Boosting Army IAMD Sensor and C2 Transformation Against Next Generation Threats

Army IAMD Transformation:

Sensor Enhancement: THAAD and Patriot track sharing, generational change in Patriot radar (Lower Tier Air/Missile Defense Sensor - LTAMDS), Sentinel A4 radar development supporting Indirect Fire Protection Capability (IFPC) Increment-2 (counter-cruise missile and UAS), Avenger Radar System Modification/Life Extension and SHORAD radar development.

System Integration/Extension/Disaggregation: Operational deployment of IAMD Battle Command System (IBCS) with fielded Engagement Operations Centers and Integrated Fire Control Network (IFCN) bringing together Army, USMC and USN sensors and shooters, IBCS integration with the Ballistic Missile Defense System (BMDS) and MDA's Command, Control and Battle Management, Communications (C2BMC) system, and creation of a disaggregated Patriot battery operations capability (Dismounted Patriot Information Coordination Central--D-PICC).

Monster-Dogs Engineering (MDE) has developed a comprehensive and transformative rapid deployment approach to surmount next-gen threat challenges to the elements and functioning of the Army IAMD Battle Command System (IBCS). The MDE approach extends the threat detection range of coherent radars in clear environments, with natural or intentional clutter and noise jamming and provides early threat detection, tracking and discrimination. Depending on waveform and environment, range extensions of 6x are possible. This applies to ballistic/non-ballistic missiles, cruise missiles, hypersonic weapons and air threats. Sensors can be ground based/mobile or airborne/at sea.

A MDE-enhanced radar with extended detection range capability will lengthen the time-window for IBCS engagement planning, accommodate longer interceptor fly-out times and allow a larger selection of shooters and their locations. If necessary, the sensors can stand back further to remain out of danger. The MDE-enhanced radar can also move forward into areas/domains adversaries would like to deny us (A2/AD). MDE can mitigate adversarial jamming designed to disrupt our ability to detect targets and conduct comms in those domains. Extended IAMD battlespaces that include sea littorals can be created.

To achieve these operational enhancements, MDE pioneered a disruptive, game-changing signal processing approach for detection and tracking that lends itself to comprehensive Army IAMD transformation. The MDE detection/tracking approach is extremely fast and accurate. (Using a uniform burst waveform, MDE achieved 0.5 sec detection and 2 second tracking of a simulated -5 dB S/C target embedded in debris and clutter--100% Pd with low false alarms/track loading. In contrast, coherent integration in equivalent Swerling-I clutter took 24 seconds to achieve 92% probability of detection for this data set.)

MDE's detection approach does not rely on generating large amounts of effective radiated power derived from large antenna gains, large pulse widths, and high-power transmitters requiring large amounts of prime power. Instead MDE pioneered a macro-level quantum disruptive signal processing approach to generate large amounts of excess signal processing gain that can be used to extend detection range or to provide resilience to jamming and clutter masking.

The unprecedented signal processing approach is based on non-kinetic statistical mechanics of interactions involving object backscatter and surrounding interference. Different frequency waves in the radar scene, produced by the radar pulse, interfere with each other, creating complex interference patterns that affect the background equilibrium. MDE transforms the I/Q radar scene into a purely statistical representations of the interference and detects anomalies, passing their range and Doppler positions and statistics to a cluster tracker.

The cluster tracker correlates the detection probabilities using persistence, predictive analytics and mutual information to associate, track, identify and rank the detected objects in order of being likely credible targets. The cluster tracker can seamlessly transition from ballistic track to non-ballistic mode. This approach lends itself to comprehensive Army distributed battlespace IAMD against the gamut of hypersonic weapons, cruise missiles, airborne targets/swarms and ballistic missiles.

The performance advantages of the new and innovative MDE detection and tracking approach were validated in MDE analyses (as sub-contractor) of foreign missile flight test data involving false EM targets and masking of RVs. MDE

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data analyses were able to penetrate countermeasures and track RVs. In the process, MDE analytic estimates of jamming mitigation limitations were validated. Other successful tests involving live data occurred at UHF in sea-state-3 clutter, X-band tracking of a test rocket in launch-stand plume, and C- and S-band debris penetration. Additionally, the MDE approach was selected as the winner in an MDA Aegis BMD PO-sponsored invitational competition at JHU/APL for clutter and debris mitigation over an FFRDC National Laboratory and a leading aerospace corporation.

MDE has developed detailed approaches to discrimination and kill assessment but lacks the high-fidelity statistical mechanics, target-specific test data for validation. That validation can be done under this effort using live flight data.

Further validation of the new MDE detection and tracking paradigms for potential broad USASMDC/ARSTRAT multi-system application can focus on first detecting and tracking in high clutter and barrage noise jamming. The prototype is currently at TRL5. The Army, working with the TPY2 and/or modernized Patriot radar prime contractor, could structure a three to six-month effort involving MDE MATLAB prototype analyses of suitably calibrated, coherent radar scene test data. Waveform, beam width, and PRF can be coordinated with the Army and prime to cover principal ranges of interest. Simulated jamming white noise injected into the test will determine performance limits.

Under a simultaneously MDE IRAD program, a COTS real-time digital Adjunct Signal Processor (CASP) can be developed to process the same flight data over the subject radar(s) test bed interface. In a subsequent six-month activity, test bed verification can transition to live radar(s) 'open-loop' tracking of cooperative targets. The radar(s) can send data to the MDE CASP in real-time while a series of multiple noise levels are injected over the target data to test MDE mitigation limits to unmask and track the target. After processing, MDE would supply detection and track confidence factors, environment and processing metadata, and range and Doppler tracks to the radar(s) signal processor.

MDE principals Catherine Mitchell and Alan Kessler (bios separately attached) are SMEs in sensor integration and functionality in adverse environments—having played an LSI sensor management role in National Missile Defense sensor deployment and PM in MDA Project Hercules CCWG counter-countermeasure design and testing.