

MS27103A

Remote Spectrum Monitor



Introduction

Over the 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. *

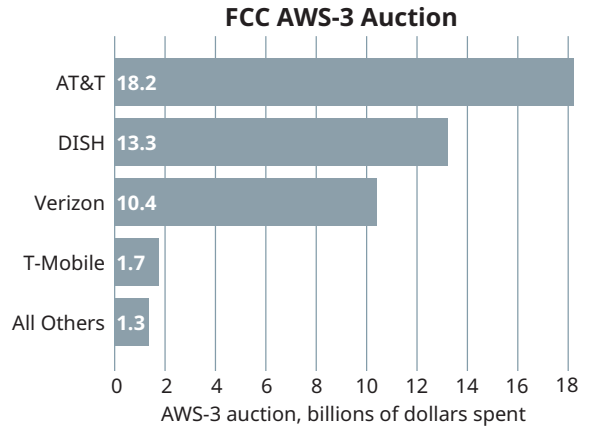


Figure 1. Expenditure per Carrier at AWS-3 Auction

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), digital enhanced cordless telecommunications (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.

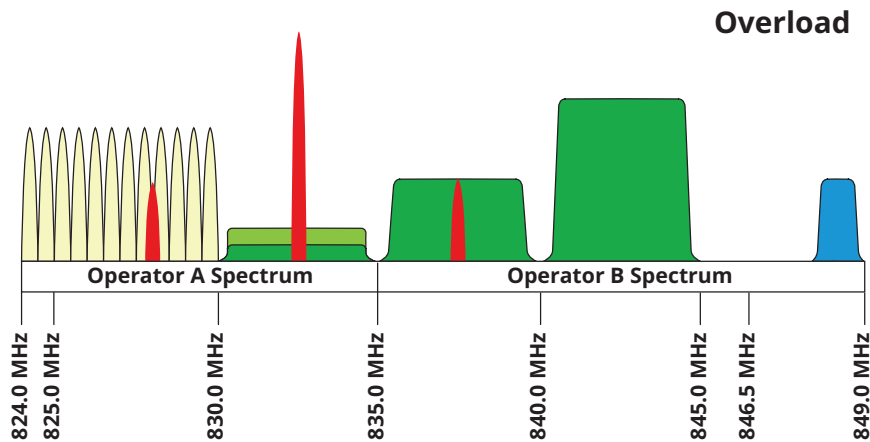


Figure 2. Malfunctioning Repeaters May Block Cellular Transmissions

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

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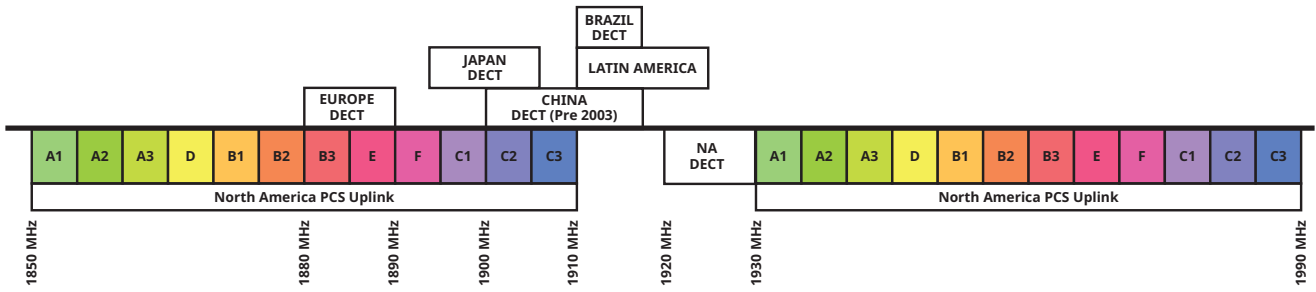


Figure 3. International DECT Phone Frequencies Operate in US Cellular Bands

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).

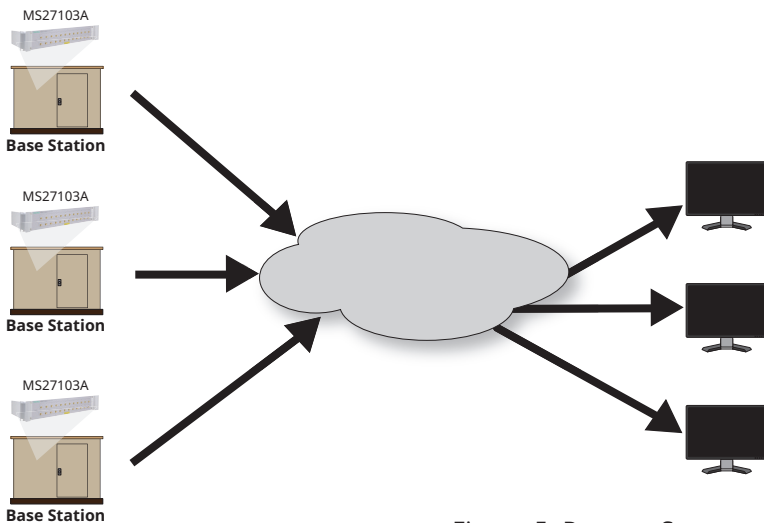
Typically when a network problem surfaces, a service employee will travel to the base station site to view the spectrum. Coupling in to the uplink antenna port, the receive band spectrum can be viewed for any unusual signal activity. If a suspicious signal is found, the technician may then perform an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



Figure 4. Technician Examining Spectrum at Base Transceiver Station (BTS) Location

Remote Spectrum Monitoring

A spectrum monitoring system will facilitate 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.



Monitoring Center

Figure 5: Remote Spectrum Monitoring

Remote Spectrum Monitor MS27103A

Remote Spectrum Monitor MS27103A

Capable of sweeping at rates up to 24 GHz/s, the Remote Spectrum Monitor 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 Remote Spectrum Monitor MS27103A to be reliably distinguished 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 Remote Spectrum Monitor 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 online 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.

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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 Remote Spectrum Monitor 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.

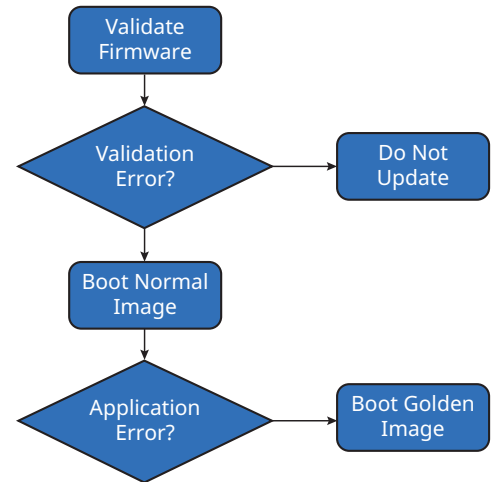


Figure 6: Remote Firmware Update Policy

Integrated Web Server

The Remote Spectrum Monitor 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 Remote Spectrum Monitor MS27103A features Gbit Ethernet, allowing fast transfers of measurement data and control information. Figure 7 shows the server application displayed on a smartphone.

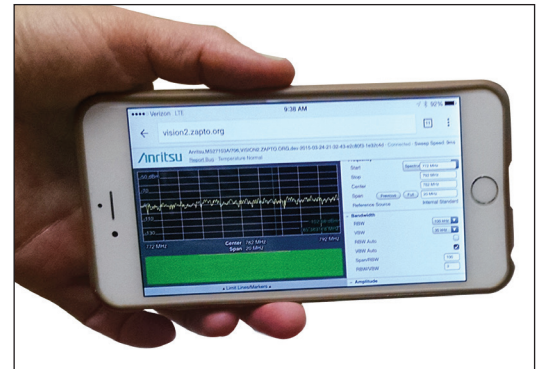


Figure 7: User Interface Displayed on Smartphone

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

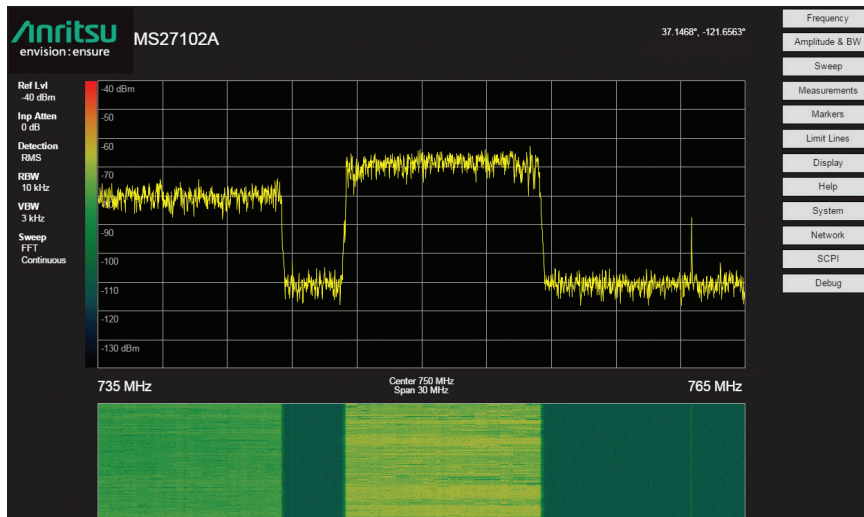


Figure 8. Screenshot of User Interface

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Hardware

The Remote Spectrum Monitor 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 Remote Spectrum Monitor 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 Remote Spectrum Monitor 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 (SOI)

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.

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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 as seen in figure 10. Remote spectrum probes are used to monitor a band of frequencies, recording spectral histories as a function of time.

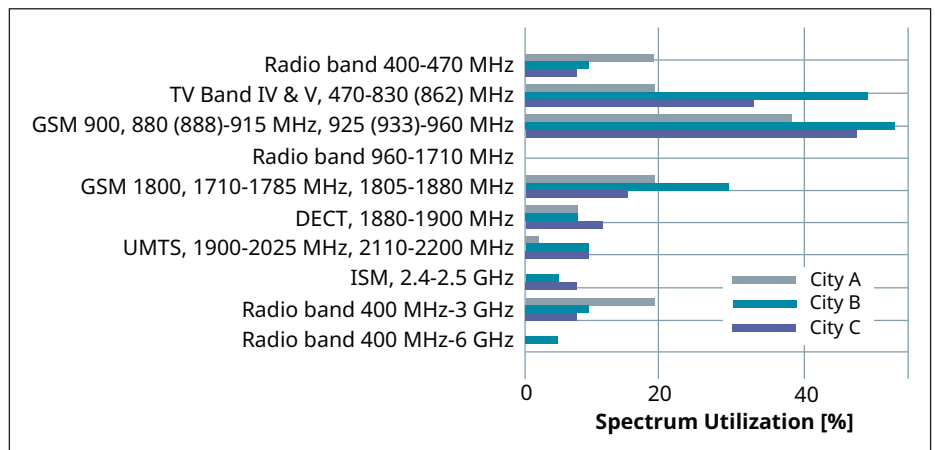


Figure 10: Spectrum Occupancy Measurement

Performance

The Remote Spectrum Monitor 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 SOI. 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.

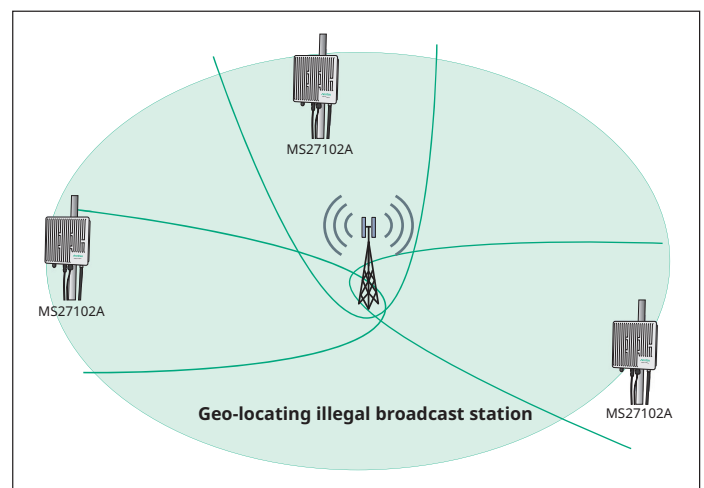


Figure 11: TDOA for Geo-Locating Interference Signal

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Communications

Communications with the Remote Spectrum Monitor 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 different static IP. Alternatively, dynamic host configuration protocol (DHCP) or domain name system (DNS) may be used. See Anritsu's Ethernet Configuration Guide for details.

All commands and inquiries with the Remote Spectrum Monitor 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 Remote Spectrum Monitor 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 Remote Spectrum Monitor 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.