cwnp® Official Study Guide

Certified Wireless Network Professional

Exam PW0-250

CWDP™

Certified Wireless Design Professional

Official Study Guide

Shawn M. Jackman, CWNE #54
Marcus Burton, CWNE #78
Matt Swartz, CWNE #57
Thomas W. Head

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Sybex was founded in 1976. More than 30 years later, we're still committed to producing consistently exceptional books. With each of our titles, we're working hard to set a new standard for the industry. From the paper we print on, to the authors we work with, our goal is to bring you the best books available.

I hope you see all that reflected in these pages. I'd be very interested to hear your comments and get your feedback on how we're doing. Feel free to let me know what you think about this or any other Sybex book by sending me an email at nedde@wiley.com. If you think you've found a technical error in this book, please visit http://sybex.custhelp.com. Customer feedback is critical to our efforts at Sybex.

Best regards,

Neil Edde

Vice President and Publisher

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We dedicate this book to our families and the continued support that has helped to make this book possible.

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About the Authors

Shawn Jackman designs and establishes new product offerings and sets Wi-Fi direction for one of the United States' largest hospital systems, Kaiser Permanente. Shawn coauthored the *CWSP Certified Wireless Security Professional Official Study Guide: Exam PW0-204* (Sybex, 2010). He has traveled the United States and internationally, designing wired and wireless networks, from concept to completion, for healthcare, warehouse, hospitality, education, metro/municipal, government, franchise, and retail environments. Shawn is a member of the CWNE Roundtable, a group of individuals who work with the CWNP Program to provide direction for the CWNE exam and certification. He lives in the San Francisco Bay Area with his wife, Joy, and their three children, Summer, Pierce, and Julia. Shawn is CWNE #54, and he can be reached via email at shawn.jackman@cwne.com.

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Matt Swartz is a Technical Leader within Cisco's Advanced Services Wireless Practice. He delivers scalable designs that enable mobility solutions across many verticals for Cisco's

largest customers. Matt's most recent focus is on high-density wireless as he drives new technology to expand capacity in these environments. Prior to joining Cisco in 2003, Matt held network engineering positions with a number of service providers and enterprises. He is CCIE #13232 (Routing/Switching & Wireless) and CWNE #57. He also holds a BS degree from Old Dominion University, and is a member of the CWNE Roundtable. Matt can be reached at matt.swartz@cwne.com.

Thomas Head has been an engineer and manager in the wireless industry for over 20 years. Tom graduated from Rensselaer Polytechnic Institute with a degree in physics. He was an engineer, then manager, of radio design at Lockheed Martin's spacecraft division. He was also manager of radio programs for Lucent Technologies' third-generation cellular base station. At Flarion Technologies, Tom was responsible for RF and network testing of Flarion's innovative Flash-OFDM wireless system. He formed his own company, Aereo Networks, in 2006, which provided wireless test services and software for the US Army, Army Reserves, and major healthcare systems. He can be reached at head@aereonetworks.com.

Foreword

So you want to design an enterprise wireless network? “I can’t connect to the Wi-Fi!” is what you’re going to hear if you don’t get your Wi-Fi right. How do you permanently remove this wonderful end user complaint from your WLAN? It starts with proper design.

I actually considered starting and ending this foreword to the *CWDP: Certified Wireless Design Professional Official Study Guide* with just the above sentiment. That sums it up, but there is much more to it. Today’s end user expects the wireless network to just work, period. When it doesn’t, customers leave, employees complain, managers scream, and your network is always to blame . . . even when it isn’t.

A few years ago, before Polycom bought them, SpectraLink ran into quite a few of these complaints, only the complaints were “These phones don’t work!” and it really was the network. What did SpectraLink do? They created a services team to design and build their customers’ WLANs properly, so that the SpectraLink phones running on those WLANs would work. It wasn’t the phones. It was the network. The network was not properly designed to support Wi-Fi phones. That was five years ago. Imagine what the network has to support today, thanks to Mr. Steve Jobs!

Whether you’re designing for a coffee shop hotspot or the Super Bowl, your design before the network is implemented will determine hero or goat status. The fun part is, much like security, it gets noticed only when it doesn’t work. If everything works flawlessly, you’ve done your job. When you hear that soulful end user scream—“Mine’s broken!”—then you know you’ve missed the mark.

So how do you design for something you can’t see? RF is a strange animal indeed, often referred to as black magic, or smoke and mirrors, so you must know RF cold. That includes

the RF math, behavior, and characteristics, in addition to the building(s) for which you are designing the network. That's right: you have to know building materials! RF acts differently around cement, metal, drywall, plaster, wood, trees, fences, and, yes, people. That's part of the reason we require a CWNA before you can be a CWDP. You have to know RF, and you have to know RF really well before you can claim to be a WLAN designer.

And, oh, wouldn't it be nice if every new WLAN was a sweet new greenfield implementation? Sorry, not going to happen. You will most likely be replacing an old 802.11b or 802.11g WLAN with an 802.11n system. And wouldn't it be nice if it were just rip and replace? Ha! Life should be so easy! If your manager or your customer suggests rip and replace, you'd do well to suggest that they find someone else to do this job. That should get someone's attention. Then it's your job to explain, for example, how differently an 802.11g network and an 802.11n network behave, not only in that particular environment, but in any environment.

With a/b/g, multipath and interference were the bane of your existence. Now, multipath is good for 802.11n Wi-Fi. That means a complete change in the way you design the WLAN for any environment.

Ah, but we don't design only for the environment, do we? No, no, we don't. We must design for the specific applications, and the type(s) of and number of devices that will utilize the WLAN, and the specific industry, and the number of end users . . . the list goes on and on. And then there's VoWiFi and video. How many people have you seen watching (fill in the blank) on YouTube on the wireless LAN? Your WLAN has to support that kind of bandwidth, lest you hear the cry of the end user: "Mine's broken!"

Reliable enterprise Wi-Fi starts with the design of the wireless network. So where do you start to end up with a great design? You guessed it: your old friend the RF site

survey. Missed it, didn't you? What's wrong? Haven't climbed enough towers, scaled enough ceilings, pushed enough carts, dropped enough handhelds, or walked enough miles lately? It's time to go back to where you started, and improve your game not just a little but a lot. When you did your first 50 RF site surveys, were you thinking about the design of the network, or were you thinking about getting the survey done as quickly and with as little pain as possible?

Now return to the RF site survey with the—no, with *your*—network design in mind. This time, you're doing the survey for the purpose of designing a reliable, scalable, secure, mission-critical enterprise wireless LAN. It's not just Internet access anymore; it is the new access layer technology for the 21st century.

You want to design my wireless network? Start with this book, and see where it takes you.

Kevin Sandlin

Co-Founder and CEO

CWNP, Inc.

Introduction

The content of this book is focused on the *real world* of wireless design. While this book provides all of the necessary information to pass the CWDP exam, the content is primarily focused on providing tangible value to immediately expand your wireless expertise. The knowledge you will obtain from this book will not only prove valuable if you plan on performing or participating in wireless designs, but will also help you understand what makes WLANs tick, spot design mistakes, troubleshoot pesky clients and applications, understand and quantify RF issues, and more.

Writing a book on wireless design in order to certify career professionals on designing for any equipment vendor isn't a light undertaking. Vendors differ in their approach. There are even different architectures that greatly vary in the way they work, which is certainly the case between equipment vendors, but major architectural differences can even be found between product lines from a single equipment vendor.

The approach taken with the CWDP is far deeper in one area in particular than any other CWNP curriculum has ever embarked upon before—RF. Radio frequency fundamentals is an extremely tough area to teach and is probably the single least understood area of wireless networking across technical professionals. This book aims to change some of that. After all, a house can't be built on a bad foundation. A wired network can't be built using bad cabling. A supersonic jet . . . you get the point. Without the proper foundation for a wireless LAN, the performance will suffer and your network may ultimately fail.

The total focus of this book isn't just the wireless network infrastructure—we also explore the client devices that the wireless network infrastructure supports. In Wi-Fi, the

communication link of a wireless client and an AP must be in parity with each other. For example, if you switch phones, even with the same mobile network carrier, your experience will vary. Where you may have once had good reception, you won't now, and vice versa. It is no different with Wi-Fi. In fact, it is worse. Mobile network carriers have incredible control over the phones they will support and perform a great deal of engineering before placing them into the hands of customers. Wi-Fi, on the other hand, has many different equipment infrastructure vendors, an even greater disparity of operating modes, and a far greater variety of client devices with comparatively very little rigor and testing between them. Industry standards have a lot of wiggle room, and as a wireless network designer, you need to take this fact into account from the onset. After all, the very reason a wireless network exists is to support client devices.

If you have purchased this book or if you are thinking about purchasing this book, you probably have some interest in taking the CWDP® (Certified Wireless Design Professional) certification exam or in learning more about what the CWDP certification exam is about. We would like to congratulate you on this first step, and we hope that our book can help you on your journey. Wireless networking is one of the hottest technologies available today and demands for mobility are great among a wide variety of industries. As with many fast-growing technologies, the demand for knowledgeable people is often greater than the supply. The CWDP certification is your opportunity to distinguish yourself from others and a way to prove that you have the knowledge and skills to support this growing industry. This Study Guide was written with that goal in mind.

This book will teach you about wireless networking so that you have the knowledge needed not only to pass the CWDP certification test, but also to be able to design, install, and

support wireless networks. We have included review questions at the end of each chapter to help you test your knowledge and prepare for the test.

Before we tell you about the certification process and requirements, we must mention that this information may have changed by the time you are taking your test. We recommend that you visit www.cwnp.com as you prepare to study for your test to determine what the current objectives and requirements are.

To adequately study for the CWDP exam, you need to do more than just study the questions and answers in this book! The practice questions we have supplied are designed to test your knowledge of a concept or objective that is likely to be on the CWDP exam, but to really learn this material, you need to read and study the chapters in the book. Please note that the practice questions will be different from the actual certification questions, but if you learn and understand the topics and objectives, you will be better prepared for the test.

About CWDP® and CWNP®

If you have ever prepared to take a certification test for a technology that you are unfamiliar with, you know that you are not only studying to learn a different technology, but probably also learning about an industry that you are unfamiliar with. It is therefore important for you to familiarize yourself with CWNP.

CWNP is an abbreviation for *Certified Wireless Network Professional*. There is no CWNP test—a common misunderstanding. The CWNP program develops courseware and certification exams for wireless LAN technologies in the computer networking industry. The CWNP certification program is a vendor-neutral program.

The objective of CWNP is to certify people on wireless networking, not on a specific vendor's product. Yes, at times the authors of this book and the creators of the certification will talk about, demonstrate, or even teach how to use a specific product; however, the goal is the overall understanding of wireless, not the product itself. If you learned to drive a car, you had to physically sit and practice in one. When you think back and reminisce, you probably do not tell someone you learned to drive a Ford; you probably say you learned to drive using a Ford.

There are seven wireless certifications offered by the CWNP program, but only five of them have exams:

CWTS™: Certified Wireless Technology Specialist The CWTS certification is a recently introduced certification from the CWNP program. CWTS is an entry-level enterprise WLAN certification, and a recommended starting point prior to the CWNA certification. This certification is geared specifically toward both WLAN sales and support staff for the enterprise WLAN industry. The CWTS certification verifies that sales and support staff are specialists in WLAN technology and have all the fundamental knowledge, tools, and terminology to more effectively sell and support WLAN technologies.

CWNA®: Certified Wireless Network Administrator The CWNA certification is a foundation-level Wi-Fi certification; however, it is not considered an entry-level technology certification. Individuals taking this exam (exam PW0-104) typically have a solid grasp on network basics such as the OSI model, IP addressing, PC hardware, and network operating systems. Many candidates already hold other industry-recognized certifications, such as the CompTIA Network+ or Cisco CCNA, and are looking for the CWNA certification to enhance or complement existing skills.

CWSP®: Certified Wireless Security Professional The CWSP certification exam (PW0-200) is focused on standards-based wireless security protocols, security policy, and secure wireless network design. This certification introduces candidates to many of the technologies and techniques that intruders use to compromise wireless networks and that administrators use to protect wireless networks. With recent advances in wireless security, WLANs can be secured beyond their wired counterparts.

CWAP®: Certified Wireless Security Professional The CWAP certification exam (PW0-270) was reintroduced by CWNP in the fall of 2010. The CWAP certification is focused on a deep-level analysis of the components of the 802.11 protocol. This certification is possibly the most difficult CWNP certification to obtain because it requires an intimate knowledge of frame analysis, spectrum analysis, and WLAN troubleshooting. For consultants and engineers who troubleshoot the most difficult networks, CWAP is a perfect certification to hold.

CWDP®: Certified Wireless Design Professional You may not need any background on the CWDP certification since you're holding this book in your hand, but we will include it anyway. CWDP was introduced for the first time by CWNP in early 2011. As WLAN technology proliferates, CWNP was consistently confronted with the need for network designers to be taught how to properly deploy a WLAN. This request reached our ears, and CWDP is our response to help prepare and validate the skill of design engineers across the globe.

CWNE®: Certified Wireless Network Expert The CWNE certification is the highest-level certification in the CWNP program. By successfully completing the CWNE requirements, you will have demonstrated that you have the most advanced skills available in today's wireless LAN

market. The CWNE certification was previously a rigorous and thorough exam covering advanced WLAN analysis, design, troubleshooting, quality-of-service (QoS) mechanisms, spectrum management, and extensive knowledge of the IEEE 802.11 standard. Since many engineers want to pursue their WLAN training in a piecemeal fashion, we have broken down the CWNE topics into individual professional-level exams. After earning all the professional certifications, candidates may apply for the CWNE certification. As the capstone certification, CWNE requires that candidates demonstrate their expertise by meeting several rigorous criteria that are validated via a CWNE application and review process.

CWNT®: Certified Wireless Network Trainer Certified Wireless Network Trainers are qualified instructors certified by the CWNP program to deliver CWNP training courses to IT professionals. CWNTs are technical and instructional experts in wireless technologies, products, and solutions. To ensure a superior learning experience for our customers, CWNP Education Partners are required to use CWNTs when delivering training using official CWNP courseware.

How to Become a CWDP

To become a CWDP, you must do the following three things:

- Agree that you have read and will abide by the terms and conditions of the CWNP Confidentiality Agreement.
- Pass the CWNA certification exam.
- Pass the CWDP certification exam.

The CWNA certification is a prerequisite for the CWDP certification. If you have purchased this book, there is a good chance that you have already passed the CWNA exam and are now ready to move to the next level of certification and plan to study and pass the CWDP exam. That is the

recommended path to achieving CWDP certification; however, there is no requirement to take the exams in order. You can take the CWDP exam prior to passing the CWNA exam, but you will not become a certified CWDP until you have passed both exams.

If you have not yet taken the CWNA exam, we recommend purchasing the *CWNA Certified Wireless Network Administrator Official Study Guide* by David D. Coleman and David A. Westcott (Sybex, 2010).

When you sit to take the test, you will be required to accept a confidentiality agreement before you can continue with the test. After you have agreed, you will be able to continue with the test, and if you pass the test, you are then a CWDP.

A copy of the CWNP Confidentiality Agreement can be found online at the CWNP website.

The information for the exam is as follows:

- Exam number: PW0-250
- Cost: $225 (in U.S. dollars; price subject to change)
- Availability: Register at Pearson VUE (www.vue.com/cwnp)
- Duration: 90 minutes
- Questions: 60
- Question types: Multiple choice/multiple answer
- Passing score: 70% (80% for instructors)
- Available languages: English

When you schedule the exam, you will receive instructions regarding appointment and cancellation procedures, ID requirements, and information about the testing center