Cisco Spectrum Expert Users Guide

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Preface

This preface describes the objective, audience, organization, and conventions of the Cisco Spectrum Expert, Release 4.0. It also provides information on how to obtain other documentation. This chapter includes the following sections:

- Objective
- Audience
- Organization
- Conventions

Objective

This guide provides the information you need to set up and configure Cisco Spectrum Expert 4.0.

Audience

This guide is for the person configuring and managing the Cisco Spectrum Expert 4.0. The user should be familiar with wireless networks, terms, and concepts.

Organization

This guide is organized into these chapters:

Chapter Title	Description
Chapter 1, “Cautions and Advisories”	Provides the list of cautions and advisories.
Chapter 2, “Cisco Spectrum Expert Introduction”	Provides an introduction to the Cisco Spectrum Expert product.
Chapter 3, “Cisco Spectrum Expert Overview”	Provides an overview of the Cisco Spectrum Intelligence technology and how Cisco Spectrum Expert implements that technology.
Chapter 4, “Cisco Spectrum Expert Setup”	Describes the physical setup of the Cisco Spectrum Expert, along with software installation

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Chapter Title	Description
Chapter 5, "Cisco Spectrum Expert Software Overview"	Describes the Cisco Spectrum Expert Software interface and its feature sets.
Chapter 6, "Cisco Spectrum Expert Software Active Devices"	Describes the list of all devices that are currently active and transmitting.
Chapter 7, "Working with Spectrum Tabs, Plots, and Charts"	Provides an overview of how to use the Spectrum tabs (**Spectrum** and **Spectrum (2)**) and to create your custom plot or chart views.
Chapter 8, "Spectrum Plots"	Describes the information displayed in each plot.
Chapter 9, "Spectrum Charts"	Describes the information displayed in each chart.
Chapter 10, "Devices View"	Provides the detailed statistics for each device.
Chapter 11, "Channel Summary"	Provides detailed information for each channel.
Chapter 12, "Device Finder"	Describes how to put the Spectrum Expert Device Finder to work.
Chapter 13, "Cisco Spectrum Expert Software Local Settings"	Describes how Cisco Spectrum Expert Software operates and presents data.
Chapter 14, "Cisco Spectrum Expert and Network Operations"	Describes how to put Cisco Spectrum Expert Software to work in the real world of network planning, maintenance, and troubleshooting.
Chapter 15, "Notices, Third Party, and Public Software Statements for Cisco's Spectrum Expert"	Lists the terms and conditions to be used.

Conventions

This guide uses the following conventions to convey instructions and information:

- Command and keywords appear in **boldface**.
- *Italics* indicate arguments for which you supply values.
- Series of menu options appear as **option > option**.

Examples use the following conventions:

- Examples depict screen displays and the command line in screen font.
- Information you need to enter in examples is shown in **bold `screen`** font.
- Variables for which you must supply a value are shown in *italic screen* font.

Note Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

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Related Documentation

These documents provide additional information about the Cisco Spectrum Expert:

- Cisco Wireless Control System Configuration Guide
- Quick Start Guide: Cisco Wireless Control System

Click this link to browse to user documentation for the Cisco Spectrum Expert:

http://www.cisco.com/web/psa/products/index.html.

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at the following URL:

http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html

Subscribe to the *What's New in Cisco Product Documentation* as a Really Simple Syndication (RSS) feed and set content to be delivered directly to your desktop using a reader application. The RSS feeds are a free service and Cisco currently supports RSS version 2.0.

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CHAPTER 1

Cautions and Advisories

Cisco Spectrum Expert technology has been designed as a safe, reliable, user-friendly tool for advanced spectrum monitoring. There are, however, a handful of actions which can inadvertently cause difficulties with using Cisco Spectrum Expert technology. There are also some environmental factors beyond your control which can cause unexpected behaviors.

Read the list of cautions and advisories below and the appropriate sections of this guide in advance to make the most effective (and trouble-free) use of this technology.

- Installation—Be sure to install the Cisco Spectrum Expert Software on your laptop *before* inserting the Cisco Spectrum Expert Sensor Wi-Fi (Sensor card) into your laptop's PCMCIA slot. See Installing the Cisco Spectrum Expert Software for more information.
- Disconnecting the external antenna from the Sensor card—You can achieve increased reception sensitivity for RF signals by attaching an external antenna to the Sensor card. However, the connector on the Sensor card is relatively fragile. Therefore, care must be taken when **disconnecting** the antenna in order to avoid physical damage to the Sensor card and the antenna. See Removing the External Antenna for more information.
- Using 802.11 Broadcast Technology with Cisco Spectrum Expert Software—Cisco Spectrum Expert Software is designed specifically to monitor the RF spectrum in the bands used by 802.11 technology—the broadcast technology used for wireless computer networks.

  If you are using Cisco Spectrum Expert Software, the technology will not function correctly if the laptop where you have installed Cisco Spectrum Expert Software and inserted the Sensor card is also broadcasting its own signals in the Wi-Fi bands.

  Your Cisco Spectrum Expert laptop cannot be part of a Wi-Fi network—that is, it cannot be connected to a Wi-Fi access point or ad-hoc network, while you are running Cisco Spectrum Expert Software. There are also limitations on using certain other network monitoring technologies on the same laptop which hosts Cisco Spectrum Expert Software.

  Note If the Sensor card is installed but you are not actually running Cisco Spectrum Expert, it is okay to allow the laptop to participate in a network.

  See Using Cisco Spectrum Expert With Other Onboard Laptop Technologies for more information.
- If you are not seeing any data or not seeing expected data—Certain peculiarities of the RF behavior can sometimes result in Cisco Spectrum Expert Software not showing any data or not showing expected data (such as not displaying any device information for a device which you know is out there). Failure to see data can also result from Cisco Spectrum Expert hardware not being installed correctly. See What If I'm Not Seeing Any Data? for more information.

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CHAPTER 2

Cisco Spectrum Expert Introduction

Purpose

Cisco Spectrum Expert monitors the RF spectrum used by a variety of wireless network and communications technologies, such as Wi-Fi (802.11) WLANs. Cisco Spectrum Expert consists of a hardware-based Spectrum Sensor card and GUI-based Cisco Spectrum Expert Software which provide complete visibility of the RF environment in which wireless network technologies operate.

Other monitoring technologies typically focus on protocol-oriented network data which only provides a picture of RF devices that are part of the network (or, in some cases, rogue devices which are attempting to penetrate network security or jam the network). Cisco Spectrum Expert is designed to monitor and report on the underlying, physical-layer RF activity which is shared by numerous devices that do not share the network protocols. See Interferers: Classified (Named), Generic, and Unclassified for a list of interfering devices.

Cisco Spectrum Expert can identify nearly all sources of RF activity in the unlicensed bands that wireless networks share with other devices (such as cordless phone and headsets, Bluetooth devices, and microwave ovens). Based on this data, network engineers can take steps to increase network performance and security in the face of interferers, network congestion, and security attacks.

Cisco Spectrum Expert

Cisco Spectrum Expert monitors the 2.4 GHz and 5 GHz bands used by 802.11 networks in the Americas, Australia, the Asia/Pacific region, Japan, and Europe.

Cisco Spectrum Expert Sensor Wi-Fi (Sensor card)

Note The Cisco Spectrum Expert Sensor Wi-Fi is also referred to as the Sensor card in this document.

LEDs

The Sensor card has two LEDs that indicate its operational status. The Status LED (located on the right) is a power indicator. When the Sensor card is plugged in, the Status LED should be green.

The other LED (Activity LED) indicates RF activity (Rx only). Possible states for the Activity LED include:

- Off—Indicates that the Cisco Spectrum Expert Software is not running.

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- On or blinks green—Normal operational state. Indicates that the Cisco Spectrum Expert Software is running and there is RF activity.
- Red blinking—May indicate a hardware problem if the blinking is persistent.

Note Occasional red blinking can be expected.

- On red—May indicate that the driver is not fully loaded. When the driver is successfully loaded, the light should turn green.

Spectrum Bands

Cisco Spectrum Expert supports various bands for spectrum monitoring. See Table 2-1 for the supported bands.

Table 2-1 Supported Bands for Spectrum Monitoring

Product Bundle	Sensor Card	Abbreviated Band Reference	Actual Bands Supported
Wi-Fi	210C	2.4 GHz 5 GHz	2.4-2.5 GHz 4.9-5.9 GHz

Cisco Spectrum Expert provides a detailed, default channel scheme for each supported band. In addition, you can define your own channel scheme. Channelization is discussed further in "Local Settings Overview."

Users Guide and Online Help

This guide provides an overview of Cisco Spectrum Expert and its principal features. Additional information can be found in the Cisco Spectrum Expert Software online help system.

This document provides:

- Cisco Spectrum Expert installation information for network engineers including information on how to install the Sensor card in your notebook laptop.
- Cisco Spectrum Expert configuration instructions.
- A description of the comprehensive RF data displayed by the Cisco Spectrum Expert Software.

Note Installation information is also available in the *Cisco Spectrum Expert Quick Start Guide*.

Product Bundles

The following items are shipped with each Cisco Spectrum Expert Wi-Fi bundle:

- One 210C Sensor Card
- One 2.4-2.5, 4.9-5.9 GHz external omnidirectional antenna and antenna clip
- *Cisco Spectrum Expert Quick Start Guide*

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Caution The external antenna attachment is a potentially sensitive component that can easily be damaged. Take care when removing (disconnecting) the external antenna. See "Removing the External Antenna" for more information.

System Requirements

The following are the system requirements for installing and running Cisco Spectrum Expert:

- Notebook computer with Pentium series processor running at 1 GHz or faster.
- Windows XP Professional or Windows Vista Business (32 bit only) operating systems.
- 256 MB of RAM required (512 MB strongly recommended).
- Display resolution of 800 x 600 or higher (1024 x 768 recommended).
- 30 MB of available disk space.
- Available card slot.
- For Cisco Spectrum Expert, an 802.11 card or onboard 802.11 capability in order to monitor Wi-Fi devices.

Using Cisco Spectrum Expert With Other Onboard Laptop Technologies

If your computer has an 802.11 interface, it should be enabled in order to detect Wi-Fi devices. Note that if you are connected to an AP or ad-hoc network through the 802.11 interface, you will occasionally see strong signals on the spectrum plots that are measurements of your own 802.11 transmissions. As long as your network transmissions are not excessive, Cisco Spectrum Expert will still operate correctly in the presence of these signals.

Other Monitoring Technologies

Cisco Spectrum Expert can share your laptop with some other passive monitoring technologies. It can run concurrently with WildPackets AeroPeek, AirMagnet Laptop Analyzer, or AirMagnet Surveyor without an inappropriate degradation in product performance.

Note This feature assumes that your laptop can accommodate the required number of Sensor cards.

Note Some of these other monitoring technologies (such as AirMagnet Surveyor) also have "active" survey or monitoring modes that transmit packets to nearby access points. If you have one of these cards installed in the same laptop with Cisco Spectrum Expert, it is important to ***not*** use these active transmission modes because they interfere with the proper operation of Cisco Spectrum Expert.

Note The products indicated above—AeroPeek, Laptop Analyzer, and Surveyor—offer monitoring capabilities which are complementary to those provided by Cisco Spectrum Expert. Although these products offer extensive 802.11 information, Cisco Spectrum Expert offers increased depth of physical layer (RF emissions data), identification of interfering devices, and more extensive spectrum plotting and related data (such as duty cycle measurements and other measures of overall RF activity).

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Concurrent 802.11 (Wi-Fi) Protocol Support

The Cisco Spectrum Expert Software detects the presence of Wi-Fi support in the laptop, either on the system board or as another sensor card. If so, and if you are using Cisco Spectrum Expert, the software provides basic support for 802.11 protocol monitoring in the Devices View (see "Working With Devices View" for more information) and Device Finder (see "Device Finder Mode" for more information) features of the software.

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CHAPTER 3

Cisco Spectrum Expert Overview

Analysis and Cisco Spectrum Expert

This chapter provides an overview of the Cisco Spectrum Intelligence technology and how Cisco Spectrum Expert implements that technology.

Cisco Spectrum Intelligence

Cisco Spectrum Intelligence addresses several current shortcomings in radio frequency (RF) network technology. These shortcomings exist in numerous RF domains such as the WLAN technology used by 802.11 computer networks. These shortcomings fall into several inter-related categories.

RF Visibility and Unlicensed Bands

Currently, RF network system administrators lack sufficient awareness of the RF environment in which their access points and stations (for WLANs) operate. Issues arise because many RF network technologies operate in unlicensed bands, which means that multiple technologies—technologies which are not meant to interoperate and which represent different aspects of the RF infrastructure—compete for use of the same bandwidth.

Discovery

Current network technologies, such as those used to monitor 802.11 WLANs, are only aware of other network elements. They are unable to discover other nearby sources (competing technologies) emitting radio frequency signals in the unlicensed bands.

Wi-Fi Performance

WLANs operate in the unregulated 2.4 GHz and 5 GHz bands and are subject to interference from other devices operating in this same frequency spectrum such as microwave ovens, cordless phones and cordless headsets, wireless surveillance cameras, garage door openers, Bluetooth technology, and other devices. There can also be co-channel interference (CCI) due to neighboring WLANs. These competing devices can degrade 802.11 network performance resulting in slow data rates and excess packet retransmissions. There is a CCI category in the Interference Power chart for displaying the CCI impact on your network.

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Wi-Fi Troubleshooting

Current WLAN technologies are aware of network devices so they can determine if there is an excess load on the network from network stations. Current technologies cannot see the whole RF spectrum in the unlicensed band and cannot identify sources of RF activity which can cause dropped network connections and other problems.

Summary

Current 802.11 (Wi-Fi) technologies offer protocol-level awareness, but not physical layer (RF) awareness. Lacking full RF spectrum awareness, existing WLANs cannot apply appropriate, adaptive responses to improve performance in the face of interferers and competing networks.

Cisco Spectrum Expert: Mitigation and Performance Enhancement

Cisco Spectrum Expert includes sophisticated technology to detect and classify sources of RF activity. Using this data, network engineers can use a variety of methods to enhance Wi-Fi WLAN performance and reliability. Some of these methods are listed below.

Clean Channels

If a certain part of the frequency spectrum is in constant use by other devices, the network engineer can program the network to not transmit over those channels. By deliberately searching for “clean” channels, the network devices can be set to broadcast over those channels.

Identifying, Locating, and Removing Interferers

Cisco Spectrum Expert can identify the types of devices which are producing RF interference. An interferer is any non-network RF device which broadcasts in the same frequency bands as network devices and can cause disruption to your network. For example, in the 802.11 domain, typical interferers include microwave ovens, cordless headphones and headsets, 802.11 FH devices, and Bluetooth devices. The network engineer is alerted to the presence of these devices and can take steps to address the problem (including relocating or shutting off the devices).

With Cisco Spectrum Expert Software, the network engineer can also use Cisco Spectrum Expert Software’s **Device Finder** mode to make the Cisco Spectrum Expert-enabled computer into a lightweight homing device to track down the precise location of the signal source. (See “Device Finder Mode” for more information.)

Tip The optional directional antenna, available from Cisco, can help with determining the location of Wi-Fi devices.

Device Specific Solutions

By knowing the ID of specific interfering devices, custom solutions can also be tailored to specific technologies and specific brands of these technologies.

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Cisco Spectrum Expert Solution

Cisco Spectrum Expert is a combined hardware and software technology which implements Cisco Spectrum Intelligence technology. Cisco Spectrum Expert makes the 802.11 WLAN system "spectrum savvy", ensuring greatly increased reliability and performance. Cisco Spectrum Expert consists of two primary components:

- **Sensor Card**—Sensor cards provide the hardware foundations for Cisco Spectrum Intelligence. Each Sensor card incorporates SAgE ASIC, a powerful spectrum-analyzer-on-a-chip. SAgE provides full visibility for the RF spectrum in the unlicensed bands where Wi-Fi WLANs operate.
- **Cisco Spectrum Expert Software**—The Cisco Spectrum Expert Software analyzes data from the Sensor card and provides a GUI-based view of network and RF activity.

With Cisco Spectrum Expert, the Sensor card and application are integrated into one convenient platform. A network engineer uses the application's device finder mode to observe how the signal strength from an interferer varies as he moves about the enterprise, which makes it possible to quickly pinpoint the location of the interfering device.

Spectrum Sensor Card

As a first step in the spectrum analysis process, the ambient RF environment must be scanned and analyzed to determine the sources of RF activity in the neighborhood of the network, especially causes of interference or other problems.

The essential internal components of a Sensor card include:

- **Radio**—The radio transceiver detects the RF spectrum and feeds this data to SAgE.
- **SAgE**—The Spectrum Analysis Engine (SAgE), performs a Fast Fourier Transform (FFT) of the RF spectrum and provides the feed of low-level data concerning the behavior of the RF spectrum. Low-level data includes basic information on the power vs. frequency in the spectrum at a given instant and information on individual pulses in the RF spectrum.

  SAgE also performs on-board statistical analysis of the spectrum and statistical analysis of RF pulses (which relieves external MCUs or CPUs of this processor-intensive task).
- **CPU**—To be fully useful, data from the Sensor card requires further software analysis from a microprocessor. The Sensor card borrows some of the processing power from the laptop's microprocessor (CPU) to perform these calculations. The CPU provides low-level analysis of the data stream. The analysis engines include:
  - **Measurement Engine**—Aggregates SAgE data and normalizes it into meaningful units.
  - **Classification Engine** —Identifies specific types of interferers (Bluetooth devices, microwave ovens, cordless phones and headsets, radar, and so on).

Cisco Spectrum Expert Software

The Cisco Spectrum Expert Software runs under Windows XP (Service Pack 2 or later) or Windows Vista operating systems. The application provides the interface (GUI) which connects the network engineer with the resources available from the Sensor card:

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- **Spectrum Views**—Provides plots and charts that offer a direct view into the RF spectrum, including measurements of RF power and network device activity. See the "Spectrum Menu" section for more information.
- **Active Devices**—Displays all currently active devices in the network neighborhood including both network devices and interferers. See the "Active Devices" section for more information.
- **Devices**—Provides detailed information on both current and historical device activity. See the "Current Devices vs. Historical Devices" section for more information.
- **Channel Summary**—Provides a statistical overview of RF activity (such as power levels and number of interferers present) on a per-channel basis. This view gives you an instant picture of which channels are subject to excess interference, and which channels have the best potential for trouble-free network activity. See the "Working with the Channel Summary" section for more information.
- **Device Finder**—In **Device Finder** mode, Cisco Spectrum Expert Software is a convenient, user-friendly RF "sniffer" optimized for displaying RF power data in a way that quickly enables the network engineer to track down interfering devices. See the "Device Finder Mode" section for more information.
- **Tools—**Supports configuration of Cisco Spectrum Expert Software. See the "Tools Menu" section for more information.

Cisco Spectrum Expert Online Help

Detailed reference information is found in the Cisco Spectrum Expert Online Help system, which can be accessed by selecting **Help > Help Topics**.

Cisco Spectrum Expert Operating Scenarios

Cisco Spectrum Expert can be used in several different modes which are described below.

Note For detailed instructions on using Cisco Spectrum Expert in real-world applications, see the "Cisco Spectrum Expert and Real World Applications" section.

Firefighting Mode

Critical Tasks:

- Identify, diagnose, and resolve problems in the RF environment as quickly as possible.

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Centerpiece Applications:

- Spectrum Charts
- Devices View
- Device Finder
- Channel Summary

Typically, the IT Administrator will have the Cisco Spectrum Expert Software running with the **Channel Summary** or one or more **Spectrum Plots** and **Spectrum Charts** in view. **Spectrum Charts**, in particular, are an important resource for detecting problems that may stress the network.

- The **Channel Utilization** chart—Indicates when one or more channels are becoming overloaded with devices.
- The **Channel Utilization** chart—Indicates when one or more channels have an overall excess of RF activity which may be due either to device overload, or interferers, or both.

Once a problem occurs and before it progresses too far, the Administrator can determine and isolate the cause of the problem through a combination of the **Devices View**, **Channel Summary**, and the **Device Finder**.

RF Expert

An RF expert is an individual with an advanced knowledge of radio frequency technology and its associated physics and electronics. This individual is familiar with the use of spectrum analyzers as well as the inner workings of wireless network systems. An RF expert is most likely to be involved with installations where the wireless system is considered mission critical.

The RF Expert uses Cisco Spectrum Expert as a 24 hour-per-day, 7-day-per-week spectrum analysis tool.

Critical Tasks:

- Investigate reported spectrum events at the raw RF level.
- Review raw RF data for cases that are unclassified by Cisco Spectrum Expert Software.
- Confirm that recommended solutions have alleviated the problem.

Centerpiece Application: **Spectrum Analyzer Plots**

The RF Expert primarily uses the detailed **Spectrum Analyzer** plotting capabilities of Cisco Spectrum Expert Software's **Spectrum Plots**. When he is called in on a problem, he uses the **Spectrum Plots** to confirm and/or supplement the intelligence capabilities built into Cisco Spectrum Expert Software.

For example, if Cisco Spectrum Expert Software reports that a video interference signal is occurring, the RF expert may wish to view the **Power Vs. Frequency** and **Real Time FFT** plots to confirm that it is not some other type of device. In addition, there will always be cases where Cisco Spectrum Expert Software does not recognize the type of interference at work. In that case, the human intelligence of the RF expert helps fill in the missing gaps.

Another critical use of the **Spectrum Analyzer** capabilities is to confirm when a problem has been fixed by corrective action. When a fix has been attempted, the IT department can't afford to wait until the next day to see that no problems resurface. The RF expert can use the **Spectrum Analyzer** functions to perform before-and-after comparisons that confirm that a fix (for example, shielding was placed around an interference device) has indeed fixed the problem. These comparisons are enabled by Cisco Spectrum Expert Software's record/playback capabilities.

See the "Spectrum Instant Replay" section for more information.

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Site Survey—Network Install and Initial Configuration

Cisco Spectrum Expert Software is an invaluable tool for supporting pre-installation Wi-Fi site surveys, and also for the initial installation and configuration of a WLAN system.

Critical Tasks:

- Set channel usage for Wi-Fi access points
- Pre-emptive interference mitigation

Centerpiece Applications:

- Spectrum Plots and Charts
- Device Finder
- Channel Summary
- Devices View

Cisco Spectrum Expert Software can be used prior to deployment of a Wi-Fi WLAN network, to obtain information which is essential for planning an optimum deployment.

- **Band and Channel Allocations—**Cisco Spectrum Expert Software can determine which bands or channels have the most RF activity. Wi-Fi access points can then be programmed to use other channels, resulting in higher speed transmissions, and reduced packet retransmissions.
- **Pre-emptive Interference Mitigation—**Any interferers which are discovered to be contributing significant RF activity can be moved, de-activated, or shielded, before putting the WLAN system into operation.
- **Access Point Placement**—As a lightweight, mobile RF probe, Cisco Spectrum Expert Software can determine which general areas have the highest level of RF activity—as determined by the **Devices View**, the **Device Finder**, and the **Spectrum Plots and Charts**—and therefore require the most access points for adequate network coverage.

Technical Concepts

Cisco Spectrum Expert Software is designed to make the RF spectrum accessible even to non-experts by performing a tremendous amount of high-level analysis on behalf of the user. For example, Cisco Spectrum Expert Software can classify interfering devices, sparing the user the necessity of interpreting a spectrum graph to determine which kinds of interfering devices are present.

Cisco Spectrum Expert Software provides a great deal of technical information, so some familiarity with RF concepts is helpful. Neither this manual nor the online Help system attempts to present a detailed discussion of radio frequency theory, but a few concepts are worth some clarification.

Duty Cycle

Among the various measures of RF power, Cisco Spectrum Expert Software includes the ability to measure and report on the RF duty cycle. *Duty cycle* is a general term which relates to how much RF energy is present in the spectrum, as measured not by raw RF power (not in watts or dBm), but rather in terms which indicate how much RF power is present in some operational or functional sense. The goal is to have a measure of RF power which suggests how much impact the RF power will have on network performance. Cisco Spectrum Expert Software uses two different measures of duty cycle:

- The percentage of time that the RF signal is 20 dB above the noise floor.
- The percentage of time a transmission from a known device is present in the channel or band.

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This guide indicates which measure of RF power is used by various Cisco Spectrum Expert Software display modes. The Online Help also includes a topic (**Duty Cycle** in the **Background Information** folder) which compares the usage of duty cycle in various contexts in the Cisco Spectrum Expert Software.

Device Classifiers

You, as the user, make the vital distinction between network devices (Wi-Fi) and interferers. In addition, the Cisco Spectrum Expert Software supports this distinction, in terms of how data is structured and classified on the display. However, the underlying technology used to detect and classify both network devices and interferers is the same. Cisco has developed advanced classifier algorithms, which run on the processor on your laptop. These classifier algorithms use the spectrum data from SAgE (discussed above) to categorize devices which are part of your network, or which can interfere with your network.

The classifiers supported in Cisco Spectrum Expert Software 3.2 include:

- Wi-Fi Access Points
  - In-Network
  - Known
  - Unknown
  - Ad Hocs
- Wi-Fi Stations
- A wide variety of Bluetooth devices
- A wide variety of cordless phones
  - Cordless Phone, 2.4/5.8 GHz, DECT1
  - Cordless Phone, 2.4/5.8 GHz, DECT2
  - Cordless Phone, 5.8 GHz, DECT3
  - Cordless Phone, 2.4 GHz, TDD/Fixed Channel variant 1
- Microwave Ovens
- Generic Fixed Frequency
- Generic Frequency-Hopped
- Generic Continuous transmitters (For example, FM Phones, NTSC, and so on.)
- RF Jamming devices
- 802.11FH devices
- 802.11n devices
- Analog Video
- Radar
- Xbox
- WiMax devices

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Generic Device Classifiers

Cisco Spectrum Expert supports the ability to classify "generic" devices. Generic devices cannot be linked to a specific device type, manufacturer, or transmission protocol. They are identified by their physical layer transmission characteristics. An example of such a device is a cordless phone that uses an unrecognized transmission protocol to exchange data with its base station (i.e., a phone that does not use Bluetooth, 802.11FH, TDD or DECT).

The following list of generic signals recognized by Cisco Spectrum Expert 4.0 is subject to revision without notice:

Pulse Type	Analog or Digital	Modulation Type	Output Parameters
Continuous	Digital	FSK	RMS power, bandwidth, coarse and fine CF [1]
Continuous	Digital	OFDM	RMS power, bandwidth
Continuous	Analog	FM	RMS power, bandwidth, coarse and fine CF
Continuous	Analog	CW	RMS power, coarse and fine CF
Burst	Digital	FSK	RMS power, bandwidth, symbol rate, coarse and fine CF, burst period
Burst	Digital	OFDM	RMS power, bandwidth, burst duration

[1]CF = center frequency, PAP = peak-to-average power

In the **Active Devices List**, these devices will be identified via a hierarchical listing which will indicate the pulse type, modulation type, and possibly the frequency. For example:

Generic Devices [5]
- **Burst, Fixed Frequency [3]**
  - **Channel Group @ 2431.3 MHz [2]**
    - **Device 1 (FSK)**
    - **Device 2 (FSK)**
  - **Channel Group @ 2434.3 MHz [1]**
    - **Device 1 (FSK)**
- **Continuous [2]**
  - **Device 4 (CW) @ 2430.1 MHz**
  - **Device 7 (FSK) @ 2440.1 MHz**

The bracketed numbers indicate the number of devices.

A similar naming scheme is used in the **Devices View**.

Interferers: Classified (Named), Generic, and Unclassified

As indicated, Cisco Spectrum Expert classifies many different interferers – that is, devices which are not network devices, but which produce RF power in frequency bands that affect your network. For purposes of Cisco Spectrum Expert operations, there are three broad categories of interfering devices:

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Classified Named Interferers

For many interfering devices, Cisco Spectrum Expert can detect and classify the type of device, in some cases to the extent that it can name the specific model of a device in question. So, for example, Cisco Spectrum Expert will not only identify an interferer as being a Bluetooth device, it will also indicate a brand name and model. However, for our purposes, a "named" device is one for which Cisco Spectrum Expert can indicate the category of operation (Bluetooth, microwave oven, cordless phone, and so on.). The user interface displays a picture of a typical device that matches the RF signature when a user double-clicks on a device in the Active Devices pane or Devices View.

Classified Generic Interferers

These are devices for which Cisco Spectrum Expert has a great deal of technical information about the *signal* from the device, such that the general nature of the RF emitter can be identified. However, the Cisco Spectrum Expert system does not present a name (such as **DECT2**, or **Bluetooth**); and Cisco Spectrum Expert does not present a list of devices (product names) that can be in this category.

For the generic devices, Cisco Spectrum Expert provides the kind of signal details indicated in the table, Generic Device Classifiers. In fact, what Cisco Spectrum Expert essentially provides are detailed parameters about the RF signal from the device, rather than about the device per se.

Example: In the case of "Continuous Transmitter FSK", "Continuous" means the device transmits continually rather than in bursts; "FSK" refers to the signal modulation. ("FSK" stands for Frequency Shift Keying.) Specific devices, such as DECT2 devices, are also "continuous FSK" transmitters; but if Cisco Spectrum Expert does not identify the interferer as, say, DECT2, it's because other expected transmission properties of DECT2 devices were not detected. Hence, Cisco Spectrum Expert only provides the broader, generic classification based on the type of signal.

Unclassified Interferers

An "unclassified interferer" is literally one that Cisco Spectrum Expert does *not* classify. That means it is not identified, as a device, anywhere on the screen (such as in the **Devices View** or the **Active Devices** list). It also means the device is not included in counts of devices. On the **Channel Summary** display, the **Interferer Duty Cycle** field does not include measurements of unclassified interferers.[1] However, Cisco Spectrum Expert still does see RF energy from unclassified interferers. See the following note.

Note The plots and charts which show RF power (**Real Time FFT**, **Power vs. Frequency**, and the **Swept Spectrogram**) or duty cycle (**FFT Duty Cycle**, **Channel Utilization**, **Channel Utilization vs. Time**, and **Swept Spectrogram**) *do* show *all* RF power / duty cycle detected by the Sensor card, regardless of the source. So, power/duty cycle from unclassified interferers is also included.

Naturally, Cisco tries to minimize the number of interferers that Cisco Spectrum Expert cannot classify at all.

1. The **Interferer Duty Cycle** on the **Channel Summary** is an estimate of the percentage of the time that a transmission is present in the channel or band. To be included in this estimate, the transmission must be associated with a known, identified device. So, transmissions from unclassified interferers are automatically excluded. In addition, it is possible that there may be some transmissions from generic interferers which Cisco Spectrum Expert cannot actually identify as belonging to those devices. Those transmissions are also not included in the **Interferer Duty Cycle** shown on the **Channel Summary**.

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CHAPTER 4

Cisco Spectrum Expert Setup

The chapter discusses the physical setup of the Cisco Spectrum Expert, along with software installation.

Note Be sure to install the Cisco Spectrum Expert Software before installing the Sensor card into your computer. If you have installed the Sensor card first, see the "Repairing a "Backwards" Installation" section for more information.

Downloading the Cisco Spectrum Expert Software

Note Install the Cisco Spectrum Expert Software *before* installing the Sensor card in the slot in your computer.

To download the Cisco Spectrum Expert Software, follow these steps:

Step 1 Go to **http://www.cisco.com/kobayashi/sw-center/sw-wireless.shtml**.

Step 2 Under Cisco Spectrum Expert, click the **Cisco Spectrum Expert Software Release** link.

Step 3 Select the most current download (.exe) file for your operating system.

Installing the Cisco Spectrum Expert Software

To install the Cisco Spectrum Expert Software, follow these steps:

Step 1 Click on the downloaded executable setup program to initiate the installation wizard.

Step 2 If security warning screens appear, click **Run** or **Yes** to confirm and continue.

Step 3 From the **Welcome** screen, click **Next**.

Step 4 On the **License Agreement** screen, review the Cisco Software license agreement and select the **I accept the terms in the license agreement** checkbox.

Step 5 Click **Next**.

Step 6 On the **Customer Information** screen, enter your User Name and Organization.

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Step 7 Click **Next**.

Step 8 On the **Destination Folder** screen, click **Next** to confirm the default install destination.

Installing the Sensor Card in the Laptop Slot

Note Install the Cisco Spectrum Expert Software before installing the Sensor card into an available slot in your computer.

The Sensor card contains Cisco custom hardware, the SAgE chip, for detecting RF spectrum activity.

Note Cisco Spectrum Expert 4.0 only supports second generation Cisco production sensor cards. These cards can be identified by the Cisco label with the model number of 210c and an 11 character alpha/numeric serial number. The older cards can continue to operate and are supported using the released 3.3.52 version of software available on Cisco.com.

To install the Sensor card, follow these steps:

Step 1 Insert the Sensor card into an open slot (i.e., a PCMCIA Card slot) on your laptop.

Note The pins go in first with the LEDs on the card facing upward.

Step 2 Press the card gently but firmly into place.

Step 3 Windows XP and Vista should automatically detect the hardware and install the necessary drivers for the Sensor card.

Note Once the installation is complete, a Windows XP or Vista pop-up window indicates that the hardware has been installed.

Step 4 When a dialog box indicates the installation is complete, click **Finish**.

Attaching the External Antenna

The Sensor card has an internal antenna, however we recommend using the external omni antenna (included) for improved detection sensitivity. An external directional antenna can also be ordered from Cisco (optional).

Caution To avoid damaging both the connector and the Sensor card, use caution when detaching the external antenna.

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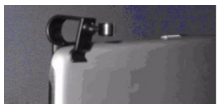
Caution Significant repetition (over 500 times) of connecting and disconnecting the external antenna may degrade the connector's performance.

Omni Antenna

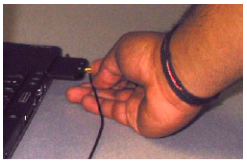
To attach the omni antenna, follow these steps:

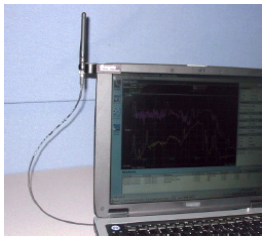
Step 1 Attach the antenna holder clip to the top of the computer's display panel.



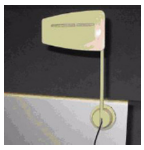
Step 2 Slide the antenna vertically into the round, horizontal holder with the swivel base above the antenna holder clip.

Step 3 Install the antenna's cable into the external jack on the Sensor card using the cable plug (MMCX male connector).





Directional Antenna



To attach the directional antenna, follow these steps:

Step 1 Mount the Velcro strip to the back of the PC using the strip's adhesive backing.

Step 2 Attach the plastic holder to the Velcro strip.

Step 3 Slide the antenna's support staff into the slot holder.

Step 4 Install the antenna's cable into the external jack on the Sensor card using the cable plug (MMCX male connector).

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See the Directional Antenna, page 4-3 for more information on how to make effective use of the directional antenna.

Removing the External Antenna

Caution Care must be taken when removing (disconnecting) the external antenna. If the plug is not removed carefully, either the MMCX antenna jack on the Sensor card, or the Sensor card itself may be permanently damaged.

Why didn't Cisco use a more robust connector for the antenna? Certain technical requirements create limits on the connector that can be used. It must be thin enough to fit in a Sensor card. Also, the extremely high frequencies involved demand a special connector which can carry these frequencies across the connection with minimal signal loss. Very few connectors can meet these stringent requirements, and we have selected what we believe is the best connector for the purpose at hand. Unfortunately, it is relatively fragile, and requires careful handling to avoid damage.

The antenna should **NEVER** be disconnected by pulling on the antenna lead (the wire connecting the antenna to the Sensor card) to avoid causing damage to the cable, connector, and Sensor card.

Caution Failure of the user to follow the instructions below can cause the antenna or Sensor card to become inoperable, and failure to properly disconnect the antenna may lead to voiding the warranty.

Essentially, the requirements for removing the external antenna is to make sure you are pulling the plug straight out of the jack.

Note You may find it easier to detach the antenna if you first remove the Sensor card from the slot. This way, you can hold the Sensor card in one hand, while grasping the antenna jack in the other. See the "Swapping or Removing the Sensor Card" section for more information.

To safely remove the plug, follow these steps:

Step 1 Grasp the plug—the part at the end of the antenna wire—at the end of the antenna lead where it is mated to the Sensor card.

The best method is to "pinch" the connector with the thumb and forefinger, and with the nails, or the tips of the fingers, under the shoulders of the connector.

Step 2 Pull the connector firmly and make sure that it is perpendicular to the edge of the card.

Carefully get a grasp on the plug—we recommend you actually use your fingernails, sliding them so as to create a gap between the plug and the jack—and gently but firmly pull the plug in a direction that is directly at right angles to the Sensor card and is perpendicular to the laptop, if the Sensor card is still inserted in the laptop. To the extent possible, you should be gripping the plug with equal, balanced pressure from opposing sides, using two or three fingers.

What you do *not* want to do is to apply any pressure to the left or right, or up or down.
We recommend you avoid a twisting motion as well.

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Using the Directional Antenna

The purpose of the directional antenna is to focus RF detection activity in a given direction. This can be useful with all Cisco Spectrum Expert Software features, but is especially useful with the **Device Finder** (see the "Device Finder Mode" section for more information).

Swapping or Removing the Sensor Card

Normally, you would not want to remove the Sensor card while the Cisco Spectrum Expert Software is running. However, you can in fact remove the Sensor card, and reinsert it, without degrading system performance.

If you do remove the Sensor card while the software is running, a pop-up window will appear directing you to reinsert the card, and hit **[OK]** to continue.

Cisco Spectrum Expert Software Startup

When Cisco Spectrum Expert Software and the Sensor card are installed, Cisco Spectrum Expert Software can identify sources of interference in the neighborhood of your network.

Note If your computer has an 802.11 interface, it should be enabled in order to detect Wi-Fi devices. Note that if you are connected to an AP or ad-hoc network through the 802.11 interface, you will occasionally see strong signals on the spectrum plots that are measurements of your own 802.11 transmissions. But as long as your network transmissions are not excessive, Cisco Spectrum Expert Software will still operate correctly in the presence of these signals.

To start the Cisco Spectrum Expert Software, follow these steps:

Step 1 From the Start menu, select **All Programs > Cisco > Cisco Spectrum Expert** or click the desktop icon.

Note If you receive a Windows security alert for a Spectrum Expert-related program called **Sensord**, select the **Unblock** option.

Step 2 From the **Connect to Sensor** dialog box, choose from:

- Sensor Card with Internal Antenna
- Sensor Card with External Antenna
- Spectrum Capture File

Note If you choose **Spectrum Capture File**, click **Browse** to identify the applicable file.

Step 3 To identify these settings as default, select the **Automatically start sensor connection with these settings next time application is launched** check box.

Step 4 Click **OK** to access the Cisco Spectrum Expert Software application.

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Note Upon starting Cisco Spectrum Expert Software, you may see a dialog box indicating that there is no 802.11 capability in your laptop. Cisco Spectrum Expert Software will work, but will not detect 802.11 devices. See "Cisco Spectrum Expert Software and Your Laptop" for more information.

Note Depending on the country in which you are located, you may need to change the settings before you can make effective use of Spectrum Expert.

Step 5 Select **Tools > Settings** to change the application settings, if necessary.

Step 6 Select the **Channel Settings** or **Monitored Bands** buttons at left. See "Console Settings" for more information.

From here, you can use all the features of Cisco Spectrum Expert Software. See "Cisco Spectrum Expert Solution" for more information.

Repairing a "Backwards" Installation

Note The Cisco Spectrum Expert Software should be installed *before* you insert the Sensor card into your PCMCIA slot.

If you have installed the Sensor card hardware first, the software installation process may not work correctly and Cisco Spectrum Expert Software may not recognize the Sensor card in your laptop. This section contains instructions on how to fix this situation, should it arise.

The installation process automatically installs the software drivers required by the Sensor card. If you install the Sensor card first, the necessary device drivers are not present.

If a message appears indicating that the necessary device drivers are not present, follow these steps:

Step 1 Click the **Don't prompt me again to install the software**.

Step 2 Select **Finish**.

Step 3 Install the Cisco Spectrum Expert Software. See "Installing the Cisco Spectrum Expert Software" for more information.

After installing the software, Windows XP or Vista may or may not automatically recognize the Sensor card. Both of these situations are addressed below.

Automatic Hardware Recognition By Windows XP Or Vista

Windows XP or Vista may automatically recognize that the necessary drivers are now present to support the Sensor card. Windows XP or Vista will install the drivers for you, and you can go ahead and use Cisco Spectrum Expert Software.

One way to find this out is simply to start the software. If the program starts successfully, this indicates it has found the Sensor card and it is ready for use.

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Another way to check that the drivers are properly installed is to select:

- **Start > Settings > Control Panel**
- Double-click on the **System** icon.
- Select the **Hardware** tab.
- On the **Hardware** tab, select **Device Manager**.

If the Sensor card—with supporting software drivers—is properly installed, then there will be an icon for **Spectrum analysis devices**. Open that icon (double-click on it), and underneath you will see listed the **Cisco Spectrum Expert Sensor**. (SAgE is the spectrum-analyzer-on-a-chip in the Sensor card.)

You can close the Device Manager, and get to work with the Cisco Spectrum Expert Software.

Cisco Spectrum Expert Software and Your Laptop

There are several important issues you need to be aware of, in terms of how your laptop interacts with Cisco Spectrum Expert Software. These are discussed below.

Laptop Resource Utilization

In general, Cisco Spectrum Expert Software is a resource-intensive software, using a relatively large amount of CPU cycles. In particular, when you are using the **Power vs. Time** spectrum plot, or the **Device Finder**, you can expect that any other softwares running on the laptop will run slowly.

Spurious Signal Detection

Every laptop computer emits RF signals which can be detected by Cisco Spectrum Expert Software. While we have implemented various algorithms to avoid classifying these as interferers, the signals will sometimes be classified as continuous interferers and they will always be visible in all the spectrum plots. This issue is more prevalent when using the Sensor card's internal antenna.

Upgrading The Cisco Spectrum Expert Software

An upgrade to Cisco Spectrum Expert 4.0 is considered a major upgrade becuase during installation any previous versions of Cisco Spectrum Expert Software are automatically uninstalled, after which, Cisco Spectrum Expert 4.0 installs as a "fresh" installation. All generated files, such as Spectrum View configurations, CCF files, screen captures and data exports will be preserved by the upgrade process. However, local settings such as Bands/Channels selection, default views and alerts configurations will not be preserved.

Note Previous versions of Cisco Spectrum Expert Software were Cognio-branded. For example, Cognio-branded Spectrum Expert 3.1 can be upgraded to Cisco-branded Spectrum Expert 4.0.

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CHAPTER 5

Cisco Spectrum Expert Software Overview

Note If your computer has an 802.11 interface, it should be enabled in order to detect Wi-Fi devices. If you are connected to an AP or ad-hoc network through the 802.11 interface, you will occasionally see strong signals on the spectrum plots that are measurements of your own 802.11 transmissions. But as long as your network transmissions are not excessive, Cisco Spectrum Expert Software will still operate correctly in the presence of these signals.

Figure 4-1: The Cisco Spectrum Expert Software

Status Bar

The Cisco Spectrum Expert Software has a **Status Bar** at the bottom which may be toggled on and off using **View > Status Bar**. The **Status Bar** displays the following information:

- Current antenna in use

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- System uptime
- User band selections
- Current mode—Live, Playback, or Recording.

Note See "Spectrum Recording and Playback" for more information.

Active Device Tree

The **Active Device** tree shows all access points, ad-hoc networks, and interferer devices currently detected by Cisco Spectrum Expert Software. The tree is normally on display on the left side of the application, but can be toggled on and off by selecting **View > Device Tree**. See "Active Device Tree" for more information.

Cisco Spectrum Expert Software Tabs and Operational Features

These five modes of operation are accessed by selecting any of the five tabs running across the top of the application display: **Spectrum**, **Spectrum (2)**, **Devices**, **Channel Summary**, and **Device Finder**. Table 5-1 shows the relationship between the display tabs and the application's operational capabilities.

Table 5-1 Cisco Spectrum Expert Software Operational Features

Display Tab	Reference	Comments
Spectrum	See "Spectrum Tabs, Plots, and Charts Overview", "Using Spectrum View Plots", or See "Using Spectrum View Charts".	Each Spectrum tab can display a mixture of Spectrum Plots and Charts. The application provides two Spectrum tabs, allowing for two different, user-configurable, default configurations of Plots and Charts.
Spectrum(2)		
Devices	See "Working With Devices View".	Detailed information on detected devices. Unlike the **Active Devices** list, this will also show historical devices (i.e., devices which are no longer active).
Channel Summary	See "Working with the Channel Summary".	Summary of RF activity on all monitored channels.
Device Finder	See "Device Finder Mode".	Cisco's "sniffer" for locating unwanted RF devices.

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Control Panel

Several of the viewing modes have specific controls which enable you to fine-tune the features of the display. For example, one of the **Spectrum Plot Controls** panel is shown at left. Normally, the **Control Panel** automatically comes into view when you select an appropriate mode, such as **Spectrum** mode (see "Using Spectrum View Plots"), **Devices** mode (see "Device Finder Mode"), or **Device Finder** (see "Working With Devices View").

- If the **Control Panel** is not displayed, select **View > Control Panel**. Select the same menu option to toggle the **Control Panel** off.
- In the **Spectrum** view, each plot or chart has its own unique controls. If the **Control Panel** is showing but the controls for the plot or chart of interest are not displayed, click on the plot or chart of interest. The appropriate controls will then be shown on the **Control Panel**.
- You can adjust the size of the **Control Panel** and the **Active Devices** view by placing the cursor over the line which divides them, left-click and hold the mouse button, and drag up or down.

Hiding/Unhiding the Active Devices List and Control Panel

You can use options on the **View** menu to hide or display the **Active Devices** tree and the **Control Panel**. You can also use the mouse to control the display of the **Active Devices** tree and the **Control Panel**, as illustrated here.

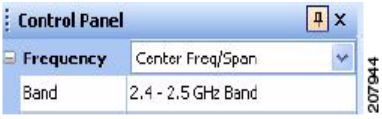
Note This guide shows examples of the **Control Panel**, but the techniques apply to the **Active Devices** tree as well.

Close

You can close the **Control Panel** or **Active Devices** tree by clicking the **Close** button.

Auto-Hide

You can hide the **Control Panel** or **Active Devices** list by clicking the **Auto-Hide** button, which has a small push-pin symbol on it.



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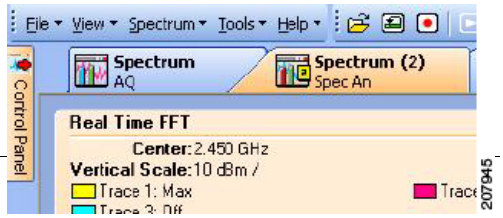
Hiding the **Control Panel** allows more room for other display features (such as a larger view of the **Spectrum** tab shown at right). However, a small vertical **Control Panel** tab is still shown at left.



Note If you *hover* (without clicking) the mouse pointer over the vertical tab for the Control Panel, the Control Panel is temporarily restored to view. This allows you to make changes or make selections on the **Active Devices** tree.

Note To restore the **Control Panel/Active Devices** tree to permanent status on the display, click the **Auto-Hide** button.

Menu Options

The Cisco Spectrum Expert Software has the following menu options.

File Menu

The **File** menu offers the following options:

- **Open Capture File**—Allows you to play back a previously recorded Cisco Capture File. See "Spectrum Recording and Playback" for more information.
- **Save Replay As**—Captures Instant Replay spectrum data to a Cisco Capture File for later playback. See "Spectrum Recording and Playback" for more information.
- **Instant Replay**—Enables a 1 to 60 minute replay of stored running FIFO capture data.
- **Record Capture File**—Captures spectrum data to a Cisco Capture File for later playback. See "Spectrum Recording and Playback" for more information.
- **Stop Capture File**—Terminates the recording of spectrum data.
- **Connect To Sensor**—Allows you to select a different Sensor card or to open a CSC file.

Note Select the **Browse** button to locate the CSC file of interest.

Note Some Sensor cards automatically use the external antenna if one is connected, and will override any contrary setting here.

Note If you expect to use these settings in the future, check the **Automatically Use These Settings Next Time** box.

- **Import Settings—**Allows you to import Local Settings into Spectrum Expert.
- **Export Settings—**Allows you to export Local Settings into Spectrum Expert.
- **Exit**—Closes the Cisco Spectrum Expert Software.

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View Menu

This menu provides access to most of the main Cisco Spectrum Expert Software features:

- **Spectrum**—Enables you to create a variety of plots and charts which provide real-time views of RF activity. You can save your configuration of plots and charts. See "Using Spectrum View Plots" for more information.
- **Spectrum (2)**—The same as with Spectrum; you can create a variety of plots and charts, and save your configuration.
- **Devices**—Shows all RF devices detected by Cisco Spectrum Expert Software. See "Working With Devices View" for more information.
- **Channel Summary**—Shows RF activity—such as power levels, and the presence of 802.11 and interferer devices—on a channel-by-channel basis. See "Working with the Channel Summary" for more information.
- **Device Finder**—Enables you to track down the location of interfering devices. See "Working With Device Finder" for more information.
- **Active Devices**—Shows all access points, ad-hoc networks, and interferer devices currently detected by Cisco Spectrum Expert Software. See "Active Devices" for more information.
- **Control Panel**—Toggles the **Control Panel** on and off. The **Control Panel** sets the details of your view in several different modes: **Spectrum View**, **Devices View**, and **Device Finder**. See "Control Panel" for more information.
- **Status Bar**—Provides various system status information and user band selections. Use this menu option to toggle the **Status Bar** display on or off.

Spectrum Menu

This menu is only visible when the **Spectrum** or **Spectrum (2)** tab is selected.

- **Add Plot**—Adds one of the available plot types.
- **Add Chart**—Adds one of the available chart type.
- **Remove Selected Items**—Removes the currently selected plot or chart from the display. (You must first select a spectrum plot or chart for this menu option to be active.)
- **Pause Selected Items**—Freezes the display of data on the currently selected plot or chart.
- **Resume Selected Items**—Only shown if you first select a plot or chart which was previously paused. Resumes the real-time update of data for that plot or chart.
- **Zoom In/Out**—Maximizes or minimizes the size of a selected plot or chart.
- **Export Selected Items Data**—Captures and exports data from a specified spectrum plot or chart and saves it to a file.
- **Cut**—Deletes the currently selected spectrum plot from the display and pastes it to the clipboard.
- **Copy**—Captures the currently selected plot or chart.
- **Paste**—Retrieves a spectrum plot or chart from the clipboard and pastes it in the display area.
- **Select All Items**—Selects all spectrum plots and charts currently displayed on the spectrum tab.
- **Open Spectrum View Configuration**—Once you have configured plots and charts on one of the two **Spectrum** tabs, you can save the plot/chart configuration. This enables you to easily restore the same configuration at a later time. See "Saving and Restoring Spectrum View Layouts" for more information.

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- **Save Spectrum View Configuration**—See "Saving and Restoring Spectrum View Layouts" for more information.
- **New Spectrum View Configuration**—See "Saving and Restoring Spectrum View Layouts" for more information.

See "Using Spectrum View Plots" for more information.

Tools Menu

This menu provides access to the **Settings** dialog. The **Settings** dialog has five panels:

- **Sensors and Antennas**—Selects which Spectrum Sensor card (and, in some cases, which antenna) the Cisco Spectrum Expert Software uses for spectrum data acquisition.
- **Console Settings**—Modifies the date and time on the Cisco Spectrum Expert Software, configures the Spectrum view to use for playback, enables the Instant Replay feature, selects the Default AP Category (In-Network or Unknown), and modifies the color of the plot's background.
- **Band and Channel Settings**—This panel determines, by Regulatory Domain (USA, Japan, .), which RF bands and channels are monitored for RF activity and reported on by Cisco Spectrum Expert Software. The default setting is to monitor the channels indicated on the **802.11b/g Channel Settings** panel. However, there are also options for other predefined 802.11a bands, including the US Public Safety Band and user-selected channels in middle and upper bands as well.
- **Alert Settings**—Used to enable or disable security and performance alerts for an interferer type or category.
- **SNMP Option / Cisco WCS Settings**
  - **SNMP Option**—Cisco Spectrum Expert Software has an ability to send SNMP traps when it detects interfering devices. This screen is used to configure the trap filters and threshold levels that will trigger the sending of an SNMP trap. The **Settings – SNMP Option** screen is used to configure the trap filters and threshold levels that will trigger the sending of an SNMP trap.

    Note The SNMP Option icon appears in the Cisco Spectrum Expert Software standard version. See "SNMP Option Settings" to configure the SNMP settings.

  - **WCS Settings**—The WCS-enabled Cisco Spectrum Expert Software provides the ability to send and receive Air Quality (AQ) data using the Cisco proprietary mode of streaming communication between Cisco Spectrum Expert Software and a Wireless Control System (WCS). The **Settings - Cisco Option** screen is used to configure the sending of data to the WCS.

    Note The WCS Settings icon appears in the Cisco WCS-enabled Cisco Spectrum Expert Software version. See "Cisco WCS Settings" to configure the WCS settings.

See "Local Settings Overview" for more information.

Help

- **Help Topics**—Provides access to the Cisco Spectrum Expert Software Help system.
- **About Cisco Spectrum Expert Software**—Provides copyright and version information for the Cisco Spectrum Expert Software.
- **About Spectrum Sensor Card**—Provides technical data for the Sensor card currently in use.

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- **Capture File Properties**—This option is active when a CCF file is playing and will display file information when invoked.

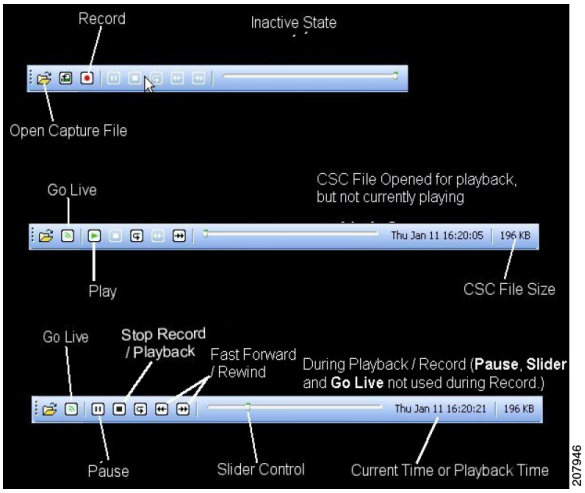
Spectrum Recording and Playback

The Mobile software enables you to record spectrum data in Cisco Spectrum Capture (CSC) files. You can then play these files back at a later time. Each CSC stores the following information to disk:

Note Cisco Spectrum Capture files are subject to a size limitation of 512 MB. You should estimate CCF file size growth at a rate of 6 MB per hour/per band selected when considering the 512 MB size limitation.

- **Active Devices**—A list of active devices vs. time, plus all information needed to reproduce the **Devices View** and any of its subviews and columns for all monitored bands during playback. (During playback you will be able to change columns and see meaningful information that changes with time, just as with live mode.)
- **Spectrum Plot Data**—All information needed to reproduce any of the Spectrum Analyzer plots (except **Power vs. Time** and **Power vs. Frequency** – these plots will not be available during playback). You can adjust the settings for the other plots and charts during playback.
- **Spectrum Chart Data**—All information needed to reproduce any of the spectrum charts during playback.
- **Reference Information**—This includes the date and time of capture, the Windows user/login name, and the Sensor card revision and serial number.

The diagram at right shows the controls used for spectrum recording and playback:



The controls are described briefly below:

- **Record**—Opens a dialog box where you can define the name and file location of a CSC file. Upon closing the dialog box, recording begins automatically. You can also initiate this operation by selecting **File ‡ Record Capture File**.
- **Open**—Opens a previously captured CCF file for playback. You can also select **File ‡ Open Capture File**. Use the **Open Capture File** dialog box to select the recording of interest.
- **Playback**—Once you have opened a CSC file, select this to start playback.
- **Stop**—Stops the recording process, and also stops the in-progress playback of a CSC file.
- **Go Live**—Returns you to live mode. Any playback or recording that was in progress is halted.
- **Slider Control**—You can use this control to move to any particular time during the playback interval.

You may select any combination of Spectrum Analyzer plots or charts during playback.

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Just as in a live spectrum session, you can right-click within the display area to get pop-up menus used to navigate to specific information. Additionally, you can use all other plot icons and features, such as adding, moving, zooming, and removing a plot or chart during playback.

Note The **Power Vs. Time** and **Power Vs. Frequency** plots are not supported during playback.

Spectrum Instant Replay

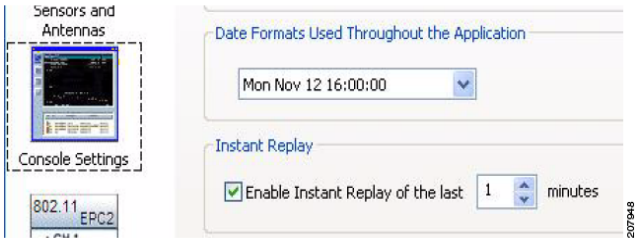
The Instant Replay feature allows you to review the most recent spectrum information up to the past 60 minutes, without having to record it in a CCF file, and play it back much as if it were being viewed live for the first time without interrupting receipt of current spectrum information. Spectrum information of interest viewed as an **Instant Replay** may then be saved as Cisco Spectrum Capture (CCF) files to share information on what is happening in the spectrum.

The screens at right show the two access methods used for Instant Replay.

Navigate from **Tools > Settings > Console Settings** to display the **Instant Replay** settings options as shown at right. The controls are described briefly below and detailed instructions on Instant Replay Settings, Initiating an Instant Replay and Converting an Instant Replay to a CCF can be found in the Online Help.

Enable Instant Replay of the last—Select to enable the Instant Replay function.

Minutes—Select the length of the Instant Replay (range 1 to 60 minutes).



What If I'm Not Seeing Any Data?

It may happen that you are viewing one of the Cisco Spectrum Expert Software displays, such as a spectrum plot, but you are not seeing any data; or data is missing for part of a plot. (For example, some of the channels on the plot have spectrum data, and others do not.) Or, you may know perfectly well that some kind of interfering device is present in the environment, but the **Devices List** and/or **Device Finder** are not detecting it.

Sensor Card Not Properly Inserted

One possible cause of this problem could be a complete lack of communication between the Sensor card and the Cisco Spectrum Expert Software. Normally, however, if communication is lost with the Sensor card, the Cisco Spectrum Expert Software will present a warning message, and then shut down.

To resolve such problems, check to ensure the Sensor card remains properly seated in the card slot.

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Faulty Configuration Settings

Another possibility is that, while you have set your spectrum plots to display certain channels or bands, your configuration settings for Cisco Spectrum Expert Software as a whole do not include those channels/bands.

To determine if this is the problem—and to rectify if—you need to check your **Channel Settings** and **Monitored Bands** under the Cisco Spectrum Expert Software's **Settings** panel. See "Local Settings Overview" for more information.

Erroneous Scale Settings

With the spectrum plots (see "Using Spectrum View Plots"), it is possible you may fail to see any data if you have an amplitude setting that is inappropriate for the actual data being monitored. For example, suppose you are monitoring the RF duty cycle, and have the vertical axis amplitude set to range from 0% to 100% (the default setting). If in fact the actual duty cycle values are very low (say, ranging from 0% to 1% or 2%), you may not see any data.

This can be a particular problem with the **Swept Spectrogram** plot, where RF power values and duty cycle values are mapped to colors. If all the measured data falls in a very narrow range compared with the **Color Scale**, you may see nothing but a solid block of a single color – in fact, you are seeing the correct data, but it seems as if you are seeing no data at all.

Selecting the **[Auto Scale]** option on these plots should normally correct this problem, but sometimes it helps to manually adjust the measurement scale.

Wrong Antenna Settings

Another possibility is that you may have an internal Sensor card with an external antenna, but you are using the Sensor card's internal antenna. (This might account, for instance, for why you might fail to see some interfering devices you expect to see.) Check your **Sensors and Antennas** settings. See "Sensors and Antennas " for more information.

Miscellaneous Device Issues

There are various RF effects that can prevent or partly hinder device detection. These are discussed in detail in the "Working With Devices View" section.

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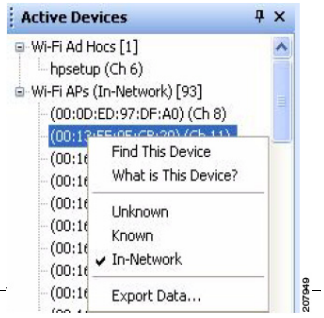
CHAPTER 6

Cisco Spectrum Expert Software Active Devices

Active Devices

The **Active Device** tree normally displays on the left side of the Cisco Spectrum Expert Software. It shows access points, ad-hocs, and interfering devices if these devices (access points and interferers) are currently live (transmitting). A tree structure organizes access points together, ad-hocs together, and different types of interfering devices together.



- To view the **Device Tree**, select **View > Active Devices**.
- If you double-click on a device, a dialog box will appear providing more detail on the device including a picture of a typical device that matches the RF signature. (You can also right-click on the device and select **What Is This Device?**)
- Right-click on any interferer device and select **Find This Device** to activate the **Device Finder**. See "Device Finder Mode" for more information.

Note The **Device Finder** can only locate certain types of devices. If you right-click on a device that can't be located, you will not be able to access the **Find This Device** option. Also, a device must be currently active (transmitting) in order to find it. If, in **Devices View**, you click on a device which is not currently transmitting, you will not be able to access the **Find This Device** option.

Current Devices vs. Historical Devices

The **Active Devices** tree only shows devices which are currently active, or transmitting, during the last measurement interval.

For an historical list of detected devices—which includes currently active devices, but also devices which are no longer detected—use the **Devices View**. See "Working With Devices View" for more information.

You can also see a pop-up list of active devices by mousing-over the trace area of a Cisco Spectrum Expert plot.

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Keeping Your Eye On A Particular Device

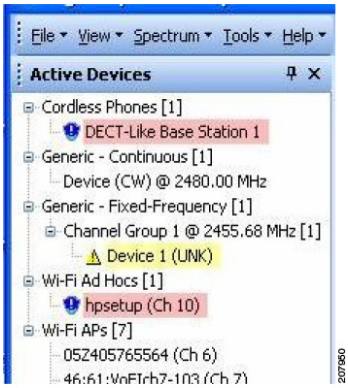
If there is a particular device that is of interest to you, you can keep an eye on the device simply by clicking on it. Your selected row will be highlighted.

As new devices are detected (or disappear from view), the **Active Devices** tree will auto-scroll and auto-sort. However, Cisco Spectrum Expert Software will make sure that your highlighted row always remains in view; in other words, auto-scrolling and auto-sorting will be adjusted so that your highlighted row always remains visible on Cisco Spectrum Expert.

Problem Indicators and Security Alerts

Problematic devices shown in the **Active Devices** pane are highlighted in yellow or red. The colors indicate the interference level of active devices. **Yellow** means the duty cycle of the interferer is greater than 25% and it affects at least one channel with a BSS device. **Red** means the duty cycle of the interferer is greater than 50% and it affects at least one channel with a BSS device.

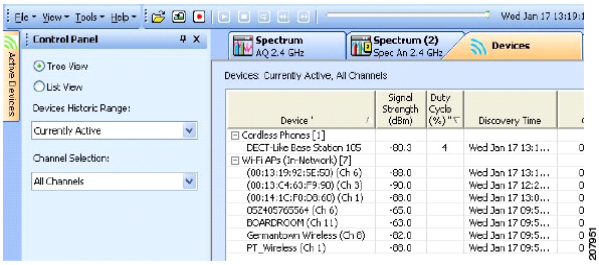
Security and alert settings are available and can be configured using the **Settings – Alert** window. Once configured, security alert icons display in the **Active Devices** tree when the predefined triggers occur.



Active Devices and Devices View

Normally, you do not need to see the **Active Devices** tree at the same time that you are in Cisco Spectrum Expert Software's **Devices** mode, since in **Devices** mode you can see all RF devices—both those which are currently active, and historical devices.

If you select the **Devices** tab in the main **Cisco Spectrum Expert Software** workspace, and select the push-pin on the Active Devices tree, Cisco Spectrum Expert Software hides the **Active Devices** tree. However, a small **Active Devices** tab remains visible at the left side of the display.



Note You can move the mouse over this tab to bring the **Active Devices** tree back into view temporarily. The **Devices Control Panel** is temporarily hidden behind the **Active Devices** pane.

If you then click on the push-pin (circled in the illustration at right), on the **Active Devices** pane, this puts the **Active Devices** pane permanently on view. The **Devices Control Panel** will then still be on view, but you will see it lower down on the left side of the display.

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You might want **Active Devices** on view at the same time as **Devices** mode, as an easy way to distinguish between currently active devices vs. the more extensive list of devices (active and historical) shown in **Devices** mode.

See "Hiding/Unhiding the Active Devices List and Control Panel" for more information.

Exporting Data

The **Export Data** feature provides additional functionality to the list of active devices in the **Active Devices** tree. The **Export Data** feature allows you to export device information to a file for future analysis. This option can be accessed by right-clicking on a device in the **Active Device** tree to display a pop-up menu.

When **Export Selected Data…** is selected, a window appears providing a default file name and Save in location (Spectrum Captures folder). The window also allows user selection of the file name and Save in location.

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CHAPTER 7

Working with Spectrum Tabs, Plots, and Charts

Spectrum Tabs, Plots, and Charts Overview

Cisco Spectrum Expert software provides two spectrum tabs, **Spectrum** and **Spectrum (2)**. Each tab operates identically. The tabs allow you to create, name, and save two distinct configurations of plots and charts. (You can create and save more than two plot/chart configurations; but you can have two of them as defaults that automatically appear on these tabs.)

Descriptions of the specific charts and plots—including the parameters for fine-tuning the plot/chart content—may be found in the Online Help, and in "Using Spectrum View Plots" and "Using Spectrum View Charts" of this guide. This chapter provides an overview of how to use these tabs (**Spectrum** and **Spectrum (2)**) to create your custom plot/chart views.

Create A Spectrum Plot or Chart

To add a spectrum plot or chart, follow these steps:

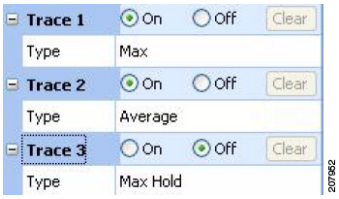
Step 1 Right-click in the workspace for the spectrum plots and select **Add Plot > <Plot Type>** or **Add Chart > <Chart Type>**.

You can also use the menu **Spectrum > Add Plot > <Plot Type>** or **Spectrum > Add Chart > <Chart Type>**.

Step 2 Use the **Plot Control** panel at the left of the display to set the parameters for the plot or chart. The particular parameters will vary depending on the type of plot. An overview of the **Plot Control** panel is presented in "Spectrum Plot Controls." Detailed descriptions of chart parameters are also contained in the Cisco Spectrum Expert Software Online Help system.

Note Of particular importance for the spectrum plots, and for some of the charts – in order to see any data displayed at all, you need to select the **On** button for at least one **Trace**. A **Trace** describes the line of data shown on a plot.

By default, the **Trace** or **Traces** for a plot are set to **Off**.



- If you are in a **Spectrum** tab and the **Controls** are not visible, select **View > Control Panel**.

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- To access the **plot Control Panel** for a particular plot or chart, simply use the mouse to click on that plot.

Note If you have more than one plot in view, then as you click on different plots, the **plot Control Panel** will display the configuration options for the currently selected plot.

Multiple Plots

You can repeat the instructions immediately above to place more than one plot on display. You can configure any combination of up to nine plots and charts (in 1024x768 mode or higher), or four plots and charts (in 800x600 mode) per **Spectrum View** tab.

Measurement Interval

Unless you have paused a plot (discussed below), the Cisco Spectrum Expert Software updates each plot or chart once per measurement interval, which is typically once every second.

Pause and Resume Plotting

At times an event may occur in your network, such that you want to immediately capture the RF environment at that moment for sustained study and review. You can pause and resume plots and charts by right-clicking in the workspace, and selecting the appropriate menu options, or by selecting these options from the **Spectrum** menu (For example, **Spectrum ‡ Select All Items ‡ Pause Selected Items**):

- **Select All Items**—Selects all plots/charts displayed in the currently selected **Spectrum** tab and enables the **Spectrum** menu options.
- **Pause Selected Items**—Freezes the data displayed on the currently selected plot(s) or chart(s). Be sure to right-click on the appropriate plot/chart when you bring up the context menu.
- **Resume Selected Items**—Resumes the real-time data display for the currently selected plot/chart(s).
- **Pause Selected Items**—Freezes the data display on all plots/charts.
- **Resume Selected Items**—Resumes the real-time update of data on all plots/charts.

Copying Plots and Charts

All plots and charts displayed in Cisco Spectrum View can be copied and pasted within the pane area of the window. You can copy and paste a plot or chart using on of the following three methods.

Method 1

Click on the top of the plot frame and hold down the **<Ctrl>** key. The cursor changes to indicate *copy* mode.

Move the mouse to the desired location.

Release the mouse button to paste a copy of the plot or chart. The copied plot or chart is subject to total count checking and PvT/PvF trace limit checking.

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Method 2

Step 1 Select a plot.

Step 2 Press **<Ctrl + C>.** The selected plot is copied to the clipboard.

Method 3

Step 1 Right-click on a plot or chart to display the pop-up menu. Or, select **Spectrum** from the **Main** menu to display the drop-down menu.

Step 2 Select the **Copy** option. The selected plot is copied to the clipboard.

Pasting Plots and Charts from the Clipboard

Spectrum View plots and charts can be retrieved from the clipboard and pasted into your current Spectrum View session, an additional Spectrum View session running on your machine, or a different machine running Cisco Spectrum Expert Software with the same card type. The paste feature is subject to total plot/chart count checking and PvT/PvF trace limit checking.

To paste a plot from the clipboard, follow these steps:

Step 1 Open the clipboard and copy the desired plot.

Step 2 Right-click within the **View** pane to display the pop-up menu.

Step 3 Press **<Ctrl + V>**. The plot gets pasted to the end of the view.

Or, you can paste a plot from the clipboard using the **Main** menu as follows:

a. Open the clipboard and copy the desired plot.
b. Select **Spectrum** from the **Main** menu to display the drop-down menu.
c. Select the **Paste** option. The plot gets pasted to the end of the view.

Cutting Plots and Charts

Use any of the following methods to cut a plot or chart:

Method 1

Step 1 Select a plot.

Step 2 Press **<Ctrl + X>**. This removes the plot and copies it to the clipboard.

Method 2

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Step 1 Right-click a plot to display the pop-up menu.

Step 2 Select the **Cut** option. This removes the plot from the display and copies it to the clipboard.

Method 3

Step 1 Select a plot.

Step 2 Select **Spectrum** from the **Main** menu to display the drop-down menu.

Step 3 Select the **Cut** option. This removes the plot from the display and copies it to the clipboard.

Method 4

Step 1 Left-click on the plot or chart of interest.

Step 2 Press **Delete**.

Method 5

Step 1 Left-click on the **X** icon located in the upper right-hand corner of the plot or chart.

Method 6

Step 1 Left-click on the plot or chart of interest.

Step 2 Select **Spectrum ‡ Remove Selected Item...** from the **Main** menu to display the drop-down menu.

Moving Plots and Charts

All plots and charts displayed in Spectrum View can be moved within the pane area of the window.

Method 1

Step 1 Left-click on the top banner of the plot frame.

Step 2 Drag the plot to the desired location. A blinking vertical line indicates the new location.

Step 3 Release the mouse button to drop the plot in the new location.

Method 2

Step 1 Right-click on the top banner of the plot frame.

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Step 2 Drag the plot to the desired location. A blinking vertical line indicates the new location.

Step 3 Release the mouse button to drop the plot in the new location. A pop-up menu displays.

Step 4 Select on of the following options:

- **Copy Here**—pastes a duplicate of the original plot in this location.
- **Move Here**—relocates the original plot to this location.
- **Cancel**—terminates the operation.

Selecting Multiple Plots and Charts

In cases where you need to perform the same operation on more than one plot or chart, multiple plots and charts can be selected. For example, you may want to remove, pause, or resume more than one plot at the same time.

Note When multiple plots and charts are selected, the control panel displays a message indicating that **Multiple items are selected and** no controls are available for configuring plots and charts.

Multiple plots and charts can be selected as follows:

Step 1 Hold down the **<Ctrl>** key.

Step 2 Left-click each plot to select it.

Zoom In/Out

For optimal viewing, a plot or chart can be maximized (zoom in) and minimized (zoom out) to its original size. A plot or chart in **Zoom In** mode is indicated by an orange background. Additionally, you can zoom in/out on up to two plots or charts at the same time.

To zoom in/out a single plot, follow these steps:

Step 1 Double-click, or right-click, the frame or left click the magnifying glass icon of the plot to maximize it. The orange background indicates **Zoom In** mode.

Step 2 Double-click the frame or left-click the magnifying glass icon to minimize it.

Or, use the **View** menu to zoom in/out:

Step 1 Select a plot.

Step 2 Select **Spectrum** from the **Main** menu to display the drop-down menu. Or, right-click within the View pane to display the pop-up menu.

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Step 3 Select the **Zoom In** option to maximize the plot. Or, select **Zoom Out** to minimize it.

To zoom in/out multiple (up to two) plots, follow these steps:

Step 1 Hold down the **<Ctrl>** key.

Step 2 Double-click the frame of each plot to maximize them. Or, double-click each frame to minimize them.

Or, use the **View** menu to zoom in/out multiple plots:

Step 1 Hold down the **<Ctrl>** key.

Step 2 Select the plots.

Step 3 Select **Spectrum** from the **Main** menu to display the drop-down menu. Or, right-click within the **View** pane to display the pop-up menu.

Step 4 Select the **Zoom In** option to maximize the plot. Or, select **Zoom Out** to minimize it.

Saving and Restoring Spectrum View Layouts

Other operations are available for working with plots and charts. The operations **Open Spectrum View Configuration…**, **Save Spectrum View Configuration…**, and **New Spectrum View Configuration** can all be selected from the **Spectrum** menu. **Remove Selected Items…** can be selected from the **Spectrum** menu.

Note All these operations can also be selected by right-clicking on the frame of a plot or chart, and selecting from the context menu that appears.

- **Save Spectrum View Configuration**—Enables you to save the current configuration of open plots and charts, including their specific display parameters. (The current data, however, is not saved.)

Step 1 In the Save Spectrum View Configuration dialog, type in the name for your configuration, or select the name of a previously defined configuration.

Note The name you type here will also appear on the **Spectrum** and **Spectrum(2)** tabs, so we suggest you use something short but descriptive, for example, “Plots Only”, “Charts Only”, “Duty Cycle Charts and Plot”, “Devices and RF Power”, and so on.

Step 2 To make the current configuration be the default configuration, be sure to first select the **Set as startup default for this view** check box. If you select this, the current configuration will appear every time you log into the Cisco Spectrum Expert Software, and select the current tab.

Note You can save a separate default view for each Spectrum tab.

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Select **[OK]** to save or **Cancel** to exit without saving changes..

- **Open Spectrum View Configuration…**—The dialog box for this operation will list all of your currently saved spectrum views. Select one view, and then select **OK**.
- **New Spectrum View Configuration**—This operation clears all currently displayed plots.
- **Remove Selected Items…**—This operation will close only the currently selected plot.

Deleting A Spectrum View

To delete a saved spectrum view, follow these steps:

Step 1 Right-click on the **Plots** workspace and select **Save Spectrum View Configuration or** Select **File > Save Spectrum View Configuration**.

Step 2 In the **Save Spectrum View Configuration** dialog, select an existing view.

Step 3 Select **Remove Saved Configuration**.

Step 4 Select **OK** on the confirmation dialog box.

Exporting Data

The **Export Data** feature provides additional functionality to all **Spectrum** plots and charts, as well as the active devices listed in the **Active Devices** tree. This feature allows you to export device information to a file for future analysis. This option can be accessed by right-clicking on a device name, on any plot or chart, or anywhere in the display pane to display a pop-up menu.

When **Export Selected Data…** is selected, a window appears providing a default file name and Save in location (Spectrum Captures folder). The window also allows user selection of the file name and Save in location. A sample exported data file for an **Interference Power** chart is as follows:

Table 7-1 Interference Power

Interference Power

Vertical Scale: 10 dBm /

Channel	In-Network Wi-Fi AP	Max Interference	Cordless Phones	Wi-Fi CCI	Wi-Fi ACI
WiFi Ch. 1	-85	-78.6	-81.2	-85	
WiFi Ch. 2		-78.6	-81.2		-82.4
WiFi Ch. 3	-90	-78.6	-81.2		-80.1
WiFi Ch. 4		-78.6	-81.2		-74.9
WiFi Ch. 5		-78.6	-81.2		-70.9
WiFi Ch. 6	-71	-78.6	-81.2	-83	-88
WiFi Ch. 7		-78.6	-81.2		-70.7
WiFi Ch. 8	-84	-78.6	-81.2		-70.2
WiFi Ch. 9		-78.6	-81.2		-65.8
WiFi Ch. 10		-78.6	-81.2		-62
WiFi Ch. 11	-62	-78.6	-81.2	-87	

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CHAPTER 8

Spectrum Plots

The **Spectrum Plots** use graphical displays to provide detailed, low-level views of the RF spectrum. The plots are based on data from the SAgE chip embedded in the Sensor card. (SAgE is Cisco's spectrum analyzer on-a-chip, containing advanced, on-board support for real-time processing of spectrum data.) This chapter describes the information displayed in each plot.

Note For information on Spectrum Charts, see "Using Spectrum View Plots."

Using Spectrum View Plots

For information on creating spectrum plots, pausing and resuming the display, and saving plot configurations, see "Spectrum Tabs, Plots, and Charts Overview." For information on how to fine-tune data displays for each plot, see "Spectrum Plot Controls."

Plot Content

Spectrum View offers five different types of plots. You can view a tooltip list of active devices by mousing-over the trace area of a Cisco Cisco Spectrum Expert Software plot. More information is available in the Online Help.

Frequency-Based Plots

There are four plots which offer different views of RF power as a function of frequency. For these plots, the entire plot is updated once per measurement interval (approximately once per second):

- Real Time FFT Plot
- Power vs. Frequency
- FFT Duty Cycle
- **Swept Spectrogram**—Combines a time- and frequency-based view of the RF spectrum.

Time-Based Plot

This plot shows the variation of an RF metric over time.

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- **Power vs. Time**—Plots data based on short time intervals (milliseconds). Mainly used for pulse detection.

Real-Time FFT Plot

A **Real-Time FFT** plot displays the RF power as a function of frequency—a Fourier transform of the RF spectrum. The data is direct data from SAgE. The plot can provide three different views: the average power (**Avg**) read during the most recent measurement interval; the maximum power (**Max**); or the maximum power detected at any time since the plot began running (**Max Hold**). This plot can also display the integrated channel power for each RF channel in RTFFT plots on a trace-by-trace basis by selecting the **Channels On** radio button in the Control Panel and using the **Show Power** drop-down box to select which channel trace should display the Integrated Channel Power.

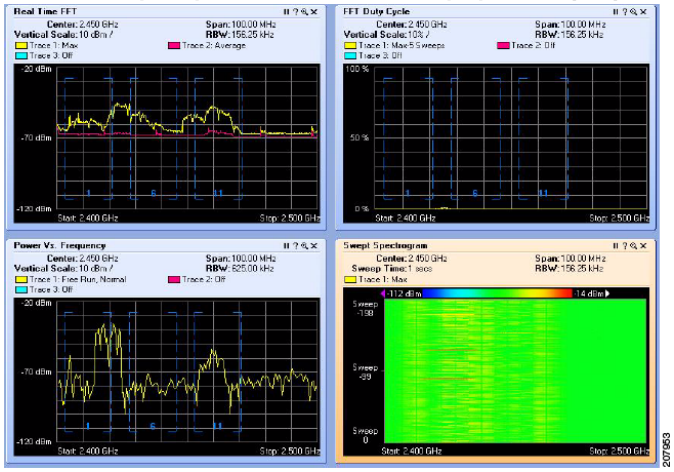
Note Integrated Channel Power is the sum of all the signals present in an RF channel. Signals are added in the mw domain and the sum is converted to dBm for display. Integrated Channel Power is disabled when an user selects "None" from the combo box. By default, the channel power of Trace 1 is displayed. The text color of Integrated Channel Power is the same as the color of the corresponding trace data. Integrated Channel Power is viewable only when RF channel bars are displayed.

See "The Real-Time FFT Plot Compared with the Power vs. Frequency Plot" for more information.

Power vs. Frequency

The **Power vs. Frequency** plot is also a Fourier transform of the RF spectrum, showing the amount of RF power detected at various frequencies. The difference between this plot and the **Real-Time FFT** plot is that the **Power vs. Frequency** plot is generated based on an analysis of SAgE data. This means that data can be aggregated and combined in various ways that are not possible with direct SAgE data, the basis for the **Real-Time FFT** plot. This plot can also display the integrated channel power for each RF channel in RTFFT plots on a trace-by-trace basis by selecting the **Channels On** radio button in the Control Panel and using the **Show Power** drop-down combo box to select which channel trace should display the Integrated Channel Power. Four spectrum plots are shown below.

Figure 8-1 Power vs. Frequency, Real Time FFT, FFT Duty Cycle, Swept Spectrogram



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Note The highlighted plot (with an orange background) is the current selected plot. To pause the selected plot, click **Spectrum > Pause Selected Items**.

FFT Duty Cycle

The **FFT Duty Cycle** plot displays the percentage of the time that the ambient RF signal is 20 dB above the noise floor. (This is represented on a per-frequency bin basis.) The **Duty Cycle** for the **FFT Duty Cycle** plot includes all RF energy, both from 802.11 devices and interferers.

Swept Spectrogram

The **Swept Spectrogram** is a different presentation of the data shown in the **Real Time FFT** and **FFT Duty Cycle** plots. Each colored horizontal line in the **Swept Spectrogram** plot displays the RF power or duty cycle as a function of frequency, as measured over the time period of one sweep in time (typically one second). The power or duty cycle values in each sweep are mapped to a range of colors, and displayed in a scrolling or "waterfall" display. This allows you to observe the FFT signals over historical time, and easily see signals with shifting frequencies and various durations. (You select between the power or duty cycle metrics using the **Control Panel**.)

See "Interpreting The Swept Spectrogram Plot" for more information.

Note The color legend for the **Swept Spectrogram** is only displayed if there is enough room on screen. Depending on your display resolution, and on how many plots you have open at once, you may need to close some other plots in order to see the mapping of colors to power levels.

Power vs. Time

The **Power vs. Time** plot displays the RF power as a function of time. The time scales involved are very brief—microseconds or milliseconds—so the plot is mainly used to observe RF pulse activity.

The Real-Time FFT Plot Compared with the Power vs. Frequency Plot

Figure 8-2 Real Time FFT Compared to Power Vs. Frequency

Both the **Real-Time FFT** plot and the **Power vs. Frequency** plot show the RF power as a function of frequency, at a given moment in time. However, the two plots differ in important respects:

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Table 8-1 Real Time FFT Comparted to Power Vs. Frequency Plots

Property	Real Time FFT Plot	Power Vs. Frequency Plot
Data Source	**SAgE Hardware**—Raw spectrum data is collected on the SAgE chip inside the Sensor card. Statistical analysis is performed directly by SAgE's onboard hardware. This enables very fast analysis of large quantities of spectrum data, but with the limitation that the parameters of the analysis are hard-coded into the design of the SAgE chip.	**SAgE plus Microprocessor Software**—Raw spectrum data is provided by the SAgE chip in the Sensor card and is then analyzed by software running on the CPU inside the laptop. This software analysis of the spectrum data provides greater flexibility in the analysis, but with the trade-off that less data can be analyzed in a given time frame.
Dwells	FFT analysis is performed on only 20 MHz of the band at one time. Each 20 MHz span is referred to as a **dwell**. By measuring several successive, adjacent dwells, it is possible to construct a plot which is essentially similar to a Fourier transform of the entire band (2.4 GHz, 5 GHz, 900 MHz, and so on.).	
Bins and Bin Sizes	Each 20 MHz dwell is divided into 128 bins, where each bin is 156 KHz wide. A power measurement is provided for each bin. The number of bins, and the bandwidth of each bin, is fixed.	With advanced software analysis, the number of bins, and the bandwidth of each bin, is user-defined, so you can achieve much finer granularity in your power measurements. For example, a single bin can be as narrow as about 9.7 KHz. To get the number of bins (data points on the plot); divide the span being measured by the RBW. For example, a 20 MHz span, with an RBW of about 20 KHz, will have about 1000 points (bins) on the plot.
Number of FFTs Per Plot	The **Real-Time FFT Plot** is updated once per second. Each plot is actually an average over the 5000 FFTs performed by SAgE during each dwell.	The software-based **Power vs. Frequency** calculations generate only one FFT per second. That one FFT is shown in the **Power vs. Frequency** plot (which is updated once per second, to reflect the new FFT). If you have set the plot to show an **Average** over all FFTs, the calculation is based on an average of several preceding FFTs that were plotted; but each successive second in real time only contributes one new FFT to that average[1].
Max Mode	One of the plotting options is to display the maximum RF power seen during the measurement interval. This is possible because the maximum power can be selected from among the 5000 FFTs.	A maximum power plot cannot be created, because actual data is available for only one FFT per second (rather than having data for 5000 FFTs, as with the real-time plot).

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Property	Real Time FFT Plot	Power Vs. Frequency Plot
Advantage of Using This Plot	Because the plot shows an average of all 5000 FFT measurements made by SAgE in a second, you are more likely to see spectrum results from devices that are frequency hoppers, or bursty transmitters.	You can achieve much finer control over the granularity of the spectra that you see.
Disadvantage of Using This Plot	You cannot control the granularity of the spectrum.	Since you only see one FFT for the entire one-second measurement interval, you are less likely to see either frequency hoppers or bursty devices.
Playback Mode	This plot can be played back historically, as well as viewed in real time.	This plot can only be viewed in real time, not historically.
Primary Application	The primary use of this plot is for looking at broad RF spectrum activity, covering an entire band. This is useful for tasks like site surveys and initial network deployment.	The primary use of this plot is for troubleshooting, particularly for identifying and analyzing the spectrum behavior of an unknown interferer. It is often most effective when looking at less than a full band.

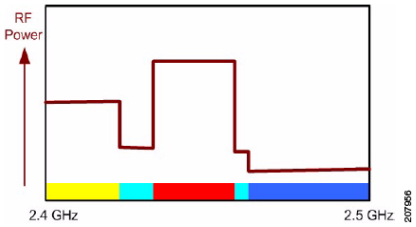
1. This footnote applies to **Power vs. Frequency** plots only, and not to the **Real-Time FFT**s. When you create the **Power vs. Frequency** plot, the very first plot shows a single FFT. And—again, assuming the plot is set to be in "Averaging" mode—the second plot adds one new FFT, and averages that with the FFT from the first plot. Each second, one more FFT is added to the average. However – the average is not performed over all preceding FFTs, but only for a more limited number, those included in a process known as "video averaging."

Interpreting The Swept Spectrogram Plot

This section provides an illustrated discussion of interpreting the visual display in the **Swept Spectrogram** plot. Color coding is used to indicate intensity of either RF power or RF duty cycle (depending on which you choose to plot, using the **Spectrum Plot Controls** panel).

Figure 7-2: Swept Spectrogram Color Mappings For RF Power (top) and Duty Cycle (bottom)

Shown here is a comparison of how the same RF power measurements might look if plotted using a standard line graph—with the height of the graph indicating the RF power—compared to using colors on a straight line as a means to indicate power levels. Here, blue is less power, yellow is more power, and red is the most power.



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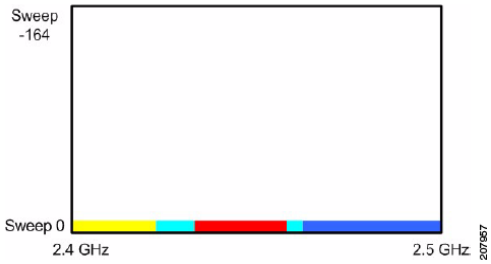
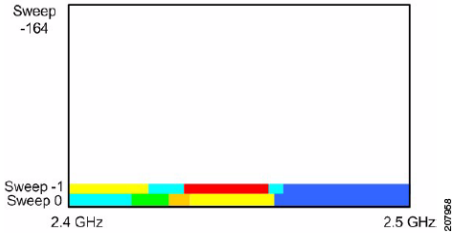
Time T = 1 This is the very first sweep you would see on starting the plot. It represents the RF power (average power, or maximum power, or duty cycle power, per your selection), as a function of frequency — and at the present moment.

The amount of power at each frequency is represented through the color coding scheme.

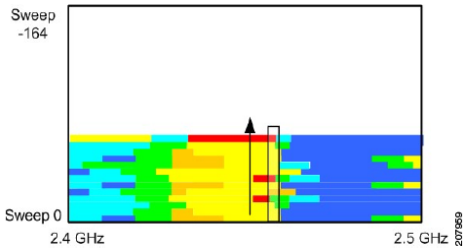


Time T = 2 In the next measurement interval (typically one second later), the previous measurement "slides up" one level, becoming sweep –1.

A new sweep, representing "now", replaces it at the bottom, becoming the new sweep 0.



Time T = n We continue, measurement interval after measurement interval, with older measurements of the RF power sliding up, and the latest "now" appearing at the bottom. By mentally visualizing a vertical "slice" of the graph, you can see how the power levels have changed at a selected frequency going back in time. (The UP arrow points from the present to the past.)



What If No Data Is Showing?

The section on "What If I'm Not Seeing Any Data?" discusses several potential reasons that you may see no data, or appear to be seeing no data, in Cisco Spectrum Expert Software. This section describes, in summary form, one particular issue unique to the spectrum plots: incorrect amplitude settings.

With spectrum plots, you may fail to see any data if the range of the amplitude setting, the lowest and highest power values shown on the plot, is inappropriate for the actual data being monitored. This can be a problem with any of the plots, but particularly with the **Swept Spectrogram**, where RF power values and duty cycle values are mapped to colors. If all the measured data falls in a very narrow range compared with the **Color Scale**, you may see nothing but a solid block of a single color – in fact, you are seeing the correct data, but it seems as if you are seeing no data at all.

Selecting the **[Auto Scale]** option on these plots should normally correct this problem, but sometimes it helps to play manually with the measurement scale. See "Amplitude" for more information.

Spectrum Plot Controls

The plot **Control Panel** lets you fine-tune the data presented by the plots. Each plot has its own plot-appropriate controls. However, many of these controls are common to more than one plot. This section discusses the typical controls. The online help fills in additional plot-specific details.

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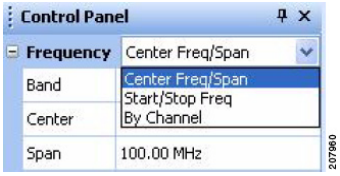
Frequency and Bandwidth To Monitor

Several plots provide measurements of the RF power (average power, maximum power, and so on.) as a function of frequency. The RF frequencies are presented as a range across the horizontal axis. **Frequency** settings enable you to establish the range of X-axis. Even for the time-based plots, however, you can still set the band and/or channel that Cisco Spectrum Expert Software will monitor.



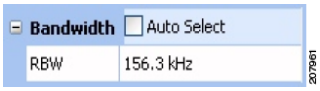
You can select the frequency to be monitored based on a **Center Frequency** and **Span**, based on a **Start/Stop** frequency, or based on specific **Channels**. You then use the **Band/Channel** drop-down menu to select a particular **Band** or **Channel** to monitor.

Once you have made a selection, the application automatically fills in default values for the **Center** frequency and **Span**, or the **Start** and **Stop** frequency. However, you can edit these default values.

- If you change the default **Center** frequency and frequency **Span**, or the **Start** and **Stop** frequencies, you may no longer be plotting entirely in channel or in band. However, Cisco Spectrum Expert Software will NOT permit you to set frequencies that are outside the hardware capabilities of the Sensor card technology. In this sense, the technology is error proof.
- You can change the bands available here—that is, the bands shown on the **Frequency** menus—by changing the **Monitored Bands** settings (**Tools > Settings > Monitored Bands**). See "Monitoring" for more information.
- You can change the channels available here by changing your **Channel Settings** (**Tools > Settings > Channel Settings**). See "Band and Channel Settings" for more information.

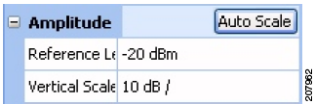
Note Cisco Spectrum Expert Software will only make available, for selection here, those channels which you have selected under **Channel Settings**, provided those channels also fall within the bands you have selected under **Monitored Bands**.

Bandwidth – The **Power vs. Frequency** plot also has a **Bandwidth** setting, which determines the size of each bin for RF power measurements. See "Power vs. Frequency" for more information.



Amplitude

Amplitude settings enable you to set the scale for the vertical axis. The exact measurements will depend on the type of measurement being made. For example, RF power measurements are in dBm, while duty cycle measurements are in percentages (since the duty cycle is typically defined as the percentage of time an RF signal is above some threshold value; or the percentage of time an RF signal is detected from a network device or interferer).



- **Reference Level** refers to the value at the top of the vertical axis.
- **Vertical Scale** refers to the change in value represented by each tic-mark on the vertical axis.

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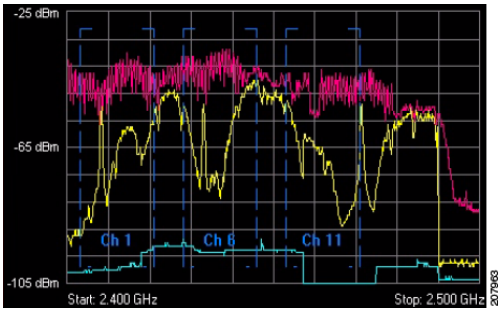
In general, the bottom of the scale is **Reference Level** – (10 * **Vertical Scale**).

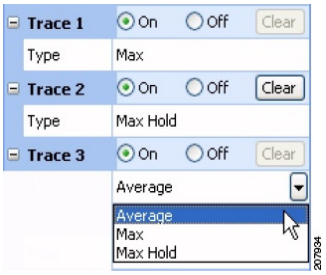
Example: If the **Reference Level** is -25 dBm, and the **Vertical Scale** is set to 5 dBm, then the top of the scale is -25 dBm, while the bottom of the scale is -25 dBm – (10 * 8 dBm) = -105 dBm.

Auto Scale – If you select **[Auto Scale]** the application automatically selects the optimum calibration for the vertical scale, based on recent power measurements.



Trace Settings

A **Trace** is the line which actually plots the RF data of interest.

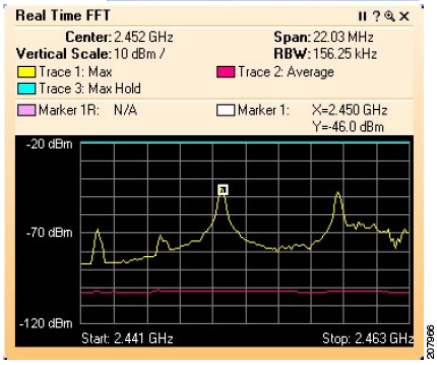


- You must select the **On** radio button for at least one **Trace**, in order to see any data at all.
- For some plots, you can have more than one **Trace**, and you can select the type of data each trace displays (such as **Average** RF power, **Max**imum RF power, **Max Hold** RF power, **Max – 5 Sweeps**, and so on.). The Online Help describes these options in detail.
- **Max Hold** maintains a display of the highest RF power measured since you began the current session. The **[Clear]** button deletes the **Max Hold Trace**, and starts a new maximum power trace, starting from the moment when **[Clear]** is selected.

Markers

A marker is a small icon on the plot which "rides" the graph at a particular point along the X-axis, in other words, at a particular frequency. The marker moves up and down according to the movement of the graph at that fixed point. The marker is the small red box riding the bottom trace in the plot shown here:

- **On / Off**—Indicates whether the marker is on or off, that is, in use at all.
- **Type**—A **Single** marker is just that, one marker that "rides" the trace. If you select **Delta**, you will initially still see a single marker on the plot. However—with a quick "mouse hand"—you can grab the marker with your mouse pointer (click and hold on the marker), and slide the marker to a second location on the plot. You now have two markers riding the trace, so that you can see the difference in behavior between two different frequencies.
- **Trace**—For plots that allow more than one trace, use the drop-down list box to select which of the traces the marker will ride.



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- **Value** – Indicates where along the X-axis (the frequency or time axis) the marker should ride the plot.

Moving The Marker With The Mouse—You can indicate the frequency value using the Value text box. However, once the marker is visible on screen, you can grab the marker (click and hold the left mouse button), and drag the marker to a new location (a new frequency or time).

Peak Search—With the marker **Peak Search** mode, the plot is continually updated with the value of the peak marker as the spectrum plot is traced to identify the peak during each cycle. This feature is selectable for both **Single** and **Delta** markers and works with RTFFT, FFT Duty Cycle, and PvF spectrum plot functions. **Peak Search** is selectable for the highest peak, next peak up, next peak down, next peak left, and next peak right.

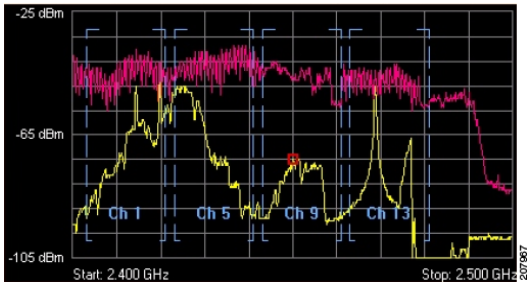
- Highest Peak
- Next Peak Up
- Next Peak Down
- Next Peak Left
- Next Peak Right

Setting The X-Axis Position of Delta Markers

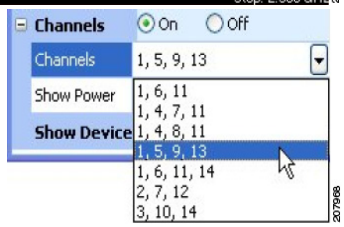
For more extensive instructions on setting the X-axis position of dual markers, see the Cisco Spectrum Expert Online Help, in particular the topic *Setting Marker Positions*.

Channels

Some of the spectrum plots use frequency values on the horizontal axis. On these plots you have, as an option, the ability to superimpose bracketed indicators of channels.



You can turn the display **On** or **Off** using the **Channels** radio buttons. The channels shown will be the ones appropriate for the band you are currently monitoring, taking into account any **Regulatory Domains** you have selected under **Channel Settings**. See "Band and Channel Settings" for more information.



Show Devices —The **On** and **Off** radio buttons allow you to enable or disable the display of devices associated with each channel as you mouse over the frequency trace in a plot.

Note Even if you turn on the **Channels** indicators, they will only be shown if fully within the span of the plot.

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Other Plot Control Panel Settings

Power vs. Time

The **Power Vs. Time** plot is used to display short burst of RF activity, known as pulses.

- **Sweep Time**—This sets the time scale over which pulse activity is measured. Specifically, it sets the range of the X-axis, which will run from a low value of **–Sweep Time** up to the present. You can use the spin control to change the setting, or type in a value directly. Type "**ms**" for microseconds and "**us**" for milliseconds. For example: **150 us**.

The plot also has a specialized **Bandwidth** setting:

- **RBW**—Determines the span of the spectrum monitored for power. This works in conjunction with the **Center Frequency** setting for the same plot. The low end of the monitored band is **Center Frequency – RBW/2**, and the high end is **Center Frequency + RBW/2**.

Note This is not the same definition for **RBW** that applies for the **Power vs. Frequency** plot (discussed below), where **RBW** sets the bin size for the X-axis.

The **Power vs. Time** plot also has a series of **Trigger** settings. **Trigger** criteria determine both what kinds of RF pulses are displayed, and when the display is updated.

- **Trigger Type**—This determines when the plot is updated.
- **Free Run**—RF energy (in your selected bandwidth) is sampled on a continuous basis, and data is "dumped" to the screen as it is available. This means the display is updated on a nearly constant basis, and data is shown whether or not any RF pulses are detected.
- **Single**—This catches a single pulse only. The display is only updated when an RF pulse is detected which matches your **Trigger Threshold** criteria (discussed below). If you select **Single**, you must then click on **[Arm]** (discussed below).
- Once such a pulse event is detected, it is displayed on the plot, and the plot is then frozen – no further activity is displayed. To catch any further pulses, you click again on **[Arm]**.
- **Continuous**—The plot is only updated when Cisco Spectrum Expert Software detects RF pulses which match your **Trigger Threshold** criteria. However, after detecting a pulse, the plot automatically "re-arms" itself, meaning every time a new pulse comes along, the plot is updated with new data. (Once again, of course, the pulses are only shown if they also fall within the bandwidth you have indicated, using the options above.)
- **[Arm]**—If you have selected a **Trigger Type** of **Single**, select **[Arm]** to tell the Cisco Spectrum Expert Software to be on the lookout for the next pulse that comes along.
- **Trigger Threshold**—This indicates the minimum power that an RF pulse must attain in order to register as a pulse, for purposes of this plot. In order to be counted as a pulse at all, for purposes of this plot, an RF pulse must exceed the amount of power you indicate here. Units are in dBm, where 0 dBm is equivalent to 1 milliwatt.

For example, if you indicate -10 dBm, then a pulse which reaches -5 dBm will be displayed, while a pulse whose maximum power is only -12 dBm will not be displayed.

Note Once the trigger line is shown on screen (as a white horizontal line), you can also change the setting by clicking-and-holding on the line with the mouse, and dragging it up or down. The current **Threshold** is displayed on the plot, just above the line.

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- **Trigger Delay**—This adjusts the centering of a pulse on your display. The default value is 0, and with this setting the beginning of an RF pulse is always centered on the midline of the time axis. If you set this to a positive value, the beginning of the RF pulse is offset to the left. If you set this to a negative value, the beginning of the pulse is offset to the right.
- Power Vs. Frequency Plot **Bandwidth**—The **Power vs. Frequency** plot has a **Bandwidth** setting, which determines the size of each bin for RF power measurements. A "bin" is the smallest span of spectrum for which power measurements are displayed.
- **Auto Select**—If you select this check box, Cisco Spectrum Expert Software automatically picks the optimum bin size. The value selected by the application will vary depending on the total bandwidth you choose to measure (using the **Frequency** settings).
- **RBW**—**RBW** stands for resolution bandwidth. Effectively, the bin sizes for RF power measurements will be just slightly larger than the value that you enter here. (So, for example, if you enter 60 kHz, your bins will be roughly 70 to 90 kHz wide.) You can only enter a value here if you first unselect the **Auto Select** check box.

Note This is *not* the same definition for **RBW** that applies for the **Power vs. Time** plot (discussed above), where **RBW** sets the size of the total bandwidth being monitored.

When you enter a value for **RBW** for the **Power vs. Frequency** plot, Cisco Spectrum Expert Software may auto-adjust your entry to the nearest valid value. The formal definition of **RBW** is the 3 dB bandwidth of the spectrum analyzer detection filter. The **RBW** determines the minimum frequency spacing that is allowed between two pure frequencies, in order for the frequencies to actually be distinguished as separate signals.

Example: If RBW is set to 70 kHz, then two signals which are separated by only 60 kHz in frequency will appear as one signal, with a combined power measurement for both signals.

- **Total Number of Bins**—The total number of bins is approximately the **Span** being monitored divided by the **RBW**.

  For example, if a 100 MHz span of the spectrum is being viewed—and if that span is divided into bins of 2 MHz in size—then the plot displays 50 separate power readings, indicating the power detected in each separate 2 MHz bin.

Note The minimum number of bins is never less than 16, and the maximum number of bins on the plot is at most 1024. If you try to establish settings for the **Span** and **RBW** which would cause higher or lower bin values, Cisco Spectrum Expert Software will auto-adjust the **RBW** or **Span** setting to bring the number of bins within the allowed range.

The **Power Vs. Frequency** plot also has a series of **Trigger** settings, similar to those for **Power Vs. Time**:

- **Trigger Type**—This determines when the plot is updated. Use the drop-down list box to select one of the three options.
  - **Free Run**—RF energy (in your selected bandwidth) is sampled on a continuous basis, and data is “dumped” to the screen as it is available.
  - **Single**—The display is only updated when RF energy is detected which matches your **Trigger Threshold** criteria (discussed below). If you select **Single**, you must then click on **[Arm]** (discussed below).
  - Once such RF energy is detected, it is displayed on the plot, and the plot is then frozen – no further activity is displayed. To catch any further activity, you click again on **[Arm]**.

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  - **Continuous**—The plot is only updated when Cisco Spectrum Expert Software detects RF energy which matches your **Trigger Threshold** criteria. However, the plot automatically "re-arms" itself, meaning every time an RF energy comes along which exceeds the **Trigger Threshold**, the plot is updated with new data.

- **[Arm]**—If you have selected a **Trigger Type** of **Single**, select **[Arm]** to tell the Cisco Spectrum Expert Software to be on the lookout for the RF energy which exceeds your **Trigger Threshold**.
- **Trigger Threshold**—This indicates the minimum RF power must be seen in order to update the plot. Units are in dBm, where 0 dBm is equivalent to 1 milliwatt.

  For example, if you indicate -10 dBm, then RF energy which reaches -5 dBm will cause the display to be updated, while RF energy below -10 dBm does not result in any update.

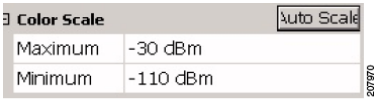
Note **Using The Mouse**—Once the trigger line is shown on screen (as a white horizontal line), you can also change the setting by clicking-and-holding on the line with the mouse, and dragging it up or down. The current **Threshold** is displayed on the plot, just above the line.

Swept Spectrogram

The **Swept Spectrogram** plot uses colors to represent RF power levels. The Color Scale options enable you to map the "highest color" and "lowest color" to specific power levels.

Here, the color **Blue** has been mapped to -110 dBm, while **Red** has been mapped to -30 dBm.

Values below the minimum value (-110 dBm, in this case) are automatically mapped to **Purple**, while values above the maximum value (-30 dBm here) are automatically mapped to.



Note **Color Scale Visibility**: For the **Swept Spectrogram**, the color scale is only visible when there is enough room to display it on screen. Depending on how many plots you have open, and on your display monitor resolution, you may need to close some plots to see the color scale.

[Auto Scale] serves the same purpose as elsewhere – it chooses appropriate upper- and lower-values based on recent power measurements.

FFT Duty Cycle Plot

For the **FFT Duty Cycle** plot, the scale of the Y-axis is based on a **Maximum** and **Minimum**, where (typically) the **Maximum** would be 100%, and the **Minimum** would be 0%.

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CHAPTER 9

Spectrum Charts

The Cisco Spectrum Expert **Spectrum Charts** use bar, line, and pie charts to provide broad summary information about activity in the RF spectrum. Like the spectrum plots, the spectrum charts are based on data from the SAgE chip embedded in the Sensor card. This chapter describes the kinds of information displayed in each graph.

Using Spectrum View Charts

For a discussion of creating charts, pausing/resuming the display, and saving chart configurations, see "Spectrum Tabs, Plots, and Charts Overview."

Note **Spectrum *Plots*** are discussed in "Using Spectrum View Plots."

Chart Content

Spectrum View offers seven different types of charts. We list all charts here, and provide more detailed discussion in the following pages.

- Active Devices
- Devices vs. Channels
- Devices vs. Time
- Channel Utilization
- Channel Utilization vs. Time
- Interference Power
- SNR

Active Devices

A pie chart which indicates—via different sized "slices" of the pie—what percentage of your RF activity is coming from different kinds of RF sources. You select which channel/band to monitor.

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Devices vs. Channels

A bar chart displays the number of devices detected on different channels. You can select which frequency bands or channels will be monitored.

Devices vs. Time

A line chart displays the number of devices detected at different times. You can select the time interval of interest (ranging from ten minutes up to 24 hours), the channel or band to monitor, and the types of devices which will be tracked on the plot.

Channel Utilization

A bar chart displays RF duty cycle as a function of channel activity. You can select which frequency bands or channels will be plotted.

Channel Utilization vs. Time

A line chart displays the RF duty cycle as a function of time. You can select the time interval of interest (ranging from ten minutes up to 24 hours), and the channel or band to monitor.
For longer time intervals, you can also select how data is aggregated – that is, you can track the average duty cycle, the maximum duty cycle, or the minimum duty cycle. See Figure 9-1 for more information.

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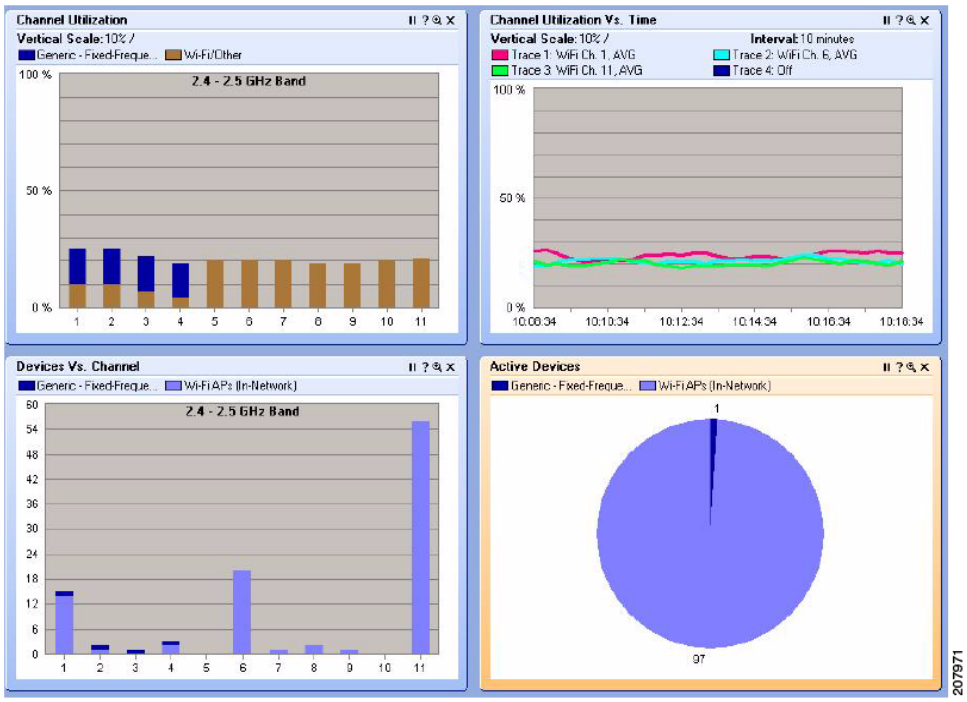
Figure 9-1 Spectrum Charts



Interference Power

A bar chart that shows the power for each selected channel is shown in Figure 9-2. The height of the bar shows the maximum power of all interference signals. Each bar consists of several lines representing the signal strength of a specific device type. The receive signal strength of the strongest In-Network Wi-Fi access point on each channel is shown by a + (plus) sign. The Wi-Fi noise floor is represented by a horizontal line across the grid background.

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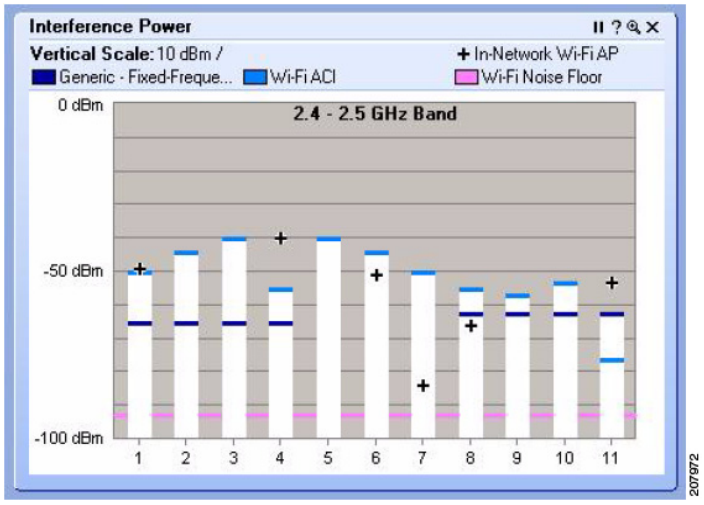
Figure 9-2 Interference Power Chart for Wi-Fi



The **X**-axis shows the channels, and the **Y**-axis shows the signal strength (from -100 dBm to 0 dBm). The height of the bar indicates the cumulative power (in dBm) for all devices in this category that affect a given channel.

To view channel and power information:

- Place the mouse to hover over a stacked bar to view pop-up information about the channel, maximum power, and the signal strength of each interfering device. Or, place the mouse to hover over a + sign to view pop-up information about the channel and the signal strength of the strongest In-Network Wi-Fi access point.
- Right-click either a stacked bar or **+** sign to view the same pop-up menu available on the **Devices vs. Channel** chart.

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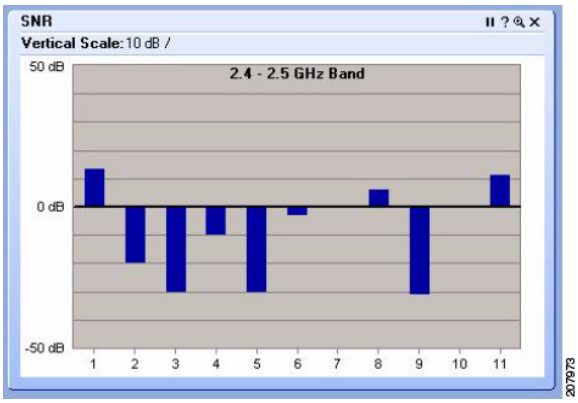
SNR (Signal To Noise Ratio)

A color coded bar chart that displays the SNR for each channel having access points. SNR is the ratio of a given transmitted signal to the background noise on the channel.

The **X**-axis shows the channels and the **Y**-axis shows the SNR power level (from -50 dB to 50 dB). The height of the bar above or depth of the bar below the 0 dB line indicates the SNR (in dB) for a given channel.



Bar Indicators

On the **Channel Utilization**, **Devices vs. Channel**, and **Interference Power** charts, the colored bars indicate the power level for each channel. Each interfering device is represented by a different color. A legend showing the devices and their associated colors is located at the top of the screen. Consequently, each colored section of the graphed bars map to the device legend.

The height of the bar shows the maximum power of all interference signals. Each color segment shows the contribution of a specific device type to the maximum power.

On the **Interference Power** chart, the receive signal strength of the strongest In-Network Wi-Fi access point of each channel is represented by a **+** (plus) sign.

Navigate to Other Views

The bars and graphs on certain charts allow you to obtain additional information on a particular channel. You can navigate from **Spectrum View** to **Devices** or **Channel Summary View**. On the following plots/charts: **Channel Utilization**, **Devices vs. Channel**, **Real Time FFT**, **FFT Duty Cycle**, **Swept Spectrogram**, and **Power vs. Frequency**, right-click on a channel bar (or anywhere in the workspace of the plot) to display the pop-up menu. Select **Show Devices Affecting <channel ID>** to display the active devices in **Devices View**. Select **Show Channel <channel ID>** to display related data on this channel (highlighted in blue) in **Channel Summary View**. The Real Time FFT can also display the integrated channel power for each RF channel.

Chart Controls

The chart **Control Panel** lets you fine-tune the data presented by the charts.

Concerning band and channel selections, first note the following:

- You can change the bands available here—that is, the bands shown on the **Channel** menus—by changing the **Monitored Bands** settings (**Tools > Settings > Monitored Bands**). See "Band and Channel Settings" for more information.

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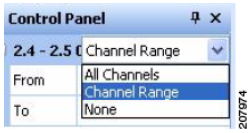
- You can change the channels available here by changing your **Channel Settings** (**Tools > Settings > Channel Settings**). See "Band and Channel Settings" for more information.

Note Cisco Spectrum Expert Software will only make available, for selection here, those channels which you have selected under **Channel Settings**, provided those channels also fall within the bands you have selected under **Monitored Bands**. (In other words, the available channels are determined by the intersection of your **Channel Settings** and **Monitored Bands**.)

Channel or Band Selection For Channel-Based Charts

Charts which use the RF channel as the independent variable (on the X-axis) include the **Channel Utilization** chart and the **Devices Vs. Channel** chart. These charts enable you to select exactly which channels will be displayed on the chart.

For each band supported by your product, a drop-down list box enables you to select one of three options:



- **All Channels**—All channels in the band will be charted.
- **Channel Range**—If you select this option, you then select a **From** channel (the lower end of a range) and a **To** channel (the upper end of the range) using the drop-down list boxes.
- **None**—None of the channels in the band are charted.

Note You may need to click on the **[+]** tree control buttons to expand visible options for each band displayed on the **Control Panel**.

The **Active Devices** plot, which is a pie chart, has no X-axis. The pie chart simply shows the distribution of different device types in a selected band or channel. The single, simple **Channel** drop-down list box lets you select which channel or band is reported on by the chart.

Selection Options for Time-Based Charts

The **Devices vs. Time** and **Channel Utilization vs. Time** charts both use time as the independent (X-axis) variable. The two plots have similar, but slightly different controls.

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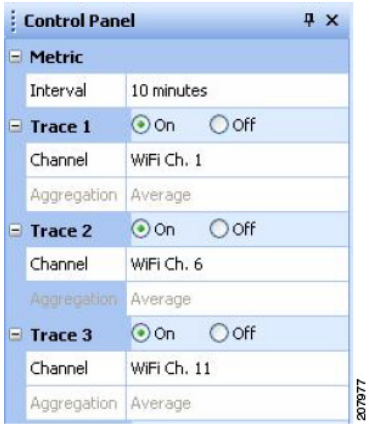
For **Devices vs. Time**, you can select:

- **Interval**—The total time interval for the X-axis. For example, if you select **8 hours**, the chart will indicate the numbers of devices seen over the time period extending from "now" back to "now minutes 8 hours."
- **Channel**—Use the **Channel** list-box to select which channel or band to monitor.
- **Trace**—The chart can show usages for up to four different types of devices at one time. For each of the four traces (represented as different colors on the chart), you have the following options:
- **On / Off**—Indicates if the trace is in use at all.
- **Category**—Indicates the type of device to be tracked by the trace. Options will vary depending on your edition of Cisco Spectrum Expert Software, but may include 802.11 devices, microwave ovens, cordless phones, and so on.
- **Aggregation**—For time intervals of 8 hours or 24 hours, each "point" on the plot actually spans a significant period of time in its own right. You can select whether, for each point on the plot, you are seeing the **Average** number of devices active in that time interval; the **Maximum** number of devices seen in that time interval; or the **Minimum** number of devices seen in the time interval.

For shorter total time intervals (4 hours or less), this option is not available. For these shorter time-frames, each point on the plot represents a short enough period of time that there is no reason to distinguish between the minimum/maximum/average number of devices. The average value is shown automatically.

For **Channel Utilization vs. Time**, you can select:



- **Interval**—The total time interval for the X-axis. For example, if you select **8 hours**, the chart will display the numbers of devices seen over the time period extending from "now" back to "now minutes 8 hours."
- **Trace**—Here, each trace, rather than corresponding to a device type, corresponds to a band/channel, and/or to a different type of data aggregation. The chart can show up to four different traces at a time. For each of the four traces (represented as different colors on the chart), you have the following options:
- **On / Off**—Indicates if the trace is in use at all.
- **Channel**—Uses the **Channel** list-box to select which channel or band to monitor.
- **Aggregation**—For time intervals of 8 hours or 24 hours, each "point" on the plot spans a significant period of time. You can select whether, for each point on the plot, you are seeing the **Average** duty cycle in that time interval; the **Maximum** duty cycle; or the **Minimum** duty cycle.

For shorter total time intervals (4 hours or less), this option is not available. For these shorter time-frames, each point on the plot represents a short enough period of time that there is no reason to distinguish between the minimum/maximum/average duty cycle. The average value is shown automatically.

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CHAPTER **10**

Devices View

The **Devices View** shows detailed statistics for each device, including both currently active devices and historical devices. Devices listed here include both network devices and interferers.
You access this view by selecting the **Devices** tab. The data in **Devices View** is organized in tabular form. (The following list of fields is provisional, and subject to change without notice.)

- **Device**—The name of the interfering device.
- **Signal Strength (dBm)**—Average received signal strength (log average) for pulses from the device.
- **Duty Cycle (%)**—Measured duty cycle for this device.
- **Discovery Time**—When the device was first detected.
- **On Time**—Amount of time the device has been on since it was detected.
- **Channels Affected**—Channels affected by transmissions from this device.
- **Network ID** —Network address for this device, if available (for example, the BSSID for 802.11 device, or the piconet address for Bluetooth devices).
- **Device ID**—The device address for the device, if available. Examples would be the MAC address for 802.11 access points, the device address for Bluetooth devices, and so on.

If there is more than one instances of a device type, the number of instances will be indicated in brackets (for example, **[5]**) in the **Device Name** field.

Figure 10-1 Devices View

Device	Signal Strength (dBm)	Duty Cycle (%)	Discovery Time	On Time	Channels Affected	Network ID	Device ID
Wi-Fi APs (In-Network) [70]							
(00:0D:ED:97:DF:A0) (Ch 8)	-70.0		Tue Nov 13 11:...	00:00:30	5..11	00:0D:ED:97:DF:A0	00:0D:ED:97:DF
(00:13:5F:0E:CB:20) (Ch 11)	-81.0		Tue Nov 13 10:...	00:14:30	8..13	00:13:5F:0E:CB:20	00:13:5F:0E:CB:
(00:16:9C:48:CC:21) (Ch 6)	-70.0		Tue Nov 13 10:...	00:08:15	3..9	00:16:9C:48:CC:21	00:16:9C:48:CC
(00:16:9C:48:CC:22) (Ch 6)	-69.0		Tue Nov 13 11:...	00:03:45	3..9	00:16:9C:48:CC:22	00:16:9C:48:CC
(00:16:9C:48:D9:E0) (Ch 11)	-85.0		Tue Nov 13 11:...	00:03:45	9..13	00:16:9C:48:D9:E0	00:16:9C:48:D9
(00:16:9C:48:D9:E1) (Ch 11)	-89.0		Tue Nov 13 11:...	00:01:45	10..12	00:16:9C:48:D9:E1	00:16:9C:48:D9

Note In the default view, all of the columns do not display. You can add or delete columns. For more information see "Adjusting The Column Display."

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Working With Devices View

Devices View and the Active Devices Panel

Normally, when the **Devices View** is in the foreground, Cisco Spectrum Expert Software automatically hides the **Active Devices** panel. However, you can have both **Devices View** and the **Active Devices** panel on display at the same time. See "Active Devices" for more information.

Adjusting The Column Display

- **Resize Columns**—You can resize the columns by using the mouse to select the dividing line between columns, and sliding the line to the left or right.
- **Change Column Order**—You can change the order of columns by left-clicking-and-holding on a column heading, and dragging the column to the left or right. (This works exactly the same as moving columns in the Windows Explorer.)

Note The **Device Name** column is always the first column when viewing in the Tree View. You cannot switch the placement of this column.

- **Add or Delete Columns**—Not all of the available columns needs to be on display at one time. In fact, in the default view, several columns are normally omitted.
- You can add any of the available columns by right-clicking on the column headings. From the pop-up menu, select **Add Column ‡ <column name>**.
- You can delete a column by right-clicking on any column heading. From the pop-up menu, select **Remove Column**.
- **Saving The Current Column Settings**—Your current column settings are automatically saved when you exit the Cisco Spectrum Expert Software.
- **Restore The Default Column Settings**—You can restore the default column configuration by right-clicking on the column headings. From the pop-up menu, select **Use Default Column Settings**.
- **Column Definitions**—To obtain a definition for any column, hover the mouse pointer over the column heading. A definition for that column heading appears in a tooltip window.

Selecting The Display Type

There are two viewing modes available in **Devices View**.

- **Tree View**—In this view, devices in column one (**Device Name**) are organized hierarchically, first under a device type heading, then under a network master (for example, access point, base station) heading. This is the default view after start-up. The following device type headings apply for the tree view:
  - Wi-Fi APs (In Network) (Wi-Fi product only)
  - Wi-Fi APs (Known) (Wi-Fi product only)
  - Wi-Fi APs (Unknown) (Wi-Fi product only)
  - Wi-Fi Ad-Hocs (Wi-Fi product only)
  - Bluetooth Piconets

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  - Cordless Phones
  - Microwave Ovens
  - Continuous Transmitters
  - Burst Transmitters
  - Chirp Transmitters
- **List View**—In this view, there is no hierarchical organization for **Device Name** data.

Note In the default List View, the **Device Name** column is not the first column; a new column, Categories, appears first.

You can switch between these two viewing modes by selecting the **Tree View** or **List View** radio buttons in the **Device Controls** panel at the left side of the application. (If the **Device Controls** panel is not showing, select **View > Control Panel**.)

Setting The Time Range

You can set the time range and channel for which devices will be listed by using the drop-down list box on the **Device Controls** panel.

Sorting The Display

You can sort the data in the **Devices View** by any of the column headings.

- **Primary Sort Column**—The primary sort is invoked by left-clicking on the column heading. The primary sort column is indicated with a single tick-mark.
- **Secondary Sort Column**—The secondary sort is invoked by shift-clicking on a column heading. The secondary sort column is indicated with a double-tick mark.

The sorts do *not* affect the outline headings in the **Device Name** column (the first column) for the hierarchical viewing mode; for this mode the sort is applied only to the data at the lowest level in the hierarchy for each outline heading. The default sort order is:

- **Primary**—Device (ascending)
- **Secondary**—Duty Cycle (descending)

Ascending and Descending Sort Order

For any given column, you can toggle between ascending sort order and descending order simply by clicking on the column heading. (If the column is currently sorted in ascending order, clicking once sets it to descending order; clicking again restores it to ascending order.)

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This works exactly the same for the secondary sort column – repeated shift-clicking toggles between ascending and descending order.

Keeping Your Eye On A Particular Device

If there is a particular device that is of interest to you, you can keep an eye on the device simply by clicking on it. Your selected row will be highlighted. As new devices as detected (or disappear from view), the **Device List** will auto-scroll and auto-sort. However, Cisco Spectrum Expert Software will make sure your highlighted row always remains in view. (In other words, auto-scrolling and auto-sorting will be adjusted so that the highlighted row always remains visible on Cisco Spectrum Expert Software.)

Locating A Device

The Cisco Spectrum Expert Software's **Device Finder** mode enables you to use your laptop as a "sniffer" to track down a specific interfering device. **Device Finder** is discussed in detail in "Device Finder Mode."

Tip To get started, you can right-click on any interfering device shown in the **Devices View**. Assuming the device is currently transmitting, you can select **Find This Device** from the pop-up menu. This starts the **Device Finder** mode. If the selected device is not currently active, the **Find This Device** option will be grayed out.

Note The **Device Finder** can only locate certain types of devices. If you right-click on a device that can't be located, you will not be able to access the **Find This Device** option. Also, a device must be currently active (transmitting) in order to find it. If, in **Devices View**, you click on a device which is not currently transmitting, you will not be able to access the **Find This Device** option..

Obtaining Detailed Information On A Device

To obtain detailed information for any device, double-click on the device in the list. A pop-up dialog box appears showing detailed information for that device.

Miscellaneous Device Issues

This section describes miscellaneous issues that affect data displayed in the **Device View**.

Signal Bounce and Fading

Narrowband signals—such as signals from analog FM cordless phones or analog video cameras—are prone to "fading." Signals naturally fade (grow weaker) with increased distance from an RF signal source. But as a technical term, "fading" refers to the fact that as a signal travels; it bounces and reflects off of multiple surfaces. So, at some distance from a single source, that single source of RF power results in multiple signals (all from the same source) crisscrossing each other.

When a single RF signal—reflected from multiple directions—crosses paths with itself, the result is signal *interference*. Signal interference can be constructive (resulting in a stronger signal at a given point), or

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destructive (resulting in a weaker signal, or even no signal, at a distance not at all far from the original source).

The result is that, at a given receiving antenna, the signal can vary greatly in power when the antenna is moved just a few inches in any direction. To further complicate matters: As people and other objects in the environment move, the source signal is reflected differently. So even if the receiving antenna stays in one place, signal strength can vary unpredictably over time.

As a result, when Cisco Spectrum Expert Software is detecting a narrowband interferer, the detection status may toggle on and off due to fading. Fading occurs in most indoor environments, and the fluctuations in the received signal level are typically correlated to the rate of motion for nearby people/objects.

Near/Far Effect

The presence of strong signals may further impair the ability of the classification software to detect weaker signals. This is the so-called near/far effect, which is caused when the strong and weak signals use up the limited dynamic range of the receiver. (In other words, the receiver can only handle so much signal strength, in total, at one time. So if the receiver is getting two signals, the strong one can essentially swamp the weaker one.)

Example: When you walk near one cordless phone while you are simultaneously listening to another cordless phone that's far away (for example, at your next-door neighbor's house), you may find that you lose the weaker signal. When you turn off the near-by cordless phone, you may find that you can detect the weaker signal again.

These effects cannot be removed by Cisco Spectrum Expert Software. The only thing we can do is make you aware of them, so that you can understand why it is that certain interferers fade in and out of view at times.

Device Detection Time

In general, the time required for Cisco Spectrum Expert Software to detect and classify devices, and reclassify their status if they go from being On to Off, will vary depending on the RF environment and location of devices relative to the Sensor card. Most devices (other than 802.11) should take 5 to 30 seconds. However, 802.11a/b/g devices and 802.11 frequency hoppers may take as long as ten minutes to be detected.

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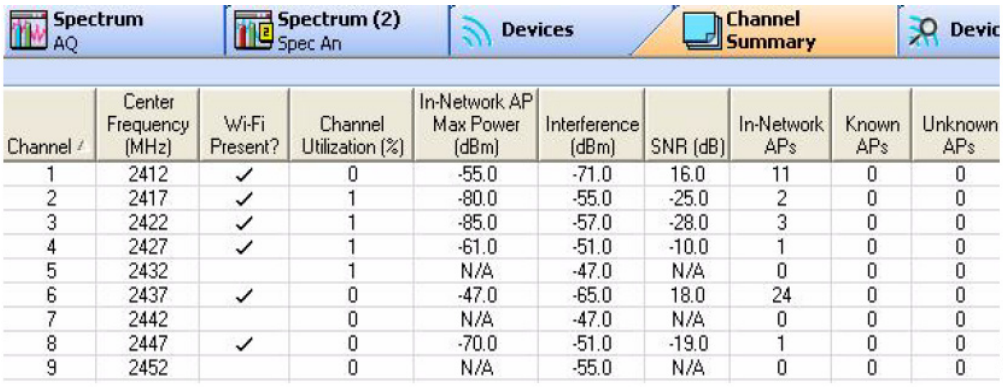
CHAPTER 11

Channel Summary

The **Channel Summary** shows specific levels of RF activity, such as average power and maximum power, and whether or not interferers are present, on a channel-by-channel basis. This information is very helpful in determining whether channel reallocations might improve your network performance.

Figure 11-1 Channel Summary



Channel	Center Frequency (MHz)	Wi-Fi Present?	Channel Utilization (%)	In-Network AP Max Power (dBm)	Interference (dBm)	SNR (dB)	In-Network APs	Known APs	Unknown APs
1	2412	✓	0	-55.0	-71.0	16.0	11	0	0
2	2417	✓	1	-80.0	-55.0	-25.0	2	0	0
3	2422	✓	1	-85.0	-57.0	-28.0	3	0	0
4	2427	✓	1	-61.0	-51.0	-10.0	1	0	0
5	2432		1	N/A	-47.0	N/A	0	0	0
6	2437	✓	0	-47.0	-65.0	18.0	24	0	0
7	2442		0	N/A	-47.0	N/A	0	0	0
8	2447	✓	0	-70.0	-51.0	-19.0	1	0	0
9	2452		0	N/A	-55.0	N/A	0	0	0

Working with the Channel Summary

To access the **Channel Summary**, select the **Channel Summary** tab or select **View > Channel Summary**.

Sorting the Display

You can sort the display by any of the columns, simply by clicking on the column heading.

Channel Data

The following data is presented for each channel:

- **Channel**—The channel number. (The display is sorted by channel number by default.)
- **Center Frequency**—The center frequency of the channel, in MHz.

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- **Wi-Fi Present?** (Wi-Fi edition only)—A check mark () in this field indicates that Cisco Spectrum Expert Software detected activity by an 802.11 device during the last measurement interval.
- **Channel Utilization (%)**—The current duty cycle of RF activity in that channel. In this case, the percentage of the time that some signal was present in the channel during the last measurement interval.
- **In-Network AP Max Power (dBm)**—The maximum power level (in dBm) of the strongest In-Network Wi-Fi (802.11) device on the channel.
- **Interference (dBm)**—Power level (in dBm) of the maximum interference on the channel (including Wi-Fi interference).
- **SNR (dB)**—The signal to noise ratio's, expressed in dB, for each channel having access points present.
- **In-Network AP(s)**—The number of Wi-Fi ACI's identified as being in the network transmitting on the channel.
- **Known APs**—Network devices (access points) impacting your network, but which are not actually part of your network (For example, access points from neighboring Wi-Fi networks).
- **Unknown APs** —Access points designated as not belonging to the network and not belonging to a nearby network. Unknown access points should be treated as potential rogues.
- **Interferers**—The number of non-Wi-Fi devices transmitting on the channel.
- **Ad hocs**—The number of access points, belonging to a temporary (ad hoc) network, transmitting on your network channel (not displayed by default).
- **AQ Index**—This is a metric to check the goodness of the available spectrum. That is, it is a measurement to check the severity of interference on a specific channel. 100 means there is no interference; 0 means there is complete interference.

Miscellaneous Channel Summary Issues

802.11 Detection Sensitivity

The threshold for Cisco Spectrum Expert Software to detect 802.11 devices is an RF power of approximately -80 dBm. This detection sensitivity is commensurate to that of a reliable 54 Mbps connection, so the detection range is less than 150 ft at 2.4 GHz and less than 100 ft at 5 GHz in an indoor environment. In a large environment users should take detection measurements at several representative locations to cover the entire 802.11 area. See the Cisco Spectrum Expert Software release notes for more information.

802.11 Device Types

When Cisco Spectrum Expert Software indicates that an 802.11 a/b/g signal is present on a channel, this may or may not indicate an access point or network in use. It could also be a zero config client (a station not currently affiliated with a network) which is transmitting probes, as it seeks out a network.

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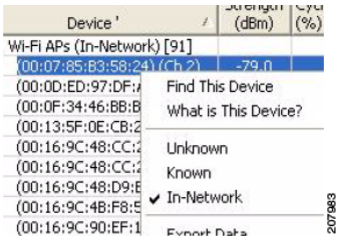
CHAPTER 12

Device Finder

In **Device Finder** mode, Cisco Spectrum Expert Software acts as a lightweight portable probe which enables you to quickly track down the location of a specific interfering device. Essentially, your Cisco Spectrum Expert Software-enabled laptop acts as a wireless "sniffer."

Device Finder Mode

This section presents a summary description of how to put **Device Finder** to work. Detailed instructions are presented in the next section.



- From the **Devices View** or the **Active Devices** tree, select the device that you wish to locate.
- Carry the Cisco Spectrum Expert system to different locations in the network environment.
- At each location, use Cisco Spectrum Expert Software to measure the signal strength from the device of interest.

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- Using these signal strength measurements, identify when you are closer to—and further from—the device of interest. Essentially, the signal strengths indicate when you are "getting warmer" or "getting colder" in terms of getting near to the signal source of interest.

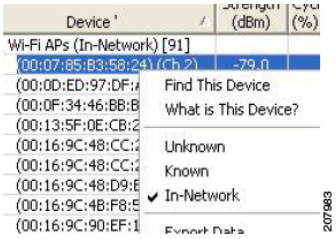
Based on these measurements, you can then home in on the location of the intruding device.

- You can also use the **Measurement Log** to record RF signal strength levels at specific locations. If the "hotter/colder" approach is proving problematic—which may happen if, for example, the signal is intermittent—the log keeps a record of where different RF levels were recorded. You can use this information, possibly with the help of a map of your network space, to triangulate the location of the interfering device.

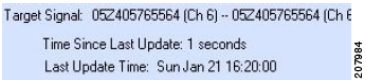
Working With Device Finder

To use the **Device Finder**, follow these steps:

Step 1 In **Devices View**, or on the **Active Devices** tree, select the device you wish to locate. Then right-click on the device name, and select **Find This Device** from the pop-up menu.



Step 2 The device is now listed in the **Device Finder**.



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Step 3 The **Signal Strength History** graph shows a moving plot of the signal strength. This plot makes it easy to visualize when you are walking to or away from the signal source.

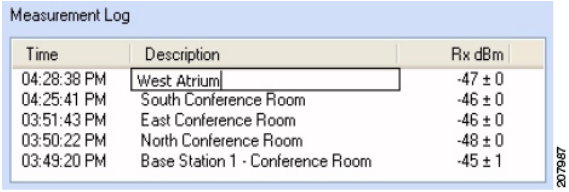
Note The plot does not automatically reset if the signal is lost.

The **Rx Signal Strength** meter also provides a real-time indicator of the signal strength from the device of interest, and is an additional tool in determining whether you are "getting warmer" or "getting colder" in terms of tracking down the interfering device.

At moments, you will record a signal of special interest. The signal may suddenly peak or drop off, or you may be systematically recording the signal at carefully planned locations.

Step 4 To maintain a record of the signal of interest, select the **Record Signal]** button, or press the **<Spacebar>**.

Cisco Spectrum Expert Software records the current signal strength and the time in the **Measurement Log**. For a **Description**, Cisco Spectrum Expert Software uses the device name as a default value.



Step 5 Type in a description of where the measurement was taken. Press the **<Enter>** key on your keyboard to confirm your description.

Step 6 You can also edit the location information in the **Measurement Log** at a later time.
Simply double-click on the description and then key in your new description; then press **<Enter>**.
(Pressing **<Esc>** cancels any changes you are making.)

Additional Device Finder Features

The **Device Finder** has the following additional features and capabilities:

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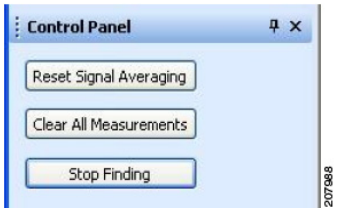
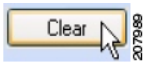


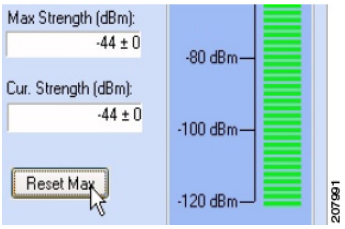
- **Stop Finding**—You can stop tracking the interferer by selecting the **[Stop Finding]** button. It is a good idea to do this after you have found the interferer of interest, since it reduces the drain on system processing resources.
- **Reset Signal Averaging**—If you select the **[Reset Signal Averaging]** button, Cisco Spectrum Expert Software no long uses prior signal values to calculate the average signal strength. Instead, Cisco Spectrum Expert Software only calculates average signal strength from "now" forward, where "now" is when you select **[Reset Signal Averaging]**.

  If you are moving around—or changing the orientation of a directional antenna—this command will cause the signal averaging measurement to restart, so you don't display data that may be representative of the prior position/orientation. A great deal of filtering is applied to provide accurate measurements, and this can help Cisco Spectrum Expert Software to respond more quickly, and not be biased from prior measurements.



- **Clear Signal Strength History**—Select the **Clear** button over the **Rx Signal Strength History** plot to clear the plot.

- **Clear Measurement Log**—You can clear the **Measurement Log** of all data by selecting the **Clear Log** button above the log.
- **Delete A Single Log Entry**—You can also delete an individual row from the **Measurement Log**. Simply select the entry, and then press the **<Del>** key on your keyboard. Then select **Yes** in the confirmation dialog box.



- **Reset Maximum Signal Strength**—If you select **[Reset Max]**, Cisco Spectrum Expert Software deletes the current value for the maximum signal strength; Cisco Spectrum Expert Software then ascertains, starting from "now", the maximum interferer signal strength measured from this time forward.
  - **Reset Max** only clears the **Max Strength** text box, and the black rectangular box in the vertical signal meter that indicates the highest strength seen. Use the **[Clear]** button (above) to clear the plot.

"Divide And Conquer" Search Strategy

To minimize your effort, and maximize your chances of locating the interferer, we recommend that you use a "divide and conquer" search strategy (also known as "rectangular bisection"). We illustrate the strategy, first with the omni antenna, and then using the directional antenna. To use this process, you will greatly benefit from using a physical map of your network space.

Omni Antenna

Note It is possible to hit a "blind spot" when using **Device Finder**. This is a location—typically a corner of a large building—where you may not get any measurements at all. If you find you are spending more than 30 seconds at any one spot, without getting an updated device reading, you should move away from that spot and try a different location.

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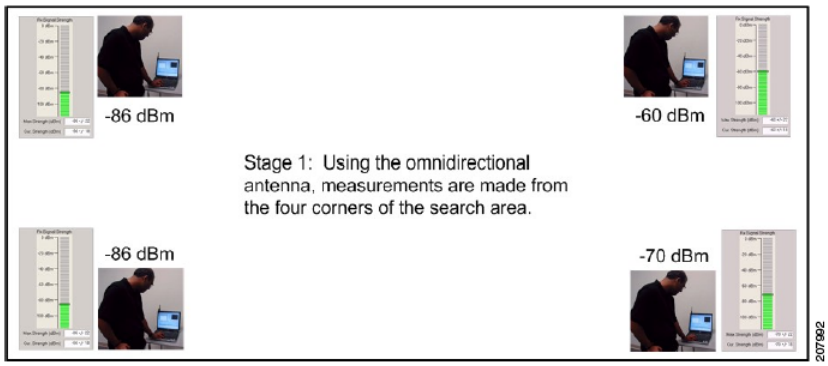
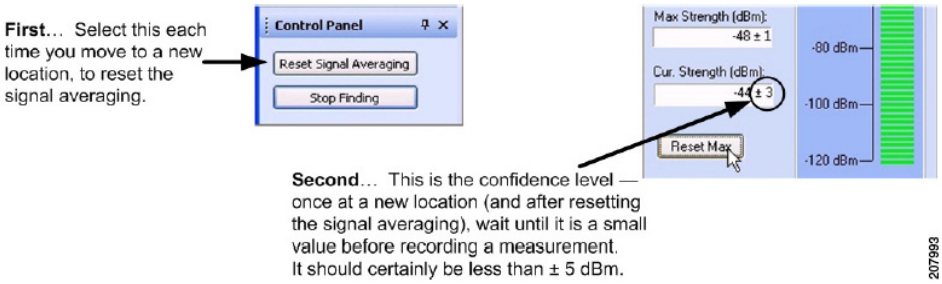
For purposes of simplicity, assume that your interfering device is located somewhere within a large rectangular office space (which might measure, for example, 50’ by 150’).

Step 1 Go to each of the far corners of the office space, and measure the signal strength from the interfering device of interest. Take note of which corner of the office yields the highest signal strength. (A printed map of your office space can be helpful for jotting down data.)



Note Each time you move the Cisco Spectrum Expert system to a new location, select the [Reset Signal Averaging] button on the Device Finder. Then, at each test location, wait for the confidence level to settle to a small value—ideally less than ±3 dBm, but certainly less than ±5 dBm—before recording the signal strength.



Step 2 In the corner which has the largest signal strength, map out a rectangular sub-search area comprising one quarter of the total office space.

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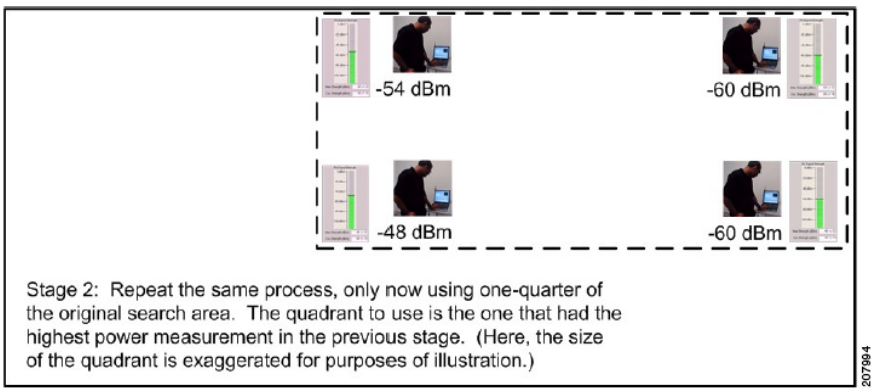
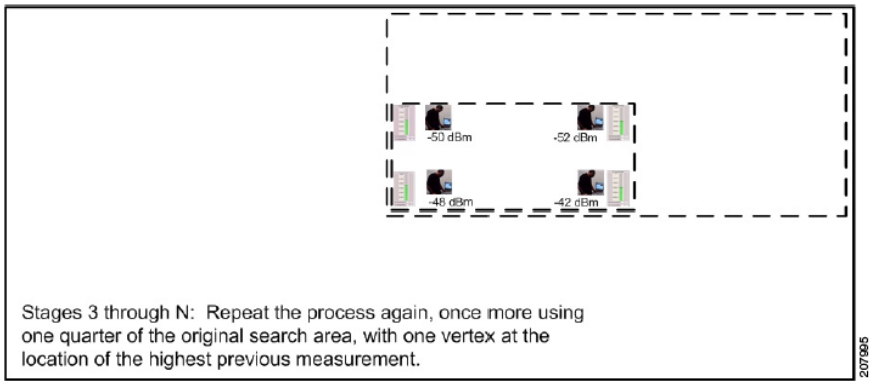
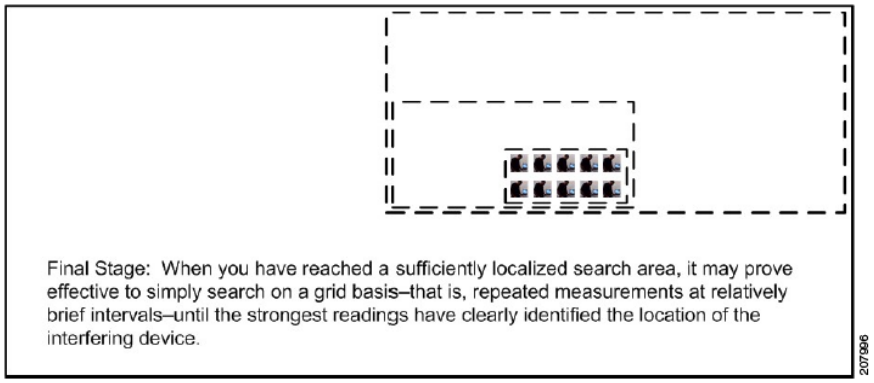


Step 3 Repeat this process, as necessary to localize your measurement.



Step 4 By repeating this process, you will be able to home in on the location of the interfering device.



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Directional Antenna

It is possible to hit a "blind spot" when using **Device Finder**. This is a location—typically a corner of a large building—where you may not get any measurements at all. If you find you are spending more than 30 seconds at any one spot, without getting an updated device reading, you should move away from that spot and try a different location.

The advantage of using the directional antenna is that you can save yourself a substantial amount of walking, because four measurements at a time can be made from one central location. See "Directional Antenna" for more information.

Step 1 Once again, assuming a rectangular office space, take your Cisco Spectrum Expert Software laptop to the center of the office space. Use the directional antenna, with **Device Finder**, to determine the signal strength coming from your interferer, as measured in each of four directions. For each measurement, the antenna should be pointed towards each of the four corners of the office.

Note Again, here, each time you point the antenna in a new direction—as well as when you move to a new location—select the [Reset Signal Averaging] button on the Device Finder. Then, wait for the confidence level to settle to a small value (at most ±4 dBm) before recording the signal strength.

Step 2 Once again, map out a rectangular sub-search area comprising one quarter of the total office space for the corner which has the largest signal strength. Again, you only need to make measurements from one spot, pointing the antenna towards four different directions.

Step 3 Repeat, again making measurements in the quadrant with the highest power reading.

Step 4 Once again, you will learn from experience whether the final measurements are best made by a continued process of rectangular bisection, or whether the final measurements should be made on a systematic grid of a local area.

Detecting Narrowband Devices

Interfering devices fall into two RF categories, narrowband and wideband. By the very nature of wideband transmissions, the signal strength from a wideband device—as measured at any one location—tends to be consistent. (If the directional antenna is in use, the signal strength from a wideband device will tend to be consistent, at a given measurement location, and for a given direction in which you point the antenna.)

By contrast, narrowband devices have certain signal peculiarities. Small changes in the physical environment—changes which have nothing to do with the device emitting the signal—can cause large fluctuations in the signal strength. For example, the simple movement of people or furniture can change the way a narrowband signal is reflected throughout the enterprise space, resulting in changes in signal strength as measured from some distance away.

Fortunately, most interferers are wideband, which makes life easier for users of Cisco Spectrum Expert Software. However, there are some interferers, such as some FM phones and TDD phones, which are narrowband devices. The signal from these devices can vary significantly over the space of just a few inches. As a result, there are some simple antenna tricks to use when searching for such devices:

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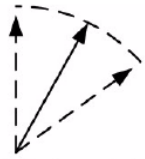
- **Omni antenna**—If you are using the omni antenna (including the built-in antenna on the Cisco Spectrum Expert Sensor card), it can be helpful to slowly, physically sweep the Cisco Spectrum Expert Software laptop in an arc along several inches, until you achieve the maximum signal strength.
- **Directional antenna**—If you are using the directional antenna (Wi-Fi only), a similar trick applies. With the laptop resting in place (such as on a cart), and with the antenna pointed in a desired direction, you can slowly sweep the antenna along an arc of roughly 30 degrees to 45 degrees, centered on the primary direction of interest, until you achieve the maximum signal strength.



Solid line indicates main direction of interest for signal measurement. Dotted lines indicate approximately 45 degree arc of measurement through which the antenna should be moved. 207997

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CHAPTER 13

Cisco Spectrum Expert Software Local Settings

Local Settings Overview

There are a number of settings you can change to determine how Cisco Spectrum Expert Software operates and presents data. The available settings are for:

- **Sensors and Antennas**—Determine which Sensor card Cisco Spectrum Expert Software uses to obtain data. For the internal Sensor card, you can also indicate the type of antenna in use.
- **Console Settings**—Use this to change the date formats seen on screen.
- **Band and Channel Settings**—Determines which 802.11 channels and how wide a bandwidth will be monitored by Cisco Spectrum Expert Sensor card.
- **Alert Settings**—Used to enable or disable security and performance alerts for an interferer type or category.
- **SNMP Option**—Cisco Spectrum Expert Software has an ability to send SNMP traps when it detects interfering devices. This screen is used to configure the trap filters and threshold levels that will trigger the sending of an SNMP trap. The **Settings – SNMP** screen is used to configure the trap filters and threshold levels that will trigger the sending of an SNMP trap.

Note The following MIB files are installed with Cisco Spectrum Expert Software under [install dir]\Cognio\Spectrum Expert\MIB and are used by the trap receiver:

File	Description
COGNIO-SMI.mib	**Enterprise OID**
COGNIO-TRAPS-MIB.mib	**Trap definition. Refer to this file for the complete trap OID information.**
INET-ADDRESS.mib	**MIB file that traps are dependent on**
SNMP-FRAMEWORK-MIB.mib	**MIB file that traps are dependent on**
SNMPv2-CONF.mib	**MIB file that traps are dependent on**
SNMPv2-SMI.mib	**MIB file that traps are dependent on**
SNMPv2-TC.mib	**MIB file that traps are dependent on**

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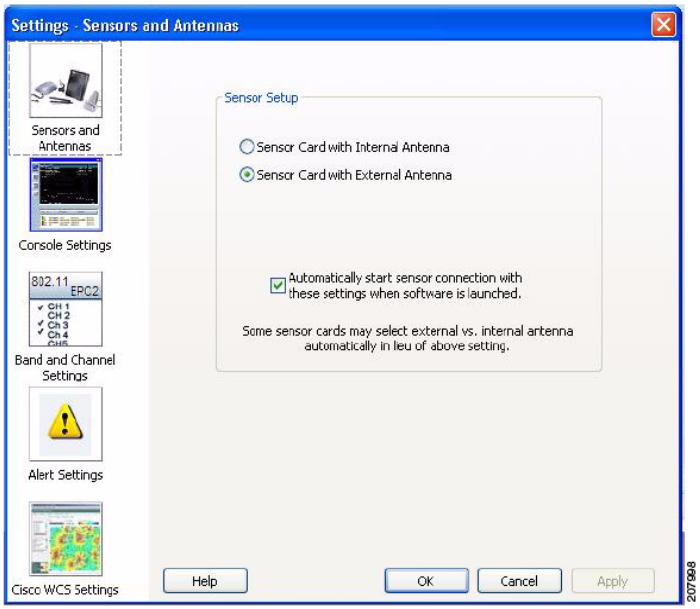
Sensors and Antennas

To modify which Spectrum Sensor card and/or antennas are used by Cisco Spectrum Expert Software, follow these steps:

Step 1 Select **Tools > Settings**.

The **Sensor Setup** panel should be displayed by default. If it is not, select the **Sensors and Antennas** button on the tool bar at left.

Step 2 Select the Sensor card/antenna combination of interest. Your choices are:



- **Sensor Card With Internal Antenna**—Tells the application to use data from the internal Sensor card. Also tells the Sensor to use its internal antenna.
- **Sensor Card With External Antenna**—Tells the application to use data from the internal Sensor card. Also tells the Sensor to use its external antenna.
- **Spectrum Capture File**— Enables you to select a CSC file for playback. Select the **[Browse…]** button to browse for a particular CSC file. See "Spectrum Recording and Playback" for more information.

Step 3 Optionally, select the **Automatically Use These Settings At Startup** check box. If you select this option, the application will automatically use these settings each time the application is started.

If left unchecked, the Cisco Spectrum Expert Software present a dialog box each time the program starts, asking you which Sensor card to use.

Step 4 Select **[OK]** to confirm your changes and close the dialog box. You can also select **[Apply]** to apply your changes while leaving the dialog box open for further work.

Console Settings

To fine-tune how the Cisco Spectrum Expert Software displays data, follow these steps:

Step 1 Select **Tools > Settings.**

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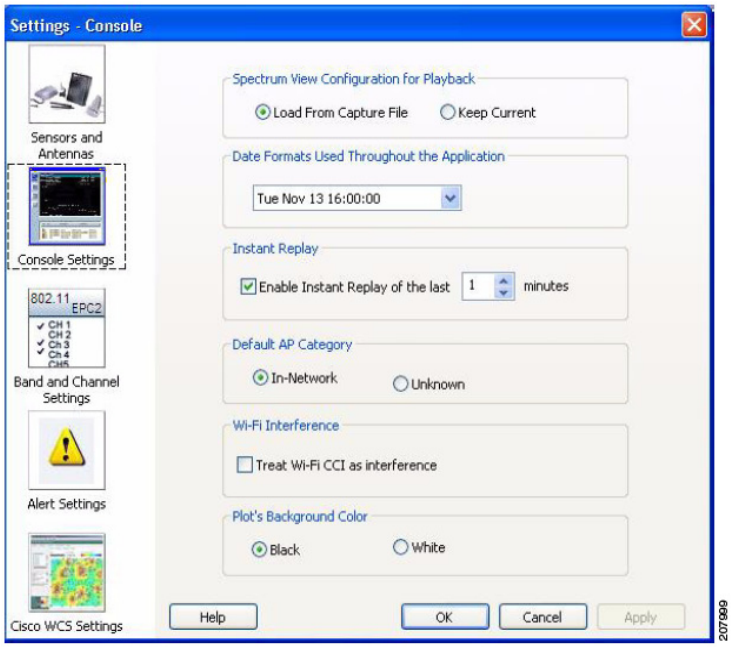
Step 2 From the tool bar on the left side of the dialog box, select **Console Settings**

Step 3 You can change the following settings:

- **Spectrum View Configuration for Playback**
- **Date Formats Used Throughout the software**—Select from the drop-down menu.
- **Instant Replay—** Select the checkbox and the number of minutes (1 to 60) you want available for use as an instant replay.
- **Default AP Category—** In-Network or Unknown.
- **Plot's Background Color—**Black or White as the background color.



Step 4 Select **OK** to confirm your changes and close the dialog box. You can also select **Apply** to apply your changes while leaving the dialog box open for further work.

Band and Channel Settings

Here you can configure the bands and channels that Cisco Spectrum Expert Software will monitor and report on. You can select band and channel settings by Regulatory Domain or define the bands and channels individually by selecting the User Defined option.

Regulatory Domain Options

To use a Regulatory Domain option to select the bands and channels, follow these steps:

Step 1 Select **Tools > Setting.**

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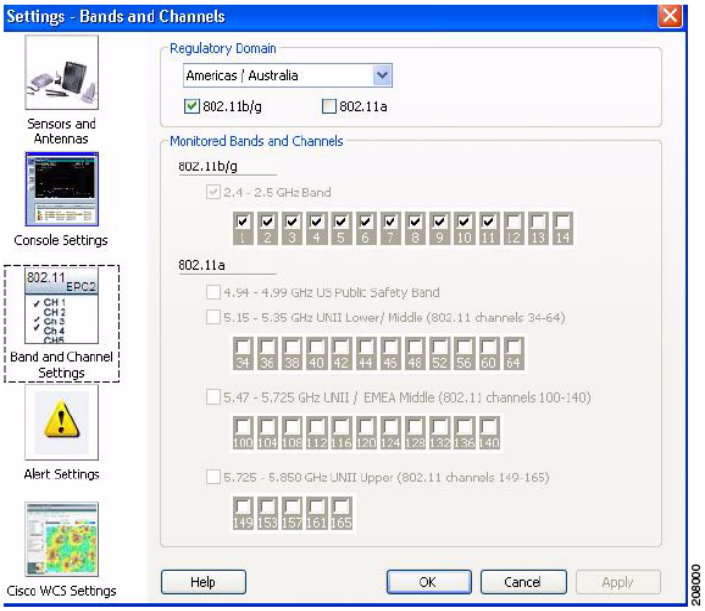
Step 2 From the tool bar on the left side of the dialog box, select **Band and Channel Settings.**

Step 3 From the **Regulatory Domain** pane drop-down pick list, select the regulatory domain to monitor. You have the following options**:**



- For **Wi-Fi**, the options include: **Americas/Australia**, **EMEA/Asia/Pacific**, **Japan**, **All Wi-Fi Channels**. For Wi-Fi, it is further possible to select the Wi-Fi standard to be covered (802.11 a, 802.11 b/g, or both) using the checkboxes. The single regulatory domain pick will apply to both Wi-Fi standards.

Note The controls in the **Monitored Bands and Channels** control pane also display the bands and channels that will be monitored when a Regulatory Domain is picked.

Step 4 Select **OK** to confirm your changes and close the dialog box. You can also select **[Apply]** to apply your changes while leaving the dialog box open for further work**.**

Note Regulatory Domains are subject to change without notice.

User Defined Option

To use the **User Defined** option to select the bands and channels, follow these steps:

Step 1 Select **Tools > Settings…**

Step 2 From the tool bar on the left side of the dialog box, select **Band and Channel Settings.**

Step 3 From the **Regulatory Domain** pane drop-down pick list, select the User Defined option.

Step 4 When you selected **User Defined**, the individual band and channel monitoring check boxes are enabled and you can select the bands and corresponding channels to monitor.

Step 5 Select one or more of the available bands from the **Monitored Bands and Channels** control pane.

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Step 6 Select one or more of the available channels check boxes for each band selected.

Step 7 Select **[OK]** to confirm your changes and close the dialog box. You can also select **[Apply]** to apply your changes while leaving the dialog box open for further work**.**

Monitoring

The Sensor card is capable of monitoring up to 1 GHz of RF bandwidth at a time. In practice, however, monitoring this much of the spectrum can result in some performance issues for Cisco Spectrum Expert Software. Moreover, for most practical softwares, it is rarely necessary to monitor that much of the spectrum at one time.

The **Band and Channel** settings enable you to determine how much bandwidth is actually monitored by the Sensor card. Monitoring only the bandwidth you need to monitor—rather than trying to have the Sensor card scan its full potential range—will result in more effective system performance.

- If you change the settings for monitored bands and channels, the Cisco Spectrum Expert Software automatically restarts, clearing all internal buffers. The display does not close down, but you lose any data currently shown on the spectrum plots, **Channel Summary**, **Devices View**, and so on.
- The bands and channels you define here determine which bands and channels are available for selection on the spectrum plots. See "Band and Channel Settings" for more information.
- If you select two bands which are adjacent or which overlap (for example, 5.47 to 5.725 GHz, and 5.725 to 5.850 GHz), Cisco Spectrum Expert Software will automatically consolidate the two bands into one band.

You can select one or more of the bands, such as the 2.4 to 2.5 GHz band, the 5.15 to 5.35 GHz band (for Wi-Fi). Selecting all or most of the bands shown may result in reduced performance or data quality, so we suggest that you select only those bands that are essential for your current monitoring and testing needs.

Alert Settings

The **Settings - Alert** screen is used to configure security and performance alerts. This screen consists of three tabs:

- **Active Devices—**This tab is used to enable or disable a security alert for an interferer type or category. Security alerts can be enabled/disabled for one, multiple, or all interferer categories.
- **Spectrum—**This tab is use to enable or disable alerts.
- **Channel Summary—**This tab is used to enable or disable alerts for channels devices being displayed on the Channel Summary view.

To enable performance alerts, follow these steps:

Step 1 Select **Tools > Settings…**

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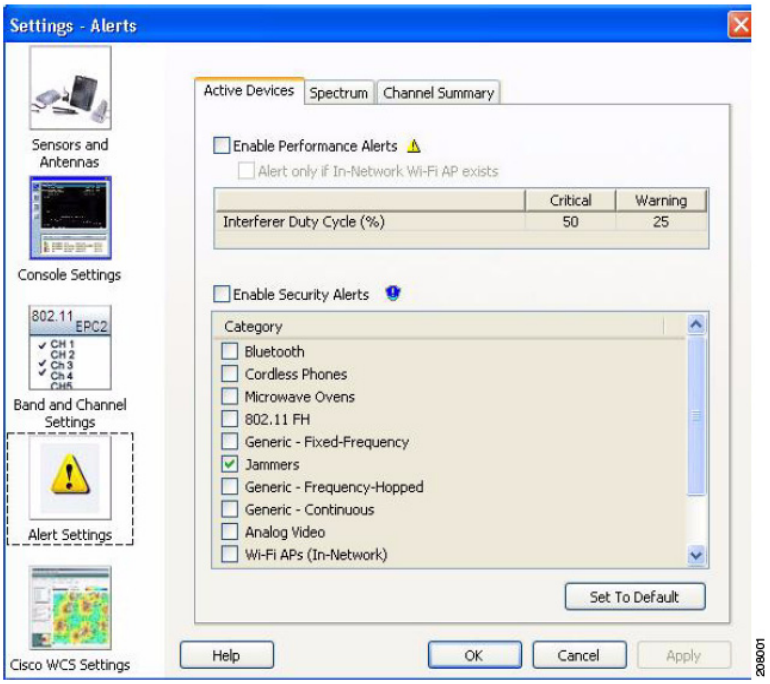
Step 2 From the tool bar on the left side of the dialog box, select **Alert Settings**.



To enable alerts for active devices, follow these steps:

Step 1 Select the **Active Devices** tab.

Step 2 Check **Enable Performance Alerts**.

Step 3 Check **Alert only if In-Network Wi-Fi access points exists**.

Step 4 Check **Enable Security Alerts**.

Step 5 In the **Category** pane, check one or multiple device categories for performance monitoring and alerts.

Note The default settings are **Jammers** and **Wi-Fi Ad Hocs** boxes checked.

Step 6 Select **Apply** or **OK**.

When the **Enable Performance Alerts** and the **Alert only if In-Network Wi-Fi access point exists** fields are checked (selected) on the **Active Devices** tab, and at least one In-Network Wi-Fi access point is present on the same channel as the interferer, all active interferers display with or with out a security alert icon in the **Active Device** pane on the **Main** window.

- If the interferer duty cycle is greater than 50% (default critical threshold value), the device displays in **Red**.

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If the total duty cycle is greater than 25% (default warning threshold value), but less than 50, the device displays in **Yellow**.

To enable Security Alerts for Spectrum, follow these steps:

Step 1 Select the **Spectrum** tab.

Step 2 Check the Enable Spectrum Alerts check box. The default settings are shown in the figure.

Step 3 Select **Apply** or **OK**.

To enable alerts for Channel Summary, follow these steps:

Step 1 Select the **Channel Summary** tab.

Step 2 Check the **Enable Channel Summary Alerts** check box. The default settings are shown in the figure.

Step 3 Check the **Alert only if In-Network Wi-Fi access point exists** check box if you want this condition to be met before having Spectrum generate a Channel Summary alert.

Step 4 Select **Apply** or **OK**.

SNMP Option Settings

The **SNMP Option** icon appears in the Cisco Spectrum Expert Software standard version. Use section SNMP Option Settings to configure the SNMP settings. If you are using the Cisco enabled Cisco Spectrum Expert Software version, then refer to section 12.6 WCS Settings**.**

The **Settings - SNMP** screen is used to enable and configure the trap filters and threshold levels that will trigger the sending of an SNMP trap for detected interferers to the designated IP Address. The screen consists of the following two tabs:

- Basic Settings
- Filters

Basic Settings Tab

The **Basic Settings** tab has two primary functions; a) to enable SNMP Traps and b) identify the designated devices using filters.

Send Spectrum Data to a Remote Computer

The **Send Spectrum Data to a Remote Computer** area contains a checkbox titled **Enable SNMP Traps for Interfering Devices** to enable the SNMP trap function and the IP Address and Computer Name fields.

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IP Address or Computer Name of the Remote Computer

The **IP Address or Computer Name of the Remote Computer** area provides IP Address and Computer name fields to identify the target system for SNMP traps.

Filters Tab

The **Filters** tab provides criteria an interferer must meet to trigger sending a trap. The four selectable criteria are:

- Active Channel Filter - is there an active In-Network Wi-Fi access point on at least one of the affected channels? The default state is DISABLED.
- Interference Channel Utilization Filter - does an affected channel have an interferer utilizing more than the user set channel utilization percentage? The default state is ENABLED and default threshold value is 10%.
- Interference Power Filter - does an affected channel have cumulative power of all interference devices at a power level within or exceeding a user set level in dBm? The default state is ENABLED. The default value for the within range is 16 dB and the exceeding default value is -70 dBm.
- Interferer Type - are there specific interferer device types that you want to trigger SNMP traps? **The type of Interferer is selected on the following list:** check box, when checked, enables the scrollable list of devices check boxes for inclusion in the trap. The default setting is DISABLED.

Modifying Trap Filters Default Settings

All threshold values are editable, meaning they can be changed to reflect differing criteria.

To modify the SNMP Traps and trap filters settings, follow these steps:

Step 1 Left-click in the box adjacent to the trap criteria to apply.

Step 2 Edit the existing value or enter a new value.

Step 3 Left-click the box adjacent to the next trap criteria to apply.

Step 4 Select **<Apply>**.

Step 5 Select **<OK>**.

Trap Filter Information Content

The trap will include the following information:

- Device Uptime
- MAC Address and Power level of top five access points
- Unique Instance ID of device
- Type of Device (Numeric code)
- Filter Parameters (when filter is enabled)
- Channel Number, Interference Utilization
- Access point MAC Address, Access point Power, Interference Power
- Device Parameters (when appropriate – not all devices will have all parameters):

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- Center Frequency
- Bandwidth
- Power in dBm
- Duty Cycle
- Channels affected
- Network address
- Pulses per second
- Pulse duration
- Modulation Type: Tone, video, AM, FM, QAM, OFDM, Chirp (Numeric code)
- PLL offset
- Frequency Deviation
- Symbol rate
- Bits per symbol
- Guard interval
- Peak to average power
- Period
- Phase
- Transmit type

Set SNMP Traps

To enable SNMP traps, follow these steps:

Step 1 Select **Tools > Settings…**

Step 2 From the tool bar on the left side of the dialog box, select **SNMP Option**.

Step 3 On the **Basic Settings** tab, select the **Enable SNMP Traps for Interfering Devices**: checkbox to enable sending SNMP traps.

Step 4 In the **IP Address or Computer Name of the Remote Computer** area, enter either the IP Address or Computer Name in the appropriate field to identify the target system that will receive the SNMP trap data.

Step 5 Select **Apply.**

Step 6 Select the **Filters** tab.

Step 7 In the **Filters** tab, select the trap filter parameters that will trigger sending an SNMP trap for a detected interferer.

Step 8 Check the **The type of Interferer is selected on the following list:** check box, as required, to select specific device types from the scrollable list of device type check boxes.

Step 9 Select **Apply** or **OK.**

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Cisco WCS Settings

Note The **Cisco WCS Settings** icon appears in the Cisco WCS-enabled Cisco Spectrum Expert Software version. Use Configure WCS Settings to configure the WCS enabled settings. If you are using the Spectrum Expert standard version with SNMP Option, refer to "SNMP Option Settings."

The **Settings – WCS Settings** screen is used to enable and configure the filters and threshold levels that will trigger the sending of Cisco Spectrum Expert Software data to the designated WCS IP Address. The screen consists of the following four tabs:

- Basic Settings
- Filters Tab
- Security
- Advanced

Basic Settings

The **Basic Settings** tab has two primary functions. One function is to enable SNMP Traps or Cisco WCS functions and also to identify the designated IP Address of the remote computer where Cisco Spectrum Expert Software data will be sent. The functions are supported by these two areas on the **Basic Settings** tab:

- Send Spectrum Data to a Remote Computer - the **Send Spectrum Data to a Remote Computer** area contains two check boxes:
  - A checkbox labeled **Enable SNMP Traps for Interfering Devices**, to enable the SNMP trap function and,
  - A checkbox labeled **Enable Cisco WCS Transmission of Spectrum Data**, to enable the Cisco WCS function and the IP Address and Computer Name fields.
- IP Address or Computer Name of the Remote Computer - the **IP Address or Computer Name of the Remote Computer** area provides IP Address and Computer name fields to identify the target system for either the SNMP traps or Cisco WCS transmission of Cisco Spectrum Expert Software data.

Filters Tab

The **Filters** tab provides four selectable channel affecting acceptance criteria an interferer must meet to trigger sending a trap. The four selectable criteria are:

- **Active Channel Filter** - is there an active In-Network Wi-Fi Access point on at least one of the affected channels? The default state is DISABLED.
- **Interference Channel Utilization Filter** - does an affected channel have an interferer utilizing more than the user set channel utilization percentage? The default state is ENABLED and default threshold value is 10%.
- **Interference Power Filter** - does an affected channel have cumulative power of all interference devices at a power level within or exceeding a user set level in dBm? The default state is ENABLED. The default value for the within range is 16 dB and the exceeding default value is -70 dBm.

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- **Interferer Type** - are there specific interferer device types that you want to include in the data sent to WCS? **The type of Interferer is selected on the following list:** check box, when checked, enables the scrollable list of devices check boxes for inclusion in the data sent to WCS. The default setting is DISABLED.

Modifying Filters Default Settings

All threshold values are editable, meaning they can be changed to reflect differing criteria.

To modify the filters settings, follow these steps:

Step 1 Left-click in the box adjacent to the filter criteria to apply.

Step 2 Edit the existing value or enter a new value.

Step 3 Left-click the box adjacent to the next filter criteria to apply.

Step 4 Select **Apply**.

Step 5 Select **OK**.

Security

The **Security** tab provides the ability to enable security measures, using certificates, for communications between Cisco Spectrum Expert Software and a Cisco WCS. Several selectable security level configurations are available to provide lower or higher security levels for the remote and local computers engaged in a Cisco WCS connection.

There are two selectable certificate options available for a remote computer (server), and two selectable certificate options available for a local computer. The user can define the combination of certificate criteria required in order to authorize a WCS connection. The selectable certificate-based security options are:

- Remote computer authorization for Cisco WCS Connections - having the following options:
  - Allow self-signed certificate for remote server (lower security level)
  - Require CA-signed certificate from remote server (higher security level)
- Identifying this computer for Cisco WCS Connections - having the following options:
  - Present self-signed certificate for this computer (lower security level)
  - Present the following CA-signed certificate for this computer (higher security level)

There are two fields available for identifying the specific CA-certificate to be used if the CA-signed option is selected for either the remote or local computer.

The Action if certificate information is not valid drop-down menu provides selectable actions to be taken upon receipt of invalid certificate information.

Advanced Tab

The **Advanced** tab provides an additional user definable setting for SNMP and four user definable WCS communication polling settings in two areas on the tab. SNMP and Cisco WCS Communication protocols function independently and can operate simultaneously. The settings are:

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- Advanced Settings for SNMP - displays the **SNMP Trap Destination Port** number. The state is grayed-out (SNMP port can't be changed).
- Advanced Settings for Cisco WCS Communication - provides four user definable settings for Cisco WCS Communication parameters. The default state is ENABLED and is disabled by deselecting the **Enable Cisco WCS Transmission of Spectrum Data** checkbox on the Basic Settings tab. The user definable parameters are:
  - Transmit Devices information every ___ seconds. The default value is 10 seconds.
  - Limit the number of Device Update records to a maximum of ___ per transmission. The default value is 15 per transmission.
  - Consider a Cisco WCS to be temporarily unavailable after ___ unsuccessful attempts. The default value is 10 unsuccessful connection attempts.
  - Attempt reconnection to an unavailable server every ___ minutes. The default value is 10 minutes.

Configure WCS Settings

To configure WCS Settings, follow these steps:

Step 1 Select **Tools > Settings**

Step 2 From the tool bar on the left side of the dialog box, select **WCS Settings**.

Step 3 On the **Basic Settings** tab, select the **Enable Cisco WCS Transmission of Spectrum Data**: checkbox to enable sending Cisco Spectrum Expert Software data to the WCS

OR

On the **Basic Settings** tab, select the **Enable SNMP Traps for Interfering Devices**: checkbox to enable sending SNMP traps.

Step 4 In the **IP Address or Computer Name of the Remote Computer** area, enter either the IP Address or Computer Name in the appropriate field to identify the target system that will receive the Cisco Spectrum Expert Software data.

Step 5 Select **Apply**.

Step 6 Select the **Filters** tab.

Step 7 In the **Filters** tab, select the trap filter parameters that will define a detected interferer.

Step 8 Check **The type of Interferer is selected on the following list:** check box, as required, to select specific devices from the scrollable list of device check boxes.

Step 9 Select **Apply**.

Step 10 Select the **Security** tab.

Step 11 Select the desired certificate security option for the remote computer and add the CA-signed certificate as required.

Step 12 Select the desired certificate security option for the local computer and add the CA-signed certificate as required.

Step 13 Select the action to be taken if certificate information is not valid or leave the default action (**Warn**) active.

Step 14 Select **Apply** to continue to the **Advanced** tab or **OK** to complete the procedure.

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CHAPTER 14

Cisco Spectrum Expert and Network Operations

Cisco Spectrum Expert and Real World Applications

The preceding sections of this guide have been devoted to an overview of Cisco Spectrum Expert, and then a detailed discussion of how to use specific features and operational modes. This section explains how to put Cisco Spectrum Expert Software to work in the real world of network planning, maintenance, and troubleshooting.

A key, general principle to keep in mind is that the RF environment, by its very nature, is highly dynamic and unpredictable. The environment varies over time as both RF sources and RF reflectors move about or change in their activity and keep in mind that an “RF reflector” can be virtually anything at all, obviously including metallic objects, but also other types of objects, and even people. Further, some RF sources, such as directional antennas, have a strong RF impact in limited spaces or directions. This chapter describes how the variability of the RF environment must be taken into account when putting Cisco Spectrum Expert Software to work.

Site Survey

A site survey is a series of RF measurements conducted not only prior to network deployment, but possibly even prior to deciding what type of network equipment to purchase. The site survey is intended to provide a general picture of the RF environment, and particularly those aspects of the RF environment which may influence purchase decisions. The information gained in a site survey will also contribute to network planning (covered in the next section).

The primary goal of the site survey is to determine which channels/bands are acceptable for network deployment. The survey can also suggest the number of network devices that may need to be purchased and deployed. This is particularly crucial for those networks, such as Wi-Fi networks, where you have a choice of the type of network equipment to purchase (802.11a, b, or g).

Physical Movement of the Laptop

The site survey entails physically moving your Cisco Spectrum Expert Software laptop throughout the network space, monitoring changes in the readings as you go. You can carry the laptop, but typically you place the laptop computer on a cart and wheel the cart about. In offices you will want to at least walk around the perimeter of each office, and perhaps up and down and side-to-side through the center of each office. In a hallway or corridor, it may be sufficient to roll the laptop down the center of the hallway. In a large, open space you may want to walk up and down in lanes, much as if you were “mowing” the carpeting or floor tiles with the laptop.

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We can't tell you the exact physical "granularity" of the survey – that is, we can't say if you should walk up and down your office in lanes spaced five feet apart or fifteen feet apart. Partly it depends on the size of the site you are covering – you are likely to have the time to follow a finer, more closely spaced path in a 5,000 square foot office than in a 100,000 square foot warehouse. We can say that the more fine-grained your site survey, the more accurate the information you will obtain. Certainly, just taking measurements in four corners of a large space, and at the center of that same space, is generally *not* sufficient.

Note Site surveys can be done not only for indoor areas, but also for outdoor deployments of network equipment. For example, it is now common to set up network backhaul links on the rooftops of buildings. A site survey done on the rooftop can detect all kinds of interference activity from neighboring transmitters. Again, the more rooftop space that is covered in the survey, the clearer and more accurate will be the picture of RF activity.

Cisco Spectrum Expert Software Survey Data

Typically, during the survey you will want to look at the Cisco Spectrum Expert Software **Channel Summary**, the **Devices View**, and two or three of the spectrum plots: the **Real Time FFT** plot, the **FFT Duty Cycle** plot, and very likely the **Swept Spectrogram** plot.

- The **Channel Summary** tells you which channels are showing the most RF activity, and gives a rough indication of how much of that activity is due to interferers, and how much is due to other network devices.
  - If the activity is due to interferers—and if those devices are in your space and under your control—you may be able to either remove or shield some of the interfering devices.
  - We are assuming that you have not deployed your own network yet. So, if you are picking up activity from other network devices, these are likely to be devices in neighboring networks. If you do not own these networks (for example, they belong to a company in an adjoining office), you may not be able to do anything to prevent this interference. In this case, you may need to plan your own network to use other channels or bands which are not in use by that network.
- The **Devices View** shows you specifically which devices are causing RF activity. The information includes the channels on which these devices are operating. Based on this specific information, you can start to determine whether you can mitigate or remove these devices; or whether, instead, you'll need to plan your network operations to work around this device activity. (For example, if the devices cannot be removed or shielded—or just plain turned off—you may need to operate your network on channels not affected by those devices.)
- The plots—**Real Time FFT**, **FFT Duty Cycle**, and **Swept Spectrogram**—can be used to obtain a more fine-grained view of spectrum activity. Note that the **Swept Spectrogram** can be used to view either the RF power or RF duty cycle. The combined time and frequency view offered by the **Swept Spectrogram** is also especially useful for viewing a variation or stability in spectrum activity over the time interval of a few minutes.
  - These plots can be particularly useful for evaluating channels that are borderline in the **Channel Summary**, or in terms of the number of devices seen on a channel in the **Devices View**.

    Both the **Channel Summary** and **Devices View** present a summary of RF activity seen over some extended period of time. It may be, however, that on some particular channel(s), the RF activity is in fact bursty in nature, i.e., it is characterized by sporadic pulses of RF activity. Because network activity itself is also bursty, such a channel may in fact be acceptable for network purposes – RF activity from non-network devices will only occasionally occur at the same time as network RF activity.

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In other words, looking at the spectrum plots can help you determine if the interference is constant or intermittent; and if the interference on a give channel is, in fact, tolerable from a network standpoint.

The spectrum plots are also useful for detecting interference which is created by devices that are completely unclassified by Cisco Spectrum Expert Software. While these devices will not show up in the **Devices View**, and will not impact the measurements in the **Channel Summary**, you will see their RF activity on the spectrum plots.

There are at least two conclusions you can generally draw from the data obtained in the above manner:

- You can determine which are your cleanest RF channels. This may determine which types of network equipment you buy, or at least which bands or channels you set your network equipment to use. For example, for Wi-Fi, if you find that the entire 5 GHz band is being swamped by nearby RF activity, you can plan your network purchases and configuration to operate in the 2.4 GHz band.
- You may find that even your best channels or bands are only relatively clean; there may still be substantial, unpreventable RF activity. This will generally indicate that you will need to purchase more network devices to obtain adequate network performance and coverage.

Of course, “more network devices” is a relative term. More than what? You would need to make some kind of baseline decision for your particular network technology—for example, how many access points would it take to provide adequate coverage for your Wi-Fi network, in a clean RF environment?—based on the particular specifications of the network equipment. Then, if the available channels are fairly congested with RF activity, you may need to scale that number by, say, 50% or 100%, to ensure reliable and speedy network performance.

Rather than purchasing more network devices, another option—if significant RF interference will be an ongoing issue—is to instead purchase more powerful network backbone devices, which can overcome the local interference with a stronger signal.

Note, however, that boosting, say, the power of your Wi-Fi access points, does not boost the power of the Wi-Fi stations which may be in use. (Your network environment may be a public one, where you do not control the design or broadcast power of all the stations that may be in use.) In this case, a higher density of backbone devices (For example, access points for Wi-Fi) may be the only effective solution.

Additional Notes on the Site Survey and the Spectrum Plots

Monitoring Multiple Bands on Spectrum Plots

A spectrum plot can only monitor one band at a time (such as 2.4 GHz or 5.15 to 5.35 GHz for Wi-Fi). However, on a single spectrum tab, you can open more than one instance of the same type of plot (such as the **Real Time FFT**). By setting each instance to monitor a different band, you can monitor at the same time all, or almost all, of the bands of interest.

Real Time Plots Versus Software-Based Plots

We do not recommend the **Power vs. Frequency** or **Power vs. Time** plots for site survey purposes. These two plots require extensive software analysis on your Cisco Spectrum Expert Software laptop, and are intended mainly for analyzing specific RF issues (typically, RF problems related to some unknown device).

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The plots indicated above—**Real Time FFT**, **FFT Duty Cycle**, and **Swept Spectrogram**—offer data directly from the Sensor card, and are designed to give a better, more accurate picture of overall RF activity in a particular band. It's that band-inclusive view which is most applicable for site survey purposes.

Conducting the Site Survey

Cisco Spectrum Expert needs to be wheeled about the anticipated network environment, and you will benefit from using multiple Cisco Spectrum Expert modes—**Devices View**, **Channel Summary**, and several spectrum plots—to conduct an effective site survey. So you need to wheel the laptop about, while switching between viewing modes, in order to get the job done.

A physical map of your site, where you can record notes of key readings, may prove helpful as well. There is no one mandatory method of doing the site survey, but what follows is one possible approach.

Step 1 Pick a location, typically one corner of the anticipated network space, in which to start the survey. Look at both the **Devices View** and the **Channel Summary**, to see which channels are causing the most activity, and what devices are responsible for that activity. Make note of this information on your map of the network space.

Step 2 Switch to the spectrum view mode, and set up the plots you wish to view. Since there are two spectrum tabs, you may want to use each tab for a different kind of plot. For example, on one tab you may set up multiple instances of the **Real Time FFT**, with each instance set for a different band. On the other tab, you might establish multiple instances of the **Swept Spectrogram** (again, picking a different band for each instance), with the **Trace Type** set to **Duty Cycle**.

Step 3 Wheel the Cisco Spectrum Expert laptop through the anticipated network environment. As you move, keep your eye on the spectrum plots—**Real Time FFT** or **Duty Cycle**, as you prefer—perhaps pausing occasionally to switch from one spectrum tab to the other.

Step 4 View all the bands you've set to display on the plots. However, you probably want to keep an eye on those bands which encompassed both the most active and least active channels seen on the **Devices View** and the **Channel Summary**. The goal is to see if this activity remains fairly consistent throughout the network space, or varies significantly.

Step 5 Any time you see a significant change in the spectrum plots—either a spike in RF activity at some frequency, or a notable drop-off—you can switch back to **Channel Summary** or **Devices View**. The **Channel Summary** will likely confirm what you've seen on the plots, namely, that there is a notable increase or decrease in RF activity on particular channels. The **Devices View**, of course, will help you identify the particular cause(s) of that activity.

Step 6 Next, switch back to the spectrum plots, and continue your walk through the network space.

Step 7 Again, at appropriate points, you will want to stop and make notes on your map of the network space.

There are several possible variations on this procedure.

- In terms of how you set up your display during the survey, another option is to put two **Real Time FFT** plots and two **Duty Cycle** plots on the same tab, covering two bands. Put two more **Real Time FFT** plots, and two more **Duty Cycle** plots, on the other tab, measuring two other bands. (You always have the option of using the **Swept Spectrogram**, and setting it to display either duty cycle or RF power.)

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- You could make an entire sweep through the network environment looking only at the **Channel Summary**; then another sweep, along the same path, with the spectrum plots on display. After determining those locations with the most RF activity, you may return to those specific locations and use the **Devices View** to ascertain the particular RF sources involved.
- If you note a particularly high level of RF activity at some point, but the source is not obvious, the **Device Finder** may help you track down the source. See Device Finder Mode for more information.

Save the RF Map

We recommend that you save the RF map you create in the course of the site survey. It will come in handy later, both for initial network device deployment, and for charting any changes in your RF environment over time.

Drawing Conclusions

At the conclusion of this process—and with your marked up network map in hand—you should have a very clear picture of which frequencies are relatively clear, and which frequencies are relatively crowded with RF activity, throughout your network space. Ideally, it will be immediately clear which channels or bands you wish to use for your network deployment.

You may find that certain bands would be best to use at some locations in your network environment, while other bands would be better to use elsewhere. In the worst case, these bands may be hardware incompatible (For example, you'd want to use 802.11b/g in part of your network, and 802.11a in another part). In this case, part of your network planning may entail removing or shielding some current sources of RF activity, to free up a particular band in a particular location.

As indicated above, the general level of network activity will also help you determine the number of network backbone devices that you need.

Antenna Options

The Wi-Fi version of Cisco Spectrum Expert has an optional directional antenna. Normally though, during the initial phase of a site survey, you will want to use the standard omni antenna, so that at each location you can pick up RF activity from all possible sources in the vicinity.

In some cases, you may find RF activity that is highly localized, without the source being apparent. (This can happen, for example, if there is a directional broadcast antenna at some distance. You will only pick up a signal when you happen to cross the path of the antenna beam.) At these locations, the directional antenna can be used to help determine the exact direction of the source of RF activity. See "Using the Directional Antenna" for more information.

Network Layout

Once you have purchased your network backbone equipment—such as access points for Wi-Fi—Cisco Spectrum Expert can support a dynamic, real-time network layout process that results in near-optimum placement of access points, and so on. Here again you will rely upon the **Devices View**, the **Channel Summary**, and the spectrum plots (**Real Time FFT**, **Duty Cycle**, and/or **Swept Spectrogram**).

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Placing the First Access Point

To start the process of deploying devices, follow these steps:

Step 1 Select a location for placement of your initial access point. Select a location that is sufficiently close to an Ethernet connection for your wired LAN.

In addition, you'll want to select a location which you had determined, in the course of your site survey, to have low RF interference. (We recommend that you save the RF map that you created during your RF site survey.)

Step 2 At the selected location, you'll use Cisco Spectrum Expert to double check that RF activity remains at acceptably low levels in the channel you intend to use. (Depending on your overall environment, the RF activity may or may not vary substantially over a relatively short time frame. For example, a neighboring office may have rearranged or reconfigured their WLAN in ways that will affect your network deployment.)

As with the site survey, you can use the **Channel Summary** and spectrum plots to check the overall level of RF activity at the selected location. The **Devices View** can tell you about any specific devices that are now causing interference, and which can possibly be removed or shielded. If there is new, and uncontrollable, RF interference which had not been detected during the site survey, you may need to select another location for initial access point deployment.

Step 3 You have selected a location for the initial access point, set it in place, and probably wired it into the WLAN. Before powering up the access point, you should set one of the **Real Time FFT** plots to monitor the channel which will be used by the access point. When you turn on the access point, you should see an immediate and dramatic gain in RF power in that channel. This tells you that the access point is broadcasting RF on the appropriate channel.

Step 4 You will now turn to the **Devices View**. Cisco Spectrum Expert should quickly detect and classify the access point, so that it is shown in **Devices View**. Of the most interest is the **Signal Strength** field. Normally, the signal strength near to the access point should be well above -70 dBm.

Note The expected, near-to-the-device signal strength will vary depending on the type of network you are deploying. Similarly, the too-low-for-reliable-operations power level (discussed below) will also vary depending on the network technology you are implementing. The values described here, in the range of -70 to -80 dBm, are appropriate for Wi-Fi network access points.

Placing the Second Access Point

To place the second access point, follow these steps:

Step 1 With Cisco Spectrum Expert once again in hand or on a rolling cart, you now want to move in some direction away from the access point you have just placed. The direction you choose will depend on your general plan of network deployment, as well as on the RF map created during the site survey.

For simplicity of description here, we'll assume you are laying out your network in some relatively, wide open space, such as a warehouse or airport terminal. Naturally, if you are in a more constrained space, such as an office, your movements will probably entail leaving one room and entering the adjacent room, or possibly walking down a hallway outside the room.

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Step 2 In general, your goal for placing the next access point is find a location which is again structurally convenient—for example, you may want to remain close to a wall, so the access point is relatively out of the way of other activity and movement—and close to another Ethernet connection.

Step 3 As you move Cisco Spectrum Expert in the general desired direction, check the device **Signal Strength** on the **Devices View**. When the **Signal Strength** falls to around -70 to -80 dBm, it is an indication that the first access point can no longer reliably communicate with network devices at your current location.

Choosing the higher threshold value, -70 dBm, will provide greater network reliability, at the price of placing access points closer together. That will mean purchasing more access points. The lower threshold, -80 dBm, may result in somewhat less network reliability and/or data rates, but also involves deploying fewer access points.

Step 4 At this point, where the access point signal strength has dropped to -70 dBm or -80 dBm, you will probably want to deploy the next access point. You should set the new access point to a channel substantially apart from the channel used for the first access point. (For example, you might vary your access points between channels 2, 5, and 8, or 1, 6, and 11.). However, before "committing" your access point to this new location, you should use Cisco Spectrum Expert to double-check a few things:

- Using the **Channel Summary**, make sure that the channel you have in mind is reasonably free of local interference.
- Check the spectrum plots to ensure that the location is fairly free from excessive RF activity of all kinds.
- If you encounter undesirable RF activity at the location of interest, take steps to mitigate the interference, deploy a more powerful access point, or choose another location.

Step 5 Set the second access point in place at the new location, and wire it into the WLAN. Set one of the **Real Time FFT** plots to monitor the channel which will be used by the access point. When you turn on the access point, you should see an immediate and dramatic gain in RF power in that channel. This tells you that the access point is broadcasting RF on the appropriate channel.

Step 6 Check the **Devices View**. Cisco Spectrum Expert should quickly detect and classify the access point, so that it is shown in **Devices View**.

Placing Successive Access Points

With Cisco Spectrum Expert once again in hand or on a rolling cart, you now want to move in some direction away from the access point you have just placed. The direction you choose will depend on your general plan of network deployment, as well as on the RF map created during the site survey. Check the Devices View. Cisco Spectrum Expert should quickly detect and classify the access point, so that it is shown in Devices View. You may need to go back to the first access point, and find a new direction—at right angles to your first path, or directly opposite—to place the third access point. Depending where each access point is placed in your overall network environment, you may need to place anywhere from one to four access points that are adjacent at some distance.

In each case, however, as you travel away from an access point, an indication that the access point no longer provides adequate signal coverage is when the access point's signal falls to around -70 to -80 dBm.

Also, be sure that adjacent access points are not broadcasting on the same channel.

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After-Deployment Site Survey

After deploying all your access points, you will want to conduct another site survey. This time, you do not need to cover all the ground, as with the initial survey. However, you want to focus on areas which, just by looking at your access point layout, you can see are relatively far from any one access point.

In those areas, you will want to move Cisco Spectrum Expert around a bit, and use Cisco Spectrum Expert's **Devices View** to ensure that at least one access point is clearly detectable, preferably, giving a **Signal Strength** greater than -70 dBm. This ensures that any device in the area will be able to communicate with at least one access point.

In addition, you may want to activate some of the known interferer devices that operate within or near the perimeter of your network—cordless phones, microwave ovens, and so on. You can use both the spectrum plots and the **Channel Summary** to see if any of these devices are swamping the RF environment with so much energy that they are likely to impede RF communications. If that is the case, you can deploy additional access points, or more powerful access points, to compensate for the interference.

Long-Term Trend Analysis

Your network's RF environment can change over time, requiring adaptive changes in your network deployment. Quite typically, these changes will be for the worse—more RF activity, and more interference—as your organization grows, and the number of wireless devices (both network related, and interferers), increases as well. You may need to deploy more network backbone devices (access points, Wi-Fi Readers, and so on.), or more powerful devices, to compensate for the change.

Ideally, you would like to know about emerging RF trends before they impact your network. Cisco Spectrum Expert can be used for systematic monitoring and recording of the RF environment, enabling you to observe emerging trends. The key tools here are the **Devices View**, the **Channel Summary**, the spectrum charts, the screen capture feature, and the record/playback feature.

Trend Analysis Procedure

The general strategy is to pick a number of key locations in your network environment, and record spectrum data at those locations at regular intervals. How frequent those intervals should be depends on your own assessment of the pace of change in your network environment. At a small but rapidly growing startup company, you may want to make measurements as often as every two weeks. At a much larger, established organization, with a more gradual growth curve in staff and activity, once every two months might be sufficient.

You can record data both in the form of CSC files, which capture real-time data for later playback (see "Spectrum Recording and Playback" for more information). For screen shots, you can maintain a notebook where you store printouts of the capture screen shots. The screen images should be annotated by both the date and location. Flipping through the pages in the date order (or laying them out on a table for side-by-side comparison) will make it easy to see significant trends in network and RF activity. Similarly, you can view successive CSC files, one after another; to discern any important increases in RF activity.

Type of Data to Record

We recommend the following types of data as being most useful for long-term trend analysis.

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- **Devices View**—The particular RF devices in use at any given moment can vary widely during the course of a day. However, you can set the **Devices View** to display all devices that have been used during an extended period of time during the day, such as the last four hours or the last twelve hours. This will create a broad picture of all the RF devices in use during a typical day, or large part of a day. If you capture this data at regular intervals (every few weeks or every few months), you can see if there is substantial growth in device usage.

  You can also see if a particular type of device is being used more and more, and can make a decision as to whether the type of device in question is likely to impact network operations.

- **Channel Summary—**This view of the RF spectrum indicates the amount of activity on each channel. Taking "snapshots" of this information at regular intervals will help you determine if any particular channels are become crowded with excess activity. This may result in you choosing to change the channel assignments for your network backbone devices.

Note The **Channel Summary** is a snapshot view of "right now." Like the use of devices, channel usage can vary significantly over the course of a day. Therefore, on the days when you elect to record data for long-term trend analysis, you may want to capture channel usage at several times during the day. This will make it easier to determine which channels have consistently high activity or low activity.

- **Time-Oriented Charts**—The time-oriented spectrum charts—**Devices vs. Time** and **Channel Utilization vs. Time**—are the ideal tool to ascertain overall RF activity over the course of a single day. By setting the time interval to 8 hours or 24 hours, you can obtain a global view of RF activity over the course of a day (8 hours, of course, is appropriate for most office environments; while the 24 hour view is appropriate for environments—some factories and warehouses, airports, and so on.—which are the hub of day and night activity).

  Since a single **Devices vs. Time** chart can display, at most, four different types of devices, you may want to put two charts on display at the same time, to capture up to eight different device types. Similarly, the **Channel Utilization vs. Time** chart can only display data for one band; putting multiple instances of the chart on display enables you to record data for multiple bands.

  As discussed above, the goal is to take screen captures of these charts at regular intervals in time (for example, every two weeks), noting both the location and date. After some extended time has passed (typically several months), placing the charts from different dates side-by-side, in ascending date order, will clearly indicate significant increases in the number of devices in use, or the RF duty cycle, or both.

- **Channel-Oriented Charts**—The **Devices vs. Channel** and **Channel Utilization** charts provide more specific information about RF usage. While they only cover a fixed, short interval of time—they update approximately every twenty seconds—they provide a clearer indication of specifically which channels are being impacted by RF activity. As with the **Channel Summary** display, discussed above, we recommend that on your "trend analysis days", you take snapshots of the channel-oriented charts at several times over the course of the day. This will help provide a combined time and channel-oriented view of RF activity.

Routine Network Monitoring and Troubleshooting

Once your network is up and running, Cisco Spectrum Expert enables you to monitor the RF environment on a daily basis, often detecting potential problems before they become apparent to users. In addition, when users flag problems, such as network slowdowns or lost connectivity, Cisco Spectrum Expert enables you to quickly pinpoint the source of the problem.

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Routine Monitoring

For routine monitoring, we suggest that you set one of the two spectrum tabs to display the following plots and charts: **Real Time FFT**, **FFT Duty Cycle**, **Swept Spectrogram**, and all of the spectrum charts (**Active Devices**, **Channel Utilization, Channel Utilization vs. Time**, **Devices vs. Channel/Time**).

Notice that more than one **Devices vs. Time** plot is in use (lower right of the picture). This is because each such plot can track a maximum of four device types. To track more than four devices, you need to put at least two such plots into use. Similarly, you have the option of using more than one **Real Time FFT** plot, or **FFT Duty Cycle** plot, in order to monitor additional bands.

Monitoring Points and Monitoring Rotation

The general procedure for routine monitoring is to pick selected monitoring points throughout your network environment.

- Throughout the day, you move Cisco Spectrum Expert from one monitoring location to another, holding your position at each location for some extended length of time (say, one hour, or two hours).
- In a large network environment—and depending on how many Cisco Spectrum Expert computers you have, and the size of your network support staff—you may not be able to cover all of your monitoring points in a single day. Instead, you may have a rotation among monitoring points that takes, say, a full week to complete, and then starts again, covering the same points, the following week.
- **Vary The Sampling Times** – If possible, each set monitoring point on your route should NOT be always sampled at the same time of day. As a very simple example, and supposing you had just five designated monitoring points (call them A, B, C, D, and E), and exactly one Cisco Spectrum Expert computer, you might employ a rotation similar to the following:

.Time Slot	.Monday	.Tuesday	.Wednesday	.Thursday	.Friday
.8 a.m. to 10 a.m.	.A	.B	.C	.D	.E
.10 a.m. to Noon	.B	.C	.D	.E	.A
.Noon to 2 p.m.	.C	.D	.E	.A	.B
.2 p.m. to 4 p.m.	.D	.E	.A	.B	.C
.4 p.m. to 6 p.m.	.E	.A	.B	.C	.D

  The point is to make sure that each location is monitored at different times of day, because it is possible that certain locations have low network utilization at one time of day, and higher utilization at another time of day.
- **Selection of Monitoring Points** – As for the selection of monitoring points, you will typically seek a mix of locations, some of which are relatively near to your network backbone devices (such as access points); while others are relatively from the network backbone devices.

  The goal is both to make sure that monitoring points far removed from the network backbone have a healthy RF environment, so they can pick up signals from the backbone; and also to ensure that the backbone devices themselves will be able to clearly receive signals from network members.
- **Variation Analysis** – In the *Section Long-Term Trend Analysis, Long-Term Trend Analysis* Long-Term Trend Analysis, we discussed capturing screen shots, or recording spectrum activity, as a tool for long-term trend analysis. You could use this daily monitoring as the core of that long-term

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trend analysis. However, recording and storing data from multiple locations every single day is likely to result in an overwhelming amount of data.We recommend measurements intended for long-term trend analysis be taken at longer intervals.

However, what you can do is make spectrum recordings or spectrum screen shots on a daily basis during the week, and then compare the recordings/screen taken at the same location, but on different days of the week, and at different times. This comparison will quickly reveal any unexpected, dramatic changes in the RF and network environment.

You can quickly determine if a particular location has dramatically increased activity at different times of day.

If you measure the same location, at the same time, at the beginning of a week, and again at the end of the week, you can immediately detect any abrupt change in RF activity. This can occur, for example, if a new RF device (say, a new microwave oven) was installed during the course of the week, and is now introducing unacceptable levels of RF.

RF and Device Monitoring

Using the spectrum view configuration described above:

- **Spectrum Charts**—The spectrum charts will show you if there is an excess of RF activity on a given channel, or an excess of devices on a given channel. You can also see how RF activity and device activity vary over time.
- **Spectrum Plots—**The **Real Time FFT**, **FFT Duty Cycle**, and the **Swept Spectrogram** all help you detect “bursty” RF activity, which may or may not register strongly on the spectrum charts (the charts generally reflect more sustained trends in RF activity). Bursty RF activity can cause network transmission and reception problems, even if the spectrum charts seem to show a relatively clear environment.
- **Active Devices Chart** and **Active Devices Tree—**Together, these two display elements provide a clear picture of which types of devices—network or interferer—are active in the network environment. The **Active Devices Tree** will also show you if there are network devices impacting your network, but which are not actually part of your network (For example, access points from neighboring Wi-Fi networks).

Troubleshooting

In addition to routine monitoring, there will be times when a network user (or, on a bad day, users), notify you about problems with network performance or connectivity. In these cases, you will want to take Cisco Spectrum Expert to the location(s) where the problems are being reported, and scan the same plots, charts, and the **Active Devices List**, as described above.

It is possible that the flawed network activity will be intermittent. You can set Cisco Spectrum Expert in place at the location where the problems are reported, and set it to record spectrum data over the course of a day for later review. At the conclusion of monitoring, you can also look at the **Devices View**, which presents an historical view of devices that were seen over a period of up to 24 hours.

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Problem Resolution

Once a problem has been detected, and the general cause has been ascertained—such as too many devices in use, or excessive interference on a particular channel—the exact nature of the solution will vary depending on the problem at hand.

In some cases, the cause of the problem is immediately evident—for example, a new microwave oven has been put into use, and the RF leaking from the microwave can be clearly seen as increasing the duty cycle every time the microwave is turned on. You could move the microwave, shield the microwave (or, possibly, try eating cold food). Similarly, the office may just have gone from standard wired-phones to cordless phones, and the new phones are causing the interference. The solution here may be to change the channel used by the network backbone devices.

In still other cases, it may be that more and more network devices are being put into use—for example, as more staff is hired, more wireless computers are used—and a threshold has finally been reached where the existing network backbone (access points) can no longer handle the traffic. The solution here is to purchase additional access points, or reallocate some access points from locations where network demand is not as strong.

Device Finder

In other cases, the general nature of the problem may be apparent, but the particular cause is not. For example, the plots and charts may clearly show increased RF activity when some device is coming into use—but the device itself is not known. (For example, it may be a generic device, and the network administrator does not recognize what device is actually implicated, based solely on the generic parameters.)

In this case, Cisco Spectrum Expert's **Device Finder** feature becomes an essential tool for tracking down the ill-behaving RF device. See "Device Finder Mode" for more information.

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CHAPTER 15

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