RF POWER MONITORING SYSTEM: REDUCE SYSTEM DOWNTIME EFFECTIVELY WITH PROACTIVE MONITORING

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Abstract:

RF network reliability is critical to public safety and business-critical LMR systems. While many radio network performance monitoring solutions exist today, they often neglect the antenna subsystem - a core part of an RF system. RF Power Monitoring Systems fill this gap by enabling proactive monitoring of vital antenna subsystem performance indicators and RF interference detection, which is key to ensuring system reliability and optimizing performance.

Introduction:

Public Safety issues can be anything from trespassing, theft, harassment, murder, structure fire, or even a serious threat to the country. With emergency calls, seconds can mean the difference between life or death. Therefore, dependable wireless systems that enable reliable emergency communications and interoperability are crucial for public safety agencies.

The attack on the World Trade Center is a good example. In a time of extreme crisis such as this, internal communications are vital but there were many breakdowns in communications that day. If your system isn't functioning properly (or isn't working at all), you will not be able to respond to these types of situations. There are many other factors and components to consider when keeping a public safety system operating properly. Proactive monitoring of the system's health status is an effective way to ensure operational reliability.

Problem Definitions:

Geographical location and extreme weather conditions are some of the challenges that tower owners and users usually face when dealing with radio system maintenance and troubleshooting efforts when something goes wrong. One common problem for radio tower sites is that access to these sites can be very limited for many reasons. For example, military base tower sites may require multiple clearances for a technician to access the site, making this a long, time-consuming process. When the system is down, or not operating as expected, critical calls may be missed or dropped. Time is of the essence, so in many cases, there isn't time to wait for clearances to be granted.

Further, RF radio sites that experience extreme fluctuations in weather may be difficult, if not impossible, to access. For example, the Town of Woody in Newfoundland has recorded nearly 21 feet of snow in just 89 days. Some sites may need to be accessed via snowmobile, helicopter, or only at certain times of the year due to excessive rain, snow, or ice. Knowing what the problem is ahead of time is beneficial in how and when you need to schedule service at the site. Depending on the problem, it may need to be scheduled right away or possibly wait until the conditions are better.

Another problem is not knowing who to call to schedule service when there is a communication issue. If your system stops working properly and you don't know what the problem is before scheduling a site visit, this could result in scheduling the wrong technician or tower crew and they may not have the correct equipment to fix it when they get to the site. For example, a tower crew would usually be called for antenna or feedline issues, and a radio technician would usually be called for radio equipment issues. Tower climbs can be very costly, so you don't want to schedule a tower crew if it's not necessary.

These are just a few examples of how remote monitoring would be beneficial to help operators quickly identify system issues and potential root causes from a central location effectively. The solutions to these problems (and many other problems) are provided below.

Solution:

The antenna subsystem is a core part of an RF communications system. While many radio network performance monitoring solutions exist today, they only monitor base stations and their core network but neglect the antenna subsystem. Therefore, operators lack a holistic view of their complete network performance, due to missing important antenna subsystem key performance indicators (KPIs) such as frequency, channelized forward power, reverse power, return loss/VSWR, and insertion loss measurements.

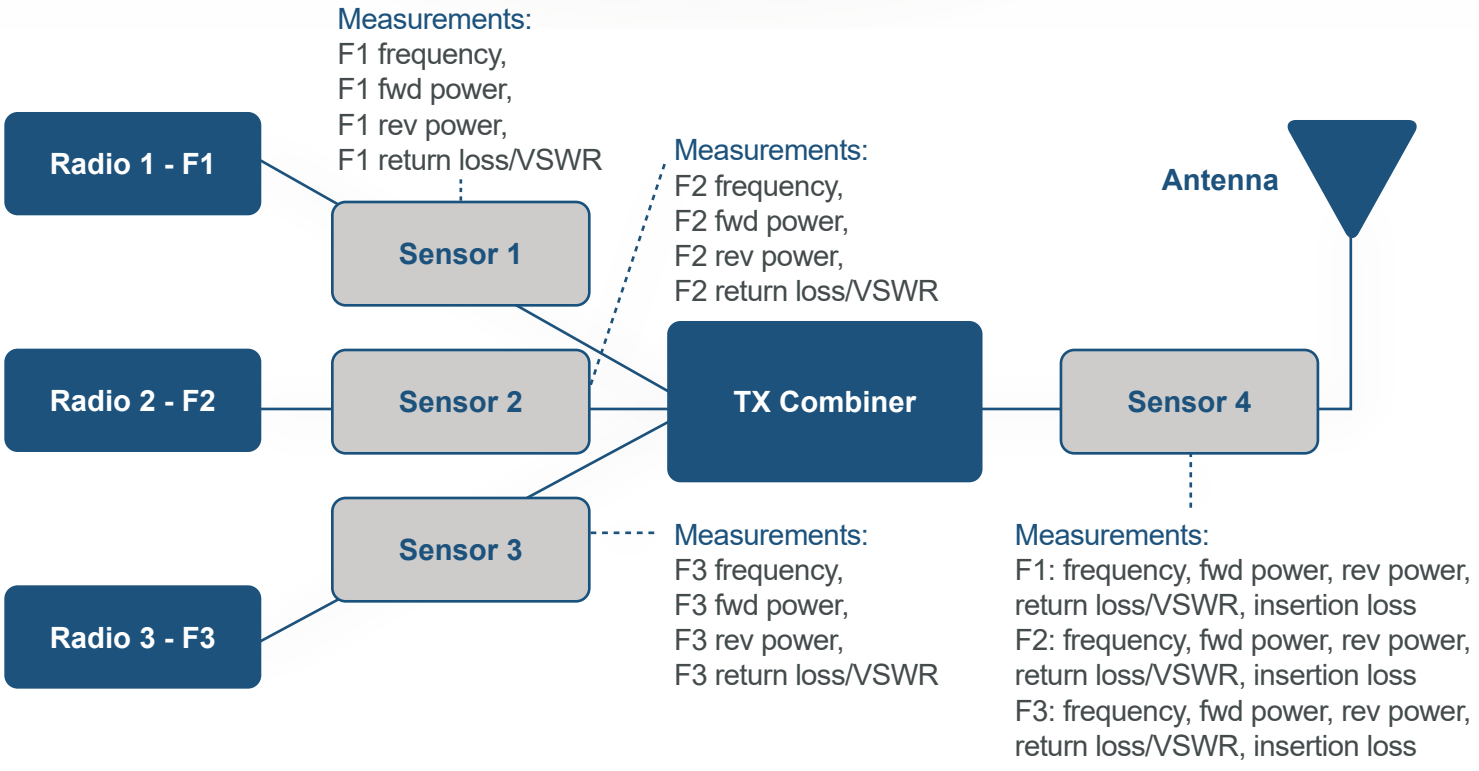

Figure 1.0

Power sensors are used to gather these measurements by placing them at desired monitoring points, as shown in Figure 1.0. If a sensor is placed between the radio and the transmit combiner, it will measure and monitor frequency, forward power, reverse power, and return loss or VSWR of that channel. Sensor 1 monitors these values for radio 1 (channel 1), Sensor 2 for radio 2 (channel 2), and Sensor 3 for radio 3 (channel 3). High reverse power or VSWR could indicate a bad isolator or filter depending on where the sensor is located. Low or no forward power or drift in frequency could mean there's an issue with the radio itself.

If the sensor is placed at the antenna port of the transmit combiner, as indicated by Sensor 4 in Figure 1.0, it can measure frequency, composite forward power, reverse power, return loss or VSWR, and insertion loss of the system. In this case, a high return loss could indicate a faulty antenna, feedline, or jumper. This way, one can monitor the antenna performance over time and plan services accordingly. For example, the performance of an antenna may degrade when the weather gets extremely cold and the antenna gets covered in a layer of ice; but as the weather warms up, the antenna thaws and it starts working as expected again. Understanding this phenomenon would prevent unnecessary site visits and replace equipment that isn't faulty.

It is extremely useful if a power monitoring system also supports spectrum analysis. The primary use of a spectrum analyzer is to measure the power of known and unknown RF signals. This feature is very helpful when installing a new site, adding new users to an existing site or when experiencing interference at a site. For example, when installing a new public safety system, one needs to be aware of collocated users and users nearby with high power transmitters. Without knowing what other frequencies are being used at or near the new site, and their associated power levels, the new site may suffer from severe RF interference issues, rendering it unreliable or even unfunctional. To avoid these types of issues, using a spectrum analyzer at the site will allow you to comprehend the RF signals that may be of concern and consider them during the design stage of a wireless communications system. This will adequately eliminate significant troubleshooting efforts later, thus saving time and money.

A spectrum analyzer can also be used after a system is installed, as the system could all of a sudden start experiencing interference issues. To investigate, one could readily use the built-in spectrum analyzer remotely to detect if there are any new RF signals at the site that could be causing the interference. This will allow the operator to take the necessary steps to correct it as quickly as possible. For example, you are operating a 2-channel public safety LMR system at a site. By using a spectrum analyzer, you would see something similar to the two signals shown in Figure 2.0, where one transmitter is operating at 155.250 MHz and the other one at 157.675 MHz. If one of your channels experiences a loss of transmit power, the signal level may now fall below the sensitivity level of your receiver so your intended receiver will not hear the call. As an example, the reduction in signal level would be seen on the spectrum analyzer as shown in Figure 3.0. This will cause an alarm and the user would be notified of this alarm. The user can then investigate the issue and address it accordingly.

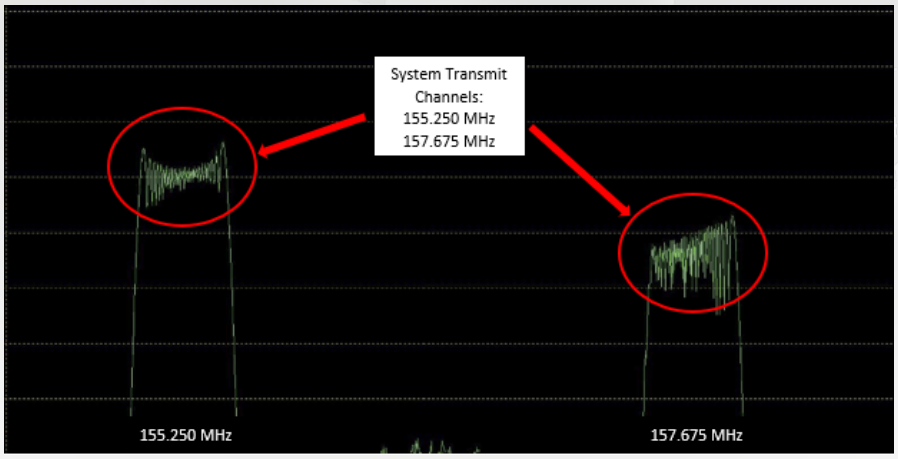

Figure 2.0 – Original System Measurement

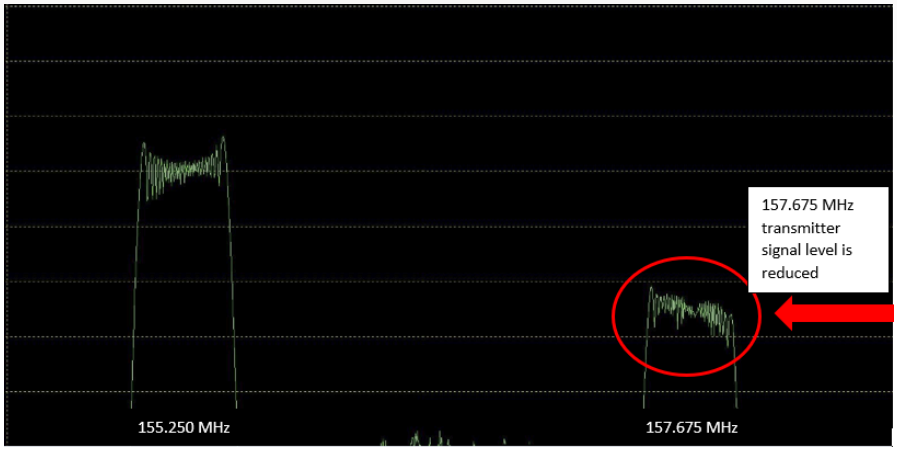

Figure 3.0 – Reduced Signal Level Measurement

For another example, let's go back to Figure 2.0 with the two known working transmitters operating at 155.250 MHz and 157.675 MHz. All of a sudden you start experiencing receiver desense on one or more of your receivers but you don't know why. By using the spectrum analyzer at this site, you notice a signal present at 156.900 MHz as depicted in Figure 4.0, demonstrating a strong transmitter near or at your site that is desensitizing your receiver. The spectrum analyzer will display the frequency of this transmitter to help you determine whether the transmitter frequency is a licensed user and take the necessary steps to address the receiver desense issue.

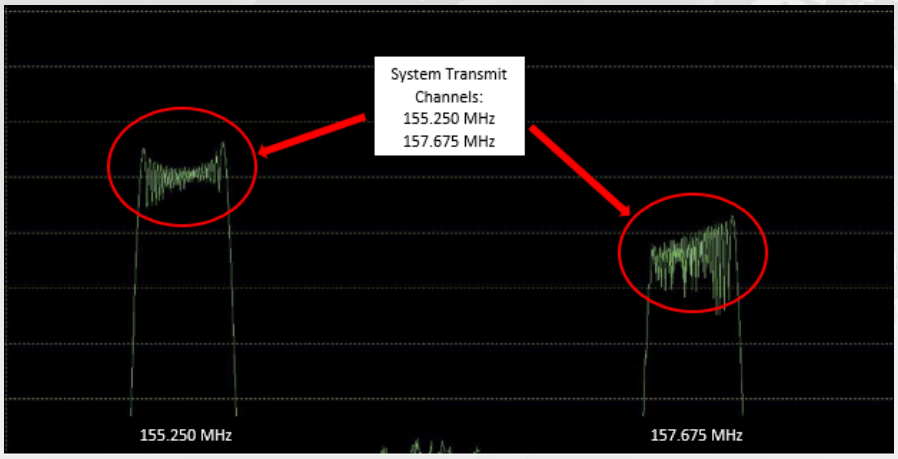

Figure 2.0 – System Transmitter Measurement

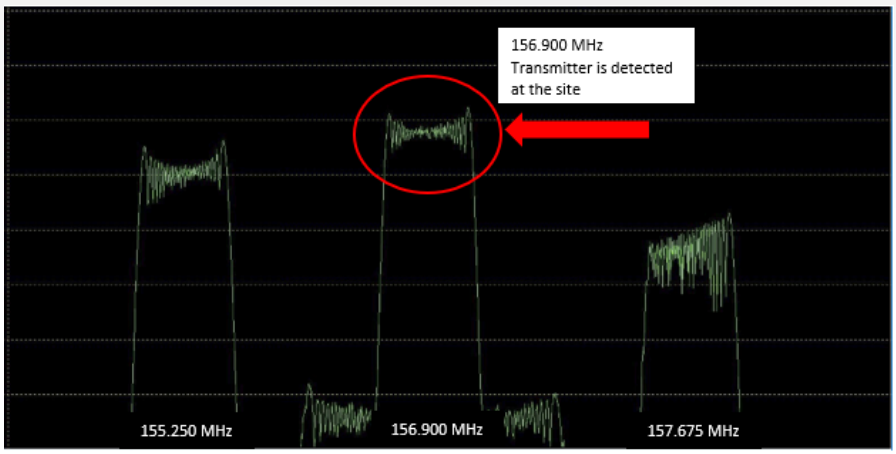

Figure 4.0 – On-site Frequency Measurement

Summary:

RF Power monitoring systems help minimize system downtime and avoid unnecessary maintenance and repairs for mission-critical wireless communications systems. The cost associated with adding power monitoring equipment will far outweigh the cost of a system failing and being down for a long period while trying to repair it.

The advantages of proactive remote system monitoring are:

- Track the overall health of your system to reduce or eliminate downtime
- Monitor sites remotely - extremely desirable for sites that have limited access
- Identify what is degrading or failing, allowing one to schedule service more efficiently to repair equipment before it fails completely
- Eliminate multiple trips to a site
- Detect and hunt down interference issues effectively
- Spectrum analysis feature to measure power levels and frequencies of known and unknown signals

Sinclair proudly offers the IntelliSENSE™ Power Monitoring System for antenna subsystems performance monitoring. For more information, please visit https://www.sinctech.com/power-monitoring-system

Sinclair Technologies, a division of Norsat International, is a leading designer and manufacturer of antenna and RF signal conditioning products, systems, and coverage solutions. Sinclair products are used extensively in public safety and private industry communication networks. With over 70 years of industry-leading expertise in all aspects of antenna and RF signal conditioning design and manufacturing and a strong focus on R&D, Sinclair continues to expand its industry-leading technical solutions.

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