ADSP Spectrum Analysis

How-To Guide

Contents

Document Conventions

The following graphical alerts are used in this document to indicate notable situations:

NOTE This symbol indicates something of special interest or importance to the reader. Failure to read the note will not result in physical harm to the equipment or data.

CAUTION This symbol indicates that if this information is ignored, the possibility of data or material damage may occur.

WARNING! This symbol indicates that if this information is ignored the possibility that serious personal or device injury may occur.

1 Introduction

As 802.11 devices operate in unlicensed 2.4GHz and 5GHz bands, managing WLAN networks bring additional challenges compared to wired networks as these devices experience noise and interference from other neighboring wireless networks operating in the same channel. In addition, other wireless devices like cordless telephones, wireless cameras, Bluetooth, weather radars, microwave ovens, etc. operate in same frequency band in which WLAN networks operate.

As a result, the presence of any of these application devices in the vicinity of 802.11 networks will have a profound impact on the reliability and throughput performance of these networks. So, organizations need IT staff with special RF skills and tools to detect interference and manage RF spectrum in which WLANs operate.

The Spectrum Analysis (SA) module in the AirDefense Service Platform (ADSP) provides exactly what is needed for organizations to “look-into” the air for potential noise and interference sources for troubleshooting physical (PHY) layer issues from a centralized remote location.

✓ ***NOTE*** This how-to-guide is based on ADSP 9.x systems.

2 Spectrum Analysis

802.11 signaling exists only at layer-1(PHY) and layer-2(MAC) of the OSI model. If you only examine layer-2 frame captures, you will miss important information about the operation of your devices. 802.11 devices share the same unlicensed medium not only with each other in their WLAN network, but also with non-802.11 based devices configured to operate in the same frequency bands. When 802.11 devices conduct their clear channel assessment (CCA) prior to transmitting a frame and do not hear any 802.11 frame transmissions, they assume that the wireless medium is idle. If a source of non-802.11 noise exists in the basic service set area, 802.11 devices will not be able to detect the noise as an interference source. So, they assume that the medium is not busy and start transmitting the frames. As a result, the signal will

collide with the noise and it will not be delivered to the intended receiver. The transmitting station will not receive an acknowledgement frame and begin the retransmission process. This will directly impact network performance. Common sources of non-802.11 interference include microwaves, cordless phones, Bluetooth devices and x.10 cameras as well as many other things.

Spectrum Analysis will enable you to detect and classify the source of interference; thus allowing you to remove it or work around it. This is a valuable tool in troubleshooting and resolving performance issues which are prevalent in WLAN networks.

Spectrum Analysis is an add-on module that gives you a tool to perform spectrum scan across 2.4GHz and 5GHz band, and identify interference sources on your wireless network.

The analysis is conducted using radio share enabled APs or sensors. You must possess a valid Spectrum Analysis license for each sensor or radio share enabled APs on which you want to perform Spectrum Analysis.

2.1 System Diagram

The following picture depicts system components involved in carrying out Spectrum Analysis in wireless networks. In order to use the Spectrum Analysis module, the deployment should have an AirDefense appliance with one or more sensors, or radio share enabled Access Points.

When a sensor or radio share enabled AP is configured for Spectrum Analysis, they monitor radio spectrum, analyze and classify potential interference sources, and communicate this information to the centralized AirDefense Services Platform. ADSP uses this information to generate alarms when the system detects noisy channel conditions or any interference sources in the vicinity.

ADSP provides the most advanced wireless LAN troubleshooting with a distributed architecture of remote sensors or radio share enabled APs that communicate with a centralized server.

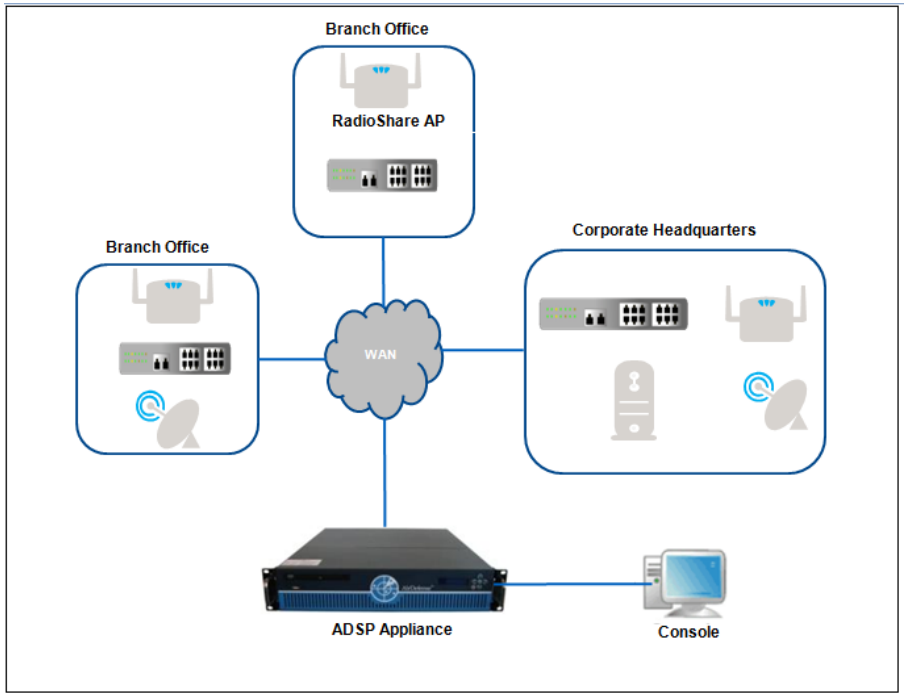

Figure 1: ADSP System Architecture

3 Licensing Spectrum Analysis

Spectrum Analysis is part of the Network Assurance Module and requires a license for unlocking this functionality in the ADSP appliance. Each device needs its own Spectrum Analysis license, where the device can be a sensor or a radio share enabled AP. Note that, the sensor can be a dedicated sensor device or a dual-radio AP where one radio is configured for a sensor and other for WLAN mode.

A radio share based Spectrum Analysis license can be used in environments where there are no dedicated sensors. The following table provides different licensing options for the Spectrum Analysis module.

Part number	Description
AD-SASN-P-1	AirDefense Spectrum Analysis license for one (1) sensor. ✓ ***NOTE*** Spectrum Analysis licenses must be assigned to a sensor and then are fixed to that sensor. ✓ ***NOTE*** Must add a first-year maintenance/service program to this product SKU.
AD-SARS-P-1	AirDefense Radio Share Spectrum Analysis license for one (1) AP. ✓ ***NOTE*** Must add a first-year maintenance/service program to this product SKU.
ADB-NARS-P-1	AirDefense Radio Share license, Network Assurance bundle for one (1) AP. Includes: AP Test, Adv. Forensics, Connectivity Troubleshooting, LiveRF and Spectrum Analysis. ✓ ***NOTE*** Must add a first-year maintenance/service program to this product SKU.

Table 1: License Options for Spectrum Analysis

The above licenses can be applied on an ADSP appliance running ADSP version 9.x from **Configuration** > **Appliance Platform** > **Appliance Licensing** in the ADSP User Interface (UI).

✓ ***NOTE*** If the selected sensor is not licensed for Spectrum Analysis, you get the following error.

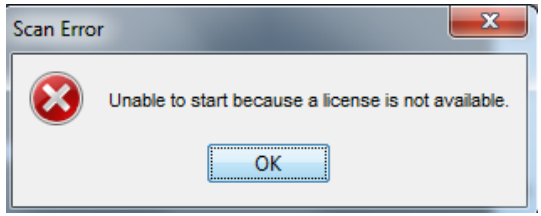

Figure 2: License Error

4 Spectrum Analysis Modes

SA can be run in the following modes:

- Background (In-line) Spectrum Analysis
- Dedicated Spectrum Analysis.

4.1 Background Spectrum Analysis Mode

In this mode, each sensor continuously carries out background scan for interference and noise sources in those channels for which the sensor is configured, and reports the information back to the AirDefense appliance. In a radio share based deployment, each AP performs background spectrum scan, but only in its operating channel.

ADSP generates alarms when the sensor or radio share enabled AP detects and reports any noise or interference. You can select the scan pattern, and enable the background spectrum from the ADSP UI. Go to **Configuration** > **Operational Management** > **Sensor Operation** and select **Scan Settings** tab, as shown below:

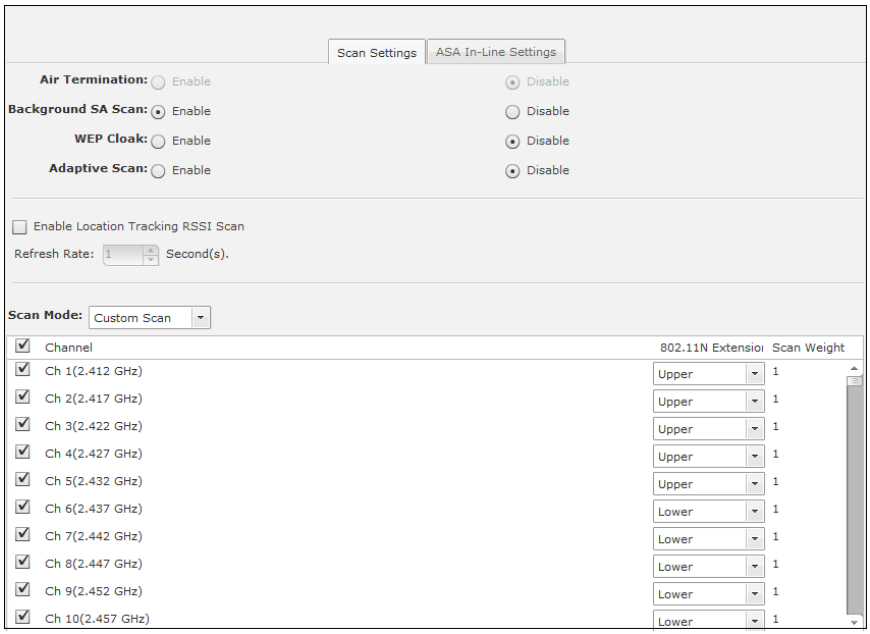

Figure 3: Background Spectrum Analysis Settings

Select **Enable** radio button for **Background SA Scan**. You can customize the spectrum scan pattern of the channels, by selecting **Custom Scan** from the **Scan Mode** list box, as shown in the above picture.

The **ASA In-Line Settings** tab is used to configure sensor settings for background ASA, as shown below.

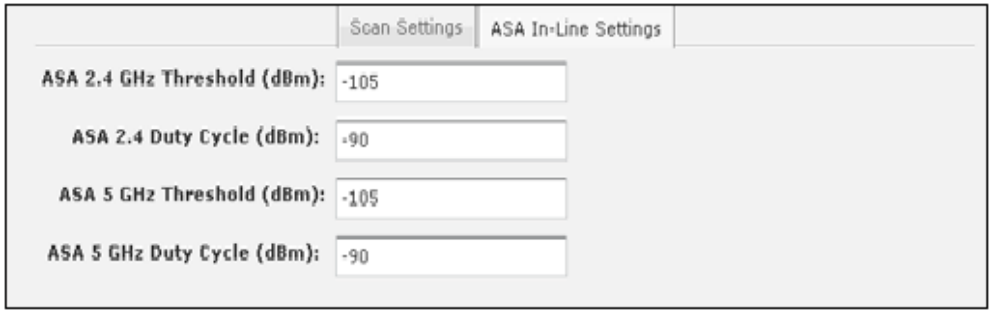

Figure 4: ASA In-line Settings

Threshold (dBm)—this is the master level control for ASA scanning. During scanning, any signal levels below this threshold will be dropped. Only those signal levels greater than this threshold will be admitted for further processing.

Duty Cycle (dBm)—the duty cycle is a measure of % utilization for each frequency. 100% duty cycle for a channel or frequency indicates that the channel is busy all the time. On the other hand, 0% duty cycle indicates that the channel is not used. The Duty Cycle controls the threshold level for duty cycle measurement. Only signal levels greater than the Duty Cycle threshold are counted in the duty cycle measurement.

There are four settings: two for 2.4 GHz band and two for 5GHz band. The user is not expected to change the default settings for normal use.

4.2 Dedicated Spectrum Analysis Mode

The on-demand Dedicated SA disables the background SA configured for a sensor and performs a full spectrum scan or interference scan for a chosen scan period based on user selection.

WARNING! When you run dedicated SA, the sensor stops its current operation (for example, WIPS) and performs only SA.

4.3 Initiate Spectrum Analysis

To initiate SA, go to the **Network** tab in the ADSP GUI, and select **Network Devices** in the **Show** list box for any desired scope in the network hierarchy. This lists all sensors and APs in that scope.

Select the target sensor or radio share enabled AP which you want to use for spectrum scan. Right click on the device, and choose the **Spectrum Analysis** option as shown below to open the **Spectrum View** window.

Depending on the sensor capabilities, you will see **Spectrum View** window with either first-generation Spectrum Analysis or Advanced Spectrum Analysis options. Refer to the following sections for more details on the dedicated Spectrum Analysis settings and spectrum charts.

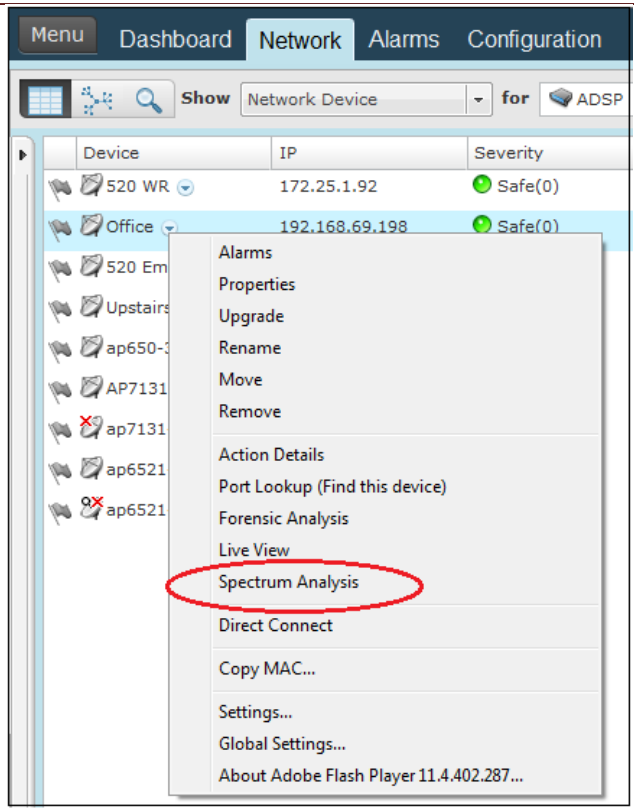

Figure 5: Invoking Spectrum Analysis

NOTE The **Spectrum View** window can only be accessed if the selected sensor is licensed and it supports Spectrum Analysis. If the sensor does not support Spectrum Analysis, the following error popup is displayed.

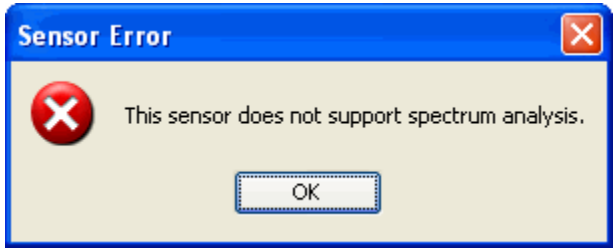

Figure 6: Sensor Spectrum Analysis Support Error

WARNING! If you attempt to run SA on an AP configured for client access (device configured as AP and sensor), the following error popup may display. This usually happens if you only have one radio turned on. If you continue, your wireless application may be disrupted but SA will run.

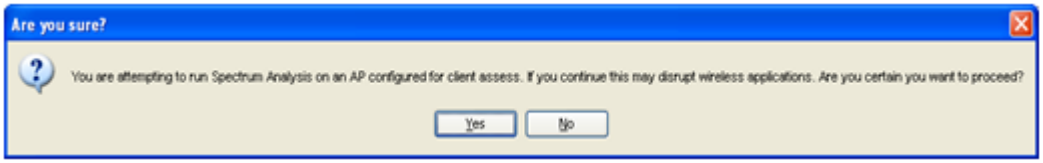

Figure 7: Spectrum Analysis Warning

5 Spectrum View Window

Dedicated SA can be performed at anytime on a sensor or a radio share AP as mentioned in Section 4.3. The dedicated spectrum scan starts automatically when you open the Spectrum View window, as shown below.

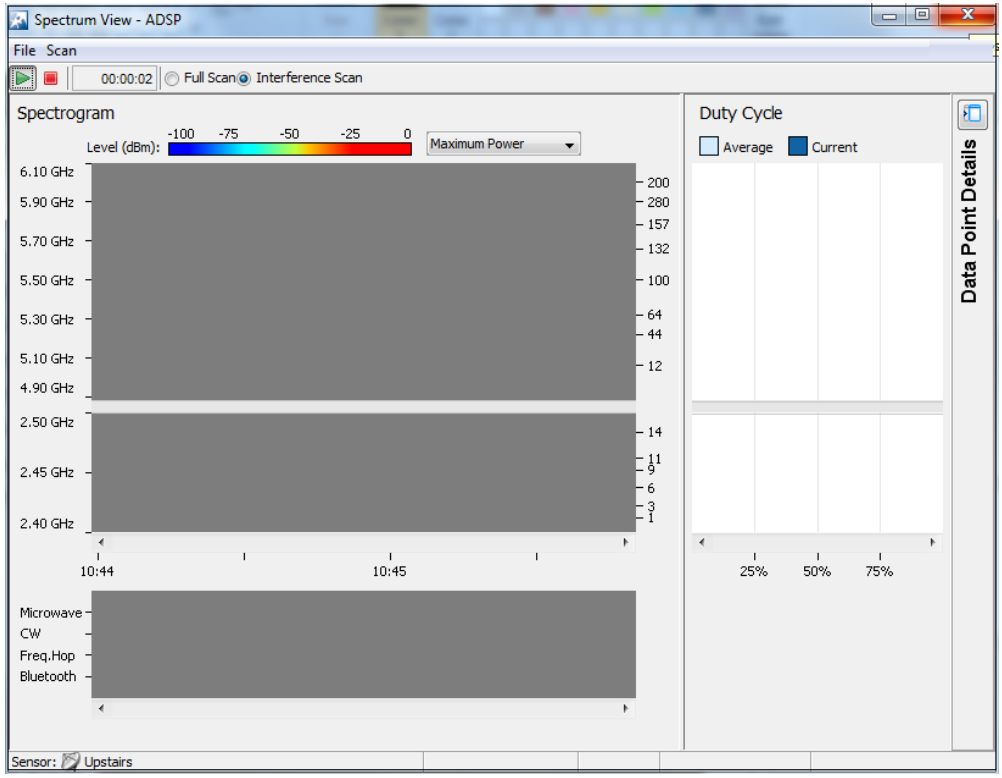

Figure 8: First-Generation Spectrum View Window

You can stop a scan by clicking the **Stop** button– or by selecting **Stop Scan** from the **Scan** menu. Similarly, the SA scan can be restarted by clicking the **Start** button– or by selecting **Start Scan** from the **Scan** menu.

✓ ***NOTE*** The default scanning time is 10 minutes and a timeout occurs if you leave the spectrum scan running for more time, as show below. Scanning time can be adjusted by selecting **Menu** > **Appliance Manager** > **System** > **Settings** > **Spectrum Scan**

Timeout in the ADSP GUI.

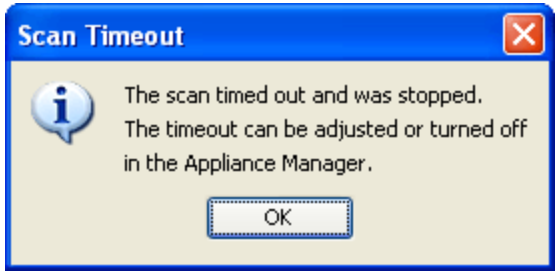

Figure 9: Spectrum Timeout Warning

Click **OK** to close the pop-up.

5.1 Spectrum Scan Settings

The default pulse definition for the spectrum scan can be changed. You can adjust the settings by selecting **File** > **Settings**.

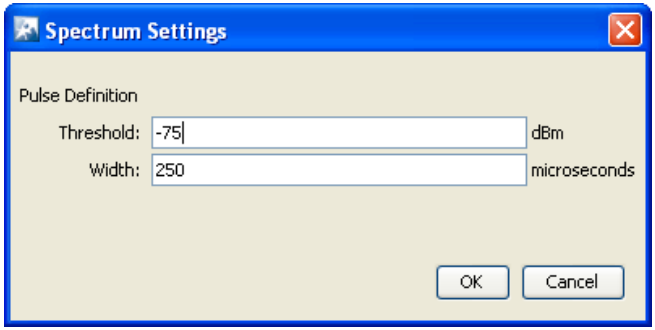

Figure 10: Spectrum Analysis Pulse Settings

There are two fields that define the pulse: Threshold and Width. You can adjust the pulse threshold (in dBm) and the pulse width (in microseconds) by typing new values.

Click **OK** to set the new values and close the window.

5.2 Spectrum Scanning Modes

There are two scanning modes:

- Full Scan
- Interference Scan.

Full Scan scans the entire 2.4GHz spectrum in 5MHz steps and 5GHz spectrum in 20MHz steps with a short dwell time of around 50 ms. Full Scan supports limited classification of interference sources, as it spends less time on each channel.

Interference Scan scans only three channels in the 2.4GHz band and three channels in the 5GHz band with a longer dwell time of around 500 ms in each channel. Interference Scan supports classification for all interference sources.

By default, Interference Scan is enabled. But, you can change the scanning mode by selecting the **Full scan** radio button or by going to the **Scan** menu in the **Spectrum View** window.

5.3 Spectogram and Duty Cycle

Spectrogram is a time sweep plot of the spectrum that shows how the RF power of the selected channels varies with time. X-axis denotes time period and Y-axis denotes frequency.

This chart displays spectral power observed across 2.4 and 5GHz channels. It indicates whether the spectrum is busy or not based on the transmit power seen from both 802.11 and non-802.11 sources.

The duty cycle chart displays how busy a particular frequency is in real-time. X-axis represents duty cycle, while Y-axis represents frequency. A 100% duty cycle for a frequency indicates it is continuously occupied, and 0% indicates that the frequency is quiet.

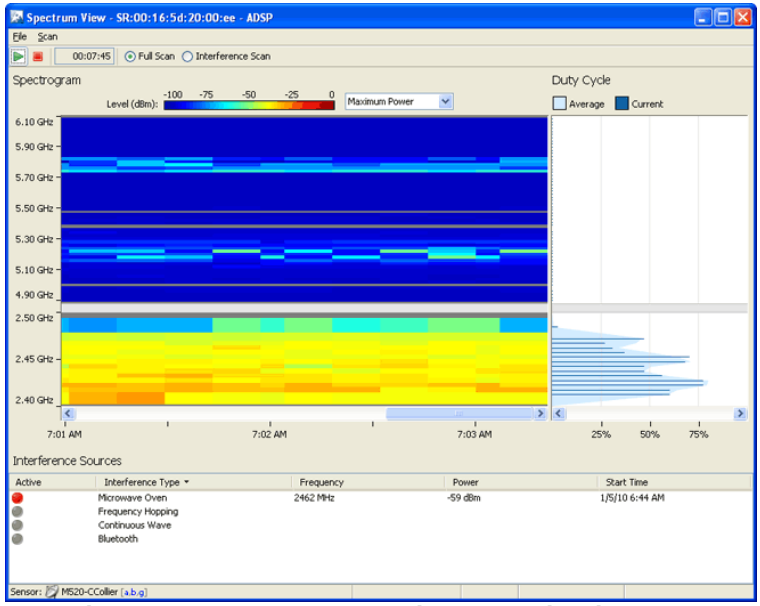

Figure 11: Spectrogram and Duty Cycle Charts

When a scan starts, data starts displaying in the right side of the spectrogram. As new data is scanned, the older data moves to the left. Once the graph is full, a horizontal scrollbar becomes visible, as show in above picture.

You can adjust the size of the Spectrogram and Duty Cycle chart by clicking and dragging the divider (left or right) between them

Click on the **Data Point Details** button on the **Spectrum View** window. It displays, frequency, duty cycle, and average, minimum, and maximum power level, as shown in the next figure.

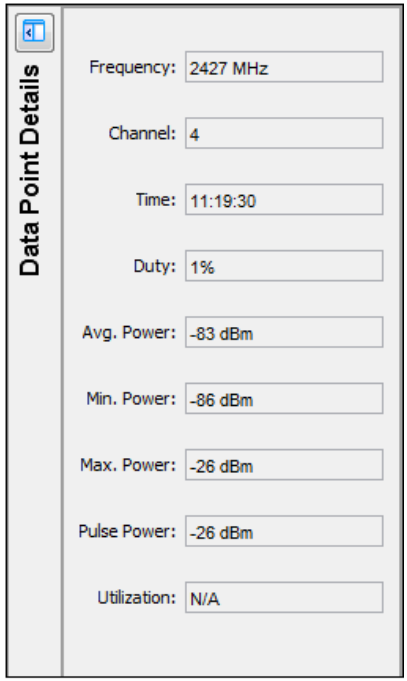

Figure 12: SA – Data Point Details

5.4 Interference Sources

The first generation SA module detects and classifies the following interference sources:

- Microwave Oven
- Frequency Hopping
- Continuous Wave
- Bluetooth.

When the system detects any of these interference sources, it highlights them in the **Interference Sources** window. Each time a scan is started; the interference source table is cleared and gets updated as the system detects these interference sources.

5.5 Closing Spectrum View Window

Select **File** > **Close** to exit the Spectrum View window. You will be prompted to save the spectrum scan data to an ADSA file. This file can be opened in Live

View or in AirDefense Mobile by navigating to **File** > **Open** > **Open Spectrum Data**.

6 Advanced Spectrum Analysis

This section describes the next generation Advanced Spectrum Analysis (ASA) implementation of AirDefense Solutions. ASA is different from the previous implementation of SA in that it takes advantage of the Fast Fourier Transform (FFT) engine in the hardware to capture spectrum samples that provide advanced detection capability to classify various types of RF interference commonly found in the 802.11 spectrum. By using FFT technique in the radio, the ASA runs in parallel with the AP and other sensor software.

Note that ASA will only run on devices with the MB92 or newer chipsets. Currently, the following products support this Advanced Spectrum Analysis:

- AP6511
- AP621
- AP6521
- AP622
- AP8132.

6.1 On-demand Advanced Spectrum Analysis

On-demand ASA can be invoked in a way that is similar way to that of SA, as mentioned in Section 4.3. If the chosen AP/sensor supports ASA, you see the window shown in the next figure.

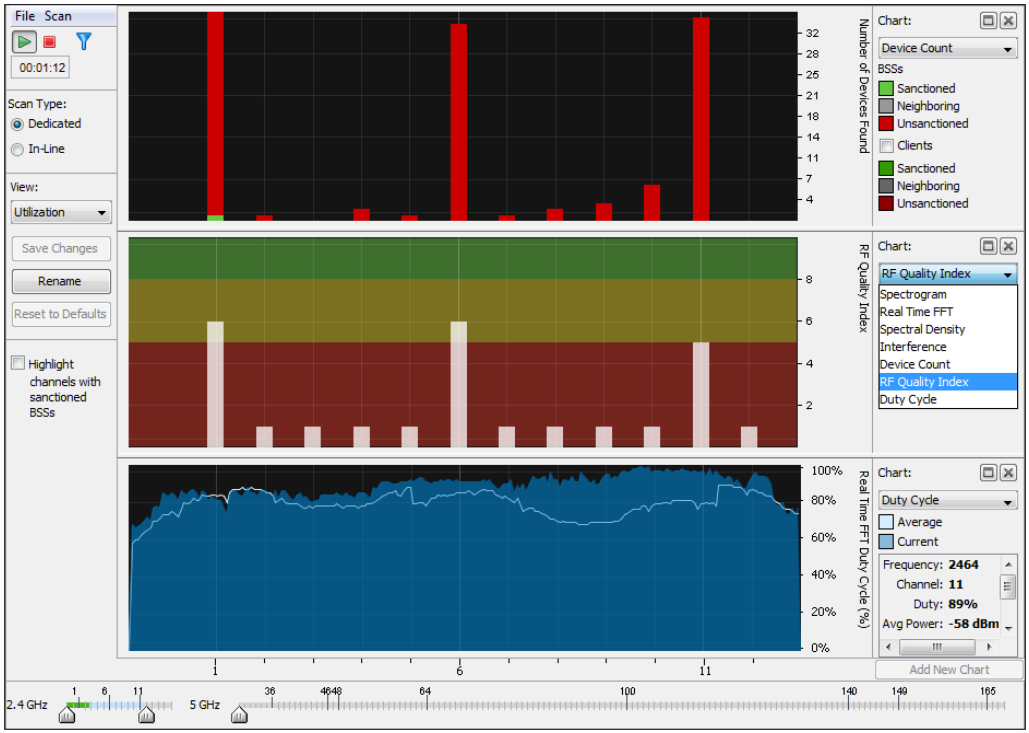

Figure 13: ASA – Spectrum View Window

The following table describes each field in the above window.

	Press this button to (re)-start the on-demand Spectrum Analysis.
	Press this button to stop the on-demand Spectrum Analysis.
	Press this button to configure Threshold and Duty Cycle values for both 2.4 and 5GHz bands for on-demand ASA. See section for more details on the definition of these fields.
Scan Type	By default, Scan Type for the on-demand ASA is set to Dedicated. You can set the ASA to run in background mode by changing the Scan Type to In-Line in above window.

View	Allows you to display appropriate Spectrum Charts based on the following categories: Utilization—This is the default view option, which displays spectrum utilization charts i.e. Device Count, RF Quality Index, and Duty Cycle. Physical Layer—Displays spectrum charts related to PHY layer, i.e., Spectrogram and Duty Cycle. Interference—Displays Interference and Spectral Density charts. Spectrum Detail—Displays Spectrogram, Real-time FFT, and Spectral Density charts.
Highlight channels with sanctioned BSSs	By default, this is enabled. The ASA charts highlight spectrum data only on those channels in which the system detects presence of sanctioned BSSs. You can disable this option to highlight the spectrum data on all the channels in the displayed charts.
	These sliders control the channels to be scanned during the on-demand Spectrum Analysis. By default, only channels to 1 to 11 are enabled. Move these sliders on 2.4GHz and 5GHz bands to adjust the channels in which ASA wants to scan in 2.4GHz and 5GHz respectively.

Table 2: ASA Window – Field Description

6.2 ASA Charts

Unlike the first-generation SA, the ASA supports the following seven charts.

- Spectrogram
- Real Time FFT
- Spectral Density
- Interference Scan
- Device Count
- RF Quality Index

- Duty Cycle.

6.2.1 Spectrogram

Spectrogram is a time sweep plot of the spectrum that shows how the RF power of the selected channels varies with time. This chart displays spectral power observed across 2.4 and 5GHz channels for which Advanced Spectrum Analysis is configured. It indicates whether the spectrum is busy or not based on the transmit power seen from both 802.11 and non-802.11 sources. This is a color coded chart.

Select the Spectrogram option from the Chart dropdown menu on the right side of the window to display the chart. The legend for different power levels is also shown in the chart. Adjust the sliders on 2.4GHz and 5GHz bands to view Spectrogram on desired channels in these bands, as shown below. You can place the cursor at any place in the window to see the channel and power level at any given time during the spectrum scan.

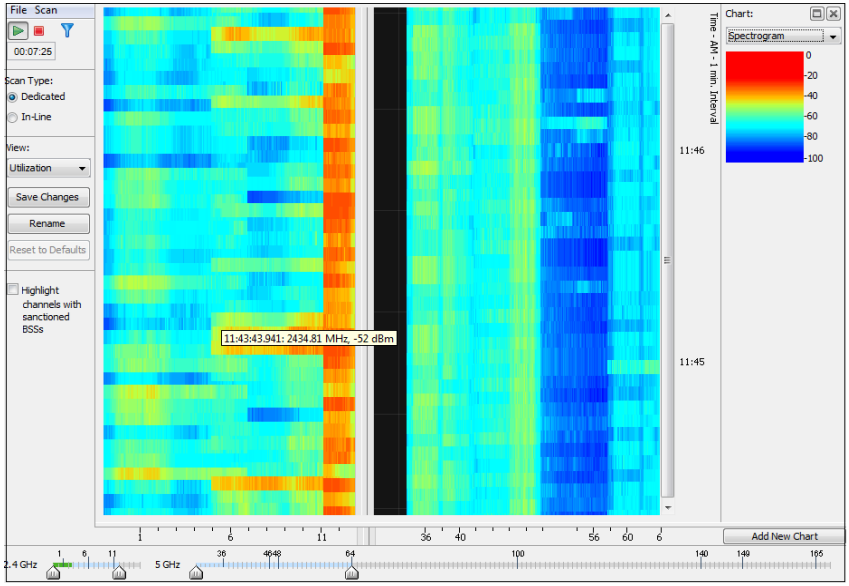

Figure 14: ASA Spectrogram Chart

6.2.2 Spectral Density

This chart plots the snapshot of the density of power observed on each channel during the SA scan. The intensity of the color indicates the power density for the frequencies. The amplitude of the curve indicates a measure of the density

of the observed energy during the scan. The higher the amplitude of the curve, the busier is the spectrum.

Unlike the Spectrogram, which provides a historic view of the spectral power, this chart represents instantaneous power and it provides a quick measure of which channels are busy and which are relatively quieter.

Select the **Spectral Density** option from the **Chart** dropdown menu on the right side of the window to display this chart. The legend for different power levels is also shown in the chart.

As shown in the following figure, adjust the sliders on 2.4GHz and 5GHz bands to view density of the power on desired channels in these bands. You can place the cursor at any place in the window to see the channel and power density.

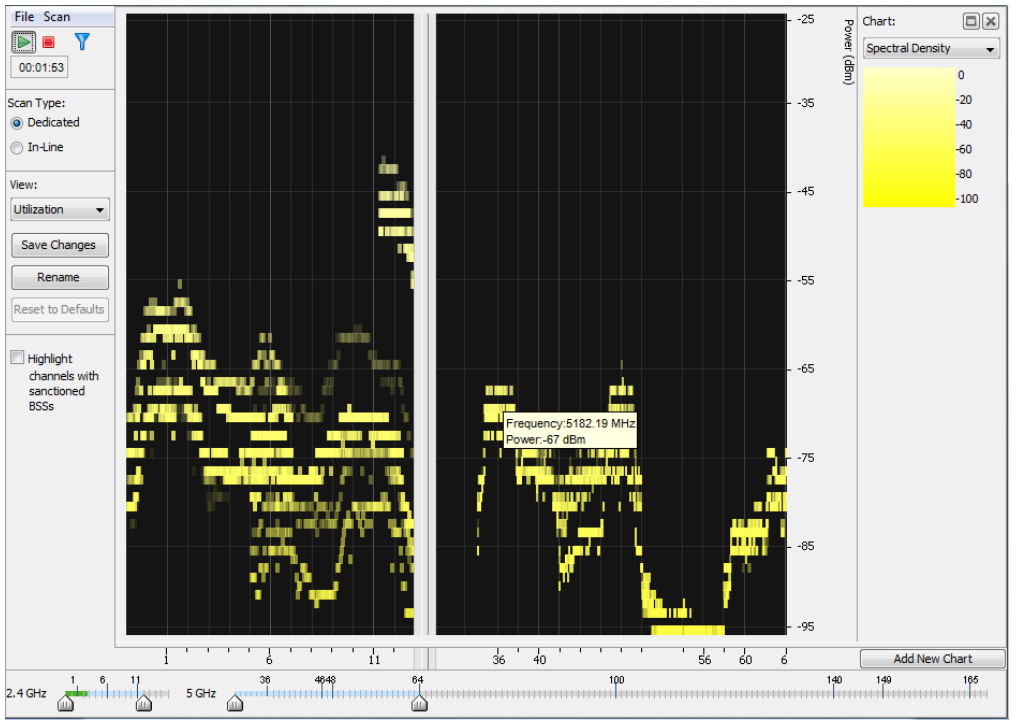

Figure 15: ASA Spectral Density Chart

6.2.3 Real-Time FFT

The real-time Fast Fourier Transformation (FFT) shows the power spectrum for the current FFT sample in terms of the average, minimum and maximum power values. In addition, it also shows the minimum and maximum power values out of all FFT samples since the Spectrum View GUI has started.

Select **Real Time FFT** option from the **Chart** dropdown menu on the right side of the window to display this chart. It plots the following power values, and you can enable or disable any of these power levels that you do not want to see on the FFT plot:

- Average Power—Average RF power of the collected samples during the scan period.
- Max-Hold—Maximum RF power of all the collected samples since the ASA was started.
- Maximum Power—This is similar to average RF Power, but it displays the maximum RF power of the collected samples instead of averaging.
- Min-Hold—Minimum RF power of the collected samples since the ASA was started.
- Minimum Power—This is similar to average RF Power but it displays the minimum RF power of the collected samples instead of averaging.

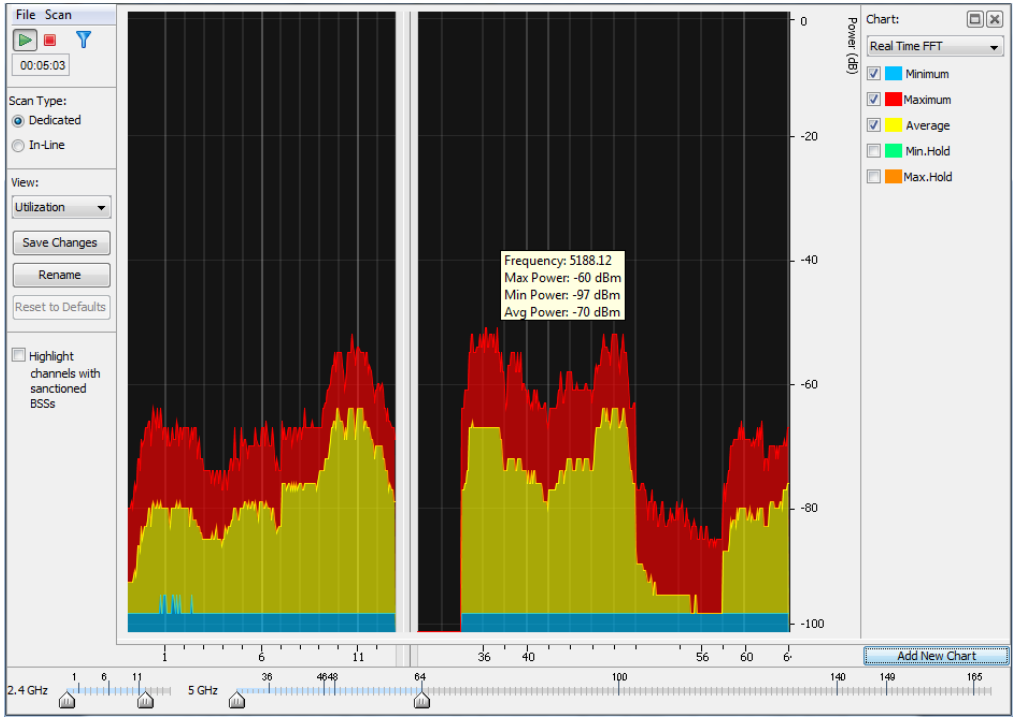

Figure 16: ASA Real Time FFT Chart

6.2.4 Duty Cycle

The duty cycle chart displays how busy a particular frequency is in real-time. A 100% duty cycle for a frequency indicates it is continuously occupied and 0% indicates that the frequency is quiet.

Select **Duty Cycle** option from the **Chart** dropdown menu on the right side of the window to display this chart. The legend for **Average and Current** power levels are shown in the chart.

Adjust the sliders on 2.4GHz and 5GHz bands to view Duty Cycle plot on desired channels in these bands, as shown in the next figure. You can place the cursor at any place in the window to see the following Duty Cycle, Power levels and spectrum utilization for any channel.

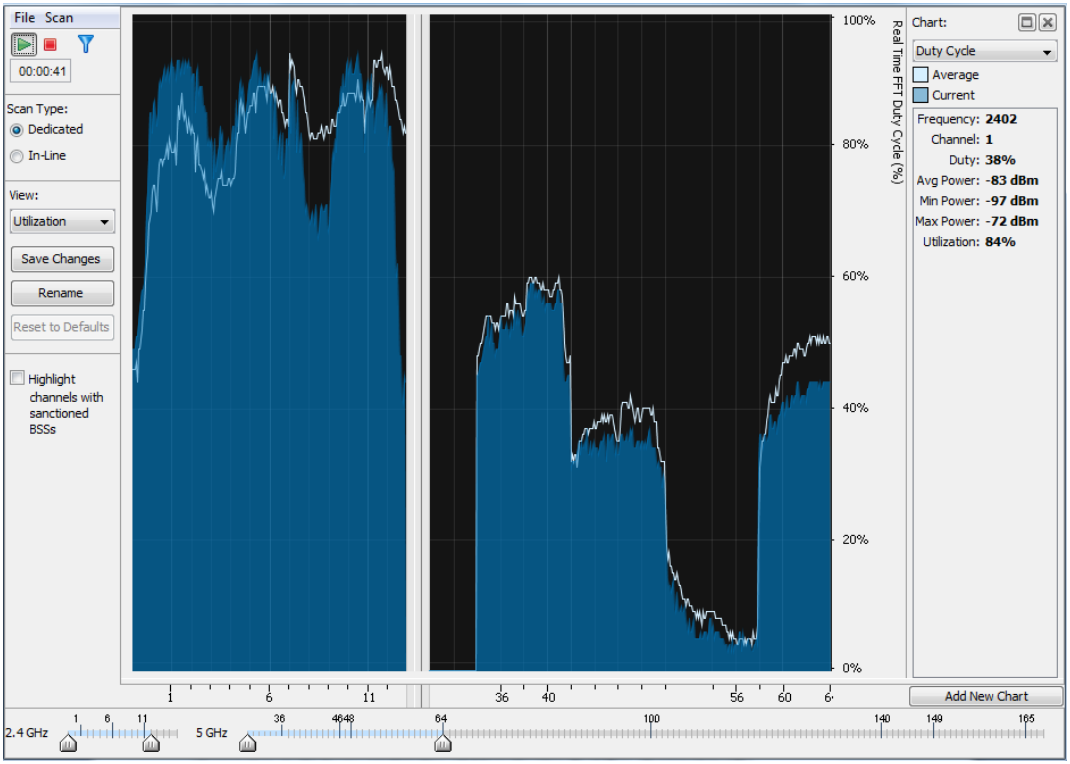

Figure 17: ASA Duty Cycle Chart

6.2.5 RF Quality Index

The RF Quality Index is a measure of the "air" quality of the RF spectrum. The index is represented on the Y-axis, where an index of 0 for a particular channel indicates that the channel is quite bad (busy) and index of 10 indicates that the channel quite good (idle). The RF Quality Index is calculated from various factors including:

- Channel utilization
- Number of retries and Cyclic Redundancy Check(CRC) errors observed in the channel
- Channel noise
- Total number of transmitted frames in the channel.

Select the **RF Quality Index** option from the Chart dropdown menu on the right side of the window to display this chart. The legend indicates Average and Current power levels.

Adjust the sliders on 2.4GHz and 5GHz bands to view RF Quality Index plot on desired channels in these bands, as shown below.

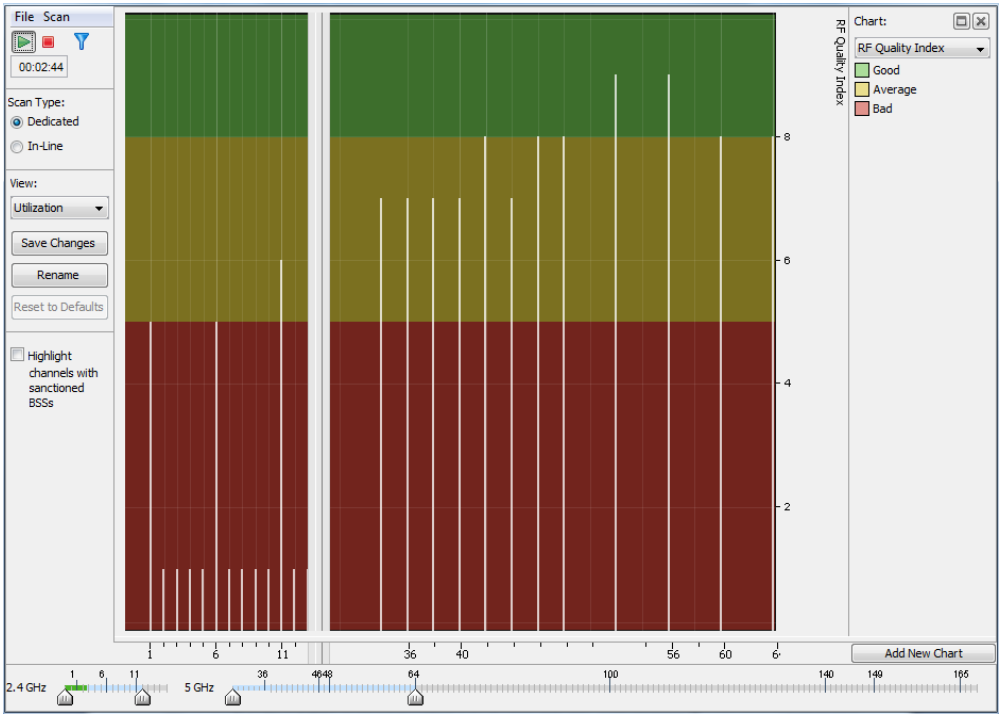

Figure 18: ASA RF Quality Index Chart

6.2.6 Interference

This chart plots all interferences sources observed across all channels during spectrum scan. During the interference scan, the system detects and classifies various interference sources commonly found in the shared 2.4 and 5GHz ISM bands. The following interference sources are supported by ASA:

- Microwave
- Wireless Camera
- 802.11 OFDM Activity

- 802.11 CCK Activity
- Bluetooth low data rate - Single slot Bluetooth
- Bluetooth high data rate—Multi Slot Bluetooth
- Cordless Phone
- Jammer—CW Source over more than 100MHz contiguous frequency range
- Continuous Transmitter—CW Source less than 100MHz contagious frequency range.

Select **Interference** option from the **Chart** dropdown menu on the right side of the window to display this chart. Adjust the sliders on 2.4GHz and 5GHz bands to scan and detect interferences on desired channels in these bands. You will see a red ball on the **Status** column against an Interference source when the system detects that particular interference category, during on-demand spectrum scan.

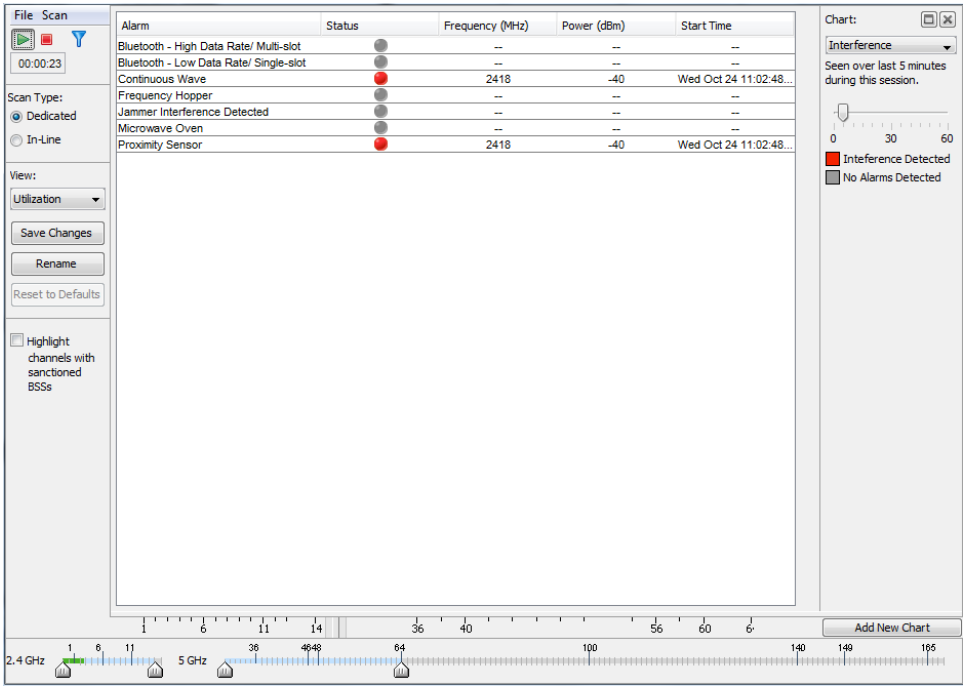

Figure 19: ASA Interference Chart

6.2.7 Device Count

This chart indicates total devices found during spectrum scan and plots these devices based on the following classification:

- Sanctioned
- Neighboring
- Unsanctioned.

This chart provides a measure of wireless activity and interference from *neighboring* and *unsanctioned* devices on *sanctioned* devices operating in each of the channel.

To launch this chart, select the **Device Count** option in the **Chart** dropdown menu, as shown in the next figure.

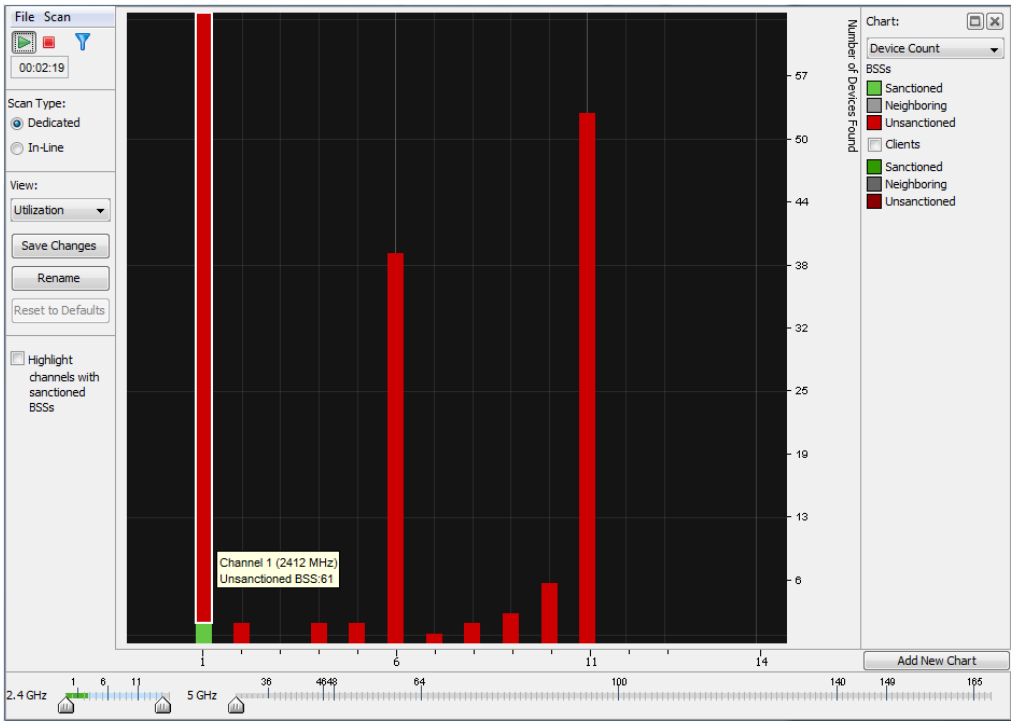

Figure 20: ASA Device Count Chart

By default, the system plots the Basic Service Set(s) (BSSs) found in each channel and you can select whether the 802.11 client devices need to be included in the analysis or not.

You can select the red, green, or gray color on any of the channels to display the number of Unsanctioned, Sanctioned and Neighboring devices respectively. For example, the picture above shows total unsanctioned BSSs discovered in channel 1.

7 Scheduling Spectrum Analysis

Use the **Schedule Spectrum Analysis** feature when you need a dedicated scan to detect noise and interference issues affecting the network. Scheduled SA generates alarms when it detects any RF or interference issues so that corrective action can be taken. You can configure the system to automatically

perform one-off on-demand SA at a given time in the day, or schedule the system to run SA daily, weekly, or monthly.

You can configure Schedule SA from the **Spectrum View** window, as described in section 5, *Spectrum View Window*.

Go to the **File** menu in **Spectrum View** window, and select **Schedule Spectrum Analysis**. You will see the following window.

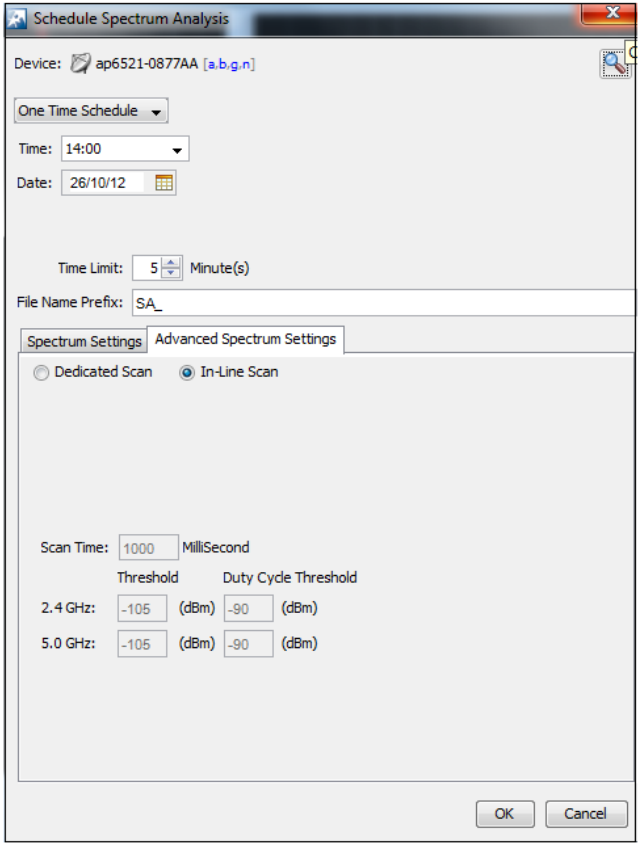

Figure 21: Schedule Spectrum Analysis

You can search the sensor or radio share enabled AP that you want to use for a scheduled SA by using the search icon on the top right corner in the windows.

You can configure scheduled SA to **One Time Schedule**, **Intra-day**, **Daily**, **Weekly**, and **Monthly**, by selecting the date, time, and day, as appropriate.

The **Time Limit** specifies the duration for which the scheduled on-demand Spectrum Analysis will run.

The **File Name Prefix** indicates the filename into which the SA data is stored. This file can be opened later by AirDefense Mobile or the Live View tools.

The **Spectrum Settings** and **Advanced Spectrum Settings** tabs allow you to configure the scan type, threshold, and duty cycle parameters, as described in Section 4.1.

Click **OK** to schedule SA.

8 Interpreting Spectrum Analysis Alarms

When a scheduled SA test is carried out on a sensor, the system generates alarms if it detects any interference sources on the configured channels. These alarms can be viewed from **Alarms** tab in the main GUI.

To find the description on all alarms generated by Spectrum Analysis module, you need to perform the steps below.

1. Go to **Configuration** > **Operational Management** > **Alarm Configuration**.
2. Select **Performance** > **RF Spectrum Analysis**.
3. Select the desired alarm, as shown in the following figure, and press **View Expert Help** to get details on when this alarm would be generated and how to mitigate this failure condition.

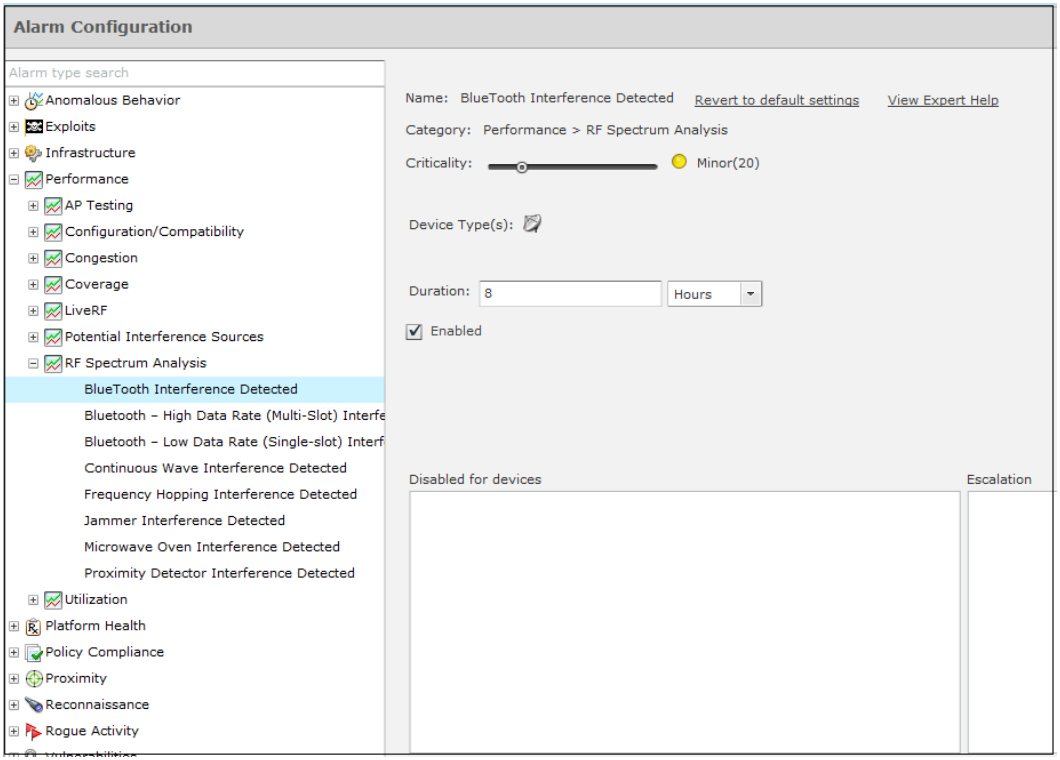

Figure 22: Spectrum Analysis Alarms

9 Supported Devices

The APs and sensors supported by ADSP are as follows:

- AP 6511
- AP 621, AP 6521
- AP 622, AP 6522, AP 6562
- AP 650, AP 6532
- AP 7131, AP 7161, AP 7181
- APs 7522, 7532 (9.1.2 or later)
- AP 7652 (standalone)
- AP 8122, AP 8132, AP 8163
- AP 8232 (with 3rd radio sensor module only)
- TW 511

For detailed descriptions and installation instructions for specific APs, refer to *ADSP Infrastructure Management Supported Devices* at the following URL: www.zebra.com/support.

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