Multi-Domain Operations Workshop

July 16 – Pre-workshop Tutorials
July 17 – 18 General and Technical Sessions
Hilton Mark Center, Alexandria, VA

The MDO Continuum: Testing, Experimentation, and Training

Limited Abstracts Available

Wednesday, July 17

TRACK 1 **Strategies for Efficient and Effective Testing**
Track Chair: **Erwin Sabile**, Booz Allen Hamilton

Time	Presenter	Presentation
11:00 AM – 11:30 AM	**Pritesh Patel,** Darkstax CEO	The Use of Digital Twin in T&E Ranges Focused on Multi-Domain Operations
11:30 AM – 12:00 PM	**John Haman,** Research Staff Member, Operational Evaluation Division, IDA	Framework of Verification, Validation, and Uncertainty Quantification (VVUQ) Testing in support of Digital Twin V&V
12:00 PM – 12:30 PM	**Billy Williams**, CHEETAS Program Management Office, KBR – Test Resource management Center (TRMC)	Data Transformation - Cloud Hybrid Edge-to-Enterprise Evaluation & Test Analysis Suite (CHEETA)
12:30 PM – 1:00 PM	**Matthew G. Goldsbury**, CTI Solution Architect, MEERKAT (Merlin Technical Lead)	Electronic Warfare M&S in support of T&E, and a Case for AI/ML for Predicting and Evaluating Non-Kinetic Effects

Bio

Matthew Goldsbury has been working in U.S. DoD Mission Planning and Analysis environments for over 18 years, and with the "Merlin" Electromagnetic Warfare (EW) modeling and simulation technology since its inception in 2010. Over the last 2 years, he has begun supporting Test and Evaluation efforts to bring tooling and capabilities originally developed in support of the EA-18G Growler to the T&E community, ideally to better realize the goal to "Test like we Fight!" Mr. Goldsbury has helped pioneer the use of Jammer Technique Analysis (JTA) within the tactical EW community and is the co-inventor of the AEA Autorouter, both capabilities being adapted today for the T&E needs of tomorrow.

Abstract

Electronic Warfare M&S in support of T&E, and a Case for AI/ML for Predicting and Evaluating Non-Kinetic Effects

A Science and Technology (S&T) effort being executed currently for the Director, Operational Test and Evaluation (DOT&E) seeks to utilize modeling and simulation (M&S) capabilities and algorithmic solutions originally built for airborne electronic attack (AEA) mission planning and analysis to further empower and provide increased capability to the Operational Test and Evaluation (OT&E) community. The software suite being built brings capability in Live, Virtual, and Constructive (LVC) environments - currently Test and Training Enabling Architecture (TENA) enabled, with Cloud Hybrid Enterprise-to-Edge Evaluation Test and Analysis

Suite (CHEETAS) support underway - providing an environment to analyze and visualize the Electromagnetic Spectrum (EMS) as executed on the range, but also enabling analysts to move past constrained RF environments to explore virtual/constructive non-kinetic effects unimpeded by open-air limitations. This presentation seeks to highlight the work being performed on this effort and the tools that are rolling out to the test community, from the ability to automate portions of test plan creation, to an automated architecture for calibrating parametric models based on observed performance data. Finally, we conclude with evaluating potential applications for Artificial Intelligence (AI) and Machine Learning (ML) in overcoming limitations of existing Electronic Warfare (EW), Electromagnetic Spectrum Operations (EMSO), and other non-kinetic modeling challenges with an emphasis on Test and Evaluation (T&E).

TRACK 2 **Electronic Warfare**
Track Chair: **Joe Jarzombek**, Acquired Data Solutions

Time	Presenter	Presentation
11:00 AM – 11:30 AM	**Matthew Goldsbury,** CTI Solution Architect, MEERKAT (Merlin Technical Lead)	EW M&S – JTA and 4-D Visualization for OT&E
11:30 AM – 12:00 PM	**Anthony Triolo,** Altio Labs	Stochastic grammar representations of cognitive EW threats for T&E
12:00 PM – 12:30 PM	**Tilghman Turner & Paul Weimer,** Redstone Test Center & Aberdeen Test Center	Creating MDO Environments with D-LVC
12:30 PM – 1:00 PM	**Joe Jarzombek,** Acquired Data Solutions	From Design to Deployment, accelerate innovation with RF Environment & Mission Simulators

TRACK 3 **Common Operating Picture Program/Mission Engineering Systems of Systems**
Track Chair: **Jean Petty**, Department of Homeland Security

Time	Presenter	Presentation
11:00 AM – 11:30 AM	**Division Chief Ryan Riccucci**, U.S. Border Patrol	Unlocking the Hidden Value In Data Using Applied Ontology, Semantic Technology, & Knowledge Graphs.
11:30 AM – 12:00 PM	**Jennifer Gillum**, IMO PEO STRI	Persistent MDO Operational T&E
12:00 PM – 12:30 PM	**Sam Lehman**, Mathworks	Harnessing Mission Engineering for Enhanced Multi-Domain Operation
12:30 PM – 1:00 PM	**Julia Brault,** Mathworks	Tracking Autonomous Systems in an Urban Env.

Abstract

Tracking Autonomous Systems in an Urban Environment

The evolution of autonomous systems, particularly unmanned aerial vehicles (UAVs), has impacted various sectors, including delivery services, transportation, and infrastructure inspection. Central to the autonomy of these systems are the capabilities of sensing, perception, planning, and execution. While sensing and

execution technologies have seen advancements, the perception and planning phases remain the focal points of research, with sensor fusion and multi-object tracking standing out as pivotal techniques for ensuring situational awareness in complex environments.

This session explores design, simulation, and analysis of advanced perception systems that integrate data from multiple sensors to enhance position, orientation, and situational awareness of UAVs operating in urban settings. We will demonstrate the process of creating realistic urban scenarios, drawing on publicly available building and terrain data. By applying lidar and radar sensor models to generate synthetic sensor data, we will explore the application of various tracking algorithms aimed at accurately estimating the state of multiple UAVs within a digitally constructed urban environment.

Key takeaways from this session include:

- Generation of synthetic lidar and radar data
- Discussion of tracking algorithms tailored to different sensor inputs
- Implementation of track-level fusion for optimal UAV positional estimates

TRACK 4 **Modeling and Simulation**
Track Chair: **Dwayne Morgan**, Acquired Data Solutions

Time	Presenter	Presentation
11:00 AM – 11:30 AM	**Michael O'Conner,** Trideum Corp	Integrating Virtual and Live Radios for MDO Testing
11:30 AM – 12:00 PM	**Dr. Policarpio Soberanis**, Ansys	Model Validation Levels: A Pragmatic Implementation
12:00 PM – 12:30 PM	**Nicholas Wakefield** Adaptive Computing, Inc.	M&S for OT&E - Choke Point Analysis
12:30 PM – 1:00 PM	**Daniel Bray,** Dstl, UK Ministry of Defense	Improving our Understanding of Naval Weapons Effects

Abstract

Model Validation Levels: A Pragmatic Implementation

The use of modeling and simulation in test and evaluation has given rise to the need for a quantification of the "goodness" of a model. The initial definition for model validation levels (MVLs) was first described by Sieck, et. al in the paper Elements of a Mathematical Framework for Model Validation Levels. These definitions were foundational but not pragmatic. To use the MVLs, we further refine the definitions set forth by the seminal work of Seick, et. al. and we include the use of data sources and uncertainty quantification as a means of quantifying the various MVLs that a model can attain. We further tie these levels to what is ultimately the need for an accredited model that can be used to V&V requirements that are not safety critical.

Thursday, July 18 – Workshop General and Technical Sessions

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TRACK 5 **Directed Energy Supporting MDO***
Track Chair: **Doug Nelson**, Teknicare, Inc.

Time	Presenter	Presentation
1:30 PM – 2:00 PM	**Dr. Bonnie Johnson**, Naval Postgraduate School	Kinetic/Non-Kinetic Layered Defense Engagement Coordination for Multi-Domain Operations
2:00 PM – 2:30 PM	**Tariq Majeed,** ODIN ISEA Lead **and Dustin Talley**, HELIOS Test Lead, NSWC	Port Hueneme DE Efforts: Optical Dazzler Interdictor Navy (ODIN): Integration and Embracement into the Fleet and Scenario Development
2:30 PM – 3:00 PM	**Raquel Astorga**, IDEA Project Lead Engineer, White Sands Missile Range	White Sands Missile Range Integrated Directed Energy Architecture: A Paradigm Shift

Bio

Dr. Bonnie Johnson is a research lead and senior lecturer with the Systems Engineering Department at the Naval Postgraduate School (NPS). She has a BS in physics from Virginia Tech, an MS in systems engineering from Johns Hopkins, and a PhD in systems engineering from NPS. She leads research projects for ONR, OPNAV, Army, and Marine Corps sponsors in directed energy systems and warfare, automated battle management aids, artificial intelligence applications, and complex adaptive systems. Prior to working at NPS, she was a senior systems engineer with Northrop Grumman and SAIC, working on Naval and Joint air and missile defense systems. Bonnie is the associate editor of ASNE's Naval Engineers' Journal for unmanned autonomous systems. Bonnie recently won the Richard W. Hamming Faculty Award in 2022 for Interdisciplinary Achievement at NPS.

TRACK 6 **AI for Operational Decision Making**

Track Chair: **Joe Jarzombek**, Acquired Data Solutions

Time	Presenter	Presentation
1:30 PM – 2:00 PM	**Jim Lockett**, Principal Engineer, MITRE	**Systems Engineering Processes to Test AI Right**
2:00 PM – 2:30 PM	**Carol Pomales,** MITRE	**Complex AI Use Cases & Trustworthy AI Metric**
2:30 PM – 3:00 PM	**Russell Graves,** Application Engineer, Mathworks	The Challenges of Incorporating and Verifying Machine Learning Models into Safety-Critical Systems

Abstract

Systems Engineering Processes to Test AI Right

We recognize the opportunity and necessity for Artificial Intelligence (AI) as a critical technology that the Department of Defense (DoD) must use to meet certain mission needs to keep pace with its near-peer adversaries, but also the challenge that it presents to Test and Evaluate it. The Office of the Under Secretary of Defense (OUSD), Developmental Test, Evaluation, and Assessments (DTE&A) is working to help the DoD community get ahead of this challenge through investigation and collaboration.

A MITRE team has been tasked to support this task, working with input from DOD Stakeholders, Federally Funded Research Centers (FFRDCs), Academia, and Commercial Industry to develop practical recommendations that demonstrate the benefits for proactive planning for Test and Evaluation (T&E) activities

for AI Enabled Systems (AIES). SEPTAR was produced to capture various best practices being developed and applied across the community and align them to DOD processes to prepare for future DTE&A guidance and policy.

Abstract

Complex AI Use Cases & Trustworthy AI Metric
AI-enabled systems (AIES) in Department of Defense (DoD) will benefit from shifting test and evaluation (T&E) from a single event to a continuous process throughout the system lifecycle. To accomplish this, we propose a 'trustworthiness' metric to quantitatively measure the choices and key activities that produce an AIES and identify risks in the development process. The measurement is framed upon research of emerging best practices for designing, building, and employing AIES sourced from DoD practitioners, academia, federally funded research and development centers (FFRDCs), and commercial industry.

Trustworthiness supports Test and Evaluation as a Continuum[1] (TEaaC), a framework developed by the Office of the Secretary of Defense (OSD) Office of Developmental Test, Evaluation, and Assessments (DTE&A) that utilizes T&E to inform decisions earlier in the lifecycle, so that risks associated with integration, operational employment, adversarial cybersecurity resilience, and user adoption can be mitigated at the earliest feasible point.

In this presentation, we will share our novel approach to trustworthiness, the method for constructing it, and the results of a case study application. The benefits and complexities of distilling overall trustworthiness from this multi-variate problem are discussed. The possibilities of informing the trustworthiness metric with commercial and open-source tools are also explored. The metric is compared to NIST's Trustworthy AI framework. [2] Through the development of this metric, DoD can better inform leaders on the risks and rewards of using AIES. Approved for Public Release; Distribution Unlimited. Public Release Case Number 24-0456.

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TRACK 7 **Expeditionary & Edge Testing and Evaluation in a MDO Environment**
Track Chair: **Jason Lucas**, 96 TSSQ/RNXT

Time	Presenter	Presentation
1:30 PM – 2:00 PM	**Jason Lucas**, 96 TSSQ/RNXT	Over Water Impact Location (OWIL)
2:00 PM – 2:30 PM	**Dr Jim Burke**, Torch Technologies	Remote Advanced Weapon Test and Evaluation Capability (RAWTEC)
2:30 PM – 3:00 PM	**William Devine**, PMSR	BLOS T&E in a maritime environment

TRACK 8 **Data and Analytics**
Track Chair: **Steve Seiden**, Acquired Data Solutions

Time	Presenter	Presentation
1:30 PM – 2:00 PM	**Michelle Allard**, Lead Application Engineer for the Navy, Mathworks	**Enhancing AI Applications with Automated Signal Labeling**
2:00 PM – 2:30 PM	**Mason Rowe, Alex Attia & Camerson Witte,** AEC-ATEC	Shifting Left the Impact of Real-Time Analytics
2:30 PM – 3:00 PM	**Stephanie Verdugo**, Owner, Afterburner Wind Tunnel Services, LLC	**Using Game Engines as an MBSE solution**

Abstract

Enhancing AI Applications with Automated Signal Labeling
The fusion of Artificial Intelligence (AI) with signal processing has highlighted signal labeling as an essential part of the workflow. This session aims to explore the methodologies in signal labeling and the integration of deep learning techniques to automate and optimize the process, while focusing on an example of automated labeling of flight maneuvers.

The presentation will introduce the fundamentals of signal preprocessing, which prepares data for effective labeling. We will discuss various strategies for extracting valuable information from signals, improving the accuracy and efficiency of the labeling process. A central focus of the session will be on the comparison of traditional signal labeling methods, which include manual annotation and algorithm-based approaches, against the innovative use of deep learning models. We will delve into an iterative method for building and refining these models, aimed at minimizing human effort while maximizing the efficiency and accuracy of signal labeling.

Abstract

Using Game Engines as an MBSE solution
Decision making for engineers and analysts requires consideration of increasing amounts of information, and less time to conduct analysis for decisions. Digital twins and model-based systems engineering (MBSE) models require very detailed linked information in specialized environments. The software tools are complex and require specialized training to use. If implementation is not perfect in the beginning, the benefits may not be realized. There is a gap for user-friendly solutions that can cope with the less-than-perfect traceability of information. This is the case for new programs and legacy systems. This topic explores using game engines as an MBSE solution with emphases on a user-friendly environment that is low cost and can adapt to user feedback. The concept in development is a handheld tablet with a representation of a system that allows the user to view aggregated maintenance information and perform guided troubleshooting.