



ASTC DRIVE

Autonomous Systems Test Capability



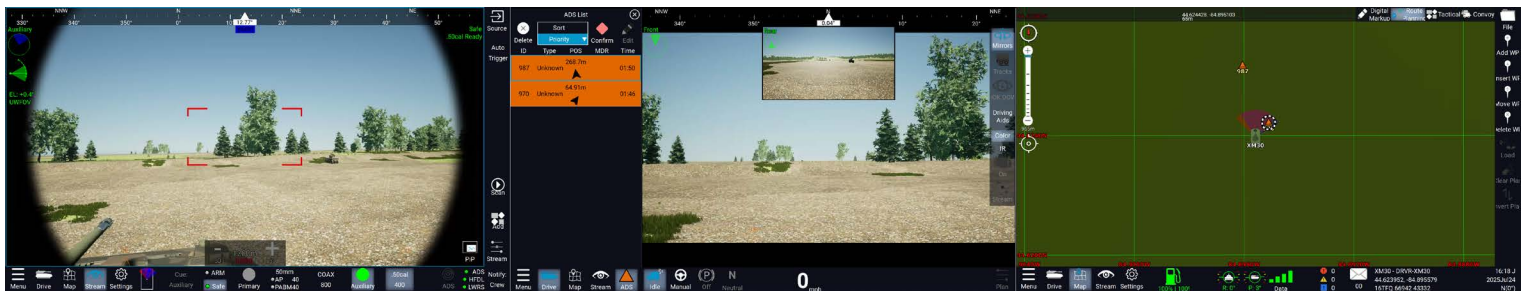
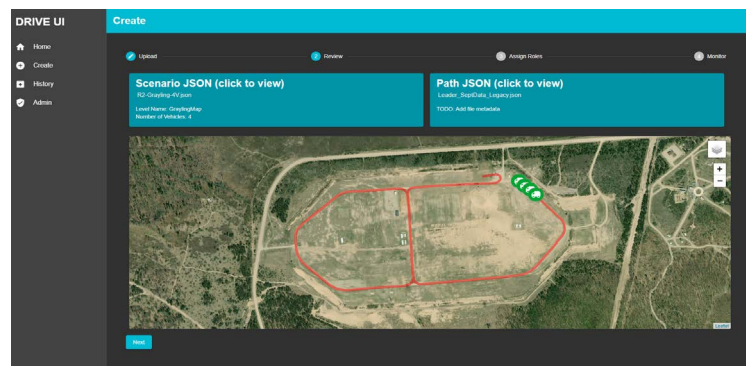
Autonomous Convoy Operation

DCS delivers comprehensive autonomy solutions spanning autonomous vehicles, advanced simulation environments, and the Autonomous System Test Capability (ASTC) Digital Robotic Integrated Virtual Environment (DRIVE). DCS provides simulation capability to support end to end autonomy development, integration, and testing for military ground systems, offering modular autonomy software through the Army's Robotic Technology Kernel (RTK) and turnkey integration for platforms such as Robotic Combat Vehicles (RCVs) and Autonomous Transport Vehicle System (ATV-S). Through ASTC, DCS delivers real time simulation tools that stimulate autonomy algorithms and support rigorous multi vehicle convoy testing. Using hardware in the loop (HITL), software in the loop (SIL), and high fidelity environments built with tools like Unreal Engine, DCS provides scalable, realistic simulation solutions that accelerate validation and deployment of autonomous capabilities in operationally representative conditions.



WHAT IS ASTC DRIVE

Under Ground Vehicle Systems Center (GVSC) technical leadership, Autonomous Systems Test Capability (ASTC) has produced multiple virtual environments that enable testing the decision making of autonomous software on autonomous systems in a virtual solutions environment. ASTC executed its testing environments with a PLS and the Autonomous Transport Vehicle System (ATV-S) program. The ASTC DRIVE program has a simulation environment that is tightly aligned with a system under real-world test, reflecting the same vehicle behaviors, interfaces, and operational assumptions. A second environment adds HITL capability that enables one to test an autonomous convoy in which virtual vehicles are interacting with live vehicles on a simulator or on a test track. Another focus of ASTC involves connecting the virtual simulations to a High-Performance Computer (HPC) to run thousands of scenarios with incrementally varying conditions. ASTC includes a framework for developing digital twins at the subsystem level.





THE ASTC DRIVE SOLUTION

From a testing perspective, building up these capabilities is invaluable. Use of these capabilities allow the testing community to start testing further left in the acquisition cycle saving valuable resources later in the cycle. With these capabilities, live testing is still needed but can be reduced as a result. When live testing does occur, risk assessments can be made and procedures can be developed appropriately to test the autonomous vehicle in a safe but effective environment. Not only will live testing be reduced, but scenarios that could have never been tested from a resource perspective can now be achieved. Testing can be focused on the "edge cases." This will allow programs to reduce their live testing while gaining more information. In addition, by integrating digital twin technology, this surrogate system allows for qualitative and quantitative analysis of autonomous system performance within realistic mission contexts. It enables the Army to stress-test subsystems, refine AI-driven decision-making models, and assess operator effectiveness under various operational conditions.

Ultimately, this effort supports the Army's modernization initiatives, ensuring that future robotic and autonomous systems can be effectively integrated into multi-domain operations while providing soldiers with the tools needed to execute missions efficiently and safely. Focusing on the interplay between robotic combat vehicles (RCVs) and human operations, the framework enables evaluation of soldiers' cognitive loads while managing tasks such as maneuvering robotic systems, interacting with aided target detection, and engaging simulated adversaries. This methodology provides a pathway for refining AI/ML capabilities, enhancing autonomy, and informing the Army's broader testing and evaluation objectives.



Acknowledgement: This material is based upon work supported by the U.S. Army Capability Program Executive Simulation, Training, Test and Threat (CPE ST3), Test Resource Management Center (TRMC) Test and Evaluation/Science & Technology (T&E/S&T) Program. These projects are funded by the T&E/S&T Program through the U.S. Army Capability Program Executive Simulation, Training, Test and Threat (CPE ST3) Threat Systems Management Office (TSMO).

Disclaimer: Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Test Resource Management Center (TRMC) Test and Evaluation/Science & Technology (T&E/S&T) Program and/or the U.S. Army Capability Program Executive Simulation, Training, Test and Threat (CPE ST3).

RISK REDUCING CAPABILITIES

ASTC utilizes seven distinct methodologies to maximize what can be tested in a virtual world to support controlled, replicable testing of autonomous technologies.

- **System Level Digital Twin:** Using digital engineering tools to create a digital twin of the terrain, vehicle mobility model, sensor models, and integrating the autonomous software under test. Sensors include Light Detection and Ranging (LiDAR), radar, camera, video and Inertial Measurement Unit (IMU).
- **HITL:** HITL testing includes use of a treadmill-like simulator for military vehicles, which allows ASTC to simulate a convoy with just one live vehicle. ASTC is able to simulate a convoy with just one live vehicle. A digital twin virtual leader is used to interact with a live follower and potentially other virtual followers. The live follower thinks it's on a road somewhere following the lead vehicle but in reality, the leader is on a simulator.
- **HPC:** By connecting the virtual simulations to a HPC, multiple scenarios can be executed simultaneously (not faster than real time). The tester can automate the modification of scenarios and judge them against specific criteria.
- **Instrumentation and Collecting Information:** Using a data logger, the tester can collect information such as what obstacles were in the scene, locations of the obstacles, as well as communications between vehicles.
- **Fault Injection:** Injecting faults in the virtual world reveals the decision-making process the software undergoes when parts of the vehicle or system are not functioning correctly. Faults include Global Positioning System (GPS) loss, GPS degradation, LiDAR degradation/loss, communications degradation/loss. Additional fault injections include generating false system health messages from vehicle mechanical components to the autonomous software, indicating engine overheated, emergency stop enabled, low tire pressure, or brake malfunctioning.
- **Weather and Obstacles:** Weather and obstacles can be injected into the virtual scene, which is not limited to just a visual perspective. To do this successfully, the autonomous kit is stimulated from a sensor perspective.
- **Human Machine Interaction with Aided Target Detection & Recognition (AiTDR):** ASTC introduced reconfigurable soldier crew stations that allow for the ability to evaluate different capabilities including manned vehicle operations, the capability to control remote vehicles and workload metrics. ASTC, working with DEVCOM C5ISR Center, developed an AiTDR plugin to work in the ProjectGL, an Unreal Engine based simulation environment.

