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13-July First Day – Tutorials

8:00 a.m. – 12:00 p.m. Morning Tutorials

Introduction to Cybersecurity Test and Evaluation

Pete Christensen, Consultant

This tutorial will familiarize attendees with Cybersecurity and Test and Evaluation as it applies to US Federal Government Programs and the U.S DOD. Note that the ideas and concepts presented also apply in principal to any acquisition program. Topics that will be addressed include Cyberspace as an operational domain, Cybersecurity threats, malware, DHS and DOD systems acquisition and associated Cyber T&E policy and process including "Cloud" Programs, requirements analysis, evaluation frameworks, cyber tabletop exercises, cooperative vulnerability assessments, adversarial assessments, cyber ranges and lessons learned.

Predicting & Validating Prototype Performance

Mark Kiemele, PhD, Air Academy Associates

Design of Experiments (DOE) is a method that can and should be used not only in the design and development of systems, but also in the modeling and validation of prototype systems **such as JADC2 systems**. Building useful prediction models and then validating them can ease the burden of making procurement decisions. This tutorial will examine two prototypes that are built to satisfy a common set of requirements. DOE will be used to model the performance of each prototype. Then validation testing will be used to confirm the models and assess the performance capability of each prototype, i.e., how well the prototypes meet the requirements. This facilitates a comparison of the capabilities of the two systems, thereby enhancing the decision as to which system to pursue. There are no prerequisites for this tutorial, as the analysis will be demonstrated via computer. Intended Audience: This tutorial is for anyone interested in learning how to model performance and evaluate the capability of multiple prototypes, which should include managers, scientists and engineers and those having to make procurement decisions, would benefit from this course. There are no specific education requirements required, though some knowledge of algebra and basic statistics would help.

Video Compression

Gary Thom, Delta Information Systems

With the growing complexity of flight test programs and the improved efficiency of compression algorithms, video is an ever increasing component of flight test data collection. This tutorial will provide a basic understanding of video interfaces. This will include a discussion of the signals, formats, resolutions and frame rates. Building on those basics the tutorial will then present a high level description of how video compression works and the trade-offs that can be made when selecting and implementing video compression components. An overview of various video compression algorithms will be provided, highlighting the differences between the algorithms. We will examine the effects of video compression on video quality and investigate some of the causes and resolutions of quality problems. Finally, there will be a brief overview of audio compression.

1:00 p.m. – 5:00 p.m. Afternoon Tutorials

JMETC/TENA Capabilities for JADC2 and Distributed Testing

Gene Hudgins, JMETC/TENA Team, Test Resource Management Center

The Test and Training Enabling Architecture (TENA) was developed as a DoD CTEIP project to enable interoperability among ranges, facilities, and simulations in a timely and cost-efficient manner, as well as to foster reuse of range assets and future software systems. TENA provides for real-time software system interoperability, as well as interfaces to existing range assets, C4ISR systems, and simulations. TENA, selected for use in JMETC events, is well-designed for its role in prototyping demonstrations and distributed testing.

Established in 2006 under the TRMC, JMETC provides readily-available connectivity to the Services' distributed test capabilities and simulations. JMETC also provides connectivity for testing resources in the Defense industry and incorporation of distributed testing and leveraging of JMETC-provided capabilities by programs and users has repeatedly proven to reduce risk, cost, and schedule. JMETC is a distributed LVC testing capability developed to support the acquisition community during program development, developmental testing, operational testing, and interoperability certification, and to demonstrate Net-Ready Key Performance Parameters (KPP) requirements in a customer-specific Joint Mission Environment.

JMETC is the T&E enterprise network solution for secret testing, and uses a hybrid network architecture – the JMETC Secret Network (JSN), based on the SDREN. The JMETC MILS Network (JMN) is the T&E enterprise network solution for all classifications and cyber testing. JMETC provides readily available connectivity to the Services' distributed test capabilities and simulations, as well as industry test resources. JMETC is also aligned with JNTC integration solutions to foster test, training, and experimental collaboration.

TRMC Enterprise Big Data Analytics (BDA) and Knowledge Management (BDKM) has the capacity to improve acquisition efficiency, keep up with the rapid pace of acquisition technological advancement, ensure that effective weapon systems are delivered to warfighters at the speed of relevance, and enable T&E analysts across the acquisition lifecycle to make better and faster decisions using data that was previously inaccessible, or unusable. BDA is the application of advanced tools and techniques to help quickly process, visualize, understand, and report on data. JMETC has demonstrated that applying enterprise-distributed BDA tools and techniques to T&E leads to faster and more informed decision-making that reduces overall program cost and risk.

TRMC has been working with Joint Staff and Air Force JADC2 Cross-Functional Teams (CFTs) regarding JADC2 and Multi-Domain Operations (MDO), to inform them on TENA/JMETC and other TRMC capabilities that could be leveraged to support the emerging Joint Staff Joint Domain Environment (JDE). Additionally, TRMC has been engaged with Army Futures Command (AFC) throughout the year in a number of areas including assessing TENA/JMETC Support coupled with Big Data Analytics (BDA), expanding OSD TRMC collaboration and cooperation to other mission areas including, but not limited to, Cyber, BDA, Knowledge Management (KM), Machine Learning (ML), and Artificial Intelligence (AI).
This tutorial will inform the audience as to the current impact of TENA, JMETC, and BDA on the T&E community; as well as their expected future benefits to the range community and the warfighter.

Real World Telemetry over IP

Gary Thom, Delta Information Systems

As telemetry ranges are making the move to network centric architectures, it is worth considering the lessons learned over the previous 10 years of designing, installing, troubleshooting and optimizing telemetry data distribution over IP networks. This tutorial will begin with the motivation for moving to Telemetry over IP (TMoIP). It will then provide a basic networking foundation for understanding TMoIP and TMoIP formats. With this basis, we will be able to discuss network design considerations and tradeoffs for a successful TMoIP deployment. Finally, we will present some of the real-world problems and issues that may arise in a TMoIP system and the troubleshooting techniques that can be used to resolve them.

Some presentations at the Workshop will be Limited Distribution C and D, which restricts participation in those sessions to U.S. citizens who are employees of the U.S. Federal Government or its contractors (C), or employees of the Department of Defense or its contractors (D). If you do not meet this requirement, you may be unable to attend every session. Attendees without need-to-know may only attend presentations cleared for public release at sessions. Those wishing to attend the Limited Distribution sessions must submit a visit request. ****All visit requests, via JPAS, DISS, or Visit Request letter, must be received by 3 PM MST on or before 9 July 2021**. Instructions for submitting visit requests can be found at www.itea.org. All presentations are cleared for public release unless noted.

14-July Second Day - Plenary Sessions, Technical Sessions, & Exhibits

7:30 a.m. Opening Ceremony:
Presentation of Colors
National Anthem
Mr. Pete Crump – ITEA President

7:45 a.m. Welcome:
Mr. Charles Garcia, MDO Program Chair & Steve Aragon, White Sands Chapter President

8:00 a.m. Welcome by Brigadier General Eric Little, Commanding General, White Sands Missile Range

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8:15 a.m. Keynote Speakers: Sandra Hobson, PhD, (SES), Acting Principal Deputy, Office of the Director, Operational Test & Evaluation, OSD and
Christopher Collins, (SES), Director Developmental Test, Evaluation, and Assessments, Office of the Undersecretary of Defense (R&E) - ***"Transforming T&E to Adequately Assess Warfighting Capability in a Multi-Domain Operational Environment"***

9:00 a.m. Keynote Speaker: George Rumford, (SES) Director (acting) and Principal Deputy, Test Resource Management

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9:45 a.m. 30-MINUTE BREAK IN THE EXHIBIT HALL

10:15 a.m. Keynote Speaker: Craig Miller, President, Viasat Government Systems

11:00 a.m. Test Resource Management Center (TRMC) Panel: ***"Multi-Domain Enterprise Test Infrastructure: Current Efforts and Future Considerations"***

Panelists:

- Ryan Norman, Chief Data Officer (CDO), Test Resource Management Center and Deputy, JMETC
- Geoff Wilson, T&E/S&T Program Manager and Hypersonics Test Lead, Test Resource Management Center
- Kenny Sanchez, C4T Executing Agent, Test Resource Management Center

12:30 p.m. Lunch Break in the Exhibit Hall

1:30 p.m. Featured Speakers: Christopher Klug, Director, Air Force Multi-Domain Test Force and
Lt Col Michael "Hijack" Fritts, Director of Operations, 411th Flight Test Squadron and F-22 Combined Test Force, Emerald Flag Founder, Test Pilot

2:30 p.m. Featured Speaker: Paul Mann, (SES) Department of the Navy Chief Engineer, Office of the Deputy Assistant Secretary of the Navy (RDT&E)

3:00 p.m. Featured Speaker: Rick Quade, (SES), Test & Evaluation Executive, Department of Navy and Director for Innovation, Technology Requirements and T&E (N94)

3:30 p.m. 30-MINUTE BREAK IN THE EXHIBIT HALL

4:00 p.m. Technical Track Sessions

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Chair	Time	Title	Presenter(s)
Session 1: Continuous Process Improvement (CPI)			
Mark Kiemele, Air Academy Associates	4:00	*Critical Thinking in Continuous Process Improvement*	Mark Kiemele, PhD, Air Academy Associates
	4:30	*Lean Six Sigma*	Mark Kiemele, PhD, Air Academy Associates
	5:00	*Design for Six Sigma*	Mark Kiemele, PhD, Air Academy Associates
	5:30	*Leveraging the CIPP Model to Achieve CPI in T&E and other DoD Applications*	Joe Stufflebeam, PhD, TRAX International
Session 2: DARPA			
Colonel (USA, Ret) Barbara Trent, COVA Strategies	4:00	*Real-time Analytics Fusion for Continuous LRPF Offensive/Defensive Threat Assessment and Response*	Gert Berthold & Kevin "Cuz" Cousin, PhD, Cova Strategies, LLC.
	4:30	*Dual-Purpose ISR Analytics Exploitation for Offensive/Defensive Multi-Domain Operations*	Gert Berthold & Kevin "Cuz" Cousin, PhD, Cova Strategies, LLC.
	5:00	*Applying Composable Inline Analytics for Intelligence Fusion*	Gert Berthold & Kevin "Cuz" Cousin, PhD, Cova Strategies, LLC.
	5:30	*Analytics Fusion across Distributed Zones of Security*	Kevin "Cuz" Cousin, PhD & Gert Berthold, Cova Strategies, LLC.
Session 3: Software Intensive in support of JADC2			
Jaime Lujan, Trideum	4:00	*C4ISR and Software Intensive Systems T&E Challenges*	Kenneth Sanchez, Kathy Smith, & Kent Pickett, NAVAIR
	4:30	*Automation of Legacy Test Systems*	Dennis Shen & Dontel Newton, Georgia Tech Research Institute
	5:00	*Synthetic Data Generation to Enable T&E S&T for Big Data Analytics*	Kenneth Sanchez, Kathy Smith, & Kent Pickett, NAVAIR
	5:30	*New Methods/Products for Comprehensive Analysis of T&E Events; Big Data Analysis for T&E*	Kenneth Sanchez, Kathy Smith, Kent Pickett, & William Wolfe, NAVAIR

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Session 4: Enabling Technologies			
Armando Juarez, GreyBeard Group	4:00	*The Next Generation DoD Imaging Architecture* *****Limited D Presentation*****	Joe Stufflebeam, Ph.D., TRAX International
	4:30	*Remote Classified Operations* *****Limited D Presentation*****	Grant Senn, Southwest Range Services (SRS)
	5:00	*Digital Beamforming Phased Arrays for Telemetry Tracking Applications* ***** Limited A/Open Presentation*****	Dorse DuBois, Mannatek; Anand Kelkar, CDSI; Juan Guadiana, Mannatek
	5:30	*Coupled Sensor Array System (CSAS)* ***** Limited A/Open Presentation*****	Jose Mendez, Southwest Range Services (SRS)

6:00 p.m. RECEPTION IN THE EXHIBIT HALL

15-July Third Day - Plenary Session, Technical Sessions, & Exhibits

8:00 a.m. Welcome and overview of the day's events by Mr. Charles Garcia – MDO Program Chair

8:15 a.m. Featured Speaker: Dr. Randy Garrett (SES), Program Manager for Geospatial Cloud Analytics (GCA) and Multi-Domain Analytics (MDA), DARPA Strategic Technology Office (STO)
"Testing for a New Age of Warfare" *- Substantial changes in enemy strategy and tactics as well as changes in the global environment necessitate changes in the DoD response. Testing must respond with new techniques to accommodate more diverse equipment and military doctrine. Testing will also need to be more agile but also more comprehensive. This presentation will provide some ideas on how testing could be enhanced to be even more effective for future conflicts.*

9:00 a.m. Featured Speaker: Col. Nick Hague, Director of Test and Evaluation, Space Force

9:45 a.m. 30-MINUTE BREAK IN THE EXHIBIT HALL

10:15 a.m. Featured Speaker: Gary Anaya, Chief, U.S. Army Fires Center of Excellence /AFC- FCC Capabilities Development & Integration Cell (CDI-Cell) – ***"Overview of the PNTAX-2020 Excursion"*** **** Limited D Presentation****

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10:50 a.m. Keynote Speaker: Brigadier General Stephanie R. Ahern, Director of Concepts, Futures and Concepts Center (FCC), Army Futures Command (AFC)

11:30 a.m. Featured Speaker: Colonel Adam Butler, Deputy Commander, Joint Modernization Command (JMC), Futures and Concepts Center (FCC), Army Futures Command (AFC)

12:00 p.m. Lunch Break in the Exhibit Hall

1:00 p.m. **Panel: University Showcase – Supporting JADC2**

- Machine & Deep Learning at NMSU: Application to Space Weather by Laura Boucheron, PhD, Associate Professor, Klipsch School of Electrical and Computer Engineering, NMSU
- Human Capital Development for Systems and Mission Engineering Contexts: Leveraging UTEP's IMSE department by Ms. Shani Rivera, Research Assistant University of Texas at El Paso
- Physical Science Laboratory's (PSL) CREW Apprenticeship Program by Marcella Shelby, PhD, Strategic Initiatives Officer, PSL, New Mexico State University

2:15 p.m. Featured Speaker: Jerry Tyree, Deputy Commander and Technical Director, White Sands Test Center, Army Test and Evaluation Command, White Sands Missile Range – ***"MRTFB Support of JADC2"***

3:00 p.m. 30-MINUTE BREAK IN THE EXHIBIT HALL

3:30 p.m. Technical Track Sessions

Chair	Time	Title	Presenter(s)
Session 5: Tools for Distributed Testing			
Joe Bullington, Jacobs	3:30	*Employing a CLONE to Enhance JADC2 Testing*	CAPT Jeff Hoyle (USN, Retired), Rajive Bagrodia, PhD, Jeff Weaver, PhD & Lloyd Wihl, Scalable Networks Technologies
	4:00	*Development and Testing of Navy Torpedoes in a Full Fidelity Simulated Undersea Environment*	Carlos Godoy, Kenneth Sanchez, Kent Pickett, Kathy Smith, NAVAIR
	4:30	*Continuous, Scaled and Agile Security Analysis of Web Application Code*	Steve Seiden, Acquired Data Solutions
	5:00	*Zero Chain" Traceability for Test, Measurement, and Diagnostic Equipment (TMDE)*	Richard H. Parker, PhD & David J. Hargett, US Army TMDE Activity

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Session 6: University Showcase - Supporting JADC2			
Richard O. Martinez, GreyBeard Group	3:30	*Deep Learning for Verification of Electronic Warfare Techniques*	Caleb Story & Jerrik Waugh, Physical Science Laboratory, New Mexico State University
	4:00	*Hot Fire Test in a Reaction Control Engine and Throttleable Engine*	Jazmin Arellano, UTEP
	4:30	*Function Level ROP Gadget Survival Using Compiler-Based Software Diversification*	David Reyes, UTEP
	5:00	*The Data Acquisition System for a 1 MW Combustor*	Md Mohieminul I. Khan, UTEP
Session 7: Directed Energy			
Mark Henderson, Blue Halo	3:30	*Directed Energy Weapon Test & Evaluation in a Relevant Multi-Domain Operational Environment* ***** Limited D Presentation*****	Nathaniel C. Charles, Francis Check & Stephen Lenart, TRAX International; Filberto Macias, White Sands Center; Gustavo L. Sierra, ATEC; Steve Squires, HELSTF
	4:00	*Design and development of a beam profiling system for range testing of 150 kW class laser systems* ***** Limited C Presentation*****	James Luke, PhD, BlueHalo
	4:30	*Mobile Laser Integrated Diagnostic Suite (LIDS) Program Update* ***** Limited C Presentation*****	Milan Buncick, PhD, BlueHalo
	5:00	*HPM Sensor on Instrumented sUAS Update* ***** Limited A/Open Presentation*****	Mark Henderson, BlueHalo
Session 8: Intellectual Property Considerations for Technology Developed with Government Funding			
Kevin Soules, Loza & Loza, LLP	3:30	*Patents*	Kevin Soules, Loza & Loza, LLP
	4:00	*Copyrights*	Kevin Soules, Loza & Loza, LLP
	4:30	*The Bayh-Dole Act*	Cameron Smith, Texas Tech
	5:00	*Monetization Strategies for Federally Funded Innovations*	William “Hutton” Jones, Texas Tech

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Session 9: Technology in Support of Operational Planning			
Michael T. McCarthy, Army Futures Command	3:30	*Infrastructure as Code*	Will Lester, Nextech Solutions
	4:00	*Video on the Edge: Software-Defined & Intent-Based Models for ISR Video Asset Management*	Will Lester, Nextech Solutions
	4:30	*Accelerate Through your PACE Plan*	Vivian Richards, Splunk, Inc.
	5:00	*Using Discrete-Event Simulation to Predict Communication Challenges and Outcomes in a Multi-Domain, Multi-Communication Environment*	Majid Raissi-Dehkordi, PhD, Nextech Solutions

Exhibit Hall Hours

Tuesday, July 13th – 8:00am – 5:30pm, Exhibitor Set-up

Wednesday, July 14th – 9:00am – 6:00pm (Networking Reception 6:00-8:00pm)

Thursday, July 15th – 9:00am – 4:00pm

Thursday, July 15th – 4:00pm – 8:00pm, Exhibitor Move-out

Host Hotel

Radisson Hotel El Paso Airport
1770 Airway Blvd.
El Paso, TX 79925
Phone: 915-772-3333

ITEA is pleased to offer a special below government per diem rate of **$98 per night.** This property is the host hotel and when making your reservation you must indicate you are with the ITEA workshop. To receive the special rate call 915-772-3333 or click the Radisson link above to book your reservation by **June 21, 2021. Be sure to use group code ITEAW for $98 rate.**

Program Planning Committee (MDO@itea.org)

Program Chair: Charles Garcia – GreyBeard Group

Technical Co-Chairs: Steve Aragon – BlueHalo & Richard Martinez – GreyBeard Group

IT/AV Co-Chairs: Armando Juarez – GreyBeard Group & Carlos Maez - SRS

Exhibits and Sponsorships: Lena Moran – 951-219-4817, Lena@itea.org

Security (Visitor Requests): Anahi Mancha, anahi.l.mancha.ctr@mail.mil

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Registration: info@itea.org or 703-631-6220

Technical Track Session Abstracts

Accelerate Through your PACE Plan

Vivian Richards, Splunk, Inc.

Integrated Joint, NATO, and Allied Forces Partner Nations (PN) solutions are needed to address the integration of cyber operations, electronic warfare, and signals intelligence analysis, exploitation, and dissemination for cooperative intelligence sharing, security assistance and operations. Novel solutions are desired that support the rapid and effective interoperability of US military technologies (inclusive of government developed and commercially available technologies), systems, and processes with NATO and PN's capabilities to deliver common- systems (and system-of-systems architectures). The solutions must provide integrated, interoperable, timely, and affordable capabilities, across the various zones of security, that promote decisive action supporting Joint, coalition and multinational military operations.

The Correlation Enhanced Understanding System (COEUS) provides an intelligent data pipeline component for understanding and enriching data which crosses multiple security zones. Data transformation algorithms allow the data to be readily compressed and processed at an intermediate representation without loss of context across an array of additional analytic and data processing technical components using open data exchange standards. Not only does this pre-processing of raw data streams into vectors provide a reduction in effective bandwidth for data transfer and end-point data stream processing; it allows for the use of a common C4ISR/C5ISR system configuration across Joint, NATO and PN forces with common operational, sustainment, and training requirements for efficient and consist information sharing and operations. While the system may be common across the forces, the fidelity of the analytics, results and levels of confidence are reflective of the level of information afforded to a security zone; e.g., all forces can share Open Source and Publicly Available Information (PAI) and unclassified information, but PN, NATO and US information sharing security protocols dictate how data vectors may be utilized across security guards, zones of security and as data inputs to analytics and the C5ISR system. Operational applications of this prototype will be explored.

Analytics Fusion across Distributed Zones of Security

Kevin "Cuz" Cousin, PhD, and Gert Berthold, Cova Strategies, LLC.

Integrated Joint, NATO, and Allied Forces Partner Nations (PN) solutions are needed to address the integration of cyber operations, electronic warfare, and signals intelligence analysis, exploitation, and dissemination for cooperative intelligence sharing, security assistance and operations. Novel solutions are desired that support the rapid and effective interoperability of US military technologies (inclusive of government developed and commercially available technologies), systems, and processes with NATO and PN's capabilities to deliver common- systems (and system-of-systems architectures). The solutions must provide integrated, interoperable, timely, and affordable capabilities, across the various zones of security, that promote decisive action supporting Joint, coalition and multinational military operations.

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Applying Composable Inline Analytics for Intelligence Fusion

Gert Berthold & Kevin "Cuz" Cousin, PhD, Cova Strategies, LLC.

To counter malign activities in complex, multiethnic, contested spaces. Information Operations (IO) teams must assess the information environment, draw conclusions, and present relevant assessments to supported elements to make sound decisions and take targeted actions faster than the adversary. The modern interconnected electronic world provides vast amounts of raw data that can provide the basis for IO assessments. Presently, getting access to the broadest spectrum of available data (PAI feeds or government owned) and sifting through that data to find, interpret, assess, and present usable information is a time consuming, labor intensive effort. Operators need an organic and rapid ability to find, curate, refine, analyze, and present information from select local, topical, or global strategic conversations to enable responsive and decisive actions.

IO requirements, across the corpus of available text and multimedia (audio, images, video), include rapidly delineating appropriate conversations along with the identification of different competing narratives within the larger conversation, the primary influencing agents for these respective narratives, as well as any artificial manipulation of the conversation through bots, trolls, astro-turfing campaigns, etc. While ingest and storage requirements vary by organization and mission intent, the common framework consists of the identification of potential sources; ingest from available sources; enrichment and data fusion; analytics processing for the generation of Situation Awareness, insights, and the analyzing of behaviors and situations that can lead to preempting threats, attacks, system failures; and the visualization of the results for decision support, within a set of tools and user interface(s).

Concept Maniac (Media Analytics for Information Operations Activities) outlines an approach to fulfill the Publicly Available Information (PAI) Find, Identify/Interpret, Assess/ Understand and Present capability using intelligent ingest, advanced algorithms and machine learning, and a range of visualization tools to provide Information Operations and data-driven intelligence. This prototype uses composed inline analytic pipelines to continuously identify, ingest and transform relevant sources into a common operating picture of SA and higher levels of situational understanding of the potential inquiry space, including potentially deep insight on conversations, entities, groups, relationships, patterns of life, behavioral characterizations and anomaly detection & alerting on conditions, behaviors and potential precursors not otherwise seen. This body of continuously updated information is accessed, extracted, and made available to all echelons through a tailorable, gaming influenced User Interface (UI) for data inquiry and decision support. Maintaining analytics pipelines independent of UI generated inquires/analyses speeds responsiveness, and thoroughness while also enabling automated notification of changes posted to the original analyst's inquiry for more complete assessment and decision making.

Automation of Legacy Test Systems

Dennis Shen & Dontel Newton, Georgia Tech Research Institute

While an automated testing environment can provide consistent, reliable, and efficient testing capabilities, adapting legacy test environments to include automation presents unique challenges to overcome.

One challenge is maintaining user confidence in the provided test environment. With legacy systems, users have high familiarity and confidence in the system as is. Any changes that are made must be implemented in a way that the user has the same confidence in the new automated test environment that they had with the original legacy test environment. These automated systems also, require the proper training to yield valid results. If the end-user decides the automated test environment is too difficult to learn, they may be reluctant to adopt it deciding instead to continue to rely on the manual methods.

Another challenge is designing an automated test environment around the legacy system. Many of these legacy systems were not initially designed with automation in mind. A complete redesign is typically cost prohibitive, and as often is the case with hardware-in-the-loop testing, a non-starter due to the investment that has already been made in building the legacy test environment. Another aspect of this challenge is how to approach tasks that require user input, e.g. pushing a button or turning a knob. The automated test solution must be able to address this part of the challenge. This directly ties into the user confidence as any large scale changes will also affect the overall user confidence in the automated test system.

All of these challenges can be addressed so that the automated system inspires the same confidence and meets the end user needs. As much as possible, existing components should be reused or adapted. Users are already familiar with these components and have confidence that generated results are valid. To aid in this effort, a decision must be made to build automation into these components, or to use another library to drive the automation capabilities. As long as the same user interfaces and components are maintained, users will have the same confidence they had with the legacy test environment. Automated testing has many benefits to the end user but care must be taken so that the user is still comfortable and confident in using a testing environment that has been automated.

C4ISR and Software Intensive Systems T&E Challenges

Kenneth Sanchez, Kathy Smith, & Kent Pickett, NAVAIR

As stated in the National Defense Strategy: Investments in Command, Control, Communications, Computers and Intelligence, Surveillance, and Reconnaissance (C4ISR) will prioritize developing resilient, survivable, federated networks and information ecosystems from the tactical level up to strategic planning. Investments will also prioritize capabilities to gain and exploit information, deny competitors those same advantages, and enable us to provide attribution while defending against and holding accountable state or non-state actors during cyberattacks. Information is now considered by many as a domain right next to cyber, space, land, sea, and air. C4T TTA will invest in new T&E technologies with the application of autonomy, artificial intelligence, and machine learning, including rapid application of commercial breakthroughs, to revolutionize the way we test and evaluate warfighter acquisition systems.

Communications capabilities of warfighting systems are becoming more agile and complex with new requirements and initiatives, such as: military tactical application of Software Defined Radios (SDR), the Air-

Sea Battle concept in a sophisticated Anti-Access/Area Denial (A2/AD) environment, future Joint Aerial Layer Networks, and the Moving Target Defenses (e.g. polymorphic networks).

Warfighting systems (e.g. Distributed Common Ground System) are employing (utilizing or generating) data-to-decision and big data capabilities within a cloud environment. This presents new challenges for T&E to assess these platforms. For C4I systems, the trend is accelerating in the three "V" dimensions of big data:

- Velocity increases requirements for Test Data-to-Decisions to operate in real-time processing.
- Variety increases requirements to process many types of structured (Variable Message Format), semi-structured (Link 16), and unstructured (voice, chat, video) data.
- Volume increases requirements to process larger and larger amounts of data (e.g. petabytes).

As you accelerate down these V dimensions, the warfighter systems are incorporating complex underlying new IT infrastructure that must be tested. These advanced IT infrastructures include cloud technologies that can have massive parallel file systems, distributed SQL and NoSQL databases, basic and advanced analytics and custom applications, and virtualization technologies.

New C4I systems must be tested in the volume designed to handle in wartime operations. Adaptable technologies are required to utilize a synthetic battlespace environment to augment the open-air range with vast simulated areas, frequency ranges, and transmitter entities for T&E in Contested/Dense communications environments. This would provide opportunities to test C4I systems under realistic controlled conditions: what-if scenarios, test pre-runs, and link analysis test planning to maximize the value of field testing and expand its scope. C4T has identified three key technology domains: Live and Simulated, Big Data Analytics, and Automated Software Testing.

Live and Simulated methods are required to replicate the more complex and distributed systems environments of today and tomorrows warfighting systems. Live and simulated entities (modeling and simulation) provide for more thorough joint mission context platform T&E.

Continuous, Scaled and Agile Security Analysis of Web Application

Steve Seiden, Acquired Data Solutions

HTTP is the language of the web, powering traditional page servers, API back-ends and IOT/OT assets. The source code footprint of web applications is growing exponentially as HTTP endpoints proliferate in the cloud, the enterprise, and in manufacturing and critical infrastructure. There is explosive growth in the number of micro-controllers that drive IOT (and IIOT) devices and many of these devices are connected to the outside world via HTTP. While the web's footprint is growing by orders of magnitude, trends in agile software development are accelerating the rate of change of the underlying source code. This acceleration of software change is driven by DevOps and ever-shrinking release cycles. Continuous, automated testing of code quality for functional features is a maturing field due to the mass adoption of DevOps practices, but security testing is often absent or is performed using slow, manual methods. DevSecOps will rely on the ability to automate, distribute and orchestrate headless test processes that include security analysis. These processes will need to examine web endpoints for black box vulnerabilities and hidden attack surface (entry points) during repeated software build/test cycles. Assert Security will describe the design principles, architecture and operation of distributed security testing of web endpoints to achieve continuous monitoring that fits cleanly into the DevOps model of rapid development.

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Copyrights

Kevin Soules, Loza & Loza, LLP

Copyrights don't just protect the painting on your wall. Copyrighted software is a key component of any intellectual property portfolio. In this segment, we will discuss high level ownership issues associated with software development, particularly when the software is developed under government contract.

Coupled Sensor Array System (CSAS)

Jose Mendez, Southwest Range Services (SRS)

WSMR will utilize this Coupled Sensor Array System as a way to provide wide-beam horizontal and vertical coverage. The CSAS will support testing scenarios requiring collecting telemetry data of up to 12 radio frequencies from multiple objects simultaneously. The CSAS will accomplish this by utilizing a combination of eight horn antennas, signal-to-noise-ratio (SNR) polling Sensor and three quad data receivers.
All equipment has been be carefully selected through test and analysis to provide the required horizontal and vertical coverage and data process. The SNR polling sensor is the brains of the coupled sensor array solution responsible for processing all of the antenna RF inputs and selecting and routing the highest RF (SNR) value from each of the designated mission frequencies (a minimum of 12 frequencies) to the appropriate telemetry receiver.

Critical Thinking in Continuous Process Improvement

Mark Kiemele, PhD, Air Academy Associates

Critical thinking is an integral part of any methodology that drives continuous process improvement. Critical thinking can be defined as the deliberate and systematic processing of information so that we can solve problems, make better decisions, and in general, just understand things better. Employers value workers who know how to think critically, because they can be trusted to make decisions independently and will not need constant handholding. But critical thinking is hard. It requires us to apply diverse tools to diverse information. It takes a lot of energy, so we need to separate the automatic thinking from the critical thinking. This session will examine two different kinds of biases that affect our thought processes: cognitive biases and data biases. Examples of each will be provided. It will also provide 7 ways to help us think more critically.

Deep Learning for Verification of Electronic Warfare Techniques

Caleb Story & Jerrik Waugh, Physical Science Laboratory, New Mexico State University

Testing and Evaluation (T&E) of air defense radar systems is imperative to maintain battlefield superiority. Part of the T&E process is testing the radar against validated electronic attack (EA) threat techniques. T&E EA threat developers are responsible for creating threat representative systems that are capable of exposing allied systems to EA threats that would be seen on the battlefield. The techniques and waveforms to be used are verified and validated by a validating authority prior to the threat system being utilized in the test to ensure the systems under test (SUT) are being evaluated accurately and correctly.

Once the systems are in flight, operation typically comes down to the pilot activating certain modes on the EA system at specific times or locations for repeatable expose of the SUT to the specific EA technique. The issues become, at this point, whether the EA system was working as it was supposed to or did something fail in flight. Employment of an EA technique verification system based on deep learning models can help to minimize the uncertainty of the proper operation of the EA system.

Employment of deep learning models in an EA system can be challenging due, in part, to the vast amounts of data needed to train the model(s). The probability of an EA system encountering a sensor using signals unknown to the model is high and can inhibit system efficacy. The approach we are undertaking to use the capabilities of deep learning models avoids a portion of this issue as we are using them to verify the output of EA system based on known modes of operation that are trained ahead of the test event.

As developers of the T&E EA threat system, the techniques to be employed in the test are known ahead of time and can be used to create and collect the data necessary to be used for model training and validation. Once the model is trained, it can then be employed in the high performance data collection system used specifically for EA verification to identify when and where the EA technique was enabled and for how long it was in use. The future of deep learning in the verification of EA techniques is rife with opportunity to improve testing methodology and improve allied system performance and survivability.

Design for Six Sigma

Mark Kiemele, PhD, Air Academy Associates

Design for Six Sigma (DFSS) is the natural evolutionary next step beyond Lean Six Sigma. Once the design of a product is finalized and in the hands of the customer, the amount of improvement that can be achieved at reasonable cost is limited. Witness the tire fiasco with Ford, the key debacle with GM, or the air bag disaster with Takata. The purpose of DFSS is to move improvement into the earlier stages of a product's or process's life cycle when design changes are less costly. Have you ever heard of "shift left?" Well, DFSS has been doing that for well over two decades now. But DFSS will require higher-powered tools such as Monte Carlo Simulation and Robust Design. While LSS is good for products and processes that already exist, DFSS is better at designing new products or redesigning existing products or processes that need performance improvement. This tutorial will discuss the what and why of DFSS and provide a roadmap or methodology that is different than DMAIC for generating design improvement very early in the life cycle.

Development and Testing of Navy Torpedoes in a Full Fidelity Simulated Undersea Environment

Carlos Godoy, Kenneth Sanchez, Kent Pickett, Kathy Smith, NAVAIR

The Technology Resource Management Center (TRMC) support for improving the Modeling and Simulation (M&S) capabilities for undersea systems has been significant for the development and improvement of the Environment Centric Weapons Analysis Facility (EC WAF) simulation and its use to support operational test for future weapon systems and countermeasures. The capability has been recognized by OPNAV N97, N96 and N94 as an advanced underwater sonar simulation in the Navy.

The ECWAF is a real time hardware in the loop torpedo simulation used throughout a torpedo lifecycle (from early development through operational testing (OT) and capability upgrades). This hardware in the loop, real time requirement imposes the most demanding M&S requirements. The resulting M&S technology development and capabilities have not only provided the Navy with the most advanced sonar stimulation environment but also established the ECWAF as the resource for Test and Evaluation of many other Navy undersea programs.

This brief will summarize new and critical technology developments that the ECWAF brings to bear during both development and operational testing of the Navy's new torpedo systems. Major T&E capabilities to be showcased include:

A. Development of WARP a range dependent propagation model that enabled the ECWAF to address range dependent bathymetry and bottom composition propagation conditions. With WARP, the ECWAF has a capability making it the Navy's only a simulation valid for operations in shallow and deep waters.

B. Enhancements of the Navy's Comprehensive Acoustic Sonar Simulation to support the development and validation of the ECWAF and its enhancements have produced a simulation based on narrow band assumptions. This technology supports the development of fully broadband systems, like the new MK 48 MOD 8 weapon and their related signal processing. The technologies and capabilities have developed into a fully Broad Band Capability in the ECWAF.

C. The Virtual Commander capability was developed to provide a target in a simulation with the ability to autonomously evade an attacking torpedo based only on exploiting the environmental acoustic conditions and the capabilities of the target submarine under attack. This Artificial Intelligence (AI) technology was funded under the FAST GRAB program and now is integrated in the ECWAF simulation and will be used to evaluate the actual potential performance of our torpedoes. This new capability addressed a fundamental shortfall in the M&S technology supporting operational testing.

D. Development of the Navy's only ray based 3D acoustic propagation model; Qprime. This new capability demonstrated by integrating Qprime in the Comprehensive Acoustic System Simulation (CASS) represents a critical capability needed for any sonar operations in very shallow waters like new torpedoes and Unmanned Underwater vehicles (UUV's).

The real time simulation capabilities of the ECWAF are currently being used to both develop and test a wide range of underwater weapons. This presentation will summarize the key technologies that support this development.

Digital Beamforming Phased Arrays for Telemetry Tracking Applications

Dorse DuBois, Mannatek; Anand Kelkar, CDSI; Juan Guadiana, Mannatek

Telemetry tracking systems face greater tracking challenges along with increasing performance requirements. Examples include: Smaller beamwidths (C-band), hypersonic vehicles, and simultaneous multiple vehicles in flight.

Smaller beamwidths present a difficult challenge to maintain pointing & tracking accuracies for parabolic reflector tracking systems; thus, increasing risk of data dropouts. Supporting multiple-vehicle scenarios with parabolic reflector tracking systems is cost prohibitive; requiring a 1:1 ratio for each vehicle in flight. Expensive legacy phased arrays are usually not an option due to their complexity, maintenance, and high acquisition cost.

Universal Beamforming Technology - Next Generation: Digital Beam Forming Arrays

The Digital Beam-forming Module (DBM) is a small, lightweight, multi-beam phased-array antenna 'tile'. It can function as a stand-alone antenna sensor, or in cooperation with other DBMs to form an exceptionally large antenna aperture for complete simultaneous coverage across an entire range.

All DBMs within an array communicate through a mesh network and orient themselves as a single aperture capable of simultaneously tracking multiple dynamic objects at different angular positions. The latest DBF antenna technology has extended the RF coverage of the antenna from S-band to L/S/C telemetry bands simultaneously.

DBM technology can also be adapted to existing reflector tracking systems as an upgrade to the feed, providing limited off-axis electronic steering capability and thereby increasing tracking performance dramatically for dynamic targets.

Directed Energy Weapon Test & Evaluation in a Relevant Multi-Domain Operational Environment

Nathaniel C. Charles, Francis Check & Stephen Lenart, TRAX International

Test and Evaluation (T&E) of Directed Energy Weapons (DEW), both High Energy Lasers (HEL) and High Power Microwaves (HPM), is critical to the successful transition DEWs to the US military forces for use in Multi-Domain Operational environments. Currently, the U.S. lacks a comprehensive test bed capability that supports the full spectrum of developmental and operational T&E of DEWs in a relevant operational environment at realistic distances and engagement geometries. Test capabilities at a variety of range distances must include telemetry, tracking, data acquisition, appropriate sensors, continuous command and control, and instrumentation that provide an appropriate level of security within a fiscally constrained environment. Due to the extremely high cost and long lead-times for near-term completion of MILCON projects that can realize a persistent DE testbed, solutions that can provide interim Limited Operational Capabilities (LOC) have gained support from White Sand Missile Range (WSMR), Army Test and Evaluation Command (ATEC) and garnered congressional plus-up in the FY21 National Defense Authorization Act. This approach supports DE capability enhancements for T&E requirements of emerging U.S. HEL and HPM systems. This presentation evaluates principals of the Multi-Domain Operational environment and explores the benefits, constraints, and limitations of DE capability enhancements at WSMR required for distributed testing. Included in the recommended solution will be LOC capability enhancements capable of addressing the complexity and variety of DE testing needs.

Dual-Purpose ISR Analytics Exploitation for Offensive/Defensive Multi-Domain Operations

Gert Berthold & Kevin "Cuz" Cousin, PhD, Cova Strategies, LLC.

A Composable Embedded Software (CES) environment can be formed for the rapid insertion of new capabilities into existing platforms by employing a hive-like computing environment, flexible and adaptive sensor packages with swarm-based collection, SWaP-C (optimized Size, Weight, Power, and Cost) processing applied across multi-domain platforms, and inline analytics for real-time information fusion. Commands and forward operators can compose software processing chains for missions, then monitor and adapt them, on the fly, in response to changing or unexpected operational mission requirements, environmental states, situations and detected anomalies. CES allows for the leveraging of each platform's suited capabilities, simultaneously coordinated, and dynamically utilized through distributed sidecar technology and event-driven Artificial Intelligence (AI)/Machine Learning (ML) automation. Not only can CES concepts reduce the costs and time (to days and hours) of fielding of multi-domain sensor platforms and new capabilities, but it also provides a

virtual, composable, integration and delivery framework of real-time services and analytics suitable to supporting distributed, adaptive sensor-to-shooter or data-to-decision solutions.

CES creates a new paradigm of mission composability, multi-modal, multi-platform sensor access and analytics fusion by embracing and enhancing the native capability of existing mobility platforms. Through swarm-like integration and the passage of data, processing, and state within, between and spanning respective mobility SWaP-C compute nodes. it is possible to increase the usability, capability, and performance of individual sensors into a composable integrated sensor architecture. This sensor architecture feeds a composable, event-driven analytics framework that fuses sensor, observation, and interim analytics results to generate continuous Situational Awareness (SA) and insights, entity & activity behavior characterization, threat, attack and system failure prediction, conditions and anomaly detection, and automated analytics-driven response recommendations for operators and commanders to visualize, assess and act upon. Response actions can range from human planning; the maneuvering/assigning/ reassigning of resources, equipment, weapon systems, forces and other assets through existing Command and Control (C2) systems; to human- and automated Observe, Orient, Decide and Act (OODA) loop courses of action (COAs) to enable preventative offensive measures and pre-emptively eliminate/neutralize identified threats, attacks and system failures. Using a digital twin concept, this can be applied operationally, in modeling and simulation, in training, and in the exploration of new offensive/defensive methods and approaches applied across observation zones.

To highlight CES capabilities, a dual-purpose demonstration mission of continuous foveated SA – across multiple observation zones - for blue and read team force protection has been developed. Manned and unmanned platforms (airframes, drones, terrestrial vehicles, and small units) provide continuous ISR sensor coverage of observation points, wherein drones, ground sensors and small units provide a picket line of continuous imaging, motion detection and signatures and analytics providing inline virtual data streams derived from all platforms, for the identification and classification of entities and behaviors and possible event and anomaly detection in the Area of Operation (AO). Composed sensor, observation, and analytics fusion generates real-time decluttered SA, entity/group and behavior tracking, sensor coverage gap notification, threat and attack prediction, conditions/anomaly identification & alerting; and the subsequent triggering of adaptive human-in-the-loop and automated responsive actions.

Employing a CLONE to Enhance JADC2 Testing

CAPT Jeff Hoyle (USN, Retired), Rajive Bagrodia, PhD, Jeff Weaver, PhD & Lloyd Wihl, Scalable Networks Technologies

This paper describes the incorporation of high fidelity, physics-based network digital twins into a JADC2 Comprehensive Live-Virtual-Constructive (LVC) Operational Network Environment (CLONE). The JADC2 CLONE will provide a fully representative live-virtual-constructive emulation of the communication network together with its operating environment and the application traffic carried by it. Such a CLONE can be used to enhance the planning and insights gained from wargames, operational analyses, and test and evaluation events in a low-cost and zero-risk environment. In order to do so effectively, the JADC2 CLONE must have sufficient fidelity to accurately reflect the network dynamics due to the interplay between the communication protocol and topology, application traffic, the physical environment, and cyber attacks, thus appropriately differentiating between cyber attacks that are a mere annoyance and those that have the potential to disrupt the mission timeline.

In this paper we analyze the critical needs for incorporating network digital twins into JADC2 simulations, prototyping, experimentation, test and evaluation while elaborating the key characteristics of a JADC2 CLONE:

- Integration of cyber/electronic warfare and kinetic domains, without modification
- Integration with both IP and non-IP communications (e.g., 1553 bus)
- Access to wireless and tactical waveforms and their specific capabilities, limitations and vulnerabilities
- Extensible attack library against network, connected weapon and C2 subsystems
- Assessments of command and staff to modify and complete operations while under cyber attacks as well as for network defenders to detect and react to such threats

In addition to analyzing and elaborating on these characteristics, this paper will also provide a use-case of a JADC2 CLONE mission simulation using Navy Distributed Maritime Operations (DMO) and Marine Corps Expeditionary Advanced Base Operations (EABO) as illustrative examples.

Function Level ROP Gadget Survival Using Compiler-Based Software Diversification

David Reyes, UTEP

Modern cybersecurity mitigation techniques have made it harder for attackers to successfully execute malicious code from what is commonly known as a buffer-overflow attack. As a result, attackers have turned to Return Oriented Programming (ROP) to achieve arbitrary code execution. This attack method strings together snippets of codes that belong to the legitimate binary, ROP gadgets, to achieve malicious behavior. Because these ROP gadgets are normally located in static locations within a binary, attackers can easily re-use their exploit code across all systems running the binary. This is known as a write-once, use-everywhere exploit. To address this issue, software diversification, a technique that modifies the instructions in binaries, while maintaining their semantic behaviors, is used as a countermeasure. While previous work has shown general success, there is a lack of research that measures and is able to predict the impact and effectiveness of specific diversification techniques on specific types of binaries. In our work, we are studying the relationship between the number of functions in a compiled binary and the number of gadgets that survive even after diversification. We also look at how different diversification techniques affect the measure of survivability.

HPM Sensor on Instrumented sUAS Update

Mark Henderson, BlueHalo

Aegis Technologies is developing a system that uses a shielded narrow-band receiver HPM sensor module which is integrated on a Group 1 and Group 2 small Unmanned Air System (sUAS) platform to measure radiated radio frequency (RF) energy in an open-air range environment. The sUAS has been hardened to survive RF attacks and has successfully flown through multiple HPM weapon system engagements. The TRL for this system is 5/6. The briefing will provide an update from early developmental efforts, actual field mapping during the MFIX 2020 exercise and calibration/survivability testing at the Survivability, Vulnerability Assessment Directorate (SVAD) located at the White Sands Missile Range (WSMR) in New Mexico, and developments in Command and Control (C2) technology.

Hot Fire Test in a Reaction Control Engine and Throttleable Engine

Jazmin Arellano, UTEP

To perform a hot fire test in RCE, Reaction Control Engine, several conditions have to be met and a procedure has to be followed. The engine trailer and the server trailer, which controls the electric hardware and gives the data to the software used to control the test, have to be located at a spot designated especially to place the engine trailer in test day. At the correct positions, cable harnesses connecting the electronic hardware in the engine trailer to the server trailer have to be connected in the designated ports and electronic hardware connections. Once the engine trailer is connected to the server trailer communication between the computer with the software controlling electronic hardware in the engine trailer and electronic hardware in the engine has to be ensured. Once the instrumentation is connected and running according to the code and procedure, the propellants have to be connected and pressurized to the pressure needed to deliver the propellant to the engine. For the case of methane, methane is acquired in the gas state, liquefaction of it has to take part along with the pressurization process of oxygen, which is acquired in the liquid state. Condensation of methane is achieved inside a tank in which liquid nitrogen is running through a coil inside the tank. The liquid nitrogen at very low temperatures take the heat from gaseous methane, making the condensation possible. This process takes couple hours, other activities such as connecting oxygen delivery lines and pressurization of liquid oxygen contained can be done in parallel. Once the amount of methane needed is condensed and the oxygen container is pressurized the engine is ready to be fired. The 500 lbf engine is similar to set up as RCE. The engine has to be taken out to the designated location in the testing facility. For this engine there is a propellant tank trailer that stores the oxygen, methane and pressurizing nitrogen tanks. Connection between the electronic hardware in the propellant trailer and in the engine trailer and the software in the control computer has to be ensured. Once the proper connection is achieved and the instrumentation responds to the controls the tanks are ready to be pressurized, connected and to be delivered to the engine to complete the hot fire test. The electronic hardware is controlled through a server trailer, in which there are two servers serving different purposes. One server receives all the data, in voltage, and converts it to digital data that can be converted and displayed in the form of temperature and pressure readings in the control computer by the software, which for this case is LabVIEW in which a code was written and adapted to display the pressure and temperature readings and control electronic valves. The second server receives the signal from the software in the control computer and sends it to the electronic hardware making it possible to give controls to electronic valves.

Infrastructure as Code

Will Lester, Nextech Solutions

Infrastructure as code (IaC) is a programmatic approach to maintaining the configuration of infrastructure. Hardware modularity is essential to the required mobility of near peer conflicts, and IaC is, in our view, the only sustainable way to manage the configuration of increasingly complex hardware at the edge. Our overview will give attendees a basic understanding of IaC concepts and software solutions coming from the commercial sector, and some success stories of where it has been deployed in the government sector. We will discuss the implications of IaC and automation on personnel utilization, security, and agility to the fighting force.

Lean Six Sigma

Mark Kiemele, PhD, Air Academy Associates

Lean Six Sigma (LSS) means different things to different folks, but in its most general definition, it is a framework for continuous process (or product) improvement (CPI). This tutorial will provide a little history as well as delve into the what and why of LSS and explain why the synergy of Lean and Six Sigma is greater than the sum of its parts alone. It will also explore the basic problem-solving methodology that is used within LSS to deliver improvement. This is called the Define, Measure, Analyze, Improve, and Control (DMAIC) methodology or roadmap. It provides a simple building block approach to solving problems and improving processes. We will identify some of the most useful tools that are used within the DMAIC approach to problem solving and compare DMAIC to other CPI approaches such as PDCA (Plan, Do, Check, Act). We will also discuss why LSS is a boon for some organizations, yet a bane for others. No matter what your current perspective of LSS is, this session should provide additional insight.

T & E in a Multi-domain Operational Environment

7/6/21 Rev N

Leveraging the CIPP Model to Achieve CPI in T&E and other DoD Applications

Joe Stufflebeam, PhD, TRAX International

The CIPP evaluation model is firmly entrenched as a valuable tool for measuring organizational and project performance within certain sectors of the Government and various educational organizations. An extension of the model to meet organizational CPI, specifically within the T&E community, is presented. The model is harmonious with other quality driven approaches, such as LSS, Agile, ISO 9001, etc. and is rooted in sound feedforward/feedback control and systems theory. The model is directly applied with a DMAIC driven approach and is malleable to meet various types of organizational needs and is tailorable to the TRL of the work being performed. Specifically, an example is shown that correlates directly with a generalized MRTFB "mission execution process" and demonstrates how the current UDS process can be updated and extended to achieve more comprehensive results. The model is very generalized and directly applicable to other processes such as the ISR driven TCPED and PCPAD processes, LVC distributed testing exercises, and S&T and CTEIP type T&E development processes.

Monetization Strategies for Federally Funded Innovations

Kevin Soules, Loza & Loza, LLP

The Bayh-Dole Act creates a unique monetization strategy for privately developed innovation funded with government contracts. In this segment we will discuss strategies for monetizing encumbered intellectual property.

New Methods/Products for Comprehensive Analysis of T&E Events; Big Data Analysis for T&E

Kenneth Sanchez, Kathy Smith, Kent Pickett, & William Wolfe, NAVAIR

Analysts are often challenged to detect, track, and explain anomalous behavior that has occurred during a test event, as evidenced in the data collected. With the advent of more sophisticated range and onboard data collection systems, the amount of data available for analysis in typical test and evaluation exercises has reached, in many cases unmanageable proportions. Often, much of the test data is not analyzed, with analysts focusing only on that limited portion of the data supporting specific test objectives. T&E Needs exist for new artificial intelligence (AI) and machine Learning (ML) Big Data Analytic technologies to assess the vast amounts of T&E datasets from a given System Under Test. We will discuss three new AI/ML techniques being developed to revolutionize the way we evaluate data for T&E.

1) Development of advanced methods for multi-variant time series analysis. Large structured datasets of time series sensor systems are produced by many new military platforms. One of the Air Force's new air frames produce over 50K sensor reports for every second of flight time. The ability to look at these massive datasets, identifying trends in well behaved data and focusing on data outside these norms is needed. AI/ML Big Data analysis techniques have been used in the commercial sector looking at financial market data for many years. However, the conversion of these techniques to DOD applications is new and will be explored in this section. Specifically, new T&E technologies will be developed to automatically identify abnormalities, perform causality analytics, prediction of equipment function and failure, and pattern recognition in datasets 1 terabyte or larger.

2) Development of advanced techniques for audio, video, and imagery. Large unstructured audio, video,

and imagery datasets are often collected at the ranges during T&E of new military platforms. Unfortunately, these data streams, while time stamped, are often difficult to correlate because of the different "views" of the recording systems. Further because of "data noise" resulting from the collection procedures, the data collected is often not clearly defined. New T&E technologies will be developed utilizing AI/ML techniques to help with the clarity, efficacy, and correlation of unstructured data types resulting in reportable analytics.

3) Development of advanced visualization techniques for big data sets. When dealing with large datasets (1 terabyte or larger) displays of common statistical measures often mask critical interactions and anomalies. These data anomalies while hidden by, means, variances and outlier analysis often point to critical conditions leading to system failures. New T&E technologies are needed to allow T&E Analysts to not only display standard performance metrics, but also to pinpoint anomalies in the dataset as a whole and will focus on AI/ML visualization techniques to help focus on "out of bounds" data interactions.

In summary, advanced technologies are needed to facilitate the timely and accurate extraction of actionable knowledge from massive amounts of structured and unstructured data generated during modern test events for C4I and SW Intensive Systems Test.

Patents

Kevin Soules, Loza & Loza, LLP

Patents are the mechanism by which our Constitution incentivizes technology development and innovation. The basic quid pro quo underlying the patent system is more complex when the government is funding that innovation. In this segment we will discuss the purpose and basic principles of patent law.

Real-time Analytics Fusion for Continuous LRPF Offensive/Defensive Threat Assessment and Response

Gert Berthold & Kevin "Cuz" Cousin, PhD Cova Strategies, LLC.

The development and integration of software capabilities for Long Range Precision Fires (LRPF) to integrate, assess, and derive pertinent information from an overwhelming stream of battlespace information provides a set of tools and methods for analyzing behaviors and conditions that can lead to preempting threats, attacks, system failures as well as strategically planning preventative offensive measures. Such capabilities would help develop plans and strategies for heading off potential attacks or incidents, as well as methods for pre-emptively eliminating/neutralizing them, mitigating their effects or maneuvering/assigning/re-assigning resources, equipment, weapon systems, forces, and other resources. These capabilities would provide insights into current operations (CUOPS) and/or future operations (FUOPS) that benefit the use of LRPF for tactical mission command and would integrate within the existing Command Post Computing Environment (CPCE) architecture to deliver advanced information sharing, situational awareness (SA), Command and Control (C2), and real-time collaboration technologies for expedient decision making and superior operational execution on the battlefield.

A LRPF Threat Assessment and Response prototype that addresses data and decision dominance is outlined. Key features include: Modular, Open Systems Architecture; Proven, scalable, multi-domain data and sensor data ingest; Composable inline Artificial Intelligence (AI)/Machine Learning (ML) analytics for SA, patterns of life generation, behavior prediction and anomaly detection; Multi-platform, distributed processing environment; and an Agile development approach compliant with the DoD Enterprise DevSecOps Initiative (DSOP) / PlatformOne. The prototype solution integrates high-Technology Readiness Level components (TRL8 and above) that execute composable, event-driven missions of ingest, fusion and inline sensor analytics for data and decision superiority. Compositions define software automation to collect and aggregate real-time sensor feeds and mission data - across the multitude of multi-modal structured, semi- and unstructured data sources, then organize, fuse, structure and automatically normalize streams of information to feed inline analytics that generate a Common Operating Picture (COP) for SA, behavior characterization, prediction and event/conditions detection and response. Sensor, observation, and intermediate analytic results are piped real-time into analytics for the continuous assessment and derivation of pertinent information, generation of insights, real-time flagging of alerts on conditions and anomalies, and prediction of threats, attacks, and system failures with confidence levels. Directly feeding Command Post Compute Environment (CPCE) systems, these results are visualized, assessed, and acted upon. Actions can range from human planning, the maneuvering/assigning/ reassigning of resources, equipment, weapon systems, forces and other assets through existing Command and Control (C2) systems, to human-in-the-loop automated Observe, Orient, Decide and Act (OODA) loop courses of action (COAs) to enable preventative offensive measures and pre-emptively eliminate/neutralize identified threats, attacks and system failures - operationally, in modeling and simulation, training and in the exploration of new offensive/defensive methods and approaches applied across observation zones.

Remote Classified Operations

Grant Senn, Southwest Range Services (SRS)

Classified mission support at the White Sands Missile Range utilizing remote sensors and platforms currently requires personnel to be on-site or, if the systems are controlled remotely, personnel must travel to and from the sites both before and after the mission to manually install/retrieve classified media, power on/off systems and patch the classified systems through a dedicated Taclane/Network-Switch data path to ensure that only unclassified data “touches” the Test Support Network.

The Remote Classified Operations solution proposes an architecture for remotely powering, operating, switching and protecting classified devices eliminating the need for personnel to be on-site or travel to and from sites to configure data paths or retrieve classified materials. The hardware and physical safeguards built into the components prevent accidental spillage and tamper-sensitive controls are proposed to guard against unauthorized access.

Synthetic Data Generation to Enable T&E S&T for Big Data Analytics

Kenneth Sanchez, Kathy Smith, & Kent Pickett, NAVAIR

Synthetic data generation is required to advance the use of Artificial Intelligence (AI) & Machine Learning (ML) techniques to evaluate warfighter acquisition systems. T&E datasets for warfighter acquisition systems are often classified and always tightly controlled avoid revealing capabilities to our adversaries. Therefore, the need for synthetic data generation is critical to development of the next generation of AI/ML test & evaluation capabilities. The goal of synthetic data generation is to produce sufficiently representative data for training artificial intelligence and machine learning algorithms -- including classification, regression, and clustering. These synthetic datasets must perform equally well when real-world data is processed through them as if they had been built with this test data. The C4T Test Technology Area is developing a synthetic data generator for creation of large multi-variant time series datasets. When creating synthetic data, the objective is to come out of the process with highly valuable, refined, and labeled data that can then be used to drive

AI/ML projects.

The C4T Multi-Variant Time Series (MVTS) – Generator consists of three main areas: Battlespace Environment Generator, Structured Dataset Generator, and Unstructured Dataset Generator. For each synthetic dataset a T&E Needs operational use case is developed to define the analytic needs as well as an operational representation of the testing datasets. Using this Operational T&E Needs use case the synthetic data generation implementation can be developed.

The Battlespace Environment Generator – Original use of the Next Generation Threat Systems (NGTS) model is used to define the operational scenario that the system under test is operating within. Additionally, the Joint Semi-Automated Forces (JSAF) model can also be used.

The Structured Data Generator leverages the capabilities of the model output to develop the representative multi-variant time series datasets. Various automated methods are used to build in the variety needed to represent that actual test dataset.

The Unstructured Data Generator creates any required audio, video, or imagery datasets. These components are further explained for the starting synthetic data generation datasets supporting:

- T&E Analytics to Assess Air Platform Tactical Situation Displays (TSD). Post flight video review of complex displays such as a TSD are time consuming, and for complicated tests can be incomplete due to the significant amount of information being displayed. An algorithm that can identify and log symbols, and then compare them to truth data would focus the limited analysis capacity on the areas of most interest.
- T&E Analytics to Assess Platform Target Location Error. The current trend of aircraft systems is that their lethality is highly dependent on the combination of interoperable datalinks, radios, and sensors. That combination, while potentially very lethal, produces non-decomposable results when aircraft are part of mixed-system force. Analyzing the combination of target location errors (TLE) shared across multiple platforms is a manpower intensive task.

In summary, advanced technologies to support synthetic data generation are needed to develop and advance the use of AI/ML techniques for evaluation of warfighter acquisition systems..

The Bayh-Dole Act

Cameron Smith, Texas Tech

This landmark legislation, enacted in 1980, defines the rights the government retains in intellectual property developed under government contract. In this segment, we will review key tenants of the Bayh-Dole Act and certain provisions contractors should be careful to address correctly.

The Data Acquisition System for a 1 MW Combustor

Md Mohieminul I. Khan, UTEP

The Data Acquisition System of a combustor is presented in this study. A 1 MW combustor was designed to house a burning environment up to 20 bar and 2500K. It is a modular structure with a 2m solid body. The instrumentation system is designed to flow different gasses into the combustor including methane. To control the fluids 22 heavy duty solenoid valves were used. It has several types of sensory instruments. Instruments include, pressure transducer, flow meters, thermocouples, and visual cameras. All the valves were controlled by a Field Programmable Gate Array (FPGA), featured in the compact Remote Input/Output (cRIO) chassis by National Instruments. The cRIO is one of the two major subsystems of the overall data acquisition system (DAQ). DAQ supplies power to the valves through relay switches. These switches operate based on the electronic signals generated by the cRIO and controlled by an operating software. The system is also designed to read and log data from all the sensors. A compact data acquisition system or compactDAQ (cDAQ) is used for that purpose. This cDAQ is the other subsystem of the overall DAQ. The cDAQ chassis is connected to the PC through ethernet and has three conditioned Input/Output modules which collect data of different forms. The sensors generate data as output voltage. A LabView code was written to calibrate and convert them into meaningful data. This code also incorporates the solenoid valve controlling section. Hence, the GUI made with LabVIEW is capable of reading, logging, and controlling all the instruments present in the system. The sensors send the output voltages to the DAQ through sensory wires. The voltage is then routed through the I/O module. The LabView code is then used to process the voltage and convert it into numerical data. The code is written on a built-in template of LabView named "Continuous Measurement and Logging". The cRIO and cDAQ is housed in two separate chassis and connected through ethernet. Since the combustion happens in an extreme environment, the separation of the two subsystems ensures safety and reduction of signal losses. The cRIO supplies high voltage to the solenoid valves hence it is located nearby the operator for prompt control. And the cDAQ receives small sensory voltages, so it is located near the combustor. Nearby acquisition system reduces wire length which in turn reduces signal losses. In this article the design and the implementation of the DAQ system will be described. The control program and GUI will also be presented and described. Instruments, sensors, valves and wiring used to build the set-up will be introduced and discussed as well.

Using Discrete-Event Simulation to Predict Communication Challenges and Outcomes in a Multi-Domain, Multi-Communication Environment

Majid Raissi-Dehkordi, PhD, Nextech Solutions

Modeling and discrete-event simulation of networks of devices containing full protocol stacks including RF communication, Cellular technologies and Low Earth Orbit (LEO) satellites in a detailed fashion to facilitate PACE. The framework models each component of the RF communication such as radio transmitter, radio receiver, antenna, channel characteristic and modulation with high fidelity. In addition, you can perform various studies for commercial radio communication methods such as Time Division Multiple Access (TDMA), WLAN, LTE, UMTS, WiMAX, ZigBee and MANET, as well as different tactical communication system technologies.

Video on the Edge: Software-Defined & Intent-Based Models for ISR Video Asset Management

Will Lester, NexTech Solutions

Streaming video is a complex topic all its own. Adding the challenges of intermittent connectivity, interoperability, transport ownership, and varying levels of domain expertise across the deployed enterprise is a recipe for disaster. Prevailing methods for troubleshooting and remediation of ISR video issues are rudimentary and incomplete. We propose a holistic approach that incorporates lessons learned from software development disciplines. We treat video as code – declaratively modeled, ephemeral, and intent-based. Deploying a video sensor solution across the forward enterprise will facilitate better troubleshooting and higher service reliability without putting ISR video experts in the field.

T & E in a Multi-domain Operational Environment

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"Zero Chain" Traceability for Test, Measurement, and Diagnostic Equipment (TMDE)

Richard H. Parker, PhD & David J. Hargett, US Army TMDE Activity

The Army's Test, Measurement, and Diagnostic Equipment (TMDE) is verified and supported through an enterprise of metrology and calibration laboratories with measurement traceability to the National Institute of Standards and Technology (NIST). As the accuracy of TMDE and measurement systems within the Army inventory continues to improve significantly, measurement standards used for calibration either do not meet accuracy specifications or do not exist. In order to provide confidence in the accuracy of this new TMDE, development of new measurement standards where traceability to the International System of Units (SI) will be established. The NIST has embarked on a sweeping program called "NIST on a Chip" (NOAC) that will revolutionize measurement services and metrology by bringing them out of the lab and directly to the user. The development is a suite of intrinsically accurate, quantum-based measurement technologies intended to be deployed nearly anywhere and anytime, performing uninterrupted without the need for NIST's traditional measurement and calibration services.

These technologies will enable users to make precision measurements referenced to the International System of Units (SI) directly. NOAC provides an opportunity for the "democratization" of measurement technology, where affordable devices drastically reduce the cost and increase the availability of precise measurements that could previously only be delivered at the world's best metrology institutes. This provides a broad range of "zero chain" SI-traceable measurements and standards that are configurable into a single small-form package and adaptable to customers' requirements. This will reduce the "levels" of calibrations needed to support weapon systems and TMDE by providing the highest level of measurement accuracy at the platform.

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