Focus

The Importance of Channel Simulation

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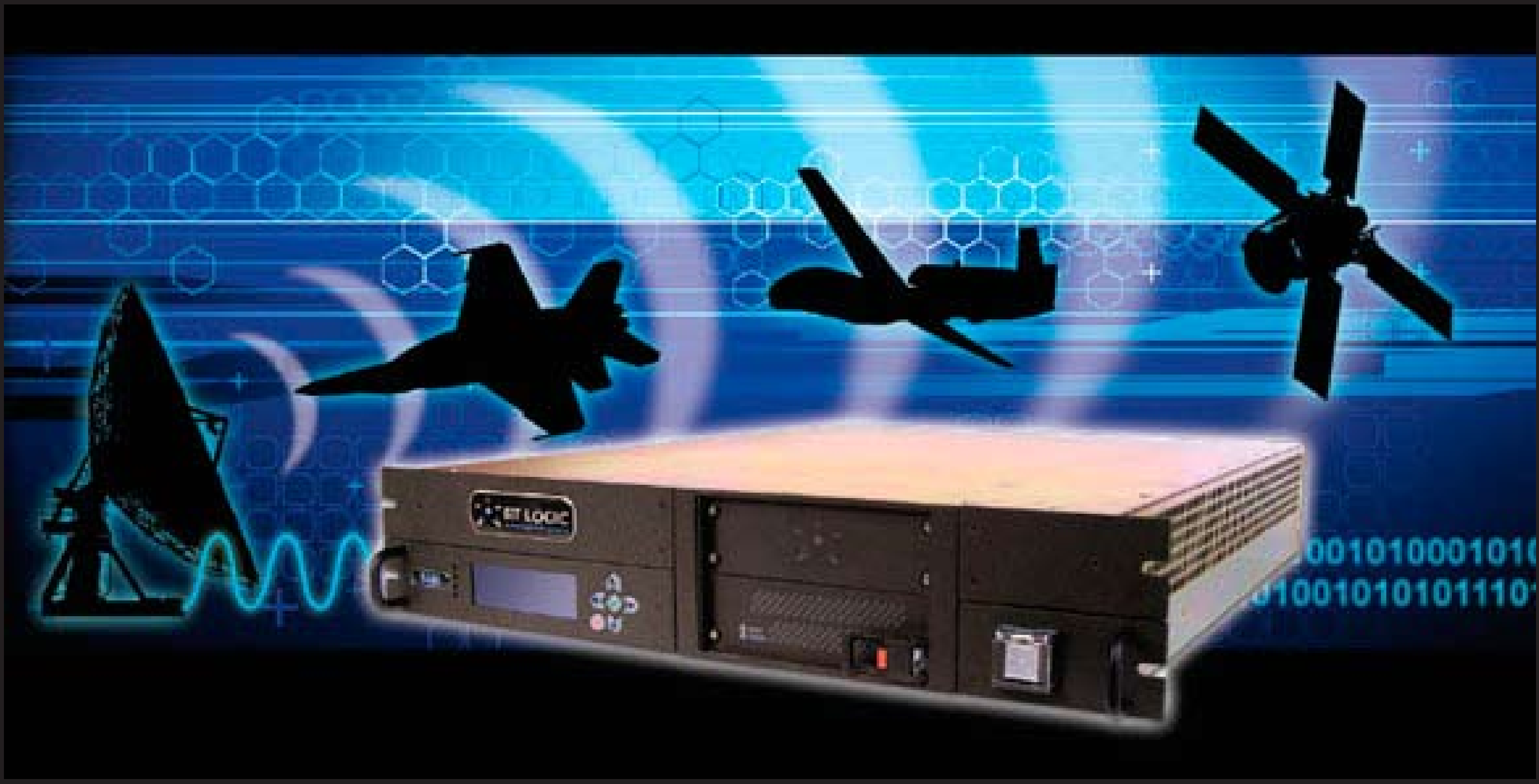
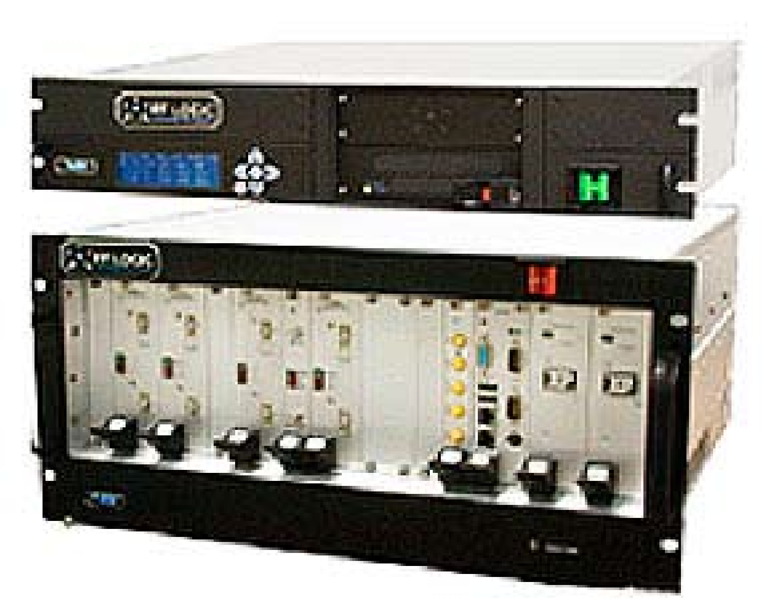
Satellite communications (SATCOM), manned and unmanned military and aerial surveillance systems, and strategic and tactical military communications all play critical roles in ensuring our economic and national security. Each of these relies heavily on radio communication links for control, data uplink, data crosslink and data downlink. As such, our skies are jam-packed with radio signals, each of which is increasingly compromised by natural, accidental and intentional interference. This interference threatens the integrity and quality of these links, and therefore the very missions they support.

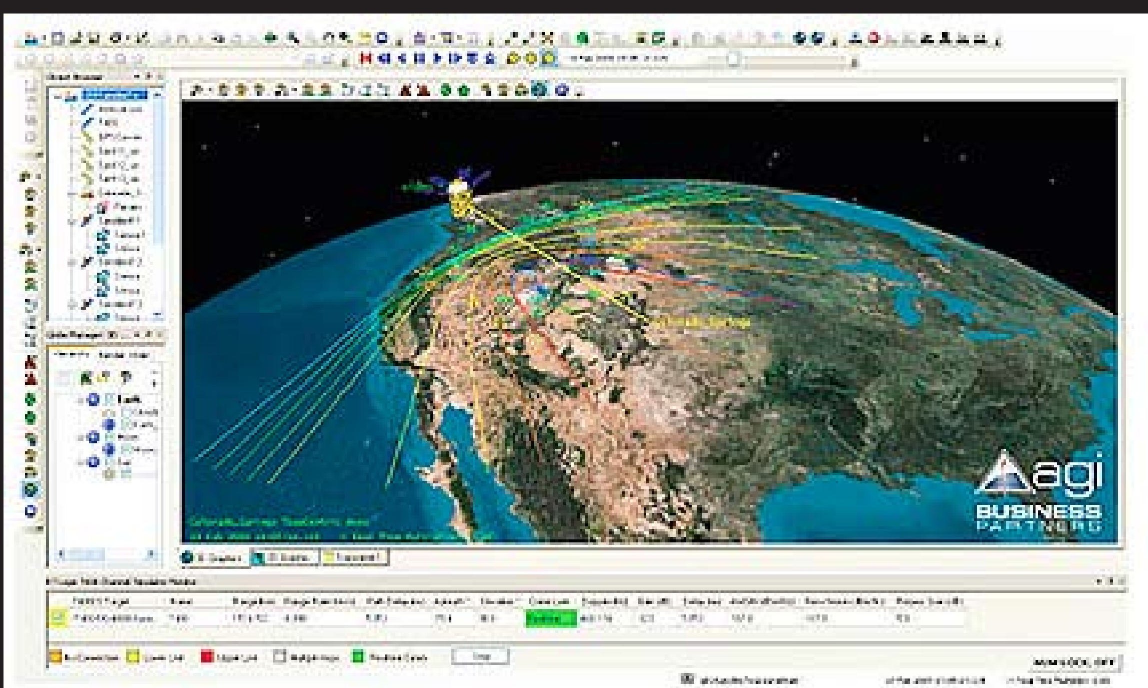
As a result, we have seen rapid development and deployment of systems that continuously monitor space, atmospheric and terrestrial communication links for signs of interference or channel abuse. These monitoring systems have moved well beyond spectrum analyzers running simple spectral masks that define nominal frequency and amplitude characteristics. Instead, modern interference detection systems employ sophisticated *digital signal processing* (**DSP**) techniques to detect and characterize even the smallest and most transient anomalies. They log results and instantly notify appropriate personnel when unauthorized signals appear, and when critical signal parameters such as **EIRP**, **C/No**, **Es/No**, center frequency, occupied bandwidth and many others are violated.





Above: RT Logic TELEMETRIX 400 Channel Simulator (T400CS)

Below: T400CS client/server software architecture facilitates a wide range of local and remote control options. Local control is provided by an easy-to-use RT Logic Graphical User Interface (GUI).



Often employing multiple remote sensors, today's interference detection systems combine signal data from geographically dispersed fixed and moving locations for enhanced overall situational awareness. Further development of such systems is proceeding rapidly, with key focus on faster detection of a broader range of interference types in wider frequency segments. Reductions in system size, complexity and price are anticipated, along with improved ease-of-use. Tighter integration with related automatic functions such as interference mitigation, traffic re-routing and signal geolocation are also expected.

Addressing the continual need for economic efficiency, many interference detection systems are multi-purposed, and are applicable toward a broad range of operational, training and test requirements. This is achieved in part with integrated hardware channel simulators capable of injecting physics-compliant target and/or interference signals indistinguishable from their real-world counterparts.

As interference detection system capabilities advance, and as automatic avoidance techniques are developed, the physical size of interference detection systems will decrease. This will spawn "built-in" interference detection and mitigation capabilities, rendering communication system receivers, for example, self-aware of interference and capable of taking evasive action without user intervention. The hardware channel simulator holds a key position, not only within multi-purposed interference detection systems, but specifically in the underlying R&D and test that enables advancements in interference detection and mitigation in the first place. In fact, since channel simulators facilitate comprehensive and accurate RF, IF, digital, firmware and software development and test, they are rapidly becoming commonplace in R&D labs and product manufacturing and test facilities.

Channel simulators create real-world signals in the laboratory by adding dynamic interference to signals, along with nominal and/or worst-case carrier and signal Doppler shift, delay, loss, noise, non-linearity, oscillator drift and phase noise. Multi-path simulation, Ricean and Rayleigh statistical fading, and others are also considered with full attention to related physics. This results in signals that are precise duplications and predictions of real-world signals. These instruments can add such effects to existing test signals or they can create test signals themselves.

Channel simulators are specifically designed for precise physics modeling of RF signals and channels. As a result, they produce more realistic signals and are less expensive to learn, use and maintain than an assemblage of non-specialized test and measurement equipment controlled by user written, tested and supported software. When channel simulators are coupled with accurate flight dynamics models, antenna radiation patterns, flight vehicle and ground station body masking, terrain and weather, to name a few, testing can assure solid communication system operations even under substantial interference situations.

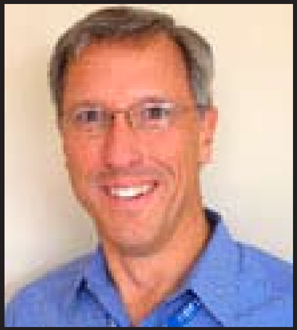
With channel simulators, designers, testers, students and trainees can work with signals that exactly match those that will be encountered in an actual mission.

Designers can verify receiver interference rejection techniques, tolerance of frequency and data rate changes and the receiver's ability to compensate for large and fast swings in received signal strength.

Test personnel can use channel simulators to present devices with a wide variety of complex and difficult-to-duplicate signals, assuring functionality and performance under the worst of conditions.

Training personnel can use channel simulators to inject signals into operational communication, monitoring and command and control systems, thereby training operators for rapid diagnosis and recognition of interference effects, types and sources. Training continues as operators take appropriate corrective action to maintain viable communication links.

Advances in interference detection and mitigation are vitally important as the dependence on radio communication links increases. The integration of channel simulators into RF interference detection mitigation systems will provide civil government, the military and commercial communications providers with the ability to better predict and react to the effects of interference. In addition, these instruments will play key roles in R&D, test and training activities for all types of communications equipment.



Steve Williams is an RT Logic Business Area Manger, responsible for R&D and business development activities for RT Logic's RF Channel Simulator, Range Test System, UAV/Target/Missile Test Systems, Spectral Warrior Interference Detection System, and high-rate digitizers. He is a frequent presenter and author on these and related subjects. His 29-year digital and RF instrumentation career has included R&D, management and business positions at RT Logic, Hewlett-Packard, Agilent Technologies and precisionWave Corporation which he co-founded. Steve holds a BSEE from the University of Illinois.