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THE NEW EW TEST PARADIGM

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The New EW Test Paradigm

By **JIM TABER**, *VP Marketing & Sales, Giga-tronics*

TESTING EW SUBSYSTEMS and systems has always been a long, technically-challenging, and expensive process. It is performed in several stages of increasing severity until the candidate product can withstand the hostile threat environments to which it will be subjected in the field. It's become even more challenging for several reasons, the most daunting being the increasing deployment of advanced AESA radars by China and Russia, the latter's demonstration of highly-advanced EW capabilities, and nearly two decades of U.S. complacency in significantly advancing its EW state of the art.

As a result, the Department of Defense has recently lit a fire under the defense industry to expedite the development of EW technologies so they can be deployed soon rather than the typical 5 to 8 years or more. As testing is a major contributor to this process, the defense industry and government are working to create a EW test paradigm that improves the way EW system testing has always been conducted.

It focuses on exposing candidate designs to more realistic threat environments earlier when it is far less expensive and easier and faster to make changes. The goal is to make new EW systems much likelier to pass the final and most exhausting (and expensive) tests on open-air ranges. To achieve this, the first testing and evaluation is performed using COTS simulation software and emulation hardware that subjects the system to the greatest amount and types of signal content including threats, friendly or benign emitters, and impediments such as noise, interference, and propagation effects. This is followed, as has long been the case, by testing in Installed System Test Facilities (ISTFs) and finally on open-air ranges.

form on which it will be deployed, they are nevertheless capable of determining system effectiveness to a significant greater and at an earlier stage in design.

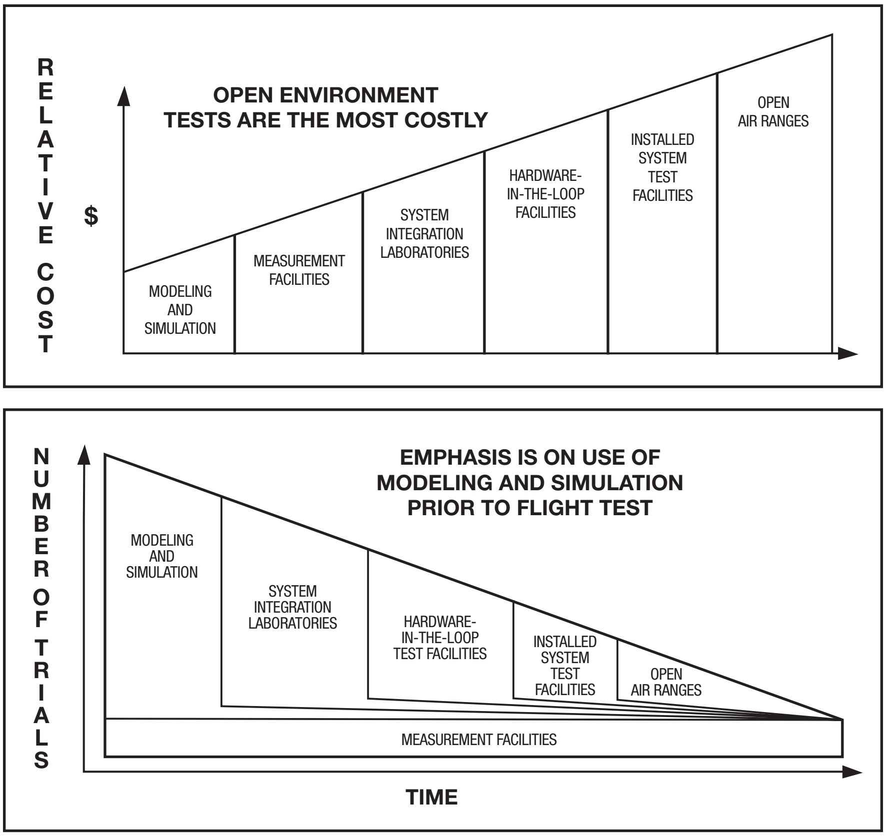

FIGURE 1 – The cost of EW testing increases in cost as it moves from the benchtop to the open-air range (a). If more representative modeling, simulation, and emulation are conducted on the benchtop (b) less time is spent at latter stages, reducing cost and increasing the likelihood that the candidate system will meet the demanding requirements of open-air range testing.

The difference between this new test paradigm and its predecessor is shown in Figures 1a and 1b.

Although benchtop, COTS-based test systems cannot yet duplicate the comprehensive testing afforded in ISTFs where the system is installed in the plat-

They can also discover problems quickly by creating a target-rich environment representative in both the number and quality of threats the system will experience in the battlespace.

Giga-tronics has developed such a benchtop test platform called TEmS (Real-

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Time Threat Emulation System) that is modular with its RF and control hardware housed in an AXIe chassis (Figure 2) so it can be reconfigured for more complex testing during final system validation. The system emulates multiple, simultaneous emitters to create realistic environments that can be injected directly into the system or radiated into it over the air. Up to 31 platforms (30 emitters and 1 system under test) are supported along with direction finding and angle of arrival (AoA) testing via automatic multi-channel software control of amplitude and phase. The system also supports time-of-arrival (ToA) of all RF signals.

The hardware is complemented by TEmS software that combines emitter characteristics with platform kinematics-- the movement of all types of emitters in relation to each other in the battlespace. Kinematic representation presents the user with a real-time representation of the platforms, emitters, and the system under test involved in a scenario (Figure 3). Users can evaluate these scenarios to determine how well the simulated engagement meets mission parameters including dropped pulses or pulses that fall below the EW receiver's detection threshold. The TEmS user interface dynamically displays how each platform moves through the battlespace and the orientation and relative positions of each platform and emitter at all times.

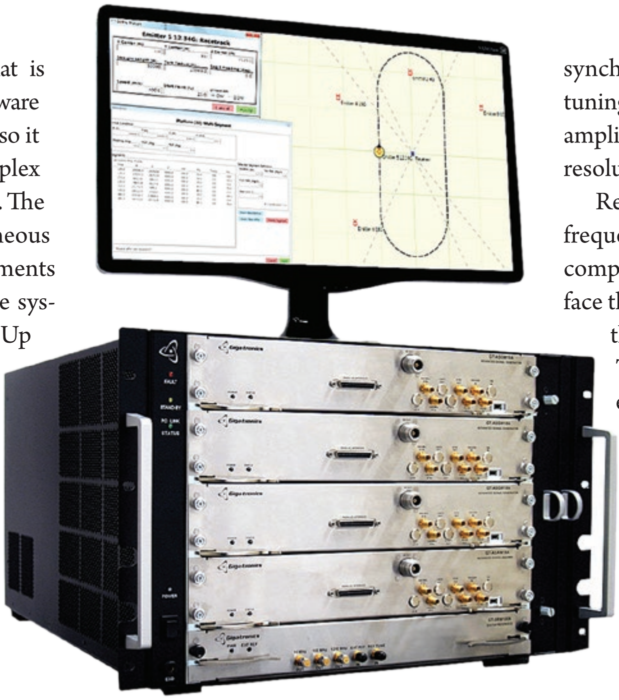

FIGURE 2 – The TEmS system configured for four channels with the display showing a battlefield scenario produced by the TeMS software running on a PC.

TEmS is the only test system that natively performs phase-coherent upconversion of multi-channel emitters and provides a real-time interface to control frequency, phase, and amplitude at the RF carrier. It uses Giga-tronics agile wideband upconverters for signal synthesis and real-time control of RF parameters. Signal generation with high-resolution control is performed by the Advanced Signal Generator (ASGM18A), which is an AXIe module synthesizer based on a 100-MHz reference that has outputs allowing other modules in the system to be coherently synchronized. It provides high-resolution tuning of generated signals, with 0.5-dB amplitude resolution, 1-Hz frequency resolution, and 0.1-deg. phase resolution.

Real-time control of the ASGM18A's frequency, phase, and amplitude is accomplished through a parallel BCD interface that allows them to be changed in less than 1 μs from 100 MHz to 18 GHz. This supports synthesis of multiple emitters on a single RF channel that operate at different RF center frequencies. Each ASGM18A can translate an IF waveform centered at 1200 MHz to anywhere between 100 MHz and 18 GHz and the IF can have an intra-pulse instantaneous bandwidth up to 1 GHz for output frequencies above 4 GHz.

The digital control interface provides significant benefits for threat emulation. For example, sub-microsecond switching speed allows multiple agile emitters to be created from a single generator (if they do not overlap in time),as switching is phase-coherent. Other effects can be created at the carrier frequency such as Doppler, jitter, and frequency drift, and when combined with a Giga-tronics phase-coherent downconverter, the two frequency-converter modules form a hardware-in-the-loop substitute for a closed-loop agile threat emulator. The digital interface also provides precise control of phase at RF for emulation of angle-of-arrival wave fronts with 0.1 deg. of control across any number of channels and 90 dB of amplitude control.

Testing of EW systems is changing dramatically owing to the requirement for insertion of new technology faster and at less cost, and one of the most important of these changes is the exposure of new designs to "realistic" threat environment far earlier in the development process. In only the last few years, this has produced test systems that achieve realism previously only attainable at later test stages, and test systems such as TEmS will further increase their abilities so that few surprises will occur on the open-air range. ■

FIGURE 3 – The TEmS battlespace is simulated using a 500 km x 500 km, flat earth environment. Pulse descriptor words from every emitter are calculated in real-time for 10 ns timing resolution as the platforms move through battlespace.