RF Wireless Channel Planning & Optimization Guide

# Purpose

To ensure optimal Wi-Fi performance, minimize interference (CCI and ACI), and meet enterprise wireless design requirements through strategic channel allocation across 2.4 GHz, 5 GHz, and 6 GHz bands.

# RF Channel Planning Best Practices

## 1. Understand the Spectrum

Different bands offer different capabilities and limitations. Below is a summary:

• 2.4 GHz: Channels 1, 6, and 11 are non-overlapping. Only 20 MHz is supported.  
• 5 GHz: Offers 25+ channels, supporting 20, 40, 80 MHz widths. DFS channels may be unavailable.  
• 6 GHz: Clean spectrum, ideal for Wi-Fi 6E+. Offers 20/40/80/160 MHz widths.

## 2. Channel Width Planning

• High-density: Use 20 MHz to reduce CCI.  
• Medium-density: 40 MHz can be considered with validation.  
• Low-density: 80 MHz may be used when interference is minimal.  
Avoid overlapping bonded channels and validate configurations.

## 3. Co-Channel & Adjacent Channel Interference Mitigation

• Use non-overlapping channels in 2.4 GHz (1, 6, 11).  
• Use DFS-aware planning in 5/6 GHz.  
• Validate with spectrum analysis and heatmaps.  
• Ensure channel reuse with a separation of at least 2–3 APs.

## 4. Access Point (AP) Placement and Orientation

• Position APs to avoid line-of-sight overlap.  
• Offset placement vertically between floors.  
• Centralize APs within coverage zones.

## 5. Power Level Optimization

• Balance 2.4 and 5 GHz power.  
• Avoid maxing transmit power.  
• Use automatic adjustment only after validation.

## 6. Band Steering & Load Balancing

• Enable band steering to encourage 5/6 GHz usage.  
• Load balance clients to prevent congestion.

## 7. Legacy Protocol & Data Rate Management

• Disable 802.11b and raise minimum rates (e.g., to 12 Mbps).  
• Carefully test legacy or IoT clients before enforcement.

## 8. Wi-Fi Site Survey & Validation Steps

• Pre-Deployment: Use predictive tools to model APs.  
• Post-Deployment: Active and passive surveys to verify RSSI, SNR, and coverage.  
• Use tools like Ekahau for visualization.

# Step-by-Step Guide for Channel Optimization

1. Collect Environmental Data  
2. Baseline Channel Utilization  
3. Map Out AP Coverage  
4. Assign Channels  
5. Optimize Power Levels  
6. Validate Channel Reuse  
7. Test Client Experience  
8. Document & Review

# Additional Considerations

• DFS Channels: Ensure client support.  
• High-Ceiling Areas: Account for vertical coverage.  
• Multi-Floor Environments: Offset APs and channels vertical

# Appendix : Wi-Fi Survey Types Explained

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| --- | --- | --- | --- | --- |
| **Survey Type** | **What** | **Why** | **How** | **Who** |
| **Wi-Fi Predictive Design** | Simulated survey using floorplans, materials, AP models | Create initial design without site visit | RF modeling tools like Ekahau/Hamina using building plans | Network Designer, or  Network Architects |
| **Wi-Fi Pre-deployment Survey** | Onsite survey using battery APs and tools | Test predicted RF attenuation and wall impacts | Bring test AP, walk site with survey software to validate model assumptions | Field Engineers  Wireless Engineers |
| **Wi-Fi Deployment Validation** | Post-installation site survey | Validate deployment matches design; confirm signal strength and quality | Measure signal levels, channel overlap, SNR, roaming, etc. | Wireless Engineers / QA |
| **Wi-Fi Diagnostic Survey** | Advanced troubleshooting survey after go-live | Identify root causes of issues like coverage gaps, interference, or misconfigurations | Use of spectrum analyzers and advanced diagnostic tools, packet capture | Senior Wireless Engineers / SMEs |

**1. Wi-Fi Predictive Design**

* **What**: A virtual simulation of wireless coverage using modeling software.
* **Why**: To plan AP placements efficiently without initial physical deployment.
* **How**: Input building layouts and materials into software to simulate RF propagation and coverage.
* **Who**: Network designers and wireless engineers during the planning phase.

**2. Wi-Fi Pre-deployment Survey**

* **What**: On-site testing using temporary APs to validate predictive models.
* **Why**: To account for real-world variables that may affect wireless performance.
* **How**: Deploy temporary APs and measure signal strength and coverage in the actual environment.
* **Who**: Field engineers and wireless specialists prior to full deployment.

**3. Wi-Fi Deployment Validation Survey**

* **What**: Post-installation survey to ensure the network meets design goals.
* **Why**: To confirm that the deployed infrastructure delivers the expected performance.
* **How**: Conduct site surveys measuring key performance indicators and adjust configurations as needed.
* **Who**: Network engineers and quality assurance teams after installation.

**4. Wi-Fi Diagnostic Survey  
 What**: Comprehensive analysis to troubleshoot and resolve network issues.

* **Why**: To maintain network reliability and performance over time.
* **How**: Use diagnostic tools to identify interference, coverage gaps, and configuration errors.
* **Who**: Network support teams and wireless consultants during operational phases.

**Wi-Fi Survey by Project Phase**

|  |  |  |
| --- | --- | --- |
| **Project Phase** | **Survey Type** | **Purpose** |
| **Plan & Design** | *Wi-Fi Predictive Design* | Design RF coverage before deployment using building floor plans and RF modeling tools. |
| **Pre-Deployment** | *Wi-Fi Pre-deployment Survey* | Validate predictive designs onsite using test APs to measure real-world attenuation and interference. |
| **Deployment Validation** | *Wi-Fi Deployment Validation Survey* | Post-installation survey to confirm coverage, signal quality, and validate that the design has been implemented successfully. |
| **Operations / Troubleshooting** | *Wi-Fi Diagnostic Survey* | Performed when users report issues; it identifies RF problems, interference, misconfigurations, or performance bottlenecks. |

**Purpose of Channel Planning**

To ensure optimal performance and **minimal co-channel interference (CCI)** or **adjacent channel interference (ACI)** by correctly allocating **non-overlapping channels** across 2.4 GHz and 5/6 GHz bands.

Key considerations for Wi-Fi channel planning:

* **2.4 GHz Band:**
  + **Non-overlapping channels:** Channels 1, 6, and 11 are the only non-overlapping channels in the 2.4 GHz band, so choose the one with the least interference.
  + **Avoid overlapping:** Using channels other than 1, 6, or 11 will lead to more interference.
  + **Minimize channel utilization:** Reduce the number of networks using overlapping channels to improve performance.
* **5 GHz Band:**
  + **Greater capacity:** The 5 GHz band offers more spectrum than 2.4 GHz, providing greater capacity.
  + **Wider channel widths:** Use wider channels (40 MHz, 80 MHz, etc.) if your environment supports them, as they offer higher throughput.
  + **Avoid interference:** Use a Wi-Fi analyzer to identify and avoid congested channels.
* **Channel Widths:**
  + **20 MHz in high density:** In densely populated areas, use 20 MHz channels to minimize interference.
  + **40 MHz or 80 MHz in lower density:** Use wider channels where possible to maximize throughput in less congested areas.
* **Site Survey:**
  + **Analyze the environment:** A site survey helps identify obstacles, interference sources, and other factors that affect Wi-Fi performance.
  + **Plan AP placement:** Based on the site survey, optimize AP placement for optimal coverage and interference reduction.
* **Additional Tips:**
  + **Use a Wi-Fi analyzer:** Tools like Wi-Fi Analyzer can help you identify congested channels and choose the best channels for your network.
  + **Consider 6 GHz:** If available, utilize the 6 GHz band for its wider spectrum and higher throughput potential.
  + **Optimize power levels:** Adjust power levels to ensure good coverage without causing excessive interference.
  + **Disable legacy rates:** Consider disabling older 802.11b rates to free up bandwidth for newer protocols.

A well-planned approach to Wi-Fi channel allocation is crucial for a stable and high-performing wireless network. This involves selecting channels that minimize interference and maximize bandwidth, especially in dense environments. In the 2.4 GHz band, prioritize channels 1, 6, and 11 as they are non-overlapping, while the 5 GHz band offers more flexibility with wider channel widths and non-overlapping channels.