Evolution of a Distributed Live, Virtual, Constructive Environment for Human in the Loop Unmanned Aircraft Testing

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RAeS Modelling and Simulation in Air Traffic Management Conference 2017
UAS-NAS Project Overview

- Cooperative aircraft
- Noncooperative aircraft
- Air traffic services (en route)
- Detect and Avoid
- Command and Control
- UAS ground control station
- Human Systems Integration
- Integrated Test and Evaluation

Air traffic services (Near airport)
UAS use “Detect and Avoid” in place of “see and avoid”
LVC-Distributed Test Environment

Live: Real people operating real assets
Virtual: Real people operating simulated assets
Constructive: Simulated people operating simulated assets
LVC Architecture Build-Up

DAA System

Virtual Assets

Constructive Assets

GCS

LVC Gateway

ATC Toolbox

HLA – High Level Architecture

Sim Toolbox

LVC GW Toolbox

Pilot Toolbox

Legacy Core LVC

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Legacy Core LVC

Virtual Assets

Constructive Assets
LVC/DAA Simulation and Flight Activities

FY12 - FY17

- FY12: UAS ADS-B Flight
- FY13: LVC Characterization
- FY14: Full Mission Sim
- FY15: Collision Avoidance Flight Test 1
- FY16: Integrated HITL
- FY17: Terminal Operations Simulation

Notable Activities:
- UAS ADS-B Flight: Demonstrates capabilities of small unmanned systems for airspace awareness and situational awareness.
- LVC Characterization: Focuses on optimizing and testing LVC systems.
- Full Mission Sim: Full-scale simulation of mission scenarios.
- Collision Avoidance Flight Test 1: Prototype testing for collision avoidance systems.
- Integrated HITL: Combines human-in-the-loop simulation for realistic testing.
- Terminal Operations Simulation: Simulation of terminal operations and procedures.

Operational scenarios and test conditions are evaluated to ensure system effectiveness.
SMART-NAS Test Bed High-Level Architecture

Support Services
- Authentication
- Simulation Architect
- ATM Data Warehouse
- User Accounts
- Scenario Library
- Simulation Archive
- Web Services

Automation
- FAA Tools
- NASA Tools
- Airline Tools
- Industry Tools
- Real-time Safety Monitoring

Traffic Generators
- Airspace Traffic Generator (ATG)
- Aircraft Simulation for Traffic Operations Research (ASTOR)
- Multi-Aircraft Control System (MACS)

GovCloud
- Component A
- Component B
- Component C
- Component D
- Component X

UTM-SE
- Visualization Services
- Analytics Services

LVC-DE
- LVC Gateway
- UAS LVC-DE

DDS – Data Distribution Service

External Simulators

ATD Systems

Traffic Generators
### LVC Enhancement

- **Live**: Real people operating real assets
- **Virtual**: Real people operating simulated assets
- **Constructive**: Simulated people operating simulated assets

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LVC Enhancement

- **Live**: Real people operating real assets
- **Virtual**: Real people operating simulated assets
- **Constructive**: Simulated people operating simulated assets
- **Autonomous**: Simulated people operating real assets

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Diagram:
- Collision Avoidance Threshold
- Remain Well Clear
- Detect-and-Avoid Threshold
- ATC Coordination
- Detect and Avoid
- CA Alert
- RWC Alert
- Preventive Alert
- Conflict Alert
- Controlled Separation
Conclusion and Next Steps

- NASA’s UAS Integration into the NAS project has developed an LVC architecture to support testing of unmanned Detect and Avoid research.

- LVC Distributed Test Environment was built up from legacy infrastructure and designed to meet DAA test objectives and requirements.

- Integrating with NASA’s SMART-NAS Test Bed will enable continued use of the LVC technologies.