Implementing a Digital Engineering Environment for Mission Engineering

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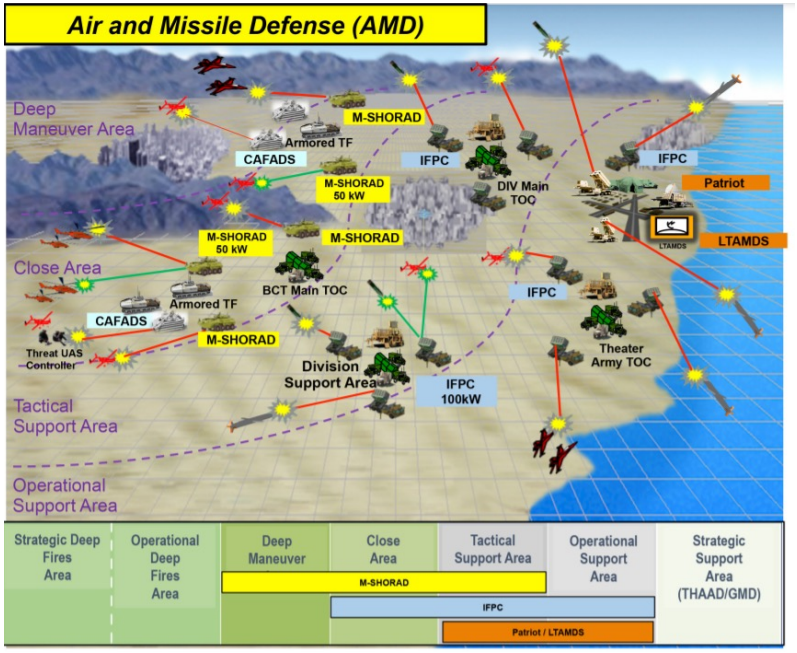
Introduction

- The presentation describes the broad mission context driving the development and the approach used to creating a **Digital Engineering Environment (DEE)** for the Joint Staff J8's Joint Integrated Air and Missile Defense Organization (JIAMDO).

- This includes the development of top-level mission threads for IAMD which can be specialized to address different mission sets, including **Counter Unmanned Aerial Systems (C-UAS)** as well as **Cruise Missile Defense (CMD).**

- The presentation includes perspectives from the DEE team, MITRE, as well as the end user, JIAMDO.



Source: *Army Air and Missile Defense Vision 2028, USASMDC/ARSTRAT*

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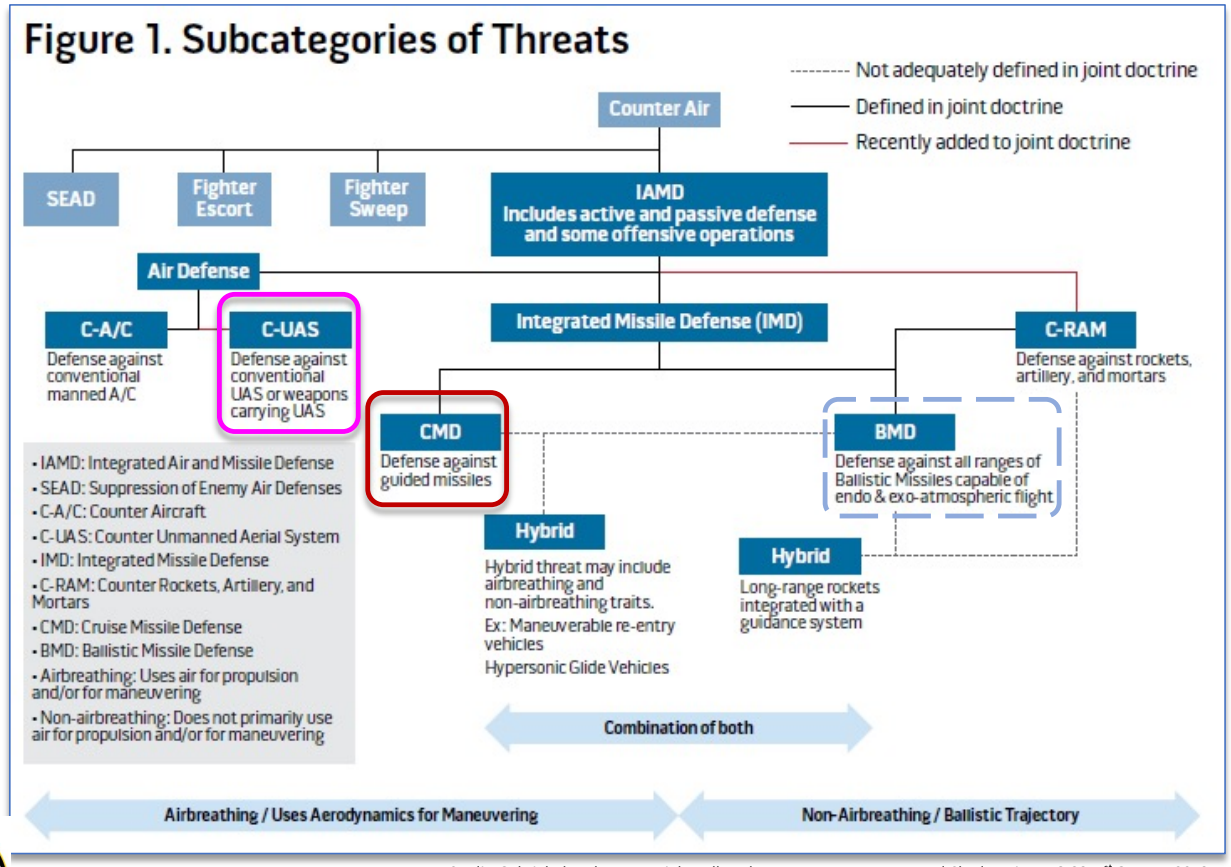
IAMD Mission Space

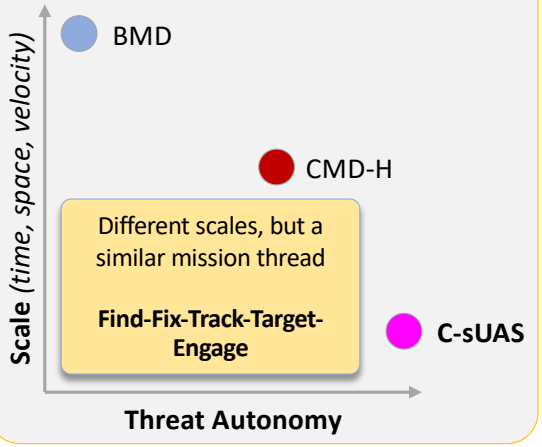


Credit: Gabriel Almodovar, Daniel P. Allmacher, Morgan P. Ames III, and Chad Davies, JFQ 88, 1st Quarter 2018

Key Insight

A Digital Engineering Environment developed for any IAMD mission can be easily re-factored to address the others.

Current work is focused on analysis of Countering Small Unmanned Aerial Systems (**C-sUAS**) – has been expanded to Cruise Missile Defense of the Homeland (**CMD-H**) in FY21, and will be expanded to support Ballistic Missile Defense (**BMD**) in FY22



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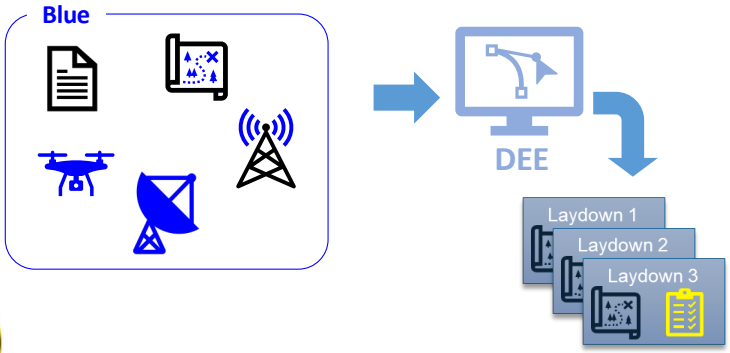
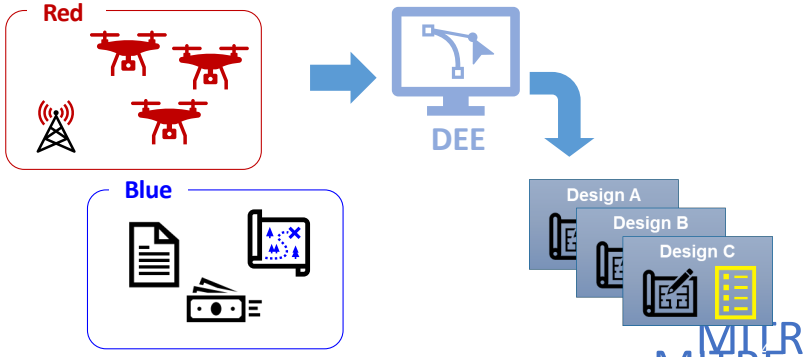
Two Complementary Analytical Approaches

- Start with knowns – *"Make the most of what you have"*
- Given existing C-sUAS system parameters, **determine the optimal set of capabilities** for a given scenario.



- Start with requirements – *"Buy the best of what you need"*
- Given adversary capabilities and BF CONOPs, **derive the required C-sUAS capabilities and parameters** that optimize performance for a given scenario.



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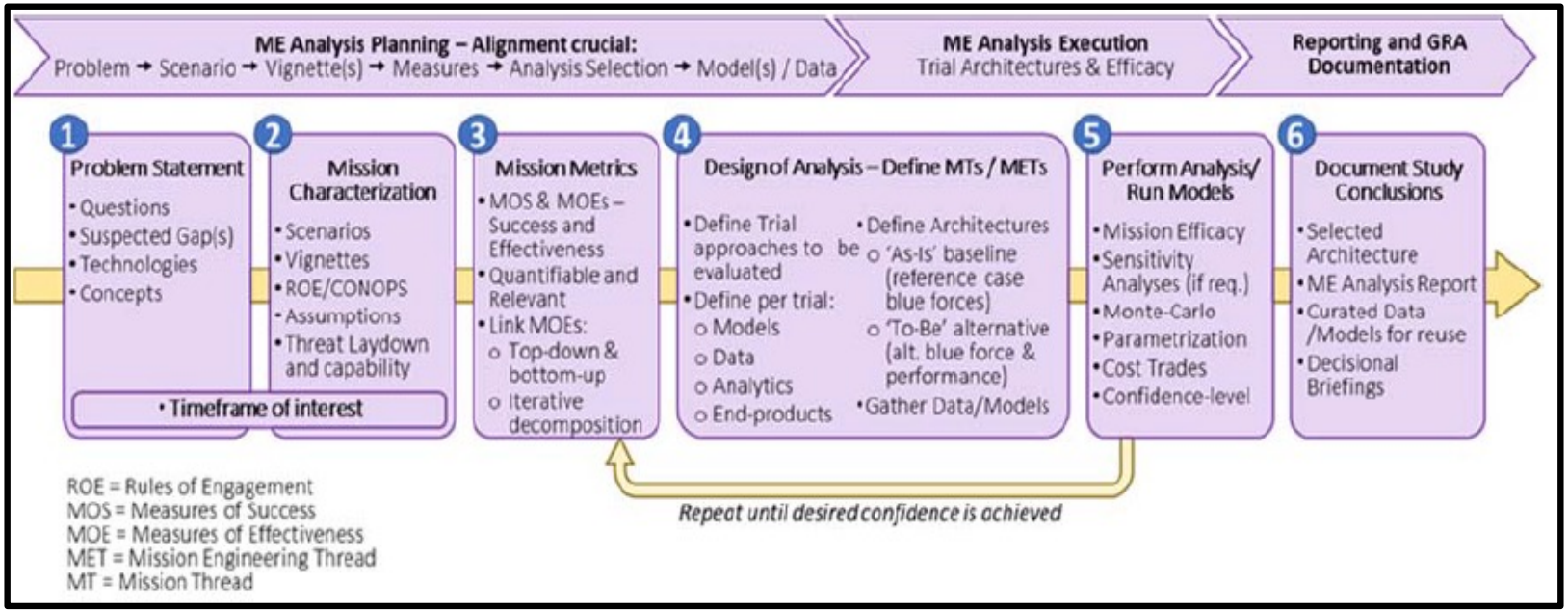
ME Approach and Methodology



ME process begins with the end in mind, a carefully articulated problem statement, the characterization of the mission and identification of metrics, and working through the collection of data and models needed to analyze the mission and document the output results.

DoD ME Guide, 2020, p5

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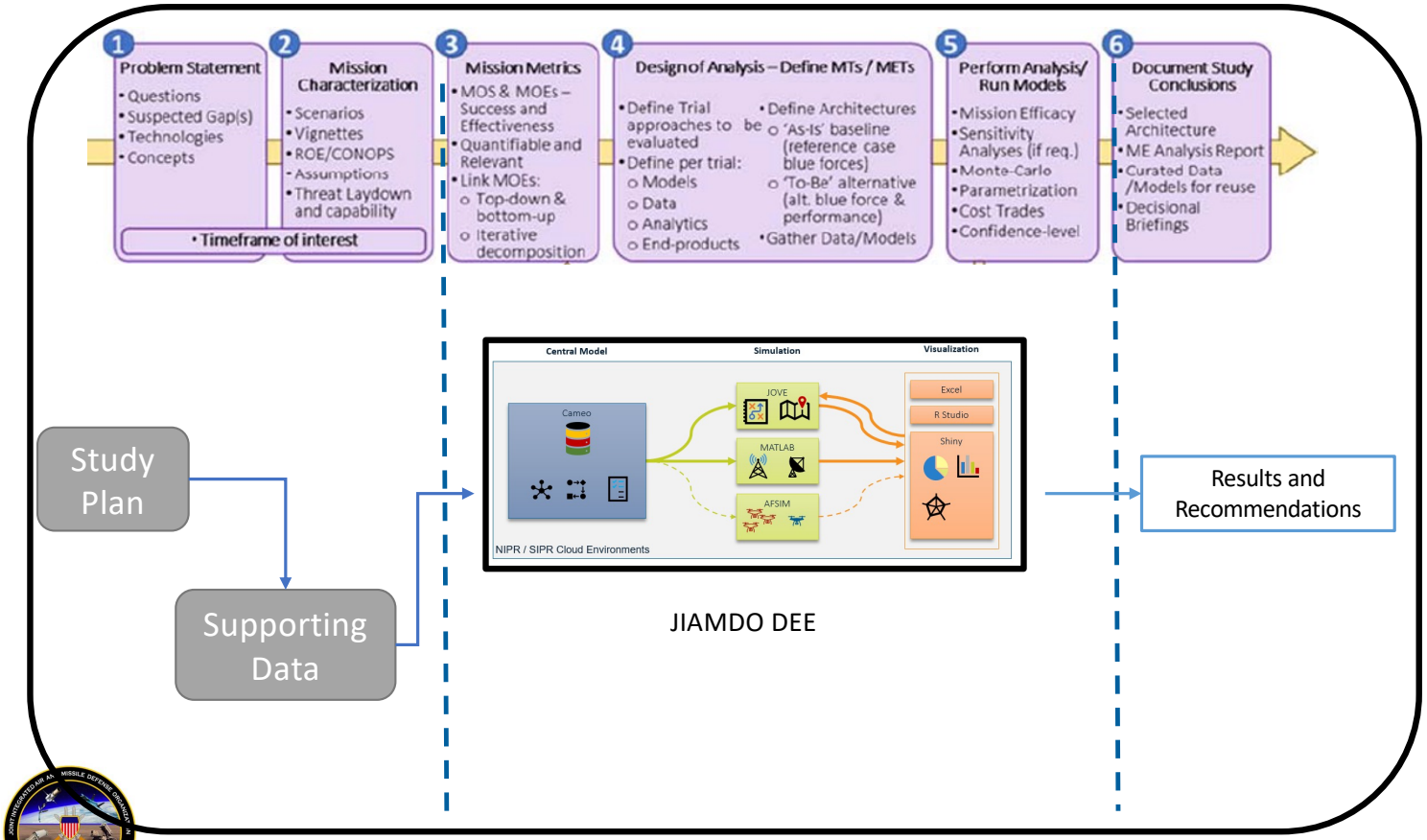
Source: OSD Mission Engineer Guide - https://ac.cto.mil/wp-content/uploads/2020/12/MEG-v40_20201130_shm.pdf

DE Framework within Mission Engineering (ME)



JIAMDO DEE

Simplifying the execution of Steps #3, #4 and #5 in the ME process

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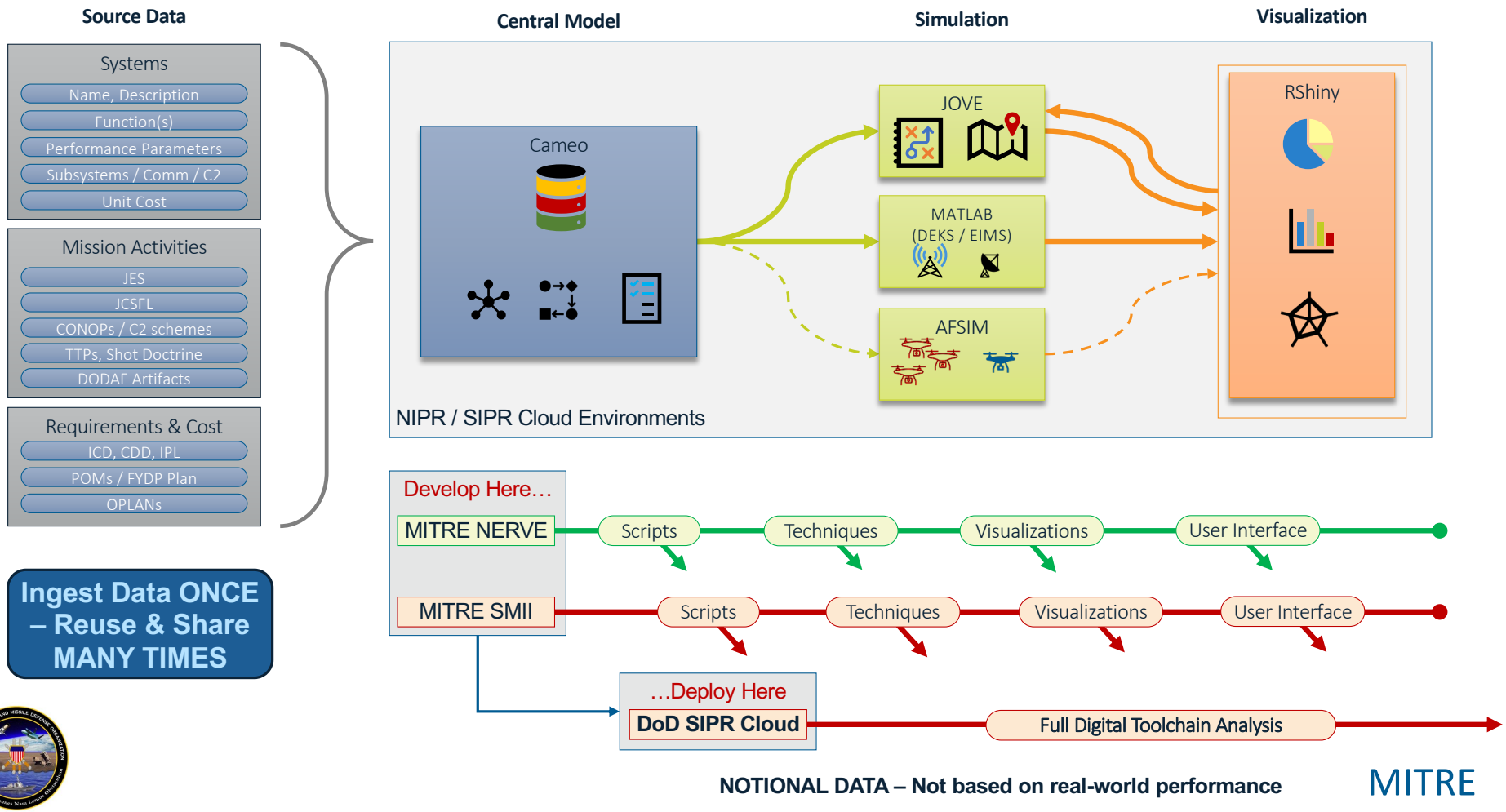
JIAMDO DE Environment – Process Flow



CUAS Digital Engineering Environment

	Product Type: Scopes the viewpoint of each product			
	REQUIREMENTS	**BEHAVIOR**	**STRUCTURE**	**PARAMETERS**
Mission Level: What problem is being modeled	Stakeholder Needs Fixed / Semi- Fixed Mission Overview C-UAS CDD Requirements	Use Cases Dynamic Targeting Use Case C-UAS Dynamic Targeting	System Context C-UxS Systems	Measures of Effectiveness Measures of Effectiveness CostItems
System of Systems: Describes the SoS to address the problem and verify the solutions.	System Requirements System Satisfy Matrix Notional SoS	System Behavior SV-4 C-UAS System A SV-4 C-UAS System B	System Structure C-UAS System A C-UAS System B	Measures of Performance System Sensing Performance Kinetic Effectors Performance Non-Kinetic Effectors Performance
Model: Describes how the M&S applicaton will represent a portion of the problem space to validate the solutions	Simulation Requirements	Simulation Behavior SV-4 Baseline Config SV-4 To Be Config	Simulation Structure Baseline Systems To Be Systems	Test Case

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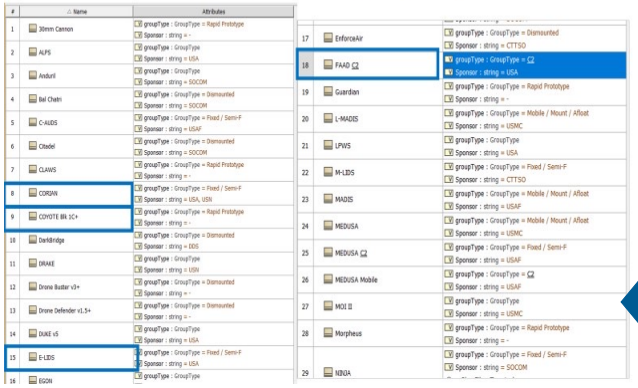
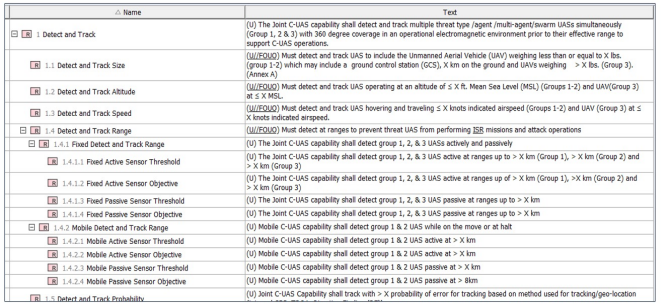
Analytic Elements

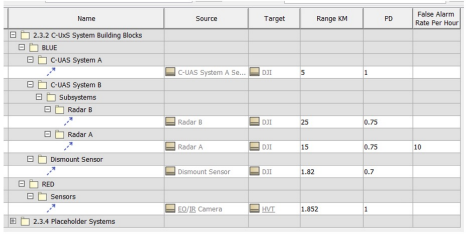
System Context – C-UAS System List

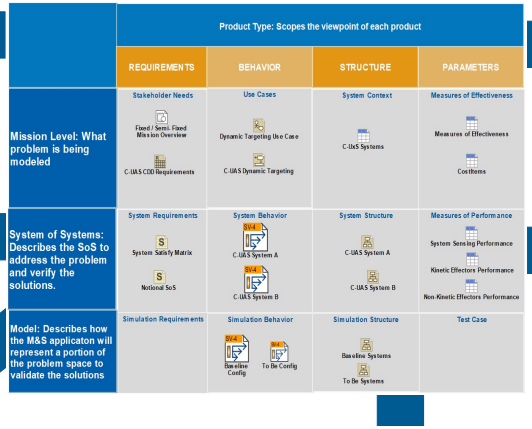


Operational Requirements from JCO CDD

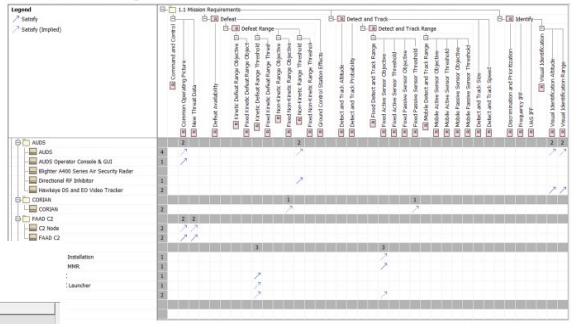


Measures of Performance
Sensing Performance





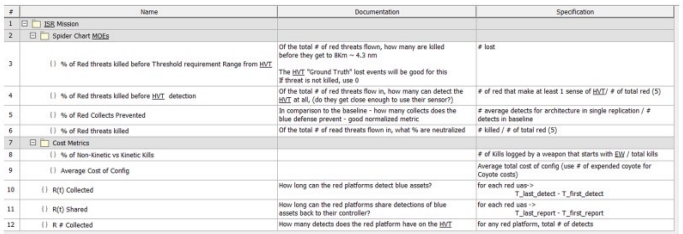
System Requirements –
C-UAS System to CDD Requirements Matrix



System Costs

Name	unitCost	expends
C-UAS System A	150	<undefined>
C2	50	<undefined>
Dismount Effector	30	<undefined>
Dismount Sensor	10	<undefined>
EW Effector	100	<undefined>
Interceptor	20	true
Interceptor Launcher	1000	<undefined>
Radar A	3416	<undefined>
Radar B	5000	<undefined>

Measures of Effectiveness



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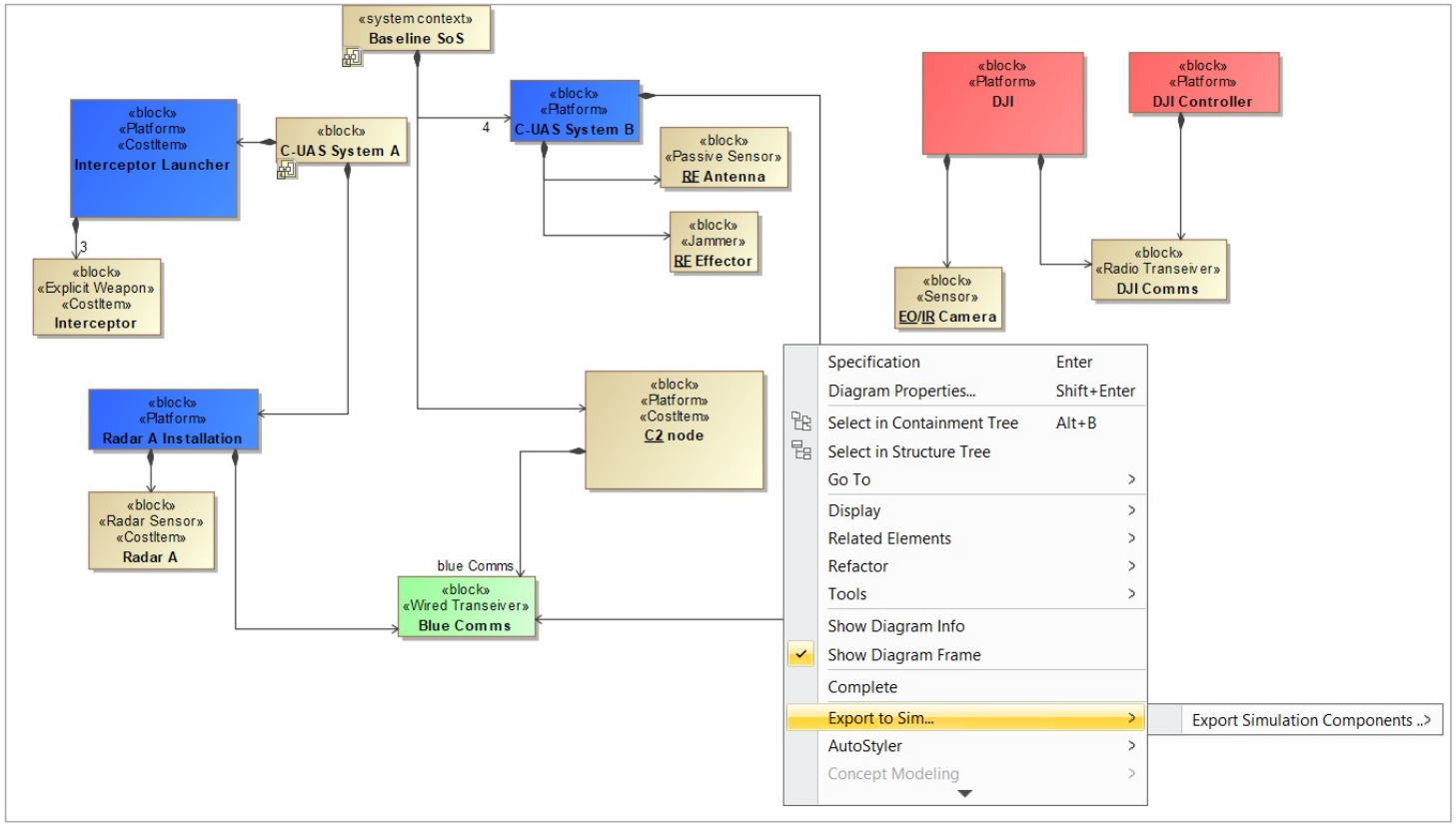
Data Exchange with Operational Simulation



Operational Simulations: A Comparison

Operational Sim Feature	JOVE	DEKS	EIMS
Capable of Effects Chain Analysis	✓	✓	✓
Graphical User Interface	Yes	In Progress	No (Planned)
Simulation Type	Discrete Event	Discrete Event	Batch Monte-Carlo
Scenario Scale	Scalable	Single Base	Single Base to Theatre Level
Fidelity	Low-Med	Low	Med-High
Simulation Timeliness	Fast	Med	Slow
Real-Time Simulation View	✓	✓	
Applicable Missions	C-UAS, CMD	C-UAS	CMD, BMD
Base Laydown System		✓	
Defended Area Analysis		✓	✓
Physics-Based Behaviors		✓	✓
Blue C2 Modeling	✓		(In Progress)
Red C2 Modeling	✓	✓	
Terrain Specification	✓	✓	✓
Engagement Metrics Calculated (Out of Box)	✓	✓	✓
Surveillance Metrics Calculated (Out of Box)		✓	✓
Threat Tracking Metrics Calculated (Out of Box)			✓

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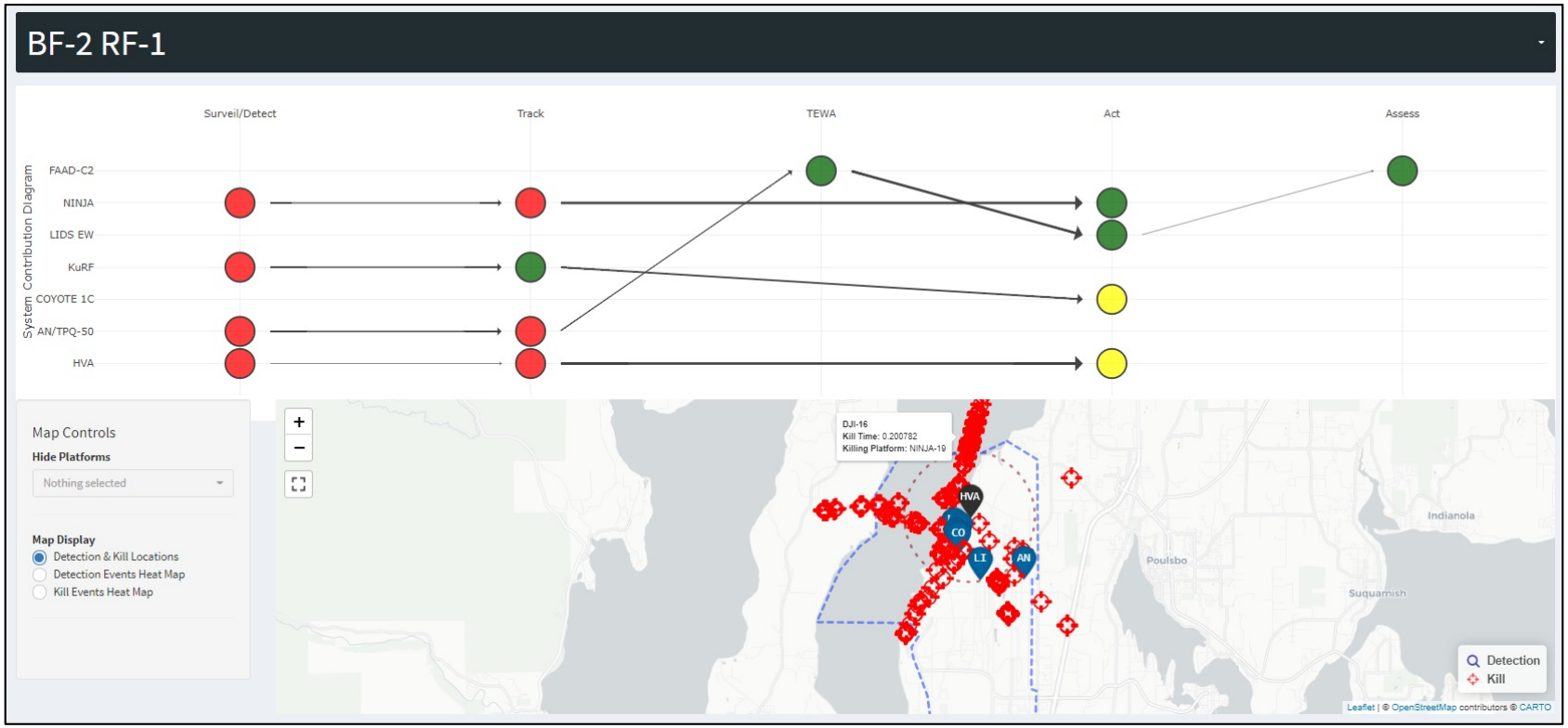
Visualization Dashboard: System Summary



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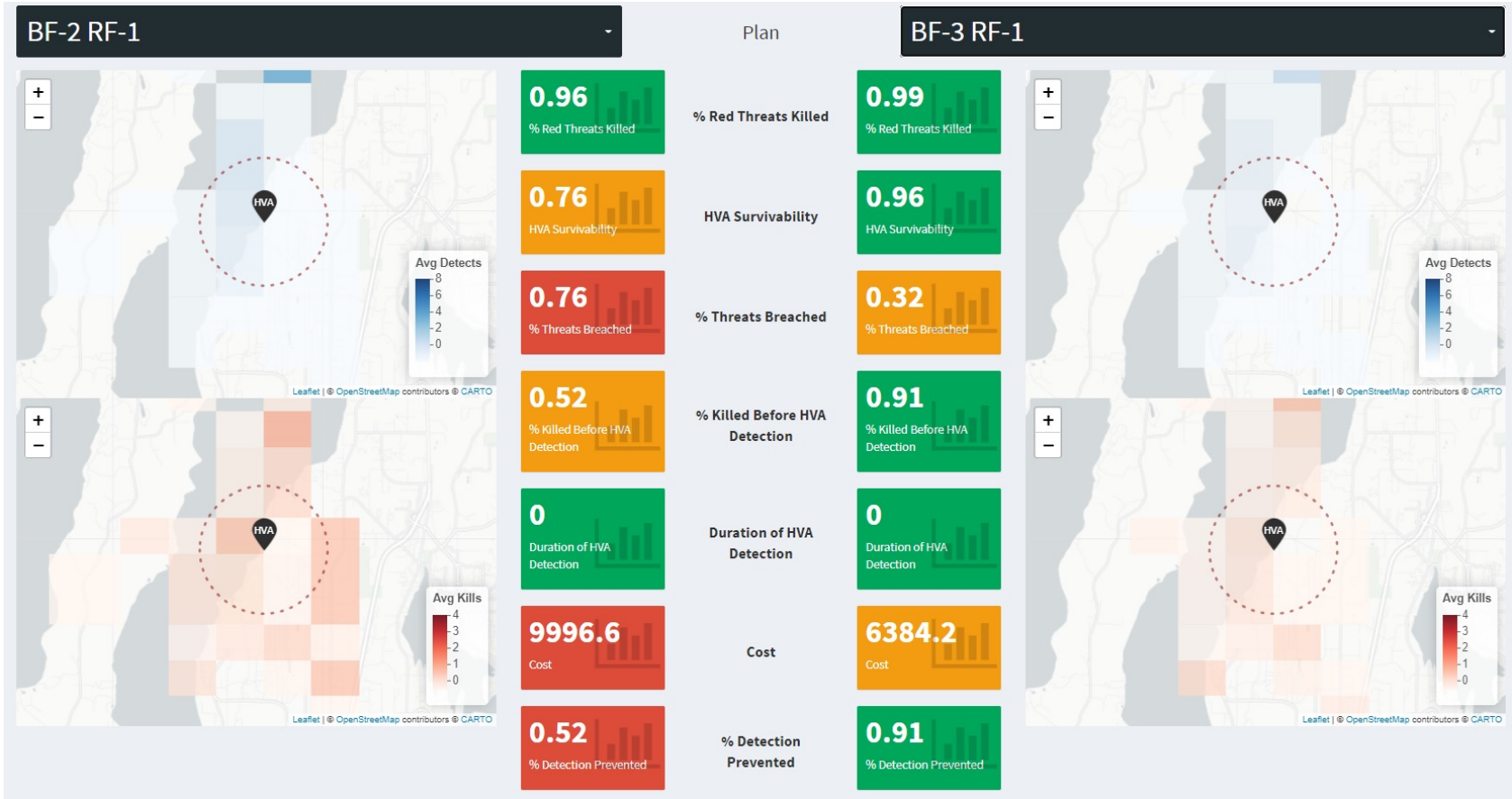
Visualization Dashboard: Laydown Comparison



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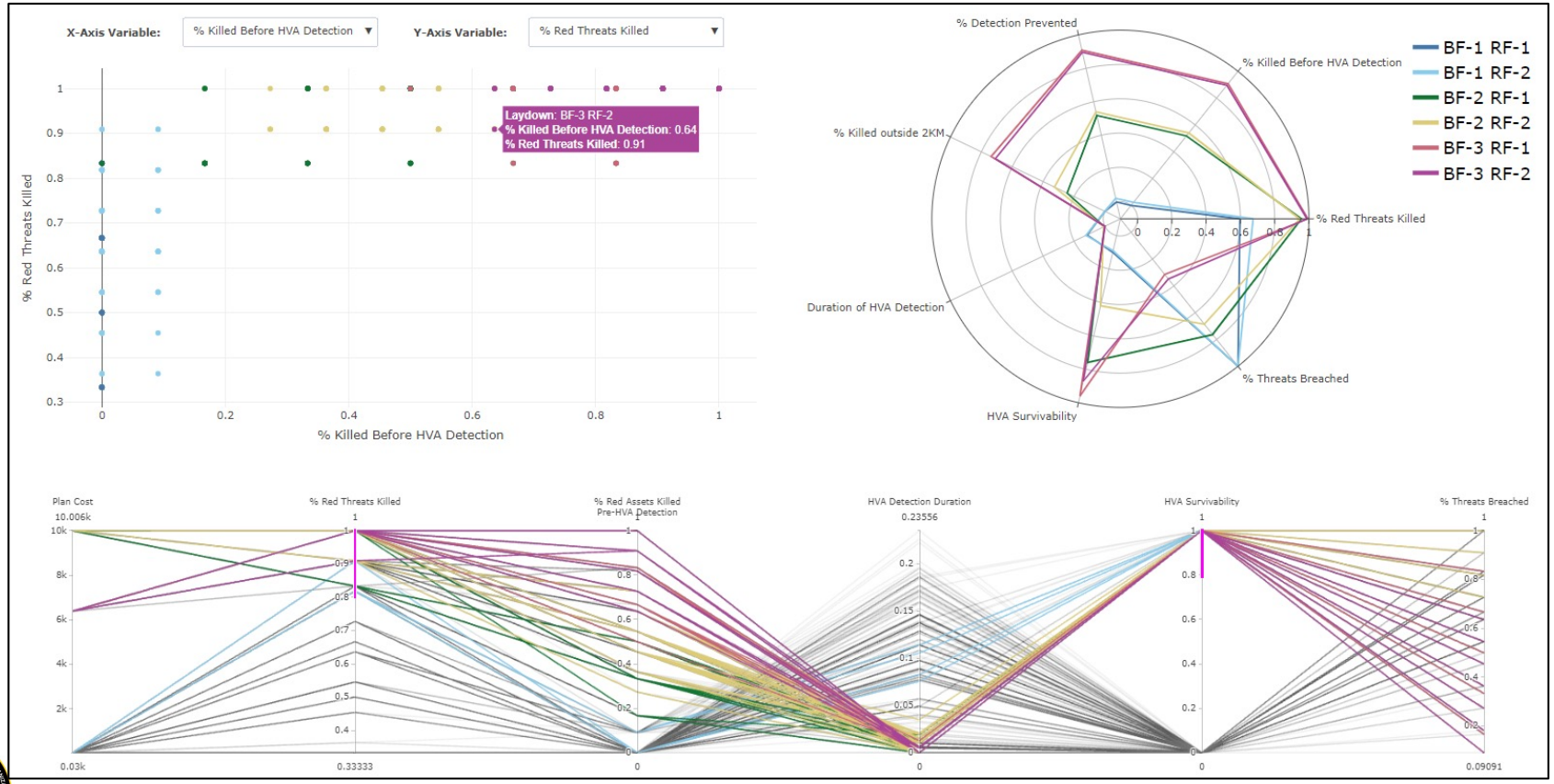
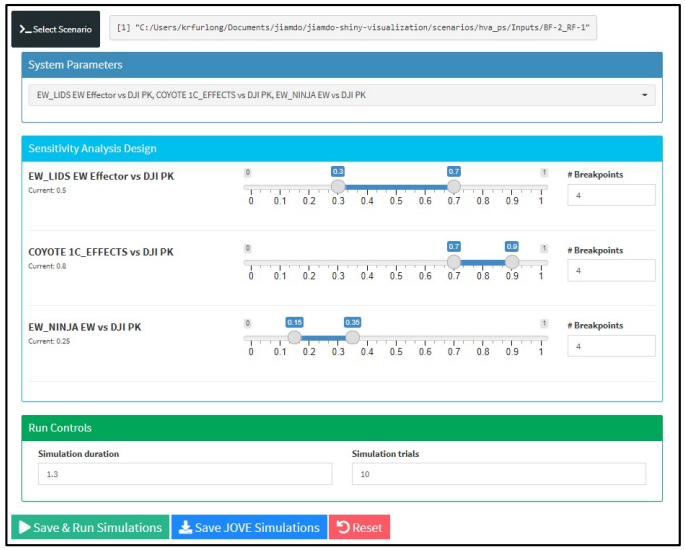
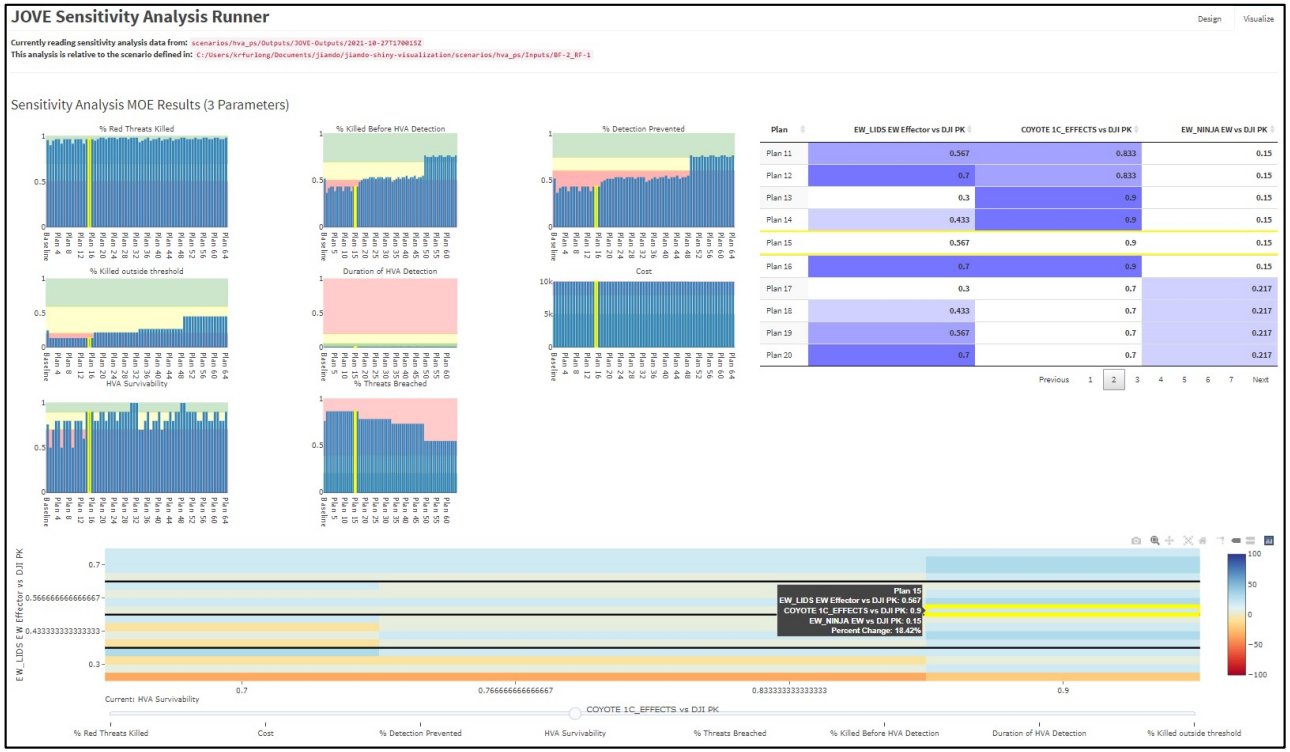
Visualization Dashboard: MOE Analysis



Visualization Dashboard: Sensitivity Analysis



Real-time experimentation and visualization of results



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Summary And Future Plans

- Digital Engineering Environment live and supporting C-UAS and CMD-H analytical exercises with multiple M&S tools available
  - Available at UNCLASS external to MITRE for JIAMDO
  - Available at SECRET internal to MITRE

- FY22 Next Steps
  - SIPR Deployment
  - AFSIM Integration
  - BMD Analysis Capability

Thank-You!

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