

Systems Engineering Transformation Surrogate Pilot Experiments: Doing Everything in Models to Demonstrate the Art-of-the-Possible

Sponsor: NAVAIR and CCDC-AC

**By
Dr. Mark Blackburn**

www.sercuarc.org

**Presented to: INCOSE North Texas Chapter Meeting
April 14, 2020**

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- NAVAIR characterized the Systems Engineering Transformation (SET) Framework for a Digital Engineering (DE)-enabled acquisition. This presentation discusses the Surrogate Pilot use cases, models and lessons learned in assessing the SET Framework for collaboration between government and industry.
- This is an evolving version of a briefing that summarizes the Systems Engineering Transformation (SET) Surrogate Experiments. It provides an overview to set the context of the SET Framework concept and Functional Areas. Research is one of the functional areas that was defined along with an evolving set of objectives that are being used to guide the experiments, and trace the results to the objectives.
- These experiments are being conducted by a team of NAVAIR Subject Matter Experts, SERC Collaborators from Stevens Institute and Georgia Tech, and a Surrogate Contractor from Altair. The ongoing results and lessons learned are captured on the All Partners Network (APAN.org @ <https://community.apan.org/wg/navair-set/set-surrogate-pilot/>) and being shared with Industry and Government.
- This briefing is Distribution A.

Research Tasks and Collaborator Network

RT-48	Mark Blackburn (PI), Stevens Rob Cloutier (Co-PI) - Stevens Eirik Hole - Stevens Gary Witus – Wayne State	RT-168 – Phase I & II	Mark Blackburn (PI), Stevens Dinesh Verma (Co-PI) – Stevens Ralph Giffin Roger Blake - Stevens Mary Bone – Stevens Andrew Dawson – Stevens (Phase I) Rick Dove John Dzielski, Stevens Paul Grogan - Stevens Deva Henry – Stevens (Phase I) Bob Hathaway - Stevens Steven Hoffenson - Stevens Eirik Hole - Stevens Roger Jones – Stevens Benjamin Kruse - Stevens Jeff McDonald – Stevens (Phase I) Kishore Pochiraju – Stevens Chris Snyder - Stevens Gregg Vesonder – Stevens (Phase I) Lu Xiao – Stevens (Phase I) Brian Chell (Grad) – Stevens Luigi Ballarinni (Grad) – Stevens Harsh Kevadia (Grad) – Stevens Kunal Batra (Grad) – Stevens Khushali Dave (Grad) – Stevens Rob Cloutier – Visiting Professor Robin Dillon-Merrill – Georgetown Univ. Ian Grosse – Univ. of Massachusetts Tom Hagedorn – Univ. of Massachusetts Todd Richmond – Univ. of Southern California (Phase I) Edgar Evangelista – Univ. of Southern California (Phase I)	RT-195	Mark Blackburn (PI), Stevens Mary Bone - Stevens Ralph Giffin - Stevens Benjamin Kruse - Stevens Russell Peak – Georgia Tech. Stephen Edwards – Georgia Tech. Adam Baker (Grad) – Georgia Tech. Marlin Ballard (Grad) – Georgia Tech. Donna Rhodes - MIT Mark Austin – Univ. Maryland Maria Coelho (Grad) – Univ. Maryland	ART-002	Mark Blackburn (PI), Stevens Dinesh Verma (Co-PI) – Stevens Kunal Batra – Stevens Mary Bone - Stevens John Dzielski, Stevens Steven Hoffenson - Stevens Steve Hespelt - Stevens Roger Jones - Stevens Benjamin Kruse - Stevens Chris Snyder - Stevens Brian Chell (Grad) – Univ. Maryland Ian Grosse – Univ. of Massachusetts Tom Hagedorn – Univ. of Massachusetts
RT-118	Mark Blackburn (PI), Stevens Rob Cloutier - Stevens Eirik Hole - Stevens Gary Witus – Wayne State						
RT-141	Mark Blackburn (PI), Stevens Mary Bone - Stevens Gary Witus – Wayne State						
RT-157	Mark Blackburn (PI), Stevens Mary Bone - Stevens Roger Blake - Stevens Mark Austin – Univ. Maryland Leonard Petnga – Univ. of Maryland			WRT-1008	Mark Blackburn (PI), Stevens Mary Bone - Stevens Benjamin Kruse - Stevens Bill Rouse – Stevens/Georgetown Russell Peak – Georgia Tech. Selcuk Cimentalay – Georgia Tech. Adam Baker (Grad) – Georgia Tech. Marlin Ballard (Grad) – Georgia Tech. Alanna Carnevale (Grad) – Georgia Tech. William Stock (Grad) – Georgia Tech. Donna Rhodes - MIT Mark Austin – Univ. Maryland Maria Coelho (Grad) – Univ. Maryland		
RT-170	Mark Blackburn (PI), Stevens Mary Bone - Stevens Deva Henry - Stevens Paul Grogan - Stevens Steven Hoffenson - Stevens Mark Austin – Univ. of Maryland Leonard Petnga – Univ. of Maryland Maria Coelho (Grad) – Univ. of Maryland Russell Peak – Georgia Tech. Stephen Edwards – Georgia Tech. Adam Baker (Grad) – Georgia Tech. Marlin Ballard (Grad) – Georgia Tech.						

SERC 2020

4

- WHAT: Context and Scope of NAVAIR SE Transformation
- HOW: Use Evolving Surrogate Pilot and Experiments to Demonstrate Art-of-the-Possible
- HOW: Transformation Elements Moving from Documents to Models
- HOW: Phase II Objectives (FY19) Aligns with SE Transformation (SET) Priorities
- HOW WELL: Contributing Modeling Examples to Support Workforce Development demonstrating Art-of-the-Possible

WHAT: **Context and Scope of NAVAIR SE Transformation**

Research in the Context of Surrogate Pilot Experiments

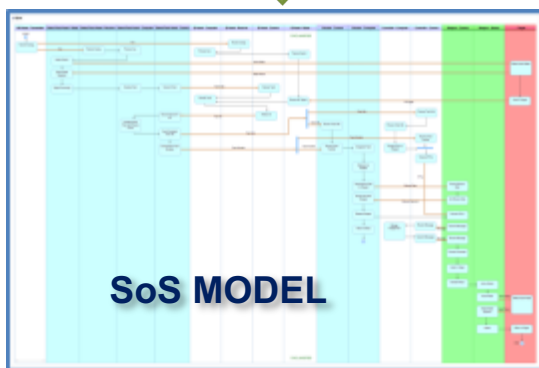
Capability Based Acquisition - Outpacing the Threat

Digital Thread enables rapid delivery of Integrated Capabilities

Integration and Interoperability (I&I)



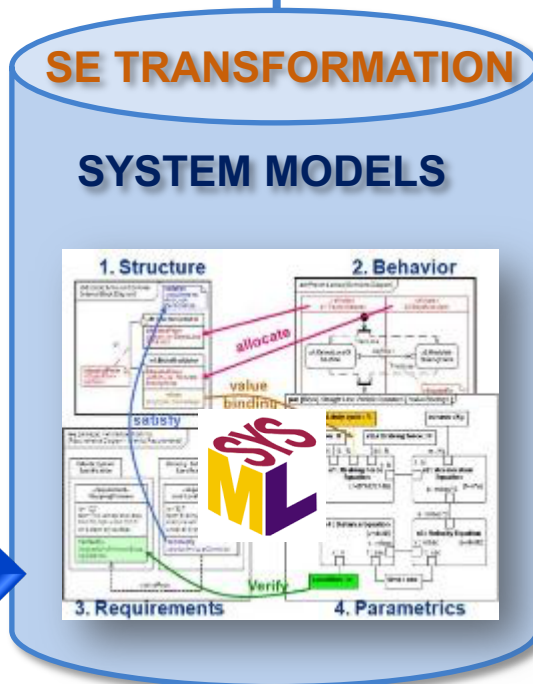
Integrated Warfare Analysis establishes CONEMPS and Effects-Chains



SoS MODEL

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

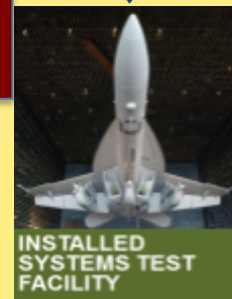
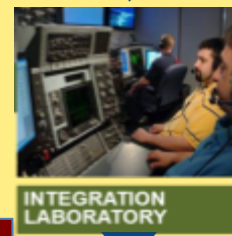
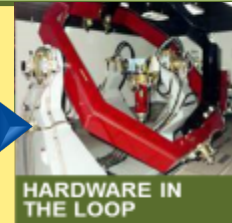
System models form "Constructive" basis for LVC M&S environment



Systems are developed in a Model-Based environment

Capabilities-Based T&E

Constructive Virtual Live



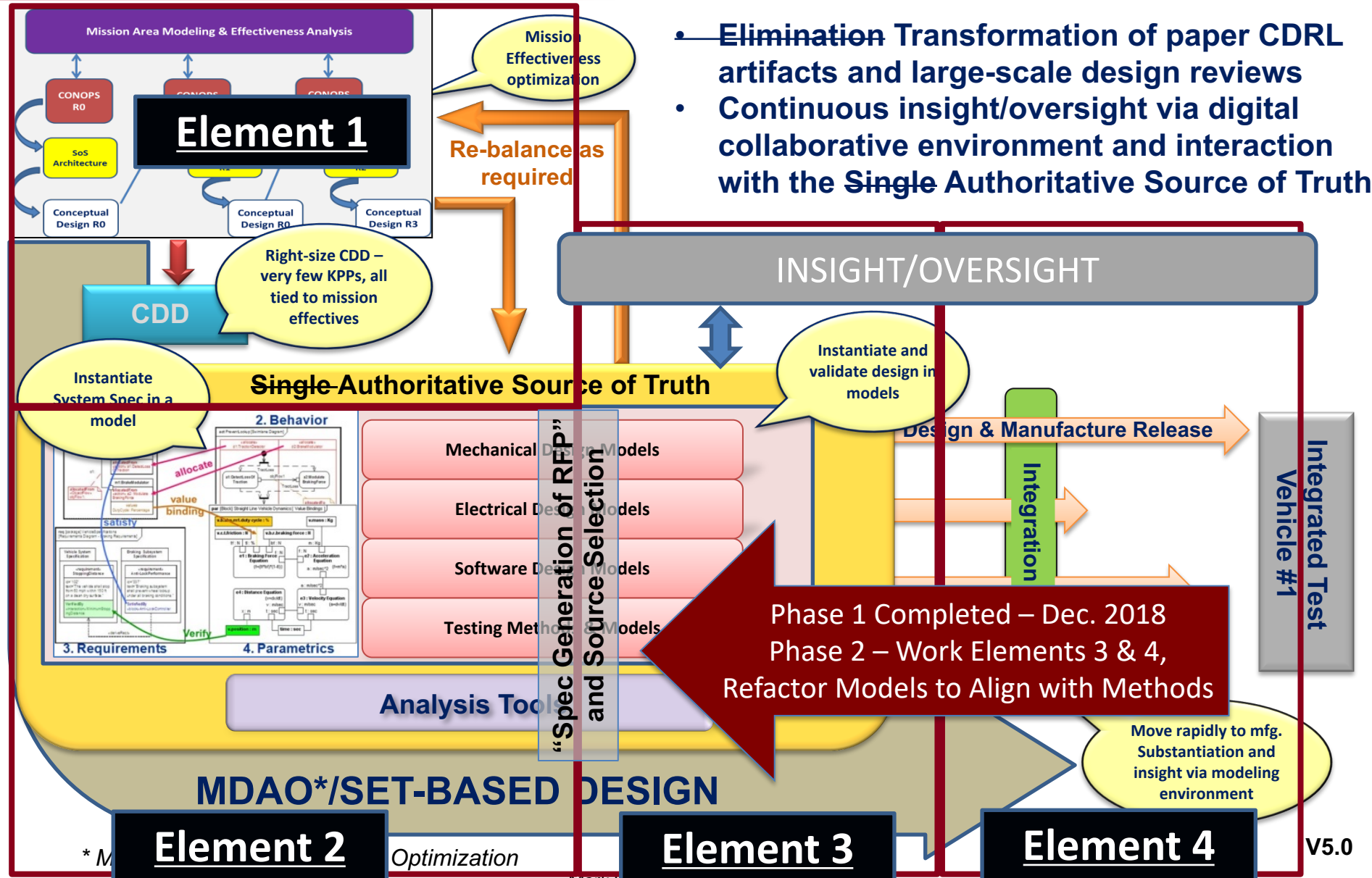
Focus is Here



LVC-based Training
maximizes Fleet proficiency

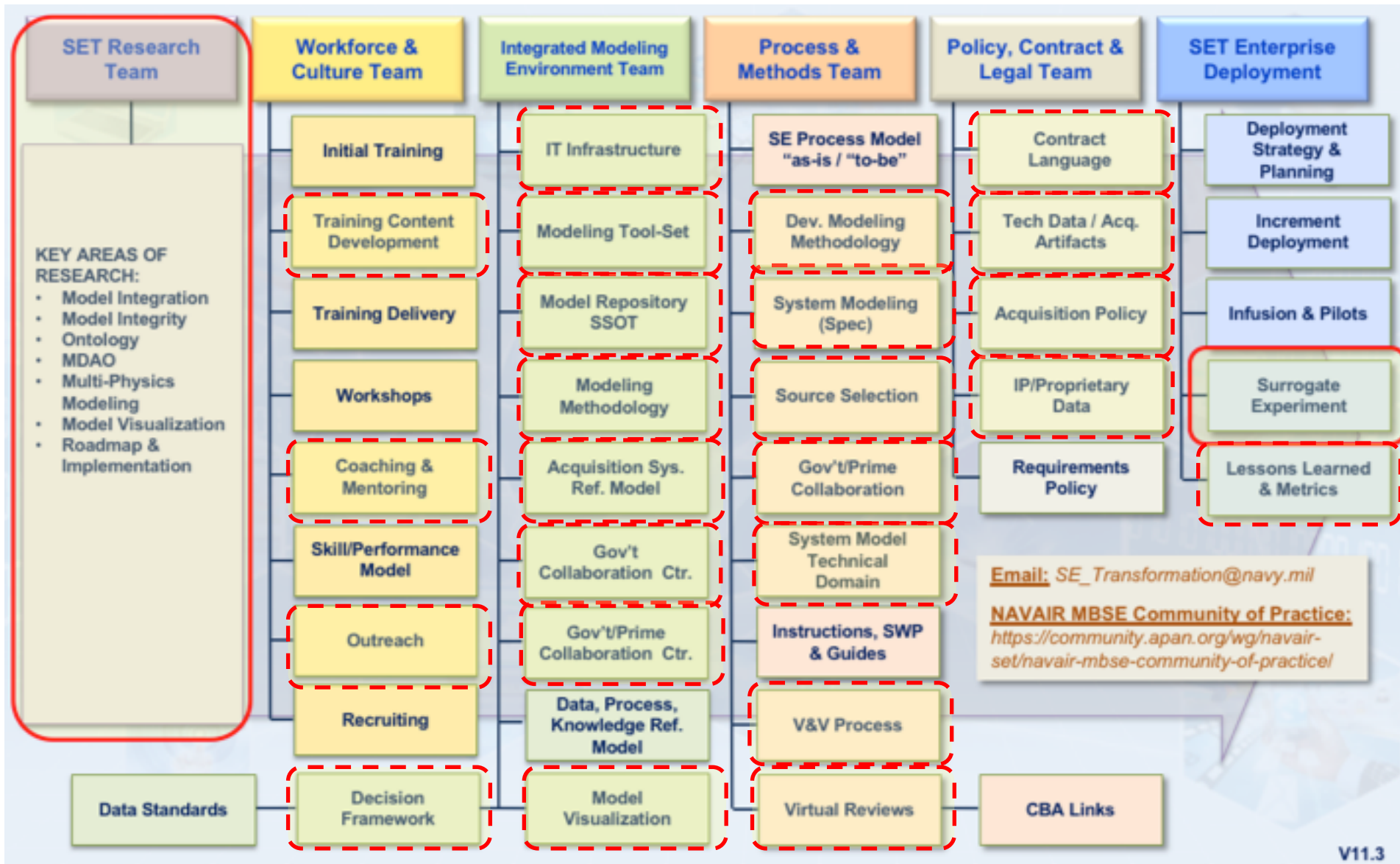
Surrogate Pilot focus is on Characterizing, Assessing, and Refining SET Framework for Model-Based Acquisition

SET Framework Concept Initially Rolled Out 2016



CDRL: Contract Data Requirements List

Research and Surrogate Experiment contributes broadly to SET Functional Areas



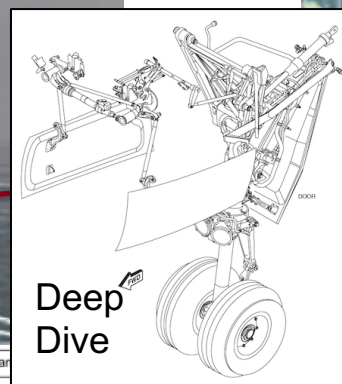
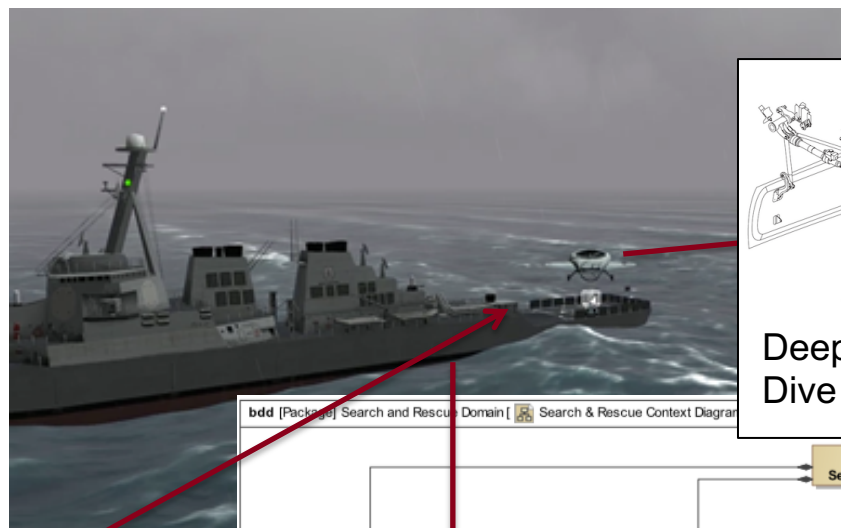
HOW: Use Evolving Surrogate Pilot and Experiments to Demonstrate Art-of-the-Possible

- **Doing “Everything” in Models to show we can**
- **Operating in a Collaborative Environment**
- **Using an Authoritative Source of Truth**

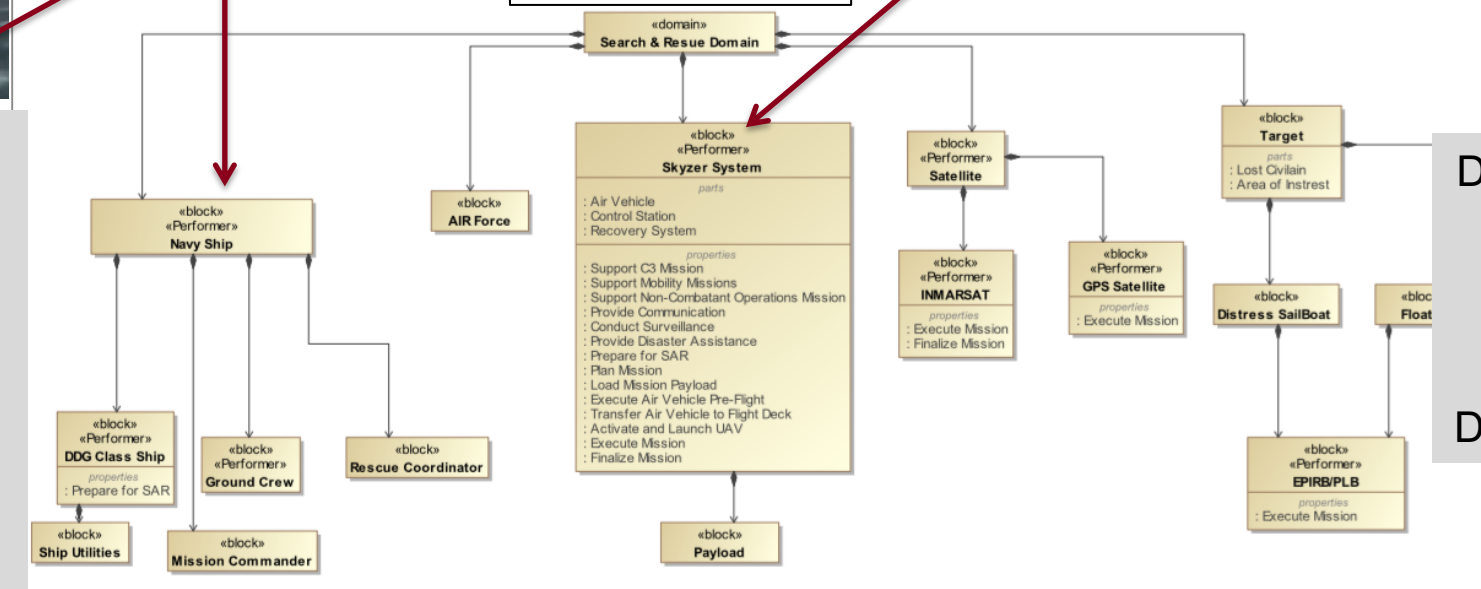
Surrogate Pilot Scenario: Skyzer UAS & Launch and Recovery for Landing Gear Deep Dive

Graphical CONOPS Scenario:
Search & Rescue

Performance constraints force Multi-physics
Design considerations - similar to Bell Eagle Eye



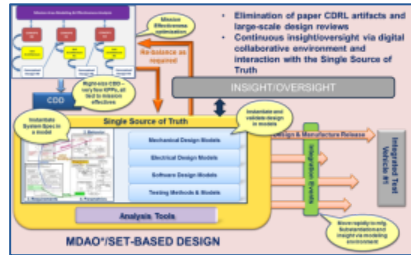
Phase II is adding ship-based Launch and Recovery Capability & Deep Dive supports Airworthiness Use Case



Descriptive Model (e.g., SysML) replace Documents

Skyzer System & Mission Models developed using SysML

Research Use Cases for Surrogate Pilot and Experimental System (Skyzer)

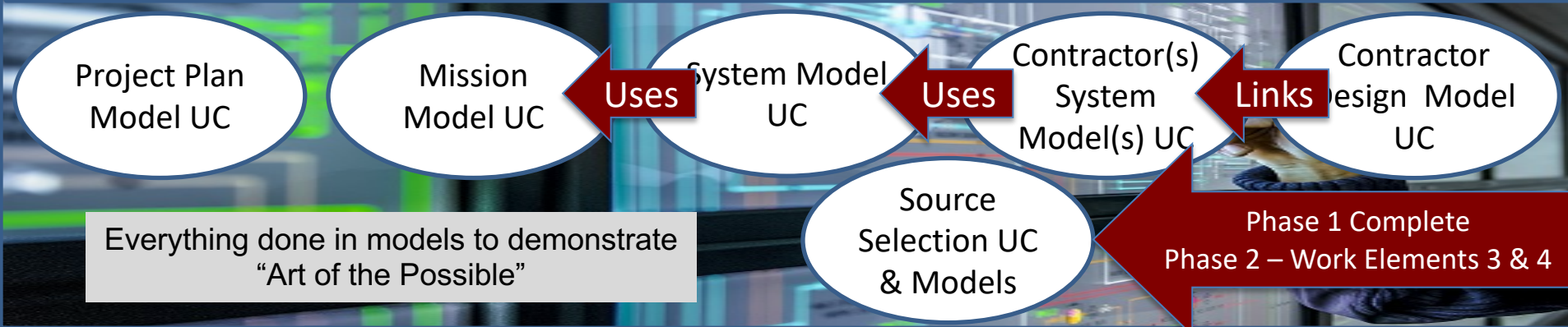


Assess SE Framework Concept



We are Collaborating in AST

Skyzer is Experimental UAS System using Authoritative Source of Truth (AST)



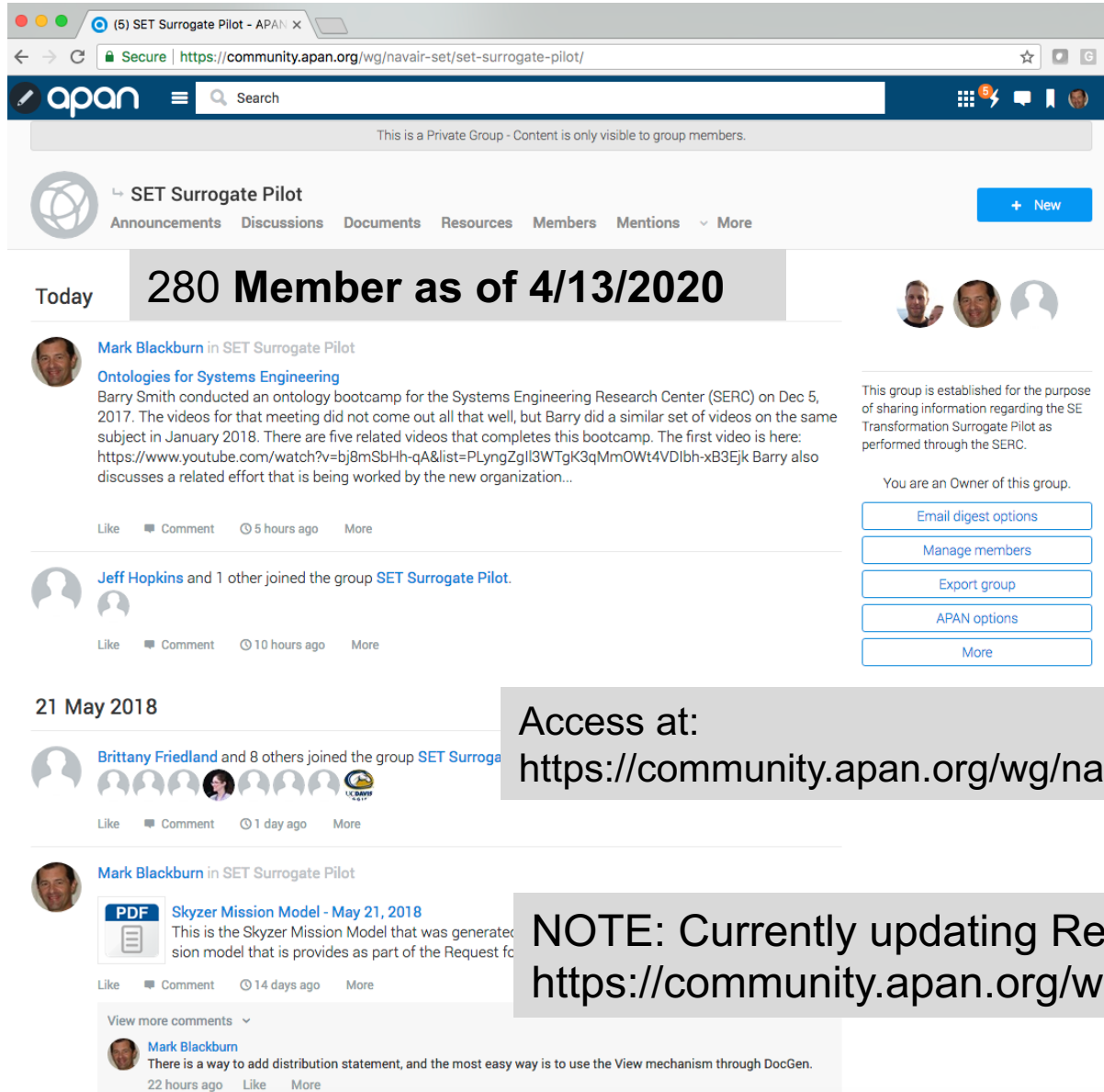
Mission Models
System Models
SOW Models
Evaluation Model
Based on Standards



Proposal for Design Models focused to demonstrate aspects for Producability Decisions involving **Multi-physics**

GFI:
Government
Furnished
Information

Continuous Updates of Discussion Threads Provided on Public All Partners Network



(5) SET Surrogate Pilot - APAN x

Secure | <https://community.apan.org/wg/navair-set/set-surrogate-pilot/>

apan Search

This is a Private Group - Content is only visible to group members.

SET Surrogate Pilot

Announcements Discussions Documents Resources Members Mentions More

+ New

Today **280 Member as of 4/13/2020**

Mark Blackburn in SET Surrogate Pilot

Ontologies for Systems Engineering

Barry Smith conducted an ontology bootcamp for the Systems Engineering Research Center (SERC) on Dec 5, 2017. The videos for that meeting did not come out all that well, but Barry did a similar set of videos on the same subject in January 2018. There are five related videos that completes this bootcamp. The first video is here: <https://www.youtube.com/watch?v=bj8mSbHh-qA&list=PLyngZgI3WTgK3qMmOWt4VDIbh-xB3Ejk> Barry also discusses a related effort that is being worked by the new organization...

Like Comment 5 hours ago More

Jeff Hopkins and 1 other joined the group SET Surrogate Pilot.

Like Comment 10 hours ago More

21 May 2018

Brittany Friedland and 8 others joined the group SET Surrogate Pilot.

Like Comment 1 day ago More

Mark Blackburn in SET Surrogate Pilot

Skyzer Mission Model - May 21, 2018

This is the Skyzer Mission Model that was generated for the Request for Information (RFI) process. The model provides a high-level overview of the mission model that is provided as part of the Request for Information (RFI) process.

Like Comment 14 days ago More

View more comments

Mark Blackburn

There is a way to add distribution statement, and the most easy way is to use the View mechanism through DocGen.

22 hours ago Like More

This group is established for the purpose of sharing information regarding the SE Transformation Surrogate Pilot as performed through the SERC.

You are an Owner of this group.

Email digest options

Manage members

Export group

APAN options

More

- Briefings
- Videos
- Models
- Discussion threads
- Instructs to see models on AWS

Access at:

<https://community.apan.org/wg/navair-set/set-surrogate-pilot/>

NOTE: Currently updating Research Group for Phase II

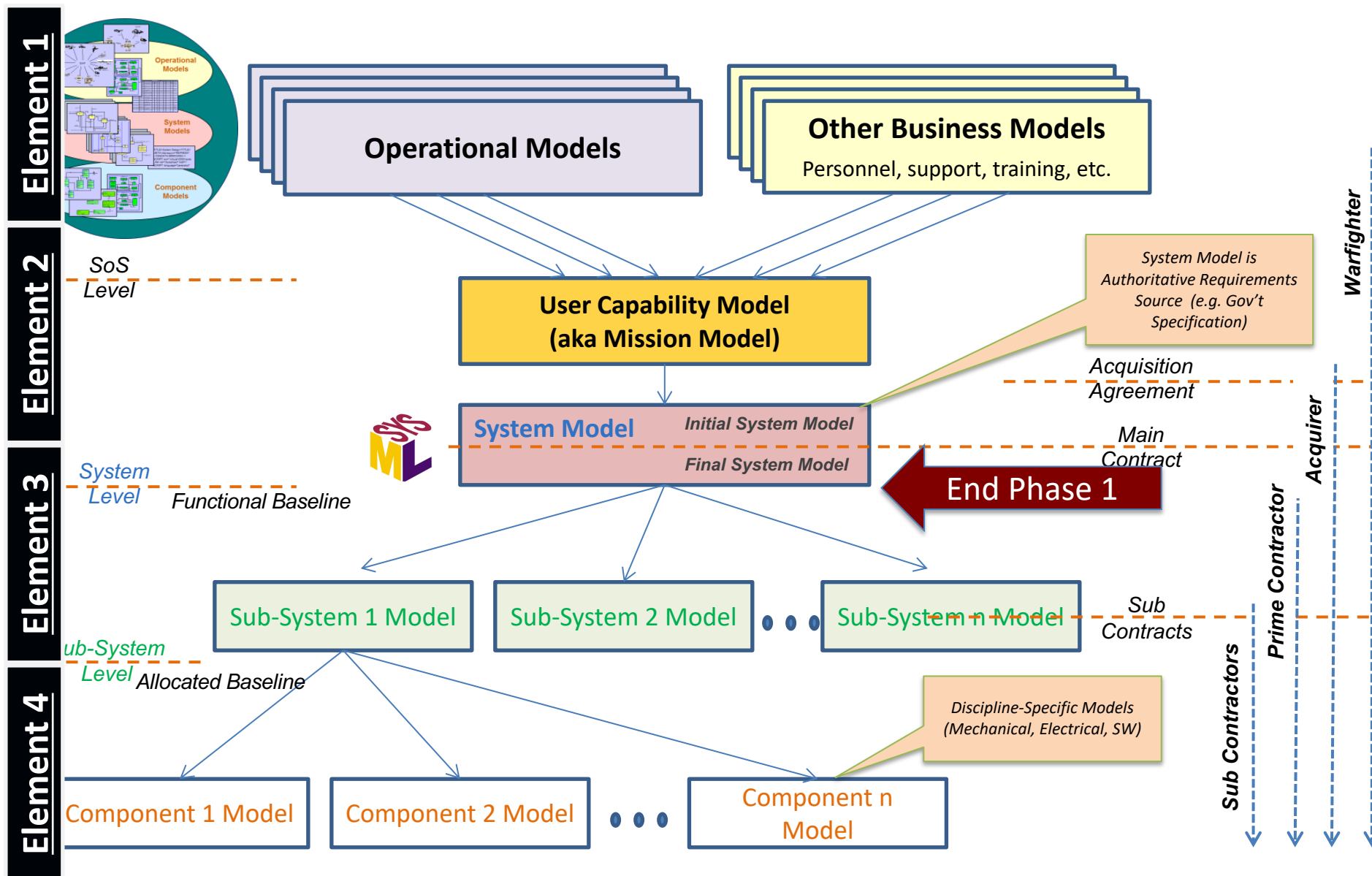
<https://community.apan.org/wg/navair-set/research/>

HOW: Transformation Elements Moving from Documents to Models

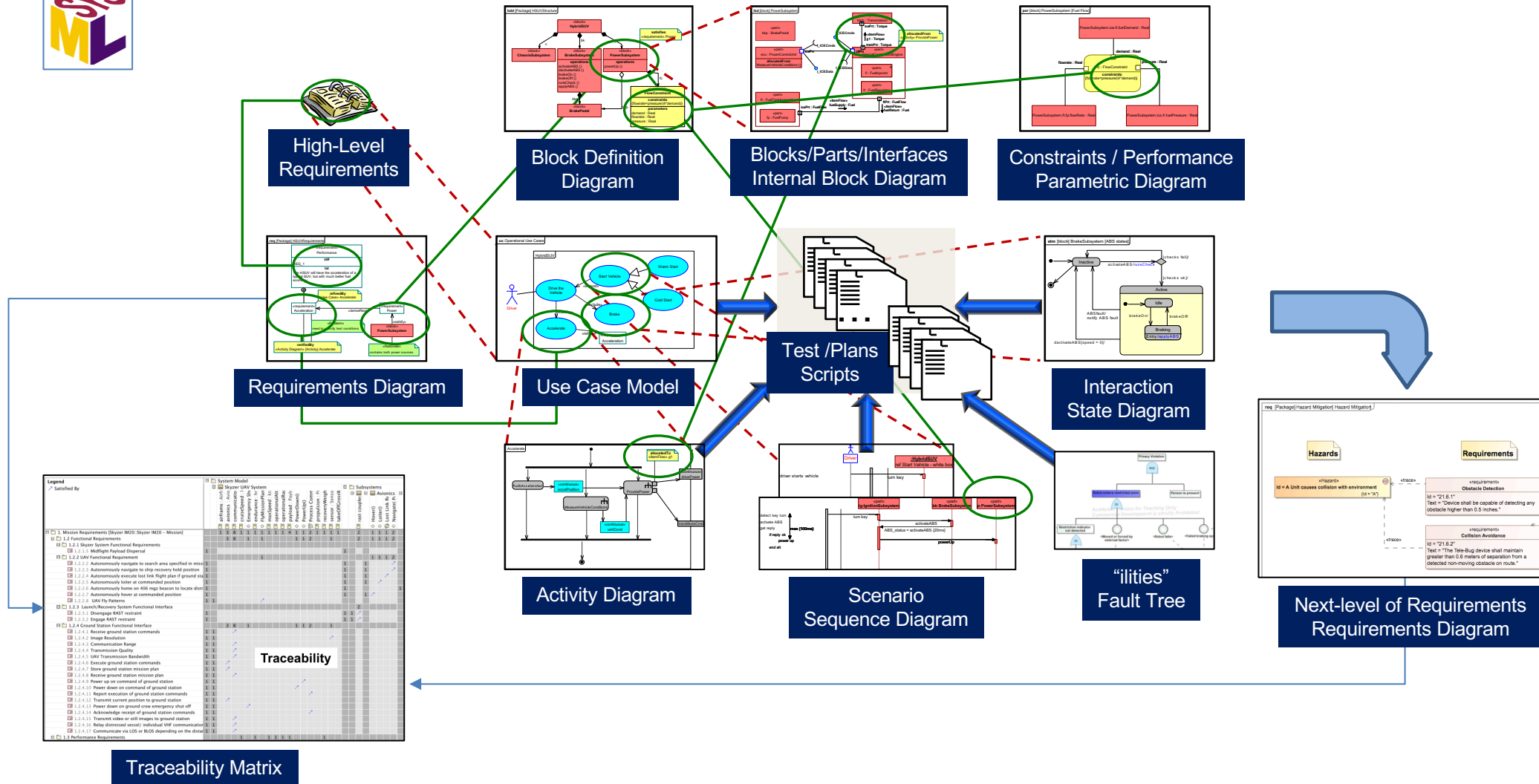
- **Developing/demonstrating Methods for Mission and System models**
- **Using models collaboratively in Authoritative Source of Truth**
- **Using OpenMBEE/DocGen to Generate Views for Stakeholder and Discipline-Specific Subject Matter Experts**

Skyzer Demonstrates Formalizing the Use of Models and Methods for the SET Framework Elements

Phase 2
 focused on
 Elements 3 & 4
 of
 SET Framework:
 How to reduce
 time by
 using models to
 better understand
 a maturing
 design

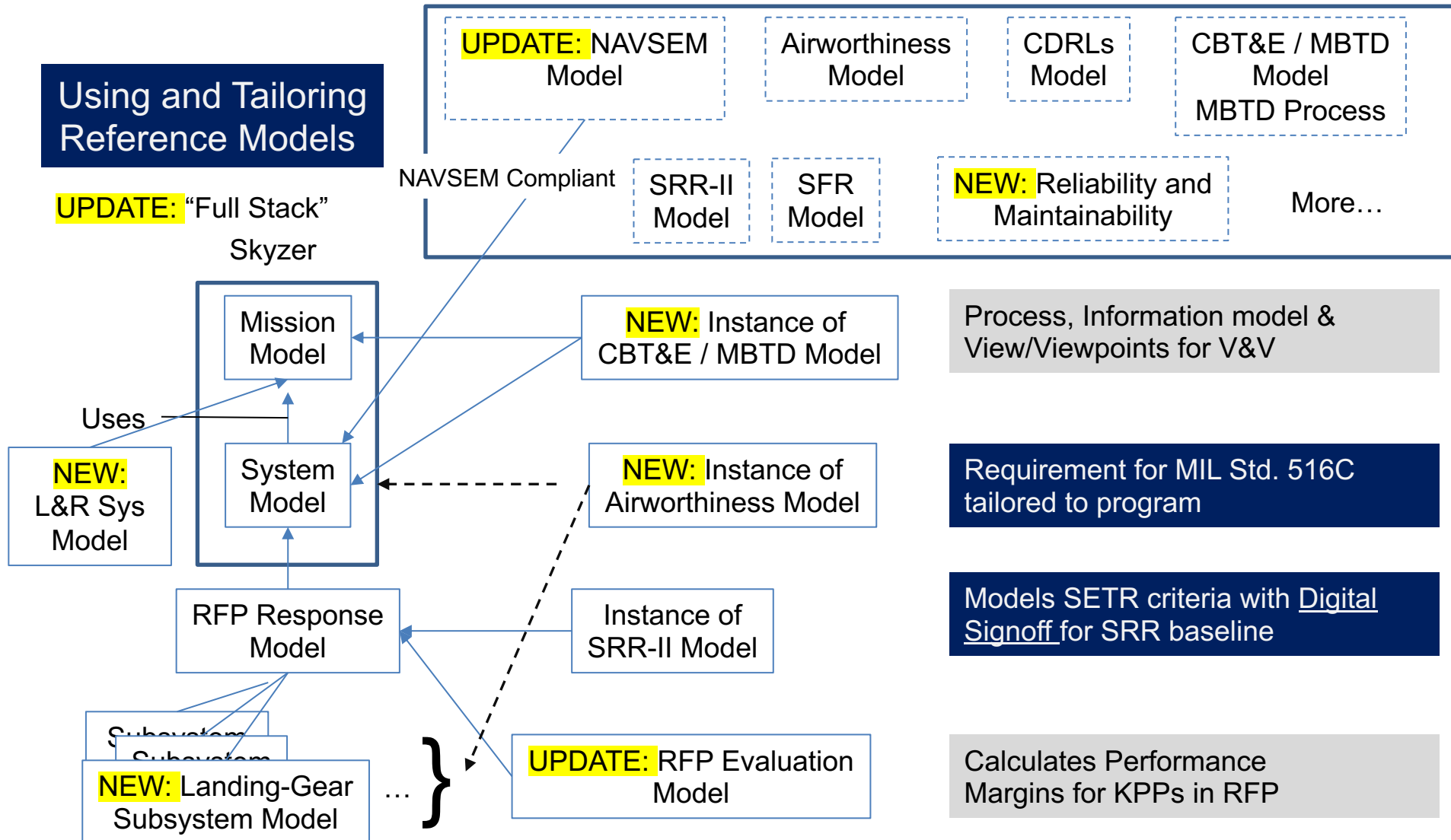


How MBSE Strengthens SE by Characterizing the Analysis of Structure, Behavior and Interfaces

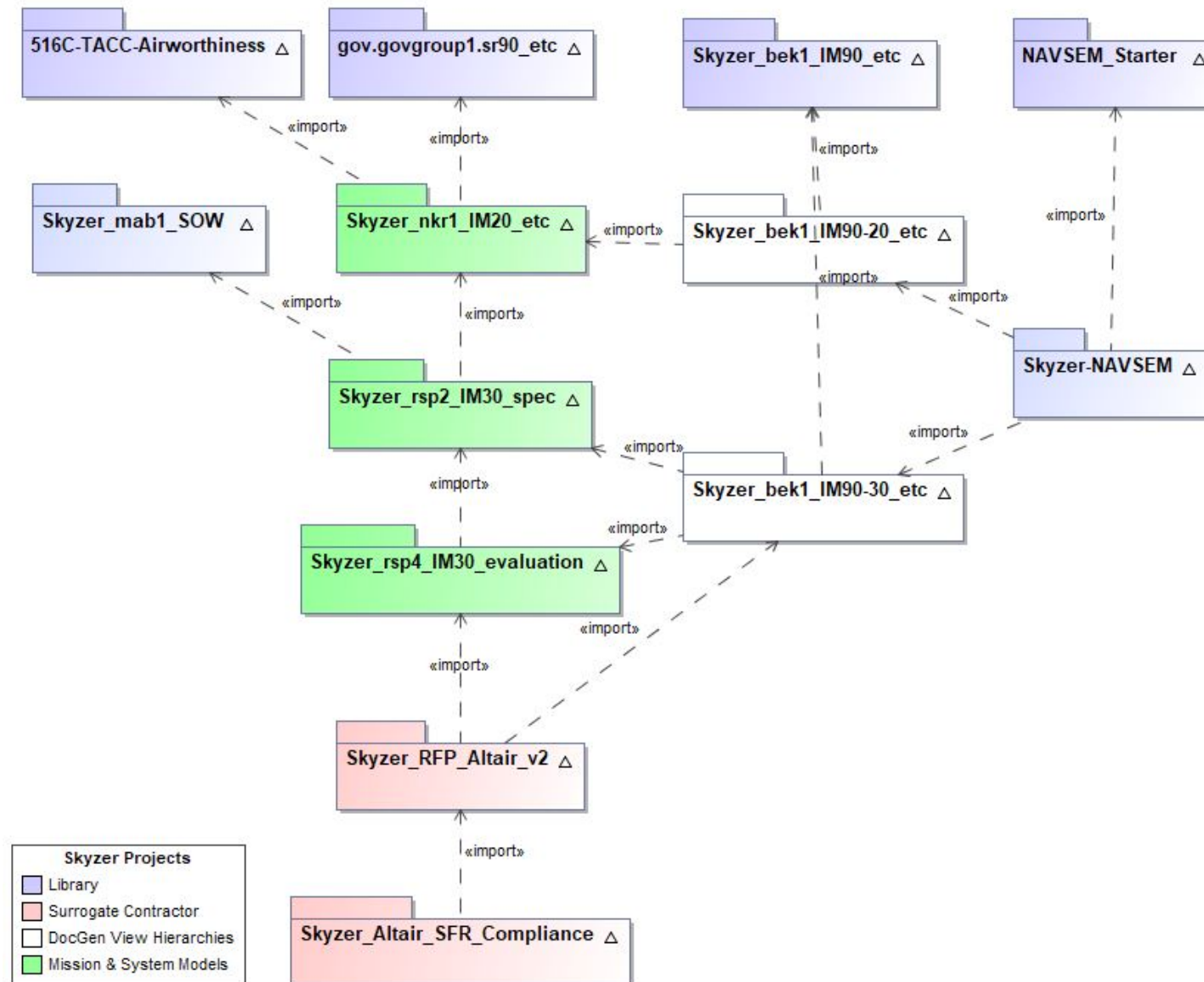


“Full Stack” of Models using Digital Signoff for Transformed SETR Criteria Represented in a Model

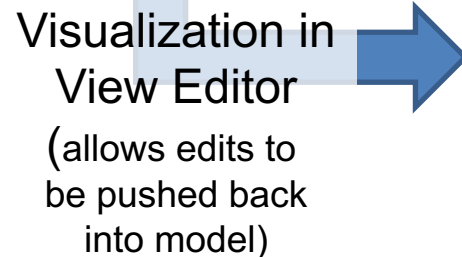
Reference models characterize reusable information and process



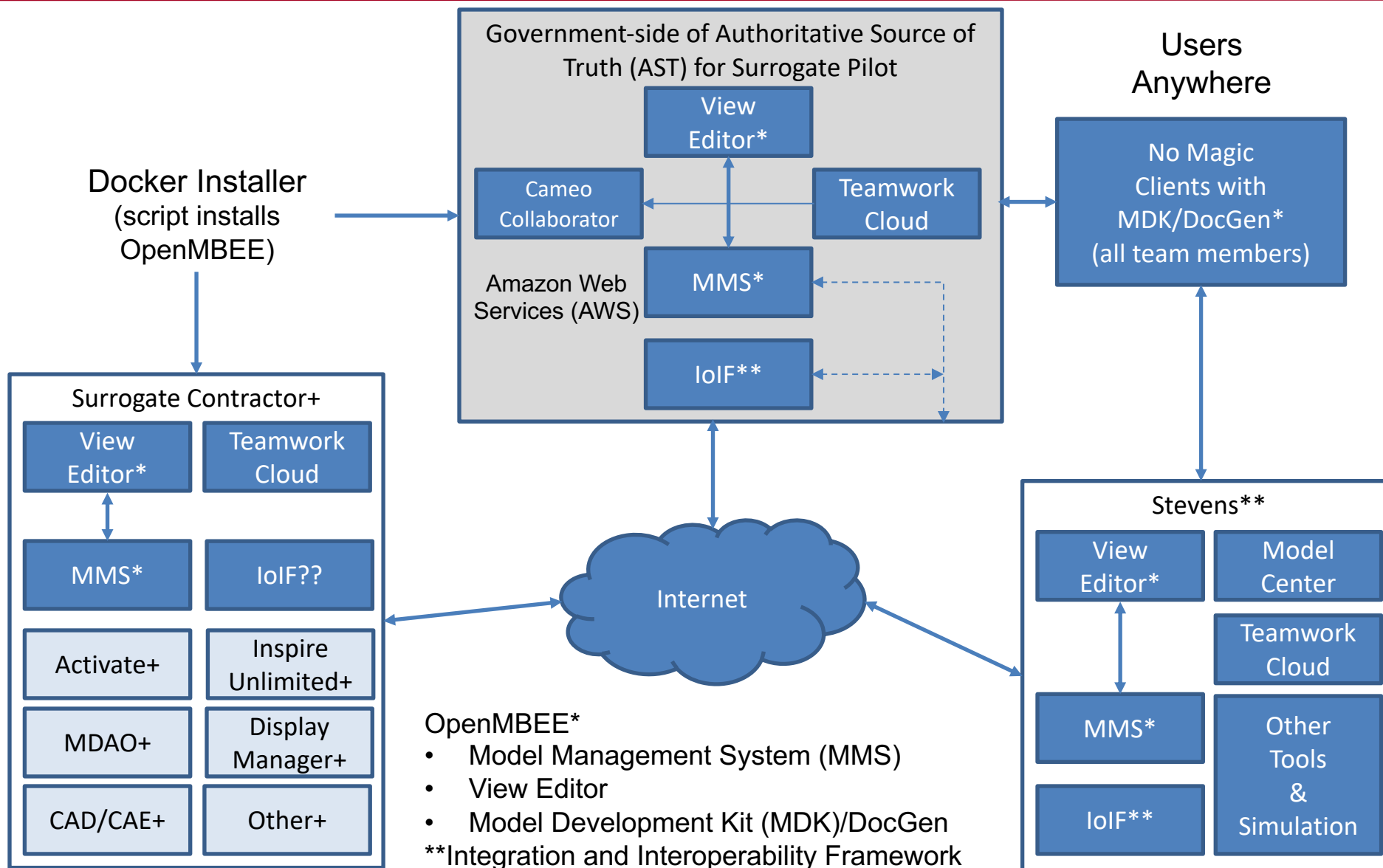
Model Organization – All Models Linked to Establish Authoritative Source of Truth



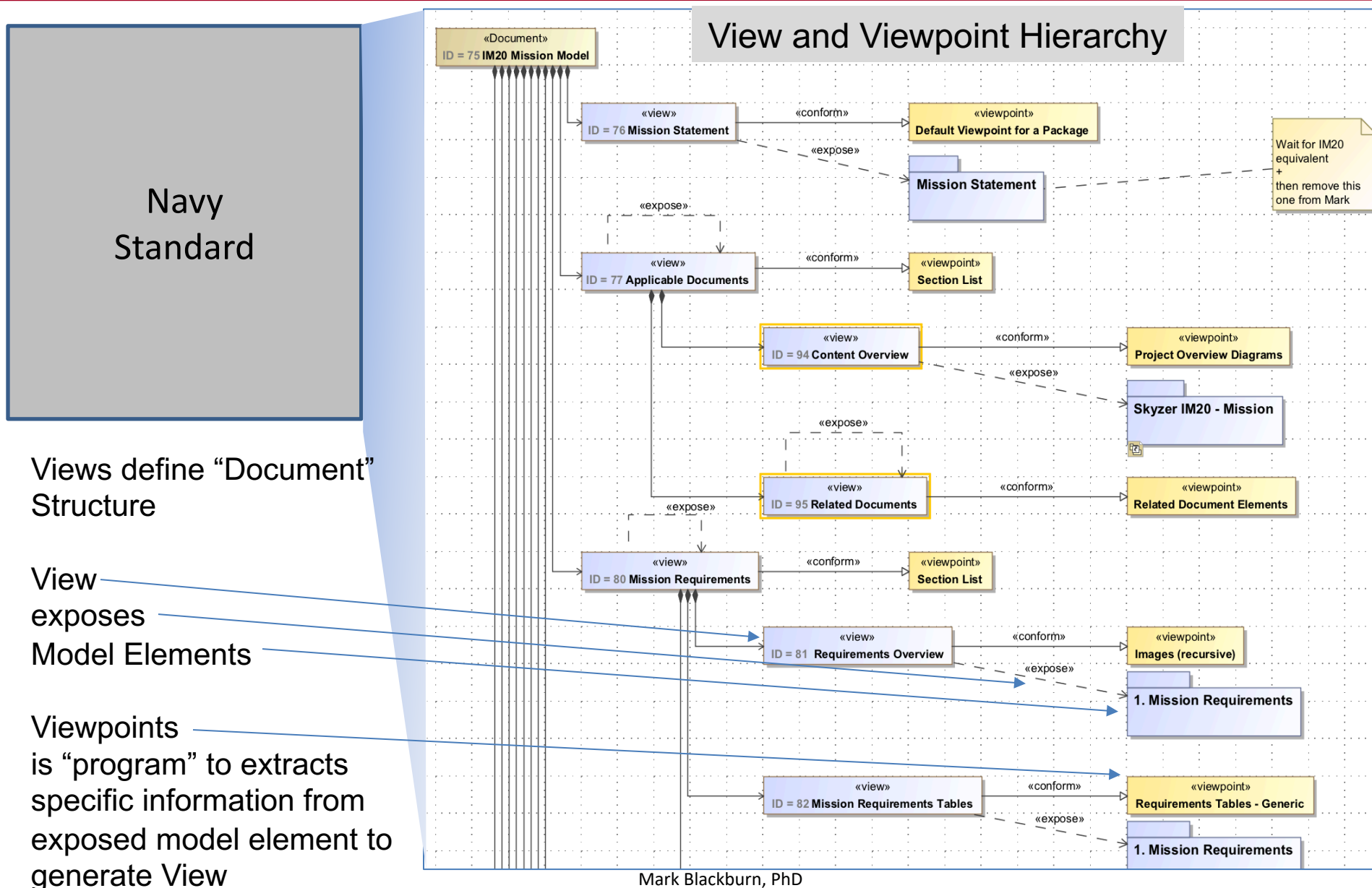
Model Management System



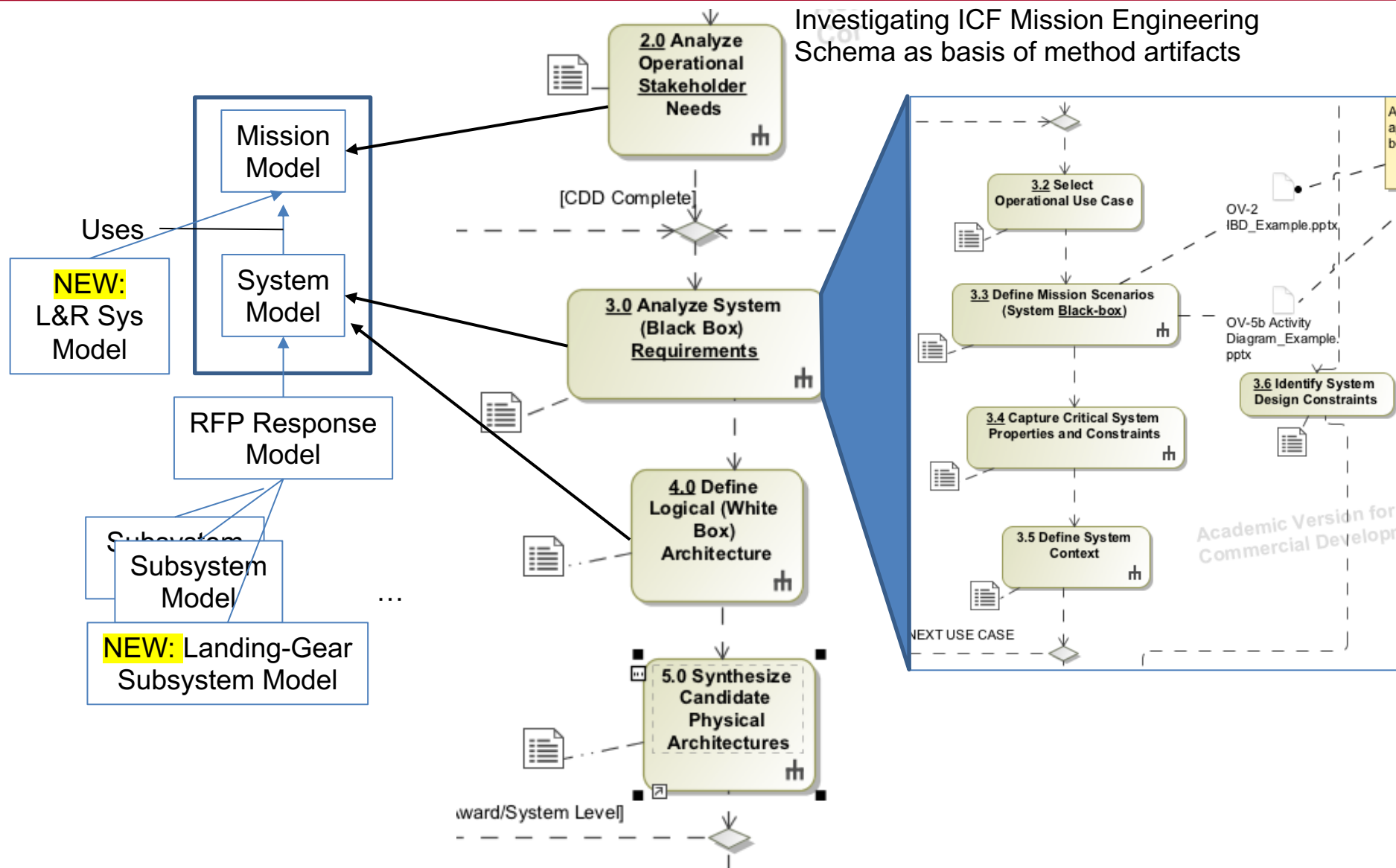
Elements of Authoritative Source of Truth



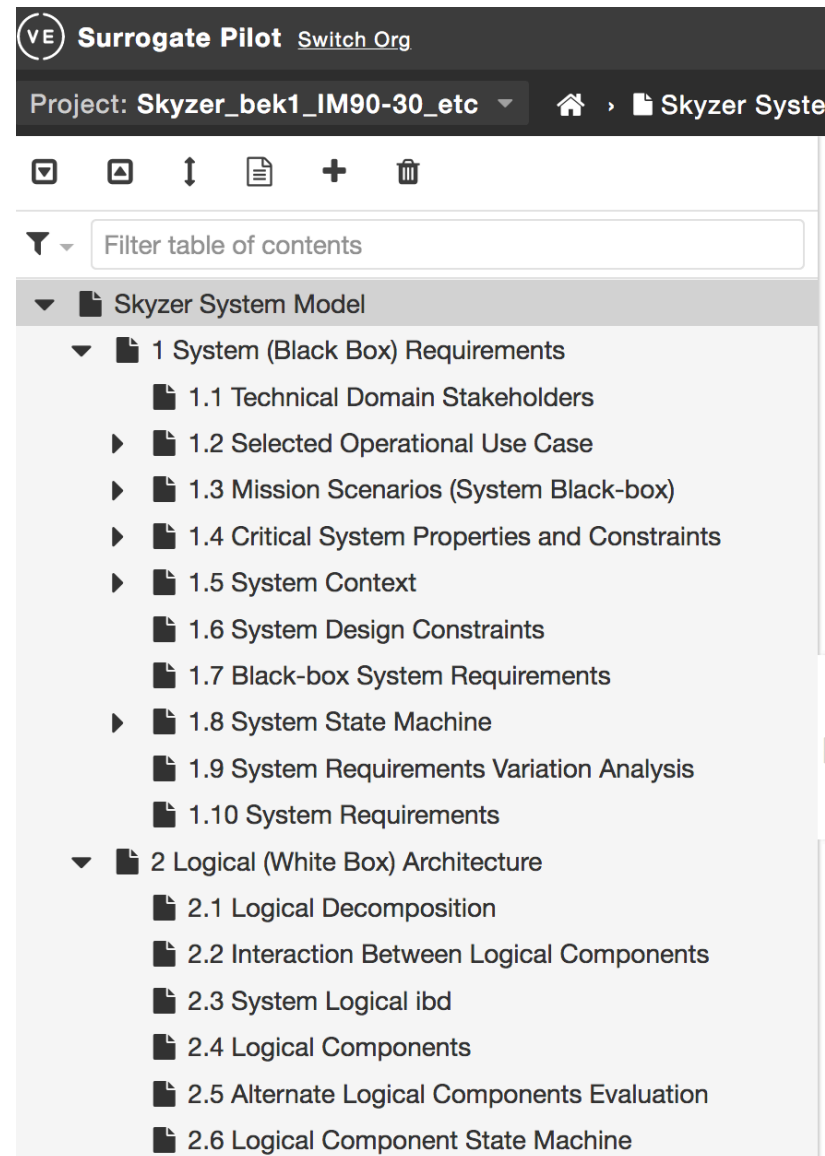
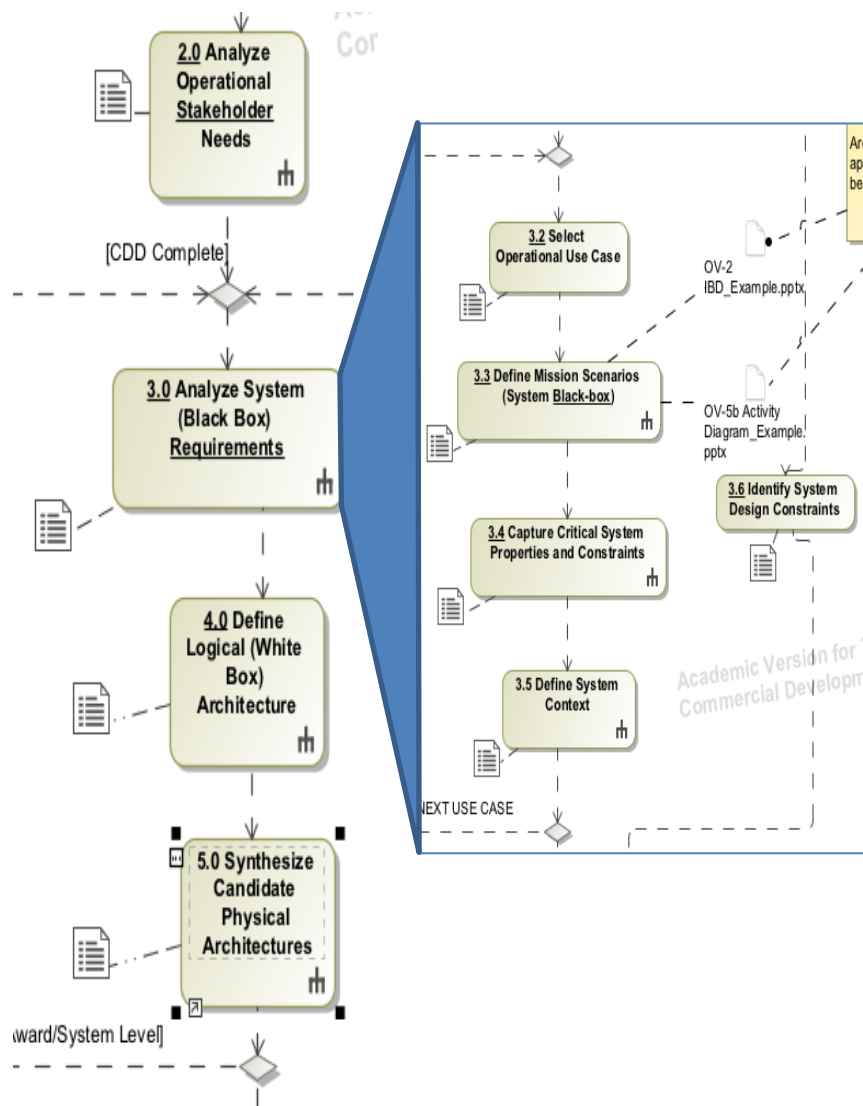
Example View and Viewpoint Hierarchy Used by DocGen



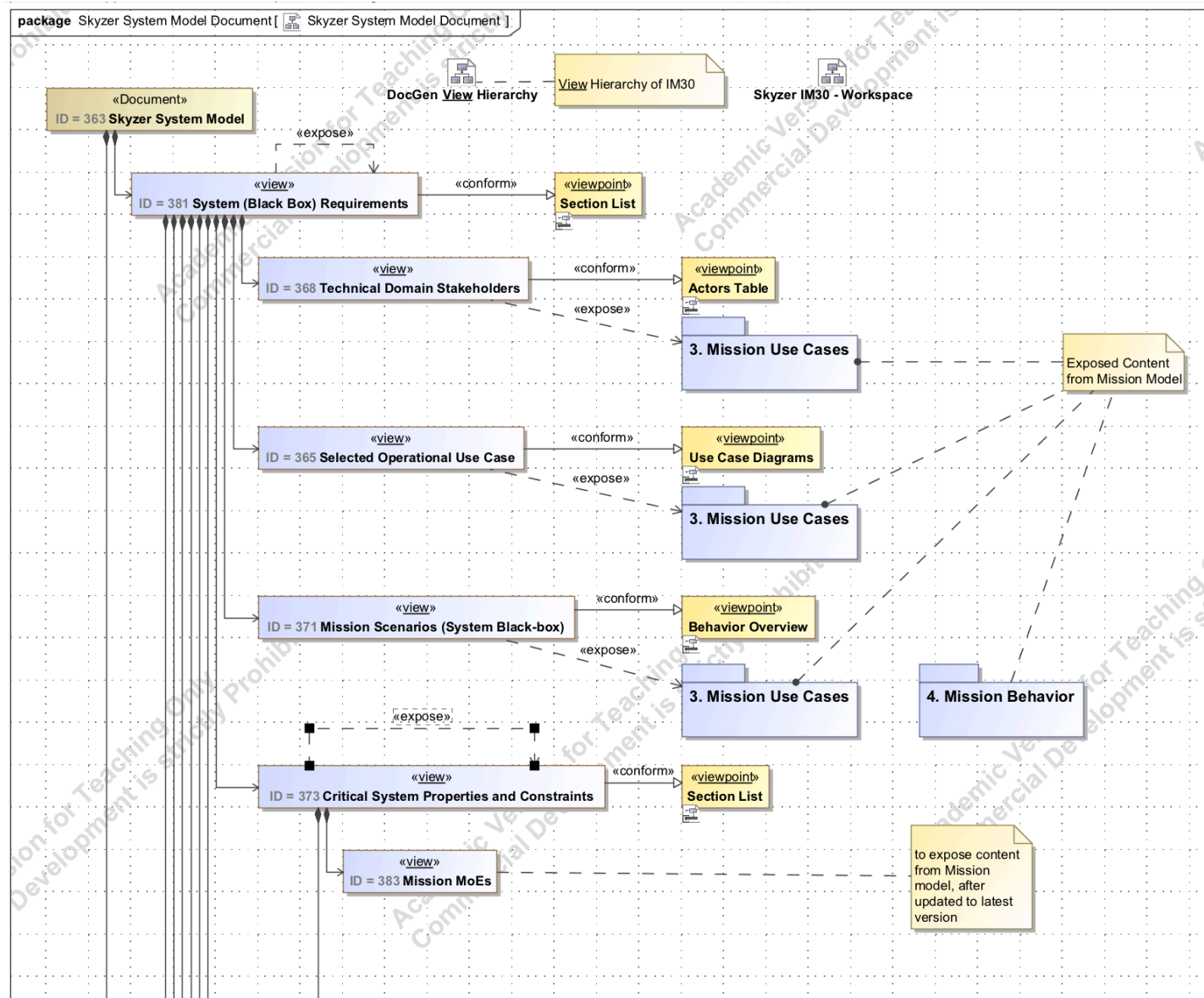
Models Need to Produce Artifacts/Work Products for NAVSEM Method



Update View and Viewpoint for Skyzer System Model



View and Viewpoint from Inside Model



Example: View Editor shows Skyzer Mission Model View

VE Surrogate Pilot [Switch Org](#)

Search selected project

UAT Help

Project: Skyzer_bek1_IM90-20_etc

Skyzer IM20 Mission Model

Branch: master

Filter items in the tree

- Skyzer IM20 Mission Model
 - 1 Mission Statement
 - 2 Applicable Documents
 - 3 Requirements
 - 3.1 Requirements Overview
 - 3.2 Mission Requirements
 - 3.3 Operational Requirements
 - 3.4 Functional Requirements
 - 3.5 Performance Requirement
 - 3.6 Design Constraints
 - 3.7 Key Performance Paramet
 - 3.8 Mission Requirements Trac
 - 4 Mission Structure
 - 5 Mission Use Cases
 - 6 Mission Behavior
 - 7 Mission Parametrics
 - 8 Mission Interface Definitions
 - 9 Skyzer UAV
 - 10 Ground Station
 - 11 Support Elements

DOCLIB

Communications Capability

3.5 Performance Requirements

#	Id	Name	Text	requirementKind
1	1.3.2	1.3.2 Cruise Speed	The UAV shall have a cruise speed of 170 knots	KPP
2	1.3.3	1.3.3 Max Payload Weight	The mission payload shall be not less than 200 lbs total in four individually deployable segments 50 lb or more.	KPP
3	1.3.7	1.3.7 UAV Operation Period	The system shall have minimum endurance of 4 hr loiter at 50 nm radius	KPP
4	1.3.4	1.3.4 Operational Radius	The Skyzer UAV shall have and operational radius of 200nm while sustaining cruise speed, carrying at least 100 lb of payload and hovering 15 minutes at the turn around point.	KPP
5	1.3.5	1.3.5 Recovery Condition	The Skyzer UAV shall be able to be recovered with at least 30% remaining fuel weight and at least 200 lb of payload.	KPP
6	1.3.1	1.3.1 Max Speed	The UAV shall have a max speed of 200 knots	
7	1.3.6	1.3.6 Operational Altitude	The Skyzer UAV shall be able to fly at an altitude of at least 15,000 ft. while maintaining minimum maneuverability requirements.	

1.3 Performance Requirements

(No Text)

Max Speed

ID:

1.3.1

Text:

The UAV shall have a max speed of 200 knots

Stereotype:

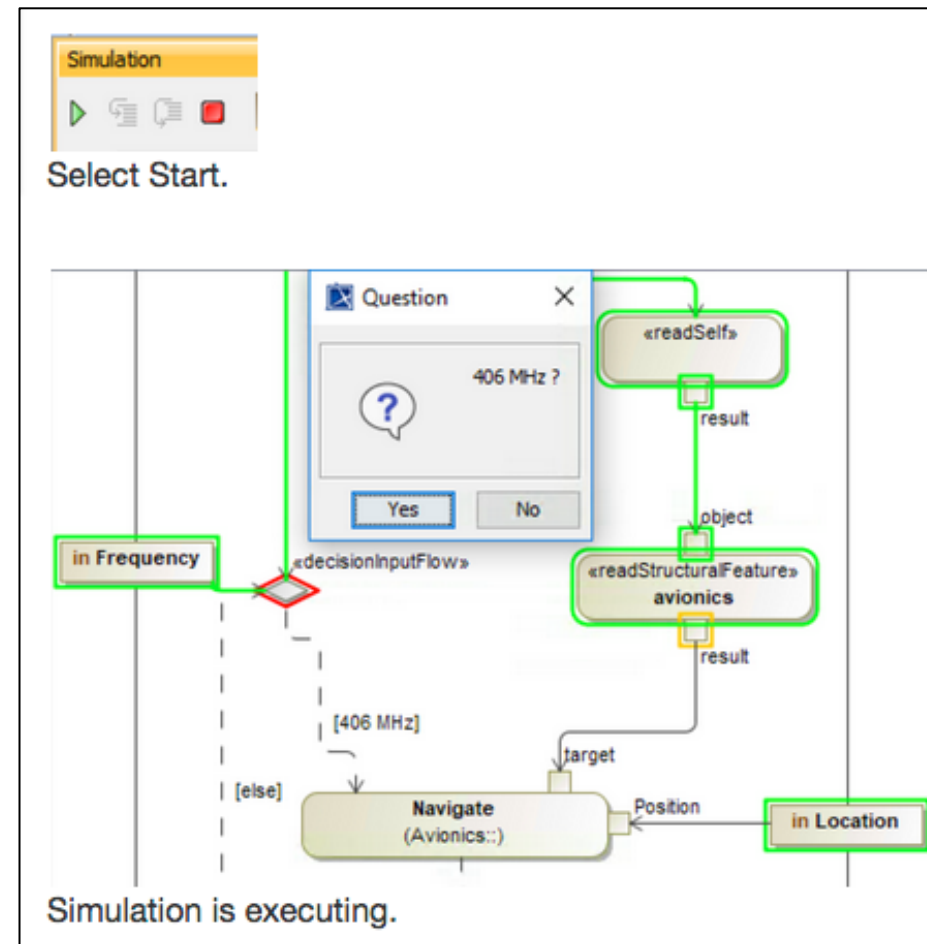
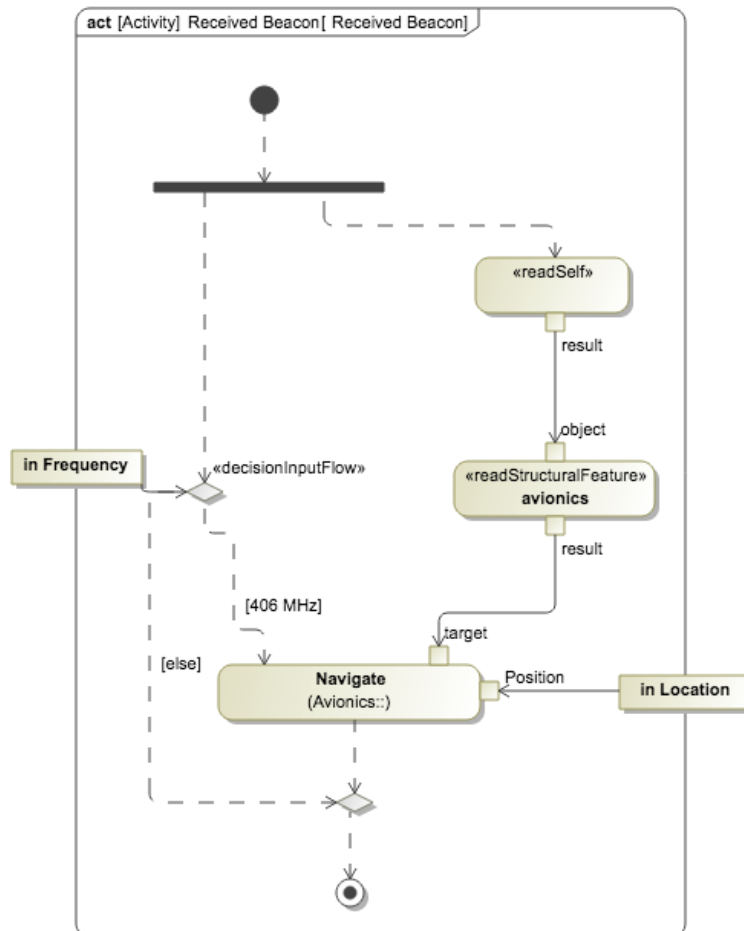
performanceRequirement

Cruise Speed

**Model information
can be “edited” in
View Editor (e.g., by SME)
and pushed
back into Model
(Fundamental to AST)**

Mission Requirements Refined into Behaviors and Analyzed through Simulations in Skyzer System Model

- State Machine Simulation in System Model supports analysis for understanding/visualizing dynamic behaviors – getting the right model and getting the model right

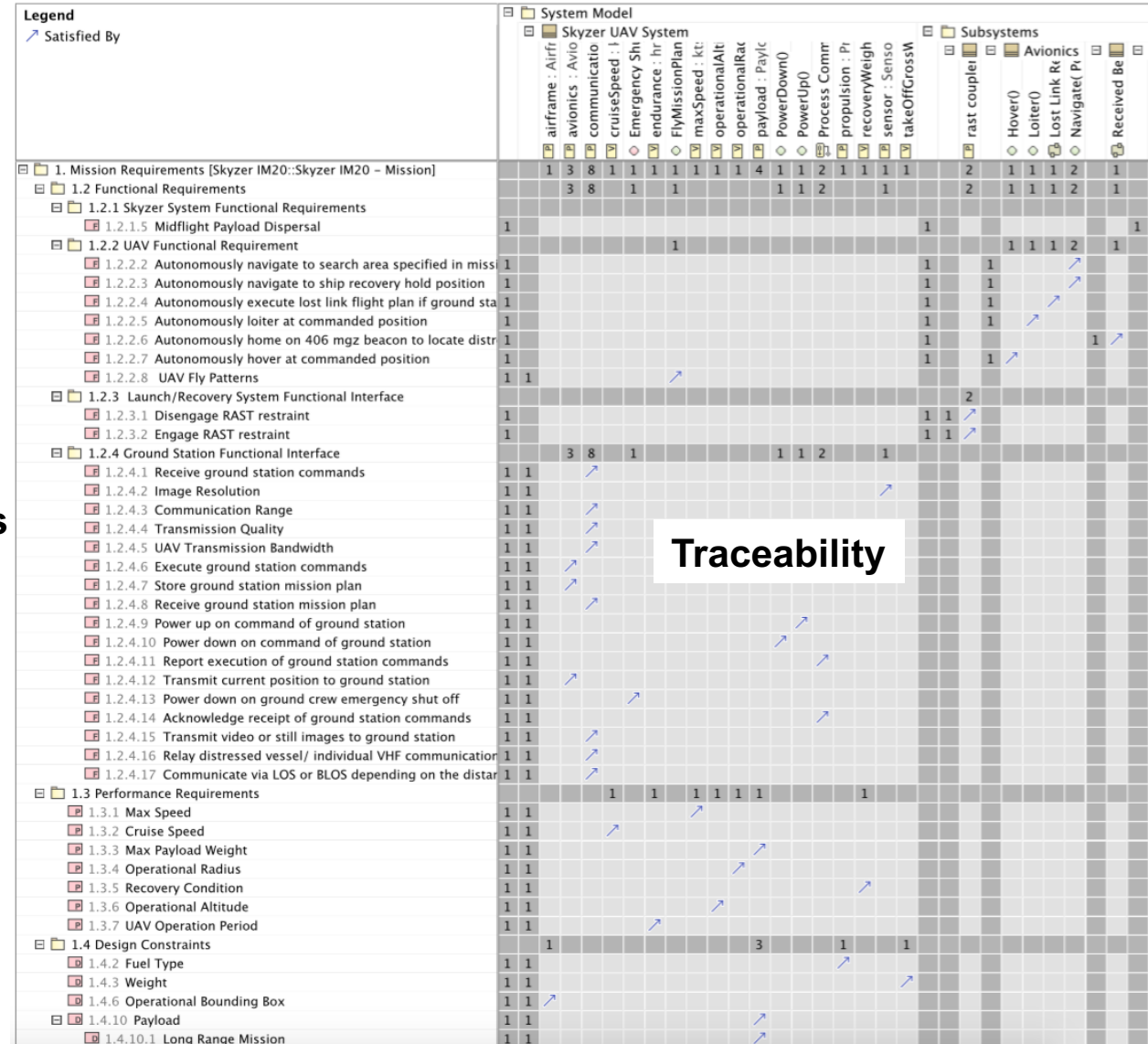


Skyzer Mission and System Requirements Traceability in Skyzer System Model

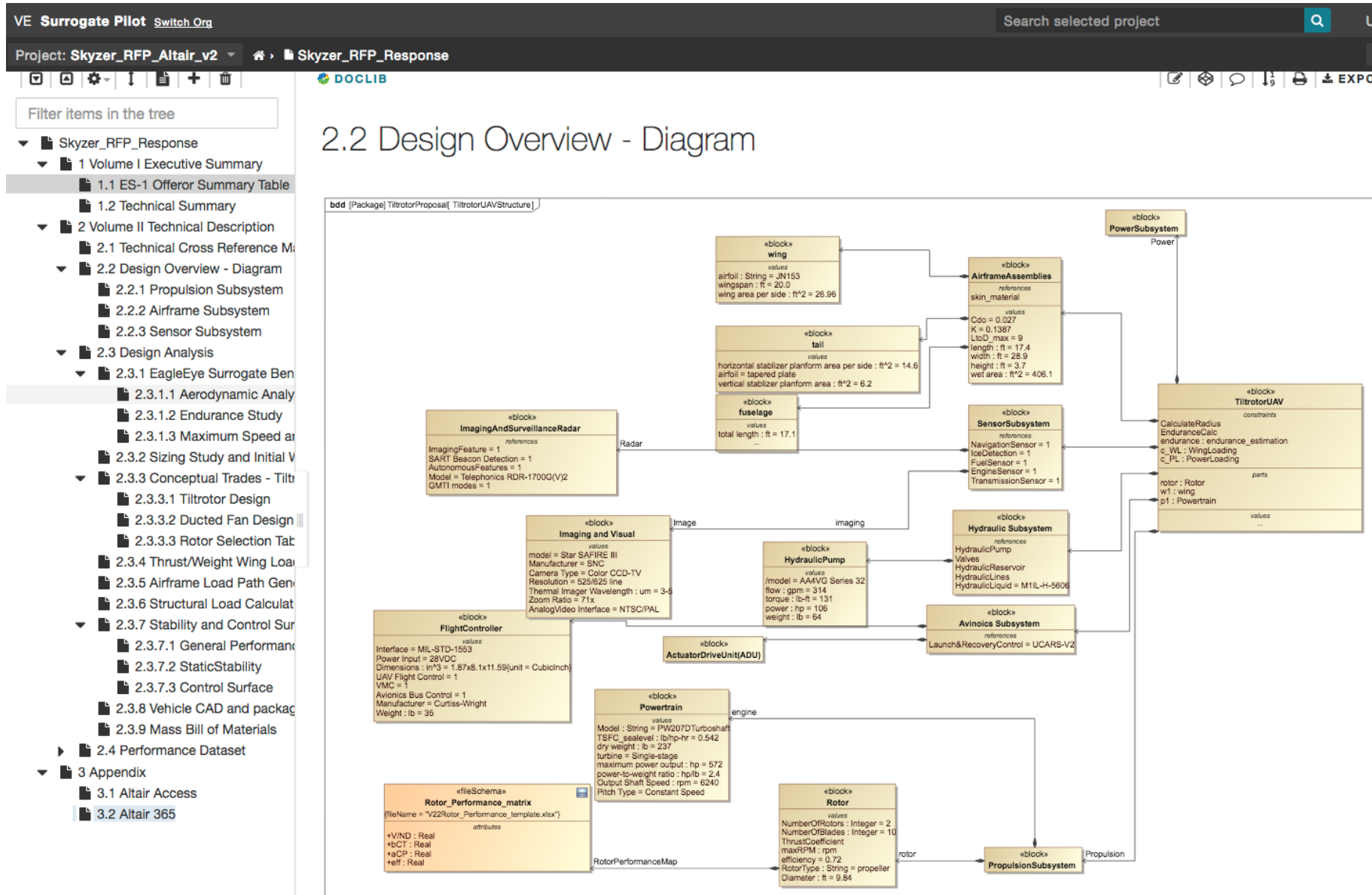
Figure 6.1. Requirements Satisfiability

Mission Requirements

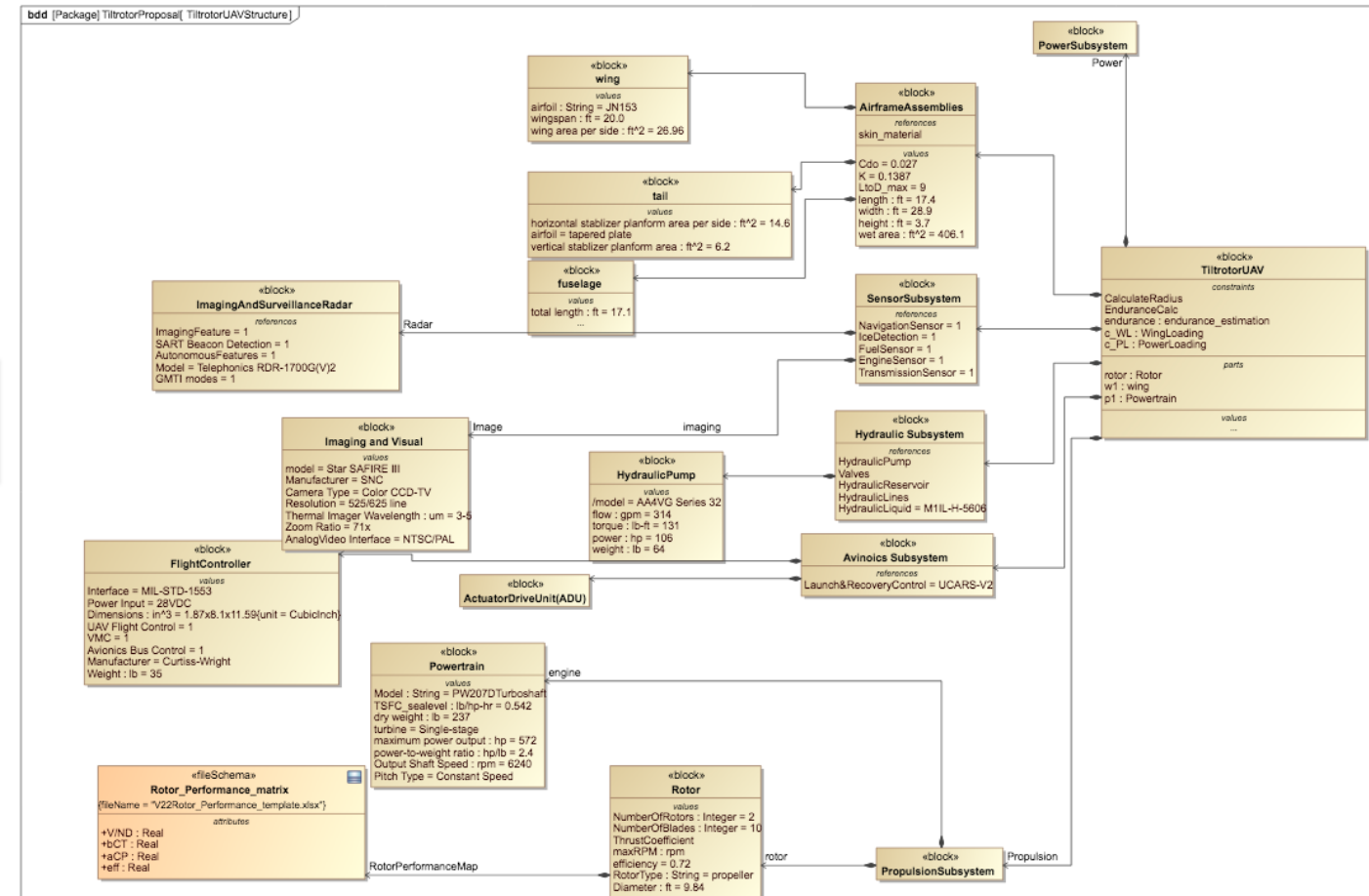
System Requirements



RFP Response Extends and Refines Skyzer System Model provided by Government as GFI



2.2 Design Overview - Diagram



View of RFP Response Hyperlinks to Discipline-Specific Models Provided in Generated View

VE Surrogate Pilot [Switch Org](#) Search selected project UAT Help M

Project: Skyzer_RFP_Altair_v2 Skyzer_RFP_Response Branch: master

Filter items in the tree

- ▼ Skyzer_RFP_Response
 - ▼ 1 Volume I Executive Summary
 - 1.1 ES-1 Offeror Summary Table
 - 1.2 Technical Summary
 - ▼ 2 Volume II Technical Description
 - 2.1 Technical Cross Reference Matrix
 - ▼ 2.2 Design Overview - Diagram
 - 2.2.1 Propulsion Subsystem
 - 2.2.2 Airframe Subsystem
 - 2.2.3 Sensor Subsystem
 - ▼ 2.3 Design Analysis
 - ▼ 2.3.1 EagleEye Surrogate Benchmark
 - 2.3.1.1 Aerodynamic Analysis
 - 2.3.1.2 Endurance Study
 - 2.3.1.3 Maximum Speed and Range
 - 2.3.2 Sizing Study and Initial Vehicle Design
 - ▼ 2.3.3 Conceptual Trades - Tiltrotor vs Ducted Fan
 - 2.3.3.1 Tiltrotor Design
 - 2.3.3.2 Ducted Fan Design
 - 2.3.3.3 Rotor Selection Table
 - 2.3.4 Thrust/Weight Wing Loading Calculations
 - 2.3.5 Airframe Load Path Generation
 - 2.3.6 Structural Load Calculations
 - ▼ 2.3.7 Stability and Control Surface Calculations
 - 2.3.7.1 General Performance
 - 2.3.7.2 Static Stability
 - 2.3.7.3 Control Surface
 - 2.3.8 Vehicle CAD and packaging
 - 2.3.9 Mass Bill of Materials
 - 2.4 Performance Dataset
 - ▼ 3 Appendix
 - 3.1 Altair Access
 - 3.2 Altair 365

Engineering Activity Checklist

ENGINEERING ACTIVITY	DELIVERABLES	Offeror's Proposal System Model Element or Documentation Base Vol/Annex and Associated Page Number
Eagle Eye Surrogate Benchmark	Engineering system model, supporting CAE models and performance results to satisfy the "Requirement Model" or "System Model" (IM30) and KPP metrics.	EagleEye Surrogate Benchmark
Sizing Study	Take off weight, empty weight, fuel fraction, warm up, take off, and landing weight fraction. Mission segment fractions.	Sizing Script @ Altair365
Conceptual Trades - Tilt Rotor vs Ducted Fan	Airframe CFD models, co-efficient's of lift and drag, respective propulsive performance results for both concepts.	Conceptual Trades - Tiltrotor vs Ducted Fan
Initial Weight Targets	Targets set from task 1C.	WeightBudgetScript@Altair365
Vehicle CAD and packaging	Vehicle package space definition and major system locations. Technical Data Package.	Vehicle CAD and packaging
Thrust/Weight Wing Loading Calculations	Airframe load case matrix.	Thrust/Weight Wing Loading Calculation
Airframe Load Path Generation	Coarse structural topology optimization results.	Airframe Load Path Generation
Structural Load Calculations	Benchmark of conventional structural arrangement in current design space	Structural Load Calculations
Stability, Performance and Flight Characteristic Calculations	Final stability, performance and flight characteristic report.	Stability and Control Surface Calculations
Mass Bill of Materials	Mass bill of materials generated from the Technical Data Package.	Mass Bill of Materials

Surrogate Pilot RFP Response in View Editor

VE **Surrogate Pilot** [Switch Org](#)

Project: **Skyzer_RFP_Altair** [WIP](#)

Filter items in the tree

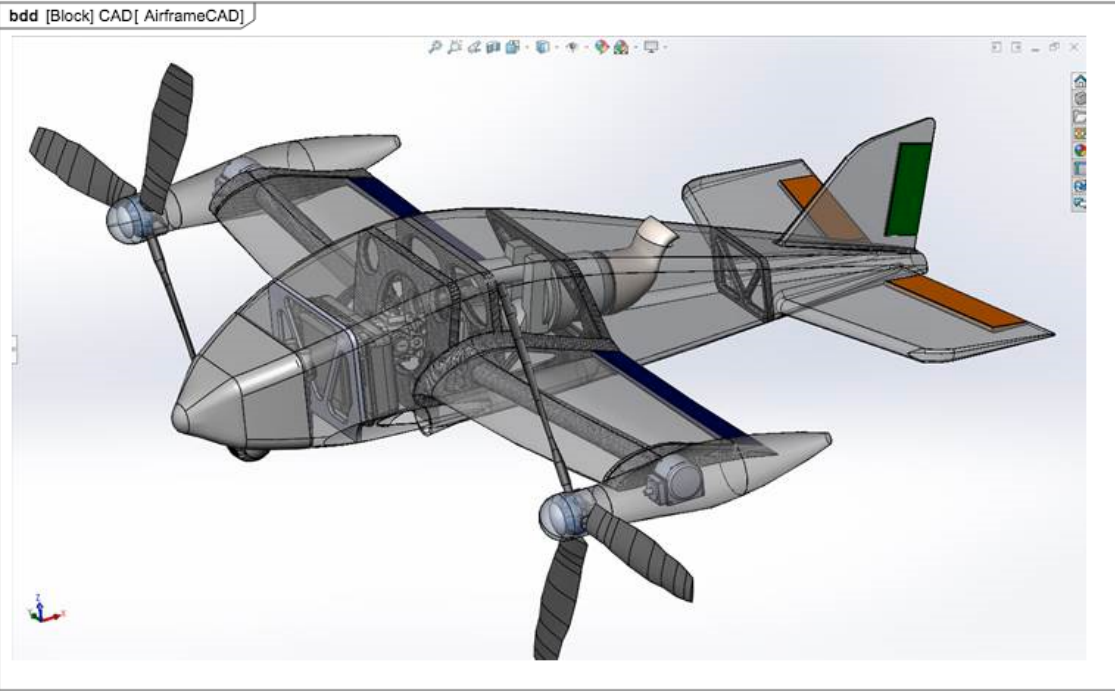
- WIP
 - 1 Volume I Executive Summary
 - 1.1 ES-1 Offeror Summary Table
 - 1.2 Technical Summary
 - 2 Volume II Technical Description
 - 2.1 Technical Cross Reference Matrix
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 - 2.2.1 Propulsion Subsystem
 - 2.2.2 Airframe Subsystem
 - 2.2.3 Sensor Subsystem
 - 2.3 Design Analysis
 - 2.3.1 EagleEye Surrogate Benchmark
 - 2.3.2 Sizing Study and Initial Weight Target
 - 2.3.3 Conceptual Trades - Tiltrotor vs Drone
 - 2.3.4 Vehicle CAD and packaging
 - 2.3.5 Thrust/Weight Wing Loading Calculations
 - 2.3.6 Airframe Load Path Generation
 - 2.3.7 Weight Study
 - 2.3.8 THPropulsion and Fuel System Integration
 - 2.3.9 Payload and OnBoard System Packaging
 - 2.3.10 Launch and Recovery System Integration
 - 2.3.11 Structural Load Calculations
 - 2.3.12 Stability, Performance and Flight Characteristics
 - 2.3.13 Bill of Materials
 - 3 Appendix
 - 3.1 Altair Access
 - 3.2 Altair 365

DOCLIB

(No Text)

TiltrotorUAVStructure

bdd [Block] CAD[AirframeCAD]



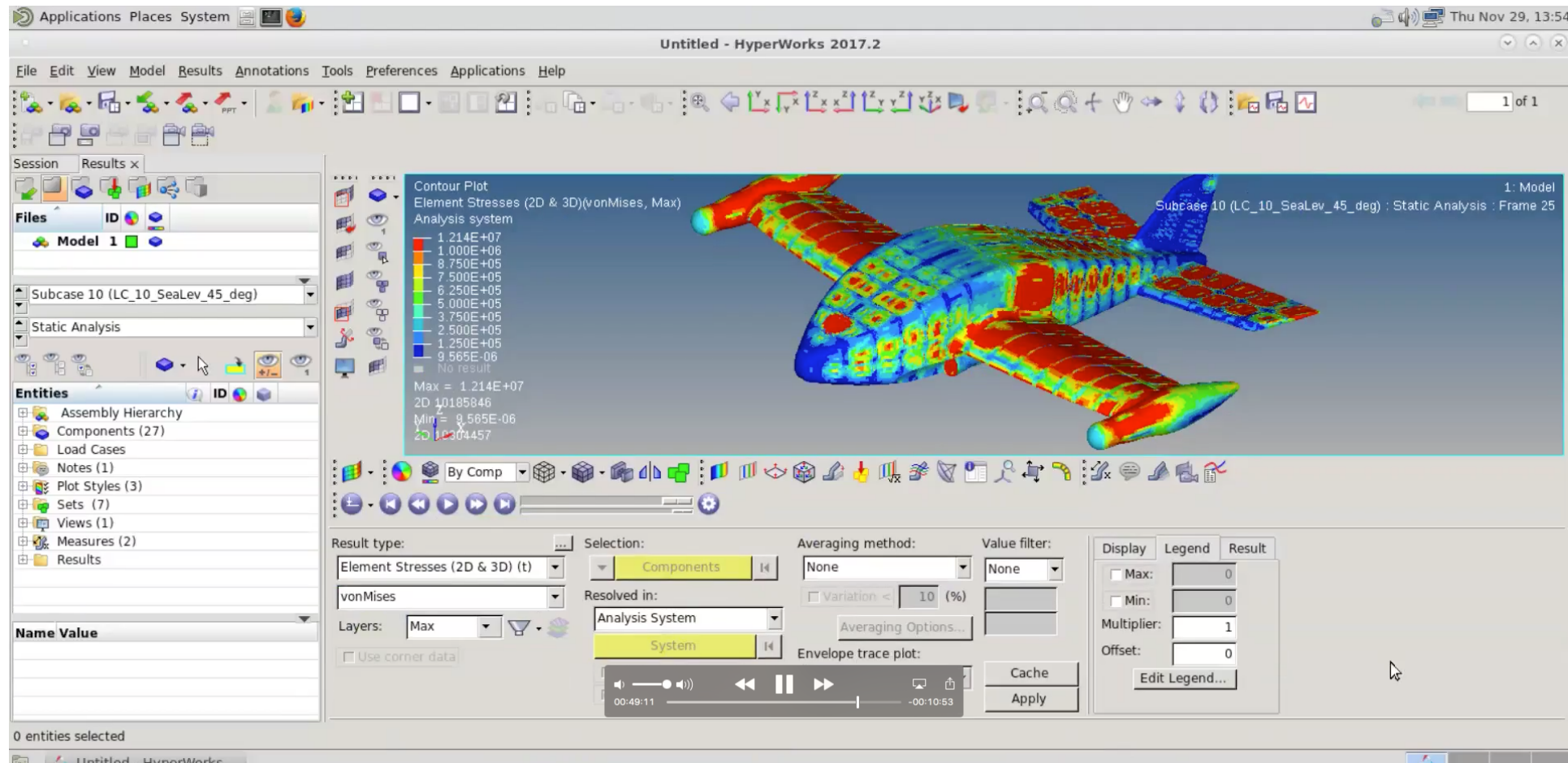
AirframeCAD

(No Text)

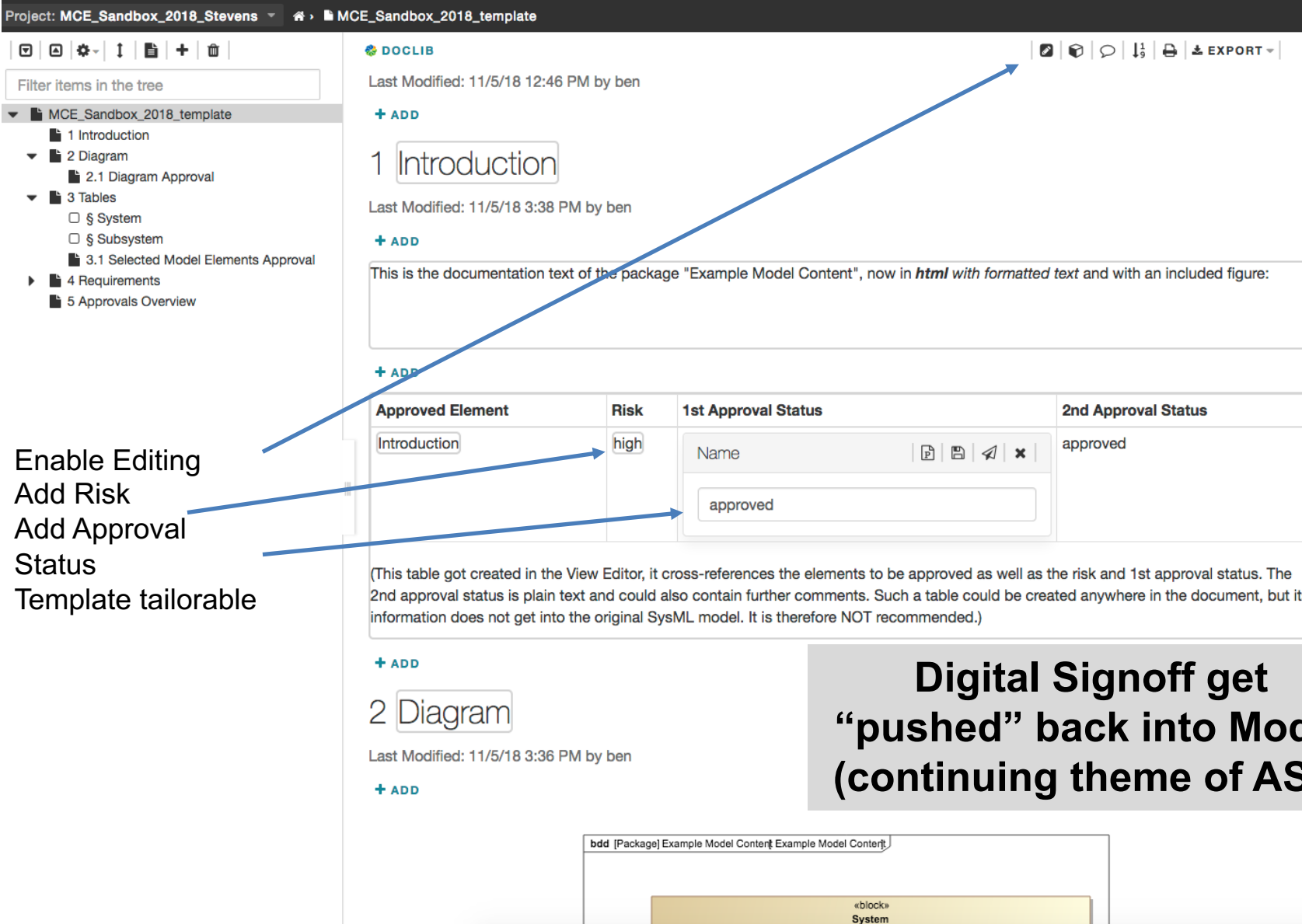
2.2.1 Propulsion Subsystem

Views Provides Hyperlinks into Discipline-specific Models and Simulation Analyses

- Research currently investigating how to do reviews and Digital Signoffs in Model for Transforming CDRL/DIDs



Transform CDRs and DIDS using Digital Signoff in Model Through View Editor



Project: MCE_Sandbox_2018_Stevens

MCE_Sandbox_2018_template

Filter items in the tree

- MCE_Sandbox_2018_template
 - 1 Introduction
 - 2 Diagram
 - 2.1 Diagram Approval
 - 3 Tables
 - \$ System
 - \$ Subsystem
 - 3.1 Selected Model Elements Approval
 - 4 Requirements
 - 5 Approvals Overview

DOCLIB

Last Modified: 11/5/18 12:46 PM by ben

+ ADD

1 Introduction

Last Modified: 11/5/18 3:38 PM by ben

+ ADD

This is the documentation text of the package "Example Model Content", now in *html with formatted text* and with an included figure:

Approved Element	Risk	1st Approval Status	2nd Approval Status
Introduction	high	Name <div>approved</div>	approved

(This table got created in the View Editor, it cross-references the elements to be approved as well as the risk and 1st approval status. The 2nd approval status is plain text and could also contain further comments. Such a table could be created anywhere in the document, but its information does not get into the original SysML model. It is therefore NOT recommended.)

+ ADD

2 Diagram

Last Modified: 11/5/18 3:36 PM by ben

+ ADD

bdd [Package] Example Model Content Example Model Content

«block»
System

**Digital Signoff get
“pushed” back into Model
(continuing theme of AST)**

Digital Signoff for SRR-II Criteria in Skyzer RFP View

Legend		Skyzer UAV System						
	Satisfy	cruiseSpeed : kts	endurance : hr	maxSpeed : kts	operationalAltitude : ft	operationalRadius : nm	payload : Payload	recoveryWeight : lb
	Satisfy (Implied)	TiltrotorUAV						
1.3 Performance Requirements		7	1	1	1	1	1	7
1.3.1 Max Speed								
1.3.2 Cruise Speed								
1.3.3 Max Payload Weight								
1.3.4 Operational Radius								
1.3.5 Recovery Condition								
1.3.6 Operational Altitude								
1.3.7 UAV Operation Period								

Model artifact provides evidence for SETR criteria

PerformanceRequirements

+ ADD

Performance parameters are used in Evaluation model. To maintain the evaluation process, these value can't be redefined in contractor's system model. Therefore, this performance table inherits the value properties defined in Skyzer UAV System.

+ ADD

2.5.3.1 Performance Requirements SignOff

Last Modified: 12/7/18 11:47 AM by ben

+ ADD

Criteria in existing NAVAIR Systems Engineering Technical Review (SETR) for SRR (can Digital Signoff subsume SETR)

Performance Requirements SignOff				
Approved Elements	Risk	Approval Status	Approved By	Comment
PerformanceRequirements	medium	Value :		Criteria SRR-II 1.f. - Requirements traceability from the CDD to the requirements baseline has been documented
		to be defined <input checked="" type="checkbox"/> undefined <input type="checkbox"/> approved <input type="checkbox"/> rejected		

Digital Signoff of Source Selection Technical Evaluation Done In the Model that is Part of Authoritative Source of Truth

VE Surrogate Pilot [Switch Org](#) Search selected project UAT Help

Project: Skyzer_RFP_Altair_v2 Skyzer_RFP_Response Branch: mast

Filter items in the tree

- ▼ Skyzer_RFP_Response
 - ▶ 1 Volume I Executive Summary
 - ▶ 2 Volume II Technical Description
 - ▶ 3 Appendix

DOCLIB

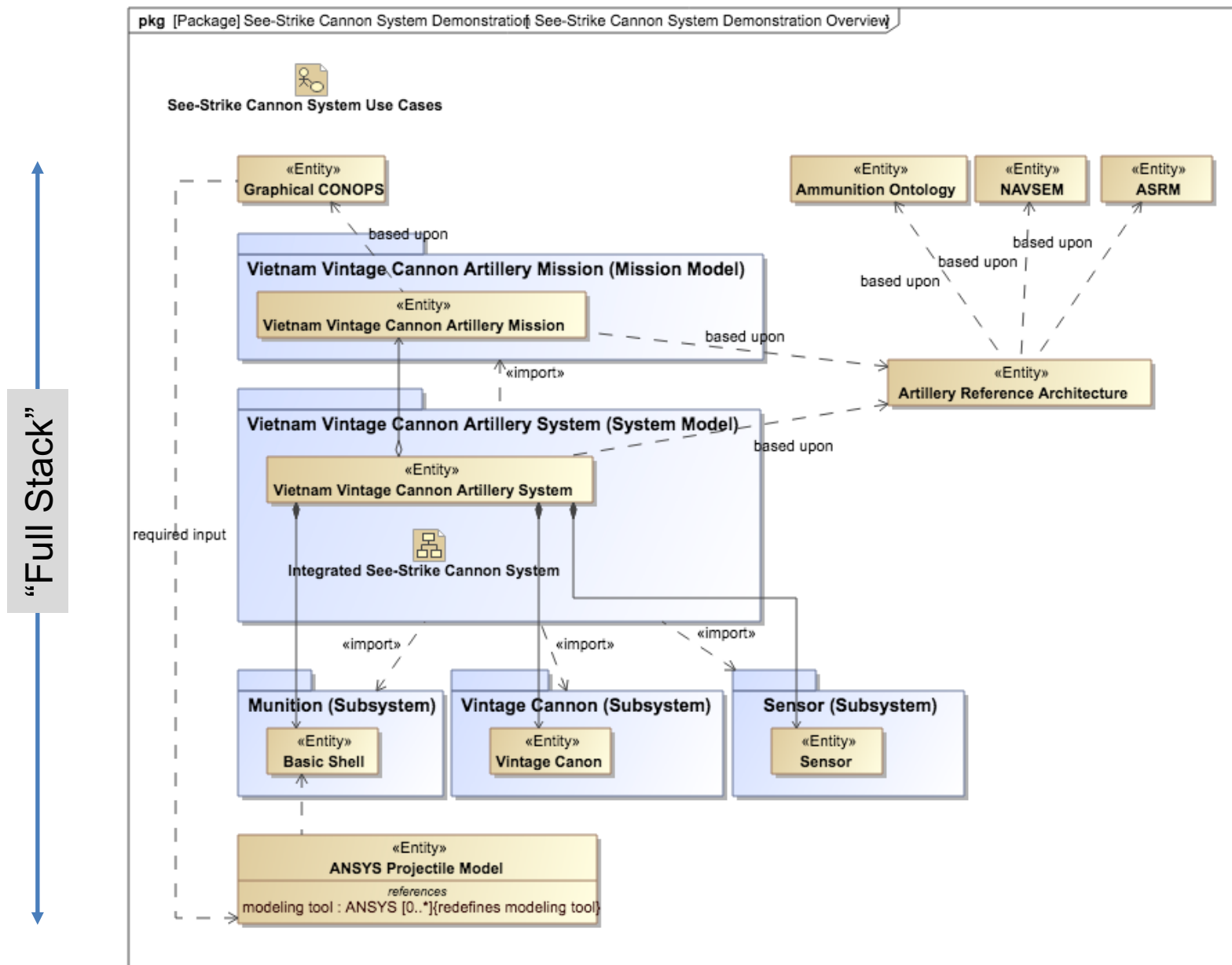
2.1.1 Technical Cross Reference Sign Off

[EXPORT CSV](#) [FILTER TABLE](#)

Technical Cross Reference Sign Off

Approved Elements	Risk	Approval Status	Approved By	Comment
Air Vehicle Performance; Operational Radius	medium	approved	Donald Polakovics	<p>Evaluation Worksheet: Overall the aircraft far exceeds the operational radius KPP.</p> <p>Potential Strengths: Very significant margin for additional mission capability and versatility.</p> <p>Weaknesses: Aircraft may be larger and more expensive than necessary to do the mission.</p> <p>Deficiencies: None</p> <p>Uncertainty: Performance analysis could not be reviewed in its entirety due to some inconsistent data. Margins seems large enough to cover this however.</p>
UAS Capability	very small	undefined	N/A	N/A
Air Vehicle Performance; Endurance	medium	approved	Donald Polakovics	Evaluation Worksheet: Overall the design appears to have sufficient endurance, with adequate development margin.

Use Case Entities (Full Stack v1) Represented in SysML Model (See Strike Cannon System)



Use Case "Full Stack" (Update)

Reference Architecture
(no longer based on
ASRM/NAVSEM)

CONOPS

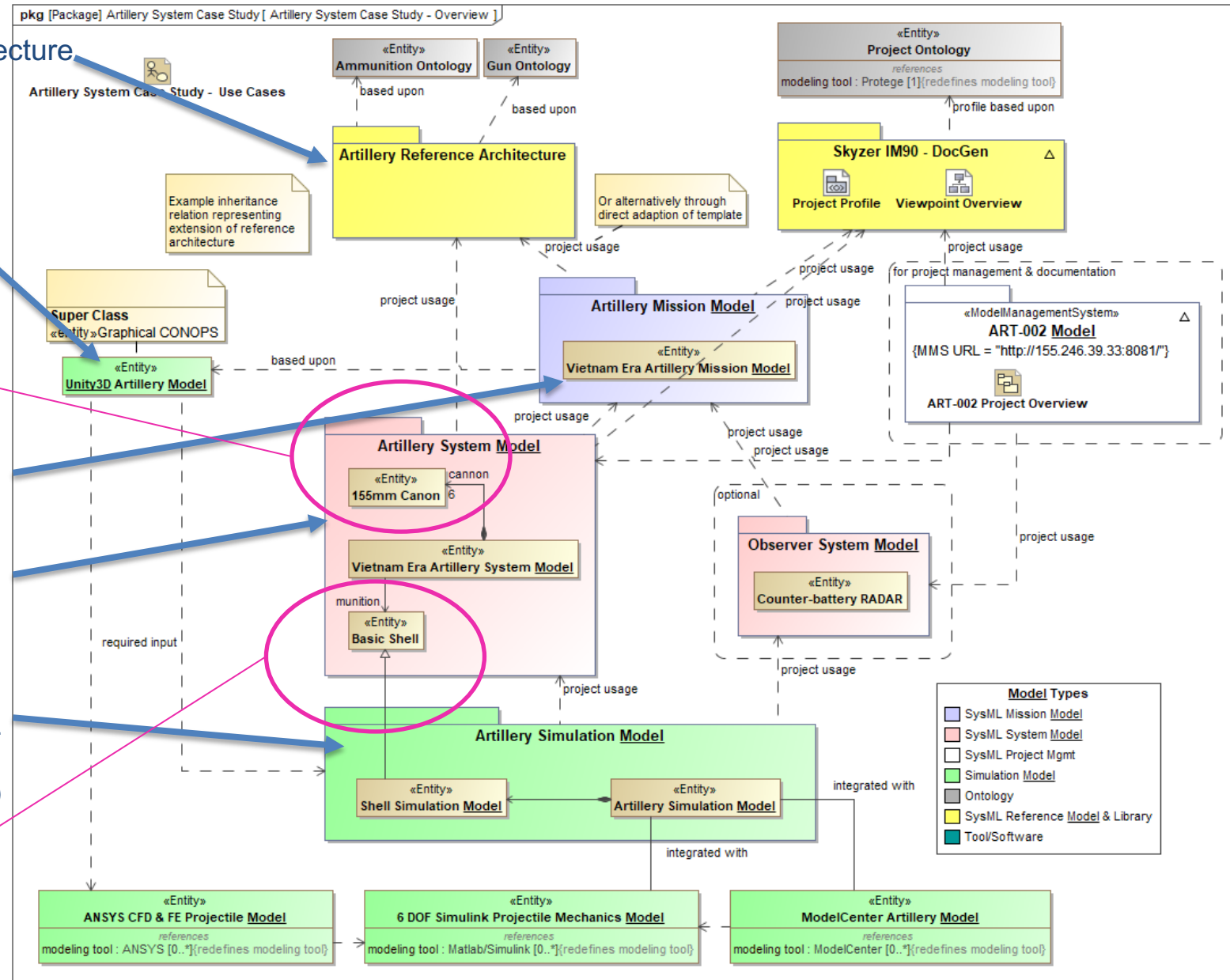
Is this a 155
or 105?
Shawn gave
curves
reference for
105mm

Created
Mission Model
(using custom profile)

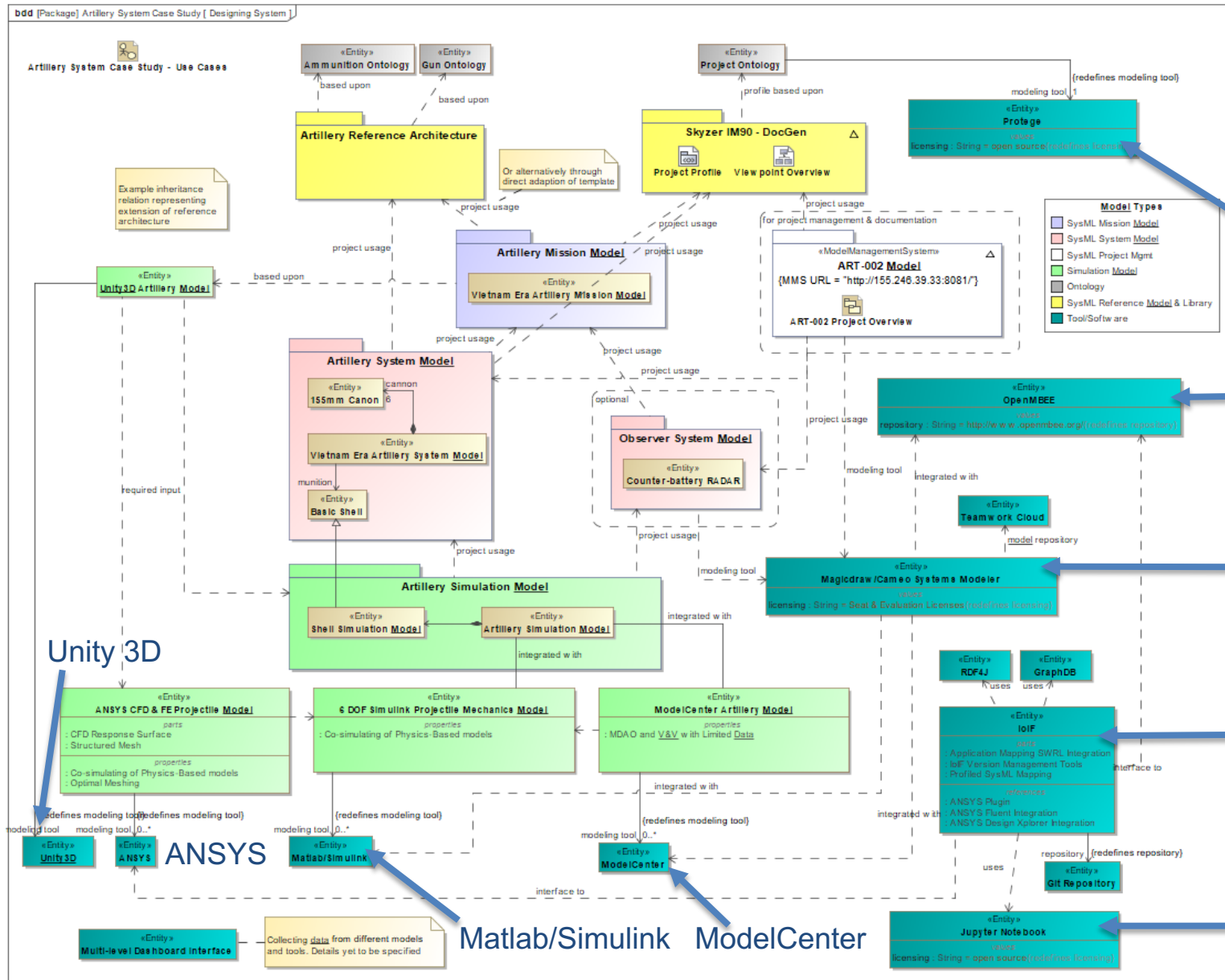
System Model
(with displayed
example model
elements)

Separate SysML
Analysis Model
(by John D.)

This should
be changed
to cartridge
(if 105mm)



Use Case Designing System



- Used Tools:

Protegé

OpenMBEE

Magicdraw/Cameo

- IoIF

Jupyter Notebook

Systems Engineering Technical and Management Plan Model (Task 15)

Formalizes Task Interrelationships and Dependencies in a SysML model

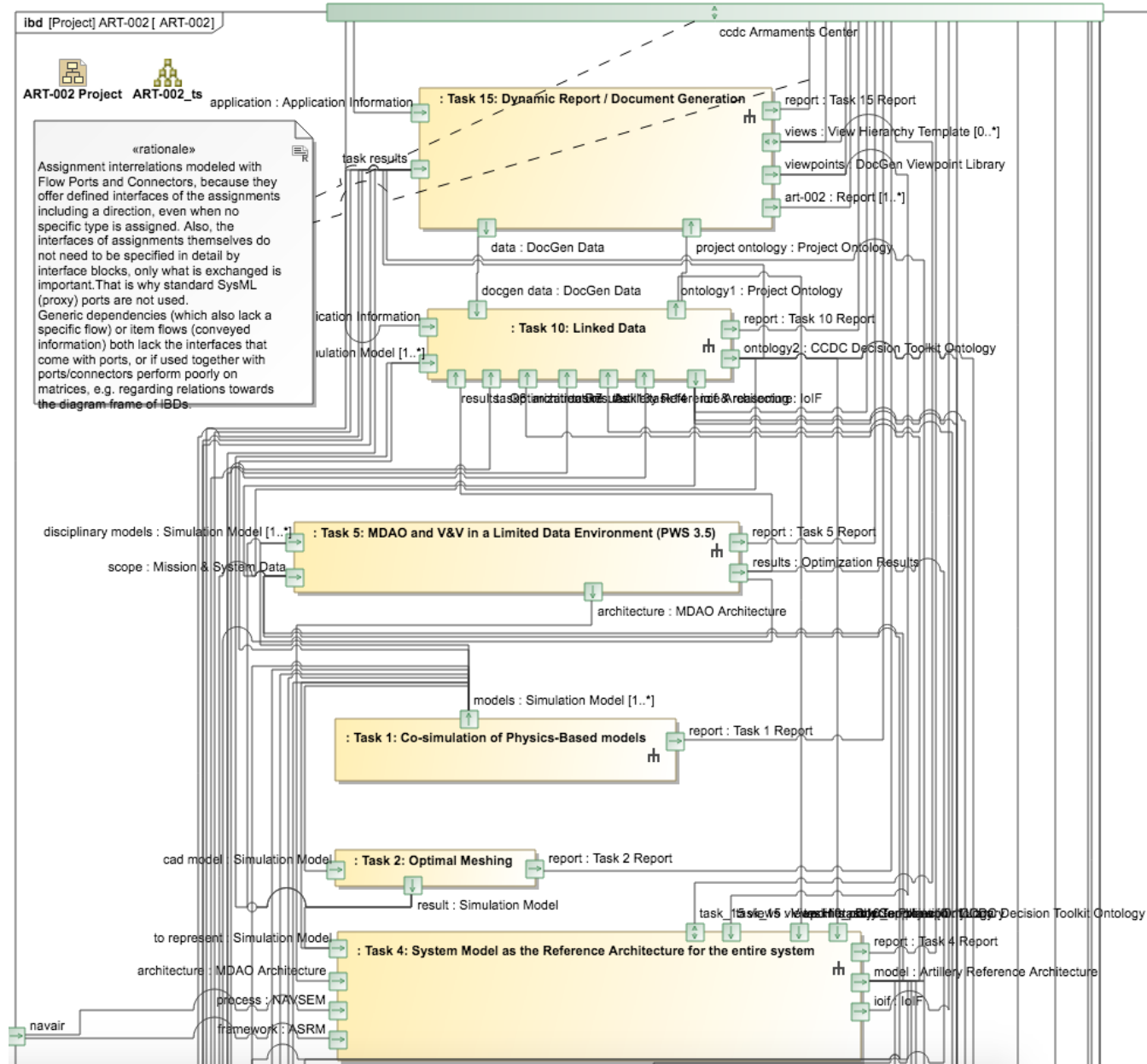
Provides systematic approach to capture accomplishments for assignments that get “pushed” back into model from View Editor

Used to automatically
generate bi-monthly status

Allow sponsor comment directly in the View Editor

Project measures generated into View Editor

Proposal representation of Task Dependencies in Backup



Review: Five Goals of the Digital Engineering Strategy*

- Goal 1: Formalize the development, integration, and use of models to inform enterprise and program decision-making.
- Goal 2: Provide an enduring, authoritative source of truth.
- Goal 3: Incorporate technological innovation to improve the engineering practice.
- Goal 4: Establish a supporting infrastructure and environments to perform activities, collaborate, and communicate across stakeholders.
- Goal 5: Transform the culture and workforce to adopt and support digital engineering across the lifecycle.

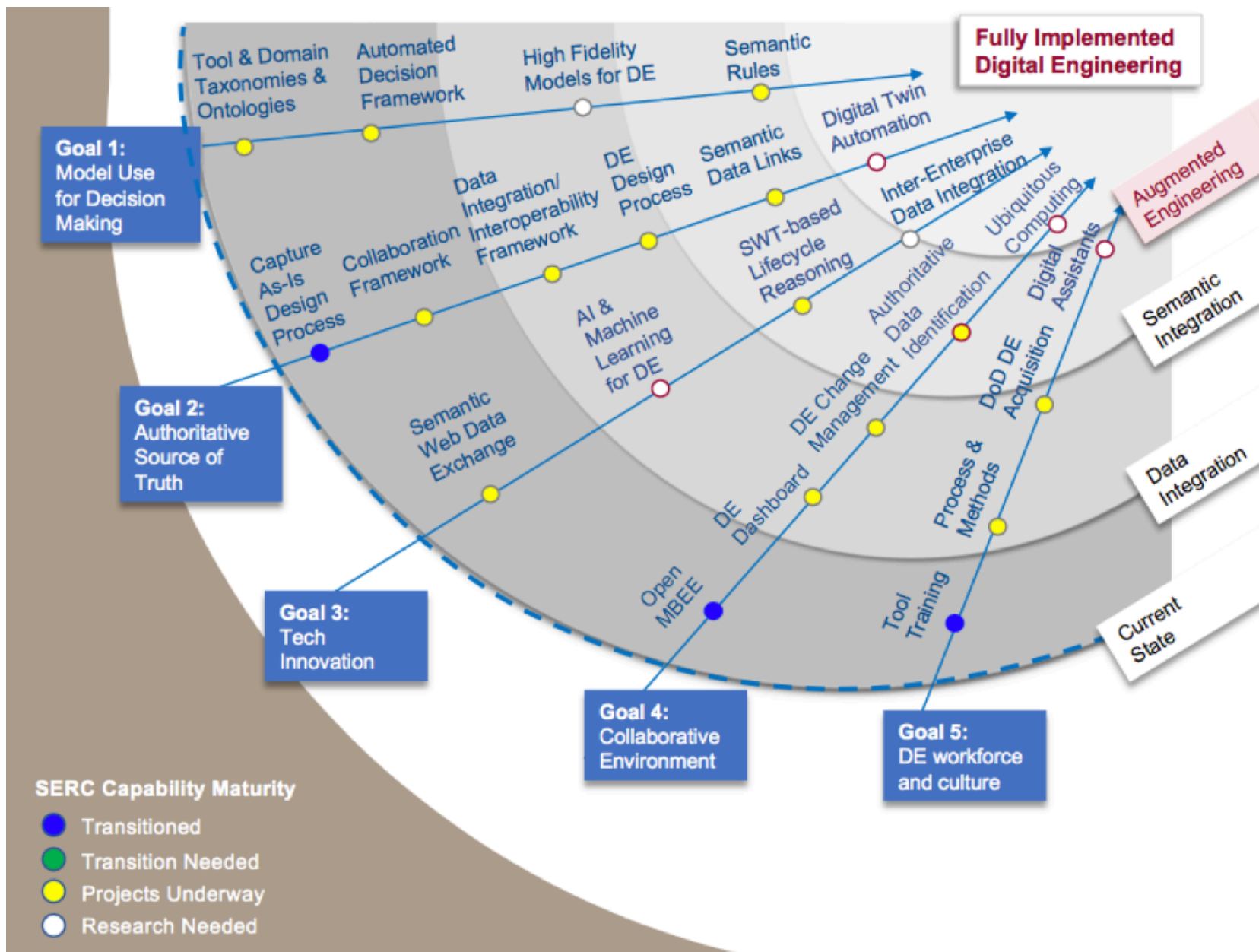


* Department of Defense Digital Engineering Strategy, June 2018

Interrelationships Between Strategic DE Goals

- Technical Innovation provide enabling technologies (Goal 3) that impact other goals
 - “Better” Descriptive Modeling technologies and methods for mission and system
 - MBSE strengthens Systems Engineering
 - Semantic web technologies (ontologies and reasoning)
- Using Authoritative Source of Truth (Goal 3 enabling Goal 2)
- Access and Visualization in Collaborative Environment (Goal 4)
- Model-enabled Decision Making (Goals 2 & 4 enabling Goal 1)
- We have examples for all of these, and those examples are being turned into Workforce Development training/examples (Goal 5) demonstrating the art-of-the-possible.

Digital Engineering for Systems Engineering Roadmap



Thank you!

Dr. Mark Blackburn

Principal Investigator

Member of SERC Research Council

Member of OpenMBEE Leadership Team

Member of Semantic Technologies for Systems Engineering

School of Systems & Enterprises

Systems Engineering Research Center

Stevens Institute of Technology