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Second Edition

Jim Doherty

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Illustrations by Nathan Clement

Cisco Press
800 East 96th Street
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Cisco Networking Simplified, Second Edition

Jim Doherty, Neil Anderson, Paul Della Maggiora

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Dedications

This book is dedicated to Bradley Mitchell.

Bradley was introduced to us by our publisher as a technical reviewer when we wrote our first book together back in 2004 (*Home Networking Simplified*).

We were so happy with his effort, his insightful comments, and his technical expertise that we asked him to be a reviewer on the next book. And on the one after that. And so on and so on until we look back and realize that over five titles, the entire set of the *Networking Simplified* series, Bradley has been a critical part of our writing team, and our books are better for it.

This is not to say that our other reviewers along the way have not been great. They have. But Bradley catches errors that no one else catches (writers, reviewers, publishing team). He is constantly making sure that we have our audience in mind and advises us to rewrite sections when have gone off the deep end. And when we refer to a 128-digit number (and then feel compelled to give an example of one), Bradley actually counts the digits, lets us know that we left off two 0s at the beginning, and then reminds us that you probably don't care about seeing the actual number anyway.

It's nearly impossible to attain perfection in a book like this, but Bradley gets us much, much closer than we would have otherwise. This book, and all our books, are better than they would have been, because Bradley took the time to help us make them better.

We've never had a chance to meet him in person. When we do, we'll shake his hand and buy him a beer (or maybe five—one for each book). In the meantime, we hope this is enough.

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Introduction

Welcome, and thank you for taking a look at this book! Unlike the vast array of networking books written by geeks for geeks, this book was written for you and for anyone who wants to understand the computer networking phenomenon that has taken the world by storm. (In other words, it's by geeks for nongeeks.) We understand that the vast majority of people working in this industry are not networking experts and that it is difficult to understand complex technical and business issues before knowing the answers to such questions as "How does the web work?," "What is a router?," and "What is an IP address?"

Whether you are a home computer user who has just purchased a broadband Internet connection or a company executive who wants to understand what your IT staff is talking about, this book is for you.

If you've decided that you want to make a career change, or if you are in school pursuing a Cisco certification, we believe that this book will serve both as a good primer, introducing the concepts of networking in clear and simple terms, and as a useful reference book as you grow in your career.

What's New in This Edition?

Five years ago, when Paul Della Maggiora and Jim Doherty wrote the first edition, we were trying to fill a gap in the market with a book that explained a broad selection of networking technologies and concepts for the beginner or nontechnical person. Upon sharing our early work, we realized we might be on to something. More talks with college interns, Cisco Academy students, and nontechnical executives at Cisco customers indicated demand for a show-me-what-it-is type of book. This book provides at-a-glance text and illustrations that explain a particular concept or technology in plain and simple language. The material illustrates how these concepts relate to our everyday lives.

We are pleased with the reception the book has received since it was first published. We have received a great deal of positive feedback both from our intended audience and, much to our surprise, from very technical people as well. In fact, the book has had enough interest that we were approached to write a second edition to cover all the new technologies that have come about in the last five years. After all was said and done, about half of this book ended up being new.

Among the biggest additions to this version are the topics covering security, communication tools, and wireless technologies. Security has become one of the biggest areas of investment for networking as companies attempt to protect their network and data from ever-increasing threats and attacks. Communication tools have also changed quite a bit in five years, as both voice and video tools have become more integrated and more sophisticated. Finally, wireless is everywhere now, and users expect all the networking tools on the wired network to be on the wireless network as well.

Another change in this book is that Neil Anderson has joined the writing team. Neil is the coauthor of four other *Networking Simplified* books that we have written since the original release of *Cisco Networking Simplified*. Neil is a great addition to the team and brings a wealth of expertise and insight to this edition.

So How Do I Use This Thing?

The book is divided into nine theme-based parts, each with several chapters covering a network concept or technology. Each chapter contains some or all of the following: a part summary, topic at-a-glance pages, and whiteboard illustrations of relevant concepts. The part summary provides a quick and easy introduction to the topic, so you should generally read it first. Useful for future reference are the topic at-a-glance pages, which illustrate core concepts. And the whiteboard illustrations demonstrate important concepts simply and graphically.

The flow of this book is a bit different from the first time around. In this edition, we took a building-block approach:

- Part I: Networking Fundamentals
- Part II: Networking Infrastructure
- Part III: Network Design
- Part IV: Network Availability
- Part V: Securing the Network
- Part VI: Data Center and Application Networking
- Part VII: Unified Communications
- Part VIII: Mobility
- Part IX: Virtualized Networks

We believe that this approach helps you get from the basics to the more advanced topics more easily. This approach also makes it easier to jump directly into a single topic of interest and understand the big picture.

The illustrations and descriptions of the topics serve to answer the primary questions "What is it?", "Why should I care?", and "What problems need to be solved?". We use "big animal" pictures to explain many of the concepts and avoid the temptation to dive into nitty-gritty details. If you are reading this book, you need to know, for example, what a router does, but not how to actually program one.

The second time around, we had as much fun as the first time through writing and illustrating this book. We also had the benefit of experience and are hopeful that we put it to good use. We hope you find this book both useful and entertaining. If it ends up being your primary reference for networking, so much the better.

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Securing Wireless Networks

Locking Down Wireless

For every networking innovation, there is a hacker looking to exploit it. The advent of wireless networking was no different; in fact, the hackers had a field day with this one early on. The reason is that before wireless, hackers had only two ways to get into a network: They could either penetrate it from the Internet or could get physical access to a live switch port inside the network.

Despite all the news about hacking, breaching a corporate network from the Internet is extremely difficult. This method provides a lot of anonymity (always a plus when breaking the law). If someone can get access to the switch port, the technical stuff is easy. There is, of course, the matter of being caught and detained, though.

When wireless came about, it was a dream for hackers, because they could sit in a car in the parking lot, or even on a bench outside, protecting their anonymity while taking advantage of what was a live port on the network.

You may be wondering why those clever IT guys didn't see this coming. The truth is, they did. In fact, wireless was viewed as such a problem that many companies refused to implement it because of the security risks. However, wireless became accessible and affordable on the consumer side. Corporate employees instantly understood the productivity gains of being able to remain connected while away from their desks. As soon as the prices of wireless routers began to drop, they did what made sense to them. They plugged their own wireless access points—literally, their own personal hotspots—into the ports in their offices so that they could roam around and check e-mail.

Now IT had a huge problem. Not only was wireless a known security risk, but they had open wireless APs that they did not control all over their networks. This was the birth of the "rogue" AP, and it made their security look like Swiss cheese. This is when something really interesting happened. IT realized that the wireless cat could not be stuffed back in the bag. Wireless was here to stay. The people had mandated that they have wireless access, and IT departments realized it was better to "own" wireless so that they could properly secure it.

Balancing Security and Access

Most people in networking believe that balancing security and access is a zero-sum game: give to one, and you must take from the other. Wireless security was no different in the beginning, because users were forced to enter 26-digit hexadecimal codes to gain secure wireless access. It was a pain, but that was the price you paid for checking your e-mail when meetings started to get boring.

Wireless security has come a long way from the "easily" breached Wired Equivalent Privacy (WEP) security keys to the more secure Wi-Fi Protected Access (WPA) and WPA2 security standards. Ease of use has also been improved. Laptops are usually preconfigured by IT so that users can securely connect without a lot of additional steps.

At-a-Glance: Securing Wi-Fi

Why Should I Care About Wireless Security?

With wired networks, intruders need to gain physical access to a building to gain access to the network via a port. With wireless networks, security is a concern because intruders only need to be in the proximity of the building to "see" the wireless signal. In addition, with wired networks intruders need access to your wire to eavesdrop, but for wireless networks they only need to be in the proximity of your client to potentially conduct eavesdropping.

Additional security measures need to be employed on wireless networks to give them the same security confidence level as with wired networks.

An additional security threat presented by wireless networks is someone plugging in a "rogue" access point, essentially an unauthorized wireless network that can put a huge hole in a business's network security policies.

What Problems Need to Be Solved?

For WLANs to be secure, the first challenge is how to secure the process of associating a client to the wireless network to prevent unauthorized wireless access.

Next, there needs to be a way to secure the communications between a client and the wireless network to prevent eavesdropping, balancing security measures with the ease of use still required for clients to access the network.

As mentioned earlier, a secure WLAN implementation needs to be able to mitigate the threat of "rogue" or unauthorized wireless access points.

Wireless security is not a trivial thing. Early attempts at so-called "wired equivalence" (WEP, for example) gave/give a false sense of security in this regard. That is, WEP made people think that they were secure when it was actually a pretty easy thing to crack.

Securing Wireless Networks

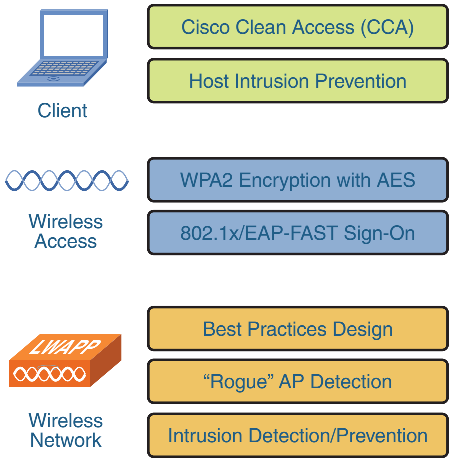
The Cisco Secure Wireless solution provides an integrated approach for deploying secure wireless and mobility services.

Clients are secured via a device "health check" and admission control with Cisco Clean Access (CCA).

Host intrusion prevention is assured with Cisco Secure Agent (CSA).

The wireless access interface is secured via 802.1x/EAP-FAST sign-on authentication, WPA and WPA2 Wi-Fi encryption, and best-practices wireless network.

Finally, the wireless network is secured via an integrated Intrusion Detection System (IDS) and "rogue" (unauthorized) wireless AP detection and mitigation. This is a unified approach to wired and wireless security because many of the features just discussed are also deployed in the wired network.

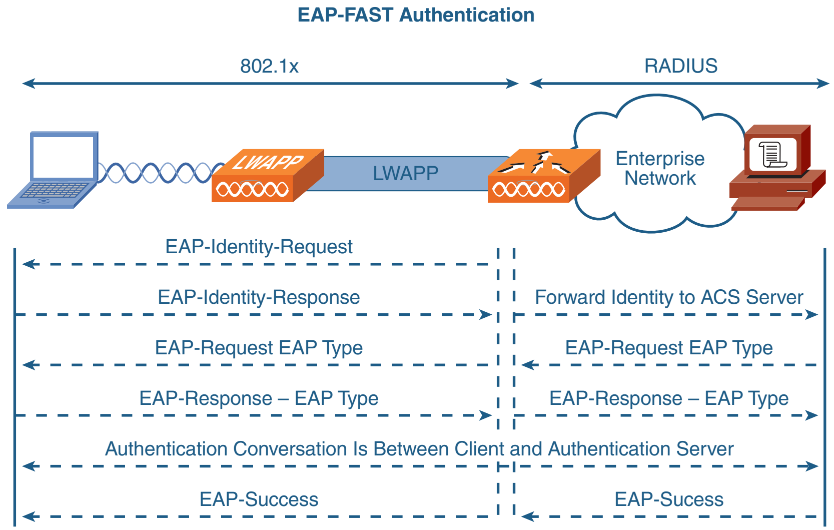


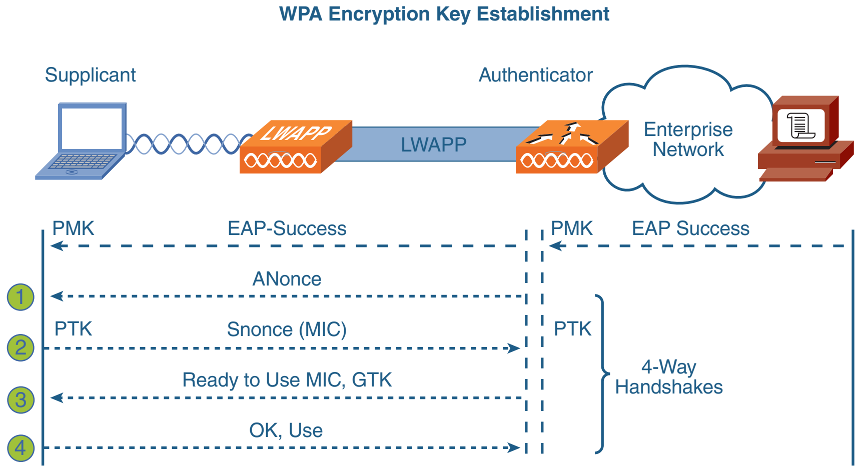
Wireless Encryption

The first important step in securing wireless is to follow best practices for client authentication and encryption. By using Extensible Authentication Protocol (EAP) and Flexible Authentication via Secure Tunnel (FAST) to authenticate wireless clients, only authorized clients are given access to the network. After they are connected, WPA or WPA2 (preferred) is used for encryption key establishment. After EAP-FAST is successful, a pairwise master key (PMK) is created.

WPA and WPA2 use a four-way handshake process to generate a pairwise temporal key (PTK) that is kept secret. WPA2 uses the Advanced Encryption Standard (AES) algorithm, adding security above WPA.

At-a-Glance: Securing Wi-Fi

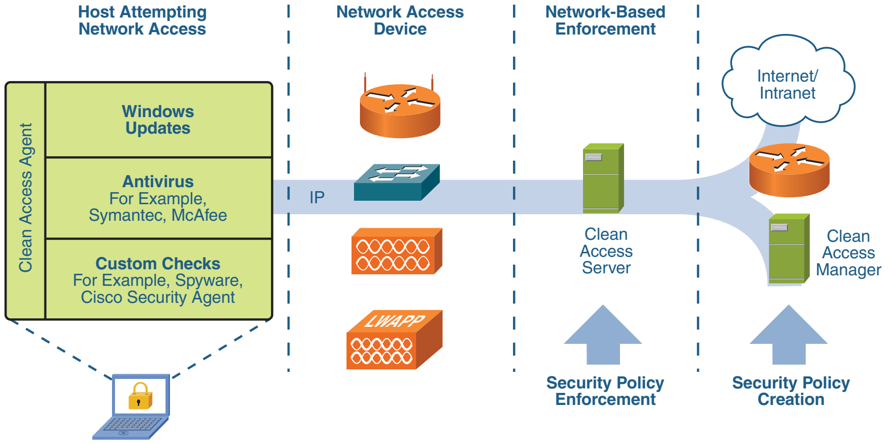




Health Checks

By their nature, laptops and other mobile devices inherently get exposed to more opportunities for infections by viruses, malware, spyware, and so on. Given that, it is a good wireless security practice to add a "posture check" to the authentication process to ensure that the client is healthy before gaining access. Cisco Network Admission Control (NAC) using Cisco Clean Access (CCA) performs an additional challenge to client devices to "prove their health" before being allowed to access the wireless network. The definition of a "healthy" device is determined by the IT staff. It can include the following:

- Free of viruses and other malware
- Correct antivirus software and signature files are loaded
- Operating system updates are current
- Custom policy checks added by IT staff



Unhealthy devices are placed in a "quarantine" wired or wireless network for remediation and are not permitted to access the rest of the production network.

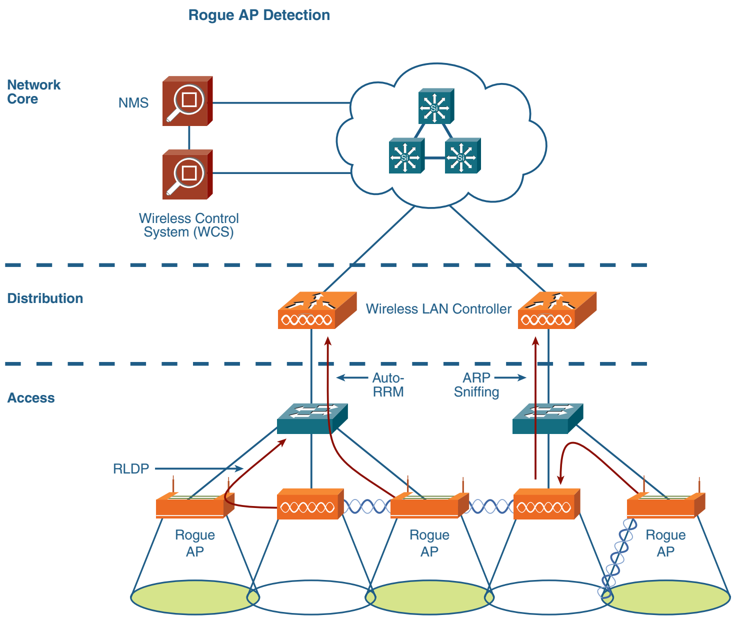
See Part V, "Securing the Network," for a more in-depth discussion of NAC and CCA.

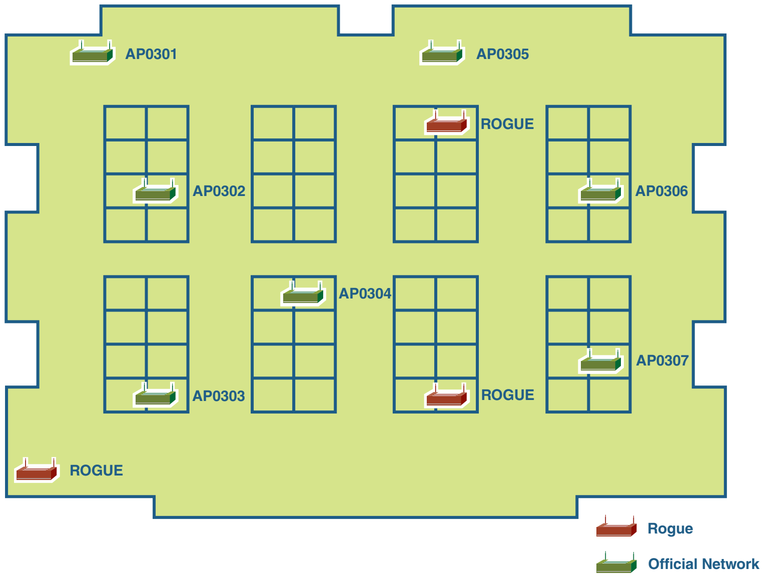
Rogue Access Points

"Rogue" or unauthorized wireless access points provide a serious security threat to a network. Locating and shutting down such unauthorized APs can be difficult without automated detection and location systems. The Cisco

At-a-Glance: Securing Wi-Fi

Unified Wireless solution uses authorized wireless access points to scan the environment for “rogue” access points. Detection information is provided to the WLCs, which can then assist in correlation and isolation and provide the information to the WCS. Wireless topology information can be married with building layout diagrams to provide visual indications of “rogue” AP locations so that IT staff can take appropriate actions to shut them down.





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