Modern electronic warfare (EW) and communications systems are designed to operate in a low probability of detection (LPD), low probability of intercept (LPI), and high interference environment. Validating technology and methods for war-fighters requires a high fidelity, physics-based test environment that accurately represents the RF propagation domain, time domain behavior, precise electronic attack (EA) techniques, and physical layer functionality of both EW equipment and threats. The Digital Test Bed (DTB) provides this environment by performing waveform level estimation of the effectiveness of EW equipment, supporting R&D, acquisition, testing, system engineering, and tactics, techniques, and procedures (TTPs). Beyond the virtual environment, the DTB readily integrates with hardware-in-the-loop (HWIL) systems for real-time force training or situations where regulatory restrictions (FAA/FCC) preclude open air testing. The Digital Test Bed manages complex, modern EW hardware simulations spanning the full equipment life cycle.

**Program Objectives**

- Provide a framework for supporting R&D, Acquisition, Testing, and TTPs of EW systems
- Provide a framework for rapid development of behavioral models that map directly to hardware components
- Develop a mechanism to bridge simulation environments and target hardware for HWIL testing
- Capture complex physics-level behavior of threat devices, particularly the threat receiver, in the presence of realistic EW system waveforms and complex electromagnetic environments (EME)
- Enhance threat and EW system modeling and simulation to enable virtual environment validation, verification, and design activities
- Integrate the DTB framework into NRL’s Interactive Scenario Builder to provide high fidelity, physics-based simulations of ground-based EW systems
- Provide a framework that is extensible to all EW systems
Interactive scenario builder

- EW Tactical Decision Aid (TDA) and RF propagation simulator developed and maintained by the Naval Research Laboratory (NRL)
- Multiple validated RF propagation models to support analyses spanning from very long-distance to site-specific simulations
- High-fidelity antenna patterns for installations on land, sea, air, and space platforms
- Provides user interface and results displays for the DTB

Communication Simulation Controller
- DTB execution sequencing
- EME generation
- Virtual Air Interface (VAI) processing
- Model setup and configuration
- All source/sink signals represented in complex baseband
- Each source/sink can have multiple parallel channels representing unique physical channels in the real hardware
- Simulation lasts for minimum time required for IED initiation, dependent on threat modeled

Threat Model Simulation
- RF and baseband operation
- Models created at the system level with sufficient fidelity to capture the behavior of RF and analog effects as well as DSP effects and limited protocol interpretation
- Threat models include simple analog links and complex, digital, commercial communication systems
- Simulation captures actual initiation messages

EW Hardware
- RF element operation
- IF chain operation (AGC, ADC, DAC)
- Digital Signal Processing (fixed & floating point)
- Threat detection and classification
- Countermeasure technique generation

Hybrid Hardware in the Loop
- ADC to controller records threat and EME signals and evaluates detection methods
- Controller to detector DSP provides source threat signals and EME to validate hardware detectors and performs Monte Carlo testing of clustered threats
- Detector DSP to controller evaluate response logic in the presence of EME and clustered threats
- Attack DSP to controller evaluates EA techniques against simulated RF propagation and emplacement effects and determines defeat mechanism
- Controller to attack DSP dynamically triggers attack plans
- Controller to DAC rapidly creates EA techniques in high-level language and evaluates efficacy using actual hardware

Kris Matson/Roger Boyer
919.582.3300 (P)
kmatson@ara.com
rboyer@ara.com
ara.com

Aaron Walker
919.341.8241 (P)
Aaron.Walker@vaduminc.com
www.vaduminc.com

Brian Sjoberg
202.404.7616 (P)
brian.sjoberg@nrl.navy.mil
www.nrl.navy.mil