Shifting Further Left!
An Approach to Virtually Testing Interoperability and Cybersecurity during Developmental Planning

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Objective

Create a vision for the integration of open, modular architectures, avionics test beds, flight simulators, ISR analyses, and physics-based modeling to evaluate the performance, interoperability, and cyber security of a concept system in a proper mission context much earlier in the life cycle.

The confluence of advances in the associated capabilities enable assessment of interoperability and potential cyber attack surfaces prior to Milestone A which should lead to a more robust TEMP and better planning for cyber testing.
Shift Left!

Introduced by Dr. Steve Hutchison through the realization that information assurance, interoperability, and cyber security were not being addressed until Milestone C.
Key Elements of Shift Left!

- Earlier testing for interoperability
- Earlier testing of cybersecurity
- Conducting DT&E in a mission context

To adequately evaluate and expose potential failure modes in the four critical development areas:

- Performance
- Reliability
- Interoperability
- Cybersecurity
Cybersecurity T&E Process Mapped to the Acquisition Lifecycle

Need for Shifting Even Further Left!

Need to be tightly integrated and mutually supportive

Program Protection Plan (PPP)
- At MS A should, at a minimum include an initial criticality analysis, candidate Critical Program Information, potential countermeasures, and Information Assurance Strategy.
- At Milestone B, PPP should be a comprehensive document.

Test & Evaluation Master Plan (TEMP)
- Initial TEMP required at Milestone A
- Opportunity to set stage for integrated DT&E and OT&E

Maximum Impact Will Occur if Integrated Early Enough to Include Well Defined Requirements in the Pre-MS B RFP!!
Getting it Right Earlier Can Bend the Cost Curve

DEFINITION OF COST
INSANITY! Riding a new technology wave by attempting to develop new technologies, S/W, and proprietary avionics architectures within the Program development cycle!

"Get it all and get it now!" The most expensive way to acquire capability!

"Get what is affordable now but design for affordable expansion!"

Let commercial industry drive the technology development wave. AF capitalizes on mature, proven, and open commercial investments with mature, open, and proven avionics maturity!

More Desirable Acquisition Cost Curve

Tailored Avionics Technologies

Improved Cost Paradigm

What’s it take to “Change The Curve”? 

Program Cost

Software Lines of Code (SLOC) as a indicator of Aircraft/Avionics Complexity

1. Proven Open H/W & S/W Avionics Backplane
2. Open System H/W & S/W development & Implementation Standards
3. Test Bed to mitigate Risk and Mature Implementation concepts
4. Modeling & Simulation Environment to assess the value of Mission Based S/W applications to integrated System Capabilities (SOS)

Existing Fighter Acquisition Cost Curve

Paradigm of Unaffordability

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"Get what is affordable now but design for affordable expansion!"

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Attributes of the Architecture

1. Architecture Design must isolate the Flight Control System from the Mission Avionics
   - Critical to both software agility and tailorability
   - Critical to affordability (minimize regression testing with the ability to accept mission risk (vice flight safety risk)

2. Architecture must be OPEN
   - Hardware (backplane)
   - Software (Mission software, network enabled applications)
Different Domains Require Different Design, Integration and Testing Approaches

Complicated
• Design, test to requirements
• Well defined boundaries
• Physics-based modeling
• Probability based design
• Precision measurements
• Statistically defensible testing
• Regression testing

Complex
• Manage outcomes vs delivering requirements
• Ill defined boundaries
• Soft, stochastic modeling
• Dynamic environment
• Experiential learning
• Requires holistic, collaborative approach
• Future built on scenarios not predictions

Flight Simulator
The Natural Interface and Integrator – Also an Opportunity for Integrated DT/OT
**SIMAF Vision**

**Human Interface**
- Cockpit
- EPIC

**Specifications**
- FACE
- OPEN Systems

**Info Architectures**
- A2AD
- ISR MRA
- TMA's

**H/W & S/W Avionics TB**
- Open H/W
- Open S/W
- S/W Emulators
- Network Enabled Apps

**Environment**
- A2AD & ISR MRA
- Threat/Blue
- Sensors/Targets

**Implementation of Technical Standards in a Test Bed configuration**

**Implementation of CONOPS/TTPS via Cockpit interfaces linked to the open avionics architecture, Mission systems software and network enabled applications**

**Information Transport across the network to and through the open avionics architecture and to/from the network enabled applications**

**Avionics/Sensor linkage, simulation, & stimulation to the A2AD and other environments and Blue, Threat, IADS**
Creating a “Modeling Commons” for Capability Planning & Analysis – 1st Step to the Digital Thread

Disparate skills, models, and communities

ISR MRA
- ISR modeling
- System of Systems
- DOT_PLF
- Networks
- Cyber interface

Physics Modeling
- Discretized Physics
- > Real Time
- Phenomena Visualization

“Modeling Commons”
Cross-domain model of a physically feasible, affordable, interoperable, and interdependent materiel solution

CREATE-AV Critical to Building Modeling Commons

Operational Modeling
- Discrete Event Simulation, Agent Based Modeling
- < Real Time
- Scenario Visualization
- Event Engineering Models
- Table Look Ups

LVC Simulator
- Discrete Event Simulation
- Real Time
- High Resolution Time–Space Visualization
- Event Engineering Models
- Table Look Ups
Importance of CREATE-AV in the Digital Thread Approach

- Multi-discipline, multi-physics, multi-fidelity capability
- Ability to rapidly and efficiently generate reduced order models for surrogate representations
- Ability to address system integration issues during detailed design (fluid/structures, airframe/propulsion, airframe/weapons)
- Scalable to take advantage of high performance computing assets
- Configuration management and Quality Control critical to confidence in applications across multiple regimes.
ERS one of top seven technologies signed out by SECDEF Gates
ERS funded demo project through CREATE-AV; DaVinci Team executing
Project successfully demonstrated advantages of CREATE-AV tools in support of early Analysis of Alternatives (AoA)

- HPC enabled application of DaVinci provides efficient, rapid, comprehensive evaluation of a resilient design space
- Surrogate design response surface enables interface with operational models to assess mission utility against costs and risks
- Probability-based analysis provides quantified assessment of feasibility, mission utility, and affordability displayed in useful format for decision makers

Concepts … ... to Decisions
Perform a very high-fidelity, multi-disciplined simulation of the air vehicle combined with system identification techniques to directly and efficiently produce a light weight algebraic description of the vehicle aerodynamics for insertion into SIMAF/EAAGLES.

Going from early vehicle concept studies to dynamic distributed mission simulations at earliest analysis phases possible.

Doable in days, not weeks or months!
Assessing Interoperability and Systems of Systems

ISR MRA

ANII
Analysis of Netted Information & Integration

 Architectural Options

Σ Systems

L-V-C

SIMAF

PCA
Physics Based Capability & Architecting Analysis

System Trades

Digital Thread Modeling Commons

High-Fidelity Performance

Design Trades

Operational Engagement

MUA
Mission Utility Analysis

Costs, Risks Tradespace

Network Costs & Risks

Operational Costs & Risks

Platform Costs & Risks
Assessment of Architectures and Cyber Attack Surfaces

National Cyber Range

JMETC

• Backplane architecture enables experimentation
• Upgradeable through digital apps
• Can be supported over the life cycle by an avionics Digital Twin, i.e., by component, by tail number
An innovative approach to integrating recent advances in emulation of modular open avionics architectures, simulation of the ISR environment, and physics-based modeling is presented.

Enables ability for testing performance, interoperability, and cyber security of new concept system in a relevant operational context early in the pre-MS-A development planning phase.

Shifting DT&E left of MS-A will enable:
- More robust inputs into the MS-A and subsequent TEMPS/PPP
- Better understanding of requirements testability for inclusion in the System Engineering Master Plan
- Earlier interfacing with the National Cyber Range
- Enhance language in the pre-MS-B RFP.
- Development of an IT&E approach

The same innovative integrated environment will also enable rapid assessments of dynamic changes in mission scenarios, configuration changes in software and hardware, and incremental development activities that deliver new features.