CWNA Guide to Wireless LANs,
Third Edition

Chapter 8: Conducting a Site Survey

Objectives

- Explain what a site survey is and how it can be used
- List and describe the tools used for conducting a site survey
- Describe the procedures for performing a site survey

What is a Site Survey?

- When installing a WLAN for an organization, areas of dead space might not be tolerated
  - Ensure blanket coverage, meet per-user bandwidth requirements, minimize "bleeding" of signal

- Factors affecting wireless coverage goals:
  - Devices emitting RF signals
  - Building structure (walls, construction materials)
  - Open or closed office doors
  - Stationary versus mobile machinery/equipment
  - Movement of mobile walls (e.g., cubicles)

https://www.youtube.com/watch?v=eeQqtzw2Dck

https://www.youtube.com/watch?v=8uGb2xxdMXg

What is a Site Survey?

- Factors affecting wireless coverage goals (continued):
  - Expansion of physical plant or growth of organization
  - Existing WLANs
    - Both inside organization, and within nearby organizations

- **Site survey:** Process of planning a WLAN to meet design goals
  - Effectiveness of a WLAN often linked to thoroughness of the site survey

Purpose of a Site Survey

- Design goals for a site survey:
  - Achieve best possible performance from WLAN
  - Certify that installation will operate as promised
  - Determine best location for APs
  - Develop networks optimized for variety of applications
  - Ensure coverage will fulfill organization's requirements
  - Locate unauthorized APs

Purpose of a Site Survey

- Design goals for a site survey (continued):
  - Map nearby wireless networks to determine existing radio interference
  - Reduce radio interference as much as possible
  - Make wireless network secure

- Survey provides realistic understanding of infrastructure required for proposed wireless link
  - Assists in predicting network capability and throughput
  - Helps determine exact location of APs and power levels required

When to Perform a Site Survey

- When to perform a site survey:
  - Before installing a new wireless network
  - After physical changes to a building
  - After changes to an existing wireless network
  - If network needs change for the organization
  - After significant changes in personnel

- **Automated RF resource management**: a dynamic self-managing WLAN
  - the wireless devices monitor the environment and automatically adjust power levels or channels to compensate for changes

Categories of Site Survey

Site Survey Category	Description
Predeployment Site Surveys	Prior to installing one or more APs, a predeployment survey should be conducted. The purpose of this survey is to understand the RF signal behavior in the specific environment.
Postdeployment Site Surveys	After the WLAN is installed, it is important to thoroughly test the setup to ensure that all of the APs are providing the necessary coverage.
Periodic Site Surveys	This "health check" site survey is generally not as thorough as a postdeployment survey. Instead, the purpose is simply to check that the WLAN is functioning as expected from the perspective of a client device.
Troubleshooting Site Surveys	When the WLAN is not functioning as anticipated a troubleshooting site survey can help to identify the reason for the inadequate performance.

Table 8-1 Categories of Site Surveys

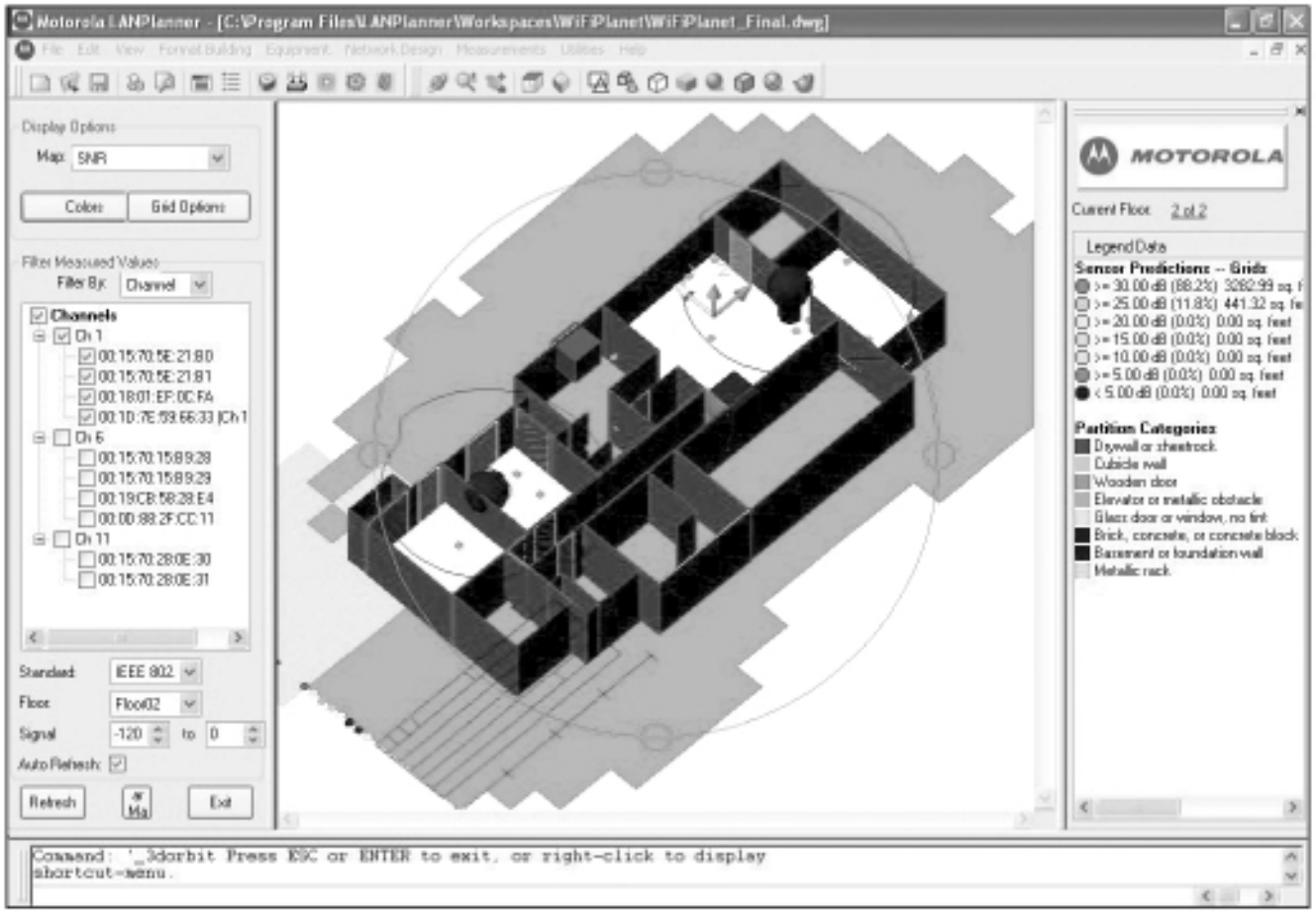
Types of Site Surveys

- **Manual site survey**: requires walking through the area of the WLAN while carrying a wireless client like a laptop or tablet computer

- Can be divided into two categories:
  - *Passive manual site survey*: client device "listens" in order to gather RF measurements such as signal strengths, noise levels, and the signal-to-noise ratio (SNR)
  - *Active manual site survey*: client device sends and receives packets to determine the status of the WLAN

Types of Site Surveys

- **Predictive site survey**: a virtual survey of the area that uses modeling techniques to design the wireless network
  - Building floor plans are loaded into the **predictive analysis simulation application** survey software (also called **RF planning and management tools**)
  - Can account for building materials, square footage, number of wireless users, types of applications, antenna models, etc.



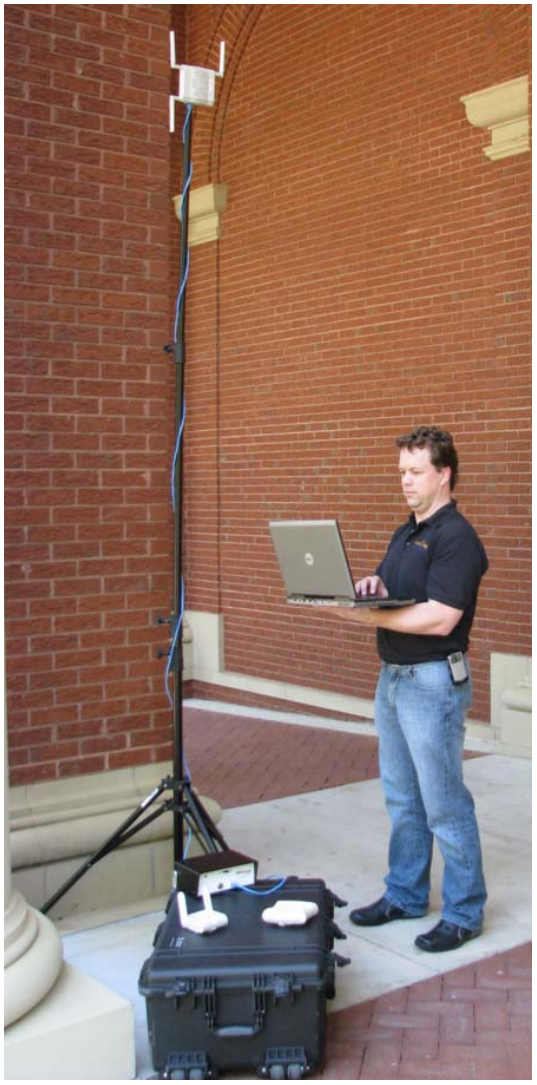
Courtesy of Motorola Solutions, Inc.

Figure 8-1 Predictive analysis simulation application

Types of Site Surveys

- Type of data needed for an outdoor site survey:
  - Height and material of buildings, light poles, or other structures that are to host an AP
  - Location, size, and density of areas where trees, foliage, hills, or other obstacles may interfere with the signal
  - Types of applications or the desired bandwidth to be carried
  - Availability of power at each building, light pole, or outbuilding to power the APs
  - Availability of data connectivity at each location

Types of Site Surveys



Site Survey Tools

- Most predictive site survey software uses AutoCAD drawing files with embedded detail about building materials

- For manual site surveys, a wide variety of tools are available:
  - Single hardware "bundle" that includes software installed on a dedicated hardware device
  - Software to be installed on different devices
  - Wireless device tools

Wireless Device Tools

- Most basic tool is AP itself:
  - Position AP in various locations, monitor signal as you move
  - APs should have ability to adjust output power
  - APs should have external antenna connectors
    - Test effectiveness of different antenna types in different situations
  - May need DC-to-AC converter for testing
- Notebook computer with wireless NIC also essential for testing
  - Previously configured and tested

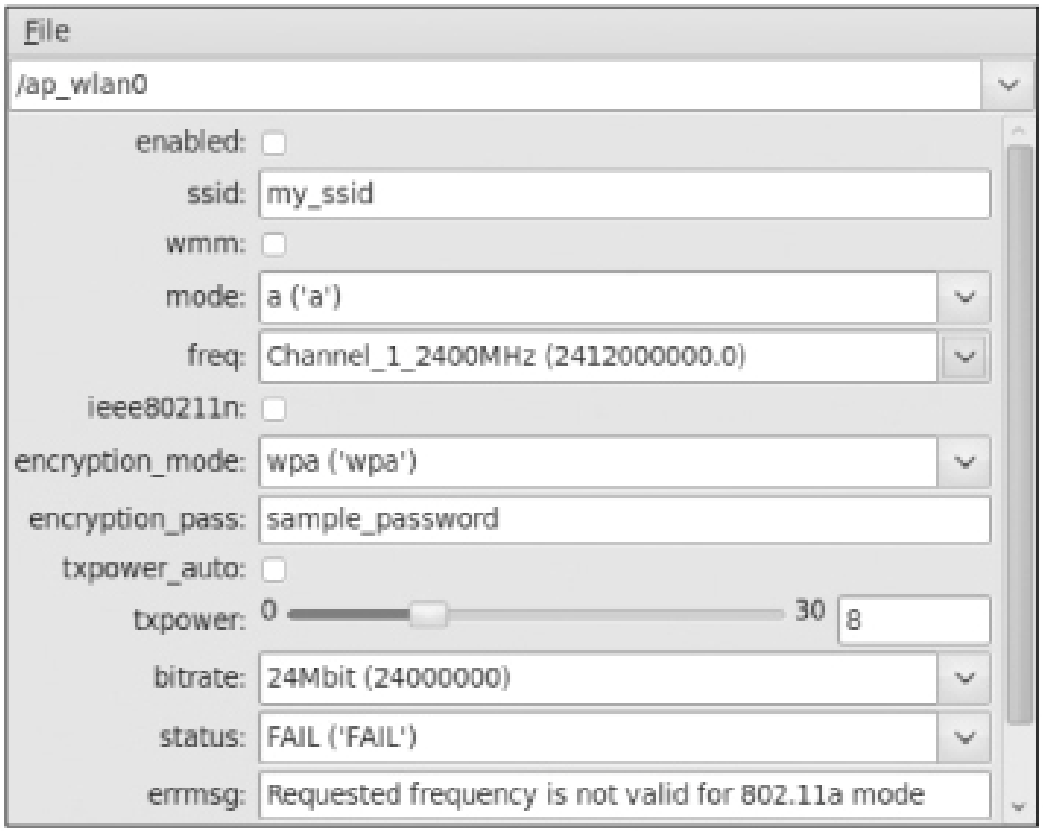


Figure 8-2 Adjust power levels with slider bar

Specialized Tools

- **Dedicated Applications:** Specifically designed for conducting WLAN site surveys

  - Full-featured site survey analyzer software settings:
    - Destination MAC Address – AP that will be involved in the test
    - Continuous Link Test – Active Mode test will run repeatedly until the Stop button is clicked
    - Number of Packets – sets quantity of packets
    - Packet Size – sets the size of the packets during test
    - Data Retries – sets the number of times a transmission will be repeated if an ACK frame is not returned by the destination device

Specialized Tools

- Full-featured site survey analyzer software settings (continued):
  - Data Rate – sets the bit rate packets will be transmitted
  - Delay Between Packets
  - Packet Tx Type - Unicast or multicast
  - Percent Success Threshold
- Basic survey analyzer software contains far fewer features

http://www.cisco.com/c/en/us/td/docs/wireless/technology/vowlan/troubleshooting/vowlan_troubleshoot/8_Site_Survey_RF_Design_Valid.pdf

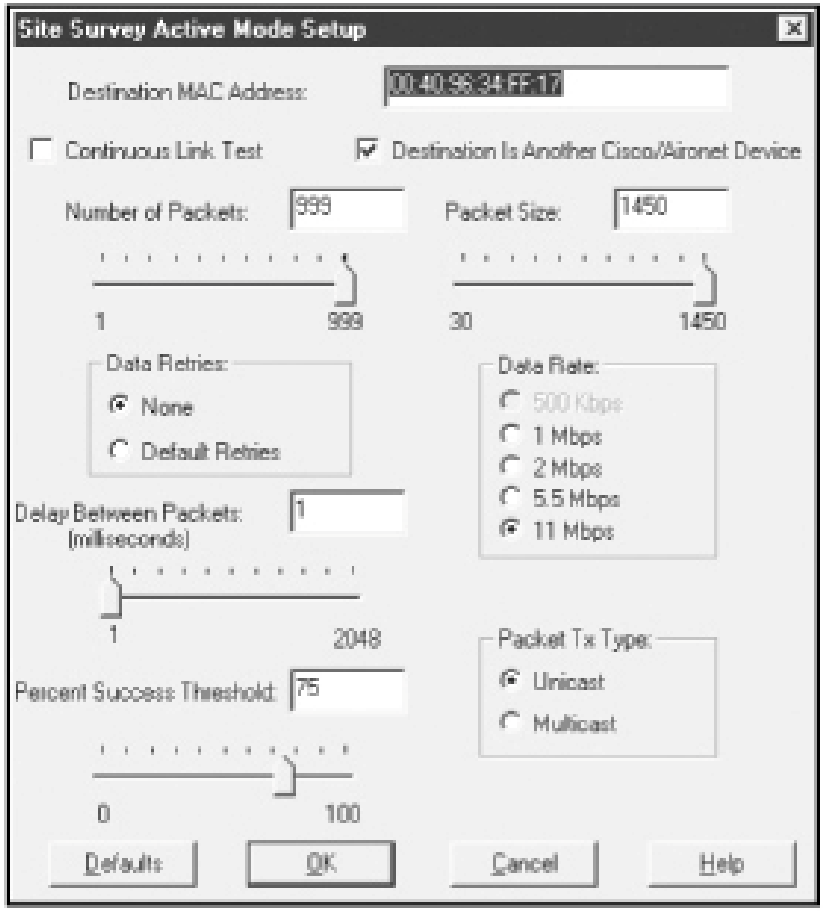


Figure 8-4 Full-featured dedicated application setup

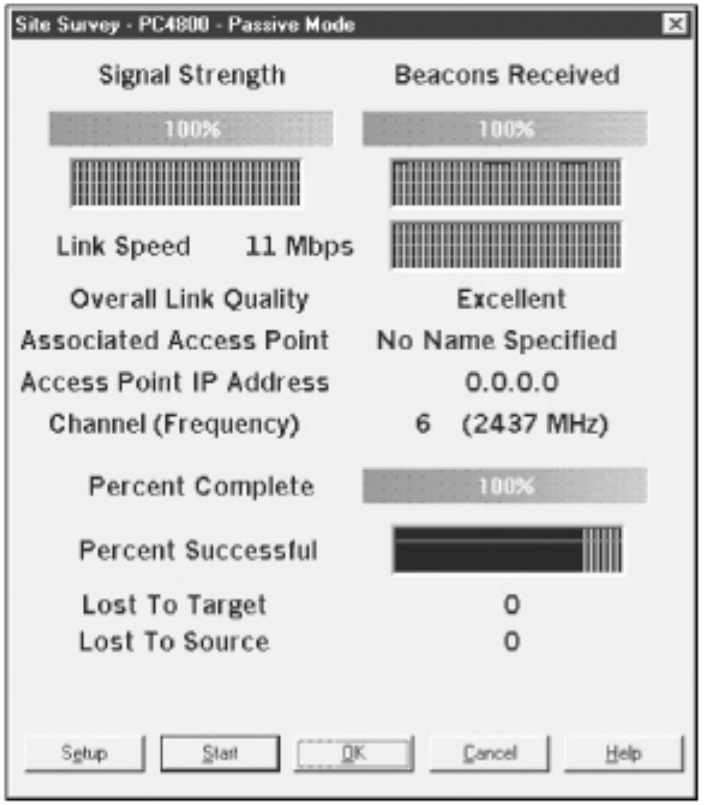


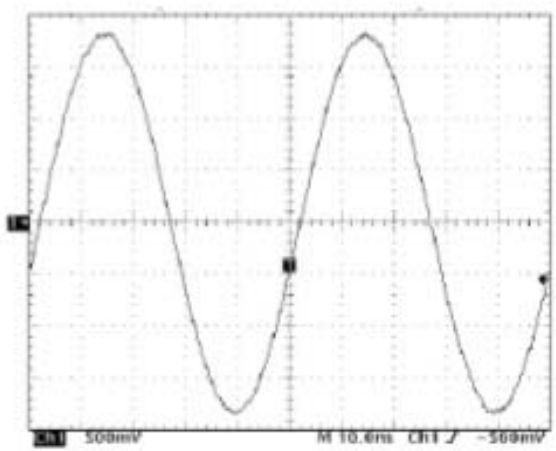
Figure 8-5 Full-featured dedicated application results

Specialized Tools

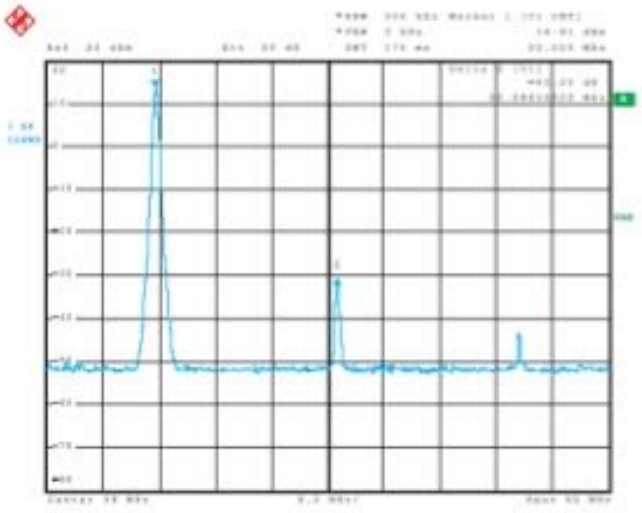
- **Spectrum Analyzers:** Scans RF spectrum and provides graphical display of results
  - Typically measure signal-to-noise ratio
  - Most common spectrum analyzer measurements are modulation, distortion, and noise
  - Helpful in identifying interference problems
    - Thus, helps properly position/orient AP

Oscilloscope and Spectrum Analyzer

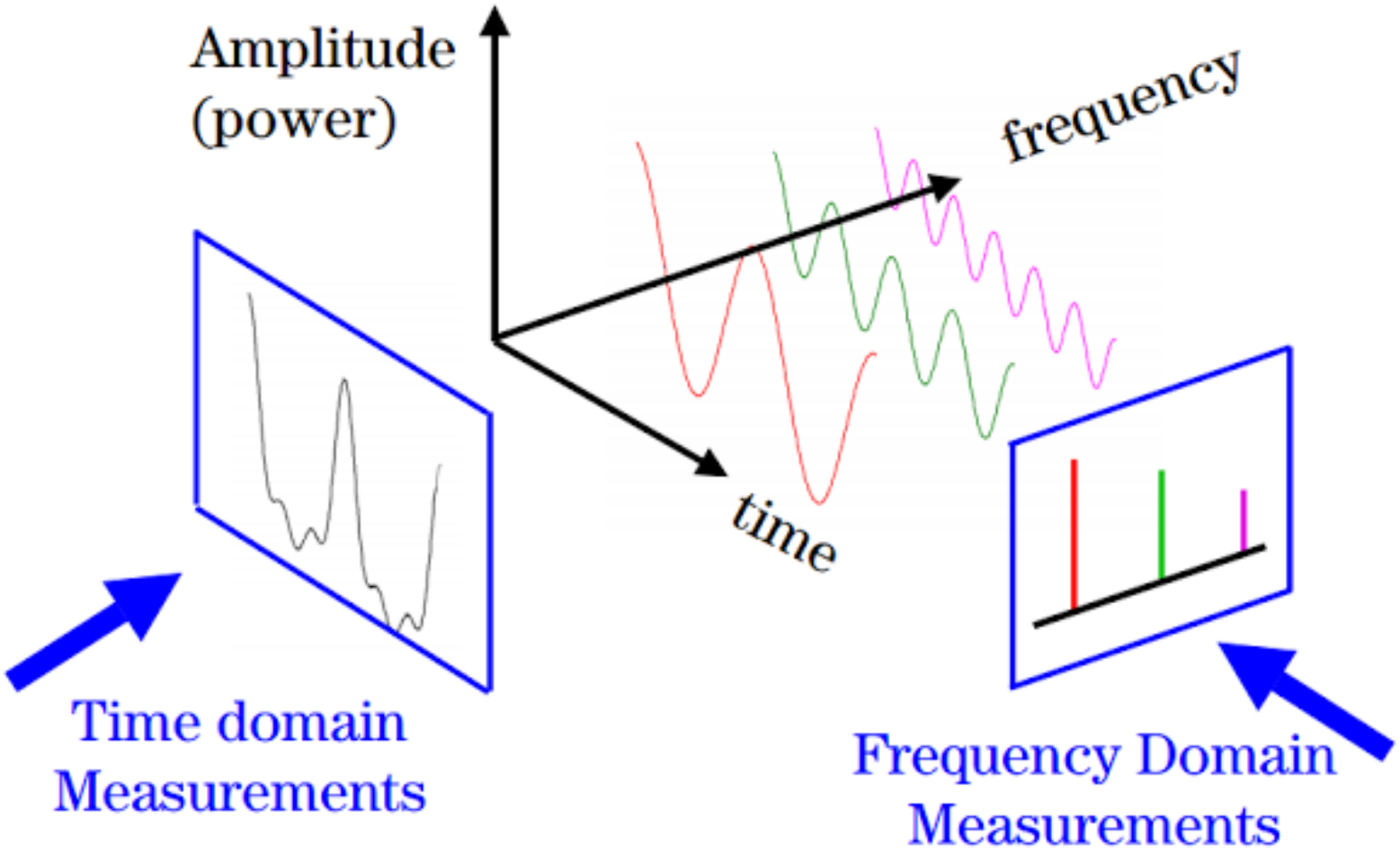
Oscilloscope vs Spectrum Analyzer?



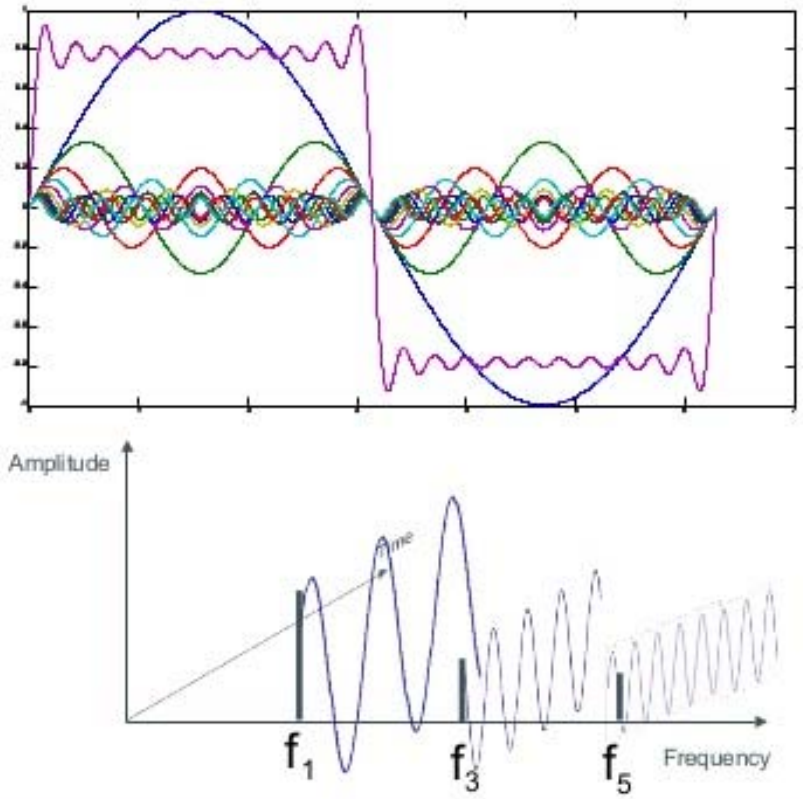
Time Domain



Frequency Domain



Oscilloscope vs Spectrum Analyzer?



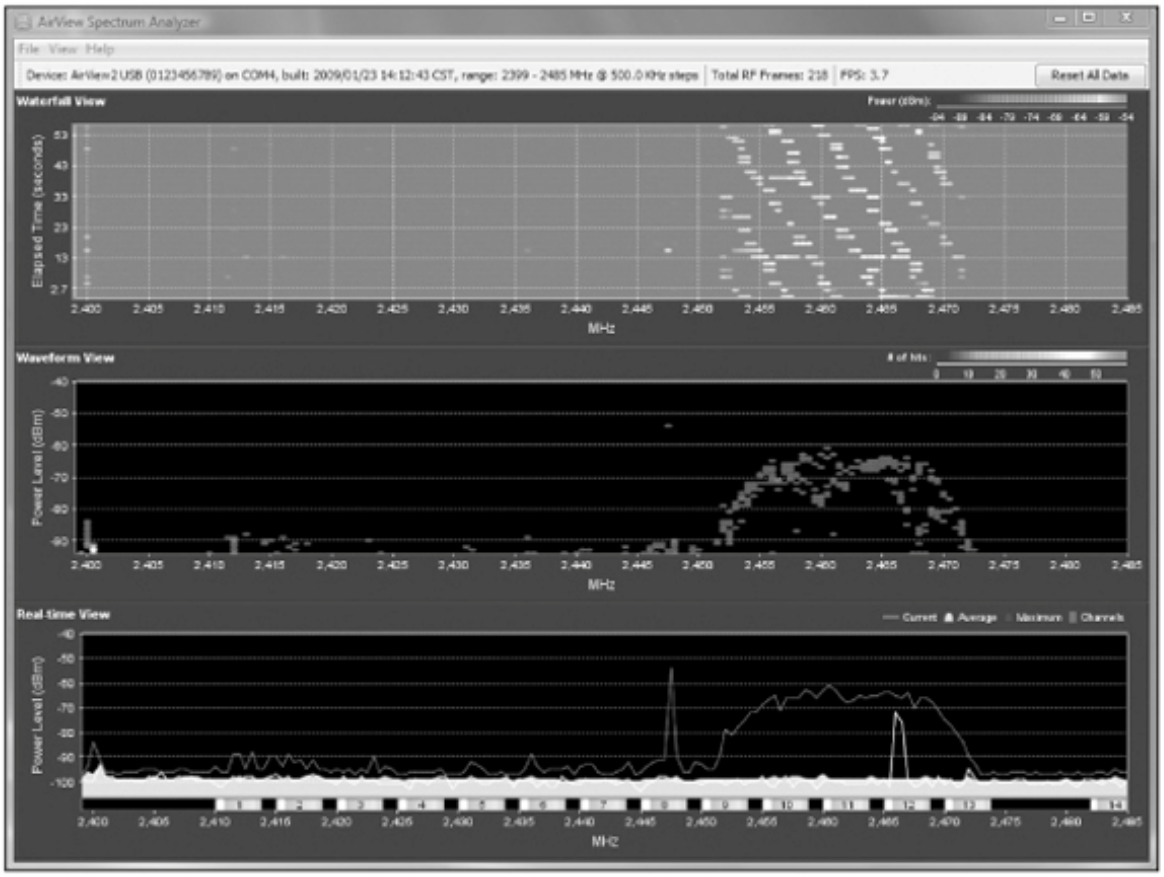


Figure 8-8 USB spectrum analyzer output

Chart Name	Description
Waterfall View	The Waterfall View (the top panel in Figure 8-8) is a time-based graph that shows the aggregate energy collected since the start of the session over time for each frequency. The power of the energy in dBm is shown across the frequency range and one row is inserted in this graph every few seconds. Different colors are used to denote different levels of energy (blues and darker shades are low energy levels and increasingly brighter colors such as green, yellow, orange, and finally red designate higher energy levels).
Waveform View	This view (the middle pane in Figure 8-8) shows the aggregate energy collected since the start of a session, with the power of the energy in dBm shown across the frequency range. This spectral view over time displays the current RF energy "signature" in an area.
Realtime View	The Realtime View (the bottom pane in Figure 8-8) displays a traditional spectrum analyzer function in which energy (in dBm) is shown real-time as a function of frequency. It can indicate the current, average, and maximum power levels per channel.

Table 8-2 Description of USB Spectrum Analyzer Views

Specialized Tools

- **Protocol Analyzers:** Can be used to pick up packets being transmitted by other WLANs in area
  - Also called a *sniffer*
  - Can be a stand-alone protocol analyzer device or a computer that runs protocol analyzer software

- Common uses of protocol analyzers:
  - Network troubleshooting: can detect and diagnose problems such as addressing errors
  - Network traffic characteristics: helps to fine-tune the network and manage bandwidth in order to provide the highest level of service to users

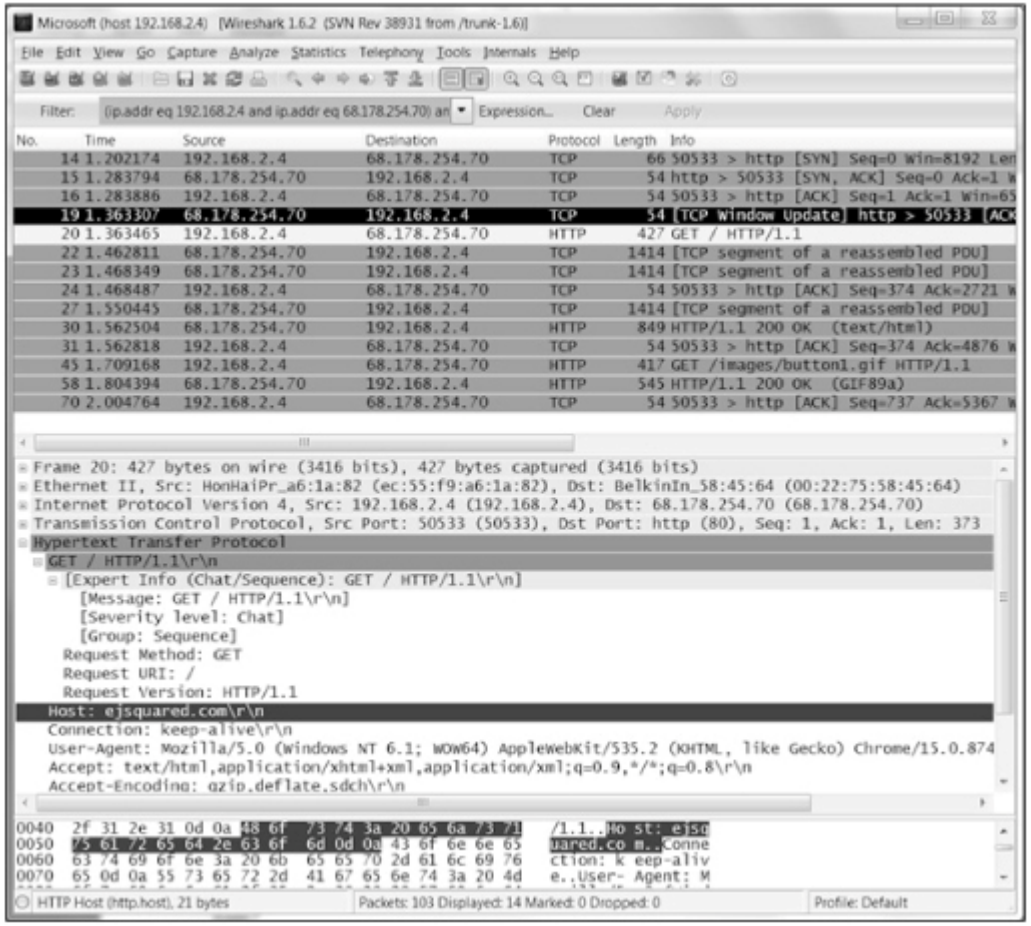


Figure 8-9 Protocol analyzer output

Specialized Tools

- Documentation Tools
  - Create a "hard copy" of site survey results
  - Make available for future reference

- Site survey report should include:
  - Purpose of report
  - Survey methods
  - RF coverage details (frequency and channel plan)
  - Throughput findings
  - Sources of interference

Specialized Tools

- Site survey report should include (continued):
  - Problem zones
  - Marked-up facility drawings with access point placement
  - Access point configuration

- It is advisable to create a database to store site survey information and generate reports

Device Identifier	XXX1SO1AP01
Description	Lab 214 AP 1
Location Details	
AP Location Identifier	AP-214A74
AP Location Notes	The Access Point is located on the interior wall close to the inner core of the building as indicated in Figure 1.
AP Mounting Notes	The Access Point should be mounted to the wall using the supplied mounting brackets.
AP Coverage Notes	The coverage for this access point is indicated by Figure 2 below.
AP Power Supply	Alternating current
Antenna Location	See Figure 9
Antenna Location Notes	The antenna is located at the same position as the access point.
Antenna Mounting Notes	The antenna is mounted to the inner wall. The antenna must be mounted vertically with the antenna facing towards the exterior of the building.
Hardware Specifications	
AP Manufacturer	Cisco Systems
AP Model	AIR-AP1220B-A-K9
Antenna Manufacturer	Cisco Systems
Antenna Model	AIR-ANT2012 (Wall Mount, Diversity directional 6.5 dBi gain)
Antenna Diversity	Yes
Configuration Details	
Channel	11
Data Rate Configuration	11 Mbps – YES; 5.5Mbps – BASIC; 2 Mbps – NO; 1 Mbps - NO
RF Power Output	0 dBm (1 mW)
ERIP Output	6 dBm

Figure 8-10 Sample site survey documentation form

Voice over WiFi (VoWiFi) Tools and Surveys

- Voice over WiFi (VoWiFi): an implementation of VoIP telephony on a WLAN

- Considerations when planning for VoWiFi:
  - *Packet loss*: a high number of lost packets can cause a noticeable impact on voice communications
    - Should be less than 1% in a VoWiFi network
  - *Delay*: amount of acceptable time that a late packet can arrive and still be used
  - *Jitter*: measure of delay between packets
    - Less than 5 milliseconds is acceptable

Voice over WiFi (VoWiFi) Tools and Surveys

- When performing a site survey the primary tools used are the built-in tools in the VoWiFi handset

- When planning for VoWiFi:
  - Have overlap between adjacent cells of coverage area to ensure sufficient RF signal strength
  - Many VoWiFi handsets do not support 802.11n and do not have multiple antennas
    - Some VoWiFi handsets support load balancing of moving a new call to an alternate channel that is less congested

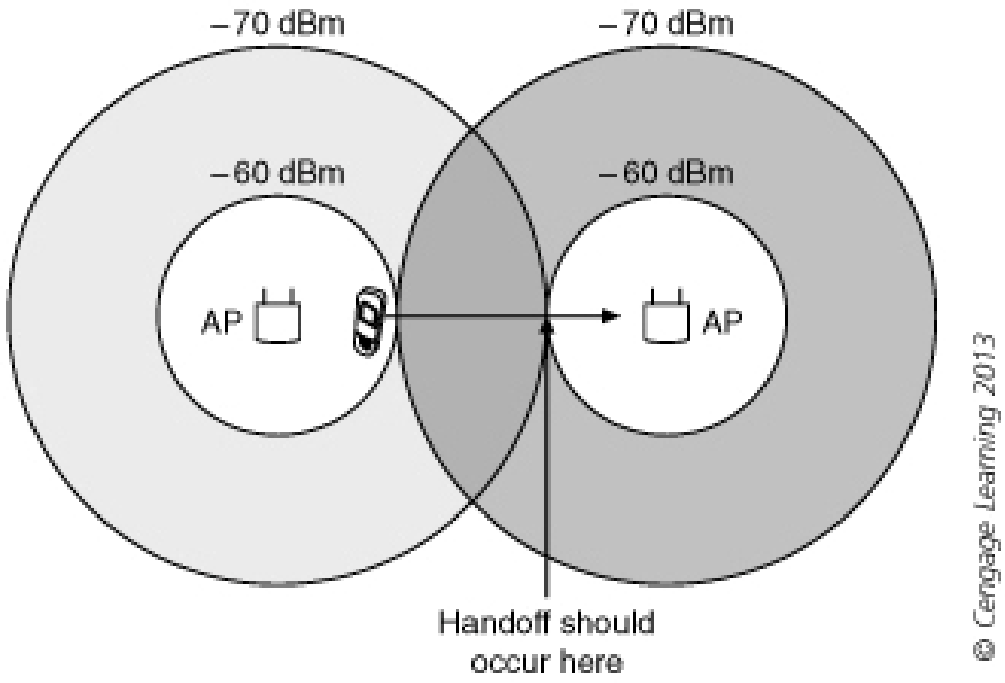


Figure 8-11 Cell overlap for VoWiFi

Procedures for Performing a Site Survey

- Three basic steps in conducting a site survey:
  - Gathering background data
  - Performing the actual survey
  - Generating the site survey report

Gathering Data

- **Examining Business Requirements:** Determine business reasons why WLAN being proposed or extended
  - If this step skipped, almost impossible to properly design and implement the network
  - Primary data gathering method is interviewing
  - Must determine type of mobility required within organization
  - Must determine per-user bandwidth requirements
    - May be different "types" of users with different bandwidth requirements

Gathering Data

- **Defining Security Requirements:** Consider type of data encryption and type of authentication that will take place across WLAN
  - Consider existing security policies and procedures
  - Examine the physical requirements as well

- **Gathering Site-Specific Documentation:**
  - Blueprints, facility drawings, and other documents
    - Show specific building infrastructure components
  - Inspecting the site
    - Document changes to blueprints and get visual perspective

Gathering Data

- **Gathering Site-Specific Documentation (continued):**
  - Behind-the-scenes site inspection
    - May require ladder, flashlight, and an escort

- **Documenting Existing Network Characteristics:** New or expanded WLAN will "dovetail" into network already in place
  - How does current network support the mission?
  - What applications run on the network?
  - How many users does it support?
  - What are the strengths and weaknesses of current network?

Gathering Data

- **Documenting Existing Network Characteristics** (continued):
  - What is the anticipated growth?
  - Types of information should be included in the current network documentation include:
    - Number and types of clients
    - Number of servers
    - Topology of the network
    - Type of media being used
    - Performance of the network
    - Types of devices connected to the network

Analyzing Technical Requirements

- Gathering data to determine the technical requirements for the WLAN is important

WLAN Requirement	Questions
Client connectivity requirements	What speed and coverage areas are needed for the various stations in the wireless network?
Indoor- or Outdoor-specific information	Are there special building or topographical issues that must be taken into consideration?
Identifying infrastructure connectivity and power requirements	Will the new/expanded WLAN interface with any existing networks? Is adequate electrical power available where equipment will be located?
Defining physical and data security requirements	What types of physical and network data security is needed to protect the network? Are there any specific aesthetics requirements?

Table 8-4 WLAN requirements

Technical Consideration	Questions
Understanding RF coverage requirements	How large is the physical area that the wireless network will serve? What type of AP and antenna should be used?
Understanding data capacity and client density requirements	Will there be adequate bandwidth for the stations? Are enough cells available to support the number of stations?
Voice over WiFi (VoWiFi)	If VoWiFi will be used, what is the correct quality of service (QoS) technique to support it?
Tracking system considerations	How will the location of wireless devices be tracked?
RF security considerations	Should a system to monitor the RF frequency to ensure security be implemented?

Table 8-5 Wireless technical considerations

Performing the Survey

- **Access Point Configuration and Location:**
  - Decide the type of AP that will be used
  - Configure the AP for optimum power output and channel assignments
  - Position AP
    - Initial location will depend on antenna type
    - Document starting position of AP
  - Using notebook computer with site survey analyzer software running, walk slowly away from AP
    - Observe data displayed by analyzer program
      - Data rate, signal strength, noise floor, and signal-to-noise ratio

Performing the Survey

- **Identifying Interference:**
  - May come from many different objects (see Table 8-6 on next slide)
  - May come from another nearby WLAN
    - Both networks may attempt to use the same or adjacent channel

- **Outdoor Surveys:** Similar to indoor surveys, but must consider climatic conditions, trees, different possibilities for antenna positions

Object	Example	Type of interference
Open space	Courtyard or open cafeteria	None
Wood	Door or floor	Low
Plaster	Inner wall	Low
Synthetic materials	Office partition	Low
Cinder block	Exterior wall	Low
Asbestos	Ceiling insulation	Low
Glass	Clear window	Low
Wire mesh in glass	Security window	Medium
Human body	Large group of people	Medium
Water	Aquarium	Medium
Brick	Outer wall	Medium
Marble	Floor	Medium
Ceramic	Floor	High
Paper	Roll or stack of paper stock	High
Concrete	Floor, pillar	High
Bulletproof glass	Security booth	High
Silvering	Mirror	Very high
Metal	Elevator shaft or filing cabinet	Very high

Table 8-6 Interference by objects

Creating the Site Survey Report

- **Narrative section:**
  - State customer requirements
  - Outline methodology
    - Outline all steps taken during survey
  - Clearly state results of measurements
    - May have tables of measurements
  - Recommendations
    - Should always address security

Creating the Site Survey Report

- **Graphic section:**
  - Generally includes maps and diagrams of coverage area
    - Data rate coverage map
    - Signal-to-noise ratio plot

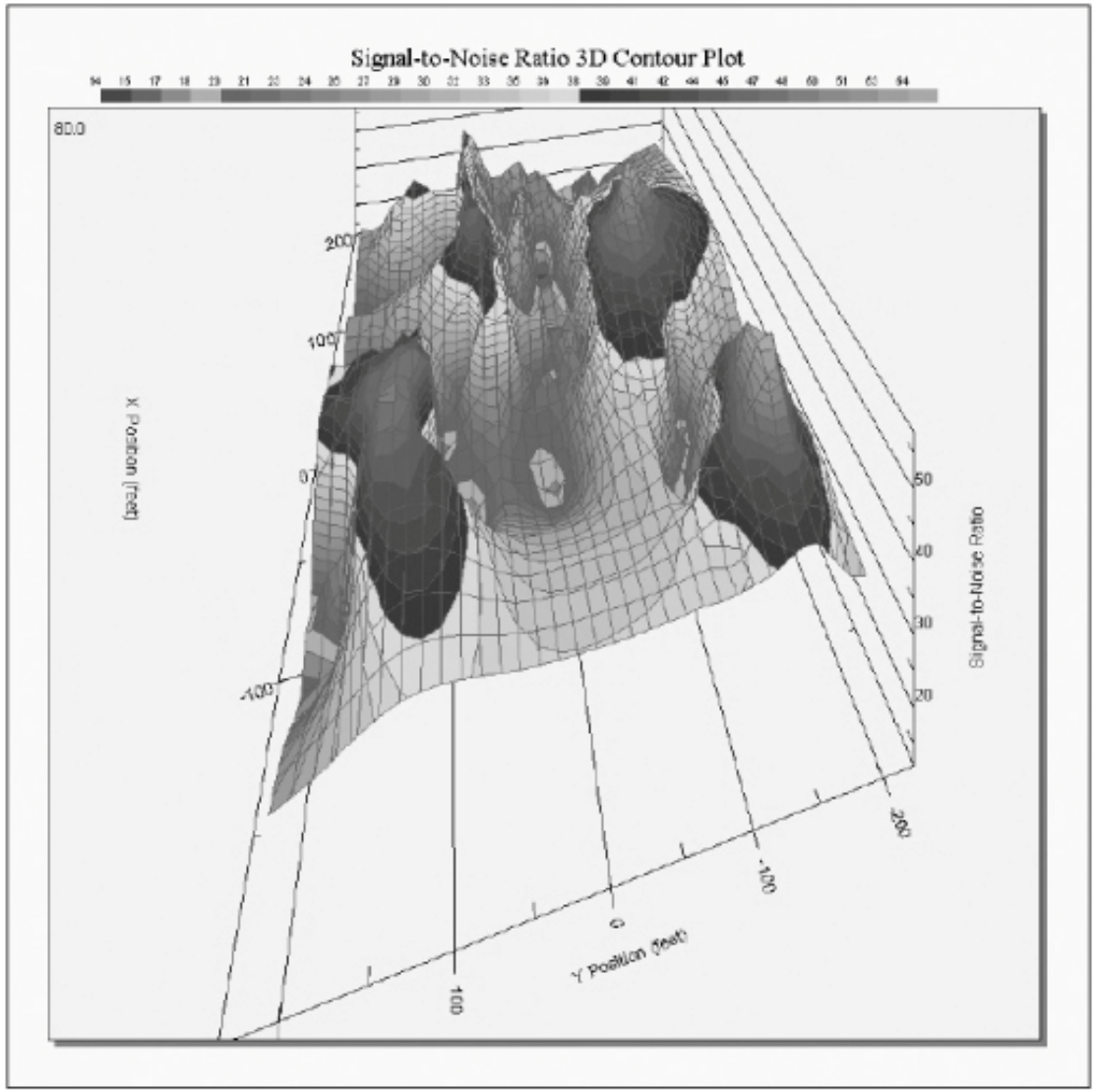


Figure 8-13 3-D SNR plot

Summary

- A site survey is an in-depth examination and analysis of a proposed wireless LAN site to meet design goals
- A manual site survey involves walking through the area of the WLAN while carrying a laptop or tablet
- A predictive site survey is a virtual survey of the area that uses modeling techniques to design the WLAN using predictive analysis simulation application survey software

Summary

- Categories of tools used
  - Wireless tools include the access point and notebook computers with a wireless NIC
  - Measurement tools include site survey analyzers, spectrum analyzers, and network analyzers
- Three steps in conducting a site survey
  - Gather the background data
  - Perform the actual survey
  - Create the site survey report, containing a narrative and a graphical section

Summary

- Outdoor surveys are similar to indoor surveys, but must consider climatic conditions, trees, different possibilities for antenna positions