The Advanced Framework for Simulation, Integration, and Modeling (AFSIM)

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Introduction

– This briefing will convey essential background on AFSIM

  o What is AFSIM?

  o Who uses it and for what purpose?

– This briefing will also convey MS&A Use Cases where AFSIM is used to support autonomy technology development.

Advanced Framework for Simulation, Integration, and Modeling (AFSIM)

Overview
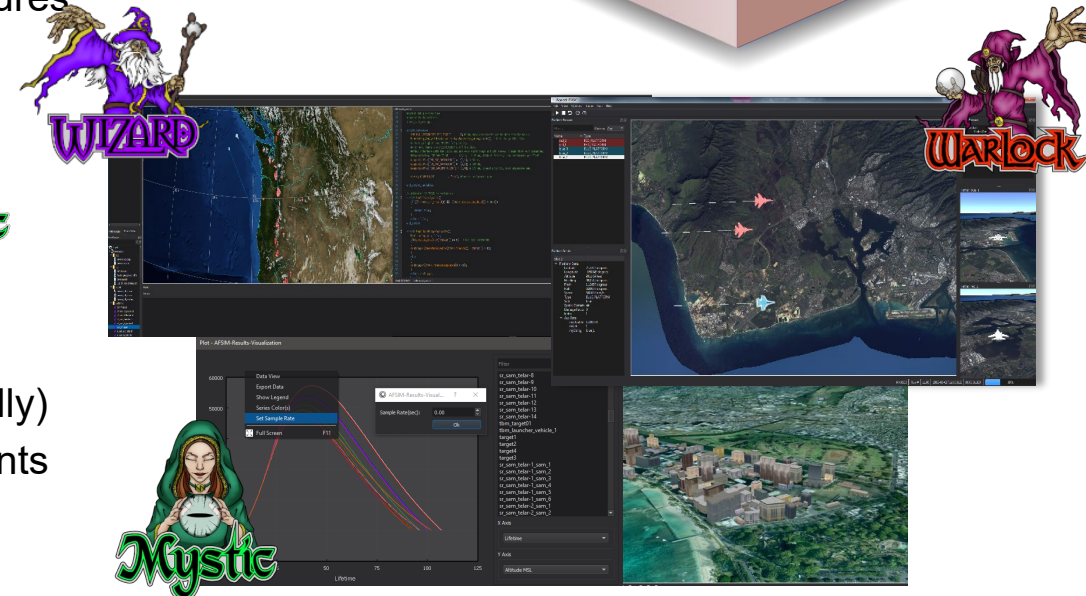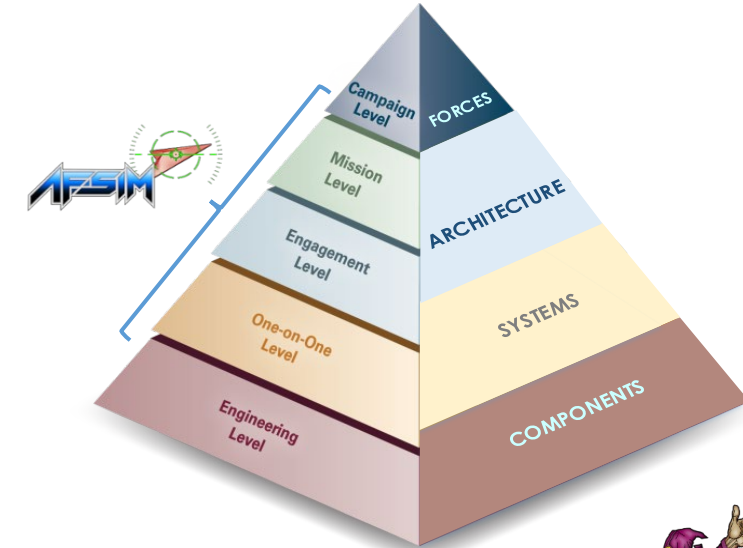
- **What is AFSIM?**
  - A U.S. government owned, open source, community-informed, military simulation framework
  - AFSIM enables multi-domain, multi-resolution modeling, simulation, and analysis

- **What capabilities does it provide?**
  - Multi-domain scenarios from sub-surface to space including EW and cyber
  - Multi-resolution modeling: e.g, basic parametric models to full 6-DOF models
  - Script-based definition of behavior, tactics, and command structures
  - Virtual and constructive analysis modes
  - A suite of support tools
    - Scenario creation, editing and execution – WIZARD
    - Real time and post processing and results visualization – Mystic
    - Constructive, OITL, M&S-powered wargames – Warlock
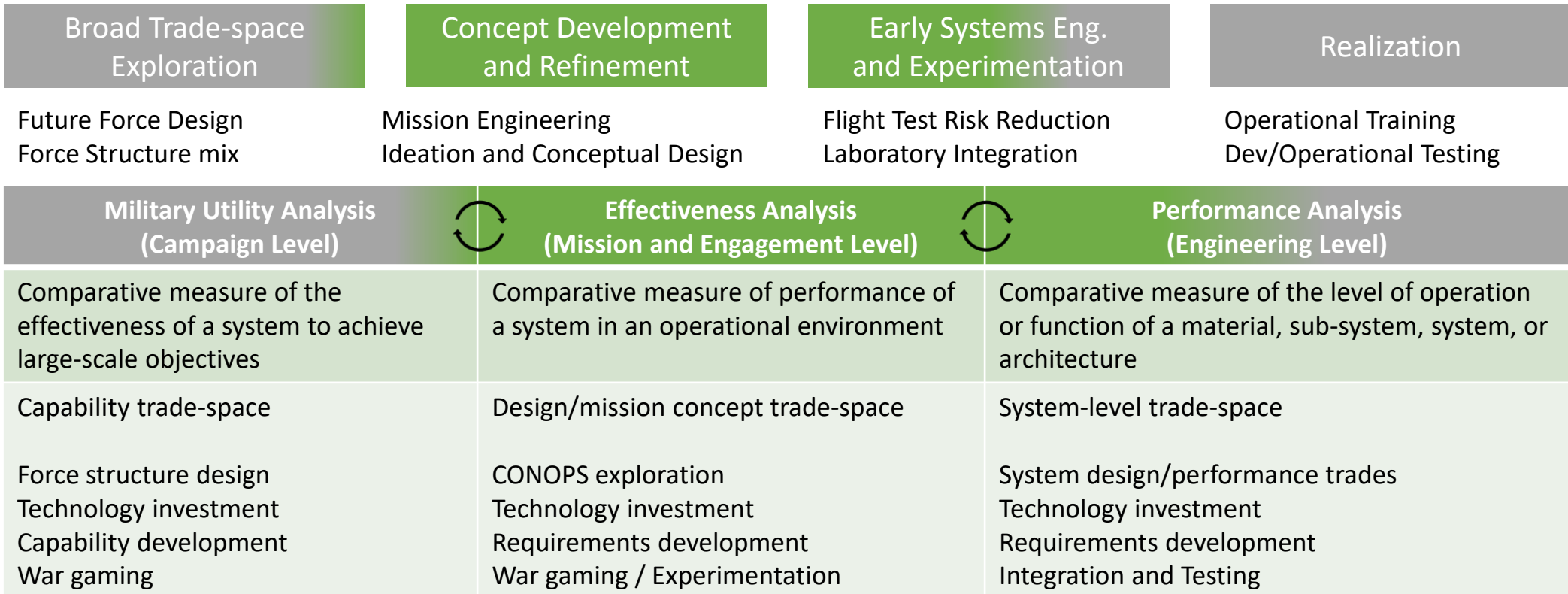
- **Who can use it?**
  - Available to U.S. Gov't and DoD Industry at no cost (IR&D friendly)
  - Available to FVEYs partners under authorized transfer agreements
  - **NATO usage currently under consideration**

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Advanced Framework for Simulation, Integration, and Modeling (AFSIM)
Purpose

– AFSIM supports a spectrum of uses across the development lifecycle

– AFSIM's "home turf" is mission effectiveness analysis (constructive, virtual, and/or live)

– AFSIM is improving compatibility with other tools for concept iteration and refinement at other levels

Broad Trade-space Exploration	Concept Development and Refinement	Early Systems Eng. and Experimentation	Realization
Future Force Design Force Structure mix	Mission Engineering Ideation and Conceptual Design	Flight Test Risk Reduction Laboratory Integration	Operational Training Dev/Operational Testing

Military Utility Analysis (Campaign Level)	Effectiveness Analysis (Mission and Engagement Level)	Performance Analysis (Engineering Level)
Comparative measure of the effectiveness of a system to achieve large-scale objectives	Comparative measure of performance of a system in an operational environment	Comparative measure of the level of operation or function of a material, sub-system, system, or architecture
Capability trade-space	Design/mission concept trade-space	System-level trade-space
Force structure design Technology investment Capability development War gaming	CONOPS exploration Technology investment Requirements development War gaming / Experimentation	System design/performance trades Technology investment Requirements development Integration and Testing

Advanced Framework for Simulation, Integration, and Modeling (AFSIM)
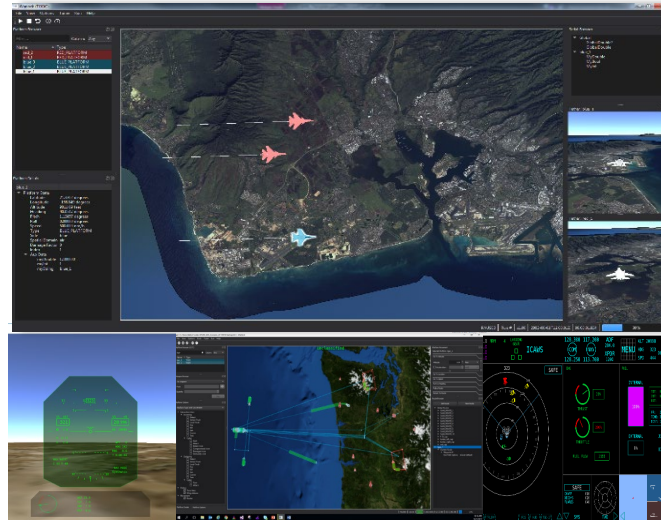## *Supporting Toolset*

AFSIM includes a supporting suite of tools. These tools reduce analyst workload and improve analyst effectiveness when answering key questions or explaining results.
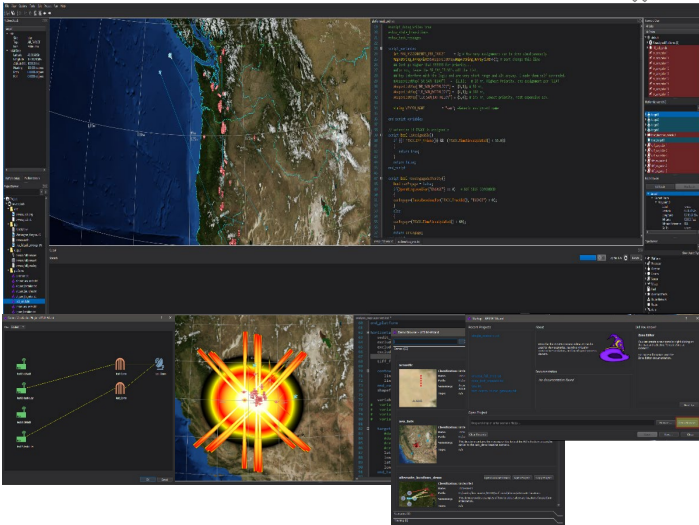

- AFSIM Integrated Development Environment
- End-to-End analyst toolchain
- Scenario development (scripting & visually)
- Simulation execution
- Post-processing link to Mystic

- Operator-in-the-loop tool
- Supports experimentation and wargaming
- Interact with human or AI-enabled agents
- Mock up novel human-machine interfaces
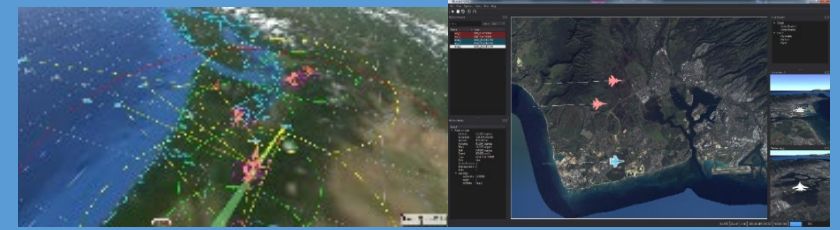- Develop plugins for custom visualizations
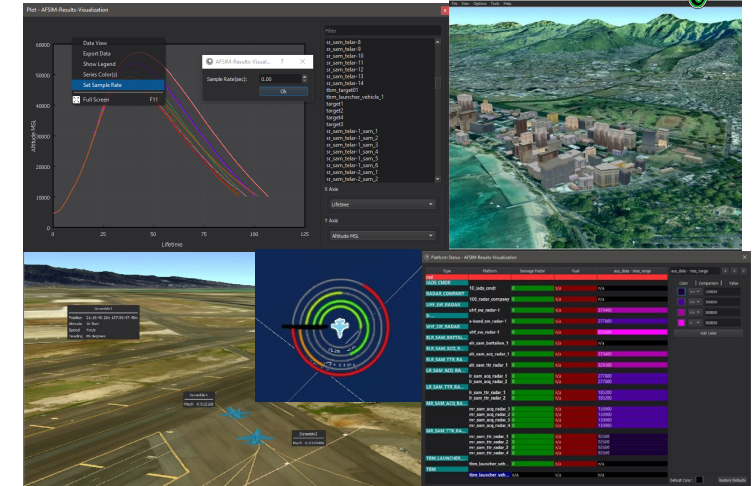
- Recording, playback, visualization
- View entity interactions
- Dive into performance statistics

MS&A Autonomy Use Cases
Overview

> **MS&A is a key capability for advancing Autonomy**

Evaluating military utility of potential autonomy concepts and capabilities in future warfare environments (2030+)

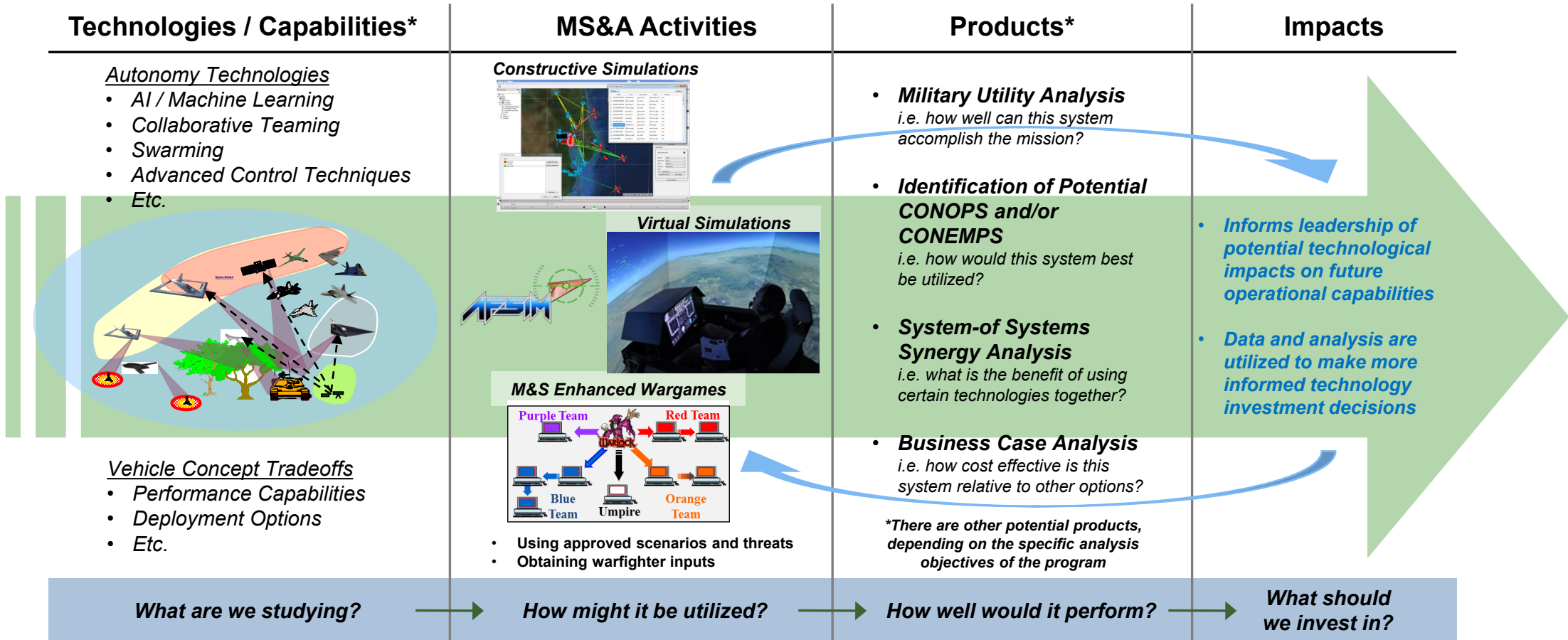**Using Modeling, Simulation and Analysis (MS&A) to mature autonomy technologies**

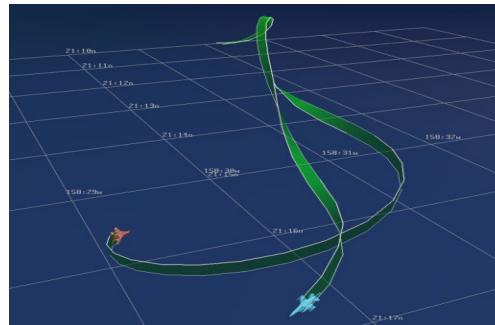**Flight test rehearsal and flight test risk reduction activities**

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MS&A Autonomy Use Cases

Autonomy Technology Investment Decision Making

Technologies / Capabilities*	MS&A Activities	Products*	Impacts

Autonomy Technologies
- AI / Machine Learning
- Collaborative Teaming
- Swarming
- Advanced Control Techniques
- Etc.

Vehicle Concept Tradeoffs
- Performance Capabilities
- Deployment Options
- Etc.

Constructive Simulations

Virtual Simulations

AFSIM

M&S Enhanced Wargames

Purple Team · Red Team · WARLOCK · Blue Team · Umpire · Orange Team

- Using approved scenarios and threats
- Obtaining warfighter inputs

- **Military Utility Analysis**
  i.e. how well can this system accomplish the mission?

- **Identification of Potential CONOPS and/or CONEMPS**
  i.e. how would this system best be utilized?

- **System-of Systems Synergy Analysis**
  i.e. what is the benefit of using certain technologies together?

- **Business Case Analysis**
  i.e. how cost effective is this system relative to other options?

There are other potential products, depending on the specific analysis objectives of the program

- *Informs leadership of potential technological impacts on future operational capabilities*

- *Data and analysis are utilized to make more informed technology investment decisions*

What are we studying?	→	How might it be utilized?	→	How well would it perform?	→	What should we invest in?

MS&A Autonomy Use Cases
Autonomy Technology Maturation

- **AFSIM utilized as a virtual testbed for autonomy technology maturation**
  - All physical entities simulated within AFSIM
  - Autonomy algorithms run external to AFSIM

- **Benefits**
  - One environment supporting autonomy R&D lifecycle
  - Reduces algorithm development and testing effort
  - Supports ML/RL algorithm training
  - Interface Flexibility
 - Evaluate autonomy scenarios that are difficult/impossible to flight test

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MS&A Autonomy Use Cases
## *LVC and Flight Test Rehearsal*

– **Autonomy LVC with AFSIM**

  o Transfer autonomy testbed to the range

  o Enables more complex flight tests with minimal added risk

  o Interface autonomy to live and virtual assets in realistic way
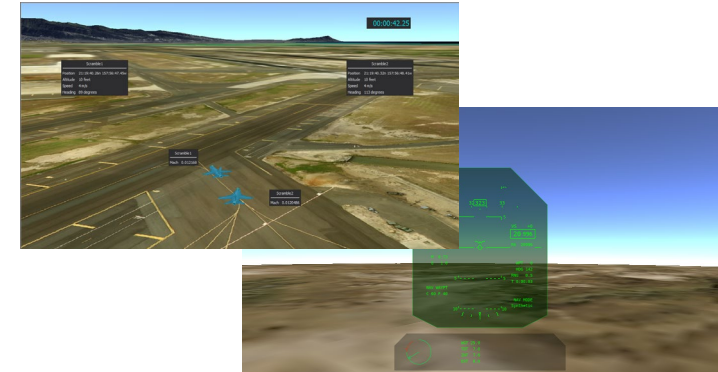
– **Flight Test Rehearsal with AFSIM**

  o Utilize AFSIM as framework for constructive/virtual environment for flight test dress rehearsal.

  o Instantiate mission scenarios in AFSIM.

  o Utilize Operator-In-The-Loop (OITL) Warlock interfaces for on the fly adjustments / feedback

  o Determine / Fix Timing

  o Practice Coordination
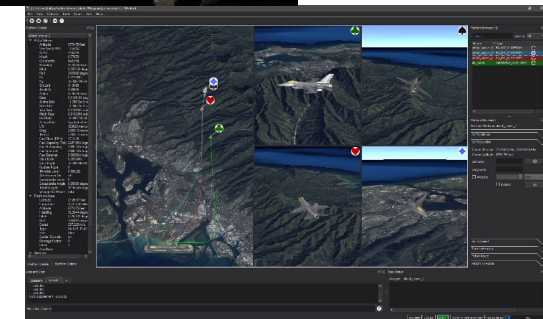
Summary

– AFSIM is a U.S. government owned, open source, community-informed, military simulation framework.

– AFSIM is capable of multi-domain and multi-resolution modeling within a single scenario.

– AFSIM is not yet available to NATO but under evaluation for future release.

– AFSIM is NOT a single solution to all M&S needs nor the only component of the AFRL and AF Enterprise MS&A infrastructure.

– MS&A is a key capability for advancing Autonomy.

– A simulation framework like AFSIM can serve well as a single, consistent environment for advancing autonomy concepts throughout the R&D lifecycle.

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Questions?