Competition is Back
Framing the Challenge
Sea Lanes Remain the Lifeblood of Our Economy

90% of global trade by **volume** / 70% of global trade by **value**
98% of telecoms traffic
Changing Environment

Sources: Jane's / RAND / US-China Commission

Advanced Fighter/Strike Aircraft (3rd/4th Generation)

Advanced Attack Submarines

Advanced ASCM Capable Surface Combatants (DD/FF)

Short Range Ballistic Missiles

1999
Changing Environment

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PRC Military Spending (Official Figures)

Spending in Billions (US)

1999 2001 2003 2005 2007 2009 2011 2013

*2014 Budget Increased 12.2%

Sources: Janes / RAND / US-China Commission

1999 2015

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USN and PLA(N) Capability Fielding Trends

DF-21D Anti-Ship Ballistic Missile

Anti-Satellite Capability

Hypersonics

Cooperative Engagement Capability

J-15 Carrier Based Strike Fighter

LUYANG III

Type 055 Cruiser

Fielding

Initial Estimate

Observed/Expected

We’re Slower!

SLOW TRAFFIC AHEAD

Initial Operational Capability

POM-08

FY-17

Standard Missile - 6

Naval Integrated Fire Control - Counter Air

Joint Strike Fighter (F-35)

High Altitude Anti-Submarine Warfare Weapon

Next Generation Jammer

Air and Missile Defense Radar

CG(X)

Maritime Strike Tomahawk

USN Warfighting Advantage has Steadily Eroded
NAVAIR Response

Commander’s Intent – *Remains Unchanged*

- Increase Speed of New Capabilities to Fleet
- Increase Readiness

Strategic Initiatives – *Focus on Speed*

- Capabilities Based Acquisition – *Rapid delivery of integrated capabilities*
- Sustainment Vision 2020 – *Predictive, integrated sustainment operations*
- Digital Business Operations – *Integrated business systems “apps” at the desktop*

Accelerating delivery of fully integrated capabilities which are designed, developed, and sustained in a **Model Based Digital Environment**
Why Are We Here Today?

• **REALLY** want / need your input
• NAVAIR cannot successfully do this without all of you(+)
• Success will drive / require a different relationship between gov’t and industry
  – Business “arrangements” will change . . . will require true partnerships . . .

Our biggest challenges will not be technology and tools, they will be cultural and business related
SE Transformation - “Shaping our Future...”
Integrated Warfare Analysis establishes CONEMPS and Effects-Chains.

**SYSTEM MODEL**

System models form “Constructive” basis for LVC M&S environment.

**SoS MODEL**

CONEMPS and Effects Chains are modeled at the System of Systems (SoS) level.

**Enabling Capabilities-Based T&E**

- **Constructive**
- **Virtual**
- **Live**

**Digital Linkage**

Systems are developed in a Model-Based environment (SE Transformation).

LVC-based training maximizes Fleet proficiency.

Digital Thread enables rapid delivery of Integrated Capabilities.

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Industry-Government Partnership

• SET applies to Government and Industry
  – Commercial cycle time is a function of development and production activities
  – DoD cycle times add the activities associated with Government oversight responsibilities
  – Both must be addressed to achieve the necessary reduction

• **Government** must reassess its role in the acquisition process and the methods for executing that role
  1. Criteria for gov’t involvement/oversight (not every decision)
  2. If involved, must be on developer’s timeline
  3. Must bring value to the decision – not just positional authority

• **Industry** must fully leverage advances in HPC-enabled models and participate in establishing a collaborative, integrated digital environment which enables continuous interaction
The Elements of SE Transformation
A system model is an interconnected set of model elements that represent key system aspects including structure, behavior, requirements, and parametrics.

In SET, the System Spec (Performance Spec) would be instantiated in a model (using SysML). It will be developed in a collaborative workspace by a cross-functional team. The model will then be placed on the development contract vice a paper spec.
The system model is linked “upstream” to mission effectiveness models and CONEMPS, and “downstream” to decomposed and allocated sub-system requirements and associated designs. It is also linked to verification tools (FEM, CFD) which validate it’s fidelity and utility for intended purpose.

The system model flows down, and is interconnected with the subsystem requirements and emerging designs. These design are instantiated in different models based on their governing physics (stress/strain, fluids, electro-magnetic, etc.)
The entire set of models and tools is held in a single repository and becomes the Single-Source-of-Truth for the duration of system development.

- Ability to *interrogate the design information* and extract data into the format necessary for the given task
  - Leverages formalism
  - Transformation rules are *reusable*
  - Provides *machine and human readable formats*
- Leverage the model by reviewing *the model itself*
- Stakeholders *focus on the views of the system model* that address their concerns
Putting It Together in a New Framework
SET Framework
4 Elements

- Elimination of paper CDRL artifacts and large-scale design reviews
- Continuous insight/oversight via digital collaborative environment and interaction with the Single Source of Truth

**Element 1**
- Mission Effectiveness optimization
- Re-balance as required
- Right-size CDD – very few KPPs, all tied to mission effectiveness

**Element 2**
- Instantiate System Spec in a model

**Element 3**
- Mechanical Design Models
- Electrical Design Models
- Software Design Models
- Testing Methods & Models

**Element 4**
- Instantiate and validate design in models
- Design & Manufacture Release
- Integrated Test Vehicle #1
- Move rapidly to mfg. Substantiation and insight via modeling environment

**Single Source of Truth**

**Analysis Tools**
- MDAO*/SET-BASED DESIGN

* Multi-Disciplinary Analysis & Optimization

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1. **Right-size CDD**  
   - Narrow top of the requirements pyramid  
   - Off-load requirements to other elements of SoS and via TTPs (CONOPS)  
   - KPPs must be tied to mission effectiveness, Ao or Cost

2. **Eliminate or reduce SETR events**

3. **Eliminate/reduce CDRLs**

4. **MDAO enabled by HPC and multi-physics computational tools allows rapid optimization and design trades**

5. **Quality improvement at all levels – reduced rework due to requirements and design defects**

6. **Continual use of mission effectiveness modeling in design trade – reduce technical churn going after 100% compliance when 80% will satisfy mission**

7. **Allow asynchronous design and manufacture release decisions – Gov’t involved real-time via IDE in production release decisions**

8. **Early T&E focused on model validation – allow models to do heavy lifting**
How NAVAIR is Executing SET
SET Framework
5 Functional Areas

KEY AREAS OF RESEARCH:
- Model Integration
- Model Integrity
- Ontology
- MDAO
- Multi-Physics Modeling
- Model Visualization
- Roadmap & Implementation

Email: SE_Transformation@navy.mil
NAVAIR MBSE Community of Practice:
Each Element requires work in the 5 Functional Areas in order to reach “Full Maturity”