Introduction

The PW0-250 exam, covering the 2010 CWDP certification objectives, will certify that the successful candidate possesses the skills necessary to design a high-performing, reliable, and secure enterprise WLAN in a broad range of applications. As a professional-level certification, this exam requires a detailed understanding of the material and will test these concepts in depth. Exam PW0-250 is one of two exams that are required to earn the CWDP certification:

1. Exam PW0-104 – Enterprise Wi-Fi Administration (CWNA)
2. Exam PW0-250 – Enterprise Wi-Fi Design (CWDP)

The skills and knowledge measured by this examination are derived from a survey of wireless networking experts from around the world. The results of this survey were used in weighing the subject areas and ensuring that the weighting is representative of the relative importance of the content.

The following chart provides the breakdown of the CWDP exam as to the weight of each section of the exam.

Wireless LAN Analysis Subject Area	**% Of Exam**
Network Planning	10 %
Enterprise WLAN Design Strategies	25 %
Infrastructure Design and Network Services	10 %
WLAN RF Design	20 %
Advanced Site Surveying	25 %
802.11 Security Design	5 %
Design Troubleshooting	5 %
Total	**100%**

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Network Planning – 10%

1.1 Identify and describe best practices for pre-deployment information gathering and network planning tasks.

1.2 Identify the business justification and the intended goals for the WLAN.

1.3 Determine the budget for a WLAN project and plan a solution accordingly.

1.4 Discover the client device types to be used and understand their impact on design requirements:

- Applications supported
- MAC feature support
- PHY support
- Antenna type, transmit power, and other RF characteristics

1.5 Determine the desired applications to be supported and understand the requirements for specific applications:

- Coverage requirements
- Capacity requirements
- Security requirements
- High Availability (Reliability / Redundancy)
- Latency requirements
- Other application-specific considerations

1.6 Determine the intended end-users for the WLAN and describe best practices for planning a network to accommodate different user groups:

- Corporate users
- Remote users
- Guests

1.7 Identify the physical environment(s) for the network and describe best practices for network deployments for different physical spaces:

- Common areas (cubicles, offices, hallways, rooms, etc.)
- Service areas (elevators, stairwells, restrooms, etc.)
- Industrial areas (manufacturing, warehousing, etc.)
- Guest areas (conference areas, lobbies, small businesses, waiting areas, etc.)
- Outdoor areas (bridging, transportation networks, outdoor stadiums, etc.)

1.8 Demonstrate a detailed understanding of RF propagation behaviors and relate these characteristics to WLAN design for specific environments:

- RF propagation characteristics
- Common construction practices
- Building materials and attenuation characteristics
- Outdoor RF characteristics

1.9 Determine RF link requirements and demonstrate common planning techniques and deployment approaches for outdoor networks, including:

- Point-to-point bridging
- Point-to-multipoint bridging

- Mesh deployments

1.10 Understand the role of regulatory compliance requirements in network planning and demonstrate best practices for maintaining compliance.

1.11 Determine network service requirements and implement Service Level Agreements (SLA) accordingly:

1.11.1. Creation
1.11.2. Monitoring
1.11.3. Reporting
1.11.4. Action

1.12 Describe best practices for updating or modifying an existing WLAN:

1.12.1. Phased upgrades
1.12.2. Upgrading clients
1.12.3. Redesigning to support new applications
1.12.4. Pre-deployment testing and verification practices
1.12.5. Firmware or software upgrades
1.12.6. Implementing new features with existing hardware
1.12.7. Replacing hardware

1.13 Discuss migration strategies for upgrading to 802.11n.

1.14 Explain the importance of building-specific planning considerations:

1.14.1. Structure characteristics

- Square footage
- Ceiling height
- Number of floors

1.14.2. Number of buildings or other campus-specific characteristics
1.14.3. Blueprints / floor plan (image file)
1.14.4. Access restrictions

- Plenum
- Mounting
- Safety and health regulations and concerns

1.14.5. Power sources
1.14.6. MDF and IDF locations
1.14.7. Wiring limitations
1.14.8. Existing WLAN information
1.14.9. Aesthetic requirements

1.15 Implement and understand the role of documentation in network planning and design:

1.15.1. Scope of work
1.15.2. NDA
1.15.3. Hold harmless
1.15.4. Network deployment acceptance criteria
1.15.5. Network design deliverable (topology map, solution explanation, design requirements, etc.)
1.15.6. Site survey deliverable
1.15.7. Bill of Materials (BOM)

- Hardware
- Software/licenses
- Support contracts

1.16 Determine and prioritize equipment selection criteria for a WLAN deployment and recommend an appropriate solution:

1.16.1. Cost
1.16.2. Appropriate use
1.16.3. Capabilities
1.16.4. Architecture
1.16.5. Accessories
1.16.6. Aesthetics

1.17 Explain the functionality and purpose of network planning tools:

1.17.1. Predictive RF modeling
1.17.2. WLAN simulators
1.17.3. RF Calculators

Enterprise WLAN Design Strategies – 25%

2.1 Demonstrate a detailed knowledge of WLAN architectures and solutions. Identify best practice design concepts for each architecture including the following considerations:

- Management solutions
- Protocols for communication and discovery
- Data forwarding models
- Scalability and bottlenecks
- Redundancy Strategies
- Device location in the network
- Encryption and decryption
- VLANs
- QoS
- Roaming considerations
- Architecture-specific security considerations
- RF and channel planning
- Capacity planning
- AP-Controller associations
- Licensing
- Advantages and limitations

2.1.1. Centralized WLAN Architectures

- Local MAC
- Split MAC
- Remote MAC

2.1.2. Autonomous WLAN Architectures

2.1.3. Distributed WLAN Architectures

2.1.4. WLAN Arrays

- Hardware arrays
- Antenna arrays

2.1.5. Mesh Networks

- Mesh as a failover mechanism
- Extension of network access with mesh as a primary backhaul technology
- Client support in a mesh

2.1.6. Remote APs (VPN)

2.1.7. Bridged Networks

- PTP
- PTMP

2.2 Describe design models and considerations for both Multiple Channel Architecture (MCA) and Single Channel Architecture (SCA) WLANs.

2.3 Discuss data forwarding models and how they impact network design:

2.3.1. Centralized forwarding
2.3.2. Distributed forwarding
2.3.3. Split-tunnel forwarding

2.4 Describe how a Distributed Antenna System works and understand its impact on WLAN design and deployment.

2.5 Explain the functions and components of the WLAN operational planes and identify their presence in a given scenario:

2.5.1. Data
2.5.2. Management
2.5.3. Control

2.6 Demonstrate a thorough understanding of design strategies and considerations specific to WLAN client devices:

2.6.1. Client application support
2.6.2. Application-specific (e.g. VoWiFi phones) vs. multi-application client devices (e.g. laptops)
2.6.3. Client management considerations

- Driver selection, configuration, and feature support
- Client utility selection, configuration, and feature support
- Endpoint network agents

2.6.4. Authentication, encryption, and security protocol support
2.6.5. MAC feature support
2.6.6. PHY support
2.6.7. Hardware components
2.6.8. Antenna type, transmit power, and other RF characteristics

2.7 Explain best practices and address common design considerations for industry-specific WLAN deployments in the following markets and scenarios:

2.7.1. Carpeted offices

2.7.2. Industrial – Warehouse and Manufacturing
2.7.3. Healthcare
2.7.4. Government
2.7.5. Hospitality
2.7.6. Education
2.7.7. Retail
2.7.8. Guest Access and Hotspots
2.7.9. Transportation
2.7.10. Mobile Office
2.7.11. Mesh/Outdoor
2.7.12. Remote Networks and Branch Offices
2.7.13. Bridging and Last-mile/ISP
2.7.14. High Density (e.g. arenas, conference halls, trade shows)

2.8 Illustrate application-specific design approaches and requirements including the following:

- Application behavior
- Protocols
- RF requirements
- Performance requirements/metrics (i.e. throughput, jitter, delay, latency, loss)
- Security requirements
- High Availability (Reliability / Redundancy)
- Other application-specific considerations

2.8.1. Data

- File sharing
- Email
- Web Browsing
- Image sharing

2.8.2. Voice
2.8.3. Video
2.8.4. Location and Tracking
2.8.5. Barcode scanners and picker systems
2.8.6. Wireless security cameras
2.8.7. FMC – Fixed Mobile Convergence
2.8.8. Other real-time applications

2.9 Explain best practices for common WLAN feature support, configuration, and deployment strategies, including:

2.9.1. QoS

- Application-level support
- Client configuration
- AP configuration

2.9.2. Power Management
2.9.3. Protection Modes and PHY Compatibility
2.9.4. WLAN Profile parameters
- SSIDs
- Data Rate and/or MCS support
- Discovery parameters (Beaconing, probe request/response parameters, DTIMs, etc.)
- Advanced parameters (Peer-to-peer blocking, RTS thresholds, aggregation, fragmentation, client limits, proprietary optimization features, etc.)

Infrastructure Design and Network Services – 10%

3.1. Demonstrate a detailed understanding of the role that the wired network infrastructure plays in WLAN design:

- 3.1.1. Backhaul speeds and capacity
- 3.1.2. Backhaul redundancy
- 3.1.3. Multicast support
- 3.1.4. PoE support

3.2. Explain design approaches related to specific layers of the OSI model.

3.3. Discuss power supply and cabling options for WLAN devices:

- AC Power in MDFs and IDFs
- AC Power in distributed locations
- Endpoint PoE
- Midspan PoE
- 802.3af and 802.3at (PoE+) PoE
- Solar power
- Data cabling

3.4. Explain the significance of QoS in multi-service WLANs and illustrate a comprehensive understanding of the following:

- 3.4.1. WLAN arbitration
- 3.4.2. WMM and EDCA operations and parameters
- 3.4.3. Policy-based queuing
- 3.4.4. 802.1p (802.1D/Q) CoS priority tagging
- 3.4.5. Differentiated Services Code Point (DSCP)
- 3.4.6. Admission control
- 3.4.7. End-to-end QoS
- 3.4.8. Airtime fairness mechanisms

3.5. Understand and describe VLAN use in wired and wireless network segmentation:

- 3.5.1. Access ports
- 3.5.2. Trunked ports
- 3.5.3. VLAN distribution

3.6. Describe load balancing, what purpose it serves for the network, and when and how it should be implemented:

- 3.6.1. Client RF/Spectrum load balancing
- 3.6.2. Load balancing clients among APs
- 3.6.3. Load balancing APs among controllers
- 3.6.4. Device licensing

3.7. Describe common design practices for high availability and redundancy:

- 3.7.1. Redundancy strategies (N+1, N+N+1, etc.)
- 3.7.2. Controller failover
- 3.7.3. Dynamic RF adjustments – channel, power, etc.
- 3.7.4. Mesh as a failover backhaul option

3.8. Illustrate best practices for roaming support in a WLAN:

- 3.8.1. Planning roaming boundaries
- 3.8.2. Understanding and managing client roaming behaviors
- 3.8.3. Application roaming requirements
- 3.8.4. L2 roaming
- 3.8.5. L3 roaming
- 3.8.6. Inter-controller roaming
- 3.8.7. Maintaining user policies and security

3.9. Consider the following network services and protocols as they relate to wireless interaction with the wired network:

- 3.9.1. RADIUS
- 3.9.2. Directory Services (LDAP)
- 3.9.3. DHCP and forwarding
- 3.9.4. DNS
- 3.9.5. NTP
- 3.9.6. Certificate Authority (CA)

WLAN RF Design – 20%

4.1. Understand the basics of 802.11 arbitration processes and wireless contention domains, and describe how these factors influence network design.

4.2. Demonstrate a detailed understanding of RF behaviors and characteristics and relate these concepts to WLAN RF design.

- 4.2.1. RF characteristics and properties
- 4.2.2. RF math equations
- 4.2.3. Units of measurement

4.3. Discuss design concepts related to frequencies and bands used for WLAN communications:

- 4.3.1. Bandwidth
- 4.3.2. Utilization and capacity
- 4.3.3. Regulatory licensing requirements
- 4.3.4. Transmit power regulations

4.4. Illustrate a comprehensive understanding of the role of channel planning and usage in network design:

4.4.1. Channel width selection

- 20 MHz
- 20/40 MHz

4.4.2. Understand the role of interference in channel selection and usage; describe and implement tactics to minimize interference:

- Co-channel interference
- Non-overlapping adjacent-channel interference
- Overlapping adjacent-channel interference
- Non-802.11 interference

4.4.3. Understand how to perform static channel plans that maximize efficiency and minimize network contention and interference
4.4.4. Understand the use of automated channel planning, calibration, and adjustments/audits.
4.4.5. Multiple Channel Architecture (MCA) considerations

- Channel utilization
- Reuse patterns
- Transmit power
- Microcell (picocell)

4.4.6. Single Channel Architecture (SCA) considerations

- Channel blankets/spans/layers
- Channel selection

4.4.7. Mesh Channel planning

4.5. Understand the purpose of, and challenges related to, creating a balanced RF link between the AP and client devices.

4.6. Demonstrate a detailed knowledge of the common problems related to high user densities and describe effective strategies to address them:

- Microcell plans
- Antenna arrays
- SCA channel blankets
- Client modifications (e.g. custom drivers)
- Band steering

4.7. Illustrate best practices for data rate/MCS configurations to manage client connectivity.

4.8. Understand the details of Dynamic Frequency Selection (DFS) and describe its impact on WLAN design:

4.8.1. Test procedures to determine if DFS channels should be used
4.8.2. Understand the impact of excluding or including DFS channels
4.8.3. Understand the impact that a BSS channel switch may have on network performance

4.9. Describe the role of Transmit Power Control (TPC) in WLANs and explain when and how it should be implemented.

4.10. Describe the purpose of, and techniques for, controlling and shaping RF to improve WLAN functionality:

- Antenna selection
- Transmit power
- AP and/or antenna mounting locations
- Enclosures and device form factor
- Antenna orientation and polarization

4.11. Identify and explain factors that motivate AP and WIPS sensor placement:

- Application performance (e.g. location services)
- Controlling RF propagation
- Coverage and capacity design
- RF environment

4.12. Describe the role of load balancing in RF spectrum management:

- Client load balancing across a spectrum
- Band Steering

4.13. Understand how Distributed Antenna Systems (DAS) work with Wi-Fi and how they impact RF design for a WLAN.

4.14. Understand common RF accessories and other components used in WLAN communications:

4.14.1. Filters and amplifiers
4.14.2. RF cabling
4.14.3. RF connectors
4.14.4. Lightning protection
4.14.5. Enclosures (e.g. environmental, safety, security)

Advanced Site Surveying – 25%

5.1. Explain the steps and procedures associated with site survey preparation:

5.1.1. Determining facility specific requirements and making appropriate arrangements:

- Arranging escorts
- Meeting access requirements, clearance, and badges
- Collecting and reviewing floor plans and/or blueprints
- Onsite training (safety and operations)
- Arranging equipment (e.g. lifts and ladders)
- Understanding industry-specific requirements (e.g. union assistance)

5.1.2. Preparing manual site survey tools for measuring RF characteristics:

- Spectrum analyzer
- Manual site survey software
- Protocol analyzer
- Throughput analysis software
- APs
- Battery packs
- Antennas
- Temporary mounts
- Other equipment

5.2. Explain how to conduct a proper WLAN site survey according to industry best practices.

5.3. Demonstrate a detailed and thorough understanding of surveying types and methodologies, including:

- Advantages, disadvantages, and purpose of each method
- Tools used to perform each type of survey
- Gathering the proper data during a site survey
- Interpreting the results of a site survey
- Applying survey data to a WLAN design
- Configuration and appropriate use of surveying tools

5.3.1. Spectrum Analysis
5.3.2. Predictive Surveys
5.3.3. Manual Surveys

- Active
- Passive

5.4. Explain the metrics, data, and other information collected and reported during a site survey:

5.4.1. Signal metrics

- RSSI
- SNR
- Noise
- Interference

5.4.2. Cell coverage and overlap
5.4.3. Application and connectivity data

- Data rates
- Throughput
- Latency
- Jitter
- Loss
- Retries

5.5. Explain how surveying methodologies may differ when preparing for specific applications:

5.5.1. Data
5.5.2. Voice
5.5.3. Video
5.5.4. Real-time location services (RTLS)
5.5.5. Other applications

5.6. Discuss how surveying approaches differ depending upon PHY and feature support:

5.6.1. 802.11a/g infrastructure
5.6.2. 802.11n infrastructure
5.6.3. Mixed 802.11a/g/n infrastructure
5.6.4. Client PHY support
5.6.5. Beamforming support (i.e. transmit beamforming, dynamic beamforming, static beamforming)

5.7. Illustrate how a site survey facilitates hardware (APs and antennas) placement and mounting decisions:

5.7.1. Cabling
5.7.2. Power availability (e.g. PoE, AC power)
5.7.3. Use of enclosures
5.7.4. Aesthetics
5.7.5. Three dimensional RF propagation
5.7.6. Physical security

5.8. Describe how antenna selection, placement, and orientation is determined by an RF site survey.

5.9. Describe how channel planning and output power configurations are determined by an RF site survey:

5.9.1. Automated RF management
5.9.2. Manual configuration

5.10. Understand the differences in tools, methods, and purpose between outdoor and indoor site surveys.

5.11. Understand how survey methodologies and requirements differ depending on network architecture:

5.11.1. Multiple Channel Architecture vs. Single Channel Architecture
5.11.2. Mesh systems
5.11.3. WLAN Arrays

5.12. Identify the purpose and methods of post-installation site surveys:

5.12.1. Application validation/audit
5.12.2. Post-deployment adjustments

5.13. Describe processes and best practices related to documenting collected survey data and generating a deliverable report.

5.14. Understand site survey tools and planners that are built into network infrastructure systems.

802.11 Security Design – 5%

6.1 Recommend appropriate authentication solutions and explain design concepts related to their use:

6.1.1. 802.1X/EAP

- Selection criteria
- Manageability
- Certificate PKI

6.1.2. Pre-Shared Key (PSK)
6.1.3. Per-user PSK (PPSK)
6.1.4. Captive Portal (HTTPS)

6.2 Recommend appropriate data encryption solutions and explain design concepts related to their use:

6.2.1. TKIP/RC4
6.2.2. CCMP/AES
6.2.3. Proprietary encryption

6.3 Explain best practice security design concepts for guest and public access Wi-Fi networks:

6.3.1. Captive portal
6.3.2. Network segmentation
6.3.3. Content filtering
6.3.4. Terms of use
6.3.5. Access control
6.3.6. VPN
6.3.7. Guest tunneling to the DMZ

6.4 Illustrate common deployment and design strategies for AAA, especially RADIUS:

6.4.1. AAA framework
6.4.2. Local RADIUS servers
6.4.3. Remote RADIUS servers
6.4.4. Integrated RADIUS servers (in WLAN Controllers or APs)
6.4.5. Protocol support
6.4.6. RADIUS Proxy

6.5 Understand design strategies for integration of client authentication with directory services:

6.5.1. Local user directories
6.5.2. Remote directories
6.5.3. Integrated user directories
6.5.4. LDAP

6.6 Describe deployment and design strategies for Wireless Intrusion Prevention Systems (WIPS):

6.6.1. Integrated

- Dedicated
- Part-time

6.6.2. Overlay
6.6.3. System configuration and defining policies

6.7 Demonstrate the importance of, and design considerations related to, Fast BSS Transition (Fast/Secure Roaming):

6.7.1. No Fast Roaming Support
6.7.2. Opportunistic Key Caching (OKC)
6.7.3. 802.11r/k (Voice-Enterprise)
6.7.4. Preauthentication
6.7.5. PMK Caching
6.7.6. Proprietary mechanisms

- Virtual BSSID
- CCKM

6.8 Identify the role and limitations of client capabilities in security planning.

6.9 Describe the methods of designing a secure network with segmentation and filtering:

6.9.1. VLAN segmentation
6.9.2. Firewalls
6.9.3. ACLs
6.9.4. Role-based access control

6.10 Identify weak security solutions and protocols, and provide acceptable alternatives.

Design Troubleshooting – 5%

7.1 Identify the appropriate uses of spectrum analysis in network design and troubleshooting.

7.2 Perform and interpret an RF analysis for an existing WLAN deployment.

- 7.2.1. Coverage
- 7.2.2. Capacity and channel utilization
- 7.2.3. Channel reuse and transmit power settings
- 7.2.4. Wi-Fi and non-Wi-Fi Interference
- 7.2.5. Communication link quality

7.3 Illustrate the use of a protocol analyzer and interpret the results to identify problems with the following aspects of network design:

- 7.3.1. Security setup and configuration
- 7.3.2. Roaming
- 7.3.3. PHY rate analysis
- 7.3.4. MAC feature parity
- 7.3.5. QoS
- 7.3.6. Client (including drivers) and infrastructure compatibility

7.4 Describe common causes and symptoms of high channel utilization, detect this problem in an existing network, and explain design best practices for remediation.

7.5 Understand proper WLAN functionality, including wired infrastructure connectivity and services, and identify problematic characteristics in network design.

7.6 Demonstrate a detailed knowledge of common client-side and application problems and isolate unexpected client behavior.