Anritsu envision : ensure

MS27101A

Remote Spectrum Monitor

Introduction

With the rapid expansion of wireless communications, the need for robust networks free of interference continues to grow. Capacity can be degraded by the presence of illegal or unlicensed signals that interfere with legitimate transmissions. These signals can be periodic or present at different frequencies over time, making the discovery and removal of these sources of interference a significant challenge.

Spectrum monitoring can serve to enforce compliance with government regulations. Police, fire fighters, air traffic control, railroads using positive train control (PTC), military and emergency services must all have access to communications free of impediments and distortion. Compliance with spectrum regulations is often enforced by spectrum monitoring.

The MS27101A is designed for such applications as white space monitoring, harm claim threshold detection, in-building interference monitoring, positive train control (see Fig. 1) and research/university applications.

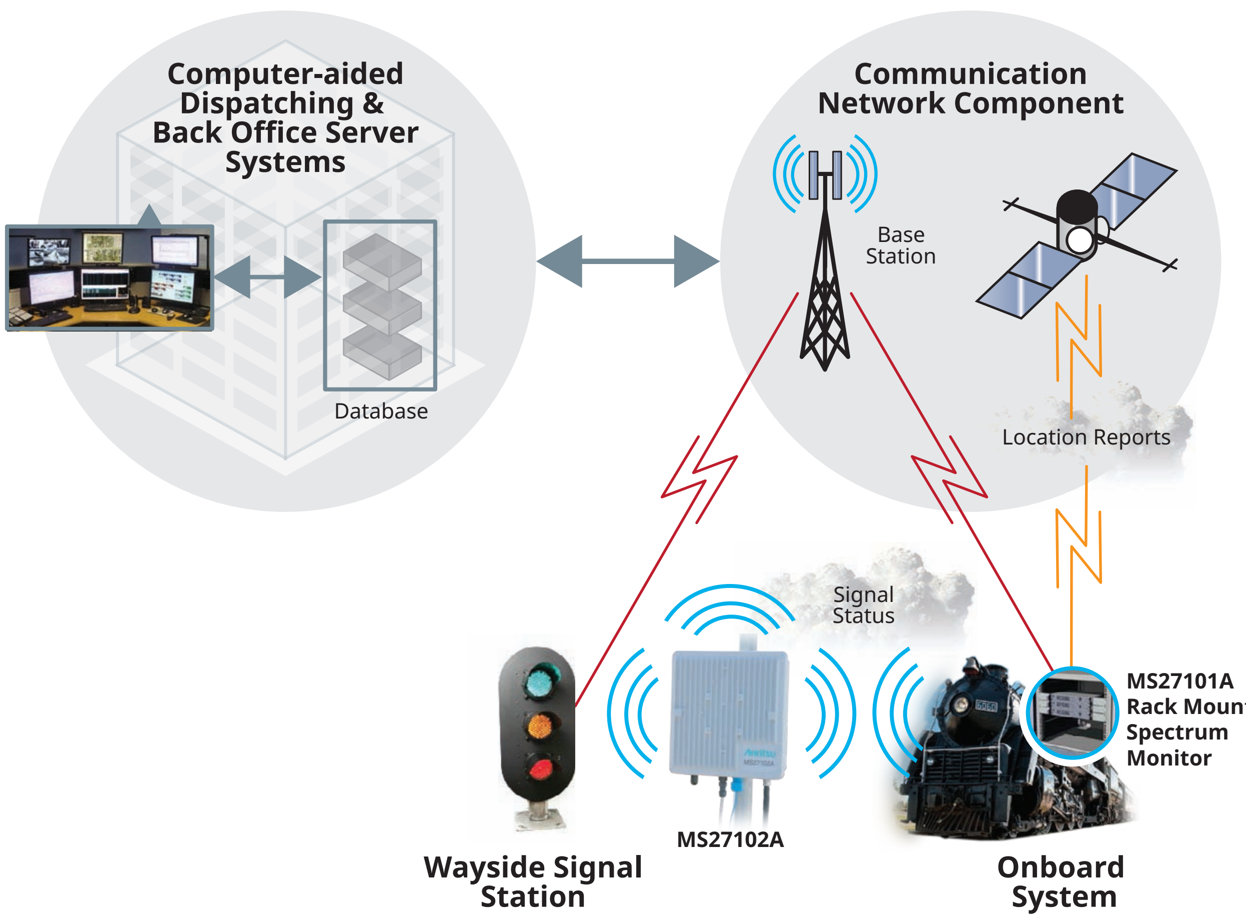

Figure 1. Positive Train Control (PTC) Application

In addition to interference detection, spectrum monitoring is also used to characterize spectrum occupancy. Government regulators and operators are often interested in determining the usage rate for various frequency bands. Monitoring these frequencies provides the information needed to optimize spectrum for maximum utilization. Spectrum can be re-purposed for other applications or multiplexed with other signals using cognitive radio techniques. See Figure 2 for an illustration of a spectrum occupancy measurement.

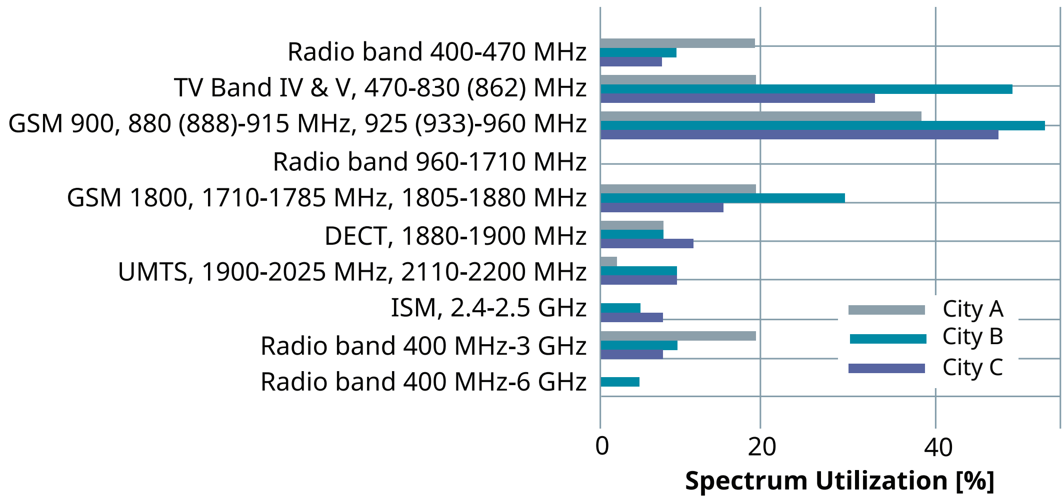

Figure 2. Spectrum Occupancy Measurement

MS27101A Remote Spectrum Monitor

Capable of sweeping at rates up to 24 GHz/s, the MS27101A allows capture of many types of signals. This includes periodic or transient transmissions as well as short “bursty” signals. Also featured is a high dynamic range, high sensitivity and low spurious signals. This enables the MS27101A to reliably distinguish between low-level signals being observed and those signals generated by the monitor itself.

Key facts

- 9 kHz to 6 GHz
- Sweep speed up to 24 GHz/s
- Integrated web server to view, control and conduct measurements via a web browser (Chrome and FireFox recommended)
- Remote firmware update capable
- Watchdog timer to insure long-term stability for remotely deployed monitors
- Linux operating system
- Low spurious signals for accurate signal discovery
- 20 MHz instantaneous FFT bandwidth
- Low power consumption < 11 watts
- Integrated GPS receiver for monitoring location and time synchronization applications
- Gigabit Ethernet available for high speed transmissions
- Interference analysis: spectrogram and signal strength
- Dynamic range: > 106 dB normalized to 1 Hz BW
- DANL: < –150 dBm referenced to 1 Hz BW, preamp On
- Phase noise: –99 dBc/Hz @ 10 kHz offset at 1 GHz
- IQ block mode and streaming with time stamping for TDOA applications
- Vision™ software optional for automated spectrum measurements, setting alarms and geo-locating signal sources

Designed For Remote Applications

With monitors potentially being deployed hundreds or thousands of kilometers from the control center, it is preferred that each monitor remain operational under all types of conditions. The MS27101A is designed for robust field deployments, with capabilities for remote power cycling, automated system recovery protocols and firmware updates “pushed” to the monitor remotely.

In the event of an application error or power fluctuation which causes an ongoing interruption in monitor communication, a re-boot policy is implemented to bring the remote monitor back to its previous state. Under these conditions, the current firmware is automatically reloaded and on-line operation is restored. Instrument settings are also restored to their previous state.

A “Golden” firmware image is also placed on each unit in a secure location in memory. If for any reason the firmware in the unit becomes corrupted, a Golden Image is used to bring back full operation of the monitor. This feature is particularly useful for remote firmware updates.

Remote Firmware Updates

There are several stages or “checks” performed when a new firmware package is downloaded remotely into the instrument. Once a new firmware image is downloaded to the monitor, various tests are performed to insure the code was properly transmitted without error. The code is then transferred into probe memory and installed. If there are any issues with this process or the new firmware does not work correctly, the Golden Image automatically replaces the downloaded firmware to keep the remote monitor operational. See Figure 3.

The Golden Image feature provides the user with assurance that the monitor stays in operation when changes are made to the code. Any bug fixes, updates or user requested features can then be remotely sent to the spectrum monitor and safely incorporated.

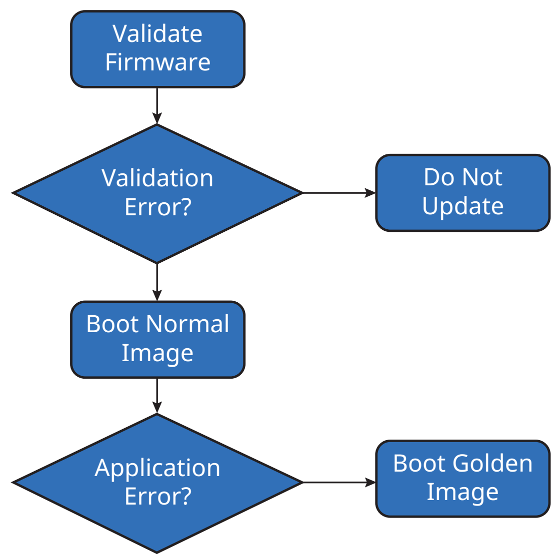

Figure 3. Remote firmware update policy

Integrated Web Server

The MS27101A features an integrated web server. Using an internet browser (Chrome and FireFox are supported), a user from anywhere in the world can log in to the spectrum monitor and control any of its features. This includes such parameters as frequency settings, RBW/VBW control, reference level configuration and many other settings relevant to the user's spectrum monitoring application. Trace data, spectrograms and other measurements can be viewed inside the browser window. A key advantage in using the web server is that it is platform agnostic. Any electronic device capable of rendering a browser will work with the web server.

Users can utilize their PC/laptop, tablet or even smartphone to view the spectrum and change instrument settings. PCs/laptops, tablets or even smart phones can be used to view spectrum and adjust remote instrument settings. Figure 4 shows the measurement data displayed on a smartphone. Figure 5 shows the screen shot displayed on a PC/laptop. The MS27101A features Gbit Ethernet, allowing fast transfers of measurement data and control information.

Figure 4. User interface shown on smartphone browser.

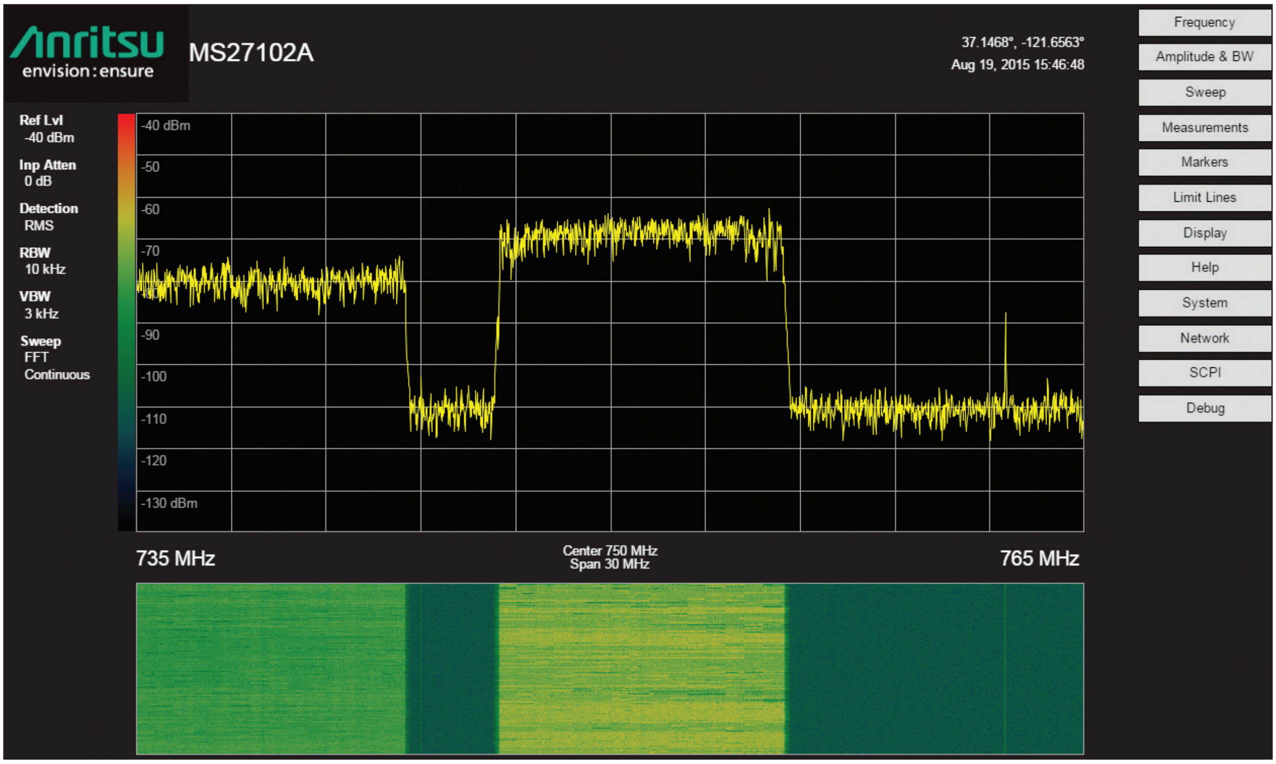

Figure 5. MS27101A Screen Shot

Hardware

The MS27101A is designed for indoor deployment. Ports include power, RF Input, Gbit Ethernet, two USB ports, External Ref In and GPS antenna. The operating temperature ranges from –40 ºC to +55 ºC.

The MS27101A typically consumes less than 11 Watts. The low power used facilitates use of the spectrum monitor powered by solar cells for remote locations.

Optionally available is a bracket kit for the MS27101A. Brackets are provided for placing the MS27101A in a standard rack-mount configuration. Additional brackets are also available in the kit for combining two MS27101A monitors to fit into a standard rack-mount cage. Figure 6 shows the contents of the rack-mount bracket kit. Figure 7 illustrates the combination of of two spectrum monitors using these brackets.

Figure 6. MS27101A-001 Rack-mount bracket kit

Figure 7. Two MS27101A probes joined together with bracket kit

Key Applications

- Spectrum Monitoring usage surveys (white space)
- Harm claim threshold (monitor spectrum for signals “de-sensing” receivers)
- Positive Train Control (PTC)
- Spectrum occupancy and frequency band clearing
- Fast and efficient detection and elimination of interference sources
- Monitor jails/prisons for illegal broadcasts

* Satellite earth station monitoring

- Security at military facilities, national borders, utilities, airports and other sensitive sites where monitors are positioned indoors
- Spectrum monitoring associated with lab RF testing
- Government regulators enforcing spectrum policy
- Geo-location of interference signals
- Maintain history of spectrum activity
- University and lab research
- Generate records of interference events for potential legal action

Signals of Interest

The wide variety of signals to be monitored fall into several categories. Each of these types of signals will be examined in some detail. These include:

- Intentional interference (including illegal or unlicensed broadcasts)
- Accidental interference
- Occupancy

Intentional Interference

Illegal AM/FM and video broadcasts are found in many parts of the world. These signals can be generated by pirated broadcast equipment or over-powered CB radios. Additionally, jammers are sometimes used for applications such as preventing students from cheating on tests, stopping employees from taking phone calls on company time or to prevent prisoners from making illicit calls from prisons. Mitigating this type of interference has become a high priority with government regulators.

Accidental Interference

A wide variety of accidental interference can be seen in the spectrum. A common problem is cable TV leakage. This type of leakage exists both from cable signals leaking into the outside environment as well as from outside signals leaking into the cable system. This problem has been enhanced with the proliferation of cable into frequencies used by broadcasters and cellular operations (such as the 700 MHz LTE band).

DECT phones also cause a problem, particularly when people bring their wireless phones along when moving from one country to another. DECT frequencies vary in different countries, providing the potential for interference when transported. Figure 8 shows the frequency bands for various DECT phones based on country of origin.

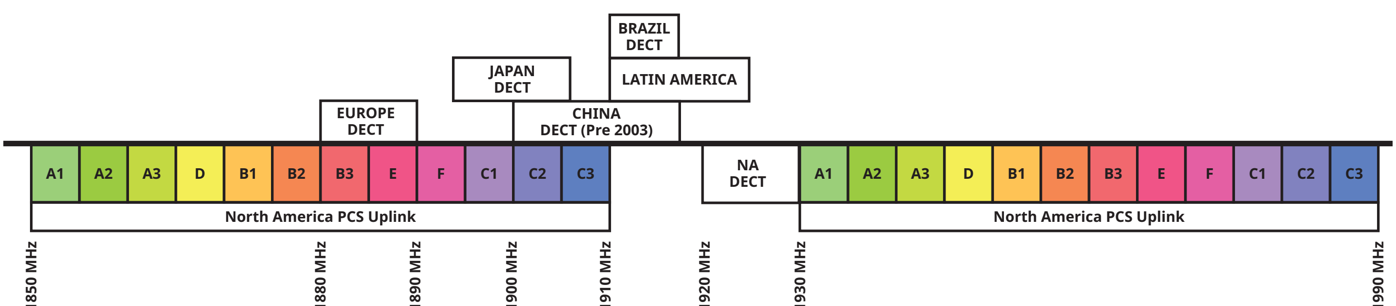

Figure 8. International DECT phone frequencies operate in U.S. cellular bands

Other sources of interference include cellular signals (due to antenna tilt or azimuth errors), repeaters oscillating, wireless microphone problems, power equipment and many others.

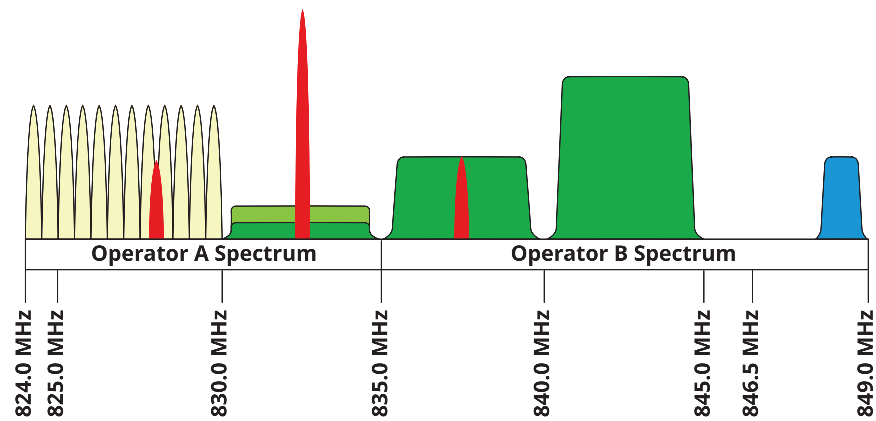

Figure 9. Malfunctioning repeaters may block licensed transmission

Occupancy

With the rapid demand for available spectrum from both public and private sectors, new ways are being investigated for making more efficient use of various frequency bands. A lot of the spectrum is potentially underutilized, providing the opportunity to re-purpose existing spectrum with additional applications.

Spectrum occupancy measurements quantify the amount of use of frequency bands over a given period of time. Remote spectrum probes are used to monitor a band of frequencies, recording spectral history as a function of time.

Performance

The MS27101A is able to sweep the frequency spectrum at rates up to 24 GHz/s. This enables the user to capture intermittent or pulsed signals. Additionally, the spectrum monitors has an instantaneous FFT bandwidth of 20 MHz.

A typical use case for this feature is the real-time capture of the entire FM radio band (88 MHz to 108 MHz in most countries). The user can perform multiple FFT captures of FM signals, storing the data for later playback and analysis. Unlicensed signals can then be identified using this information.

Multiple spectrum sensors can also be deployed to extend the RF monitoring capabilities and for geo-location of signals of interest. Using three or more probes, Anritsu’s optional Vision™ software can be used to position an interferer signal or illegal broadcast. Additionally, IQ measurements are time stamped using the probe’s GPS receiver. This enables the user to employ their own software using Time Distance of Arrival (TDOA) capabilities to find interferers, given each monitor IQ measurement is precisely time stamped.

Communications

Communications with the MS27101A are conducted via wired Ethernet. Each monitor is shipped with a pre-programmed static IP address. See Anritsu's Ethernet Configuration Guide for further details. Alternatively, a USB cellular modem can be used for communicating with the MS27101A. Although 3G modems can be used, a 4G modem is recommended for its high throughput rates.

All commands and inquiries with the MS27101A are done with SCPI commands. Anritsu provides a user manual listing each SCPI command along with its corresponding description and command syntax.

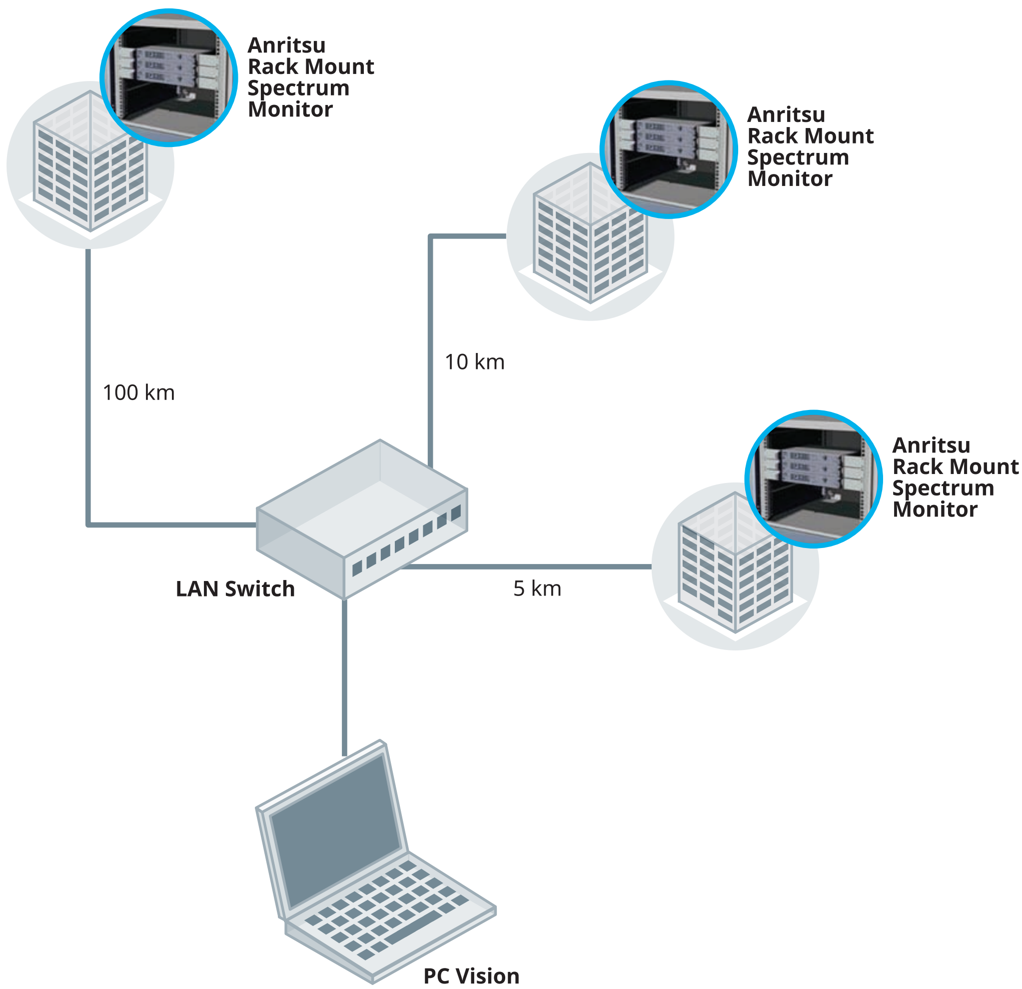

Figure 10. MS27101A Indoor Spectrum Monitoring System.

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Remote Spectrum Monitor

Introduction

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A spectrum monitoring system will facilitate the identification and removal of illegal or unlicensed interference signals. By monitoring spectrum on a continual basis, problem signals can be identified as they occur in real time. Patterns of unwanted signal activity can also be examined, providing an efficient way to characterize and locate the source of the interference problem.

In addition to interference detection, spectrum monitoring is also used to characterize spectrum occupancy. Government regulators and operators are often interested in determining the usage rate for various frequency bands. Monitoring these frequencies provides the information needed to optimize spectrum for maximum utilization. Spectrum can be re-purposed for other applications or multiplexed with other signals using cognitive radio techniques.

Spectrum monitoring can also serve to enforce compliance with government regulations. Police, fire fighters, air traffic control, military and emergency services must all have access to communications free of impediments and distortion. Compliance with spectrum regulations is often enforced by spectrum monitoring. Figure 1 shows the MS27102A deployed to monitor Positive Train Control (PTC) frequencies. PTC is being deployed worldwide to provide automated signaling for train control. The MS27103A can also be used inside the train to insure wireless integrity.

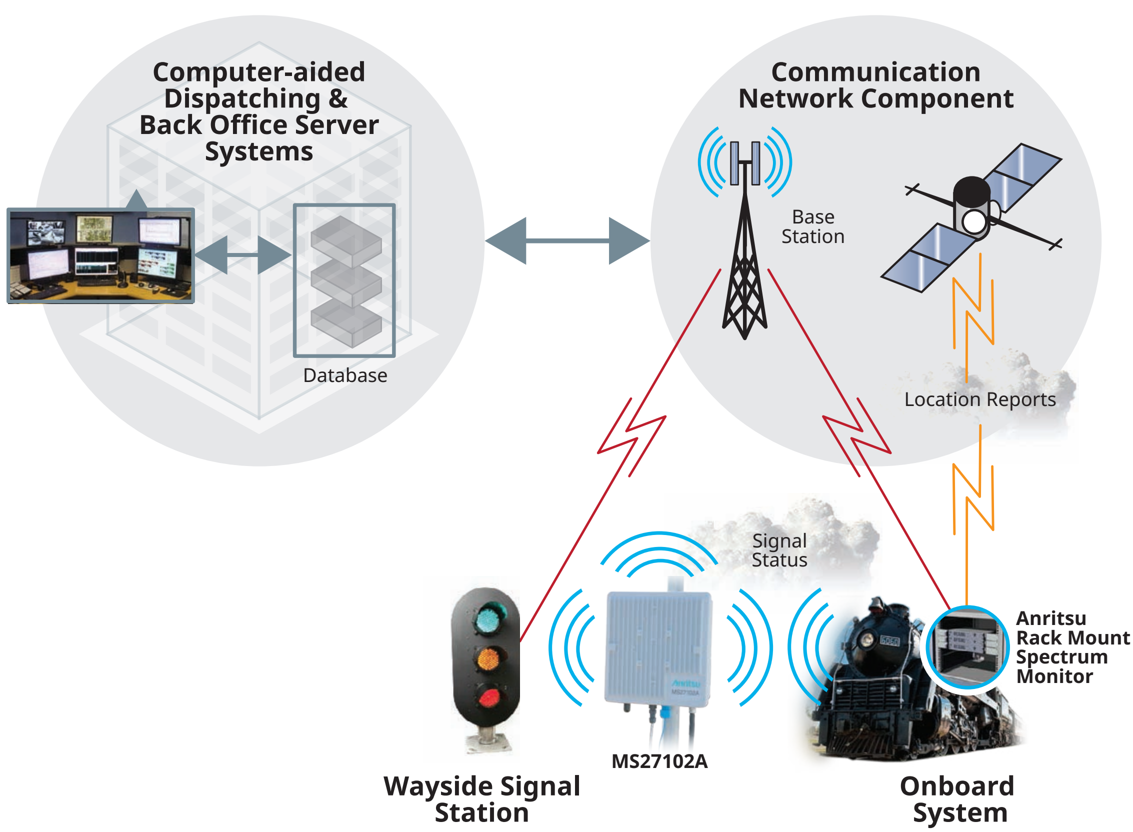

Figure 1: Spectrum Monitoring System monitoring PTC frequencies

MS27102A Remote Spectrum Monitor

Capable of sweeping at rates up to 24 GHz/s, the MS27102A allows capture of many types of signals. This includes periodic or transient transmissions as well as short “bursty” signals. Also featured is a high dynamic range, high sensitivity and low spurious signals. This enables the MS27102A (shown here in Fig 2) to reliably distinguish between low-level signals being observed and those signals generated by the monitor itself.

Figure 2: MS27102A Outdoor Spectrum Monitor (IP67)

Key facts

- 9 kHz to 6 GHz
- Sweep speed up to 24 GHz/s
- Integrated web server to view, control and conduct measurements via a web browser (both Chrome and FireFox supported)
- Remote firmware update capable
- Watchdog timer to insure long-term stability for remotely deployed monitors
- IP67 rated for outdoor deployments
- Linux operating system
- Low spurious signals for accurate signal discovery
- 20 MHz instantaneous FFT bandwidth
- Low power consumption < 11 watts (input voltage 11 to 24 VDC)
- Integrated GPS receiver for monitoring location and for time synchronization applications
- Gigabit Ethernet available for high speed transmissions
- Interference analysis: spectrogram and signal strength
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- DANL: <–150 dBm referenced to 1 Hz BW, preamp On
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- Vision™ software optional for automated spectrum measurements, setting alarms and geo-locating signal sources

Designed For Remote Applications

With monitors potentially being deployed hundreds or thousands of kilometers from the control center, it is imperative that each probe remain operational under all types of conditions. The MS27102A is designed for robust field deployments, with capabilities for remote power cycling, automated system recovery protocols and firmware updates “pushed” to the monitor remotely.

In the event of an application error or power fluctuation which causes an ongoing interruption in monitor communication, a re-boot policy is implemented to bring the remote probe back to its previous state. Under these conditions, the current firmware is automatically reloaded and on-line operation is restored. Instrument settings are also restored to their previous state.

A “Golden” firmware image is also placed on each unit in a secure location in memory. If for any reason the firmware in the unit becomes corrupted, a Golden Image is used to bring back full operation of the probe. This feature is particularly useful for remote firmware updates.

Figure 3: MS27102A Outdoor Spectrum Monitoring System

Remote Firmware Updates

There are several stages or “checks” performed when a new firmware package is downloaded remotely into the instrument. Once a new firmware image is downloaded to the monitor, various tests are performed to insure the code was properly transmitted without error (see Fig 4). The code is then transferred into probe memory and installed. If a failure occurs during firmware acquisition or validation, the process is aborted and the failure status is returned to the user. If the firmware update is installed but does not operate correctly, the Golden Image automatically replaces the downloaded firmware to keep the remote monitor operational.

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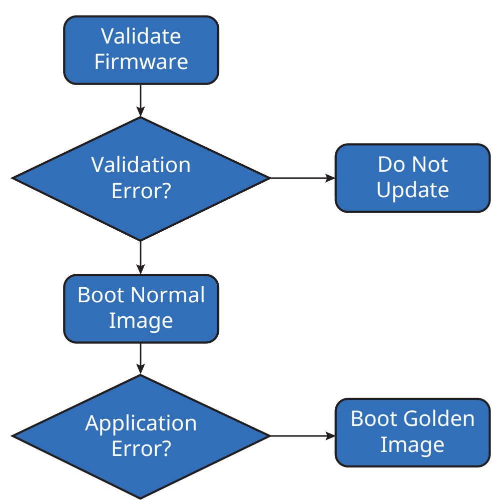

Figure 4: Firmware Update Policy

Integrated Web Server

The MS27102A features an integrated web server. Using an internet browser (Chrome and FireFox are supported), a user from anywhere in the world can log in to the spectrum monitor and control any of its features. This includes such parameters as frequency settings, RBW/VBW control, reference level configuration and many other settings relevant to the user's spectrum monitoring application. Trace data, spectrograms and other measurements can be viewed inside the browser window. A key advantage in using the web server is that it is platform agnostic. Any electronic device capable of rendering a browser will work with the web server. Users can utilize their PC/laptop, tablet or even a smartphone to view the spectrum and change instrument settings. The MS27102A features Gbit Ethernet, allowing fast transfers of measurement data and control information. Figure 5 shows the server application displayed on a smartphone.

Figure 5: User interface displayed on smartphone

See figure 6 below for the main user interface provided by the web server.

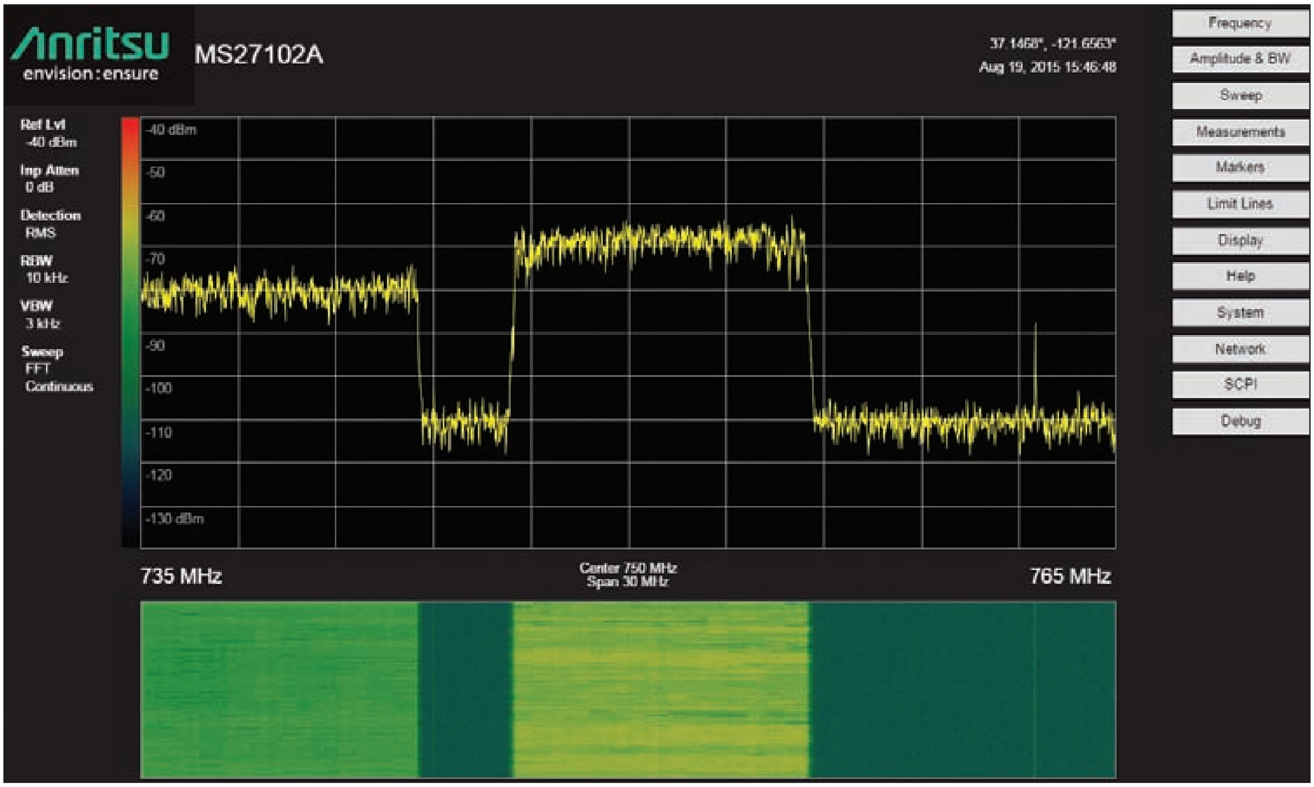

Figure 6. Screenshot of user interface

MS27102A Remote Spectrum Monitor

Hardware

The MS27102A is rated to IP67 standards for outdoor deployment. It is dust tight (no ingress of dust) as well as water resistant. This involves testing the probe for immersion into as much as 1 meter of water for durations of up to 30 minutes. Each port on the unit is ruggedized and weatherized. Ports include power, RF Input, Gbit Ethernet and GPS antenna. See figure 7 for port positioning. With an operating temperature range from –40 ºC to +55 ºC, a rugged weatherized case and splash proof design, the MS27102A works in the most extreme weather conditions with guaranteed performance anywhere and anytime.

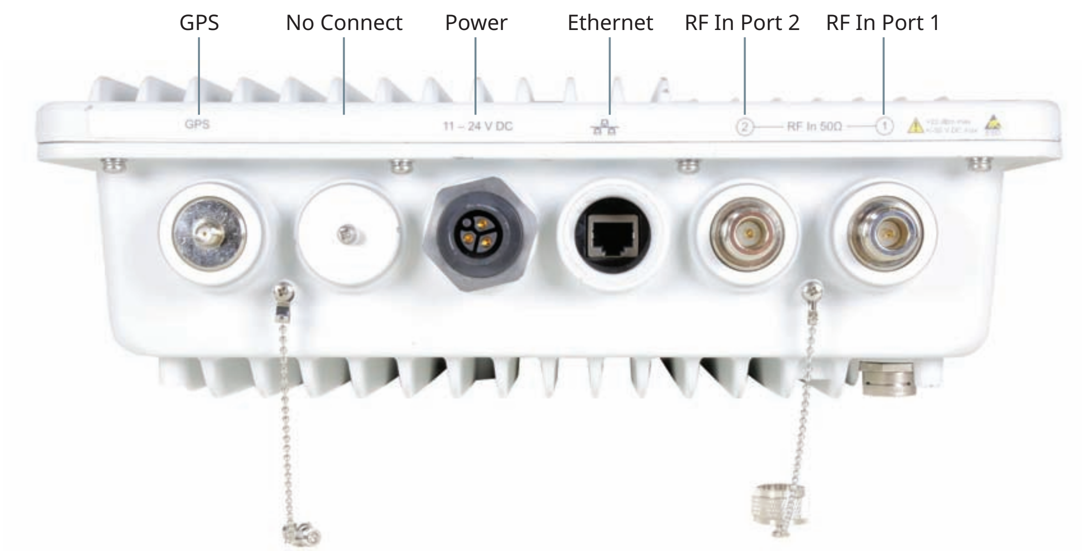

Figure 7. Port locations on MS27102A (2-port option shown)

The MS27102A comes with a mounting plate designed for field applications. With user supplied U-Bolts or clamps, the mounting plate allows the monitor to be mounted on poles of varying diameters. Instructions for mounting your spectrum monitor can be found on the Anritsu website.

The probe uses power from a 11 VDC to 24 VDC source, typically consuming less than 11 Watts. The low power consumed facilitates the use of the spectrum monitor powered from solar cells.

Key Applications

- Radio surveillance and monitoring
- Detection of illegal or unlicensed transmitters, including AM/FM and cellular broadcasts
- Coverage measurements
- Spectrum occupancy and frequency band clearing
- Fast and efficient detection and elimination of interference sources
- Monitor jails/prisons for illegal broadcasts
- Security at military facilities, national borders, utilities, airports and other sensitive sites (see fig. 8)
- Spectrum monitoring associated with lab RF testing
- Government regulators enforcing spectrum policies

Fig 8: Anritsu remote spectrum monitor positioned at airport

Signals of Interest

The wide variety of signals to be monitored fall into several categories. Each of these types of signals will be examined in some detail. These include:

- Intentional interference (including illegal or unlicensed broadcasts)
- Accidental interference
- Occupancy

Intentional Interference

Illegal AM/FM and video broadcasts are found in many parts of the world. These signals can be generated by pirated broadcast equipment or by using over-powered CB radios. Figure 9 shows a table listing interference complaints per year registered by the UK government communications regulator Ofcom. In this table, ‘Critical service’ refers to interference reports affecting life services communications.

Additionally, jammers are sometimes used for applications such as preventing students from cheating on tests, stopping employees from taking phone calls on company time or to prevent inmates from making illicit calls from prisons. Jammer signals can often leak out into the wider environment, interfering with other legitimate services. Mitigating these types of interference has become a high priority with government regulators.

YEAR	INTERFERENCE COMPLAINTS			
	Critical service		All other	
	London	Rest of UK	London	Rest of UK
1010	29	4	506	72
2011	35	0	424	69
2012	36	2	288	48
2013	21	5	179	93

Fig 9: Interference complaints published by Ofcom, communications regulator in the UK

Accidental Interference

A wide variety of accidental interference can be seen in the spectrum. A common problem is cable TV leakage. This type of leakage exists both from cable signals leaking into the outside environment as well as from external signals leaking into the cable system. This problem has been enhanced with the transmission of cable signals into frequency bands used by broadcasters and cellular operations (such as the 700 MHz LTE band).

DECT phones also cause interference problems, particularly when people bring their wireless phones along when moving from one country to another. DECT frequencies vary in different countries, providing the potential for interference when transported. Figure 10 below shows spectrum used in the U.S. for certain cellular frequencies. DECT phones brought by travelers from other countries can often cause interference.

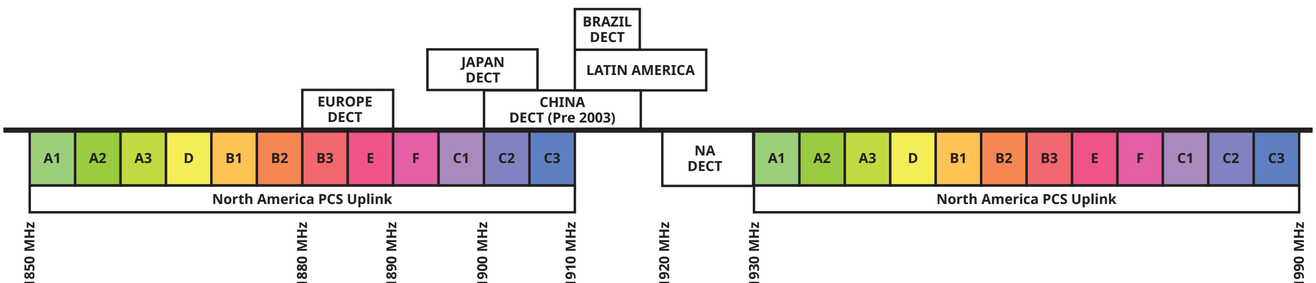

Figure 10: DECT phones improperly used can cause unintentional interference

Other sources of interference include cellular signals (due to antenna tilt or azimuth errors), repeaters oscillating, wireless microphone problems, power equipment and many others.

Occupancy

With the rapid demand for available spectrum from both public and private sectors, new ways are being investigated to allow more efficient use of various frequency bands. A lot of the spectrum is potentially underutilized, providing the opportunity to re-purpose existing spectrum with additional applications.

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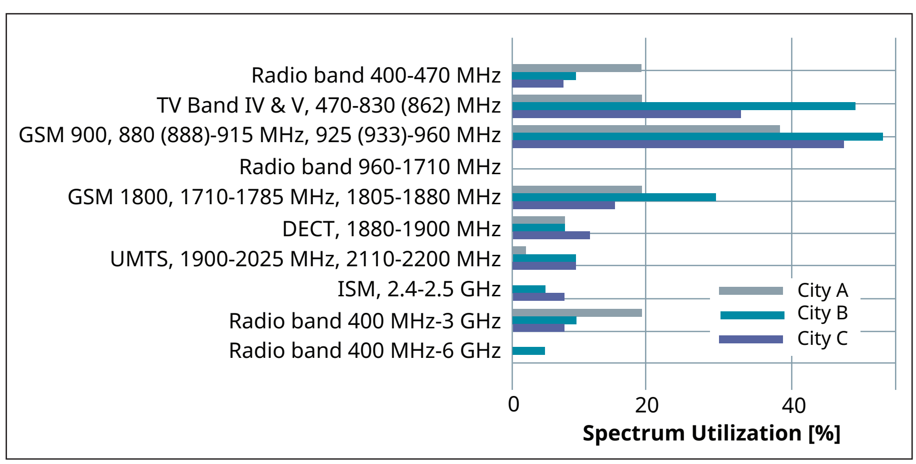

Figure 11: Spectrum occupancy measurement

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Performance

The MS27102A is able to sweep the frequency spectrum at rates up to 24 GHz/s. This enables the user to capture intermittent or pulsed signals. Additionally, the spectrum monitor has an instantaneous FFT bandwidth of 20 MHz.

A typical use case for this feature is the real-time capture of the entire FM radio band (88 MHz to 108 MHz in most countries). The user can perform multiple FFT captures of FM signals, storing the data for later playback and analysis. Unlicensed signals can then be identified using this information.

Multiple spectrum sensors can also be deployed to extend the RF monitoring capabilities and for geo-location of signals of interest. Using three or more probes, Anritsu's optional Vision™ software can be used to position an interferer signal or illegal broadcast. Additionally, IQ measurements are time stamped using the probe's GPS receiver. This enables the user to employ their own software using Time Distance of Arrival (TDOA) capabilities to find interferers, given each IQ measurement is precisely time stamped. See figure 12 for TDOA example.

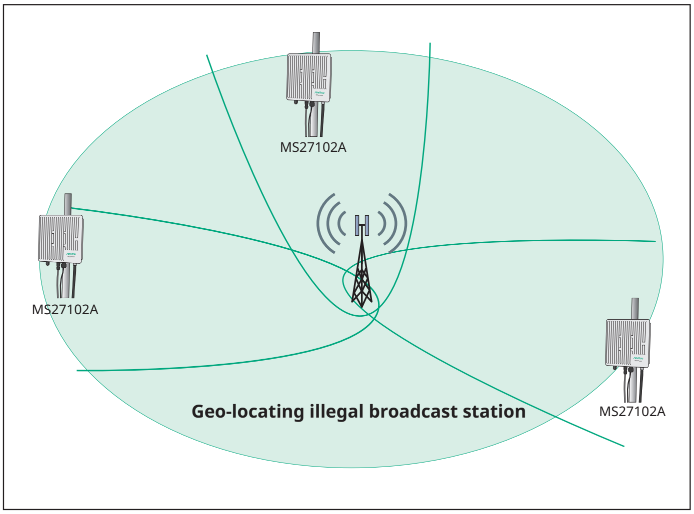

Figure 12: Time Distance of Arrival for geo-locating interference signal

Communications

Communications with the MS27102A are conducted via wired Ethernet. Each monitor is shipped with a pre-programmed static IP address. After making a connection with this IP address, users can then change the address to a different static IP. Alternatively, DHCP or DNS may be used. See Anritsu's Ethernet Configuration Guide for details.

All commands and inquiries with the MS27102A are done using SCPI commands. Anritsu provides a user manual listing each SCPI command, a description of each command and the correct syntax for each command. Users may also download a text file containing SCPI commands to be executed in sequence on the probe.

Summary

The MS27102A is the ideal solution for unwanted signal detection. Using Anritsu's Vision software or your own applications, users can identify patterns of interference, record spectrum history and geo-locate the sources of problem signals. Together with other Anritsu interference mitigation products, Anritsu provides the total solution to your interference mitigation needs.

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Product Brochure

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MS27103A

Remote Spectrum Monitor

Introduction

Over the past few years, large investments have been allocated for frequency spectrum through government auctions. This auction process has been replicated in many parts of the world. A small sample of some of the dollar amounts for various years are shown below, with currencies given in USD:

- $50 billion - Germany (year 2000)
- $13 billion – India (year 2015)
- $5 billion - Canada (year 2011)
- $38 billion – UK (year 2000)

Source: Wikipedia

In early 2015, the AWS-3 auction (65 MHz of spectrum) netted $45 billion in the U.S. See figure 1 for a breakdown in expenditures per carrier. This represents a 4x increase over the AWS-1 auction (90 MHz of spectrum) in 2006 when measured in $/MHz-Pop. *

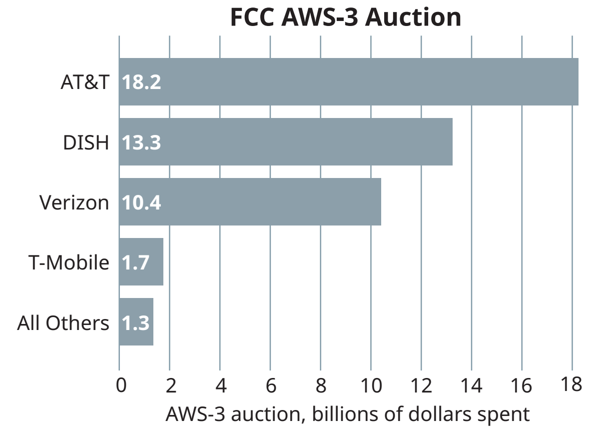

Figure 1. Expenditure per carrier at AWS-3 auction

Protecting Your Investment

To protect the investment value of this spectrum, it is imperative that operators provide quality service to their customers. With superior voice/data quality in the network comes increased demand for that service.

With the proliferation of cellular standards and new frequencies being assigned, operators face increasing challenges to keep their networks operating at an optimal level. Interference from a variety of sources leads to dropped calls, slow data rates and poor network performance. Today's users want their applications to work anywhere and anytime, at the fastest data rates possible. Optimizing the user experience is therefore a primary goal of network operators. This translates into customer loyalty, reduced customer churn and superior brand.

Interference Degrades Network Capacity

A key impediment to good network performance is the presence of interference. Sources of interference include illegal or unlicensed broadcasters, repeaters (Figure 2), DECT phones (Figure 3), jammers, wireless microphones and cable TV leakage. Interference can also come from other cellular networks, particularly along national borders where competing services are subject to different regulatory entities.

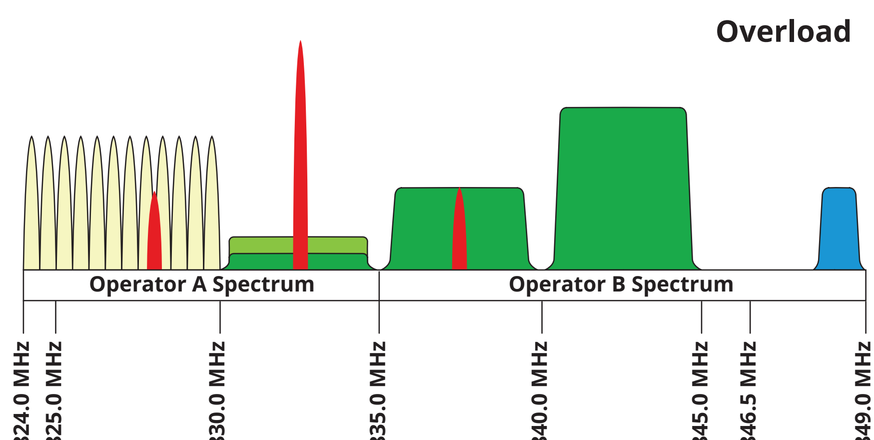

Figure 2. Malfunctioning repeaters may block cellular transmissions

* MHz PoP is the standard unit for measuring spectrum prices. It is defined as Sales Price / (MHz of license x population covered).

MS27103A Remote Spectrum Monitor

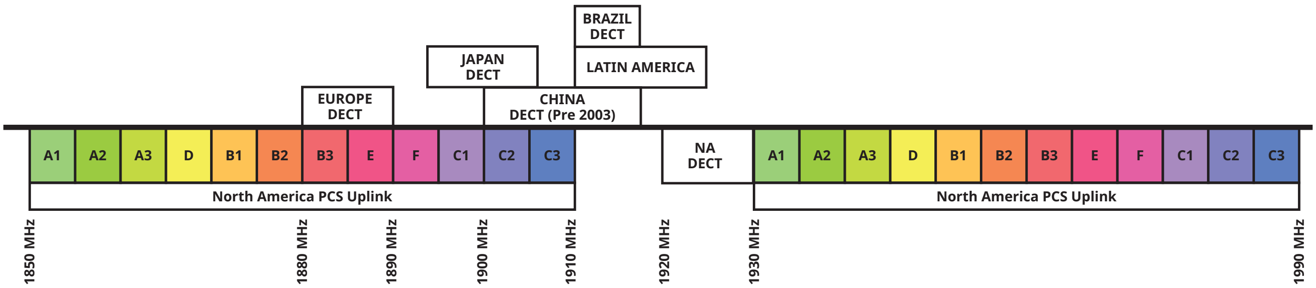

Figure 3. International DECT phone frequencies operate in U.S. cellular bands

Traditional methods for mitigating interference are expensive and time consuming. Usually the first indication of a problem is an alarm generated by a Key Performance Indicator (KPI). KPIs can detect the presence of unusual network behavior such as dropped calls, hand-over success rates and traffic channel congestion rates. When a problem in the network is suspected, a variety of issues can serve as the cause of the problem. These include equipment firmware malfunctions, hardware problems, passive inter-modulation (PIM) and external interference. Trouble-shooting the system to identify the category of problem can by itself consume a lot of time and effort even for experienced technicians (see Figure 4).

Typically when a network problem surfaces, a service employee will travel to the base station site to view the spectrum. Coupling in to the uplink antenna port, the receive band spectrum can be viewed for any unusual signal activity. If a suspicious signal is found, the technician may then perform an interference hunt to locate the source of the problem.

Figure 4. Technician examining spectrum at BTS location

Remote Spectrum Monitoring

A spectrum monitoring system will facilitates the identification and removal of interference signals that reduce network capacity. By monitoring spectrum on a continual basis, problem signals can be identified as they occur in real time. Patterns of unwanted signal activity can also be examined, providing an efficient way to characterize and locate the source of the interference problem. Figure 5 shows one possible configuration for Anritsu's remote spectrum monitor.

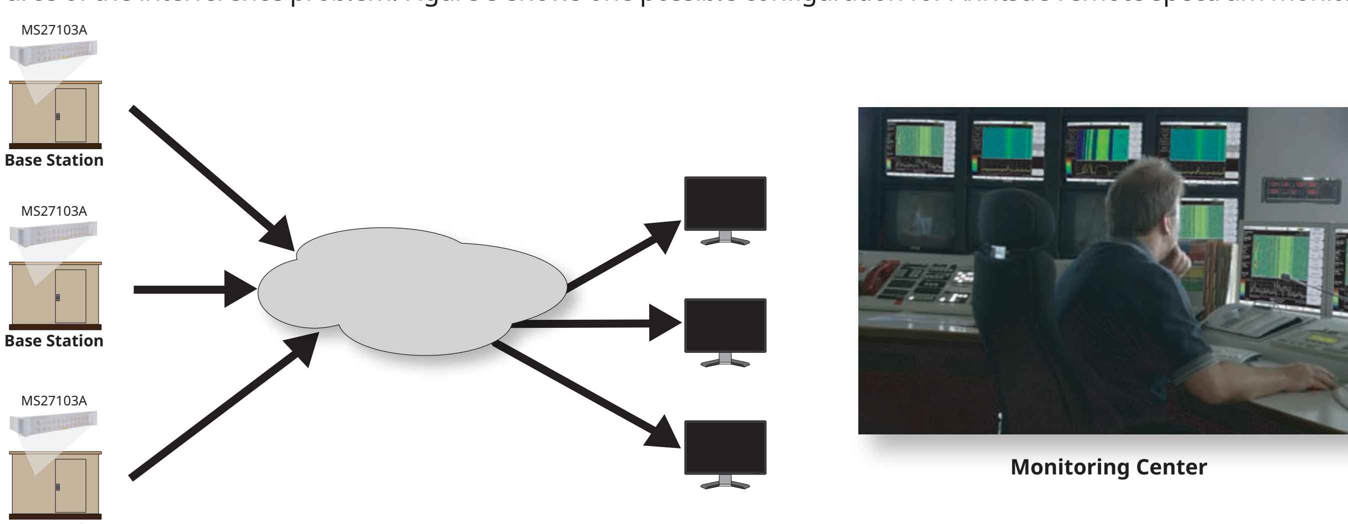

Figure 5: Remote spectrum monitoring

MS27103A Remote Spectrum Monitor

Capable of sweeping at rates up to 24 GHz/s, the MS27103A allows capture of many types of signals. This includes periodic or transient transmissions as well as short “bursty” signals. Also featured is a high dynamic range, high sensitivity and low spurious signals. This enables the MS27103A to reliably distinguish between low-level signals being observed and those signals generated by the monitor itself.

Key facts

- 9 kHz to 6 GHz
- Sweep speed up to 24 GHz/s
- Integrated web server to view, control and conduct measurements via a web browser (both Chrome and FireFox supported)
- Remote firmware update capable
- Watchdog timer to insure long-term stability for remotely deployed monitors
- Available in a 12 or 24 port RF In configuration
- Linux operating system
- Low spurious signals for accurate signal discovery
- 20 MHz instantaneous FFT bandwidth
- Low power consumption < 11 watts (input voltage 11 to 24 VDC)
- Integrated GPS receiver for monitoring location and for time synchronization applications
- Gigabit Ethernet available for high speed transmissions
- Interference analysis: spectrogram and signal strength
- Dynamic range: > 106 dB normalized to 1 Hz BW
- DANL: <–150 dBm referenced to 1 Hz BW, preamp On
- Phase noise: –99 dBc/Hz @ 10 kHz offset at 1 GHz
- IQ block mode and streaming with time stamping for TDOA applications
- Vision™ software optional for automated spectrum measurements, setting alarms and geo-locating signal sources

Designed For Remote Applications

With monitors potentially being deployed hundreds or thousands of kilometers from the control center, it is imperative that each probe remain operational under all types of conditions. The MS27103A is designed for robust field deployments, with capabilities for remote power cycling, automated system recovery protocols and firmware updates “pushed” to the monitor remotely.

In the event of an application error or power fluctuation which causes an ongoing interruption in monitor communication, a re-boot policy is implemented to bring the remote probe back to its previous state. Under these conditions, the current firmware is automatically reloaded and on-line operation restored. Instrument settings are also restored to their previous state.

A “Golden” firmware image is also placed on each unit in a secure location in memory. If for any reason the firmware in the unit becomes corrupted, a Golden Image is used to bring back full operation of the probe. This feature is particularly useful for secure remote firmware updates.

Remote Firmware Updates

There are several stages or “checks” performed when a new firmware package is downloaded remotely into the instrument. Once a new firmware image is downloaded to the monitor, various tests are performed to insure the code was properly transmitted without error. The code is then transferred into probe memory and installed. If there are any issues with this process or the new firmware does not work correctly, the Golden Image automatically replaces the downloaded firmware to keep the remote monitor operational. See figure 6 for illustration of the MS27103A remote firmware update policy.

The Golden Image feature provides the user with assurance that the monitor stays in operation when changes are made to the code. Any bug fixes, updates or user requested features can then be remotely sent to the spectrum monitor and safely incorporated.

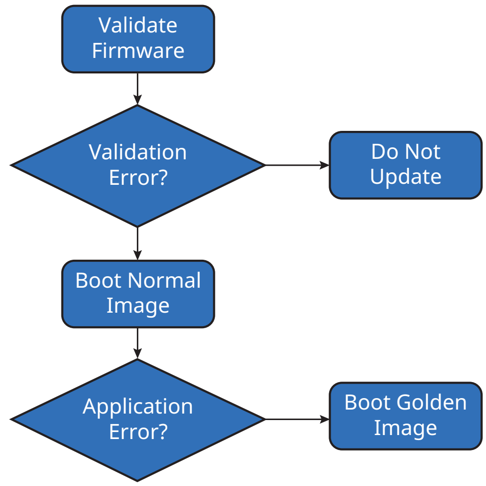

Figure 6: Remote firmware update policy

Integrated Web Server

The MS27103A features an integrated web server. Using an internet browser (Chrome and FireFox are supported), a user from anywhere in the world can log in to the spectrum monitor and control any of its features. This includes such parameters as frequency settings, RBW/VBW control, reference level configuration and many other settings relevant to the user’s spectrum monitoring application. Trace data, spectrograms and other measurements can be viewed inside the browser window. A key advantage in using the web server is that it is platform agnostic. Any electronic device capable of rendering a browser will work with the web server. Users can utilize their PC/laptop, tablet or even a smartphone to view the spectrum and change instrument settings. The MS27103A features Gbit Ethernet, allowing fast transfers of measurement data and control information. Figure 7 shows the server application displayed on a smartphone.

Figure 7: User interface displayed on smartphone

See Figure 8 below for the main user interface provided by the web server.

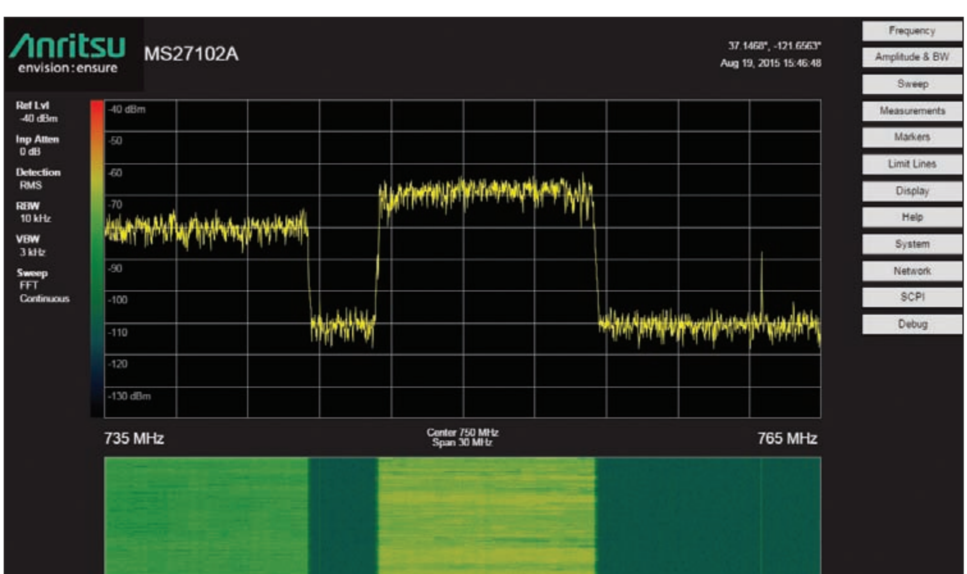

Figure 8. Screenshot of user interface.

Hardware

The MS27103A provides 12 RF Input ports as a standard configuration. This model is typically used with 3 sector BTS architecture, with multiple carriers per sector. A high speed switch is placed in the monitor to provide measurement capability for each RF input. This electronic switch can move from port to port in approximately 300 nS. A greater than 30 dB isolation is provided between each RF Input port to assure the integrity of the measurement.

Option 424 allows the MS27103A to be upgraded to 24 RF Input ports. This option is optimal for 6 sector BTS operation or other applications where access to a large number of antennas and frequency bands is required. See Figure 9 for a 24-port RF input configuration.

The probe operates with either a 220V/110V AC source or –48 VDC supply. The MS27103A is environmentally friendly, typically consuming less than 11 Watts.

Figure 9. MS27103A with 24-port option

Key Applications

- Network interference monitoring
- Geo-location of interference signals
- Maintain history of spectrum activity
- Set power threshold levels to automatically generate alarms
- Generate records of interference events for potential legal action

Signals of Interest

The wide variety of signals to be monitored fall into several categories. Each of these types of signals will be examined in some detail. These include:

- Intentional interference (including illegal or unlicensed broadcasts)
- Accidental interference
- Occupancy

Intentional Interference

Illegal AM/FM and video broadcasts are found in many parts of the world. These signals can be generated by pirated broadcast equipment or over-powered CB radios. Additionally, jammers are sometimes used for applications such as preventing students from cheating on tests, stopping employees from taking phone calls on company time or to prevent inmates from making illicit calls from prisons. Jammer signals can often leak out into the wider environment, interfering with other legitimate services.

Accidental Interference

A wide variety of accidental interference can be seen in the spectrum. A common problem is cable TV leakage. This type of leakage exists both from cable signals leaking into the outside environment as well as from outside signals leaking into the cable system. This problem has been enhanced with the transmission of cable signals into frequency bands used by broadcasters and cellula operations (such as the 700 MHz LTE band).

DECT phones also cause interference problems, particularly when people bring their wireless phones along when moving from one country to another. DECT frequencies vary in different countries, providing the potential for interference when transported.

Other sources of interference include cellular signals (due to antenna tilt or azimuth errors), repeaters oscillating, wireless microphone problems, power equipment and many others.

Occupancy

With the rapid demand for available spectrum from both public and private sectors, new ways are being investigated to allow more efficient use of various frequency bands. To ensure continued growth in the future, regulators will be looking at various frequency bands that may be under-utilized. This spectrum can be re-purposed from low occupancy to high occupancy applications. Spectrum clearing and resolving interference issues will be important as a prerequisite to using these frequencies. Spectrum occupancy measurements quantify the amount of use of frequency bands over a given period of time (see Figure 10). Remote spectrum probes are used to monitor a band of frequencies, recording spectral histories as a function of time.

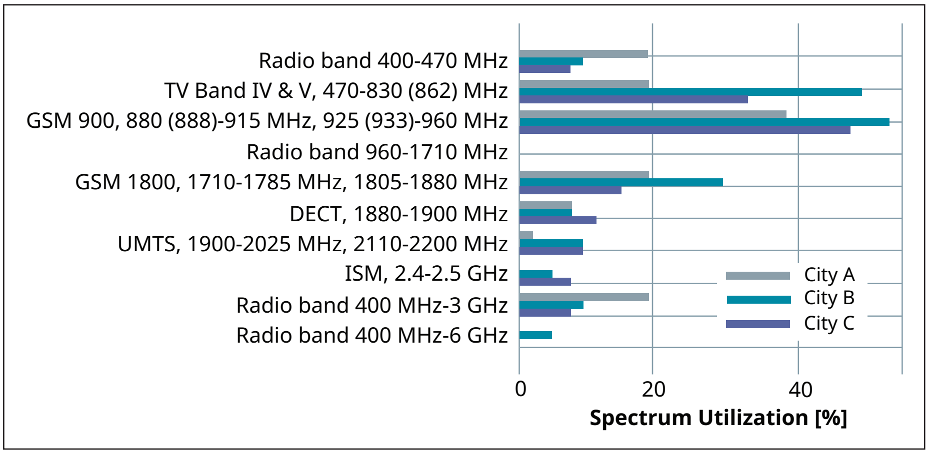

Figure 10: Spectrum occupancy measurement

Performance

The MS27103A is able to sweep the frequency spectrum at rates up to 24 GHz/s. This enables the user to capture intermittent or pulsed signals. Additionally, the spectrum monitor has an instantaneous FFT bandwidth of 20 MHz.

Multiple spectrum sensors can also be deployed to extend the RF monitoring capabilities and for geo-location of signals of interest. Using three or more probes, Anritsu's optional Vision™ software can be used to position an interferer signal or illegal broadcast. Additionally, IQ measurements are time stamped using the probe's GPS receiver. This enables the user to employ their own software using Time Distance of Arrival (TDOA) capabilities to find interferers, given each IQ measurement is precisely time stamped. See Figure 11 for TDOA example.

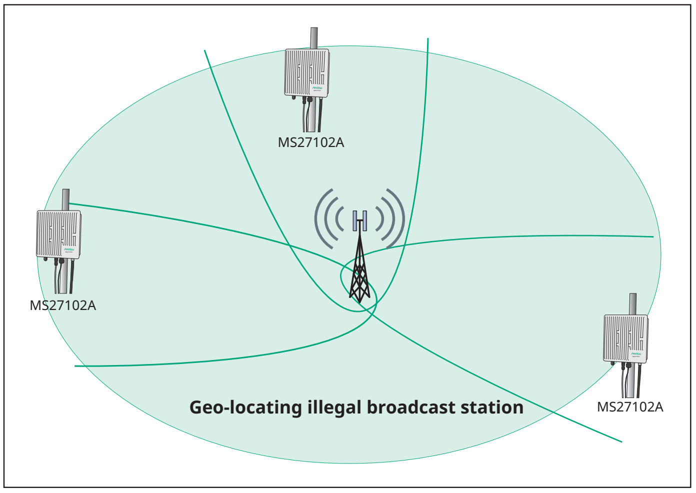

Figure 11: Time Distance of Arrival for geo-locating interference signal

Communications

Communications with the MS27103A are conducted either via wired Ethernet or wireless modem. Each monitor is shipped with a pre-programmed static IP address. After making a connection with this IP address, users can then change the address to a difference static IP. Alternatively, DHCP or DNS may be used. See Anritsu's Ethernet Configuration Guide for details.

All commands and inquiries with the MS27103A are done using SCPI commands. Anritsu provides a user manual listing each SCPI command, a description of each command and the correct syntax for each command. Users may develop their own list of SCPI commands and save to a text (.txt) file. This file can then be downloaded to the spectrum monitor for execution.

Summary

Key benefits for Anritsu remote spectrum monitoring include both automation and scalability. To minimize expenses while preserving network integrity, a highly automated process is needed. The MS27103A takes a lot of the guesswork out of identifying causes for slow data rates or dropped calls. Using Anritsu's Vision software or your own applications, users can identify patterns of interference, record spectrum history and geo-locate the sources of problem signals. The MS27103A is also highly scalable. Additional monitors can be added to your network seamlessly as the need for interference mitigation grows. Also, new features and options that become available can be added remotely. No site visits required. Together with other Anritsu interference and PIM mitigation products, Anritsu provides the total solution to insure the integrity of your valuable spectrum.

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Product Brochure

Anritsu envision : ensure

MX280001A

Vision™ Software

MX280001A Vision Software

Introduction

Spectrum monitoring systems facilitate the identification and removal of interference signals that degrade network capacity. By monitoring spectrum on a continual basis, problem signals can be identified as they occur in real time. Patterns of unwanted signal activity can also be examined, providing an efficient way to characterize and locate the source of the interference problem.

In addition to interference detection, spectrum monitoring is also used to characterize spectrum occupancy. Government regulators and operators are often interested in determining the usage rate for various frequency bands. Monitoring these frequencies provides the information needed to optimize spectrum for maximum utilization. Spectrum can be re-purposed for other applications or multiplexed with other signals using cognitive radio techniques.

Spectrum monitoring also serves to enforce compliance with government regulations. Police, fire fighters, air traffic control, military and emergency services must all have access to communications free of impediments and distortion. Compliance with spectrum regulations is often enforced by spectrum monitoring. Figure 1 shows spectrum monitors surrounding a prison facility, looking for illegal transmissions.

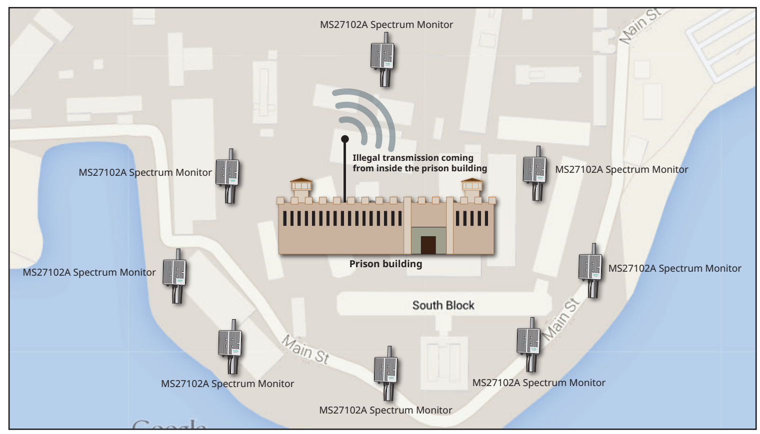

Figure 1: Monitoring for illegal transmissions from prison facility

Vision™ Software Overview (MX280001A)

The Vision™ software platform works with Anritsu's spectrum monitoring hardware to automate the process of collecting measurement data, providing useful information about network health and use of the spectrum. Using multiple hardware probes covering a wide geographical area, Vision presents a comprehensive picture of spectral activity to assist users in monitoring the spectrum for unusual activity. Figure 2 shows a typical signal monitoring system with Anritsu spectrum monitors positioned for maximum coverage.

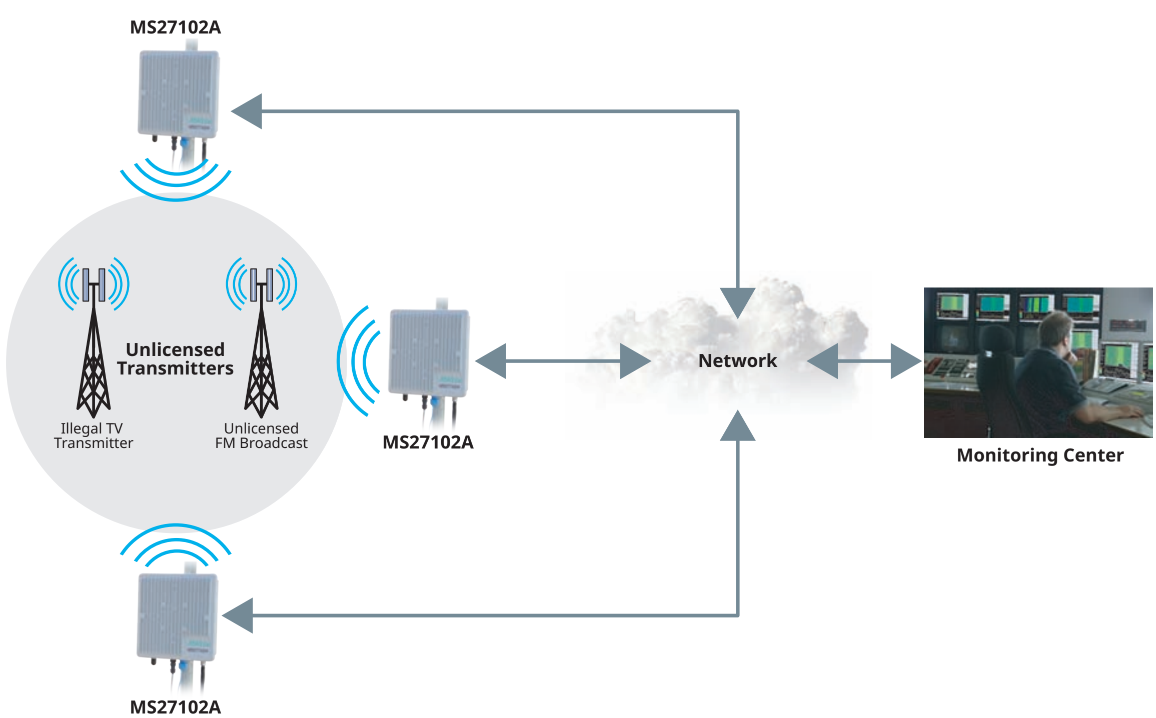

Figure 2: Spectrum monitoring system

Vision software facilitates a variety of applications used for spectrum monitoring systems. One important application includes determining the presence of interferers in a network which can degrade communications services. Cellular operators in particular are vulnerable to such interference that manifests itself in slower data rates and dropped calls. In most cases, network performance is compromised on the uplink frequency bands (communication from the mobile unit to the base station). However, network quality of service can also be impacted by interference on the downlink channels. This type of interference can be prevalent at the cell periphery where the power levels of the interference signals approximate those transmitted by the base station itself.

Another important application for Vision software is the detection of illegal or unlicensed broadcast signals. Illegal broadcasters may set up AM/FM, cellular or other types of transmissions which must be identified and ultimately located. By using spectrum monitors, unlicensed broadcasts can be tracked, processed and stored in a database for further examination and potential use in legal proceedings. See figures 3 and 4 for important spectrum monitoring applications.

Figure 3: Stadium monitoring

Other applications include the following:

- Inform spectrum policy – accumulate historical spectrum data to determine percent time of occupancy
- Monitor jails/prisons for unauthorized transmissions
- Monitor borders, airports, nuclear facilities and other sensitive areas
- Railroads – monitor spectrum for potential interference of positive train control (PTC) signals
- Satellite reception interference detection
- Interference monitoring at large venues such as stadiums, malls, etc
- White space monitoring
- Indoor monitoring (board rooms, embassies and other sensitive facilities). See Figure 5.

Figure 4: Airport frequency monitoring

Figure 5: Indoor transmissions detection

Vision Software – How it Works

Vision is an optional software program which runs on a PC using the Windows operating system (Windows 7 or 8). This software provides control and automation capabilities when used with Anritsu's spectrum monitor hardware. Vision is composed of two components responsible for monitoring and geo-locating interference signals, called Vision Monitor and Vision Locate respectively. Each performs a wide range of spectrum monitoring and control applications designed to mitigate interference problems and detect unusual signal activity. A summary of each Vision software product is presented below.

Vision Monitor

The Vision Monitor program is the visible user interface for monitoring remote spectrum activity. It provides a listing of all hardware monitors in the system along with a graphic overview of system health. A screenshot of the main user interface for Vision Monitor is shown in figure 6.

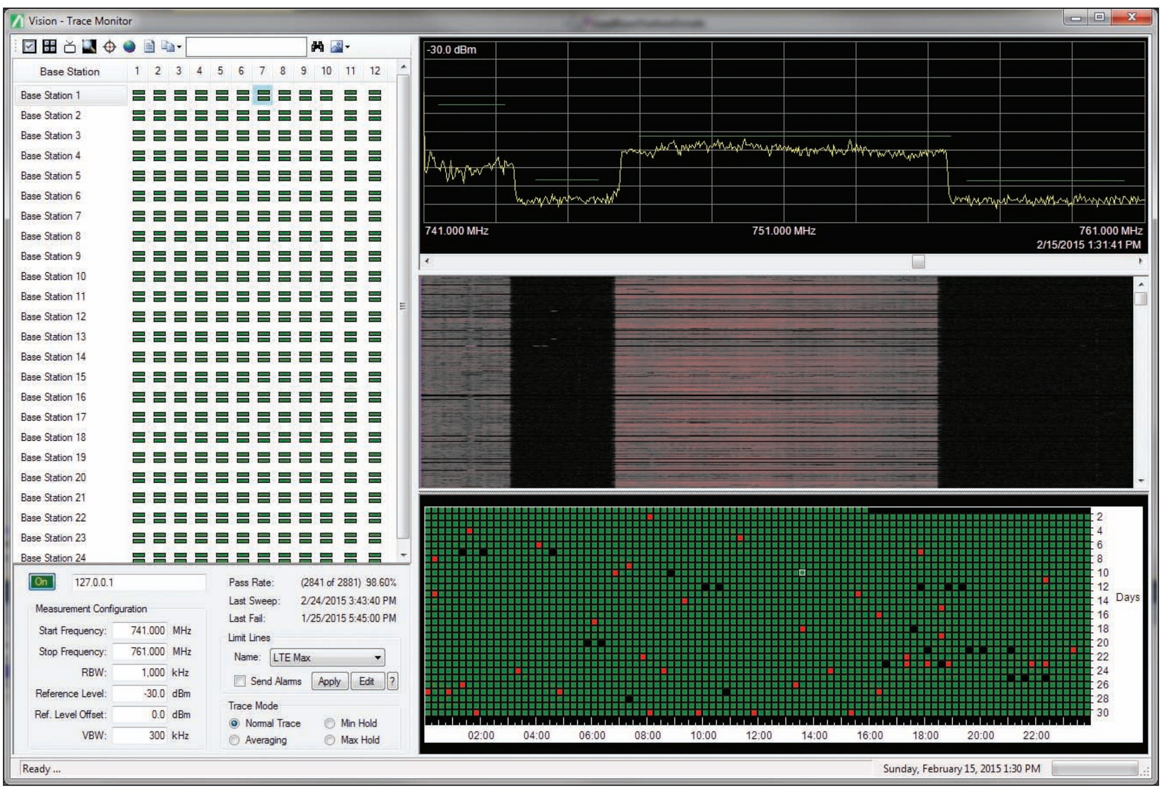

Figure 6: Vision monitor screen

Shown here is a listing of the deployed monitors, with the ability to view both "real-time" and historic measurement trace and spectrogram data.

Vision Monitor performs a wide range of spectrum monitoring duties. These functions include:

- Measurement acquisition
- Data storage
- Threshold setting/Alarm generation
- Reporting

Users can set up the Vision program to take automatic measurements for all spectrum monitors. The measurements are in turn uploaded into a database for further review. The database is updated with new data, while old information is periodically purged according to user settings. Functions are also available for archiving, copying and compressing the database. See Figure 7 for illustration

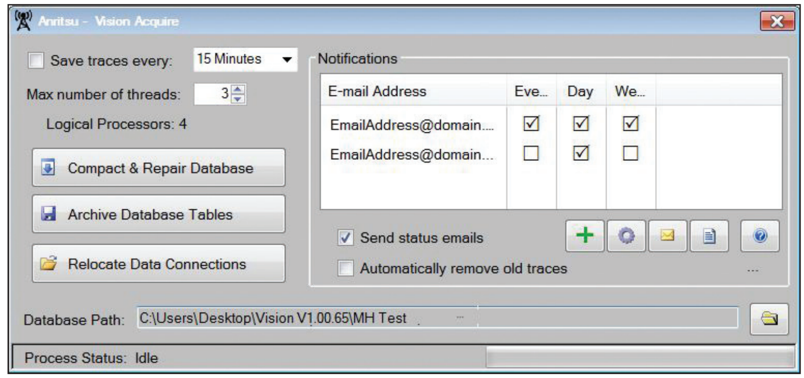

Figure 7: Vision Monitor measurement and database control

With Vision Monitor, the user can set up limit lines for triggering alarms, view spectrum history and change measurement parameters of individual or groups of spectrum monitor probes. The program makes heavy use of intuitive graphics to indicate the presence of interference or other signals of interest. Additionally, searches both in real-time and over history can be made to indicate patterns of interference. In some cases, interference may only occur at certain times of the day or certain days of the week. It is important to be able to capture the signal, identify the pattern and subsequently hunt for the signal location at the appropriate times. In addition to trace data, spectrograms can be viewed to indicate changes in frequency over time for suspicious signals.

For each remote monitor, Vision Monitor is capable of collecting data from as many as 24 input RF ports. This can be ideal for cellular systems with multiple sectors and multiple frequencies per sector. Figure 8 shows a screen shot of the user interface with multiple monitors overlayed on a map. Both GoogleMaps and OpenStreetMap are available. Using this map, alarm threshold violations can be easily seen with color changes on the probe indicating a frequency threshold violation at that site. If needed, automated email alerts can be sent to any email address provided. These alerts can be emailed in real-time or sent as summary reports on a daily or weekly basis. These reports are a great tool for provide a snap shot of the network's health and provide time-stamped indications of when a suspicious signal might be present.

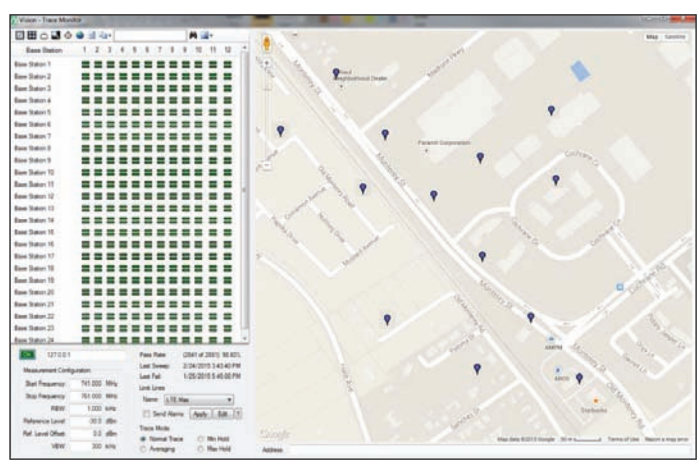

Figure 8: Monitor positions overlaid on map

Vision Locate

Vision Locate is an optional program used with Vision Monitor. Once an interferer or suspected illegal signal is identified, a geo-location algorithm is employed to fix the approximate position of the signal. This enables the user to narrow down the signal location, minimizing the time and expense for pin-pointing its position. A sample map is shown in Figure 9 showing the suspected interference position. In this window, the probe locations are indicated by the red squares. The interference position is identified by the concentric circles.

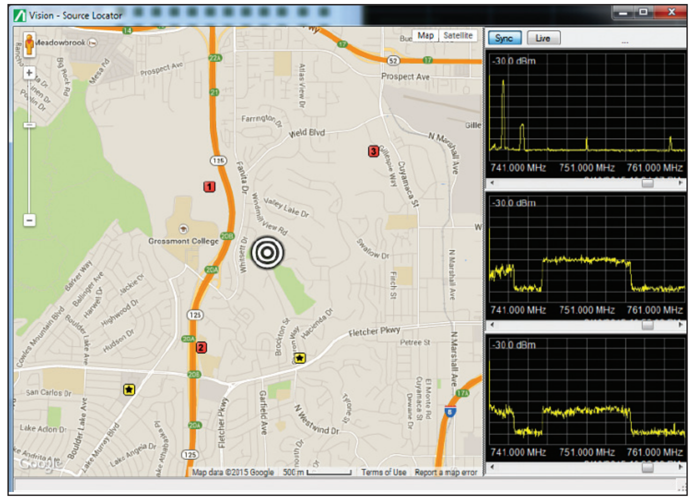

Figure 9. Geo-location of signal on map overlay

For interference that may have occurred in the past, users can also use historical data for positioning the signal of interest. A search can be done for alarm violations that occurred at any of the spectrum monitor probes in the network. Using three probes in the vicinity, the interference position can be geo-located.

Power of Arrival (POA) algorithms are used to position the interference signal. Three or more probes must be in the vicinity to detect the signal of interest in order to correctly triangulate the position.

Remote Spectrum Monitoring Hardware

Anritsu offers several spectrum monitoring systems designed for both indoor and outdoor environments. The MS27102A monitor is an outdoor IP67-rated probe that can be positioned on towers, rooftops or poles. It is ideally used to monitor for both interference and unusual signal activity. The MS27103A, which maintains 12 or optionally 24 RF inputs, is designed specifically for cellular system or in applications requiring multiple RF inputs. The MS27103A is also ideal for monitoring for interference in DAS environments. Both platforms are designed for stability, sweep speed and low spurious signals. Figures 10 and 11 show each probe.

Figure 10: MS27102A

Figure 11. MS27103A (24-Port RF Input option shown)

Key features for each hardware platform include the following:

- 9 kHz to 6 GHz
- Sweep speed up to 24 GHz/s
- Integrated web server to view, control and conduct measurements via a web browser (both Chrome and FireFox supported)
- Remote firmware update capable
- Watchdog timer to insure long-term stability for remotely deployed monitors
- IP67 rated for outdoor deployments
- Linux operating system
- Low spurious signals for accurate signal discovery
- 20 MHz instantaneous FFT bandwidth
- Low power consumption < 11 watts (input voltage 11 to 24 VDC)
- Integrated GPS receiver for monitoring location and time synchronization applications
- Gigabit Ethernet available for high speed transmissions
- Interference analysis: spectrogram and signal strength
- Dynamic range: > 106 dB normalized to 1 Hz BW
- DANL: <–150 dBm referenced to 1 Hz BW, preamp On
- Phase noise: –99 dBc/Hz @ 10 kHz offset at 1 GHz
- IQ block mode and streaming with time stamping for TDOA applications
- Vision™ software optional for automated spectrum measurements, setting alarms and geo-locating signal sources

Summary

In order to minimize expense while preserving network integrity, a highly automated process is required. Vision software provides an efficient user-friendly method for monitoring frequencies, alerting the user when unusual signal activity is present. By identifying patterns of interference, recording spectrum history and geo-locating the position of target signals, Vision software is the perfect solution for your interference mitigation needs.

Ordering Information

The Vision software application can be downloaded from the Anritsu website. In order to use Vision, an Anritsu spectrum monitor must be purchased and enabled with the option. Note that in order to use Vision Locate for geo-location, Vision Monitor must also be purchased.

MS27102A-0400	Vision Monitor enabled on MS27102A
MS27102A-0401	Vision Locate enabled on MS27102A
MS27103A-0400	Vision Monitor enabled on MS27103A
MS27103A-0401	Vision Located enabled on MS27103A

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