® Reference

Mike Wills

SYBEX
A Wiley Brand

The Official (ISC)²® SSCP® CBK® Reference

Fifth Edition

The Official (ISC)²® SSCP® CBK® Reference

Fifth Edition

MIKE WILLS

SYBEX
A Wiley Brand

Portions of this Work are reused from (ISC)² SSCP Systems Security Certified Practitioner Official Study Guide, 2nd Edition by Mike Wills copyright 2019 John Wiley & Sons, Inc.

Portions of this Work are reused from The Official (ISC)² Guide to the CISSP CBK Reference, 5th Edition by John Warsinske with Mark Graff, Kevin Henry, Christopher Hoover, Ben Malisow, Sean Murphy, C. Paul Oakes, George Pajari, Jeff T. Parker, David Seidl, Mike Vasquez copyright 2019 (ISC)²

Published by John Wiley & Sons, Inc. Indianapolis, Indiana

Published simultaneously in Canada

ISBN: 978-1-119-60194-4
ISBN: 978-1-119-60196-8 (ebk.)
ISBN: 978-1-119-60200-2 (ebk.)

Manufactured in the United States of America

Library of Congress Control Number: 2019952065

10 9 8 7 6 5 4 3 2 1

Acknowledgments

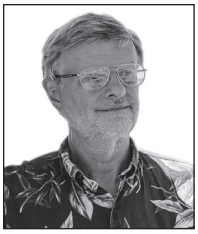
"It's like writing two books at once, only harder," Jim said to me when he asked me to take on writing this Common Book of Knowledge book while I was still writing the SSCP Study Guide. More like taking one subject, turning it sideways, and shaking hard, perhaps! Unlike the Study Guide, writing this book felt more like writing several hundred short white papers on closely related subjects.

Since this book needed to speak to troubleshooters, I drew on decades of teaching I'd received from many professionals in the military, in government, and in the private sector about the fine art and brute-force cybernetics of debugging networks, systems, highly secure communications systems, and all of the arcana of controlling space-based systems working many different missions. I've also drawn on years of working with small and medium but otherwise rather down-to-earth business IT systems and what it took to get them back into operations. Where that problem-solving focus comes through clearly and helps you shoot the troubles you have to deal with, I owe a great debt of thanks to those who let me learn how in real time.

Without the tireless support of the editorial team at Wiley/Sybex—Jim Minatel and Kelly Talbot—I think I'd *still* be struggling with unflowing the lessons and reflowing them into reference and troubleshooting memory-joggers. And as with producing the Study Guide, the technical review by Jacob Penovich, as well as by Tara Zeiler and Charles Gaughf at (ISC)^2, have all helped make what you have in your hands right now deliver the right content in the best way possible. Christine O'Connor, Kim Wimpsett and the rest of her team of proofreaders and copyeditors made it all look great too! Any remaining mistakes, omissions, or confusing passages that remain are mine, not theirs; let me know please when you find one!

Finally, I wish to thank my wife Nancy. She saved my life and brought me peace. Her strength inspired me to say "yes" one more time when Jim called me, again, about doing this book, and she has kept both of us healthy and happy throughout. We go together, on adventures like writing, and on ones for which we do need to pack a pocket handkerchief.

About the Author



Mike Wills, SSCP, CISSP, CAMS, has spent more than 40 years as a computer systems architect, programmer, security specialist, database designer, consultant, and teacher (among other duties). Starting out as a bit of a phone phreak in his college days, he sharpened his skills on the 1960s generation of mainframes and minicomputers, just in time for the first 8080 and Z80 microprocessors to fuel the home computer revolution. Learning about the ARPANET just added spice to that mix. Since then, he's had ones, zeros, and now qubits under his fingernails too many times to count, whether as part of his jobs, his teaching, or his hobbies.

Mike earned his BS and MS degrees in computer science, both with minors in electrical engineering, from the Illinois Institute of Technology; and his MA in defence studies from King's College, London. He is a graduate of the Federal Chief Information Officer program at National Defense University and the Program Manager's Course at Defense Systems Management College.

As an Air Force officer, Mike served in the National Reconnaissance Office, building and flying some of the most complex, cutting-edge space-based missions large and small. As a "ground control" guy, he specialized in the design, operation, and support of highly secure, globe-spanning command, control, communications and intelligence systems that support U.S. and Coalition missions around the world. These duties often required Mike to "optimize" his way around the official configuration management and security safeguards—all on official business, of course.

Because no good deed goes unpunished, he then spent two years on the Joint Staff as a policy and budget broker for all command, control, and communications systems, and then taught in the School of Information Warfare and Strategy at National Defense University. He's taught at senior leader colleges in both the United States and United Kingdom and has been a continuing guest lecturer at the UK's Defence Academy. He served as advisor to the United Kingdom's Joint Intelligence Committee, Ministry of Justice, and Defence Science and Technology Laboratories on the national and personal security implications of science and technology policy; this led to him sometimes being known as the United Kingdom's nonresident expert on outer space law.

Mike is the author of the *SSCP Official Study Guide 2nd Edition*. Along with his SSCP and CISSP, Mike is also a Certified Anti-Money Laundering Specialist.

Currently he is an assistant professor of applied information technologies in the College of Business at Embry-Riddle Aeronautical University, Worldwide Campus, where he is the change

leader and academic visionary behind bringing the Microsoft Software and Systems Academy program into ERAU's classrooms at 13 locations around the United States. Prior to this, Mike helped create two new master of science degrees—information security and assurance, and management of information systems—and was program chair of both during their launch and first year of teaching. He also taught in Worldwide's Security and Intelligence Studies program during its 2005 launch in ERAU's European Division.

Mike and his wife Nancy currently call Montevideo, Uruguay, their home. Living abroad since the end of the last century, they find new perspectives, shared values, and wonderful people wherever they go. As true digital nomads, it's getting time to move again. Where to? They'll find out when they get there.

About the Technical Editor

Jacob Penovich is an experienced information security practitioner who has worked in a variety of roles from systems administration to ethical hacking and penetration testing. Jacob is driven by a strong belief in the practice of empowering team members, colleagues, and the local InfoSec community while striving to help cultivate an environment of knowledge exchange and growth.

Holder of numerous industry certifications including the CISSP, GPEN, GWAPT, and more, he considers himself a lifelong learner who is always on the lookout for unique challenges, upcoming threats, and new ways to approach InfoSec issues. He loves to volunteer and give back whenever possible and enjoys working with local high schools and colleges to help inspire the next generation of InfoSec pros. When not absorbed in a computer screen, he can be found in the company of his amazing wife Jessica and their grumble of pugs.

Contents at a Glance

Contents

Foreword

WELCOME TO *THE OFFICIAL (ISC)² Guide to the SSCP CBK*! By picking up this book, you've made the decision to take the next step in your career and have demonstrated your commitment to continuing your professional education.

The recognition that comes with an (ISC)² Systems Security Certified Practitioner (SSCP) credential next to your name shows your understanding of and proficiency with the hands-on technical work that is needed in the information security field. It demonstrates that you closely follow best practices, policies and procedures in accordance with the *SSCP Common Body of Knowledge*. Whether you are using this guide to supplement your preparation to sit for the exam or you are an existing SSCP using this as a reference, this book helps to facilitate the practical knowledge you need to assure strong information security for your organization's daily operations.

The recognized leader in the field of information security education and certification, (ISC)² promotes the development of information security professionals throughout the world. As a SSCP with all the benefits of (ISC)² membership, you will become part of a global network of more than 140,000 certified professionals who are working to inspire a safe and secure cyber world. By becoming a member of (ISC)² you will have also officially committed to ethical conduct commensurate to your position of trust as a cybersecurity professional.

Reflecting the most pertinent issues that security practitioners currently face, along with the best practices for mitigating those issues, *The Official (ISC)² Guide to the SSCP CBK* offers step-by-step guidance through the seven different domains included in the exam, which are:

- Access Controls
- Security Operations and Administration
- Risk Identification, Monitoring and Analysis
- Incident Response and Recovery
- Cryptography
- Networks and Communications Security
- Systems and Application Security

Drawing from a comprehensive, up-to-date global body of knowledge, this book prepares you to join thousands of practitioners worldwide who have obtained the SSCP. For those with proven technical skills and practical security knowledge, the SSCP certification is the ideal credential. The SSCP confirms the breadth and depth of practical security knowledge expected of those in hands-on operational IT roles. The certification provides industry-leading confirmation of a practitioner's ability to implement, monitor and administer information security policies and procedures that ensure data confidentiality, integrity and availability (CIA).

The goal for SSCP credential holders is to achieve the highest standard for cybersecurity expertise – managing multi-platform IT systems while keeping sensitive data secure. This becomes especially crucial in the era of digital transformation, where cybersecurity permeates virtually every value stream imaginable. Organizations that can demonstrate world-class cybersecurity capabilities and trusted transaction methods enable customer loyalty and fuel success.

The opportunity has never been greater for dedicated men and women to carve out a meaningful career and make a difference in their organizations. *The Official (ISC)*^{2} *Guide to the SSCP CBK* will be your constant companion in protecting and securing the critical data assets of your organization that will serve you for years to come.

Thank you for reading and good luck in this next step along your career path.

Regards,

David P. Shearer, CISSP
CEO, (ISC)^2

Introduction

CONGRATULATIONS ON CHOOSING TO become a Systems Security Certified Practitioner (SSCP)! In making this choice, you're signing up to join the "white hats," the professionals who strive to keep our information-based modern world safe, secure, and reliable. SSCPs and other information security professionals help businesses and organizations keep private data *private* and help to ensure that published and public-facing information stays unchanged and unhacked.

Whether you are new to the fields of information security, information assurance, or cybersecurity, or you've been working with these concepts, tools, and ideas for some time now, this book is here to help you grow your knowledge, skills, and abilities as a systems security professional.

Let's see how!

ABOUT THIS BOOK

You're here because you need a ready reference source of ideas, information, knowledge, and experience about information systems security. Users of earlier editions of the CBK describe it as the place to go when you need to look up something about bringing your systems or networks back up and online—when you can't exactly Google or Bing it. As a first responder in an information security incident, you may need to rely on what you know and what you've got at hand as you characterize, isolate, and contain an intruder and their malware or other causal agents. This book cannot answer all of the questions you'll have in real time, but it may just remind you of important concepts as well as critical details when you need them. As with any reference work, it can help you think your way through to a solution. By taking key definitions and concepts and *operationalizing* them, showing how they work in practice, this book can enrich the checklists, troubleshooting guides, and task-focused procedures that you may already be using in your work.

✔ Why This CBK as Well as a Study Guide?

Good question! This Common Book of Knowledge (CBK) provides you the data, information, knowledge—and in some cases, some bits of wisdom—that have been hard-won by the experience of many SSCPs and other information security professionals. This CBK is structured around the SSCP domains of knowledge; as such, it's not a cover-to-cover learning journey but more of an atlas for such a journey.

The SSCP Official Study Guide exists because (ISC)² wanted a book that would teach as well as guide, explain as well as capture the common knowledge about keeping information systems secure, protecting information assets, and information assurance that all SSCPs should have at their mental fingertips. As creators of the SSCP program, (ISC)² defines that common body of knowledge, in continuous consultation with system security experts and practitioners from business, industry, government, and academia from around the world. This book is its natural companion.

The SSCP Seven Domains

This book directly reflects the SSCP Common Body of Knowledge, which is the comprehensive framework that (ISC)² has developed to express what security professionals should have working knowledge of. These domains include theoretical knowledge, industry best practices, and applied skills and techniques. Chapter by chapter, this book takes you through these domains, with major headings within each chapter being your key to finding what you need when you need it. Topics that are covered in more than one domain will be found within sections or subsections in each chapter as appropriate.

(ISC)² is committed to helping members learn, grow, and thrive. The Common Body of Knowledge (CBK) is the comprehensive framework that helps (ISC)² fulfill this commitment. The CBK includes all the relevant subjects a security professional should be familiar with, including skills, techniques, and best practices. (ISC)² uses the various domains of the CBK to test a certificate candidate's levels of expertise in the most critical aspects of information security. You can see this framework in the SSCP Exam Outline at `www.isc2.org/-/media/ISC2/Certifications/Exam-Outlines/SSCP-Exam-Outline-Nov-1-2018.ashx`.

Chapter by chapter, domain by domain, these domains are as follows:

Chapter 1: Access Controls Policies, standards, and procedures that define who users are, what they can do, which resources and information they can access, and what operations they can perform on a system, such as:

1.1 Implement and maintain authentication methods

1.2 Support internetwork trust architectures

1.3 Participate in the identity management life cycle

1.4 Implement access controls

Chapter 2: Security Operations and Administration Identification of information assets and documentation of policies, standards, procedures, and guidelines that ensure confidentiality, integrity, and availability, such as:

2.1 Comply with codes of ethics

2.2 Understand security concepts

2.3 Document, implement, and maintain functional security controls

2.4 Participate in asset management

2.5 Implement security controls and assess compliance

2.6 Participate in change management

2.7 Participate in security awareness and training

2.8 Participate in physical security operations

Chapter 3: Risk Identification, Monitoring, and Analysis Risk identification is the review, analysis, and implementation of processes essential to the identification, measurement, and control of loss associated with unplanned adverse events. Monitoring and analysis consists of determining system implementation and access in accordance with defined IT criteria. Collecting information for identification of, and response to, security breaches or events, such as the following:

3.1 Understand the risk management process

3.2 Perform security assessment activities

3.3 Operate and maintain monitoring systems

3.4 Analyze monitoring results

Chapter 4: Incident Response and Recovery The show must go on is a well-known saying that means, even if there are problems or difficulties, an event or activity must continue. Incident response and recovery ensures the work of the organization will continue. In this domain the SSCP gains an understanding of how to handle incidents using consistent, applied approaches like business continuity planning (BCP) and disaster recovery planning (DRP). These approaches are utilized to mitigate damages, recover business operations, and avoid critical business interruption.

4.1 Support incident life cycle

4.2 Understand and support forensic investigations

4.3 Understand and support Business Continuity Plan (BCP) and Disaster Recovery Plan (DRP) activities

Chapter 5: Cryptography The protection of information using techniques that ensure its integrity, confidentiality, authenticity, and nonrepudiation, and the recovery of encrypted information in its original form.

5.1 Understand fundamental concepts of cryptography

5.2 Understand reasons and requirements for cryptography

5.3 Understand and support secure protocols

5.4 Understand Public Key Infrastructure (PKI) systems

Chapter 6: Network and Communications Security The network structure, transmission methods and techniques, transport formats, and security measures used to operate both private and public communication networks.

6.1 Understand and apply fundamental concepts of networking

6.2 Understand network attacks and countermeasures

6.3 Manage network access controls

6.4 Manage network security

6.5 Operate and configure network-based security devices

6.6 Operate and configure wireless technologies

Chapter 7: Systems and Application Security Countermeasures and prevention techniques for dealing with viruses, worms, logic bombs, Trojan horses, and other related forms of intentionally created damaging code.

7.1 Identify and analyze malicious code and activity

7.2 Implement and operate endpoint device security

7.3 Operate and configure cloud security

7.4 Operate and secure virtual environments

Using This Book to Defeat the Cybersecurity Kill Chain

Your employers or clients have entrusted the safety and security of their information systems to you, as one of their on-site information security professionals. Those systems are under constant attack—not just the threat of attack. Each day, the odds are great that somebody is knocking at your electronic front doors, trying the e-window latches on your organization's web pages, and learning about your information systems and how you use them. That's reconnaissance in action, the first step in the cybersecurity kill chain.

As an SSCP you're no doubt aware of the cybersecurity kill chain, as a summary of how advanced persistent threat (APT) actors plan and conduct their attacks against many private and public organizations, their IT infrastructures, and their information assets and systems. Originally developed during the 1990s by applying military planning doctrines

of effects-based targeting, this kill chain is similar to the value chain concept used by businesses and public-sector organizations around the world. Both value chains and kill chains start with the objective—the desired end state or result—and work backward, all the way back to choosing the right targets to attack in the first place.[1] Lockheed-Martin first published its cybersecurity kill chain in 2011; the MITRE Corporation, a federally funded research and development corporation (FFRDC), expanded on this in 2018 with its threat-based Adversarial Tactics, Techniques, and Common Knowledge (ATT&CK) framework. ATT&CK takes the kill chain concept down into the tactics, techniques, and procedures used by squad-level and individual soldiers in the field. (Note that in military parlance, planning flows from strategic, through operational, to tactical; but common business-speak usage flips the names of the last two steps, looking at business operations as being the point-of-contact steps with customers, and the tactical layer of planning translating strategic objectives into manageable, measurable, value-producing packages of work.) ATT&CK as a framework is shown in Figure 1, highlighting the two major phases that defenders need to be aware of and engaged with: prestrike planning and the enterprise-level targeted strikes at your systems, your data, and your mission.

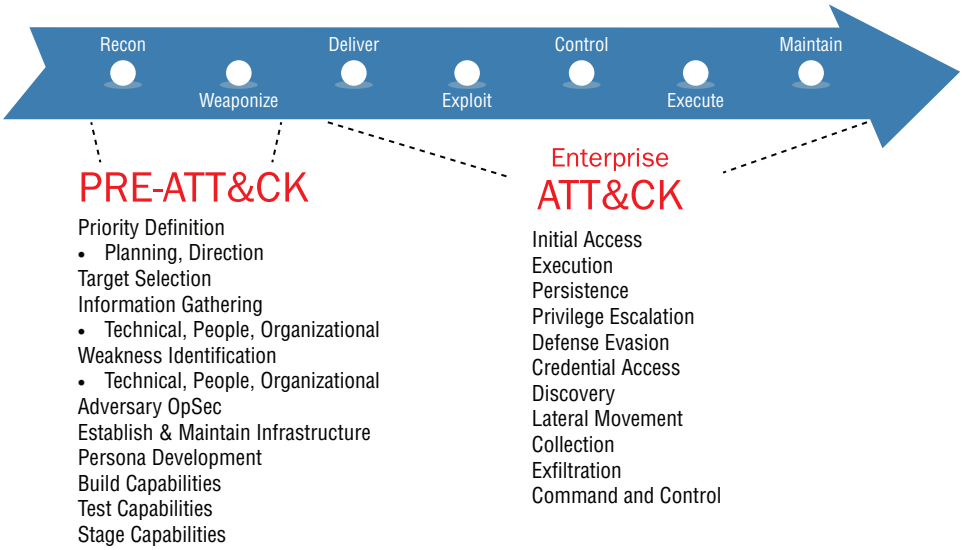


FIGURE 1 MITRE's ATT&CK cybersecurity kill chain model

[1] I had the privilege of developing and teaching some of these evolving concepts at the U.S. National Defense University's School of Information Warfare and Strategy, 1998-2000. At the School, we made extensive use of the "Strategic Information Warfare" series of publications by Roger C. Molander and others at the RAND Corporation, which were exploring this backward chain from desired strategic effect to the "kill effect" required of attacks on information and information systems.

MITRE, Lockheed Martin, and others may give slightly different names to the different phases of their kill chain models. For example, MITRE's combines exploitation with installation, while emphasizing the persistent presence of the adversary inside your systems as they maintain their capabilities to quietly wreak havoc and achieve their objectives. The names of the phases aren't important; their underlying flow of ideas is what matters. To date, there does not seem to be any evidence that any given attacker has used exactly one planning model or another. There is abundant evidence, however, that defenders who do not understand these models pay for their ignorance—or, more precisely, their employers and clients do.

Combining these two models gives us eight phases of the life of an APT's kill chain and suggests which domains of knowledge (and therefore which chapters) may be your first ports of call as you plan to detect, prevent, degrade, or defeat the individual tasks that might make up each step in such a kill chain's operation. These are shown in Table 1.

TABLE 1 Kill Chain Phases Mapped to Chapters

KILL CHAIN PHASE	ATTACK OPERATIONS	DEFENSIVE OPTIONS
Reconnaissance	All-source intelligence gathering to inform the attack: OSINT, scanning, early intrusion, social engineering	All chapters: enhance overall risk/security posture, awareness, vigilance
Weaponization	Select and prepare access techniques and pathways	Chapters 1, 7
Delivery	Email, USBs, URLs, access control gaps, etc.	Chapters 1, 2, 5, 6, 7
Exploitation	Malware, rootkit exploits, live off the land	Chapters 1, 4, 6, 7
Installation	Backdoors, false or subverted user IDs	Chapters 1, 7
Command & Control	Privilege escalation, credential access; lateral movement; find, fix, select in-system targets	Chapters 1, 2, 4, 6
Execute the Attack	Exfiltrate; corrupt; encrypt for ransom; springboard to other targets	Chapters 4, 5
Maintain Hostile Presence	Continue to exploit target's systems and data; continue hiding one's tracks	Chapters 1, 4, 6, 7

You might be wondering why all chapters seem to apply to the Reconnaissance phase. The key to this is to recognize that the attacker will seek to find all possible sources of information about your organization, its business associates and relationships, its communications patterns, and its IT systems. APTs seek understanding of their targets' business and social networks, the "watering holes" where their people gather to collaborate with