



U.S. ARMY ABERDEEN TEST CENTER

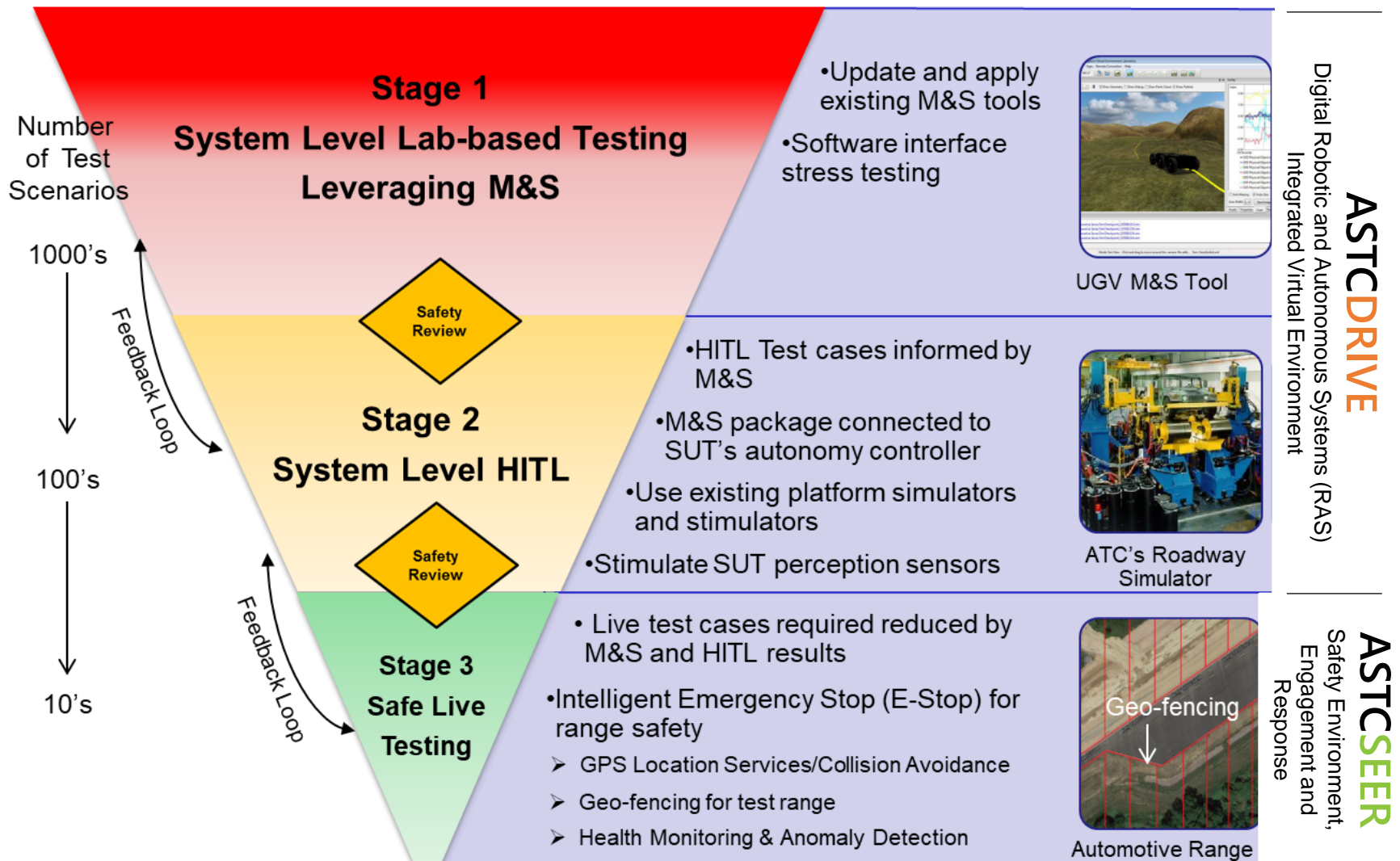


The Use and Benefits of Modeling and Simulation with Autonomous Vehicle Testing

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Modeling and Simulation OV-1 Overview



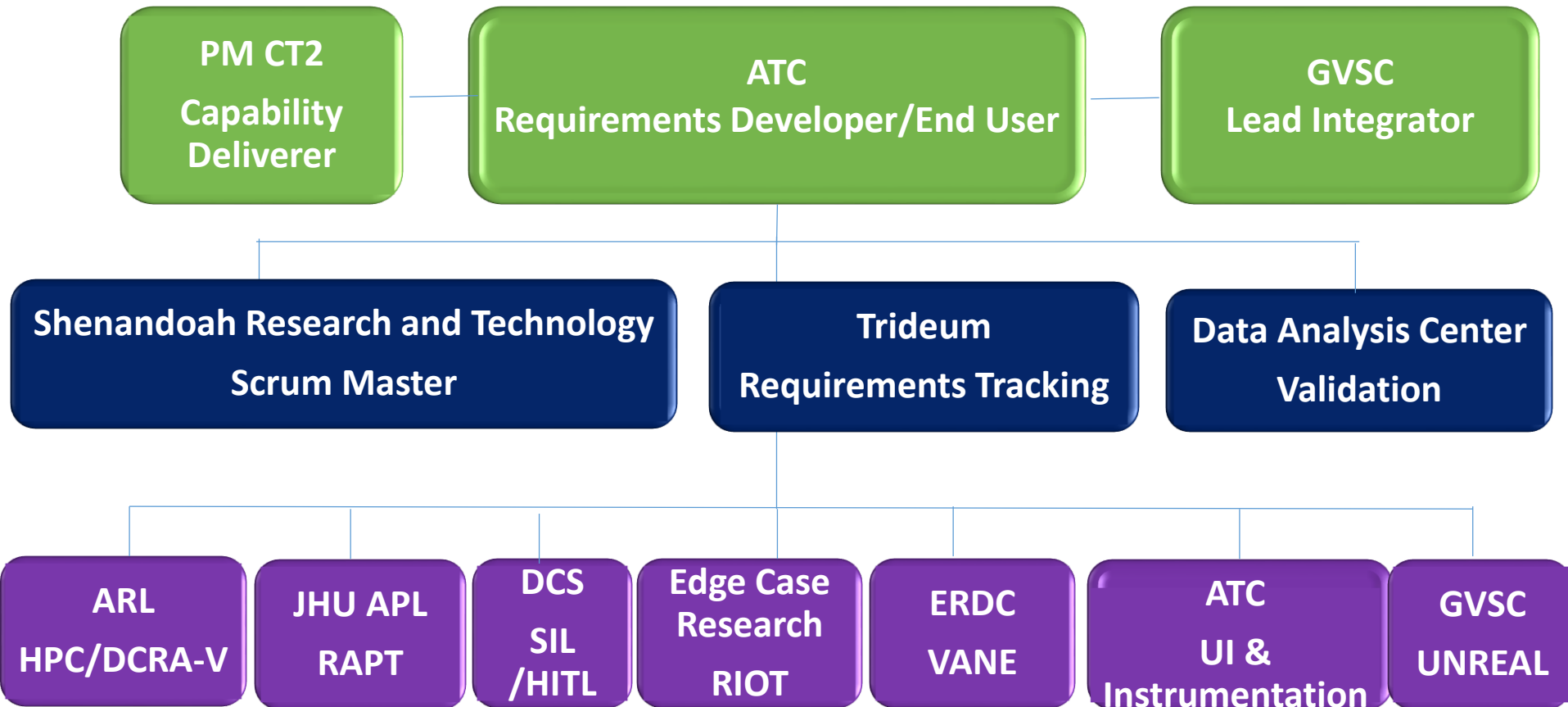
DRIVE and SEER allow for more test scenarios to be conducted while reducing the number of live scenarios and ensuring the safe conduct of those live scenarios

What is DRIVE?



ASTC's DRIVE is a Virtual Test Center.

ASTC DRIVE Structure and Responsibilities



50+ personnel from 10+ organizations are supporting the ASTC DRIVE development

DRIVE Overview

ExLF 1.2 could have benefitted from DRIVE

TOOL: UNREAL
Capability: Virtual Environment
IOC DATE: 1Q FY 21
FOC DATE: 1Q FY 21
EXAMPLE: Digital Twins of ATC's ATEF and Perryman Test Area

TOOL: HITL
Capability: Links Virtual Leader with Live Follower
IOC DATE: 1Q FY 23
FOC DATE: 1Q FY 23
EXAMPLE: hardware and mechanical check of autonomy



TOOL: RAPT
Capability: Scenario Planning and Evaluation
IOC DATE: 2Q FY 21
FOC DATE: 1Q FY 22
EXAMPLE: Evaluates multiple scenarios against predetermined criteria which reduces live test scope



TOOL: DCRA-V
Capability: Data Collection, Reduction, Validation, Analysis
IOC DATE: 2Q FY 21
FOC DATE: 1Q FY 22
EXAMPLE: Sensor Information, Vehicle Response Data

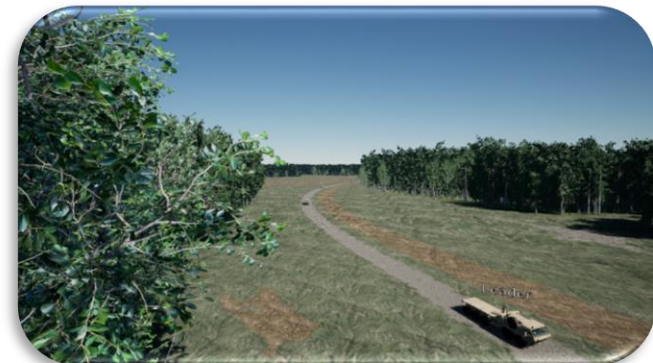
TOOL: RIOT
Capability: Fault Injection/Fault Analysis
IOC DATE: 3Q FY 22
FOC DATE: 3Q FY 22
EXAMPLE: Loss of GPS, steering malfunction, loss of LIDAR

TOOL: VANE
Capability: Weather, Obstacles, Time of Day, Sensors
IOC DATE: 2Q FY 21
FOC DATE: 1Q FY 22
EXAMPLE: Rain, Snow, Fog, Twilight, People, Animals, LIDAR Response

DRIVE will have an Initial capability that can start supporting testing 1Q FY 22

DRIVE will use 6 tools integrated into 1 program that will provide various modeling and simulation capabilities through a Software Integration Lab and the High Performance Computer at Aberdeen Proving Ground.

Software Integration Lab



Stage 2 Hardware in the Loop

Extensive Hardware in the Loop Testing



ATC's Roadway Simulator

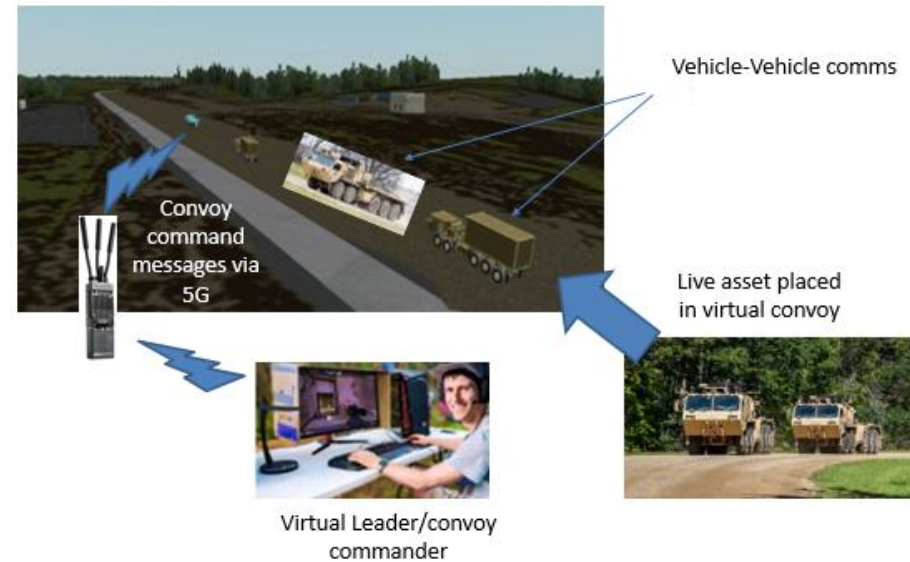


ATC's EMI Chamber



ATC's Combat Systems Support Laboratory

Wireless Hardware in the Loop Testing



What is Safety Environment, Engagement and Response (SEER)?



SEER is hardware/software applique kit that will allow unmanned operations to occur with no safety driver but still allow the test team control over the systems under test allowing more repeatable definite data to be collected.

SEER Overview

Capability: Intelligent Emergency Stop

Example: SEER will detect if the system's emergency stop failed to operate and stop the vehicle as well as allow the Test Engineer to stop it through a button press if something undesirable was observed.



Capability: Anomaly Detection

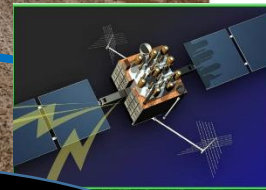
Example: SEER will detect electrical and mechanical anomalies and bring the vehicle to a safe stop if they are present.

Capability: Mobile Safety Zone

Example: Examine Radar, LIDAR, and other information to keep a safe distance from other objects especially other vehicles. SEER would cause the vehicle to come to a safe stop if that cannot be achieved.



SEER's expected delivery date
is 4Q FY 22



Capability: Geo Fencing

Example: Examine Position and cause the vehicle to come to a safe stop if it departs the allowable location.

ASTC SEER will facilitate ATC with conducting unmanned operations while still having control of the systems under test.

Stage 1 Benefits

A typical ExLF test is about 1,000 miles over the course of 8 weeks



Typical ExLF testing has required 2 additional weeks of retesting

	Live	ASTC
Time of Scenario	15 minutes*	15 minutes*
# of hours per day	12 (8 actual testing)	24
# of hours per week	60	168
# of scenarios per hour	3	400
# of scenarios per day	24	9,600
# of scenarios per week	120	67,200
# of personnel needed per day	20	6
~Cost Per Day	\$16,800	\$3,780
~Cost Per Week	\$84,000	\$16,800
Retest Cost	\$168,000	\$1,050
Fuel Cost	\$9,600	\$0
ATEC Planning and Setup Cost	\$32,400	\$8,400
Test Closeout Cost	\$32,400	\$8,400
Total Cost	\$914,400	\$18,900

*Based on one lap with a four vehicle convoy around ATEF

Modeling can run a typical Leader Follower test phase in 2.5 hours collecting 192 Gigabytes of test data, reducing the cost by a 1/50th, and the carbon foot print by 3,200 gallons of fuel.

Questions