Outpacing the Competition: A Systems Engineering Challenge

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Phoenix Integration Users Conference

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Competition is Back

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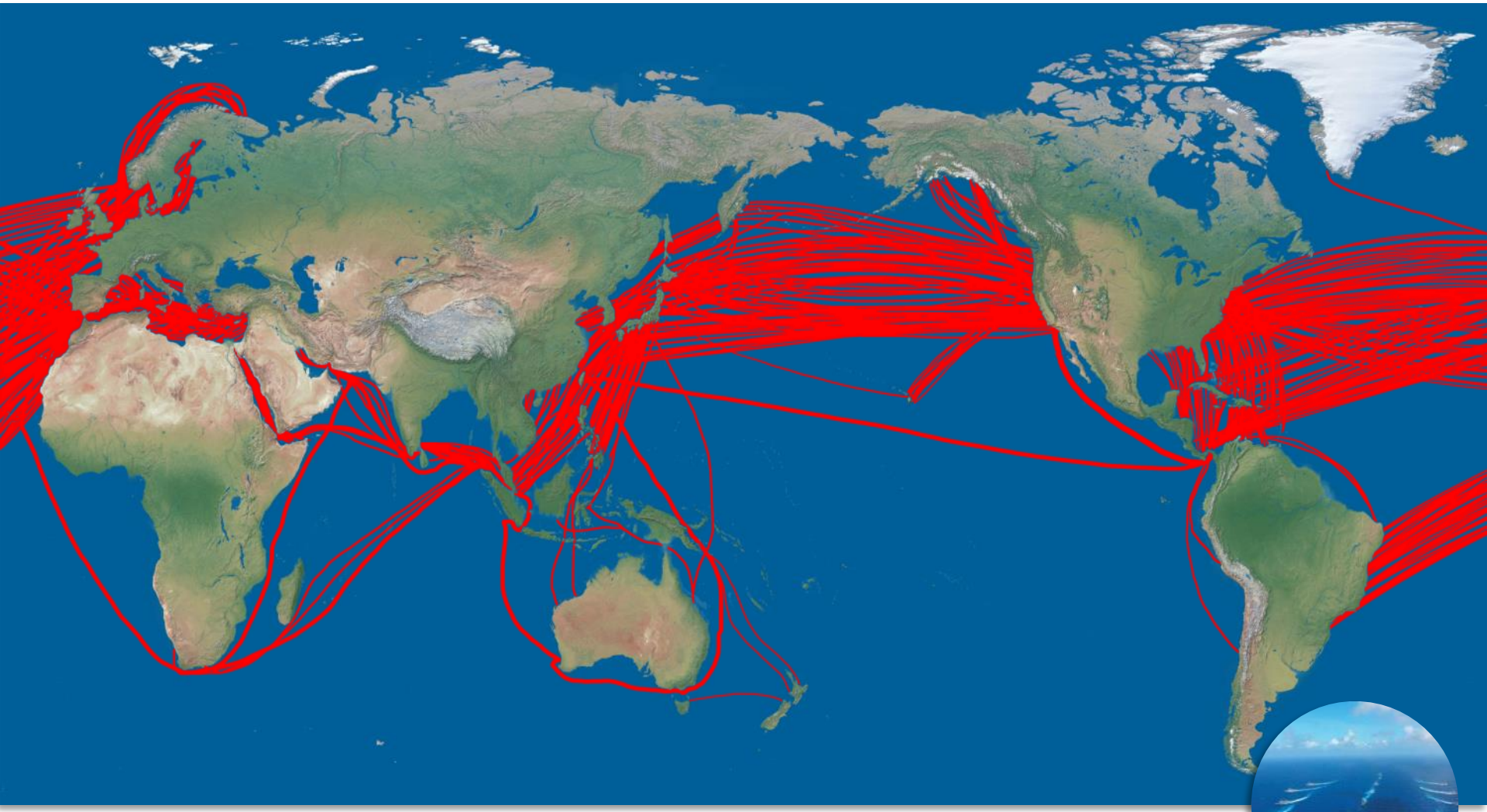
Framing the Challenge

Sea Lanes Remain the Lifeblood of Our Economy



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

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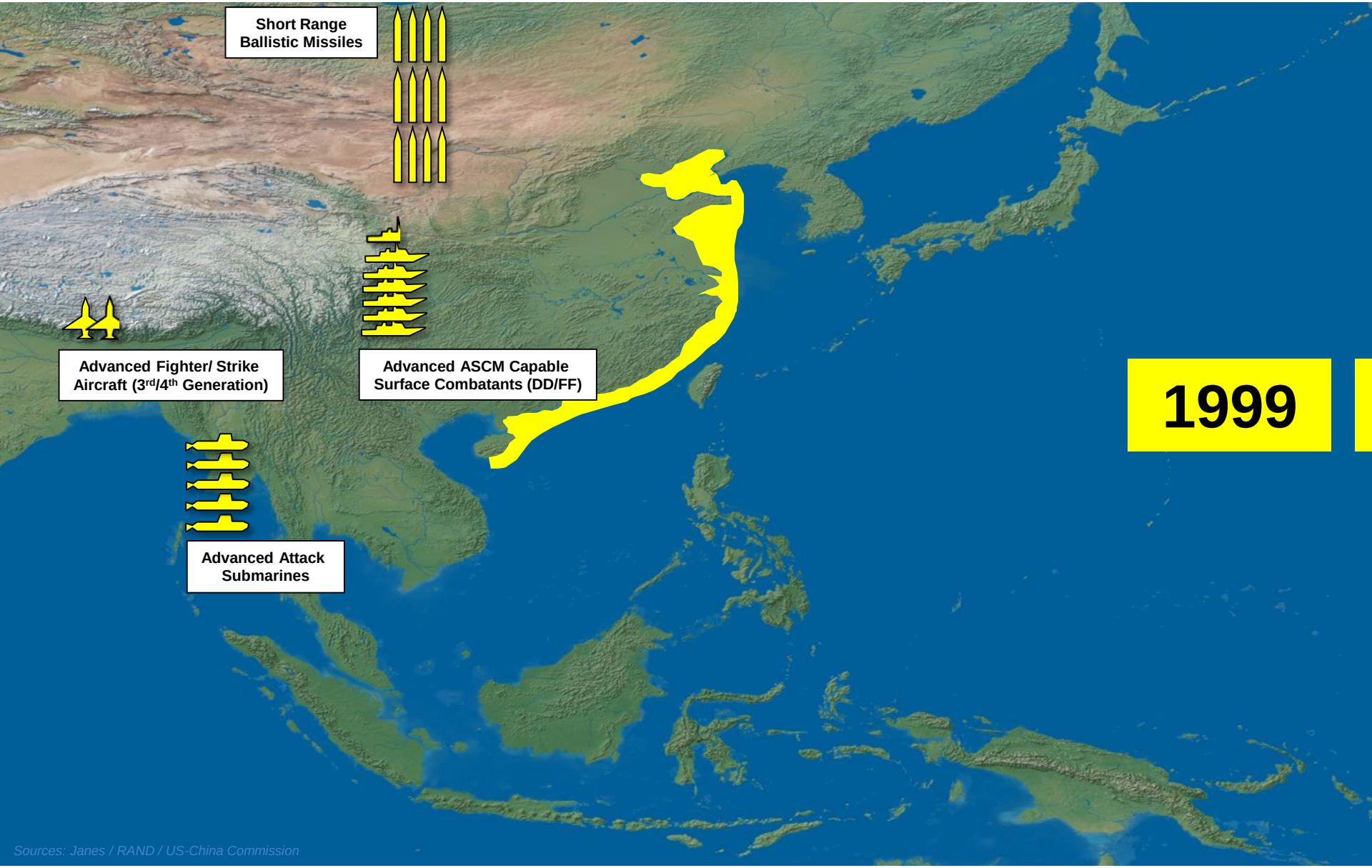
Changing Environment



Sources: Janes / RAND / US-China Commission

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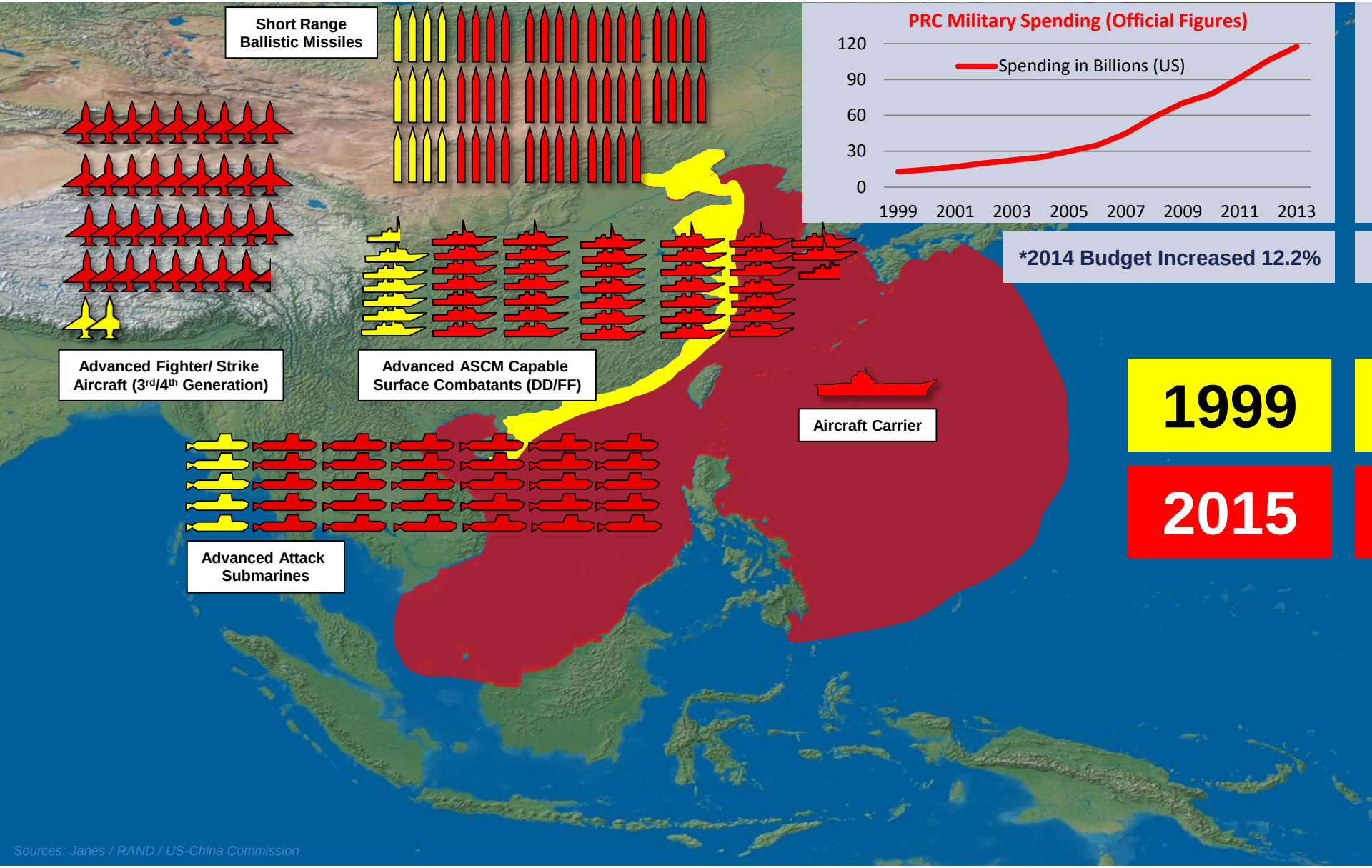

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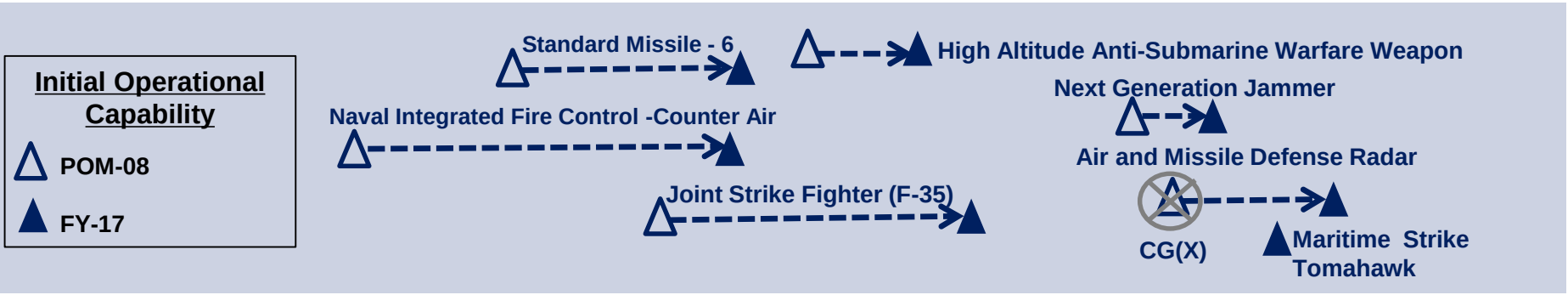
USN and PLA(N) Capability Fielding Trends

We're Slower!



USN Warfighting Advantage has Steadily Eroded

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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

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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

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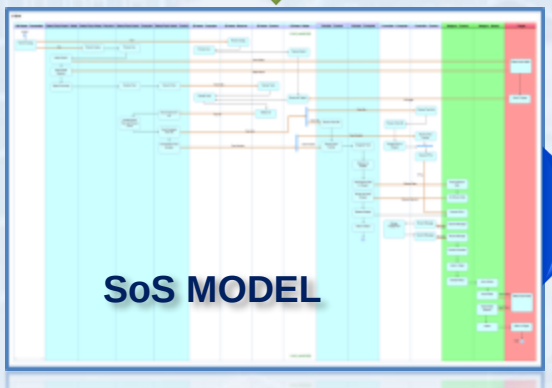
SE Transformation - "*Shaping our Future…*"

NAVAIR Public Release 2018-194. Distribution Statement A – "Approved for public release; distribution is unlimited"

Capability Based Acquisition - Outpacing the Threat

Digital Thread enables rapid delivery of Integrated Capabilities

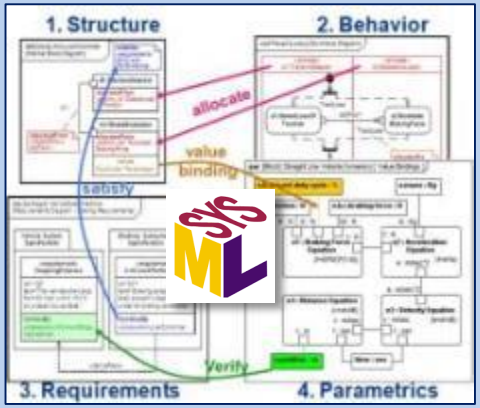
Integrated Warfare Analysis establishes CONEMPS and Effects-Chains



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

System models form "Constructive" basis for LVC M&S environment

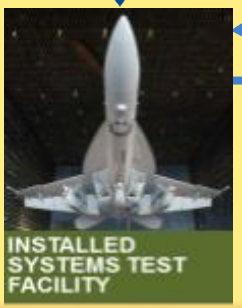
SYSTEM MODEL



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

Enabling Capabilities-Based T&E

Constructive | Virtual | Live



LVC-based training maximizes Fleet proficiency

Digital Linkage

Industry-Government Partnership

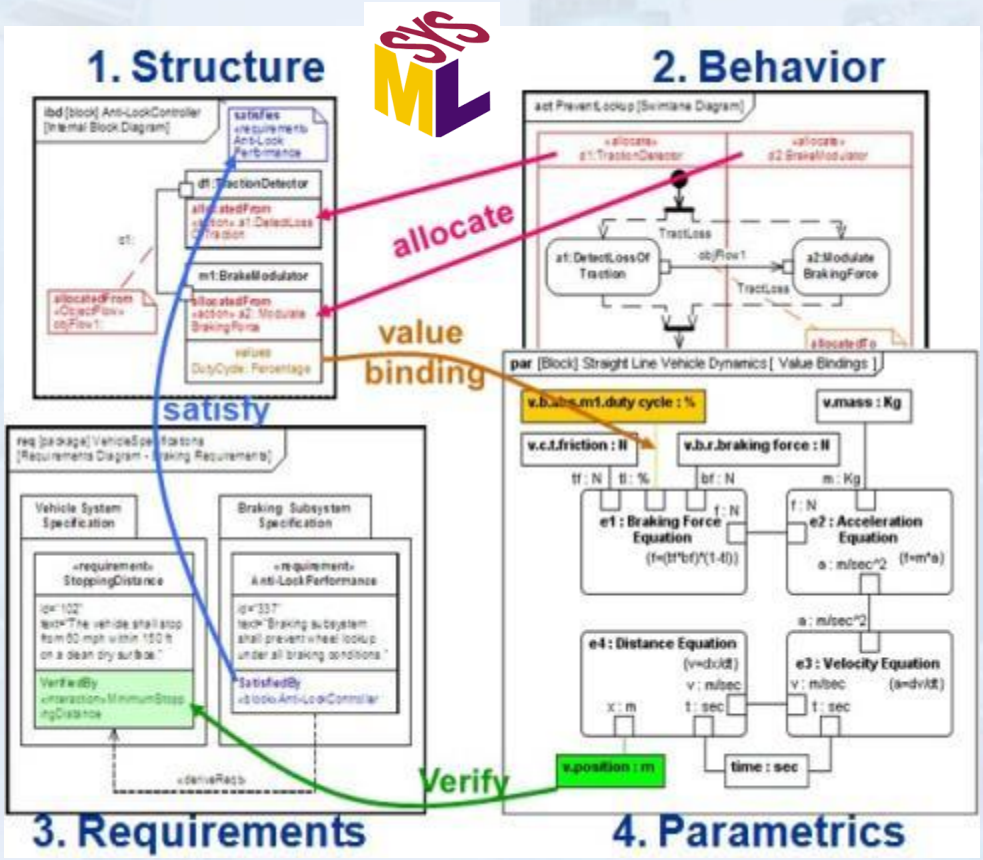
- SET applies to Government and Industry
  - Commercial cycle time is a function of development and production activities
  - DoD cycle times add the activities associated with Government oversight responsibilities
  - Both must be addressed to achieve the necessary reduction

- **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

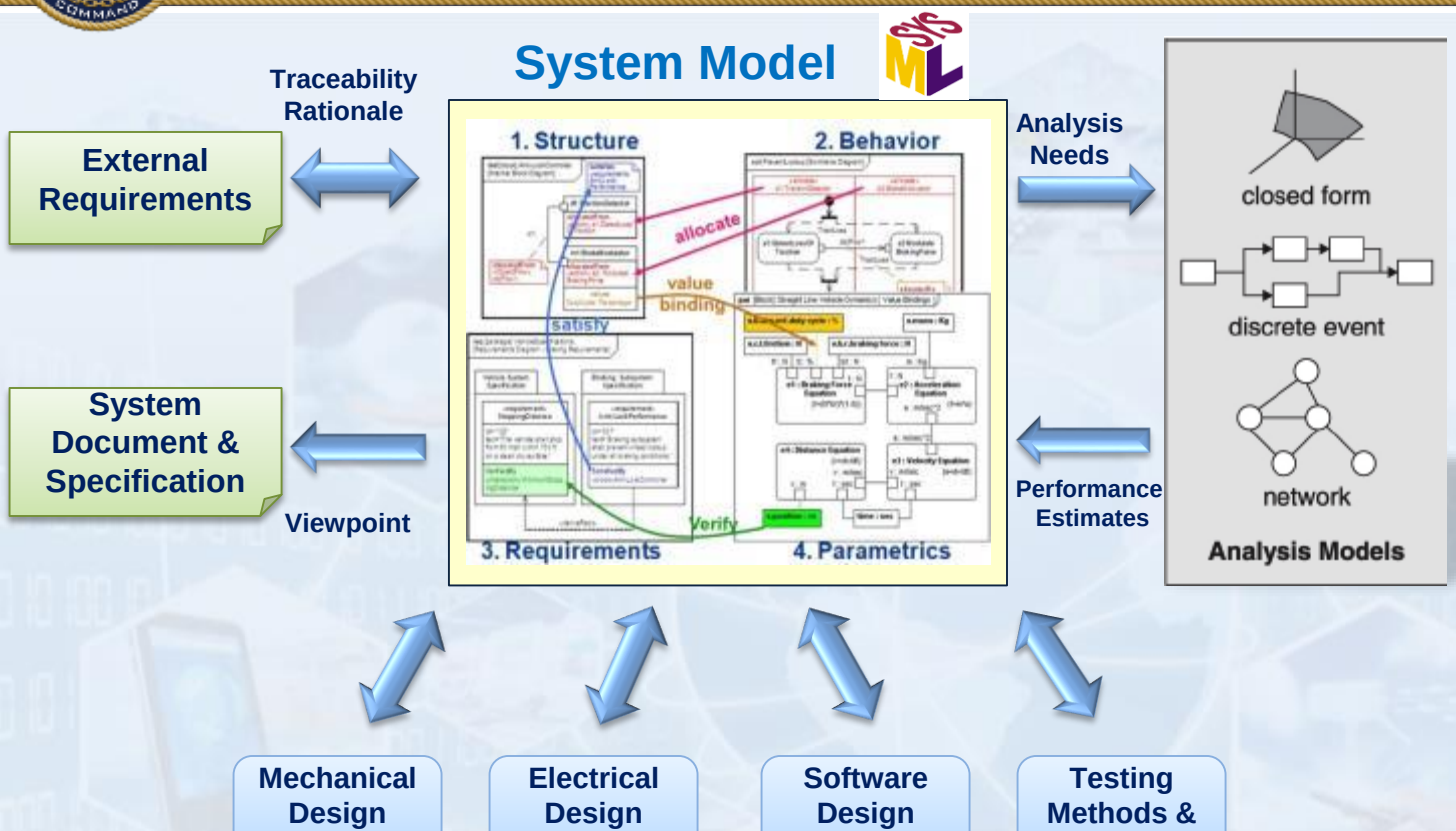
System Specification as a Model



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

System Model – As An Integration Framework

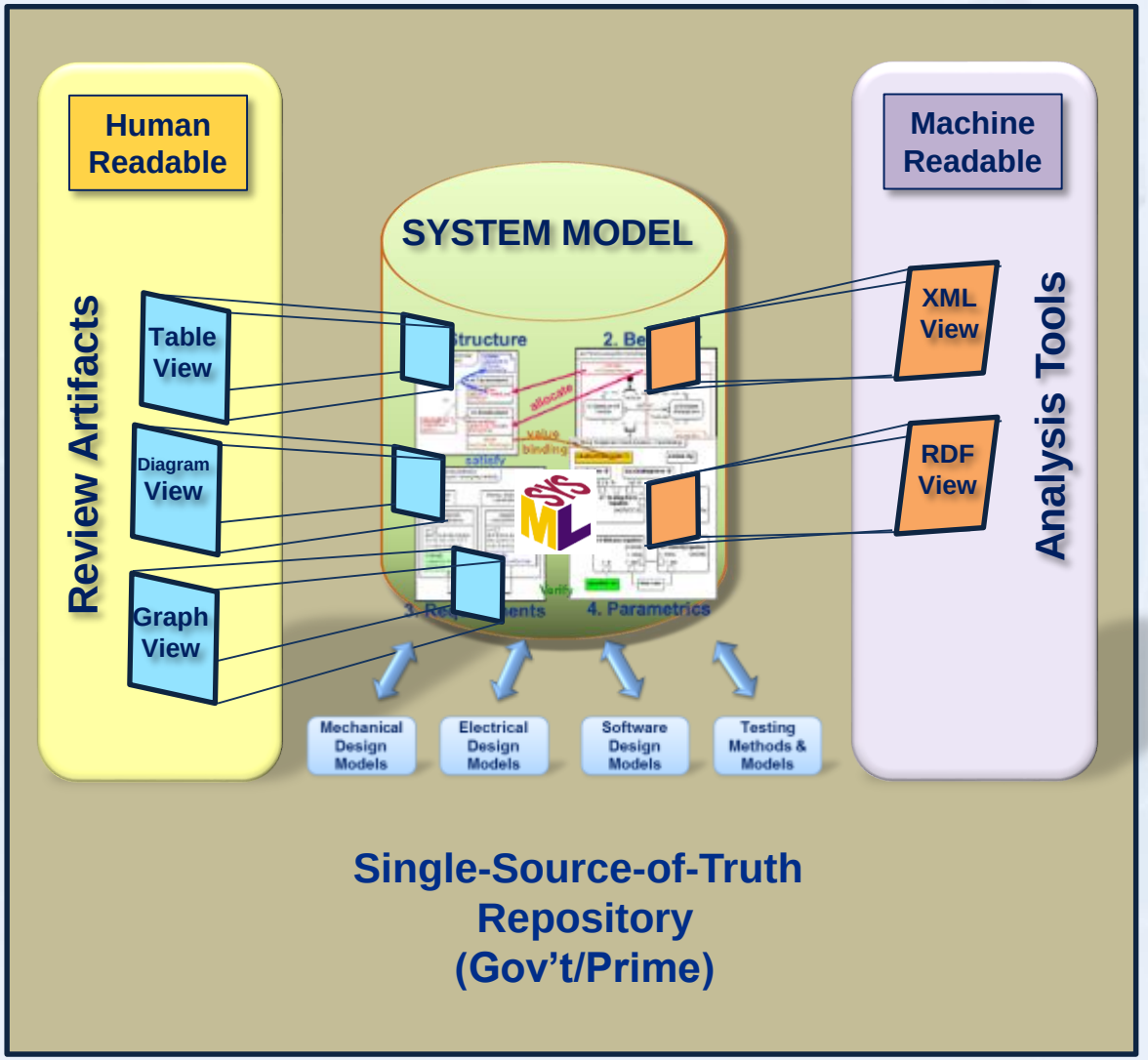


System Framework for Design

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.)

Single Source of Truth



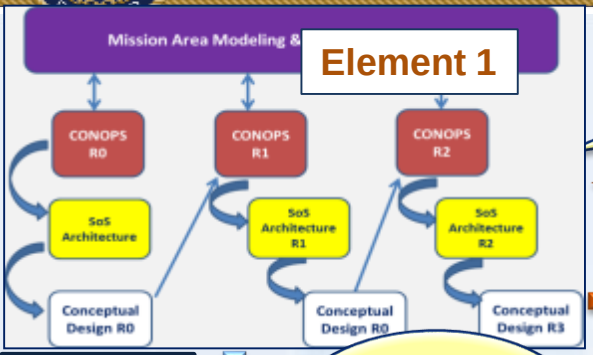
The entire set of models and tools is held in a single repository and becomes the Single-Source-of-Truth for the duration of system development

- 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



Mission Effectiveness optimization

Re-balance as required

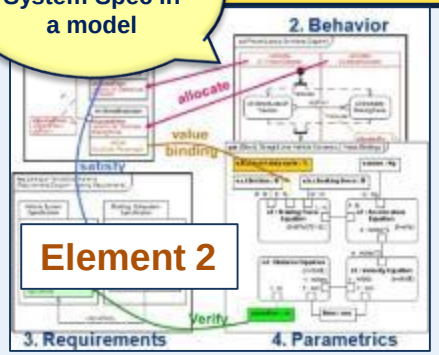
Right-size CDD – very few KPPs, all tied to mission effectives

CDD

Instantiate System Spec in a model

Single Source of Truth

Instantiate and validate design in models



Element 2

Element 3

Mechanical Design Models

Electrical Design Models

Software Design Models

Testing Methods & Models

Analysis Tools

Element 4

Design & Manufacture Release

Integration Events

Integrated Test Vehicle #1

Move rapidly to mfg. Substantiation and insight via modeling environment

MDAO*/SET-BASED DESIGN

- 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

** Multi-Disciplinary Analysis & Optimization*

V6.0

How SET Can Reduce Development Cycle Time

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

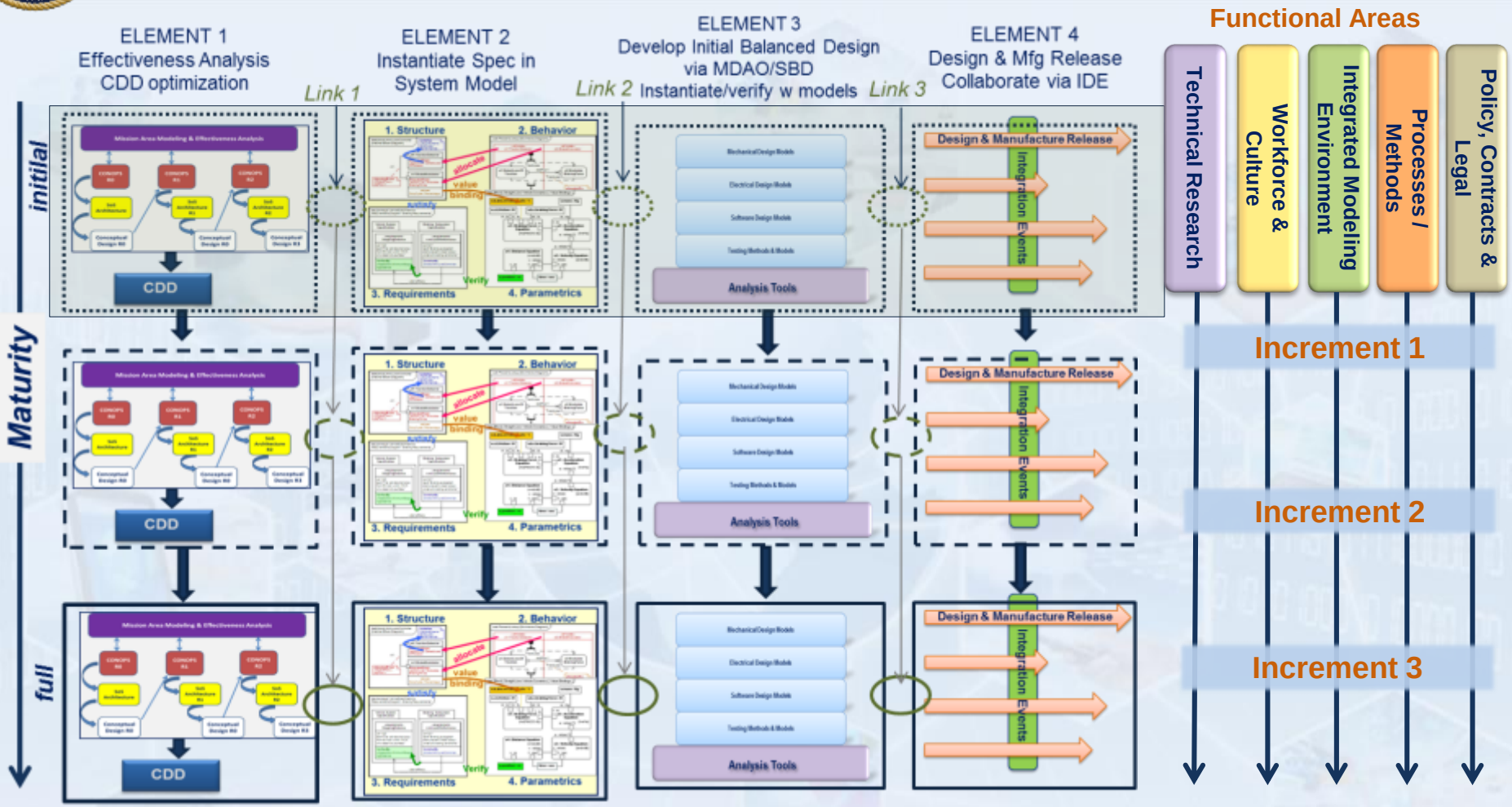
SET Research Team	Workforce & Culture Team	Integrated Modeling Environment Team	Process & Methods Team	Policy, Contract & Legal Team	SET Enterprise Deployment
KEY AREAS OF RESEARCH: • Model Integration • Model Integrity • Ontology • MDAO • Multi-Physics Modeling • Model Visualization • Roadmap & Implementation	Initial Training	IT Infrastructure	SE Process Model "as-is / "to-be"	Contract Language	Deployment Strategy & Planning
	Training Content Development	Modeling Tool-Set	Dev. Modeling Methodology	Tech Data / Acq. Artifacts	Increment Deployment
	Training Delivery	Model Repository SSOT	System Modeling (Spec)	Acquisition Policy	Infusion & Pilots
	Workshops	Modeling Methodology	Source Selection	IP/Proprietary Data	Surrogate Experiment
	Coaching & Mentoring	Acquisition Sys. Ref. Model	Gov't/Prime Collaboration	Requirements Policy	Lessons Learned & Metrics
	Skill/Performance Model	Gov't Collaboration Ctr.	System Model Technical Domain		
	Outreach	Gov't/Prime Collaboration Ctr.	Instructions, SWP & Guides		
	Recruiting	Data, Process, Knowledge Ref. Model	V&V Process		
Data Standards	Decision Framework	Model Visualization	Virtual Reviews	CBA Links	

Email: *SE_Transformation@navy.mil*

NAVAIR MBSE Community of Practice:
https://community.apan.org/wg/navair-set/navair-mbse-community-of-practice/

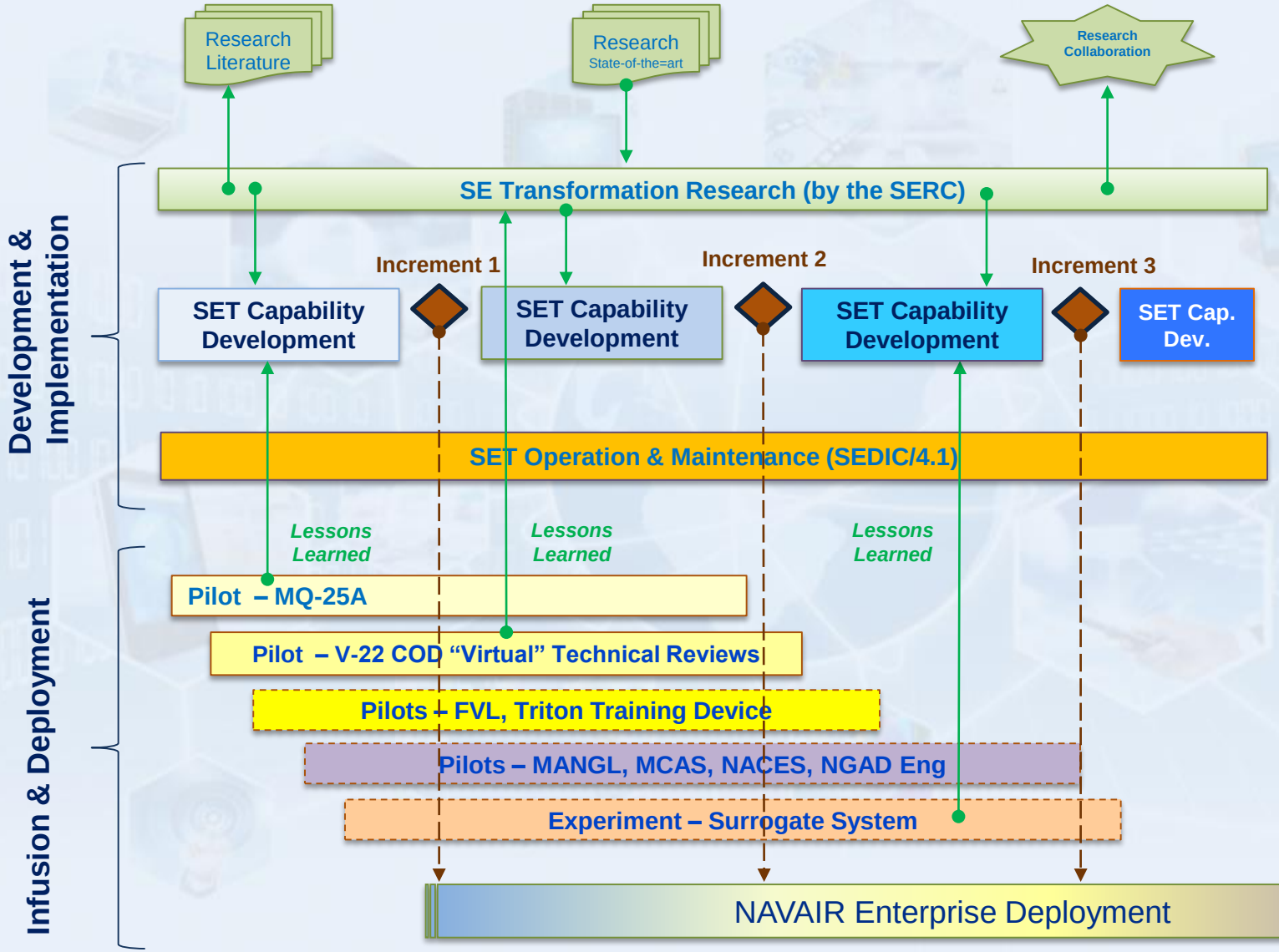
V11.3

Execution Framework



Each Element requires work in the 5 Functional Areas in order to reach "Full Maturity"

SET "Roll-out" Strategy



SET RESEARCH
- Model Integration
- Model Integrity
- Implementation Methods
- Roadmap

INTEGRATED MODELING ENVIRONMENT(IME)
- Modelling Methodology
- Modelling Tool-set
- Modelling Language
- Model Repository
- Collaboration Center

TOOLS – Licenses, Sustainment, etc..
- Collaboration Center , IT, CM, SW Releases, etc..
- Process Documentation - instruction, SWP, SSP, Guides

TRAINING
- Help Desk

PILOTS & DEMONSTRATIONS
- Collaborative Environment
- Technical Review Framework (e.g. MDAO)
- System Model
- Engineering Data in Models

V7.0