Electronic Proving Ground (EPG) Technology Snippets

Mark Hynes
U.S. Army White Sands Missile Range
Electronic Proving Ground, Fort Huachuca, Arizona

U.S. Army Electronic Proving Ground (EPG) engineers must develop innovative solutions to meet the challenges of a demanding command, control, communications, computers and intelligence (C⁴I) test environment. The engineers try to meet these challenges by applying existing commercial off-the-shelf (COTS) technology whenever possible. However, requirements frequently cannot be met using commercial technology. In such cases, EPG engineers apply their expertise in the areas of hardware/software design and systems integration. These unique solutions range from small interfaces or control boxes to large-scale, multimillion-dollar, open-air jamming systems. EPG engineers evaluate and integrate COTS technologies to the greatest extent possible, developing innovative solutions that minimize cost and maximize reliability and functionality.

Because the command, control, communications, computers and intelligence (C^4I) test environment is spread out over large geographical areas, the test equipment is subjected to severe physical conditions including shock, vibration, rain, dust, mud and temperature extremes. The test equipment is often deployed on the exterior of tactical vehicles and, as such, robust mechanical designs are required. The test equipment must also perform its function without interfering with the performance of the systems under test. Thus, electromagnetic interference (EMI) must be considered in the design process. The following are several examples of innovative solutions developed by EPG engineers to meet the unique requirements of C^4I testing.

Global Positioning System (GPS) Tracker/Tactical Radio Enclosure (GTT)

The GPS GTT enables real-time position tracking of mobile platforms during field test exercises. The GTT provides a visual indication (that is, an icon on a map) of each installed GTT. This information is updated as platforms move and is logged for future reference.

Development cost of the GTT was greatly reduced by the use of existing test technology. The GTT uses the Tactical Radio Enclosure (TRE), a commercial off-the-shelf (COTS) GPS receiver, and Starship.

EPG engineers developed the TRE *(Figure 1)* to support real-time data communications from a test control station to mobile platforms in the test environment. The TRE is a rugged, weatherproof and EMI-filtered enclosure suitable for use in severe military environments. It is mounted on the exterior of tanks, armored vehicles and HUMVEEs and runs off of vehicle power. The TRE supports various COTS ultra high frequency (UHF) data radios.

Figure 1. Tactical Radio Enclosure (TRE)

The GTT uses a low-cost COTS GPS receiver to provide accurate time and position information. This receiver, developed by Garmin Limited, contains an antenna, 12-channel GPS receiver and controller, all housed in a small, plastic "hockey puck" enclosure that is secured to the vehicle via a magnetic mount.

Starship is a Windows-based program used to command, control and display status of any system or entity (for example, instrument, control, live battlefield system, simulated battlefield entity) that has a communications interface, can be controlled and that reports status. Test officers use it to provide control and status of real and virtual players in test exercises spread out over wide geographical areas. Starship displays information on a map with icons representing the location and status of various players. The GTT provides Starship with real-time position location information so that real test entities, such as "rovers" (test support personnel vehicles), can be shown on the map.

The physical instantiation of the GTT is a small, printed circuit board *(Figure 2)* that plugs into the existing TRE. The TRE houses a digital radio that gives the test officer wireless command and control of test instrumentation installed on mobile test platforms. This enables effective distributed testing of modern military communications systems. Each rover vehicle contains a TRE outfitted with a GTT and a Garmin GPS receiver. The GTT and the GPS run off of vehicle power and require minimal current. Every

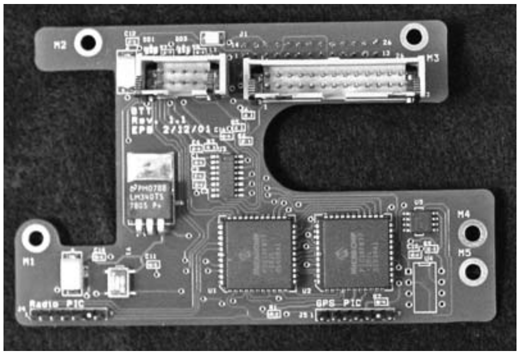

Figure 2. GTT printed circuit board

GTT contains a unique unit identification number enabling the simultaneous tracking of up to 999 different platforms.

The location of each GTT is presented to the test officer by Starship, an existing test tool that manages and displays the status of distributed test assets. The GTT operates as an autonomous agent enabling automated insertion of each tracker into the Starship test scenario. Upon power up, the GTT announces itself to the world. Starship receives this message and inserts the GTT icon on the map without user intervention.

The GTT gives the test officer real-time visibility into test operations. It was developed using COTS and existing government-owned test technology, thus reducing its life cycle cost. The plug-and-play nature of the GTT Autonomous Agent reduces test preparation cost while increasing test readiness.

Autonomous Wireless Sensor System (AWSS)

The AWSS *(Figure 3)* provides automated remote electromagnetic spectrum sampling in a ruggedized form factor. The AWSS is used on the move and in fixed locations. Its small form factor Windows 2000 processing unit enclosed in radio frequency (RF)-filtered, weather-tight enclosure is ideal for this application. All points of data collection are remotely controlled via a digital radio that operates in the license-free 902-928 megahertz (MHz) frequency band. The AWSS is an autonomous agent, and as such, it automatically links into the master controller upon power up. To avoid spectrum contamination, the AWSS synchronizes the digital radio transmissions with the spectrum sampling intervals. The AWSS uses a GPS receiver to provide time and location stamping of the data as they are collected. The AWSS utilizes the new-generation, off-the-shelf compact spectrum analyzer, which spans 100 kilohertz (kHz) to 3 gigahertz (GHz).

Figure 3. AWSS prototype system

The AWSS communicates with the Remote Sensor Unit (RSU), shown in *Figure 4,* by way of a local area network (LAN). The RSU houses the spectrum analyzer, data radio and GPS receiver in a weather-tight, EMI-filtered enclosure. This arrangement enables the optimal placement of the spectrum collection instrument. The AWSS has an internal battery back-up system, enabling reliable operation in harsh mobile test environments.

Figure 4. AWSS Remote Sensor Unit (RSU)

Modular Covert Remote Electronic Warfare Simulator (MCREWS)

The MCREWS *(Figure 5)* is a validated, accredited and certified synthetic jammer system. The MCREWS modular design enables low-cost upgrades to new frequency bands. The RF module's flexible design enables the programming of arbitrary frequency modulation (FM), arbitrary amplitude modulation (AM) and pulse modulations, as well wideband noise modulations and frequency hopping waveforms. MCREWS also contains a complete data collector, providing data stimulation, data collection, position location, accurate time tagging and communication with Starship. The MCREWS validation was approved on June 6, 2000. The accreditation was approved on March 13, 2000, and the certification was approved on March 30, 2000.

EPG developed MCREWS to provide a synthetic jamming solution, thus

Figure 5. MCREWS

overcoming existing problems and restrictions associated with the conduct of open-air jamming. The MCREWS technology uses a simple control tone to provide a highly accurate surrogate representation of threat jamming without the associated frequency clearance and security problems that arise when transmitting high-power jamming signals.

MCREWS is designed to simultaneously jam up to four separate victims aboard the host platform, while replicating up to four individual ground-based or airborne threat jammers operating in the very high frequency (VHF) and UHF bands. The MCREWS has the versatility to be used in live, virtual or playback modes, which allows the system to support developmental test, operational test and training requirements.

Current MCREWS capabilities include: (a) synthetic jamming; (b) collecting and recording wide area network (WAN) and LAN data from victim platforms undergoing test; (c) remote control and monitoring of field-deployed MCREWS units via Starship; and (d) stimulation of the victim's data throughput via an EPG-developed traffic generator. In this manner, the MCREWS system provides the tester with the tools necessary to conduct jamming; to collect measures of performance information; and to control and monitor live or virtual scenarios as they are conducted.

T2P2-PCI

The Tenacious Timekeeper Position-Plus Peripheral Component Interface (T2P2-PCI) provides GPS-based time and position information to a Windows NT-based system running on a personal computer (PC) platform. The T2P2-PCI board *(Figure 6)* is compatible with the PCI bus, available on most late-model PCs. This model supercedes an earlier model, the T2P2-ISA, which was compatible with the Industry Standard Architecture (ISA) bus. The T2P2-PCI driver supports multiple applications to read time, position and GPS receiver status concurrently. Time is accessed through a direct memory read providing an extremely low latency.

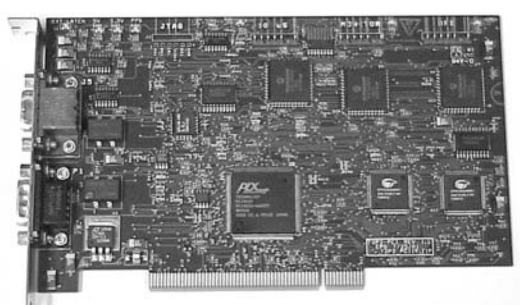

Figure 6. T2P2-PCI board

The T2P2-PCI produces timing synchronized to Universal Time, Coordinated (UTC) Zulu with an average accuracy of better than +/-1 millisecond. It reports position up to once per second with an accuracy of 15 meters. Time reports are internally updated, using a flywheel mechanism, in the event that the GPS signal is lost. The internal clock drift of less that 50 parts per million provides excellent sub-second timing accuracy.

T2P2-ISA

Like the T2P2-PCI, the T2P2-ISA, shown in *Figure 7,* provides GPS-based time and position information to a Windows NT-based system running on a PC platform. The T2P2-ISA board, as already mentioned, however, is compatible with the ISA bus, which is available on most earlier model PCs. The T2P2-ISA driver supports multiple applications to read time, position and GPS receiver status concurrently. Time is accessed through a direct memory read providing an extremely low latency. The card sports an auxiliary RS-232 serial port, an optional controller area network (CAN) controller and a liquid crystal display (LCD) pushbutton controller. The T2P2-ISA produces timing synchronized to Universal Time, Coordinated (UTC) Zulu with an accuracy of +/-1 millisecond. It reports position up to once per second with an accuracy of 15 meters. Time reports are internally updated, using a flywheel mechanism, in the event that the GPS satellite signals are lost. The GPS data source is provided by a low-cost COTS GPS receiver manufactured by Garmin Limited. ❑

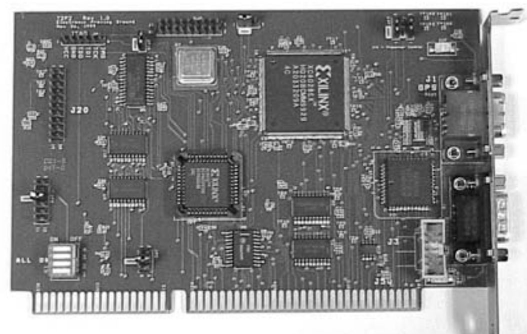

Figure 7 T2P2-ISA board

Mark Hynes is a senior engineer with the U.S. Army White Sands Missile Range Electronic Proving Ground (EPG), Fort Huachuca, Arizona. He has been with EPG for 14 years, during which time he has completed numerous innovative development projects and distinguished himself by obtaining six patents. Hynes has provided a catalyst for technology transfer and enjoys a reputation for innovating cost-effective, quality solutions for testing command, control, communications, computers and intelligence (C^4I) systems, ultimately to the benefit of U.S. soldiers. He began his career at the Naval Research Laboratory in Washington, D.C., where he developed cutting-edge microwave simulators and electronic support measures (ESM) receiver systems. Hynes holds a bachelor of science degree in electrical engineering from Virginia Tech, Blacksburg, Virginia; and a master of science degree in electrical engineering from the University of Maryland.