

ABSTRACT

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“Findings and Lessons Learned about Trustworthiness and Trust in
Autonomous Multi-Agent Systems from NASA’s ATTRACTOR Project”

A Distributed Simulation-to-Flight Framework to Support Investigating Trust/Trustworthiness in Multi-Agent Systems

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As autonomous systems continue to grow both in use and complexity, the necessity for robust and extensible simulation-to-flight frameworks is paramount for establishing an effective architecture for autonomous systems. Hardware test flights are time-consuming and cost prohibitive during early system design and development. Simulation environments can be useful tools to accelerate algorithm development and testing. However, transitions from simulation to flight (sim-to-flight) can be challenging, unless systems are designed with this transition in mind and with the necessary capabilities built into the architecture and framework. One of the objectives of Autonomy Teaming and TRAjectories for Complex Trusted Operational Reliability (ATTRACTOR) was to design and develop a distributed mixed-reality simulation environment to begin establishing a basis for certification of autonomous systems via research into trust and trustworthiness. ATTRACTOR’s objective was to construct computational concepts of trustworthiness and justifiable trust in multi-agent autonomous teams, to inform future certification of safety-critical and time-critical autonomous systems in aviation.

In this paper, we present an autonomous systems architecture and development framework paired with a persistent distributed modeling and simulation (ModSim) environment for test and evaluation of autonomous systems. They were designed under ATTRACTOR in order to measure and establish trustworthiness and trust in single- and multi-agent human-machine systems whether these machines are fixed-wing general aviation, rotary-wing Unmanned Aerial Vehicles (UAVs), ground rovers, or even spacecraft. The Autonomous Entity Operational Network (AEON) framework enables autonomous system development with an easily extensible collection of libraries and plug-n-play nodes facilitated by the Data Distribution Service (DDS) communication protocol standard. The Baseline Environment for Autonomous Modeling (BEAM) simulation environment is a distributed mixed-reality Unity™-based environment built around the same DDS communication paradigm allowing for easy integration with AEON-based autonomous applications, enabling sim-to-flight with minimal configuration changes. Using AEON and BEAM, source code that runs in simulation ports directly to hardware and has successfully flown in the National Airspace System (NAS) at NASA LaRC many times over the lifetime of ATTRACTOR.

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