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Military Wireless Systems Require Sturdier Defenses

Military Wireless Systems Require Sturdier Defenses

by Fred Ilsemann

Radio frequency interference is pervasive in the wireless age. Cell phone customers undoubtedly have encountered some level of RFI at one time or another.

For military users of wireless systems, failure to safeguard against unwanted RFI-particularly when it comes to sensitive defense systems-can have serious consequences.

While some RFI is innocuous, it can become a real threat when it interferes with systems used by military forces, such as remotely controlled weapons.

Because virtually every wireless device is subject to RFI, it is important that the source and strength of this interference be determined before it affects a component or system. The goal is to prevent RFI signals (both continuous emissions as well as short duration transient events) from interfering with any component or system that depends on radio frequency signals for operation or is susceptible to damage when exposed to high RF power levels.

Consider, for example, a communications satellite during assembly, testing or preparations for launch. Prior to launch, the satellite is subjected to a variety of quality-control tests and procedures. If unwanted RFI signals are allowed to interfere with any of the processes, they could contribute to ultimate failure of the satellite.

Electronic warfare systems or components undergoing tests at a range also could be affected by unwanted RFI. If this interference doesn't cause direct harm (sometimes rendering a component or entire system useless), it could prevent accurate validation and calibration during the testing and evaluation phases. When RFI incidents such as these occur, it can be difficult or impossible to determine the cause of the failure or the reason for otherwise substandard performance.

It should be noted that RFI is not a new phenomenon. There are established technologies that are employed to deal with its detection. Among them are spectrum-analysis instruments that typically analyze a discrete, narrow band of frequencies that are usually present concurrently with other frequencies. Tuning to a discrete frequency implies prior knowledge of the RFI. Therefore, the spectrum analyzer is usually programmed to cover a range of frequencies.

Systems that can detect radio frequency interference—for use on airborne, shipboard and land platforms—are becoming more affordable with the use of commercial technologies.

(Wide Band Systems photos)

By design, the spectrum analyzer scans (using a fixed RF bandwidth) over the frequency range of interest. The scanning reduces the probability of intercept. As the frequency range increases, the degradation can be significant resulting in unreliable RFI detection.

To circumvent this problem, an alternative approach has been to combine multiple spectrum analyzers in an attempt to cover a broader range of simultaneous signals from one or more RFI sources. These systems are not foolproof, but certainly improve the mean time to intercept.

However, the characterization of short-duration events (on the order of 100 nanoseconds) diminishes the performance of these systems. Digital signal-processing techniques are required to analyze the collected spectral data to determine the pulse width, pulse repetition interval and peak amplitude.

The addition of digital signal processing implies the integration of peripherals to the system and still does not address the intercept and characterization of transient RFI events.

Other real-world effects, such as scan patterns and multipath, further degrade the performance of traditional spectrum analyzer-based systems. Multipath is the occurrence of multiple images of an RF signal due to reflections from objects in the environment. Consider that a receiver located at a fixed site can receive an RF signal from an emitter by many paths including both direct (line of sight) and from reflections. The multipath condition can result in degrading processing at the receiver with respect to pulse width, amplitude and pulse repetition interval.

Certain RFI monitors have taken advantage of the latest in high-speed digitizers to directly sample the RF environment. These approaches typically rely on "down conversion" and "channelization" to cover broad RF bandwidths. Down conversion refers to the translation of an RF signal to an intermediate frequency (IF) signal. This process involves a device called a mixer and converts the input RF to a different frequency, usually to a lower frequency. For example, a receiver that processes frequencies between 2 and 6 GHz can use a down converter to translate signals from 14 to 18 GHz into the lower frequency band where processing can occur.

The channelization technique divides a wide RF bandwidth into several frequency bands-each with a narrower bandwidth. Each subset is referred to as a channel. For example, a 2-18 GHz RF bandwidth could be divided into four channels, each with 4 GHz bandwidth. Further, a single receiver that operates on 2-6 GHz can then he used in conjunction with a down converter to process each channel, thereby covering the entire RF bandwidth.

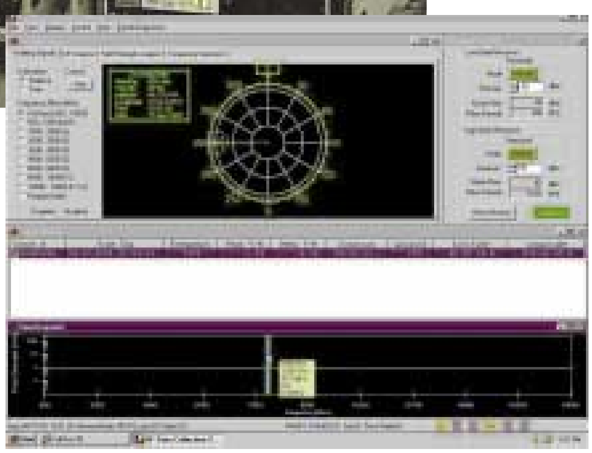
New Technology

Recently, a new signal detection methodology was developed, based on the application of instantaneous frequency measurement (IFM), integrated with commercial processors that permit simultaneous detection, monitoring, and tracking of RF signals (continuous wave, pulsed, and transient) at frequencies from 0.5 to 18 GHz.

This advanced RFI signal detection technology relies on instantaneous frequency measurement (IFM) receiver systems originally developed for electronic warfare applications in the defense market. A typical signal detection system employs two independent IFM receivers, one low band [0.5-2 GHz] and one high band [2-18 GHz). Each IFM receiver incorporates a digital frequency discriminator, which provides digital encoding of wide band RF input signal frequency data for pulsed or continuous-wave signals. The digital frequency discriminator is an essential component of an IFM receiver system. In addition to encoding RF frequency, the discriminator also provides a threshold based on the instantaneous RF signal-to-noise ratio, error detection and various flag functions, including pulse on pulse, pulse on continuous wave, frequency modulation on pulse and phase modulation on pulse.

Each IFM receiver also incorporates a digital amplitude quantizer that characterizes the RF amplitude and generates a standard video signal for measuring RF envelope pulse width and time of arrival data.

A typical RFD/CS operator workstation. All components are mounted on a wheeled chassis, and modular construction using Commercial Off the Shelf Methodology adds cost-effectiveness, and enhances flexibility and usefulness. this self-contained system contains a remote laptop PC (this can be located anywhere since transmission from the workstation is wireless), a mouse, keyboard, computer, power supply, and associated hardware/software.



A typical display monitor with tactical plan position indicator that depicts azimuth of incoming RF signals. A signal strength indicator records field strength of emitters in excess of user defined threshold as described in the text.

(Wide Band Systems photos)

The IFMs incorporated in these new signal detection systems help to assure accurate and reliable detection, monitoring, and tracking of unwanted RF signals. Unlike spectrum analyzer systems, the IFM technology does not scan and provides 100 percent probability of intercept for RF events as short as 100 nanoseconds.

By integrating the IFM receiver technology with antenna arrays, precise bearing to an RFI source can also be determined. In most cases an omni-directional antenna is employed to ensure a high probability of intercept for all azimuth angles. Characterization of the antenna response is used with the measured RF amplitude to calculate the field strength of the RFI.

This RFI monitoring architecture also employs off-the-shelf processors and peripherals. Microsoft Windows compatible software applications are used to collect the output of the IFM receivers and present RFI related data to the operator using a variety of graphical displays. One feature of the software allows users to select threshold parameters for unwanted RFI and set an alarm point at which the unwanted RF signal—regardless of its source—would be considered objectionable or harmful.

Complete log files of all RFI events are maintained by the system, which can run unattended. Other features include local area network access and automatic paging of remote users.

Many systems that require safeguarding from RFI are operated continuously for days and weeks (often in remote locations). An RFI monitor that can operate reliably, unattended, significantly reduces the human resources and logistics required to support the operation.

Because wireless components and systems are employed on many different platforms, RFI detection systems must perform in airborne, shipboard and land mobile environments. Configuring systems such as these has traditionally been cost-prohibitive, mainly because of the "militarized" nature of the various components. By using many commercially available products, the technology can become more affordable. ***ND***

Fred Ilsemann is general manager of Wide Band Systems, Defense Systems Division, in Neshanic Station, NJ

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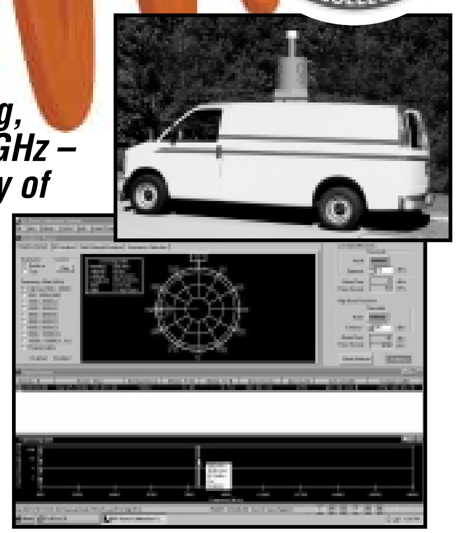

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