

MEMORANDUM FOR TEST AND EVALUATION PROFESSIONALS

SUBJECT: Advancements in Test and Evaluation of Autonomous Systems Workshop Report

The third Advancements in Test and Evaluation of Autonomous Systems (ATEAS) workshop, sponsored by my office and hosted by the Scientific Test and Analysis Techniques (STAT) Center of Excellence (COE), was held April 11–14, 2022. The workshop facilitated the test and evaluation (T&E) community's sharing of current best practices and lessons learned in autonomy T&E, while also encouraging the development and identification of new methods, processes, and tools to rigorously test and evaluate artificial intelligence (AI)-enabled autonomous systems.

Autonomous defense systems have increased in interest and investment in the Department with a focus on developing and deploying game-changing emerging technological capabilities. As part of its modernization priorities, DoD needs autonomous and AI-enabled capabilities that provide flexible options for the joint force. The challenges associated with robust T&E of these systems to achieve developmental and operational mission assurance are significantly more complex than those of historical weapons systems.

The 2022 ATEAS virtual workshop gathered leading experts across DoD, industry, and academia to discuss and share insights and best practices for conducting T&E of autonomous systems. This effort captured a broad and diverse set of T&E advances from participants. The STAT COE completed its ATEAS workshop report in July 2022. This report and previous ATEAS workshop reports contain essential insights to share with the T&E professional community.

The 2022 workshop report describes methods and tools that address challenges and gaps in DoD autonomy T&E processes; shares insights and lessons learned from ongoing autonomy projects; and identifies initiatives that will enable future improvements in developing, testing, and fielding AI-enabled autonomous systems. The report also identifies and clarifies autonomy T&E challenges and priorities from workshop participants representing the military services and key federal partners, helping to create a shared vision of autonomy T&E.

Developmental testing is a key component in obtaining decision-quality data for informing acquisition decisions and the systems engineering process. For complex, AI-enabled autonomous systems, a growing consensus indicates that continuous, integrated, agile testing including contractor, developmental, operational, and follow-on T&E—is needed to achieve assured safety and mission effectiveness for Warfighters. The 2022 ATEAS workshop report captures recent advancements in test strategies and test plans for assessing autonomous systems, and further refines the challenges in the T&E of autonomous systems that must be addressed to achieve mission assurance and improve program risk management. The attached summary provides an overview of the 2022 ATEAS workshop report. To obtain a copy of the full report, please contact my Chief Engineer, Mr. Orlando Flores, at 571-372-4145 or orlando.f.flores.civ@mail.mil.

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Christopher C. Collins Executive Director, Developmental Test, Evaluation, and Assessments

Attachment: As stated

cc: DOT&E USD(A&S) Commander, JITC ED SE/A Army/TE Navy/TE Air Force/TE MDA/TE US Space Force/TE DISA TRMC

Advancements in Test and Evaluation of Autonomous Systems 2022 Workshop Report Summary

Overview

The third Advancements in Test and Evaluation of Autonomous Systems (ATEAS) workshop, sponsored by the Executive Director, Developmental Test, Evaluation, and Assessments and hosted by the Scientific Test and Evaluation Techniques (STAT) Center of Excellence (COE), took place virtually April 11–14, 2022. The ATEAS workshops bring together subject matter experts (SMEs) in fields such as autonomy, robotics, and computer science to accelerate progress in autonomy test and evaluation (T&E).

The 2022 ATEAS workshop's virtual implementation increased the opportunity for a broad range of SMEs to participate. The workshop included more than 180 participants from 40 organizations across the joint services, federal government, industry, and academia, including eight senior executive service speakers and 25 technical expert presenters. The entire 2022 ATEAS presentation catalogue and recordings of the event will be available on the Defense Technical Information Center "DoDTechipedia" website.

Workshop Objectives

The 2022 ATEAS workshop objectives included the following:

- Sharing lessons learned for T&E of autonomous defense systems focused on autonomous/artificial intelligence (AI) unique qualities.
- Capturing best practices, methods, techniques, and tools.
- Collaborating to update the forthcoming T&E Companion Guide for Autonomy.
- Sharing current initiatives to improve tools, techniques, or frameworks.

Workshop Themes and Presentations

Each day of the 2022 ATEAS workshop addressed a theme within autonomy:

- Day 1: Autonomy T&E Policy, Vision, and Overarching Resources
- Day 2: Live, Virtual, and Constructive (LVC) Simulation and Run-Time Assurance for Autonomy
- Day 3: Technologies and Lessons for Autonomy T&E
- Day 4: Assured Autonomy and Human-Machine Teaming

Day 1: Autonomy T&E Policy, Vision, and Overarching Resources

Senior executives from the Office of the Under Secretary of Defense for Research and Engineering discussed their visions and initiatives for autonomy and AI and participated in an executive question and answer (Q&A) panel to discuss autonomy policies and challenges. Technical experts from the STAT COE, Defense Advanced Research Projects Agency, Joint Artificial Intelligence Center (now under the Chief Digital and Artificial Intelligence Office), and industry spoke on overarching methods and tools for addressing challenges and gaps in autonomy T&E, including the draft T&E Companion Guide for Autonomy, assured autonomy software tools, and an end-to-end integrated approach to autonomy T&E.

Day 2: LVC Simulation and Run-Time Assurance for Autonomy

Senior executives from the Office of the Director, Operational Test and Evaluation; Air Force; and Navy discussed their perspectives on autonomy and AI T&E and participated in an executive Q&A panel on infrastructure, personnel, and ethics assessments. Technical experts from the Air Force Research Laboratory (AFRL), Johns Hopkins University Applied Physics Laboratory, Aberdeen Test Center, and Unmanned Maritime Systems Program Office spoke in the afternoon. Their presentations on advances in LVC simulation highlighted LVC use across several projects, including the development of test infrastructure to support autonomy T&E.

Day 3: Technologies and Lessons for Autonomy T&E

Technical experts from the National Aeronautics and Space Administration, Army Combat Capabilities Development Command (CCDC), MITRE, Air Force Institute of Technology, AFRL, Test Resource Management Center, and industry gave perspectives on new tools and technologies in development that can support autonomy T&E. Several presenters discussed lessons learned from their autonomy-related work in the areas of digital engineering, digital twins, verification, and validation, and their integration with test surrogates.

Day 4: Assured Autonomy and Human-Machine Teaming

Technical presenters from AFRL, Naval Research Laboratory, Naval Postgraduate School, MITRE, Institute for Defense Analyses, and Army CCDC spoke on challenges regarding assured autonomy, formal methods, data, and trust metrics. Discussions revealed that human collaboration with machines is a complicated ontology that spans domains and developmental phases and cycles. Standards in metrics, data management, and formal methods are being developed to deliver repeatable and meaningful results.

Workshop Findings and Recommendations

Participant feedback and SME review from several organizations helped shape workshop findings and recommendations. The STAT COE identified the most notable and widespread issues, risks, and opportunities discussed at the 2022 ATEAS workshop. The STAT COE then analyzed and distilled these findings into the following autonomy T&E recommendations:

- 1. **Finding**: There is widespread recognition of a need for holistic test strategies to integrate developers, testers, and users across autonomous defense system life cycles with continuous, agile testing.
 - **Recommendation**: Research, develop, and share case studies in continuous, agile approaches to autonomous systems development, testing, and operations to accelerate implementation across DoD and influence future policy, technology, and resources on continuous and agile testing.

- 2. **Finding**: Open architecture and other autonomy standards are developing to support modular application of autonomy, including standards in metrics, requirements, instrumentation, interfaces, and other related test processes.
 - **Recommendation**: Develop and widely share open-system architectures and standards for autonomy to enable transparent and repeatable test requirements, measures, and instrumentation and help inform future policy on architectures and standards.
- 3. **Finding**: Government organizations are acting as the "prime contractor" for autonomous defense system development and taking on the systems integrator role.
 - **Recommendation**: Identify and share lessons learned and best practices in program management utilizing project integrator roles within DoD organizations.
- 4. **Finding**: Autonomous defense systems impose new burdens on operators and human teammates. Quantifying trust requires identification and application of effective requirements, metrics, and T&E methods, such as early iterative testing. Efforts to quantify trust or enable users to calibrate trust in autonomous defense systems have advanced, but trusted autonomy remains a challenge.
 - **Recommendation**: Plan and execute a small, focused future workshop or technical exchange for sharing case studies in the calibration of trust and best practices, including metrics for early iterative human-machine interface testing, human-machine interaction, teaming, and trust in autonomous defense systems.
- 5. **Finding**: Workshop surveys identified autonomous defense system safety as the most critical challenge and the highest-ranked topic for further research and development. Using assurance arguments in a formal assurance case framework may provide a consistent, repeatable, enduring method to obtain appropriate, calibrated operator and certifier trust in autonomous defense system safety.
 - **Recommendation**: Research and share learning from pilot projects or case studies to develop formal assurance cases for autonomous defense system safety, security, responsibility, and/or mission effectiveness.
- 6. **Finding**: Test infrastructure may require enterprise-level investment to meet future autonomy demand and support multiple simultaneous autonomous defense system programs with mature and reusable test surrogates.
 - **Recommendation**: Research and plan for reliable and reusable test infrastructure to support and accelerate future autonomy T&E.
- 7. **Finding**: Participants expressed strong desires to improve the ability to collaborate and to have web-based resource references, including test range support, community contacts, tools, data repositories, and other frequent collaboration.

- **Recommendation**: Plan and execute quarterly or semiannual technical exchanges or small workshops to continue autonomous defense system collaboration by facilitating and strengthening relationships and networking among autonomy and T&E community experts.
- **Recommendation**: Establish a single online DoD autonomy T&E resource site that can host a variety of collaborative tools and information for autonomous defense system T&E.
- 8. **Finding**: Autonomous defense systems currently lack clearly defined pathways for a variety of system certifications.
 - **Recommendation**: Define specific certification requirements and identify certification processes for autonomous defense systems. Consider frameworks such as assurance arguments to certify autonomy products and processes.

Workshop Conclusion

These findings represent the work of nearly 200 participants in the 2022 ATEAS workshop. Feedback from participants and senior leaders indicates that workshop engagement, breadth of expertise, and scope of participation met or exceeded expectations. To meet the demand of the T&E community and needs of the entire DoD enterprise, senior leaders may desire future ATEAS workshops and perhaps smaller technical exchanges in between workshops at regular intervals to address future autonomous defense system T&E challenges, guidance, lessons, methods, and policy.