GLOBAL EDITION

# Corporate Computer Security

FOURTH EDITION

Randall J. Boyle | Raymond R. Panko

ALWAYS LEARNING

PEARSON

Fourth Edition

# Corporate Computer Security

**Global Edition**


**Randall J. Boyle**
*Longwood University*

**Raymond R. Panko**
*University of Hawai`i at Mānoa*



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*To Courtney Boyle, thank you for your patience, kindness, and perspective on what's most important in life.*

*—Randy Boyle*

*To Julia Panko, my long-time networking and security editor and one of the best technology minds I've ever encountered.*

*—Ray Panko*

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# PREFACE

The IT security industry has seen dramatic changes in the past decades. Security breaches, data theft, cyber attacks, and information warfare are now common news stories in the mainstream media. IT security expertise that was traditionally the domain of a few experts in large organizations has now become a concern for almost everyone.

These rapid changes in the IT security industry have necessitated more recent editions of this text. Old attacks are being used in new ways, and new attacks are becoming commonplace. We hope the changes to this new edition have captured some of these changes in the industry.

## WHAT'S NEW IN THIS EDITION?

If you have used prior editions to this text, you will notice that almost all of the material you are familiar with remains intact. New additions to the text have been driven by requests from reviewers. More specifically, reviewers asked for a text that has a new opening case, business case studies at the end of each chapter, new hands-on projects, updated news articles, and more information related to certifications.

In addition to these changes in content, we have tried to add supplements that make the book easier to use and more engaging for students. Below is a list of the significant changes to this edition of the text.

***Opening Case***—The opening case in Chapter 1 covers a series of data breaches that resulted in one of the largest known data losses to date. The case looks at the sequence of events surrounding the three data breaches at Sony Corp. It then examines how the attackers were able to steal the data, possible motives behind the attacks, arrests and punishment of the attackers, and the impacts on Sony Corp. This case acts as an illustration of the real-world threat environment corporations face today.

***Business Case Studies***—This edition has tried to have more of a business focus by adding in a real-world case study at the end of each chapter. The case studies are designed to show how the material presented in the chapter could have a direct impact on an actual corporation. After each case study, there are key findings from prominent annual industry reports related to the case and chapter material. Case studies, combined with key findings from relevant industry reports, should provide ample material for classroom discussion. Open-ended case questions are included to help guide case discussions. They also offer students the opportunity to apply, analyze, and synthesize the material presented in the chapter.

***New Hands-on Projects—***Each chapter has new, or updated, hands-on projects that use contemporary security software. Each project relates directly to the chapter material. Students are directed to take a screenshot to show they have completed the project. Projects are designed such that each student will have a unique screenshot after completing each project. Any sharing or duplication of project deliverables will be obvious.

***Updated News Articles***—Each chapter contains expanded and updated IT security news articles. Over 80 percent of the news articles in this book reference stories that have occurred since the prior edition was published.

***Expanded Material on Certifications***—Reviewers of the prior edition asked for more material related to IT security certifications. We live in a world that relies on credentials as a means of conveying legitimacy, skill, and possibly experience. In this respect, the security field is no different. To this end, we have updated and expanded the certification focus article in Chapter 10. It is likely that students pursuing a career in the IT security industry will seek some type of certification.

## Why Use This Book?

***INTENDED AUDIENCE*** This book is written for a one-term introductory course in IT security. The primary audience is upper-division BS majors in Information Systems, Computer Science, or Computer Information Systems. This book is also intended for graduate students in Masters of Information Systems (MSIS), Master of Business Administration (MBA), Master of Accountancy (MAcc), or other MS programs that are seeking a broader knowledge of IT security.

It is designed to provide students with IT security knowledge as it relates to corporate security. It will give students going into the IT security field a solid foundation. It can also serve as a network security text.

***PREREQUISITES*** This book can be used by students who have taken an introductory course in information systems. However, taking a networking course before using this book is strongly advisable. For students who have not taken a networking course, Module A is a review of networking with a special focus on security aspects of network concepts.

Even if networking is a prerequisite or corequisite at your school, we recommend covering Module A. It helps refresh and reinforce networking concepts.

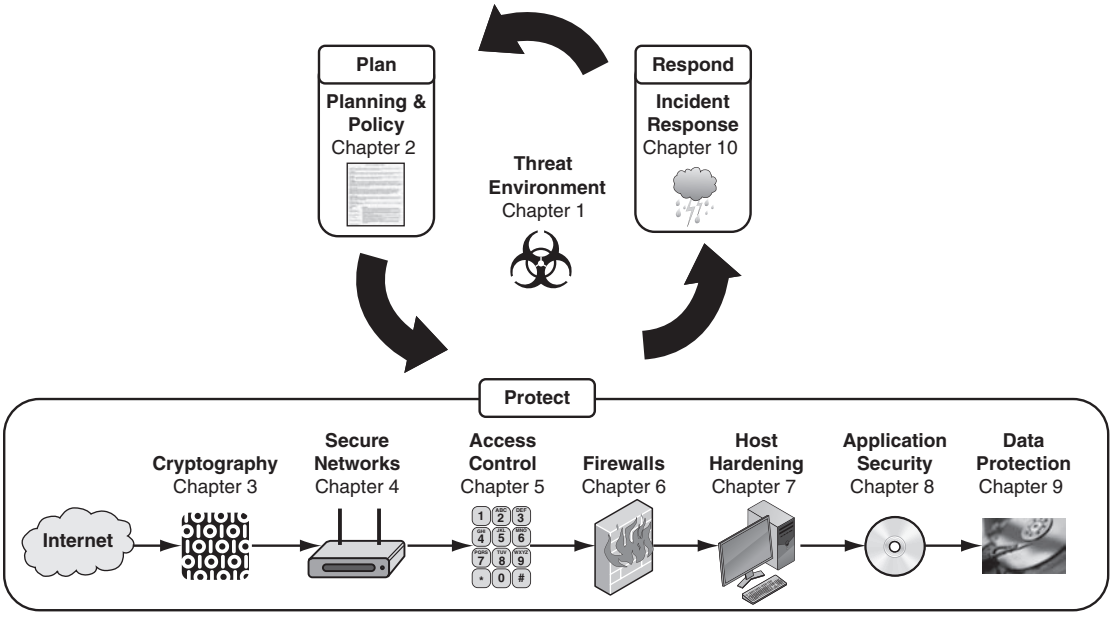
***BALANCING TECHNICAL AND MANAGERIAL CONTENT*** Our students are going to need jobs. When you ask working IT security professionals what they are looking for in a new hire, they give similar responses. They want proactive workers who can take initiative, learn on their own, have strong technical skills, and have a business focus.

A business focus does not mean a purely managerial focus. Companies want a strong understanding of security management. But they also want a really solid understanding of defensive security technology. A common complaint is that students who have taken managerial courses don't even know how stateful packet inspection firewalls operate, or what other types of firewalls are available. "We aren't hiring these kids as security managers" is a common comment. This is usually followed by, "They need to start as worker bees, and worker bees start with technology."

Overall, we have attempted to provide a strong managerial focus along with a solid technical understanding of security tools. Most of this book deals with the technical aspects of protective countermeasures. But even the countermeasure chapters reflect what students need to know to manage these technologies. You can "throttle" the amount of technical content by using or not using the Hands-on Projects at the end of each chapter.

## How Is This Book Organized?

The book starts by looking at the threat environment facing corporations today. This gets the students' attention levels up, and introduces terminology that will be used throughout the rest of the book. Discussing the threat environment demonstrates the need for the defenses mentioned in later chapters.




The rest of the book follows the good old plan–protect–respond cycle. Chapter 2 deals with planning, and Chapter 10 deals with incident and disaster response. All of the chapters in the middle deal with countermeasures designed to protect information systems.

The countermeasures section starts with a chapter on cryptography because cryptographic protections are part of many other countermeasures. Subsequent chapters introduce secure networks, access control, firewalls, host hardening, application security, and data protection. In general, the book follows the flow of data from networks, through firewalls, and eventually to hosts to be processed and stored.

***USING THE BOOK IN CLASS*** Chapters in this book are designed to be covered in a semester week. This leaves a few classes for exams, presentations, guest speakers, hands-on activities, or material in the module. Starting each class with a demonstration of one of the hands-on projects is a good way to get students' attention.

It's important for students to read each chapter before it's covered in class. The chapters contain technical and conceptual material that needs to be closely studied. We recommend either giving a short reading quiz or requiring students to turn in Test Your Understanding questions before covering each chapter.

***POWERPOINT SLIDES AND STUDY FIGURES*** The PowerPoint lectures cover nearly everything, as do the study figures in the book. Study figures even summarize main points from the text. This makes the PowerPoint presentations and the figures in the book great study aids.

***TEST YOUR UNDERSTANDING QUESTIONS*** After each section or subsection, there are Test Your Understanding questions. This lets students check if they really understood what they just read. If not, they can go back and master that small chunk of material before going on. The

test item file questions are linked to particular Test Your Understanding questions. If you cut some material out, it is easy to know what multiple-choice questions not to use.

***INTEGRATIVE THOUGHT QUESTIONS*** At the end of each chapter, there are integrative Thought Questions which require students to synthesize what they have learned. They are more general in nature, and require the application of the chapter material beyond rote memorization.

***HANDS-ON PROJECTS*** Students often comment that their favorite part of the course is the Hands-on Projects. Students like the Hands-on Projects because they get to use contemporary IT security software that relates to the chapter material. Each chapter has at least two applied projects and subsequent Project Thought Questions.

Each project requires students to take a unique screenshot at the end of the project as proof they completed the project. Each student's screenshot will include a time stamp, the student's name, or another unique identifier.

***CASE STUDY*** Each chapter includes a real-world case study focused on how IT security affects corporations. More specifically, each case study is designed to illustrate how the material presented in the chapter could impact a corporation. Along with each case study are related key findings from prominent annual industry reports. Links to each industry report are provided and can be used as supplementary reading. Case studies, combined with key findings from relevant industry reports, should provide ample material for classroom discussion.

***CASE DISCUSSION QUESTIONS*** Case studies are followed by a series of open-ended questions to guide case-based classroom discussions. They offer students the opportunity to apply, analyze, and synthesize the material presented in the chapter within the context of a real-world business case.

***PERSPECTIVE QUESTIONS*** There are two general questions that ask students to reflect on what they have studied. These questions give students a chance to think comprehensively about the chapter material at a higher level.

***HEY! WHERE'S ALL THE ATTACK SOFTWARE?*** This book does not teach students how to break into computers. There is software designed specifically to exploit vulnerabilities and gain access to systems. This book does not cover this type of software. Rather, the focus of the book is how to proactively defend corporate systems from attacks.

Effectively securing corporate information systems is a complicated process. Learning how to secure corporate information systems requires the entire book. Once students have a good understanding of how to secure corporate systems, they *might* be ready to look at penetration testing software.

With 10 chapters, you do have time to introduce some offense. However, if you do teach offense, do it carefully. Attack tools are addictive, and students are rarely satisfied using them in small labs that are carefully air-gapped from the broader school network and the Internet. A few publicized attacks by your students can get IT security barred from the curriculum.

## Instructor Supplements

This is a hard course to teach. We have tried to build in as much teacher support as possible. Our goal was to reduce the total amount of preparation time instructors had to spend getting ready to teach this course.

Learning new course material, monitoring current events, and managing an active research agenda is time-consuming. We hope the instructor supplements make it easier to teach a high-quality course with less prep time.

***ONLINE INSTRUCTOR RESOURCES*** The Pearson Higher Education website (www.pearsonglobaleditions.com/Boyle) has all of the supplements discussed below. These include the PowerPoint lectures, test item file, TestGen software, teacher's manual, and a sample syllabus.

***POWERPOINT LECTURES*** There is a PowerPoint lecture for each chapter. They aren't "a few selected slides." They are full lectures with detailed figures and explanations. And they aren't made from figures that look pretty in the book but that are invisible on slides. We have tried to create the PowerPoint slides to be pretty self-explanatory.

***TEST ITEM FILE*** The test item file for this book makes creating, or supplementing, an exam with challenging multiple-choice questions easy. Questions in the test item file refer directly to the Test Your Understanding questions located throughout each chapter. This means exams will be tied directly to concepts discussed in the chapter.

***TEACHER'S MANUAL*** The Teacher's Manual has suggestions on how to teach the chapters. For instance, the book begins with threats. In the first class, you could have students list everybody who might attack them. Then have them come up with *ways* each group is likely to attack them. Along the way, the class discussion naturally can touch on chapter concepts such as the distinction between viruses and worms.

***SAMPLE SYLLABUS*** We have included a sample syllabus if you are teaching this course for the first time. It can serve as a guide to structuring the course and reduce your prep time.

***STUDENT FILES*** Study Guide and Homework files in Word are available for download by accessing www.pearsonglobaleditions.com/Boyle.

***E-MAIL US*** Please feel free to e-mail us. You can reach Randy at BoyleRJ@Longwood.edu, or Ray at Ray@Panko.com. Your Pearson Sales Representative can provide you with support, but if you have a question, please also feel free to contact us. We'd also love suggestions for the next edition of the book and for additional support for this edition.

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We would like to thank all of the reviewers of prior editions. They have used this book for years and know it well. Their suggestions, recommendations, and criticisms helped shape this edition. This book really is a product of a much larger community of academics and researchers.

We would also like to thank the industry experts who contributed to this edition. Their expertise and perspective added a real-world perspective that can only come from years of practical experience. Thanks to Matt Christensen, Dan McDonald at Utah Valley University, Amber Schroader at Paraben Corp., Chris Larsen at BlueCoat Systems, Inc., David Glod at Grant Thornton, Andrew Yenchik, Stephen Burton, and Susan Jensen at Digital Ranch, Inc., Morpho, and Bruce Wignall at Teleperformance Group.

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Lastly, and most importantly, I (Randy) would like to thank Ray. Like many of you, I have used Ray's books for years. Ray has a writing style that students find accessible and intuitive. Ray's books are popular and widely adopted by instructors across the country. His books have been the source of networking and security knowledge for many workers currently in the industry.

I'm grateful that Ray trusted me enough to work on one of his books. I hope this edition continues in the legacy of great texts Ray has produced. It's an honor to work with a generous person like Ray.

***Randy Boyle***
***Ray Panko***

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**Contributor**

Sahil Raj, Punjabi University

**Reviewers**

Fabian Ng Yaw Tong, School of InfoComm Technology, Ngee Ann Polytechnic

Lucas Chi Kwong HUI, The University of Hong Kong

Ng Hu, Multimedia University

# ABOUT THE AUTHORS

**Randy Boyle** is a professor at the College of Business and Economics at Longwood University. He received his PhD in Management Information Systems (MIS) from Florida State University in 2003. He also has a master's degree in Public Administration and a BS in Finance. His research areas include deception detection in computer-mediated environments, information assurance policy, the effects of IT on cognitive biases, and the effects of IT on knowledge workers. He has received college teaching awards at the University of Alabama in Huntsville, the University of Utah, and Longwood University. His teaching is primarily focused on information security, networking, and management information systems. He is the author of *Applied Information Security* and *Applied Networking Labs*.

**Ray Panko** is a professor of IT Management at the University of Hawai`i's Shidler College of Business. His main courses are networking and security. Before coming to the university, he was a project manager at Stanford Research Institute (now SRI International), where he worked for Doug Englebart (the inventor of the mouse). He received his BS in Physics and his MBA from Seattle University. He received his doctorate from Stanford University, where his dissertation was conducted under contract to the Office of the President of the United States. He has been awarded the Shidler College of Business's Dennis Ching award as the outstanding teacher among senior faculty. He is also a Shidler Fellow.

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CHAPTER 1

# The Threat Environment

## Chapter Outline



## Learning Objectives

**After studying this chapter, you should be able to:**

- Define the term *threat environment*.
- Use basic *security terminology*.
- Describe threats from *employees* and ex-employees.
- Describe threats from *malware* writers.
- Describe traditional external hackers and their *attacks*, including break-in processes, social engineering, and denial-of-service attacks.
- Know that *criminals* have become the dominant attackers today, describe the types of attacks they make, and discuss their methods of cooperation.
- Distinguish between *cyberwar* and *cyberterror*.

## 1.1 INTRODUCTION

The world today is a dangerous place for corporations. The Internet has given firms access to billions of customers and other business partners, but it has also given criminals access to hundreds of millions of corporations and individuals. Criminals are able to attack websites, databases, and critical information systems without ever entering the corporation's host country.

Corporations have become critically dependent on information technology (IT) as part of their overall competitive advantage. In order to protect their IT infrastructure from a variety of threats, and subsequent profitability, corporations must have comprehensive IT security policies, well-established procedures, hardened applications, and secure hardware.

### Basic Security Terminology

**THE THREAT ENVIRONMENT** If companies are to be able to defend themselves, they need an understanding of the **threat environment**—that is, the types of attackers and attacks companies face. "Understanding the threat environment" is a fancy way of saying "Know your enemy." If you do not know how you may be attacked, you cannot plan to defend yourself. This chapter will focus almost exclusively on the threat environment.

*The threat environment consists of the types of attackers and attacks that companies face.*

**The Threat Environment**
- The threat environment consists of the types of attackers and attacks that companies face

**Security Goals**
- **Confidentiality**
  - Confidentiality means that people cannot read sensitive information, either while it is on a computer or while it is traveling across a network
- **Integrity**
  - Integrity means that attackers cannot change or destroy information, either while it is on a computer or while it is traveling across a network. Or, at least, if information is changed or destroyed, then the receiver can detect the change or restore destroyed data
- **Availability**
  - Availability means that people who are authorized to use information are not prevented from doing so

**Compromises**
- Successful attacks
- Also called incidents and breaches

**Countermeasures**
- Tools used to thwart attacks
- Also called safeguards, protections, and controls
- Types of countermeasures
  - Preventative
  - Detective
  - Corrective

**FIGURE 1-1** Basic Security Terminology (Study Figure)

**SECURITY GOALS** Corporations and subgroups in corporations have **security goals**—conditions that the security staff wishes to achieve. Three common core goals are referred to collectively as **CIA**. This is not the Central Intelligence Agency. Rather, CIA stands for confidentiality, integrity, and availability.

- ***Confidentiality***—Confidentiality means that people cannot read sensitive information, either while it is on a computer or while it is traveling across a network.
- ***Integrity***—Integrity means that attackers cannot change or destroy information, either while it is on a computer or while it is traveling across a network. Or, at least, if information is changed or destroyed, then the receiver can detect the change or restore destroyed data.
- ***Availability***—Availability means that people who are authorized to use information are not prevented from doing so. Neither a computer attack nor a network attack will keep them away from the information they are authorized to access.

Many security specialists are unhappy with the simplistic CIA goal taxonomy because they feel that companies have many other security goals. However, the CIA goals are a good place to begin thinking about security goals.

**COMPROMISES** When a threat succeeds in causing harm to a business, this is called an **incident**, **breach**, or **compromise**. Companies try to deter incidents, of course, but they usually have to face several breaches each year, so response to incidents is a critical skill. In terms of the business process model, threats push the business process away from meeting one or more of its goals.

*When a threat succeeds in causing harm to a business, this is called an incident, breach, or compromise.*

**COUNTERMEASURES** Naturally, security professionals try to stop threats. The methods they use to thwart attacks are called **countermeasures**, **safeguards**, **protections**, or **controls**. The goal of countermeasures is to keep business processes on track for meeting their business goals despite the presence of threats and actual compromises.

*Tools used to thwart attacks are called countermeasures, safeguards, or controls.*

Countermeasures can be technical, human, or (most commonly) a mixture of the two. Typically, countermeasures are classified into three types:

- ***Preventative***—Preventative countermeasures keep attacks from succeeding. Most controls are preventative controls.
- ***Detective***—Detective countermeasures identify when a threat is attacking and especially when it is succeeding. Fast detection can minimize damage.
- ***Corrective***—Corrective countermeasures get the business process back on track after a compromise. The faster the business process can get back on track, the more likely the business process will be to meet its goals.

## TEST YOUR UNDERSTANDING

1. **a.** Why is it important for firms to understand the threat environment?
   **b.** Name the three common security goals.
   **c.** Briefly explain each goal.
   **d.** What is an incident?

e. What are the synonyms for *incidents*?
f. What are countermeasures?
g. What are the synonyms for *countermeasure*?
h. What is the goal of countermeasures?
i. What are the three types of countermeasures?

# CASE STUDY

## The Sony Data Breaches

If this terminology seems abstract, it may help to look at a specific attack to put these terms into context and to show how complex security attacks can be. We will begin with one of the largest losses of private customer information. These were a series of data breaches at Sony Corporation.

### Sony Corporation

Sony Corporation is a Japanese multinational corporation founded in 1946 that focuses on electronics, game, entertainment, and financial services. It employs about 146,300 people and has annual revenues of about $72.3 billion. Sony is widely known for its televisions, digital imaging, audio/video hardware, PCs, semiconductors, electronic components, and gaming platform.

### The First Attack

The first of three attacks on Sony occurred on April 17–19, 2011, just weeks after the catastrophic earthquake, tsunami, and subsequent reactor meltdowns in Japan. Attackers used SQL injection to steal 77 million accounts containing personally identifiable information (PII) including names, addresses, dates of birth, usernames, passwords, security questions, and some credit card numbers.[1] Considering the amount and sensitive nature of the data stolen, this attack is easily one of the most severe losses of consumer data to date.

Sony detected unusual server activity on April 19 and brought in forensic examiners to determine if data may have been stolen.[2] On April 20, Sony turned off access to the entire 77 million-user Sony PlayStation Network (PSN) fearing that the attackers accessed user accounts. Sony then provided the FBI with information about the attack.

Sony publicly acknowledged the intrusion on April 26, more than a week after it became aware of it. Sony would later face scrutiny about its decision to delay telling its customers that attackers had access to their account information for a full week.

On April 30, the CEO of Sony, Kazuo Hirai, apologized to PSN gamers for the loss of their account information and the continuing PSN outage.[3] At the press conference Hirai said,

> These illegal attacks obviously highlight the widespread problem with cybersecurity. We take the security of our consumers' information very seriously and are committed to helping our consumers protect their personal data. In addition,

[1] Shane Richmond and Christopher Williams. "Millions of Internet Users Hit by Massive Sony PlayStation Data Theft," *The Telegraph*, April 26, 2011. http://www.telegraph.co.uk/technology/news/8475728/Millions-of-internet-users-hit-by-massive-Sony-PlayStation-data-theft.html.
[2] Dean Takahashi, "Chronology of the Attack on Sony's PlayStation Network," *VentureBeat.com*, May 4, 2011. http://venturebeat.com/2011/05/04/chronology-of-the-attack-on-sonys-playstation-network/#QuSrgtEootxXhtil.99.
[3] Dean Takahashi, "Sony Executive Kaz Hirai Apologizes for PlayStation Network Outage," *VentureBeat.com*, April 30, 2011. http://venturebeat.com/2011/04/30/psn-outage-apolog/.