



# Intrusion Prevention Fundamentals

An introduction to network attack mitigation with IPS



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Earl Carter  
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**Cisco Press**

800 East 96th Street  
Indianapolis, IN 46240 USA

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Earl Carter and Jonathan Hogue

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Published by:

Cisco Press

800 East 96th Street

Indianapolis, IN 46240 USA

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Printed in the United States of America 1 2 3 4 5 6 7 8 9 0

First Printing January 2006

Library of Congress Cataloging-in-Publication Number: 2005922371

ISBN: 1-58705-239-3

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Printed in the USA

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## Dedications

**Earl's dedication:** Without my loving family, I would not be where I am today. They always support all the projects that I undertake. Therefore, I dedicate this book to my wife Chris, my daughter Ariel, and my son Aidan.

**Jonathan's dedication:** To my wife Liz, for believing in me.

## Acknowledgments

First, we want to say that many people helped us during the writing of this book (too many to be listed here). Everyone that we have dealt with has been very supportive and cooperative. The technical editors, Greg Abelar, Shawn Merdinger, and Gary Halleen, supplied us with their excellent insight and greatly improved the accuracy and clarity of the text.

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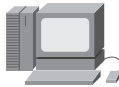
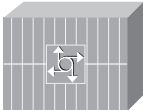











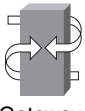



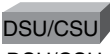


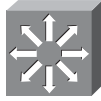





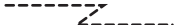
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# Icons Used in This Book

 Communication Server	 PC	 PC with Software	 Sun Workstation	 Macintosh	 Access Server
 Token Ring	 Terminal	 File Server	 Web Server	 CiscoWorks Workstation	 Modem
 Printer	 Laptop	 IBM Mainframe	 Front End Processor	 Cluster Controller	
 Gateway	 Router	 Bridge	 Hub	 DSU/CSU	 FDDI
 Catalyst Switch	 Multilayer Switch	 ATM Switch	 ISDN/Frame Relay Switch		
 Network Cloud	 Line: Ethernet	 Line: Serial	 Line: Switched Serial		

## 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).
- *Italics* indicate arguments for which you supply actual values.
- Vertical bars (|) separate alternative, mutually exclusive elements.
- Square brackets [ ] indicate optional elements.
- Braces { } indicate a required choice.
- Braces within brackets [{ }] indicate a required choice within an optional element.

## Introduction

Intrusion Prevention is a fairly new technology that you can deploy to protect your network from attack and help enforce your security policy guidelines. Understanding this technology is vital to successfully deploying this technology on your network. This book is designed to provide an overview of Intrusion Prevention that enables technology analysts and architects, especially those in charge of corporate security, to determine how Intrusion Prevention can be deployed on their networks. Furthermore, the information provided assists the reader to assess the benefits of Intrusion Prevention.

## Goals and Methods

The goal of this book is to provide an introduction and in-depth overview of Intrusion Prevention as a technology, rather than a technical configuration guide. It uses real-world scenarios and fictitious case studies to walk readers through the lifecycle of an IPS project from needs definition to deployment considerations. Cisco IPS products are used as examples to help readers learn how IPS works, make decisions about how and when to use the technology, and what “flavors” of IPS are available. However, the intent of the material is to provide information on Intrusion Prevention as a technology, not just Cisco Intrusion Prevention products. The book answers questions such as the following:

- Where did IPS come from? How has it evolved?
- How does IPS work? What components does it have?
- What security needs can IPS address? How?
- Does IPS work with other security products? What is the “big picture?”
- Are there best practices related to IPS? What are they?
- How is IPS deployed, and what should be considered before a deployment?

Intrusion Prevention can be applied to your network at both the host level and at the network level. Each of these levels has specific capabilities that complement each other to provide a stronger overall level of security protection. This book explains the benefits of each of these areas of protection, and it walks the reader through detailed deployment examples to help you understand the steps you need to perform to deploy Intrusion Prevention on your network.

## This Book’s Audience

The primary audience for this book comprises information technology analysts and architects, especially those in charge of corporate security, networks, and business needs. These people should have an intermediate level of experience. The secondary audience includes network and security engineers with advanced experience as well as general technology analysts and journalists with experience at a beginner’s level.

This book assumes that the reader has a basic understanding of common security technologies such as antivirus, Intrusion Detection Systems, and firewalls. Readers should also have a basic understanding of security threat and security regulations.

## How This Book Is Organized

This book is organized into five major parts with subsections for each part. Part I introduces Intrusion Prevention technology as a whole, with subsections that detail the history and evolution of Intrusion Prevention System (IPS), the reason for its evolution, and continuing technology trends. Part II focuses on Host Intrusion Prevention specifically, how it works technically, an in-depth technical look at its components, what problems it can solve, purchase decisions, and so on. Part III examines Network Intrusion Prevention in a similar manner. Part IV delves into deployment of both technologies. Part V provides a sample Request for Information (RFI) document as well as a glossary of some key terms associated with Intrusion Prevention.

### ■ Part I: Intrusion Prevention Overview

The initial part provides a high-level overview of intrusion prevention. This overview provides the reader with a strong background understanding of Intrusion Prevention that is expanded in the Host Intrusion Prevention and Network Intrusion Prevention parts.

- **Chapter 1, “Intrusion Prevention Overview”**—This chapter examines the factors that led to the existence of IPS, the evolution of security threats, the evolution of attack mitigation, and basic IPS capabilities.
- **Chapter 2, “Signature and Actions”**—This chapter discusses the types, triggers, and actions of IPS signatures.
- **Chapter 3, “Operational Tasks”**—This chapter reviews the high-level tasks related to using IPS. These include deployment, configuration, monitor IPS activities, and secure IPS communications.
- **Chapter 4, “Security in Depth”**—This chapter demonstrates the importance of security in depth. It gives examples, explains the role of the security policy, and describes future IPS developments that re-enforce the concept.

### ■ Part II: Host Intrusion Prevention

This part provides detailed information about Host Intrusion Prevention and uses Cisco Security Agent (CSA) as a realistic example. The information provided, however, is not detailed step-by-step configuration examples. Instead, it explains in detail how the products can be used to provide Intrusion Prevention. Throughout each chapter, specific information is provided as to how CSA handles specific Host Intrusion Prevention problems that you might experience on your network.

- **Chapter 5, “Host Intrusion Prevention Overview”**—This chapter looks at the capabilities, benefits, and limitations of HIPS.
- **Chapter 6, “HIPS Components”**—This chapter examines the inner workings of HIPS agents and management infrastructures.

### ■ **Part III: Network Intrusion Prevention**

This part provides detailed information about Network Intrusion Prevention, along with realistic information to use Cisco Network Intrusion Prevention products. The information provided, however, is not detailed step-by-step configuration examples. Instead, it explains in detail how the products can be used to provide Intrusion Prevention. Each chapter provides detailed information on Cisco Network Intrusion product capabilities and how those capabilities can protect your network.

— **Chapter 7, “Network Intrusion Prevention Overview”**—This chapter explains the capabilities that Network Intrusion Prevention Systems (NIPS) can add to a network to enhance its security posture.

— **Chapter 8, “NIPS Components”**—This chapter analyzes and explains the various components that comprise a NIPS, including various sensor types and management options.

### ■ **Part IV: Deployment Solutions**

This section walks you through the deployment of Intrusion Prevention in different network configurations.

— **Chapter 9, “Cisco Security Agent Deployment”**—This chapter describes the tasks and decisions you need to make during the implementation of a real-world HIPS product, the Cisco Security Agent (CSA).

— **Chapter 10, “Deploying Cisco Network IPS”**—This chapter describes the tasks and decisions you need to make during the implementation of a real-world NIPS deployment, using the Cisco Network Intrusion Prevention System products as an example.

— **Chapter 11, “Deployment Scenarios”**—This chapter covers an assortment of IPS deployment scenarios where each scenario uses a different type of company as an example.

### ■ **Part V: Appendix**

— **Appendix A, “Sample Request for Information (RFI) Questions”**—This appendix provides a sample RFI to help the reader understand some of the issues that need to be considered when defining your IPS deployment requirements.

- **Glossary**—The glossary provides the definitions for various terms related to Intrusion Prevention along with definitions of other terms related to the book that the reader might need to understand.

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# **Part I: Intrusion Prevention Overview**

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**Chapter 1 Intrusion Prevention Overview**

**Chapter 2 Signatures and Actions**

**Chapter 3 Operational Tasks**

**Chapter 4 Security in Depth**



# Intrusion Prevention Overview

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Computer and network security products evolve. Like living things, they change, grow, and adapt to reflect the conditions around them. Specifically, new threats to security force conditions in which security products adapt by implementing countermeasures that can handle the new threats. Examining the birth of a product and its evolution helps you understand why the product exists, what it can do, and how it might change in the future.

Intrusion Prevention Systems (IPS) are security protection devices or applications that can prevent attacks against your network devices. These systems began life as an adjunct feature of contemporary products, such as firewalls and antivirus products, and evolved into an independent and full-featured set of products in their own right. You find two types of IPSs: Network and Host. This chapter examines the factors that led to the existence of IPSs. It describes the evolution of computer security threats, the evolution of attack mitigation, and some of the IPSs' capabilities.

## Evolution of Computer Security Threats

Security threats have always been around. Anything of value makes a viable target for a thief. Traditionally, theft required physical access to the object being stolen, limiting the number of attackers and increasing the chances of the perpetrator's being caught. This model applied to initial personal computer systems in which the computer was treated like another piece of expensive electronic equipment worth stealing.

Initially, mainframes and minicomputers allowed access to a limited number of directly connected dumb terminals. Gradually, the need for extended connectivity became more important. This need for connectivity led to dialup access to mainframes and minicomputers. Adding dialup connectivity increased the scope of attackers by enabling anyone across the world (with access to a telephone and a computer with a modem) to attempt to access the systems. This access, however, was still fairly limited in that attackers had to determine the phone number to use to connect to the computer system and pay the long distance charges if they were not in the same physical vicinity as the system being accessed. Furthermore, because mainframes and minicomputers were very expensive, attackers had difficulty gaining access to a system to try to find security vulnerabilities (except on the limited number of operational systems).

The development of the Internet has created an environment in which millions of computers across the world are all connected to each other. Furthermore, access to this network is fairly ubiquitous and cheap, enabling any thieves in the world to target your computer, regardless of their physical location. Personal computers are now also cheap. Attackers can easily (and cost effectively) set up various computers with different operating systems and search for exploitable vulnerabilities. Searching for vulnerabilities on systems that they control enables attackers to refine their exploit code before using it on actual systems. After they find a new vulnerability and develop an exploit, they can attack similar systems across the world. Therefore, the way you protect your computer assets has to change to match this new threat landscape. In addition, the international and distributed nature of the Internet makes it very difficult to regulate and control attacks against computer systems.

To protect access to internal networks, most companies deploy a firewall at their network perimeter to limit external access. The development of wireless network access (another technological enhancement) has enabled attackers to bypass these perimeter protection mechanisms. With wireless access, users do not need to be physically connected to gain access to the network. The problem is that wireless connectivity does not stop at the walls of your building. In many deployments, attackers can sit in the parking lot in front of your business and potentially gain access to your wireless network. Without proper protection, this wireless access gives attackers direct connectivity to your internal network.

### **FIREWALL**

A *firewall* is a software or hardware application that limits network access to a private network from external networks. By limiting access, a firewall protects computer resources on the private (or internal) network. Firewalls can control which external systems can access which private systems, as well as limit the systems and applications to which private systems are allowed to connect.

The threats computer security professionals faced two-and-a-half decades ago are comparatively rudimentary and trivial by today's standards. They had no need for IPSs at that time. Unfortunately, threats have matured rapidly since then and are now sophisticated enough to warrant an advanced countermeasure like an IPS.

Many factors impact the security threats to which a computer system is vulnerable. Naturally, some threats are more severe than others, so when trying to understand why an IPS is necessary in today's networks, you need to consider the following factors:

- Technology adoption
- Target value
- Attack characteristics

## Technology Adoption

It is sometimes easy to forget that, at 75 years of age, the digital computer industry as a whole is fairly young. You still find plenty of room for innovation, and new innovations in computing occur regularly. Inventions such as the personal computer and the Internet force businesses to change the way they operate.

The operational change might take some time because businesses don't usually adopt new technologies quickly. New technology comes with a set of risks, such as poor return on investment, security concerns, training costs, and so on. However, most technologies reach a point at which the rewards for adoption outweigh the risks. At that point, the technology is widely adopted, and the potential security risks become a reality. Even when these technologies are adopted, however, the objective many times is to simply get the technology working, with security being left as a future add on.

Four widely adopted technologies stand out as having had a tremendous impact on the evolution of security threats and thus the evolution of IPSs:

- Client-server computing
- The Internet
- Wireless connectivity
- Mobile computing

### Client-Server Computing

Before the client-server architecture became commonplace in the 1990s, most businesses relied solely on mainframes for their computing needs. Users gained access to the mainframe using dumb terminals that were physically connected to the mainframe (but not each other), had a computer screen and a keyboard, but had almost no processing capability. All processing occurred on the mainframe.

#### MAINFRAMES

*Mainframes* are large and powerful computers that support thousands of simultaneous users. Early mainframes operated in timesharing mode, where all users shared processor time, or batch mode, where user programs were sequentially executed on the computer.

Client-server is a computing architecture that has largely replaced mainframes because of its lower cost of ownership. In client-server processing, power is not centralized. Instead, it is distributed across many networked computers, each acting as either a client or server. Clients are expected to provide a great deal of processing power so that the servers can be free to handle intensive computational operations.

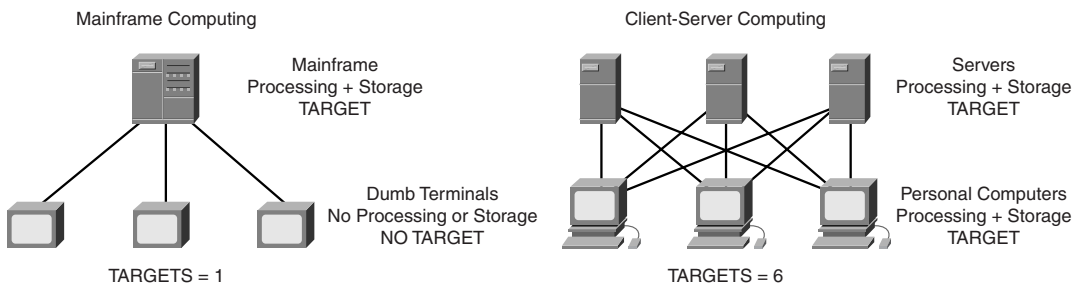
### CLIENT-SERVER ARCHITECTURE

Servers are passive because they wait for a request from a client, fulfill the request, and send it back. Clients actively send requests and wait for a reply from the server. In either case, both computers must be networked together and have processing capability.

Attacks against dumb terminals were limited because the attacker needed physical access to the system. One common attack against these systems was for one user to use the dumb terminal and then run a program that mimicked the normal login program in an attempt to steal login credentials from other users who tried to use the dumb terminal. A terminal, however, that cannot store data and has no processor is usually not an attractive target. Furthermore, dumb terminals cannot be used as a client or a server because they have no processing capability and are not connected together.

Dumb terminals were replaced by personal computers or workstations that could meet the requirements of the client-server architecture. This resulted in a dramatic increase in the number of target hosts and networks available to an attacker. Figure 1-1 illustrates this increase. Large businesses can have hundreds of thousands of networked computers, all of which are potential targets for an attack.

Figure 1-1 Mainframe Versus Client-Server



A client-server architecture not only has more targets for an attacker, but it is also all networked together. If an attacker is able to compromise one computer, any computer connected to the compromised system is now a secondary target. Peer-to-peer networking contributed greatly to this problem by increasing the number of potential pathways between the systems. Furthermore, because the networked computers have high-speed connections and fast processors, they are very valuable and powerful targets.