

THE VALUE OF PERFORMANCE.
NORTHROP GRUMMAN



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Using MBSE in Agile Development

NDIA Systems Engineering Conference

Grand Hyatt Tampa
Bay
2900 Bayport Drive
Tampa, FL 33607

25th October 2018



H1 Lead Technology Integrator (LTI) Program





Northrop Grumman and Bell Integrator Roles

- **Integrator role provides the ability to streamline the deployment of integrated technologies to the platform**
- **Success to the deployment of new capabilities relies on close partnerships with all H-1 suppliers as we move to Model Based Development and Agile Methods**
- **Will be working with industry to flow down new capabilities so that PMA, working with Northrop Grumman and Bell can continuously integrate the new technologies in phased approaches**
- **Overall contracting strategies are being investigated to allow the rapid deployment of technologies and to support the needs of the H-1 Platform in the future**
- **As development continues on the platform we are looking at obsolescence opportunities to provide more advanced capabilities as the technology advances.**



H-1 Drivers and Objectives

- I. **Speed to the Fleet** – Industry & PMA must be capable of rapidly delivering integrated and effective capabilities to the warfighter
- II. **Quick Reaction Sustainment** – Industry & PMA must have the flexibility and agility in our team structure, contracts, processes, and planning to react to emerging fleet needs and correct priority deficiencies
- III. **Platform interoperability** – Industry & PMA must manage integration of new technology to meet key mission and performance requirements

Rapid deployment and sustainment of interoperable technology is needed for the H-1 Platform



H-1 Core Goals

- **Enable planning and management of the H-1 avionics and mission systems as one integrated system**
 - Joint working level teams integrated and collaborating across the subsystems
 - Sharing of PMA-276 and Industry resources and tools to optimally, effectively, and rapidly deliver capabilities
- **Leverage commercial software processes to reduce product development timelines**
 - Yearly SW releases available for fleet fielding
 - System Deficiencies integrated within the same cycle
 - Leverage Continuous Integration methodologies for deployment
- **Enable better forecasting of integrated capability deliveries**
- **Requirement Management at the platform level**

Supporting the warfighter with deployment of capabilities to the fleet



Bolt-on vs Integrated



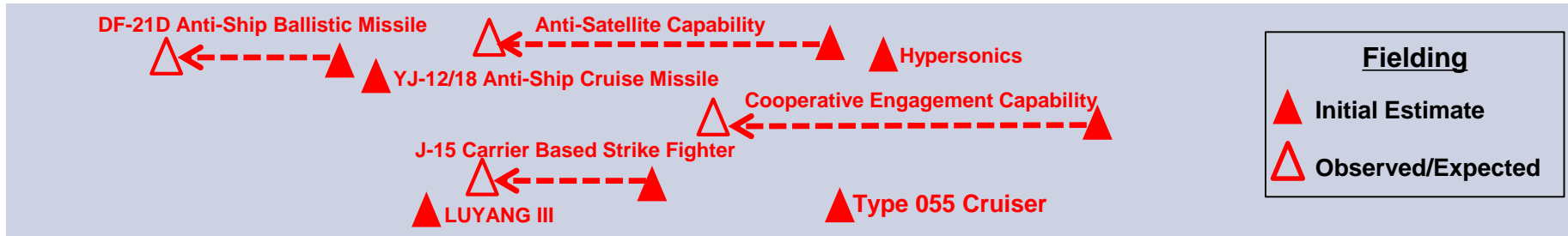
Clear system architectures & integration plans optimize the overall platform performance



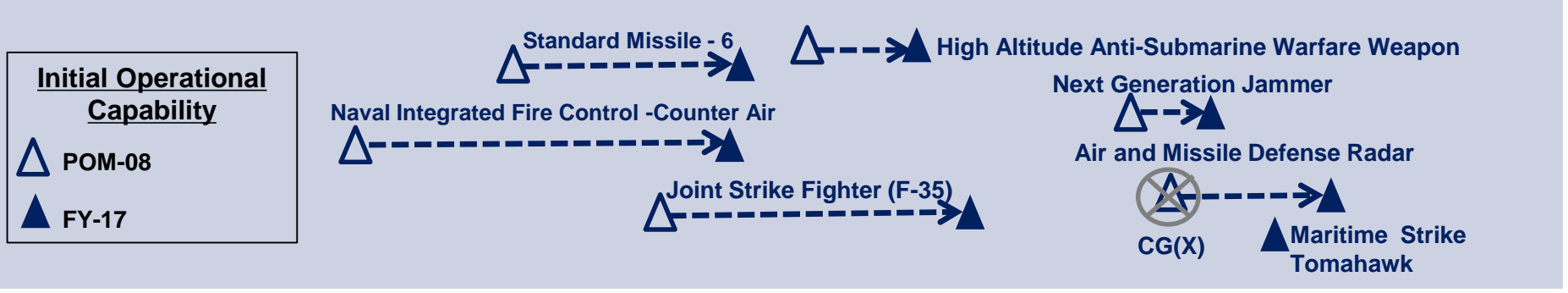
Navy Challenge



USN and PLA(N) Capability Fielding Trends



We're Slower!



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**



SE Transformation - “*Shaping our Future...*”

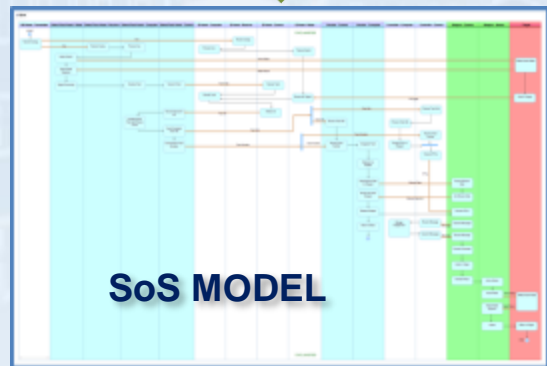


Capability Based Acquisition - Outpacing the Threat

Digital Thread enables rapid delivery of Integrated Capabilities



Integrated Warfare Analysis establishes CONEMPS and Effects-Chains

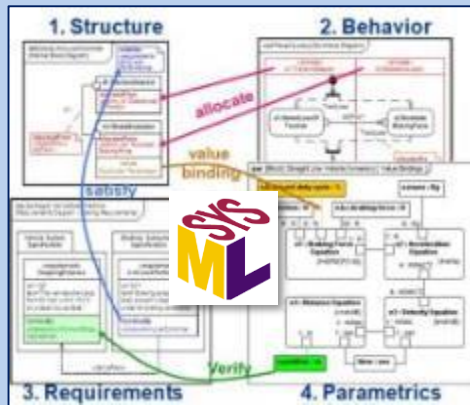


CONEMPS and Effects Chains are modeled at the System of Systems (SoS) level

Digital Linkage

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

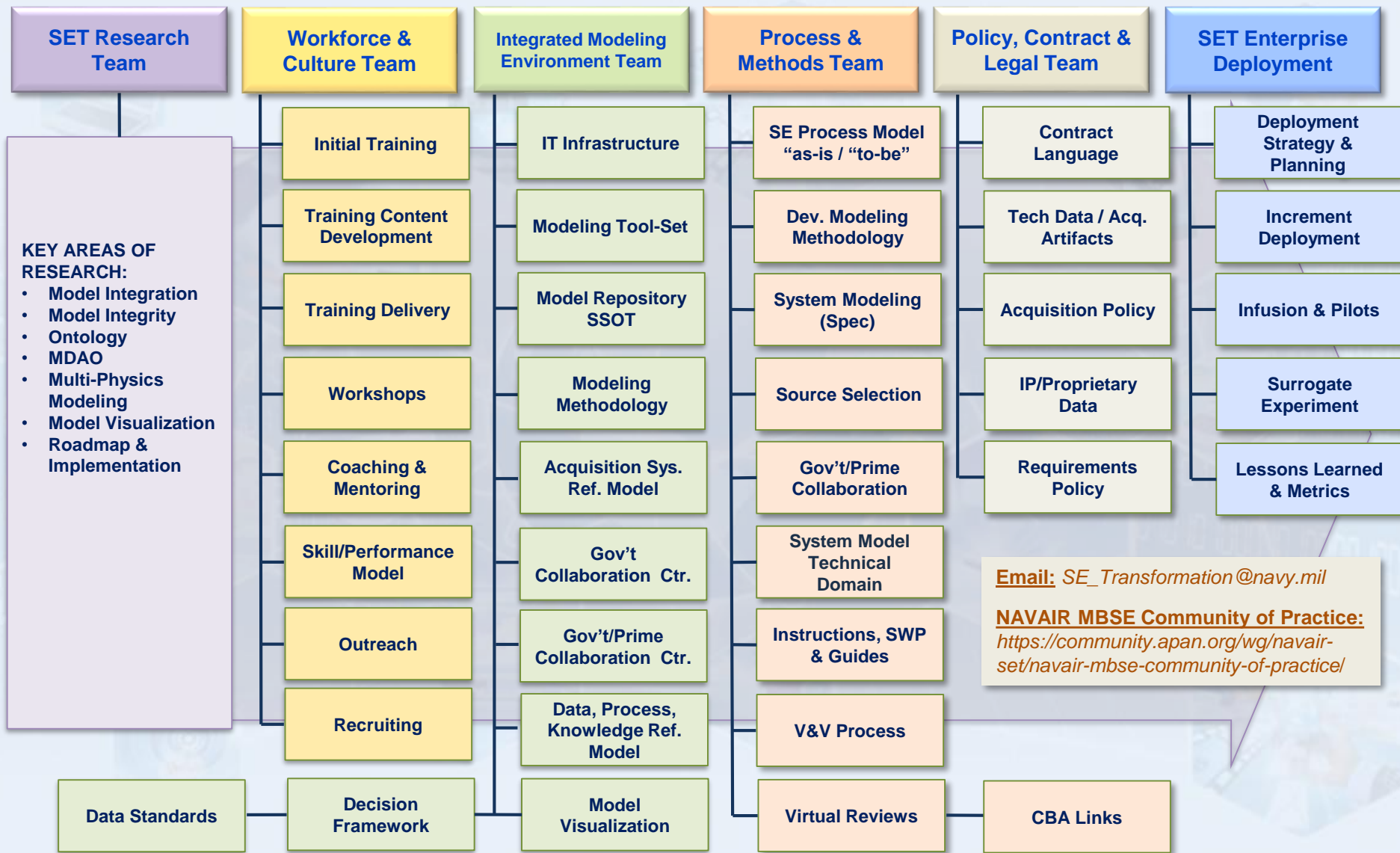


LVC-based training maximizes Fleet proficiency



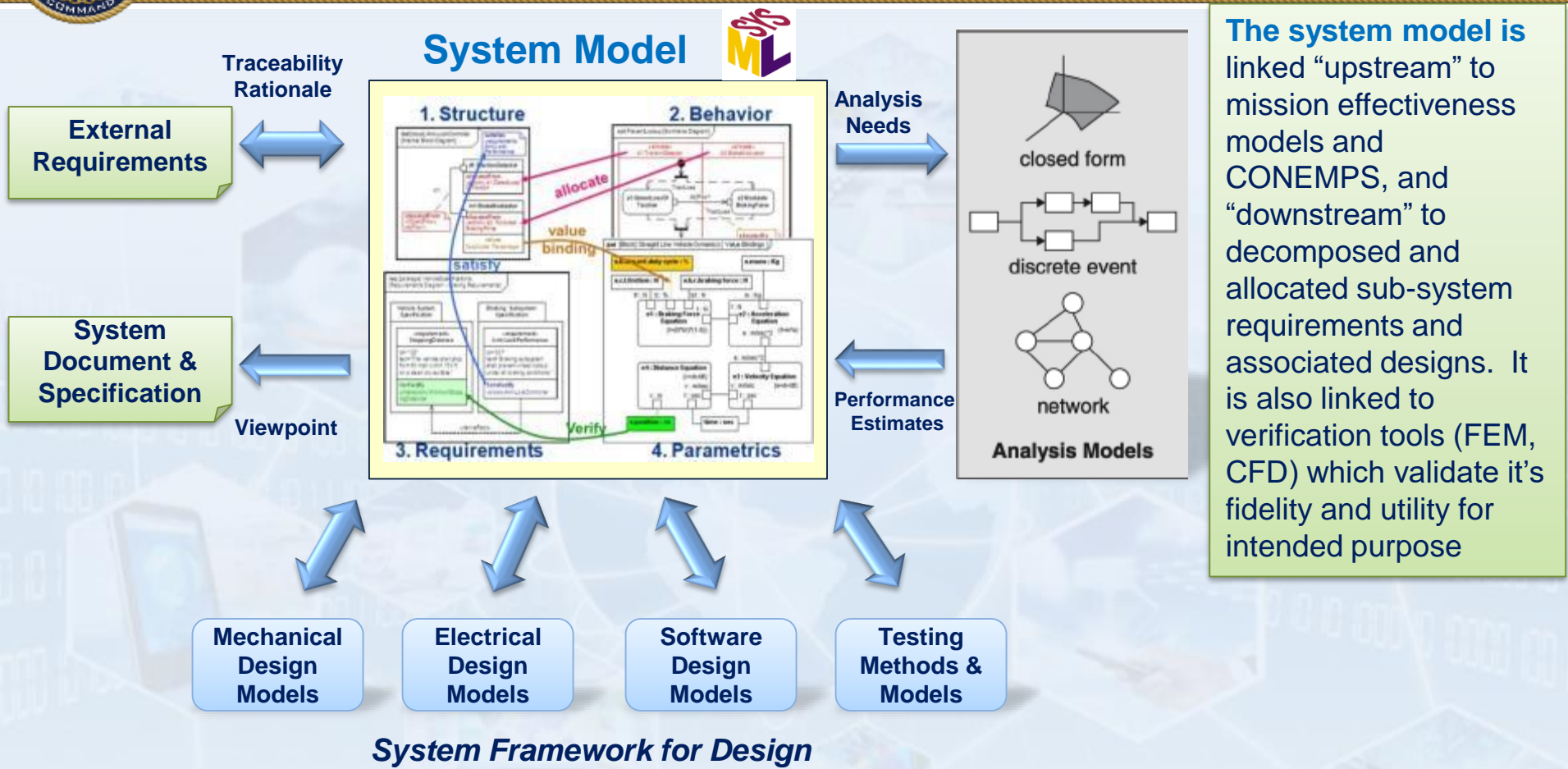
SET Framework

5 Functional Areas





System Model – As An Integration Framework



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.)

Northrop Grumman and NAVAIR Partnership



Partnership Value of MBSE

Transformation

- Align to DoD Digital Engineering Strategy
- USG MBE Acquisition/Development Strategy
- DoD, NAVAIR, Air Force Digital Eng Group
- Shape emerging industry Standards
- Collaborative and Integrated Model Reuse
- NG Collaboration across Sectors

Value

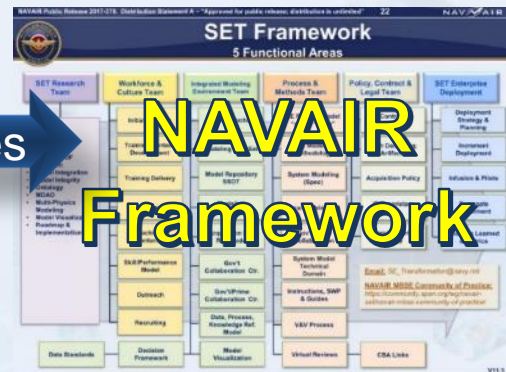
- Improved First Time Quality
- Common Processes/Model Repositories
- Aligned with Customer's Desire to Own the Technical Baseline
- Enable trusted partner relationship with customers

Goals

- To deliver a system specification of the as is product baseline and to be functional and allocated baselines in a model
- To leverage the model as the work products for plans, approach, and technical baselines
- To eliminate all paper CDRLs (e.g. Plans, Architectures)
- To bake in MBSE into Sprint Teams for mentoring and execution
- To digitally collaborate with all stakeholders for review and development of digital artifacts



Drives

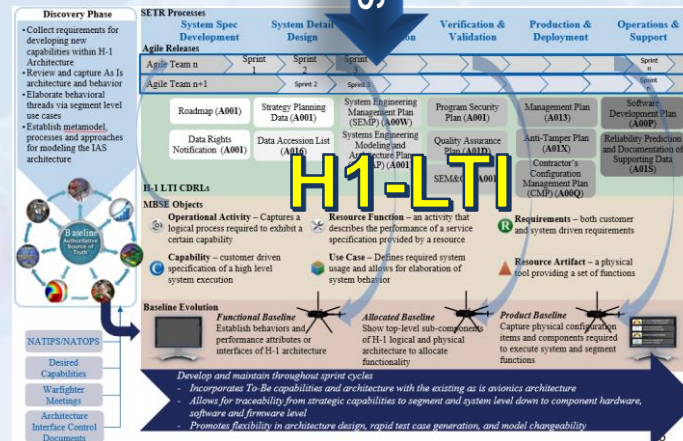


NAV AIR Framework

July '18 – DoD DE Vision

March '18 – US Navy (NAV AIR) System Eng Transformation (SET)

Drives





Partnership Value of Agile

Transformation from Waterfall to Agile

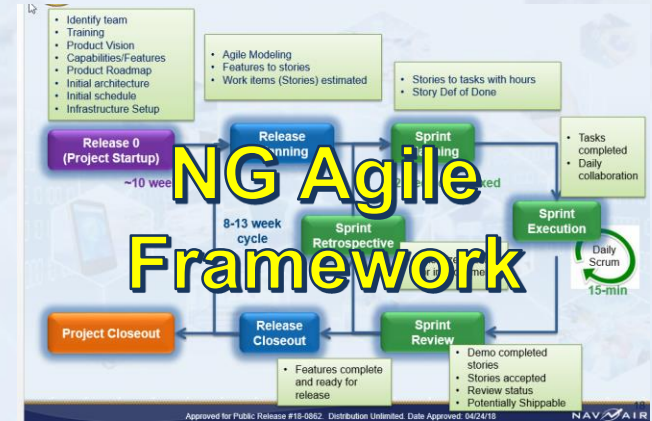
- Bring empirical approach
- Measure progress thru demonstration
- Empowers customer
- Approaches like MBSE allows for agility

Value

- Regular delivery/demonstration of incremental value
- Embrace and respond to capability needs
- Detailed capability to user story to tasking for teams
- Defect generations for continuous improvement
- Enable trusted partner relationship with customers

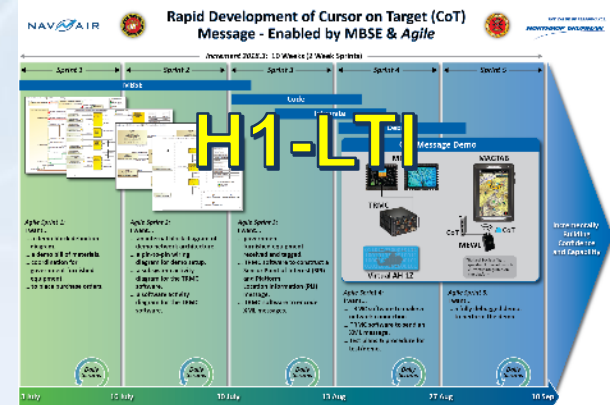
Goals

- To deliver what we promise for increment
- To ensure govt and contractor agreed to definition of done and acceptance
- To build an integrated team of SMEs from govt and contractor on sprint teams
- To deploy capabilities based on warfighter need in a year



Approved for Public Release #18-0862

Delivers

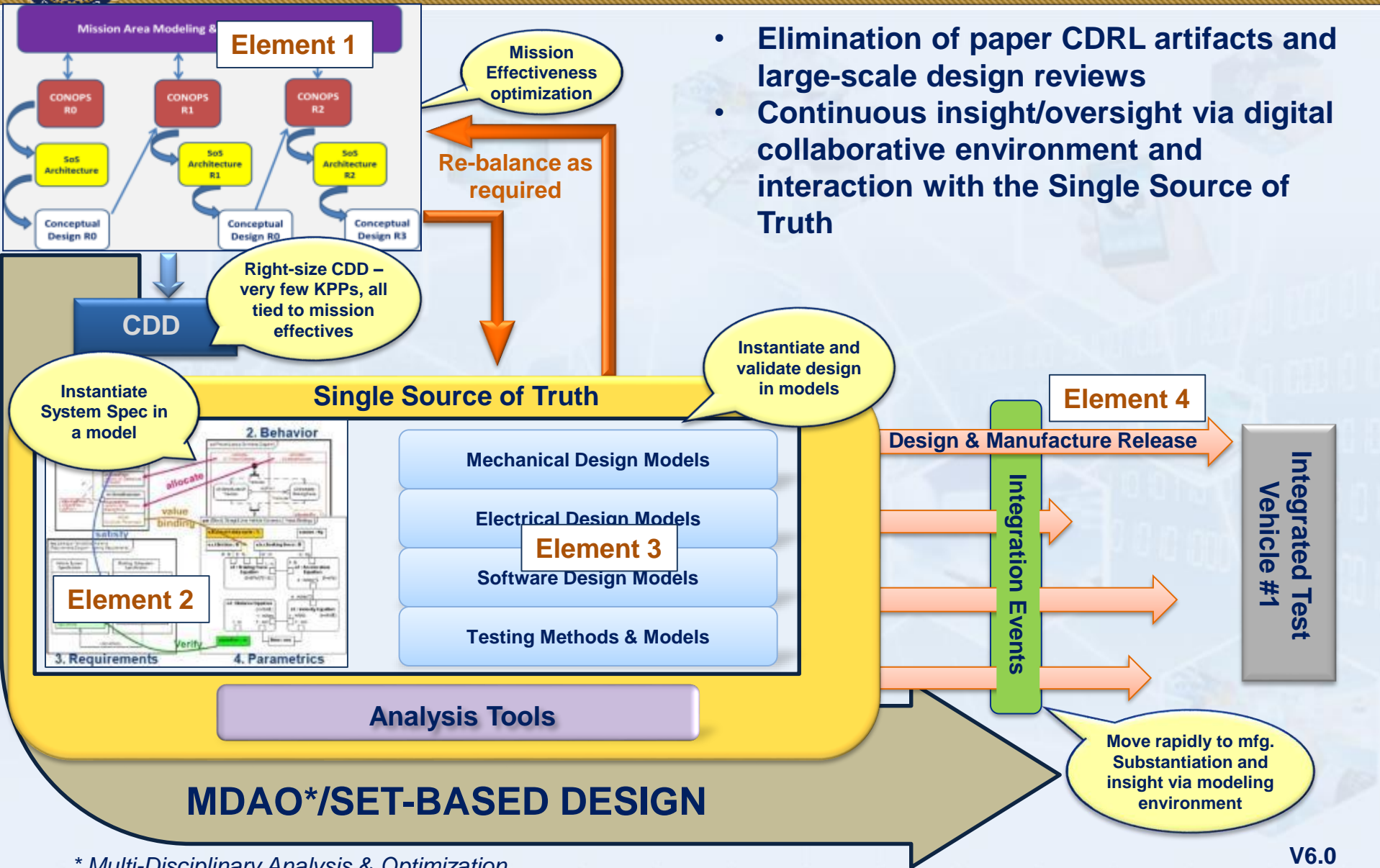


Partnership Builds MBSE & Agile Framework



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

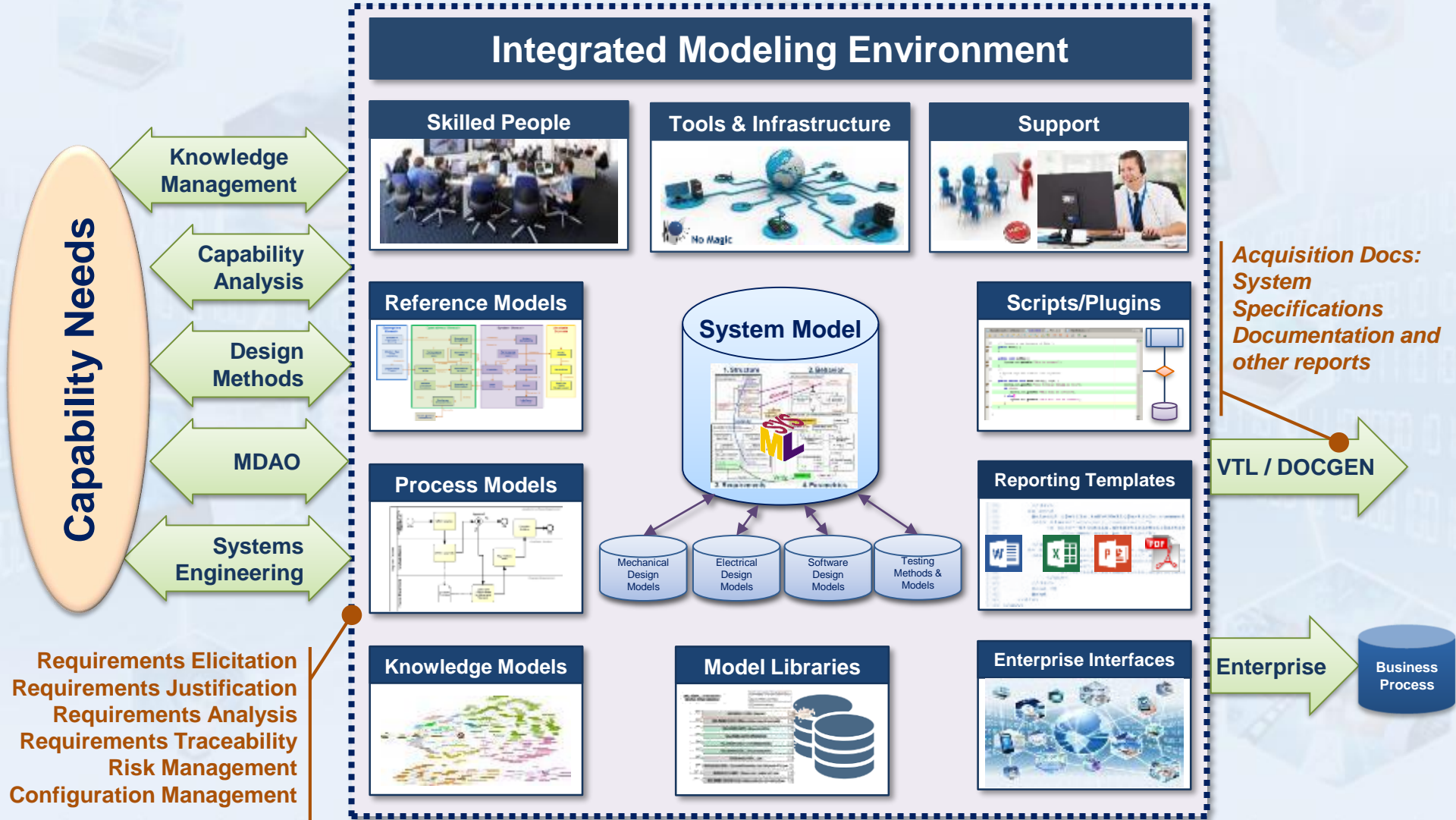
* Multi-Disciplinary Analysis & Optimization



SET Integrated Modeling Environment (IME)

Conceptual View – End State

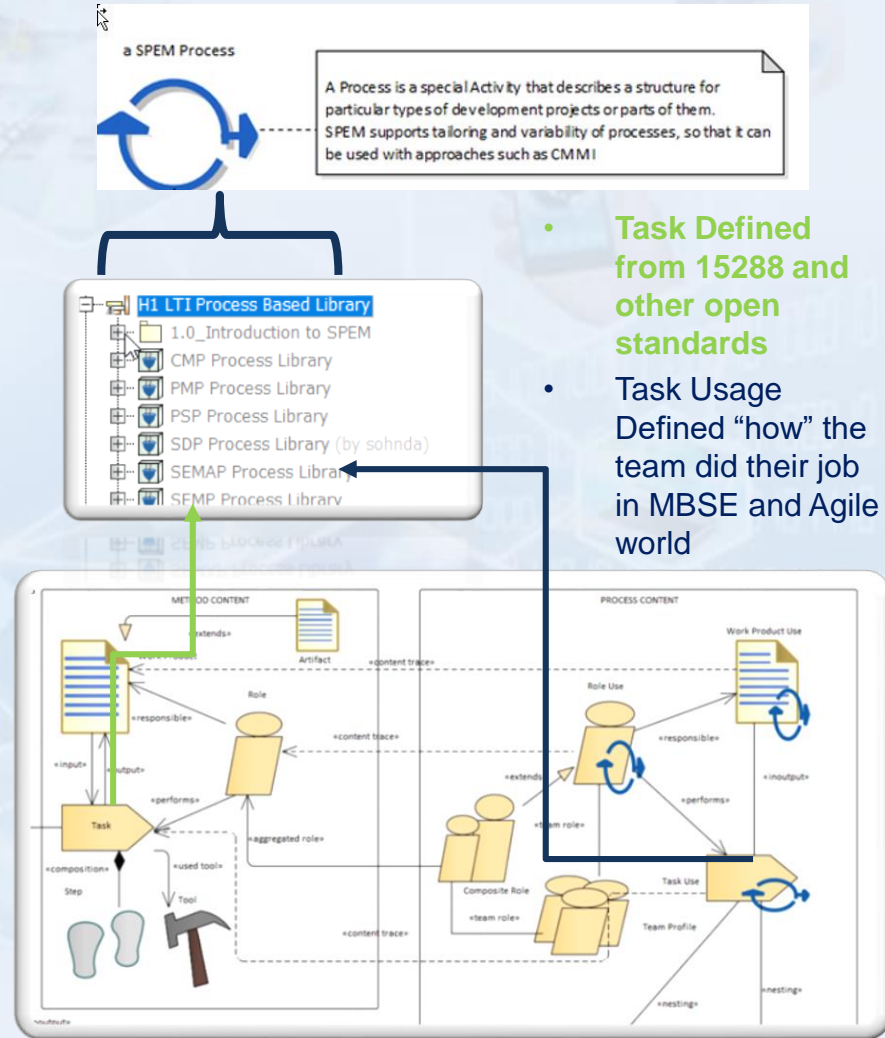
A modeling capability, not just a tool...
A Combination of Methodology, Language, and Tools...





Modeling the Process and Approach via Model-based

- Software and System Engineering Metamodel (SPEM) 2.0 chosen to assist Agile teams in knowing their role in how to perform their work in this new paradigm
 - Goal
 - Manage libraries of reusable Method Content such as work product definitions across processes
 - Bring in concrete syntax defined by UML +profiles
 - Provide concepts for modeling process and approaches detailed in MBSE and Agile

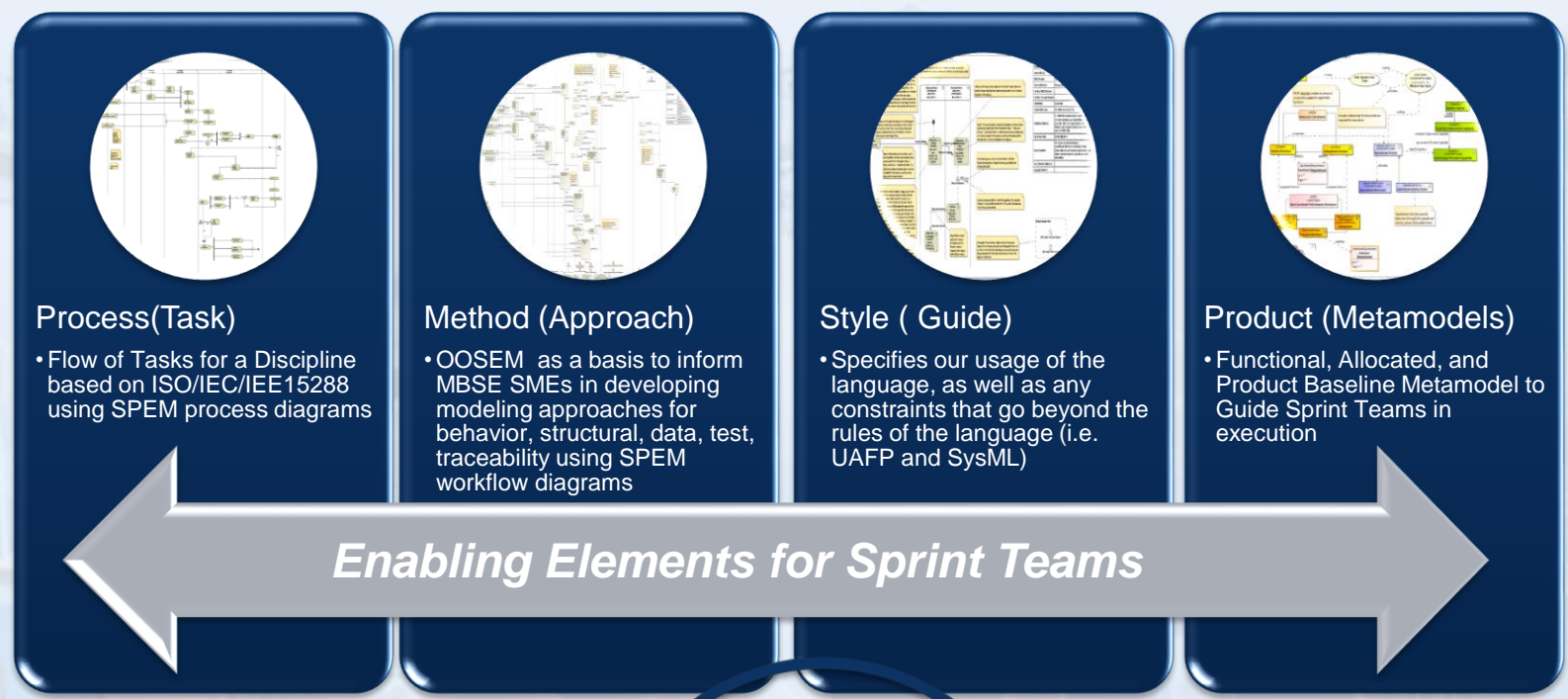


- Task Defined from 15288 and other open standards
- Task Usage Defined “how” the team did their job in MBSE and Agile world

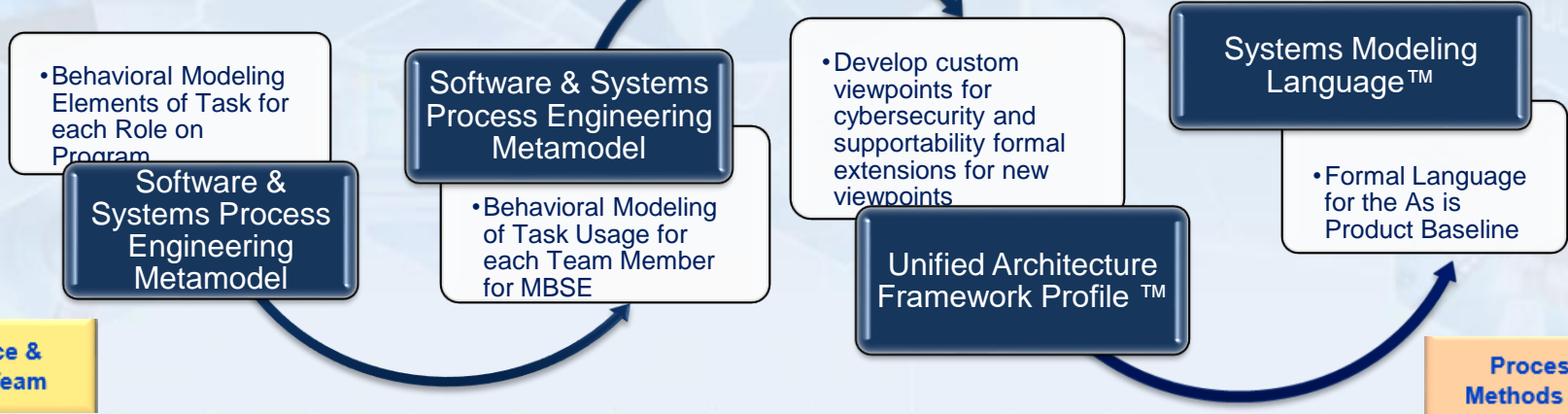
Source: <https://www.linkedin.com/pulse/how-can-agile-modeled-dr-nicolas-figay/>



Providing the MBSE Pillars to the Team



Enabling Elements for Sprint Teams

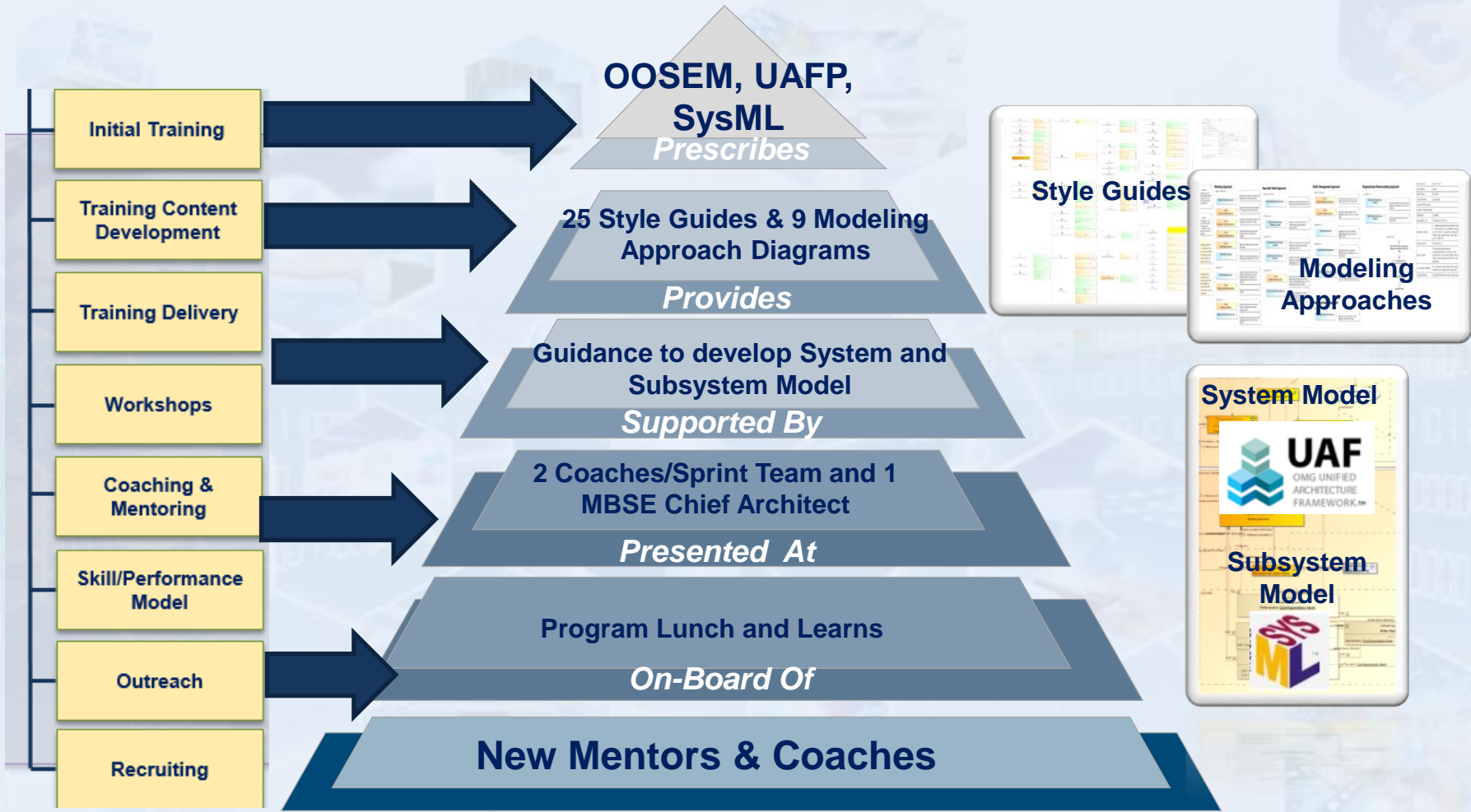


Process & Methods Team



Intersection of Methods with Workforce

Element 2



Workforce & Culture Team

Process & Methods Team



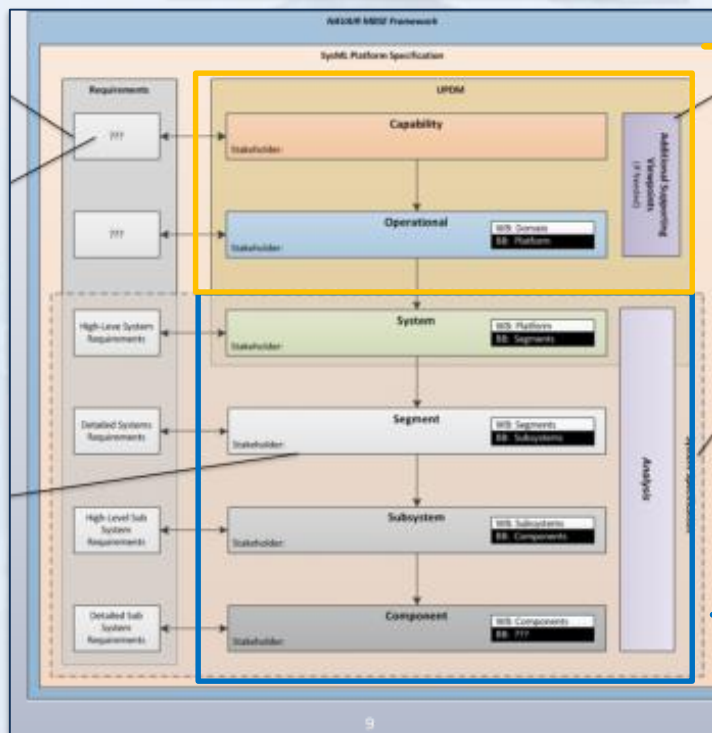
Model-based Pattern for Agility

Element 1

Element 2

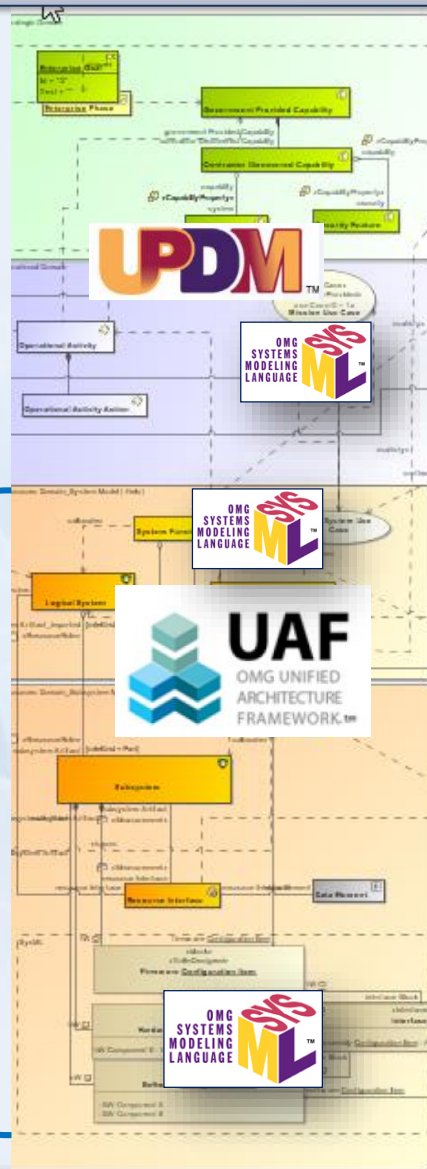
Metamodel Crosses Model Boundaries

NAVAIR MBSE Framework



Integrated Modeling Environment Team

Process & Methods Team



Government Provided Operational Model

- Warfighter Vignettes inform the Operational Model
- RO support refinement

Contractor Provided System and Subsystem Models

- System & Subsystem Specification in a model; Specifications produced directly from the Models
- Technical Competencies generate portions

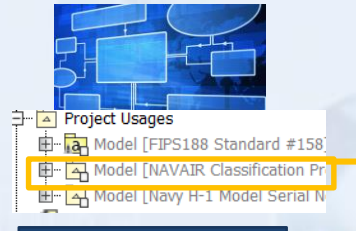


Digital Artifact Creation for Technical Baseline

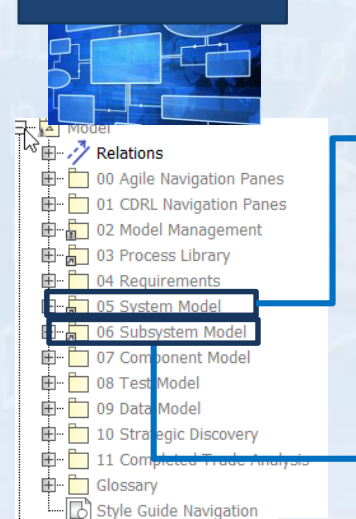
Element 1
Element 2

Digital Views (e.g. Architectures) within Models

Operational Model

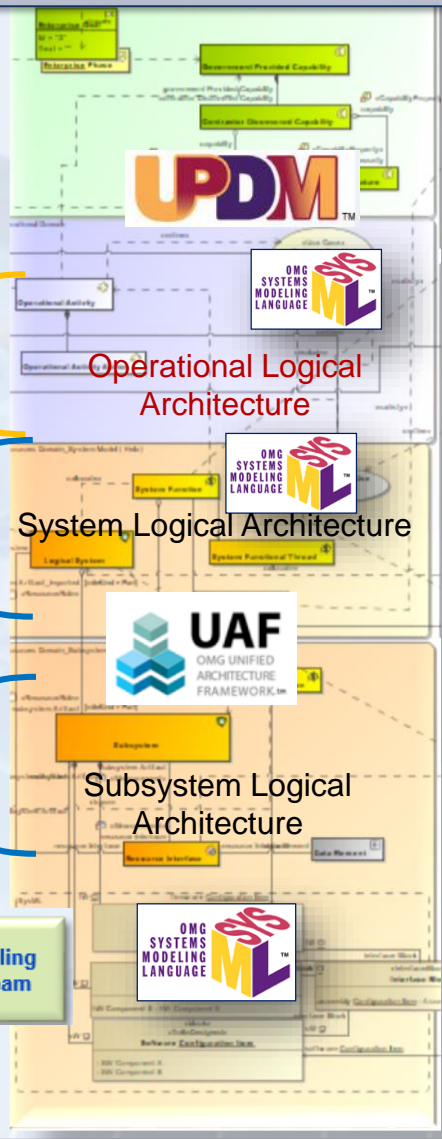


System & Subsystem Model



Lives in one Repository

Integrated Modeling Environment Team

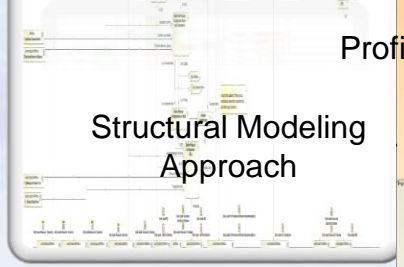


Builds
Guided By

Enabling Elements



Process & Methods Team



Profiles for Policy, Delivery, and Approval



Deliverable is the .mdzip

System, Subsystem, Test, Analysis, and Software Specification in a model with Project Usage to the Operational Model delivered to Government

Policy, Contract & Legal Team



Digital Artifact Creation for Plans

Element 1

Element 2

Process Model

Digital Views (e.g. Processes & Approaches) within Models

Enabling Elements

Modeling Approach Activity Diagrams

Deliverables from Model

Work Products Defined within Each Model

Each Plan has a Process Based Library

- Each Plan deliverable has a Cover Page, Navigation Pane to the activity diagrams within each process library

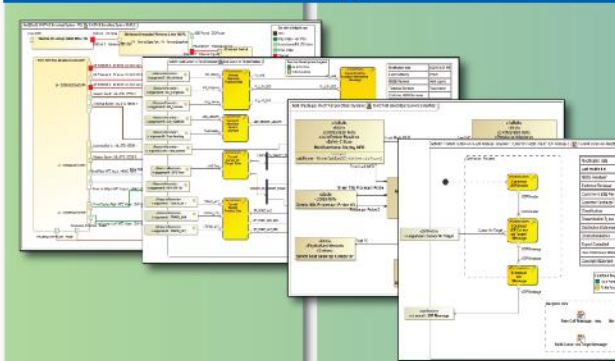
Process & Methods Team



Rapid Development of Cursor on Target (CoT) Message - Enabled by MBSE & Agile



Increment 2018.3: 10 Weeks (2 Week Sprints)



Agile Sprint 1:
I want...
... a demo block definition diagram.
... a demo bill of materials.
... coordination for government furnished equipment.
... to place purchase orders.



3 July

Agile Sprint 2:
I want...
... an internal block diagram of demo network architecture.
... a pin-to-pin wiring diagram for demo setup.
... a subsystem activity diagram for the TRMC software.
... a software activity diagram for the TRMC software.



16 July

Agile Sprint 3:
I want...
... government furnished equipment received and tagged.
... TRMC software to construct a Sensor Point of Interest (SPI) and Platform Location Information (PLI) message.
... TRMC software to encode XML messages.



30 July

Agile Sprint 4:
I want...
... TRMC software to make a network connection.
... TRMC software to send an XML message.
... test plans & procedure for test/demo.

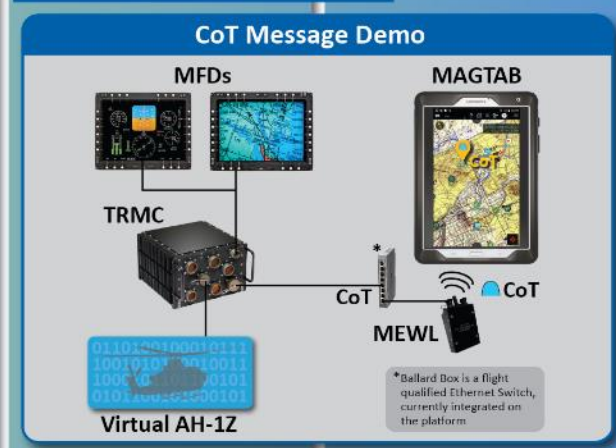


13 Aug

Agile Sprint 5:
I want...
... a fully debugged demo.
... to perform the demo.



27 Aug



Incrementally Building Confidence and Capability

10 Sep



Retrospectives



What Went Well?	What Didn't Go So Well?	What Should We Work to Improve?
<ul style="list-style-type: none"> - Incorporate MBSE Enablers as predecessors of user stories better control of current sprint's scope - Improved team communication - stuck with backlog population from sprint planning meeting - no added user stories - processes of reviews and approvals seems smoother - planning meeting went much smoother with properly planned backlog - better support of yankee/zulu - improved sprint burndown - Incremental burn down went well - Embedded MBSE and Chief Eng's into Yankee and Zulu helped their teams with progress 	<ul style="list-style-type: none"> - Tasks were added even though user stories weren't mostly for MBSE reviews. - Added scope during the PI and Sprint - caused scope growth - Generic Acceptance Criteria was commented as "not executable" by other reviewers - Change in R&R during planning state - Show dashboard for dependencies across teams - Need to include CDRL support or show availability changed - Customer approvals creating roadblocks for several user stories 	<ul style="list-style-type: none"> - Better descriptions of Features and User Stories - Better descriptions of Acceptance Criteria - Delegate and distribute across the team, instead of several people piling on work - Opportunity to brief across teams on new guidance (style guides, approaches, etc) - Improve alignment with customer priorities - Make sure review tasks exist for both the author and the reviewer at the beginning of the sprint
Key Takeaways	Key Takeaways	Key Takeaways
<ol style="list-style-type: none"> 1. Teams Yankee and Zulu are better supported now with dedicated members from X-Ray MBSE. 2. <u>No</u> User Stories were added this time, and the team stuck with the backlog prepared during the planning meeting. Note: Addition of User Stories during the sprint had been a problem in previous Sprints. 3. Better preparation and grooming of User Stories ahead of the Sprint Planning meeting. 4. Incremental Acceptance was an improvement over approving all at the end of the Sprint. 5. Backlog burndown performance was noticeably improved. 	<ol style="list-style-type: none"> 1. Communications about X-Ray team changes at the last minute was disconcerting and surprising. 2. Team members being oversubscribed (>100%) continues to be a problem that needs to be resolved, particularly with addition of supporting of teams Yankee and Zulu. 3. Need to get customer commitments to complete peer review timely, or perhaps consider alternative methods 	<ol style="list-style-type: none"> 1. Need better (clearer, comprehensive, unambiguous) descriptions of Features, US, Task Descriptions and Acceptance Criteria. 2. Need all X-Ray team members to provide better communication about availability, and to step-up and take-on tasks to allow for distribution of work scope vs. concentration to only a few members. 3. Identification of specific responsible persons required to participate in the review process. Recommendation is to prioritize the User Story associated with Peer Reviews



Element 3 - End-State Process and Methods (Technical Domain)



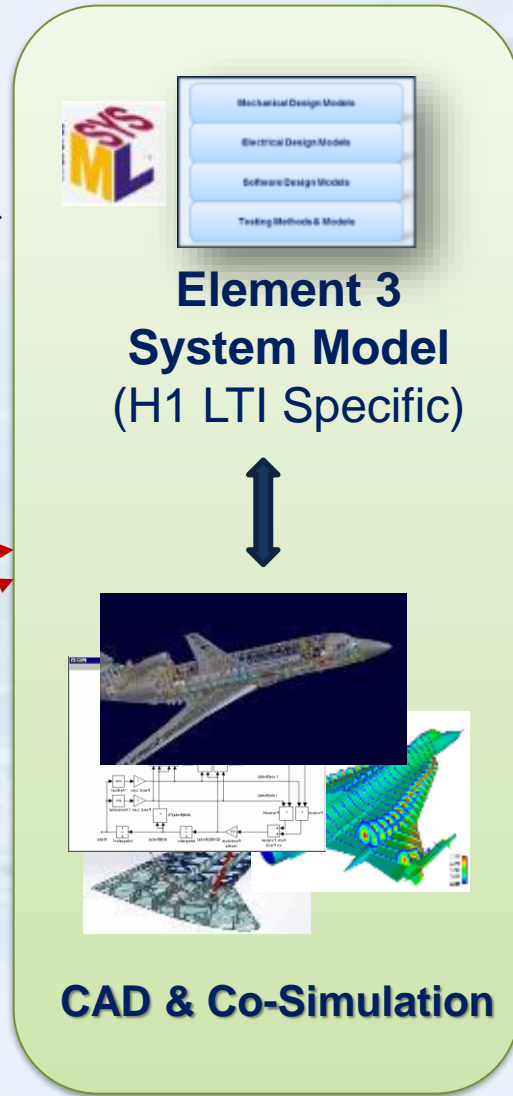
Element 3



Element 2
System Model
(H1 LTI Specific)



Gov.-NG Collaboration
Through IDE



Process and Methods End State

- Competencies use System & Subsystem Model to define, simulate, validate and verify system compliance and interfaces
- Government and industry employ model data as alternative to CDRL's.
- Near continuous stakeholder awareness significantly reduces cost and scope of milestone reviews
- Integrated Model Based V&V

Integrated Development Environment (IDE)



AGILE & MBSE: Pros and Cons

- **Pros**

- MBSE is exposing risks on a per-sprint basis, allowing the development team to adjust in near real-time as work is accomplished under the AGILE process
- The SE and other core engineering disciplines are being made aware more comprehensively of constraints and issues resulting from cross-discipline design in a single design environment

- **Cons**

- MBSE Sprint Team overloaded with managing health of system model due to larger development teams
- Enforcing EVM in addition to the AGILE process is hindering the organic development of the model
- Sprint Period of two weeks inhibits start up of system model for structure and behavior elements
- Lack of cross sprint team awareness of approaches and style guides even with scrum of scrums
- Lack of an allocated baseline prior to Agile



Questions





Abstract

- **NAVAIR's latest program goal is to deploy, integrate, and sustain significant interoperable technology upgrades to increase the mission profile of the aircraft system in the coming years. The Northrop Grumman MBSE Agile Team has been establishing a system model for the as is product baseline, to be designed baseline, and the processes for each technical discipline with modeling approaches to transition into a digital technical baseline for the program. In the last two releases, the team has been developing modeling approach activity diagrams and style guide diagrams within the architecture modeling application, CAMEO Enterprise Architect®, to meet the Systems Engineering Modeling and Architecture Plan (SEMAP). The approach diagram provides each sprint team the “tasks, work products, and flow” to complete each type of modeling domain (e.g. behavioral) while the style guide diagrams are unique example diagrams with aligning requirements for each definition and usage of objects compliant with UAF and best practices from industry following Object-Oriented System Engineering Methodology (OOSEM). The team is also extending current NAVAIR profiles like classification of each element and view while developing new profiles for data rights and approval. Other MBSE efforts in the corporate portfolio will be able to leverage these style guides, approach diagrams, and profiles to establish system modeling methods for applying system engineering models to streamline digital technical reviews, submit digital deliverables, and increase technical competencies integration into generating their modeling approaches within the broader system model.**