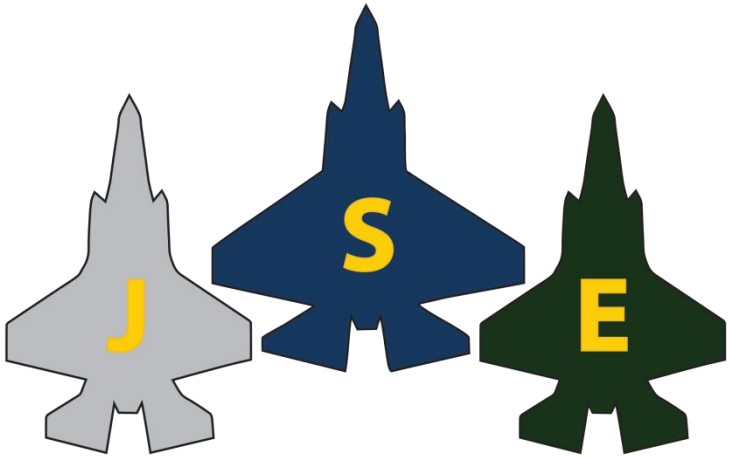

Joint Simulation Environment

2018

Presented by:
Jeremy S. Smith

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Path to the Joint Simulation Environment (JSE)

- **F-35 requires a high fidelity simulation for use during operational testing**
  - **A significant percentage of the operational test points are not executable on the open air ranges**
- **Using a simulation for scored operational testing drives JSE requirements**
  - **Unprecedented scale**
  - **Extreme number of entities**
  - **Major complexity**
  - **Unprecedented overall fidelity**
  - **Unprecedented levels of overall validation**
- **These conditions are not unique to the F-35 program**
  - **It is no longer possible to scale few vs few tests to assess what will happen in theater-wide conditions**
  - **The nature of modern system-of-systems capabilities makes testing prohibitively expensive**

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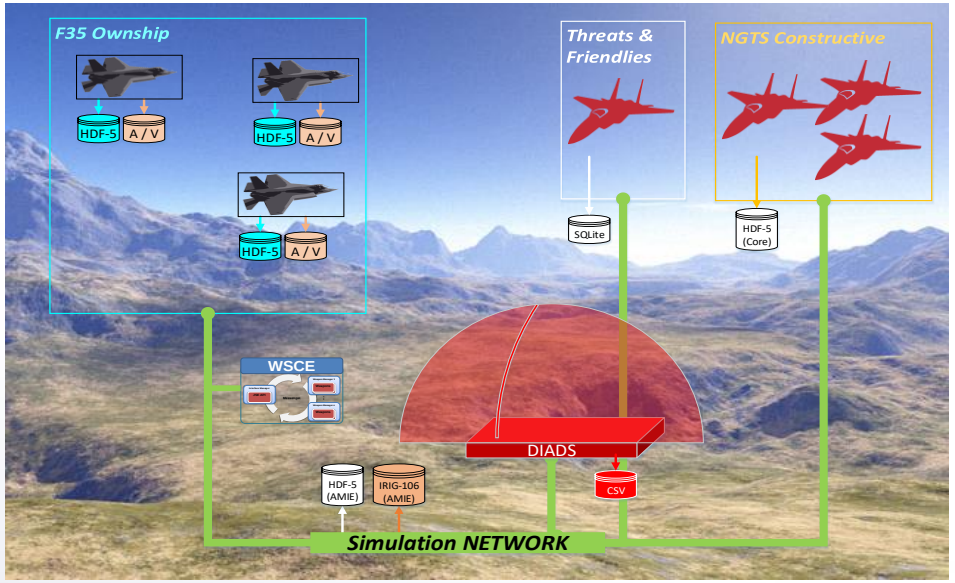
IOC System Capabilities

- **Theater-wide simulation**
- **Provide, thousands of an extremely wide range of red, blue, and white entities including:**
  - **Aircraft with associated weapons**
  - **Ships with associated weapons**
  - **Extensive Integrated Air Defense Systems**
  - **Surface to Air Missiles**
  - **Fixed and mobile ground targets**
  - **Dismounted soldiers**
  - ***Many entities include electronic attack and electronic protection properties***
- **Weather and smoke effects in visual and infrared**
- **Sun and moon diurnal effects**



JSE Initial Operational Capability (IOC) System Attributes

- **Scalable, expandable, compose-able, inclusive**
  - **Federated where it can be but tightly coupled where necessary**
- **Combines constructive, virtual, hardware-in-the-loop, and anechoic chamber hosted entities**
- **Secure environment**
- **Maximum reuse of government elements and facilities**
- **Government leadership (Navy, Air Force, Intelligence Community)**
  - **Government integrator**
  - **Core components largely designed and built by government**
  - **Government owned/managed interfaces and architectures**
  - **Inherently protects proprietary information**
  - **Open enough to accommodate many government and contractor systems and architectures**
- **But still can accommodate proprietary models**
  - **Through government controlled interfaces**
  - **And with enough understanding to accredit for intended use**

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JSE Initial Software Architecture

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*F-35 In A Box

OFP

Fusion

Aero

OTR Wpns

Comms

IFF

EW

DAS | EOTS | Radar | INS/GPS | CNI

AMIE

SAM ACQ Radars | C3 Hierarchy | IADS EW Radars

DIADS (Most Current Baseline)

Refined interface

17 High Fidelity SAMs

SAM XX FC TMAP | SAM XX Seeker TMAP | SAM XX Flyout TMAP

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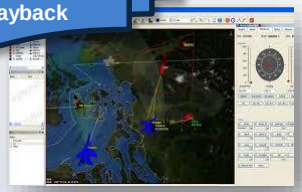
EAAGLES

NASIC FireControl | SIMAF Signature | SIMAF Weapons

SIMAF Threat Aircraft

Analysis and Reporting Toolset

- Shot Card
- Timeline GAANT
- Event Table
- Record / Playback



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Simulation Control Executive

Mission Visualization

- God's Eye View
- Cockpit Displays

Patuxent River JSE Location

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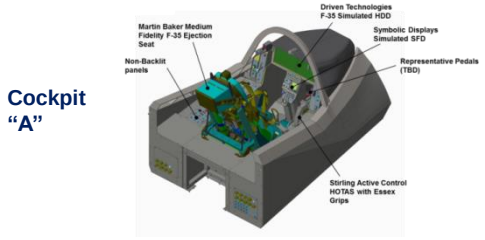
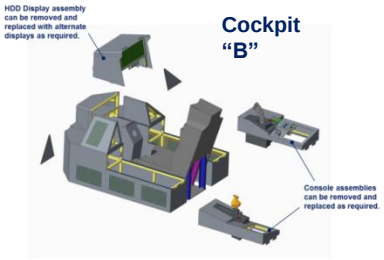
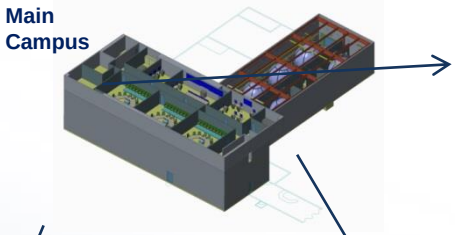
Hardware and Facilities

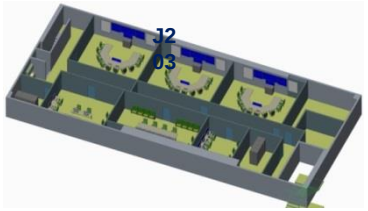
Integration, design, and, in some cases, manufacturing, performed by government team

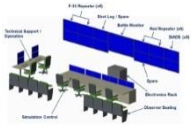
- State of the art visual systems (government architected and integrated)
  - Fourteen simulators with identical visuals
  - 300 X 135 degree
  - High resolution, 11 projectors
  - 5 meter domed format
- Cockpits (internally designed and manufactured)
  - 8 High Fidelity F-35 Simulators (Cockpit "A" Configuration)
  - 6 X F-35 High Fidelity & R/B Medium Fidelity Simulators (Cockpit "B" Configuration)
  - Can accommodate other existing cockpits from Manned Flight inventory
- **Government Laboratories (19,000 SQ FT)**
  - D101 (Eight simulators, racks, control stations, servers, infrastructure)
  - E103 (Six simulators, control stations)
  - J203 (Red/Blue brief/debrief, control stations, observer area)
  - Mass brief and debrief and event observation room
  - C104 (Infrastructure and security)
  - C103 (Development stations)
  - H206 (Complete low fidelity simulation)

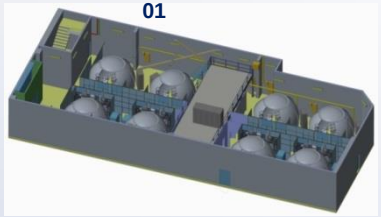




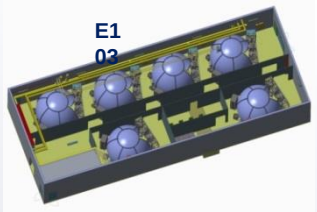








Cockpit "A"



Cockpit "B"

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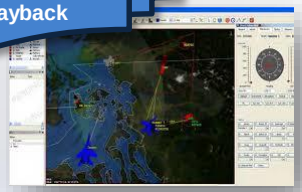

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Other MITL Blue Aircraft

Simulation Control Executive

Mission Visualization

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Next Generation Threat System (NGTS)

- NGTS is a synthetic environment generator that models threat and friendly aircraft, ground units, ships and submarines, associated weapons, sensors, and subsystems.
- Supports test and evaluation, training, and research and development
- Scalable, modern architecture
- User-defined behaviors
- Government-owned and developed
- JSE running latest NGTS version, 3.1

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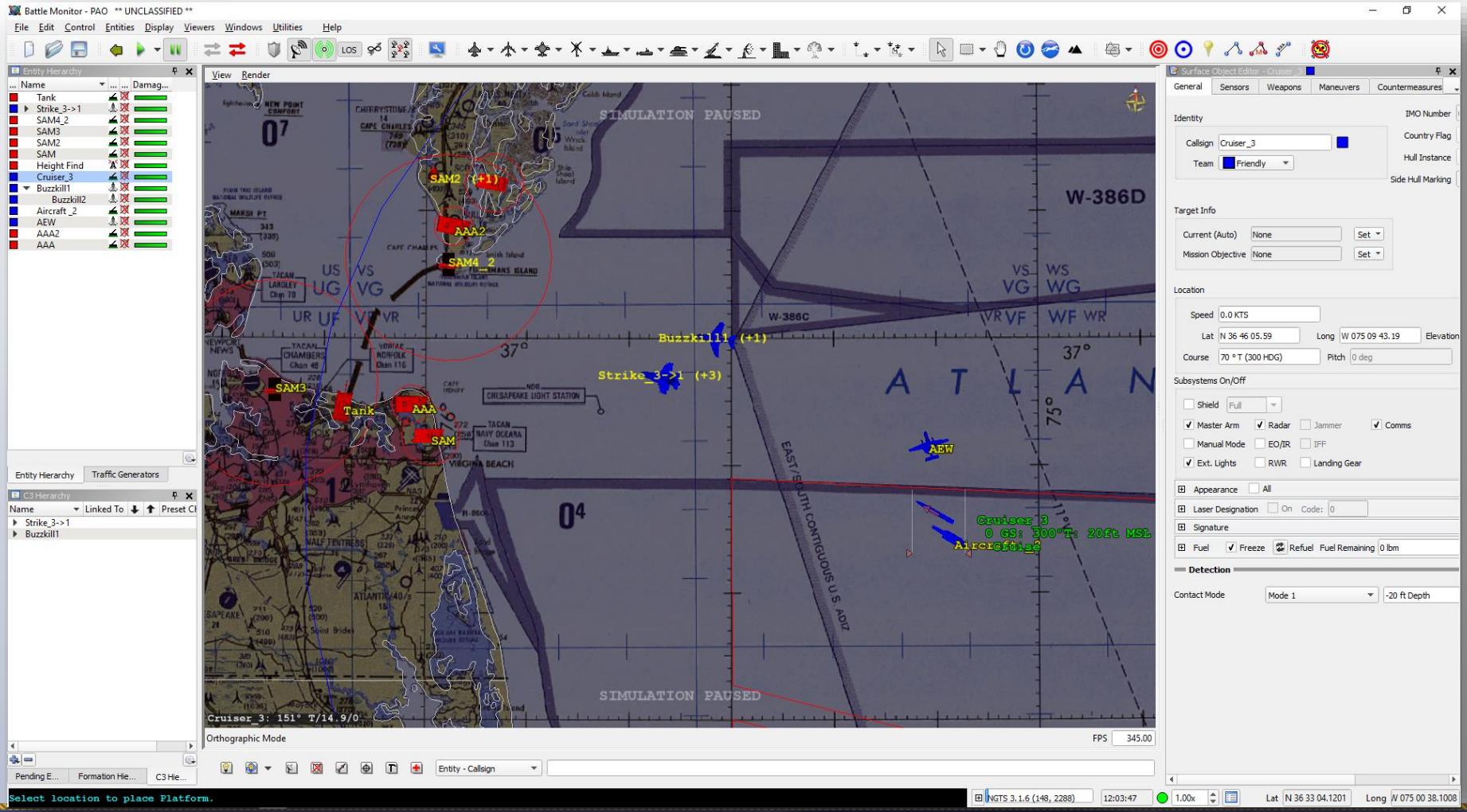
Next Generation Threat System (NGTS)

- Provides Constructive threat and friendly aircraft
  - Threat aircraft include NASIC TMAP Models
    - Radar
    - Weapons
    - Fire Control
    - IRST
    - Jammer (as applicable)
  - Partnership with NASIC to ensure proper model integration
- Provides SAM target engagement radar and missile flyouts
  - Uses MSIC TMAP models
  - Partnership with MSIC to ensure proper model integration
- Battle Monitor is primary simulation viewer for scenario planning and execution

Battle Monitor

- Battle Monitor provides a clear picture of the overall battlespace in a 2D/3D viewer
- Visualize flight paths, radar beams, weapons fires/detonations and entity states
- Display external data sent over DIS/HLA



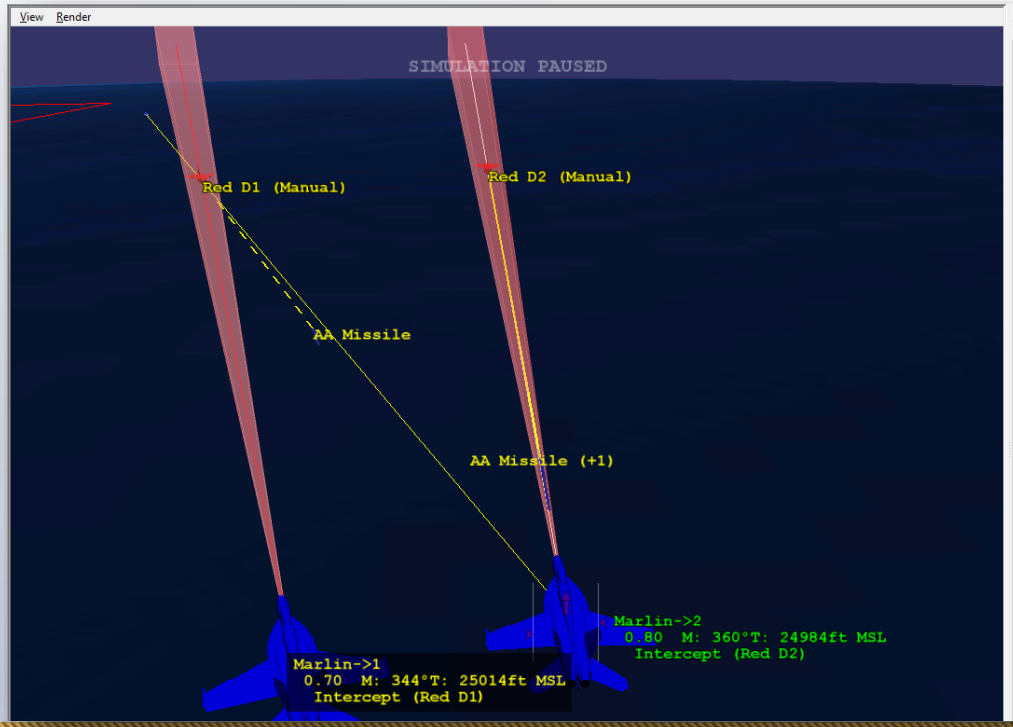
User Defined Behaviors

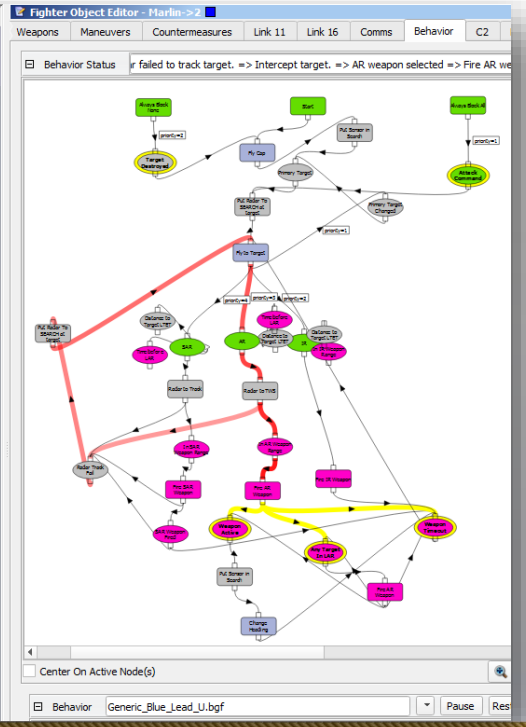
NGTS is delivered with default behaviors created for entities. The SME developed behaviors scale to allow automatic execution of today's and future adversary tactics.

The default behavior approach simplifies operator use and allows customers to modify an existing functional behavior if changes in tactics are desired.

Behaviors can be displayed in both a dynamic graph or textually on the Battle Monitor.

"If the user can think it, the user can make it…without code changes"





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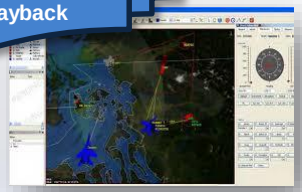

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Simulation Control Executive

Mission Visualization

- God's Eye View
- Cockpit Displays

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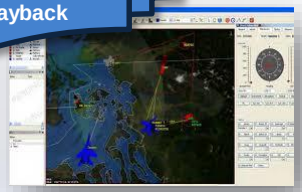

Simulation Control Executive

Mission Visualization
- God's Eye View
- Cockpit Displays

What is AMIE?

- Architecture Management Integration Environment (AMIE) is a cross-platform middleware that provides an interface abstraction, a collection of libraries, and a set of tools that help solve the reusability problem associated with the direct implementation of interface protocols.

- Simply put, AMIE lets you write an application once, and use it with many different protocols.

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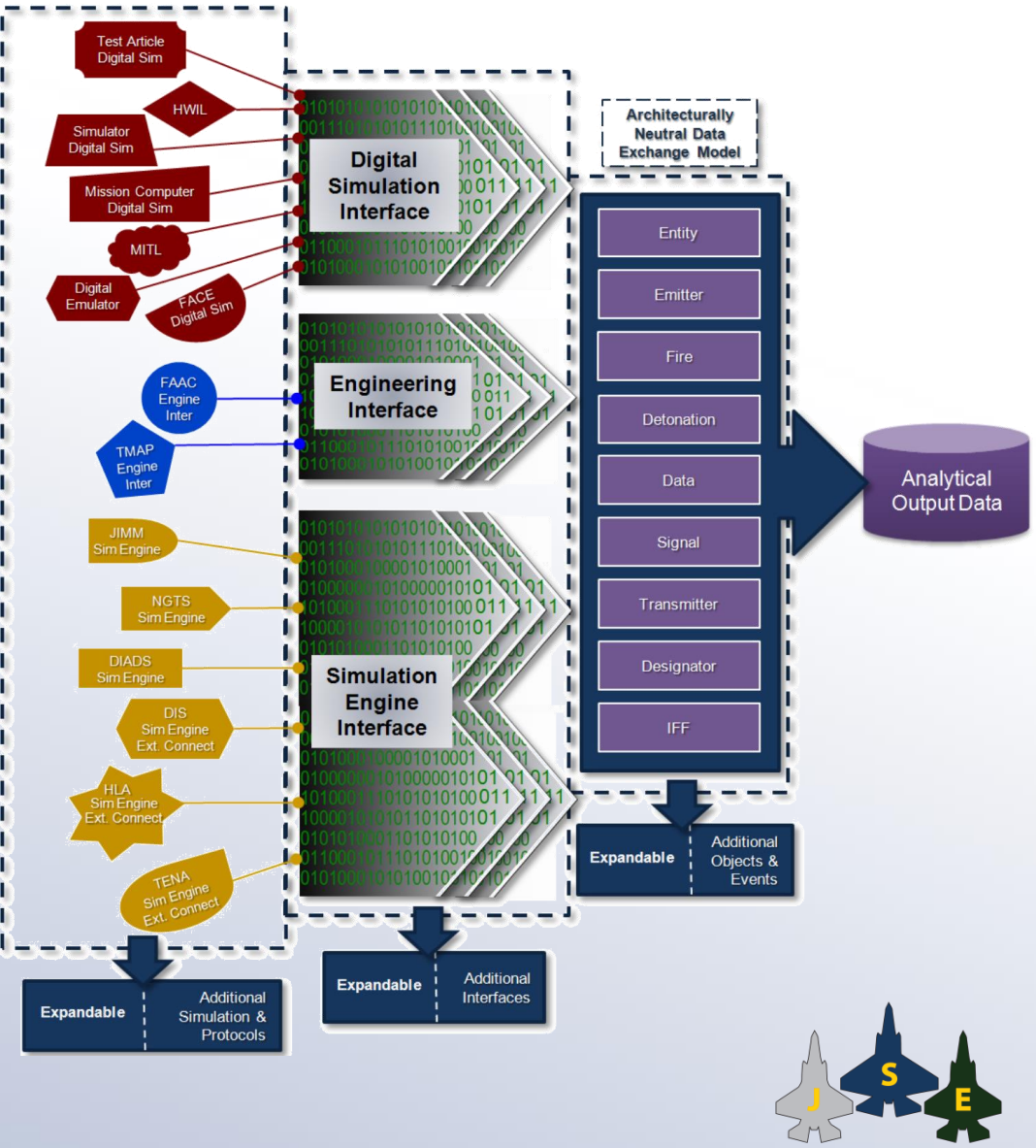
Architecture Management Integration Environment (AMIE)



- Government owned and supported
- Promotes re-use and efficiencies across the acquisition lifecycle.
- Non-proprietary open architecture
- Reusable plugins exist for :
  - DIS
  - HLA NASMP
  - TENA
  - JIMM
  - JREAP
- Comprehensive set of support tools and libraries exist for supporting integration.
- Runs on both Windows and Linux platforms

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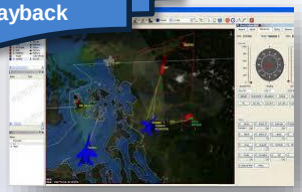

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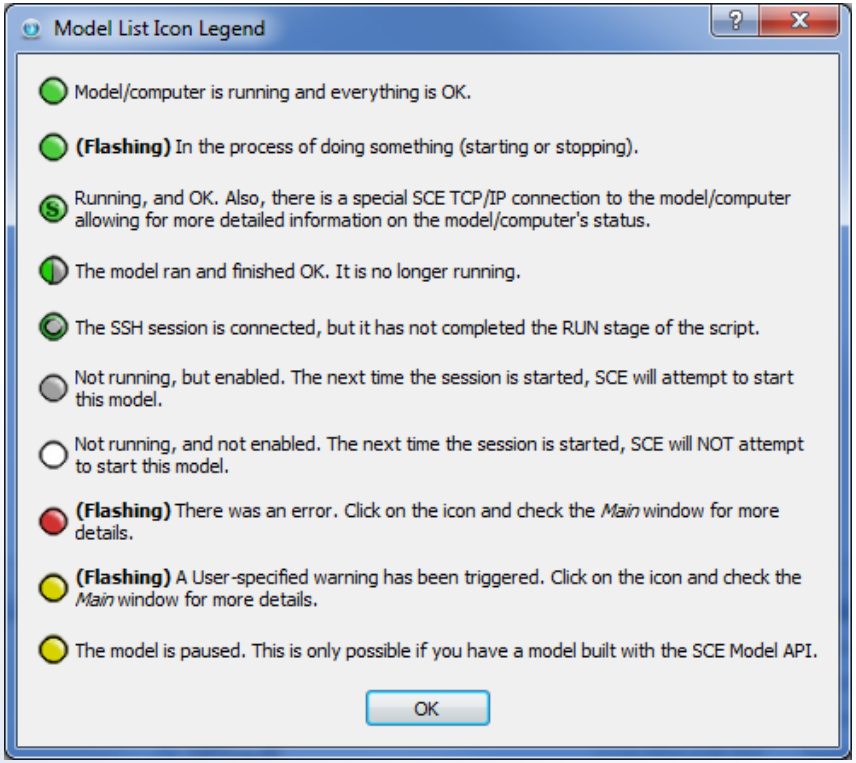
Simulation Control Executive

Mission Visualization

- God's Eye View
- Cockpit Displays

SCE (Simulation Control Executive)

- SuperFly GUI used to launch facility-wide SCE Session
  - Cockpit IO, Airframes, Projectors, NGTS Core simulations, Engineering Operator Stations (EOS), control rooms
- For each dome there are two SCE Sessions
  - Airframe
  - Cockpit IO, Dome infrastructure
- Overall health and status is reported to a facility-wide session



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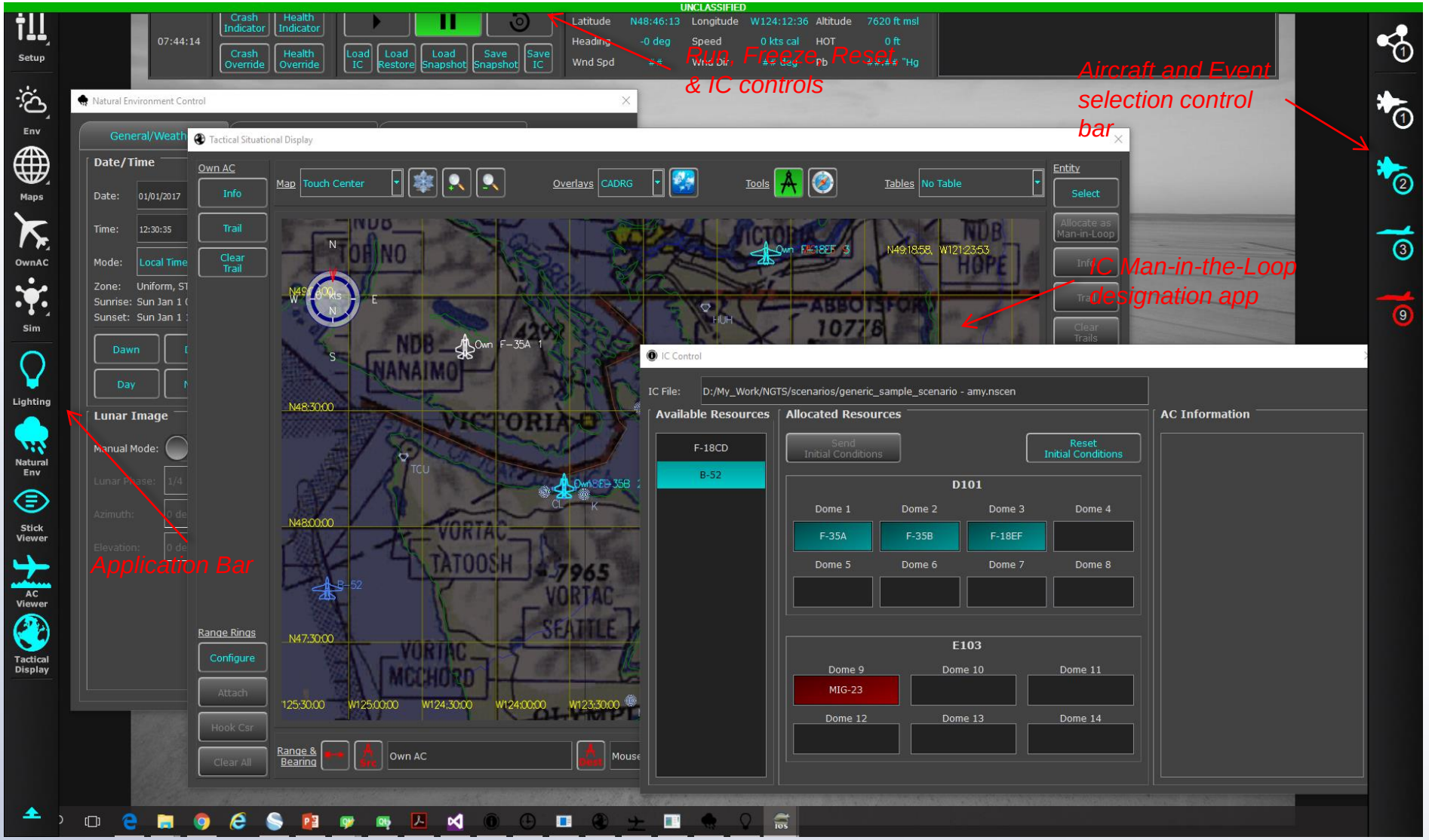
Engineering Operator Station Desktop



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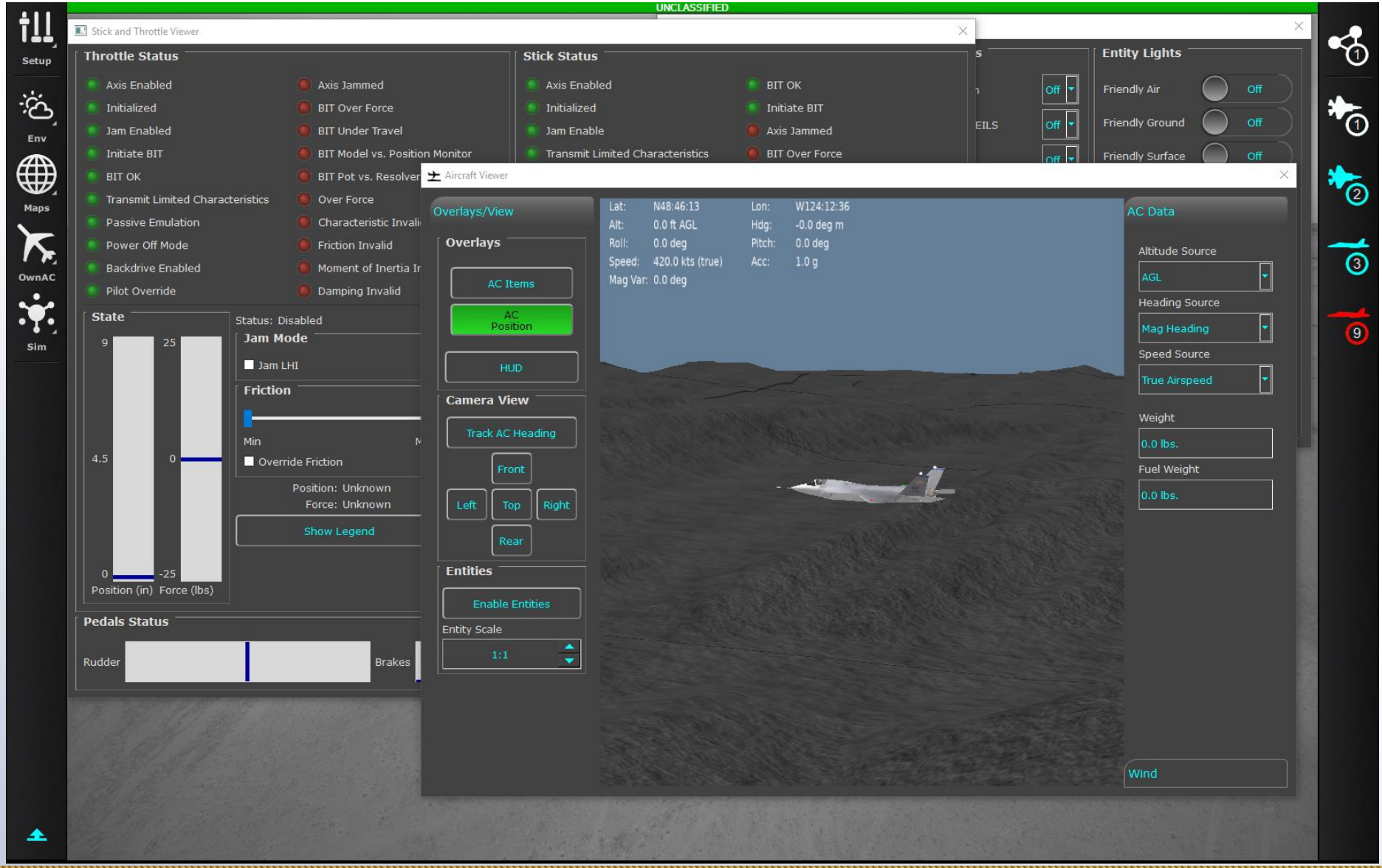

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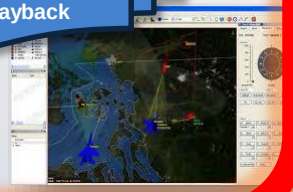
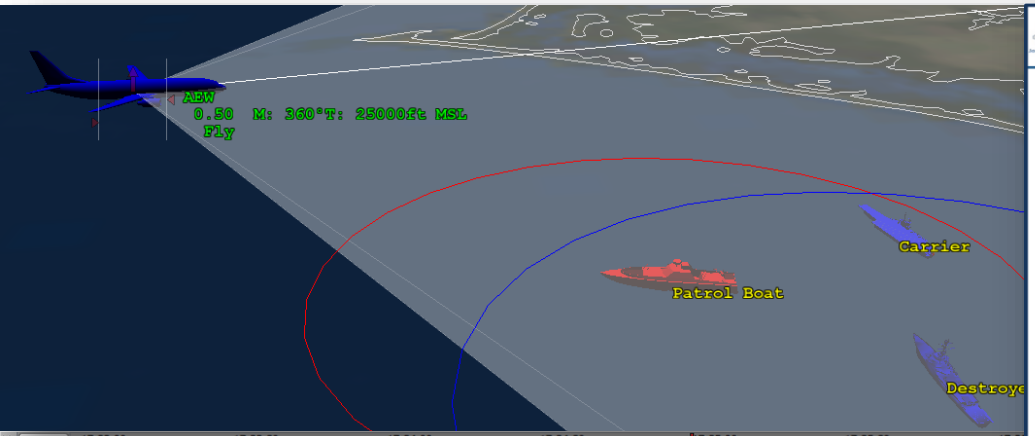
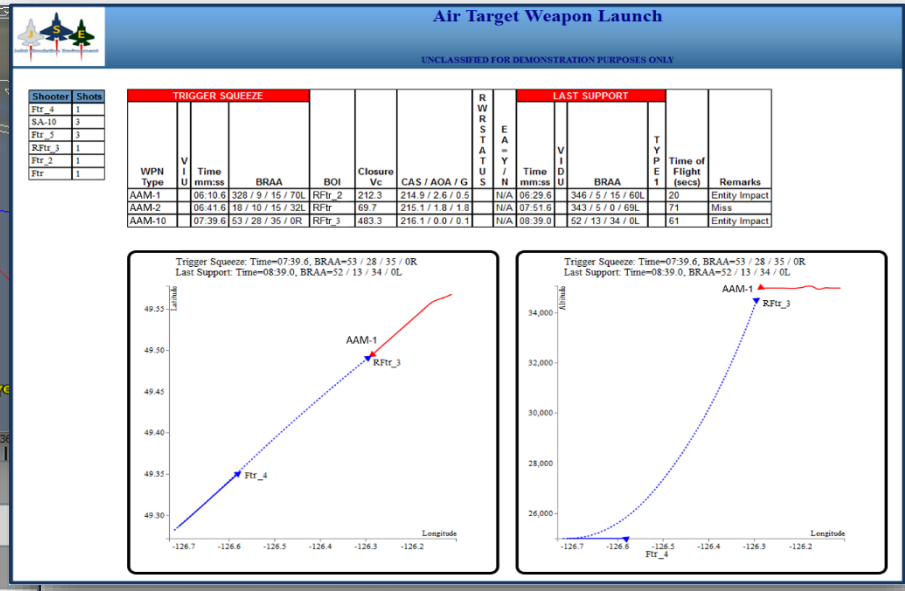
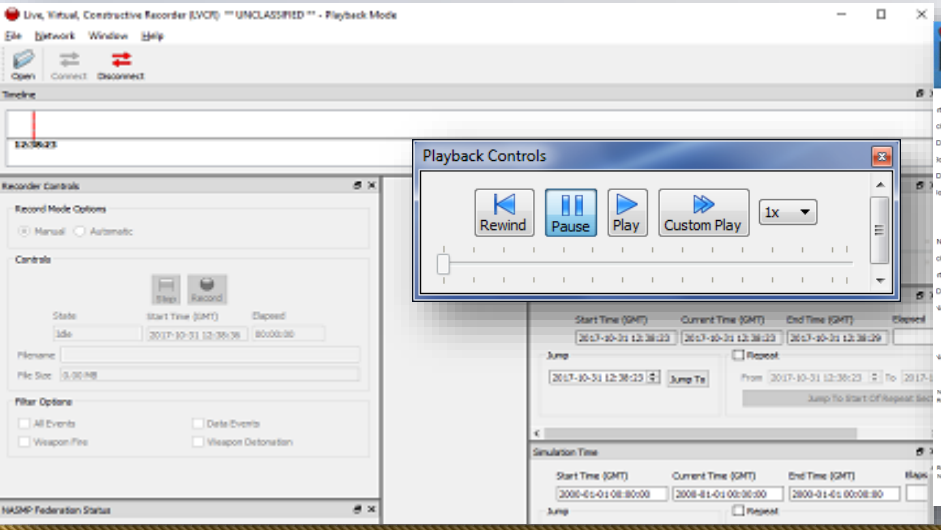
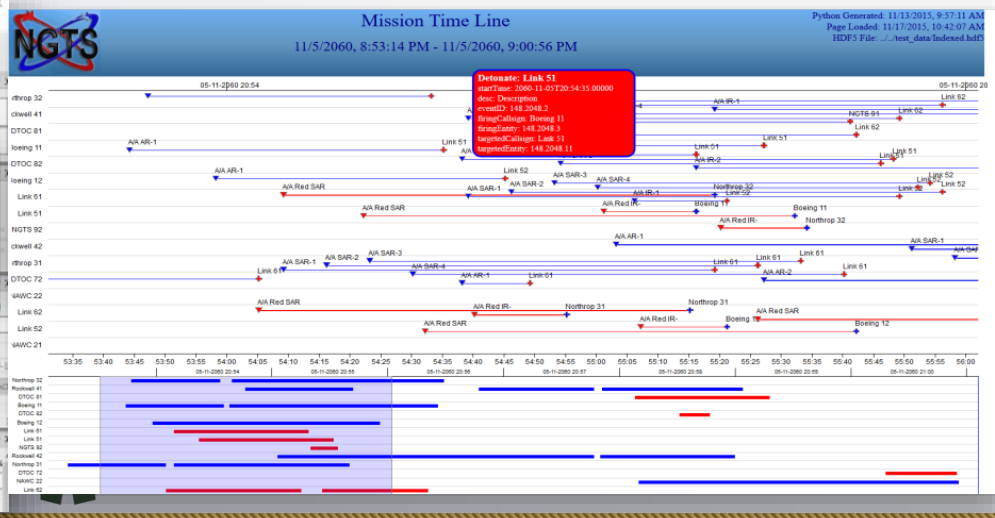


Record, Debrief, Analyze and Report









JSE Data CONOPS

- Run a mission
- Record/View data using Debrief Recording/Playback Tool
- Debrief with Battle Monitor for playback
- Ingest Log files
  - AMIE Net & Video (CH 10)
  - NGTS Core Logger (HDF5)
  - Ownship (HDF5)
  - DIADS (CSV)
  - Threat Air (SqlLite)
- Generate reports or query/analyze data
- Store data with metadata for Smart mining

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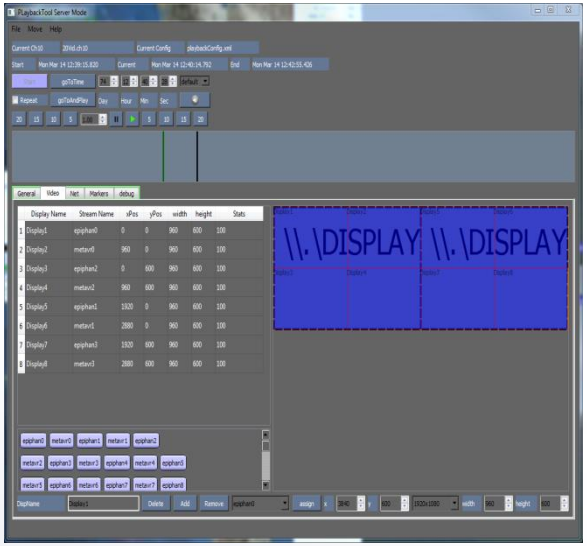
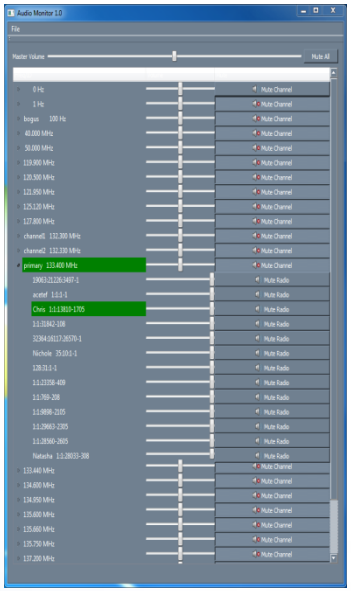
Brief/Debrief Capability

- Record cockpit video from all 14 cockpits (two heads down and HMD)
- Record Audio from ASTI
- Record simulation data (DIS)
- Display Live or recorded video
- Listen to any ASTI Channel live or recorded
- Battle Monitor as situational display live or recorded
- Playback of video, audio and simulation data synchronized
- Playback and rewind at up to 20x speed
- Jump to any time in playback
- All data is stored in chapter10 format
- All software is Government owned or open source





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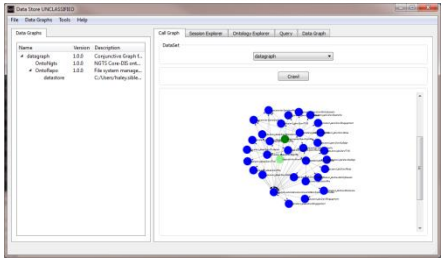
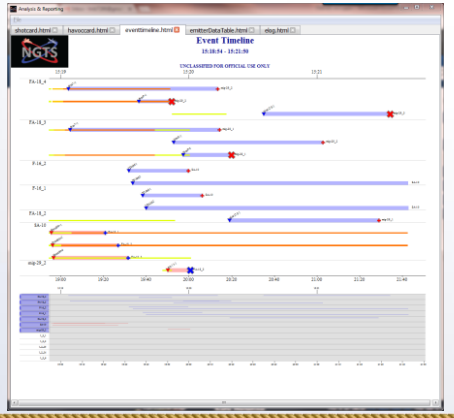
Recording & Analysis



What *can* you do with that data?

- System Performance Assessment
  - Verification: Compare system data to expected results
  - Validation: Provide information so knowledgeable experts can make decisions
  - Data Mining: Look across many flights or sim runs, identify patterns
- Human Performance Assessment (Enhanced Debrief)
  - Instructor-developed performance measures
  - Analyze data, produce dimensions relevant to the audience
  - Answer questions with graphical interface
  - Display data in helpful ways
    - Shot Cards, Weapon Event Timeline w/subsystems, EW effectiveness, Harm Shots, 2C Reports, Training Rules and more
  - Multi-ship environment + Single-ship actions -> kill chain (winning or losing)
- Incorporate into debrief - associate individual performance with a pattern



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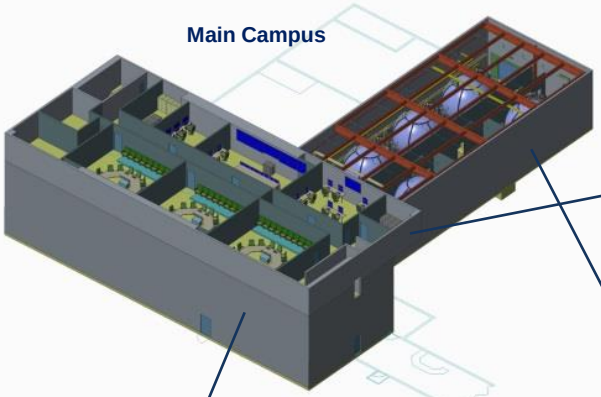
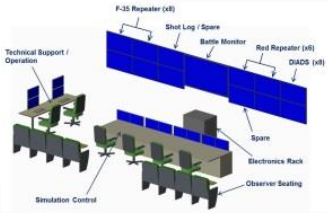
Hardware and Facilities

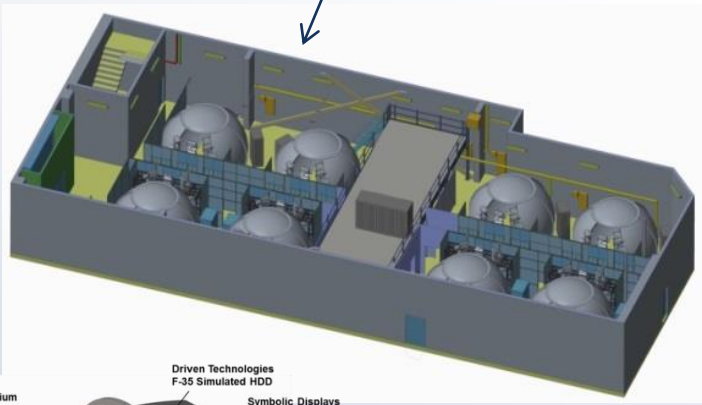
Main Campus



J203

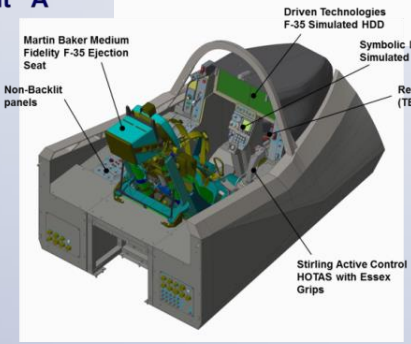


D101

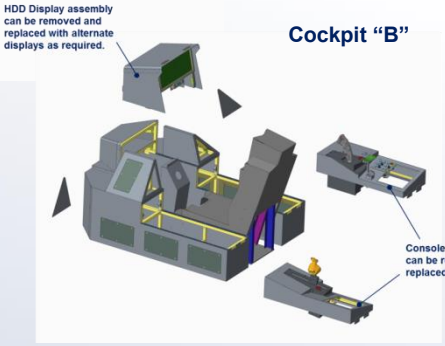


E103

Cockpit "A"



Cockpit "B"



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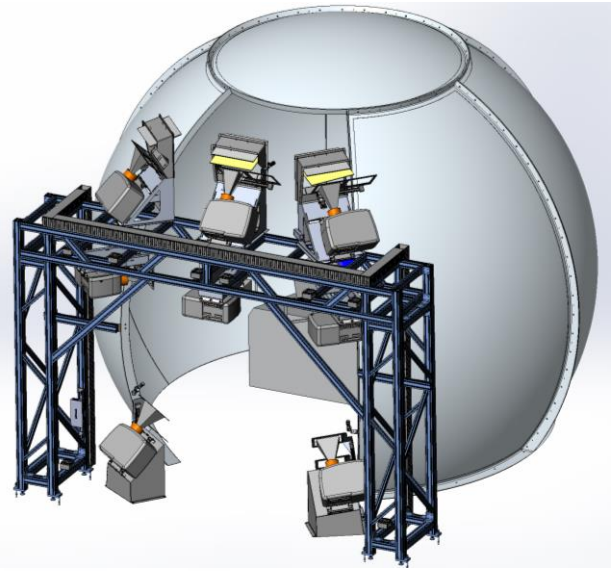
Visual Systems

State of the art visuals with edge blending

- 14 Rockwell Collins 300°x160° visual display domes with auto-alignment
- 14 Aechelon Out the Window (OTW)/Sensor Video Image Generators (IG)
  - Commercial-off-the-Shelf (COTS) product widely used
- Common visual databases and models
  - Government Owned
- Rockwell Collins SimEye SX50T II Helmet Mounted Displays (HMD)
- Heads-Up Display (HUD) projected on Front Display



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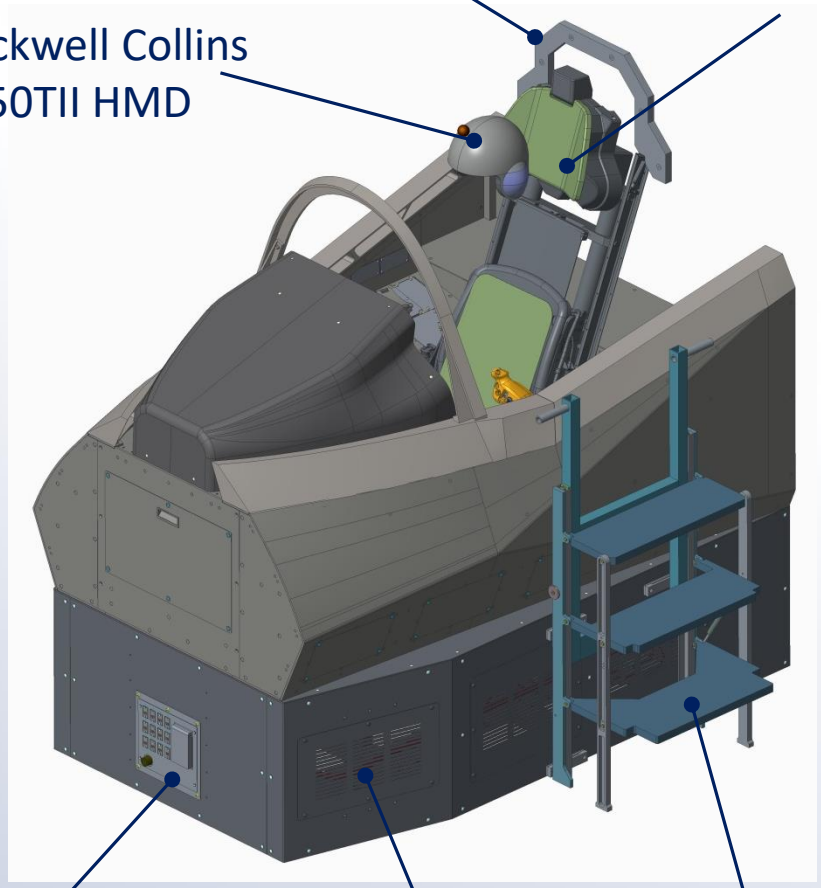
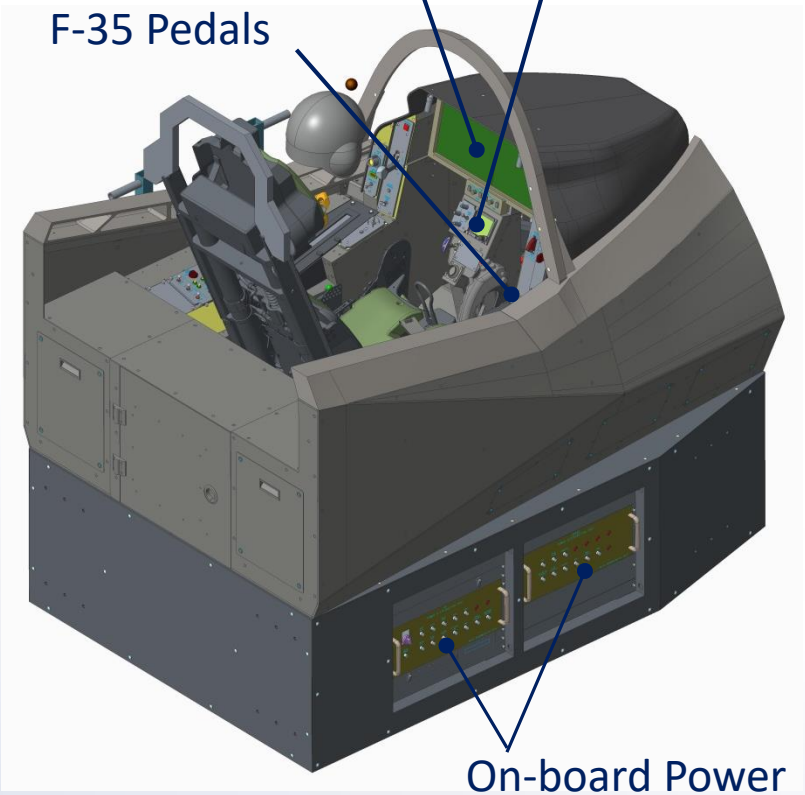
Eight F-35 Crewstations

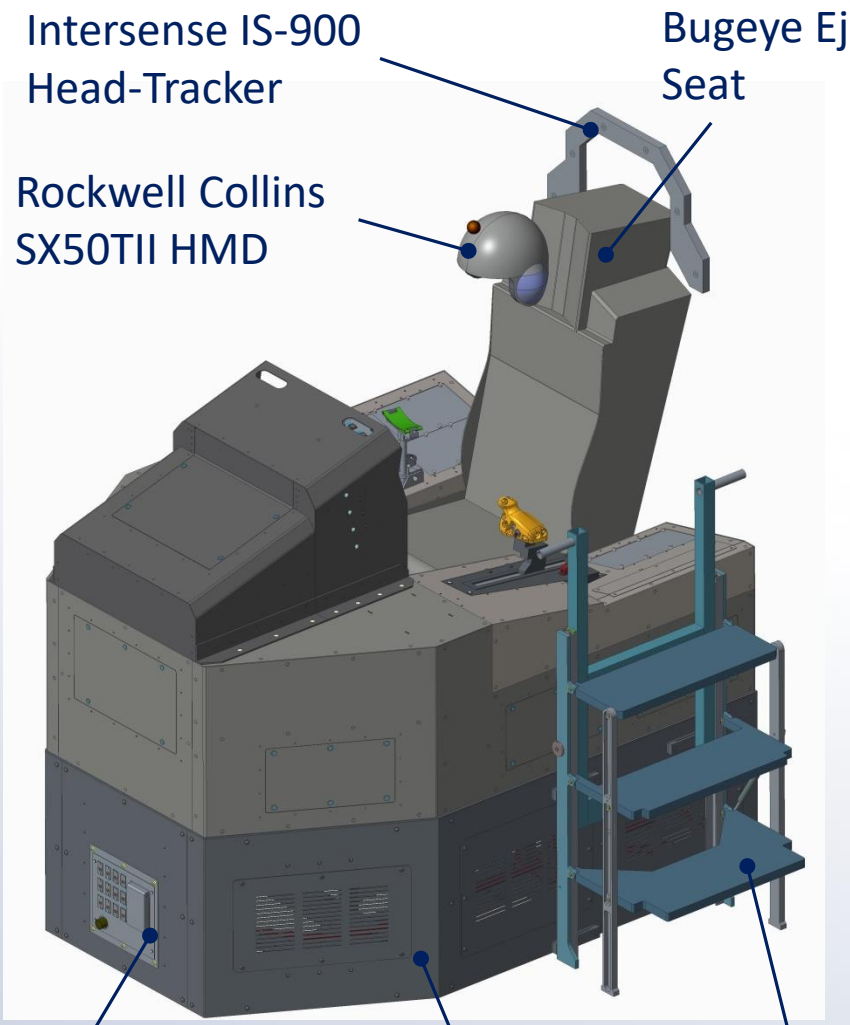


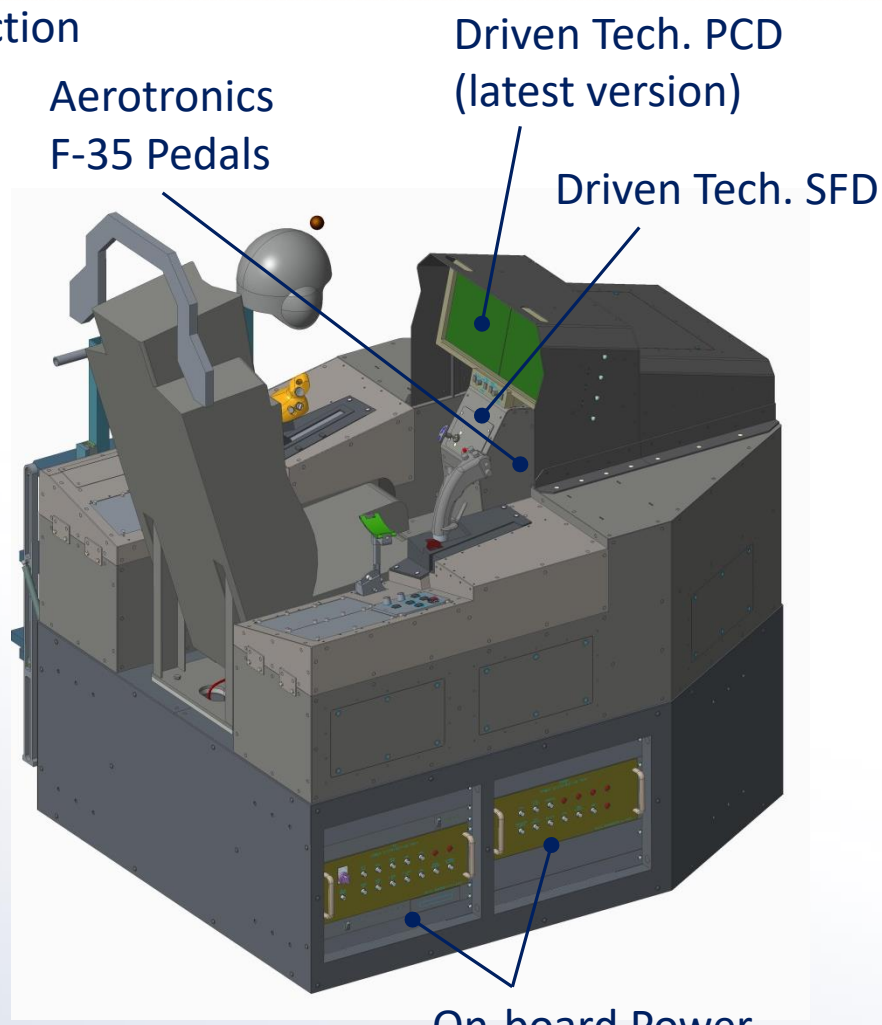


Designed and manufactured in government facility

F-35 Crewstations

Six Red & Blue Crewstations





Designed and manufactured in government facility

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Red & Blue Crewstation

JSE After IOC

- Networked across Joint facilities
- Linked to airborne aircraft
- Air Force Vision
  - Form kernel of Air Force Live, Virtual, Constructive architecture
  - Included in current Air Force budget
- Naval Opportunities
  - Additional US Navy and Marine Corps virtual aircraft and weapons
  - More virtual and constructive ships, submarines and weapon systems
  - Virtual and constructive amphibious and ashore weapon systems
  - Expansion to include additional mission areas such as NIFC-CA, ASuW, ASW, Maneuver Warfare, Cyber, Space etc.
  - Use in current and emerging System of Systems development and testing

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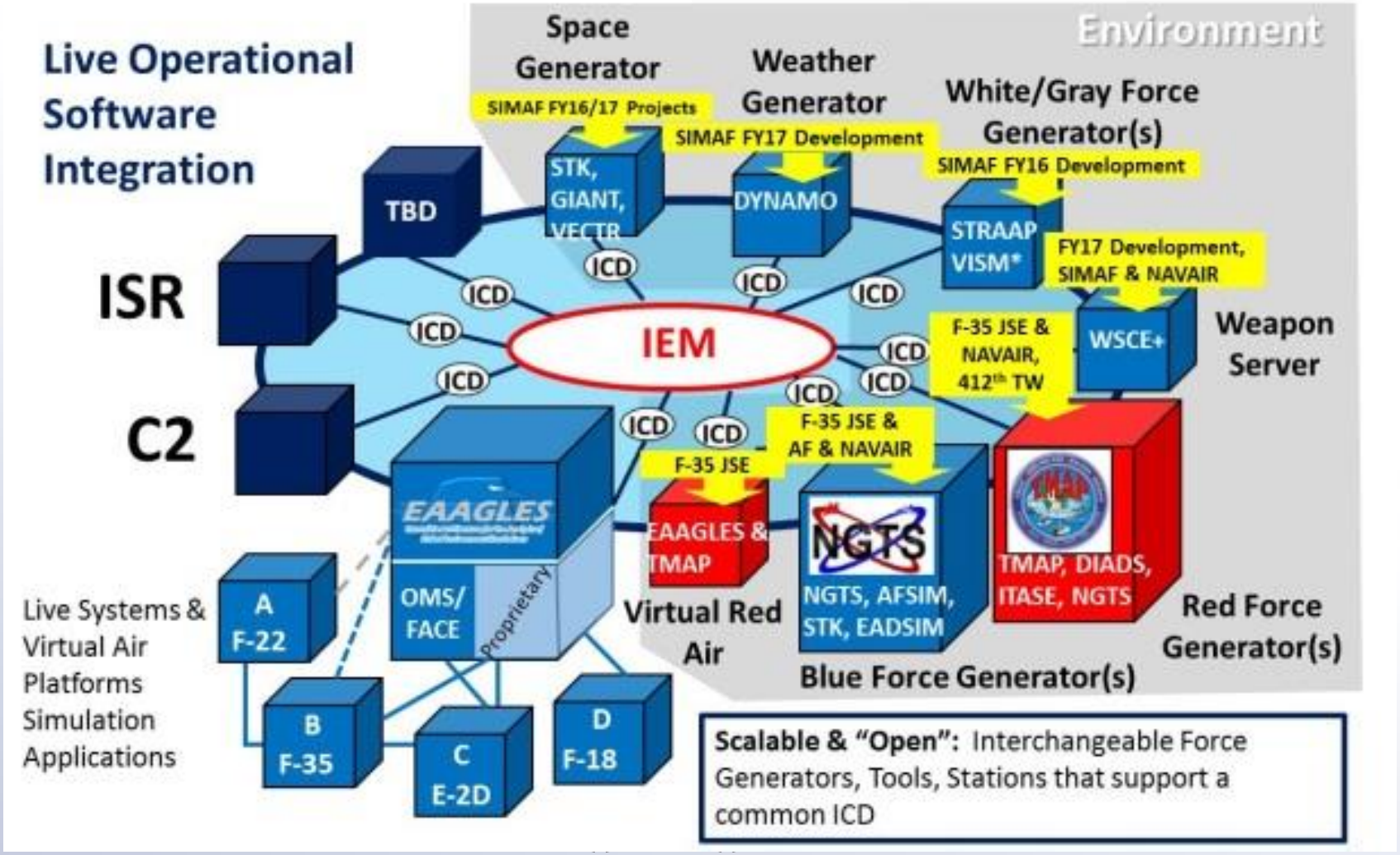
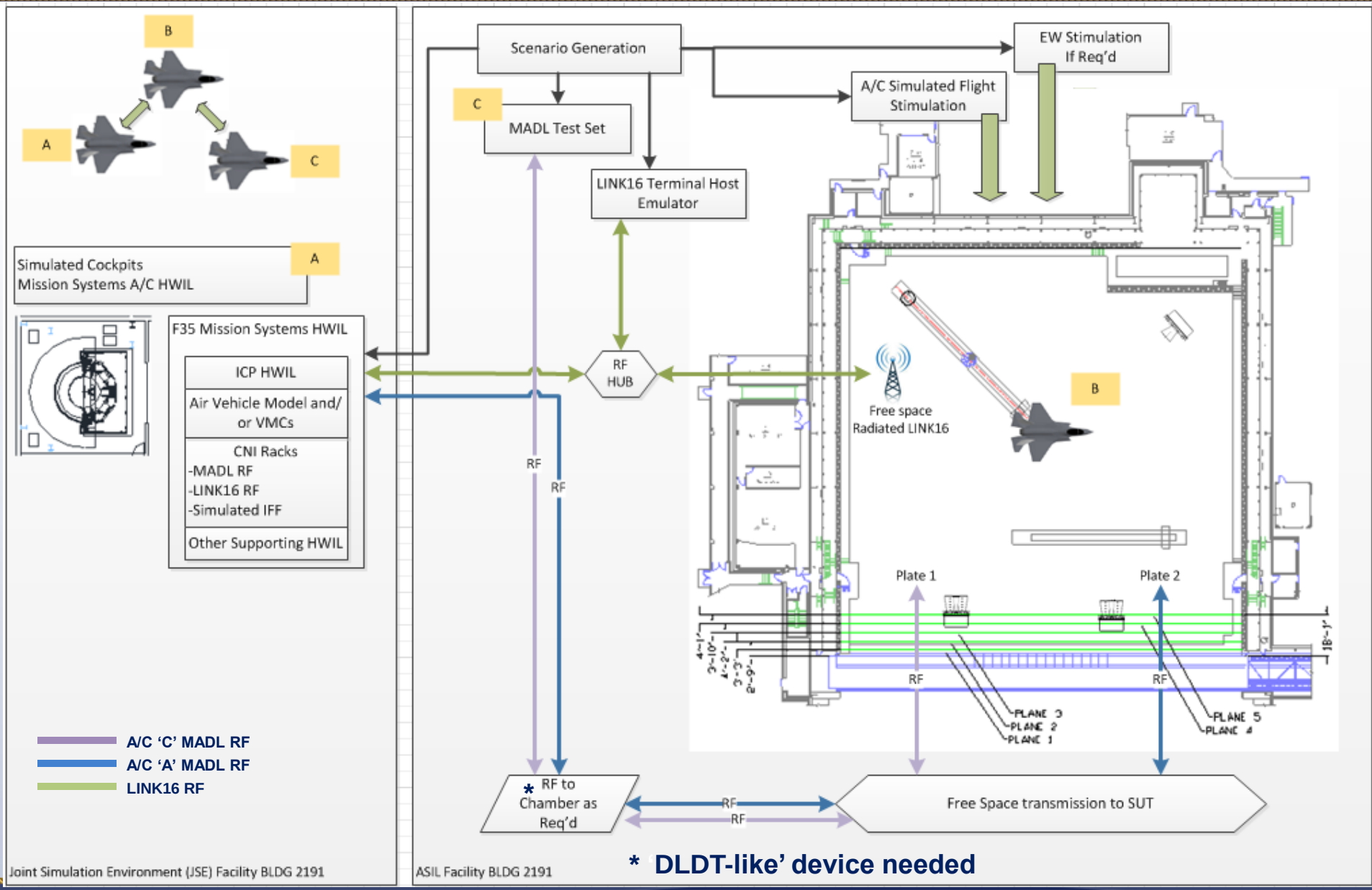
Follow On Software Architecture



Example of JSE LVC Testing Setup



*** DLDT-like' device needed**

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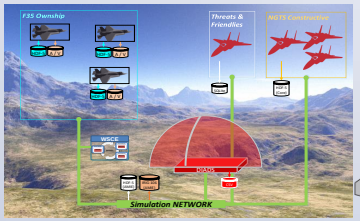
Joint Simulation Environment (JSE)

- Government designed and built immersive virtual simulation supporting 5th generation mission systems Research Development Test & Evaluation (RDT&E).
- Supporting F-35 Operational Testing and 4th – 5th gen integration testing as well as future testing needs of the F-35 and other platforms.
- Flexible, reusable, tailorable, and cost effective solution for developmental, operational and interoperability testing.
- Includes multiple Department of Defense Enterprise Standards, including Next Generation Threat Simulation (NGTS), Architecture Management Integration Environment (AMIE), Digital Integrated Air Defense System (DIADS), Threat Modeling Analysis Program (TMAP), Weapon Server Common Environment (WSCE), and Extensible Architecture for the Analysis and Generation of Linked Simulations (EAAGLES) as common interfaces.
- Integration with Air Combat Environment Test & Evaluation Facility (ACETEF) Large Anechoic Chamber



Features:

- Integrated use of Navy and AF facilities, models, methods, & tools
- Man In The Loop (MITL)
- Hardware In The Loop (HITL)
- Ability to Link geographically distributed MITL/HITL Assets
- Leverage of Intelligence Community models
- Architectures to support the expansion of the JSE over time
- Architectures to support the extension of the JSE for other Service uses

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Backup

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Acronyms

- AMIE=Architecture Management Integration Environment
- JSE=Joint Simulation Environment
- DIADS=Digital Integrated Air Defense System
- TMAP=Threat Modeling Analysis Program
- EAAGLES=Extensible Architecture for the Analysis and Generation of Linked Simulations
- EOS=Engineering Operator Station
- IOC=Initial Operational Capability
- ITASE=Integrated Threat Analysis Simulation Environment
- MITL=Man In The Loop
- NASIC=National Air and Space Intelligence Center
- SIMAF=Simulation and Analysis Facility
- WSCE=Weapon Server Common Environment

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