NPS Acquisition Research Symposium Synergizing the Software Acquisition Pathway (SWP) With the Unified Architecture Framework (UAF) For Operationalization

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Introduction

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- DoD policy and directives motivate the transformation from document-based information to structured model-based information to enable opportunities for enhanced analysis, decision-making, and collaboration between stakeholders
- Effective model-based systems engineering (MBSE) to support acquisition objectives requires structure and ontology for capturing and transforming information into useful digital assets. The Unified Architecture Framework (UAF) provides a structured ontology for enterprise architecture definition that aligns well to Department of Defense (DoD) Adaptive Acquisition Framework (AAF) Software Acquisition Pathway (SWP).
- The SEI presents a foundation for a consistent MBSE strategy for the SWP using a scenario-based approach for constructing and analyzing value in operational process flows and aligning UAF views to structure information

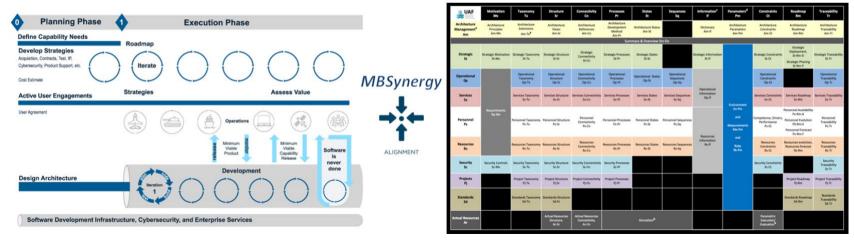


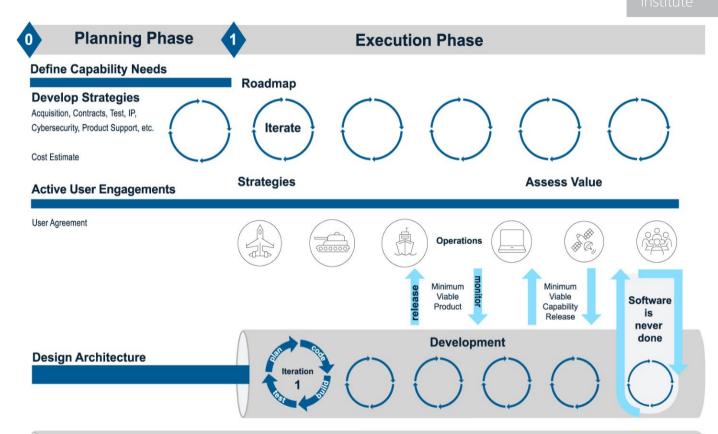
Figure 1: SEI MBSynergy - Aligning the SWP to UAF

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Lifecycle View of the Software Acquisition Pathway

- Purpose is to provide software intensive development programs with a streamlined path for rapid and iterative software capability delivery to users
- Established in the FY20 NDAA Section 800 and is further defined in DODI 5000.87
- 86 DoD programs using the SWP
- 2 phases (Planning & Execution) with the objective of delivery capability within 1 year
- 34 identified documents or collections of information required with varying applicability based on attributes of the program

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Software Development Infrastructure, Cybersecurity, and Enterprise Services

Figure 2: Lifecycle view of Software Acquisition [Source: Defense Acquisition University "Software Acquisition | Adaptive Acquisition Framework"]

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Unified Architecture Framework

- Architecture framework that provides visualization for specific stakeholders concerns through engineering domains organized by various views
- Evolved from DODAF/MODAF/UPDM and built on SysML
- 89 views
- UAF defines a metamodel for each viewpoint- the main concepts and relationships you need to build this specific viewpoint
- Enterprise Architecture Guide for UAF provides a workflow for model developers



Figure 3: UAF View Matrix [Source: Unified Architecture Framework (UAF) Domain Metamodel Version 1.2, Copyright © 2025 <u>Object Management Group ®, OMG ®</u>, Reprint Permission Granted.]

Aspect

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Basis for Mapping SWP Activities to Scenarios

SEI has designed a process founded on principles of CMU SEI's Architecture Tradeoff Analysis Method (ATAM) for using scenario-based analysis for eliciting MBSE value in enterprise activities. The model-based approach guides users through the processes of:

- eliciting scenarios for the use of MBSE as part of the enterprise architecture
- capturing enterprise goals and objectives aligned to quality attributes
- understanding the model-based processes and flow of information
- · defining the measures that will verify that the goals will be achieved

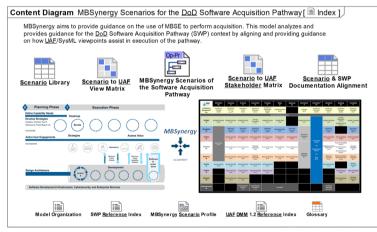
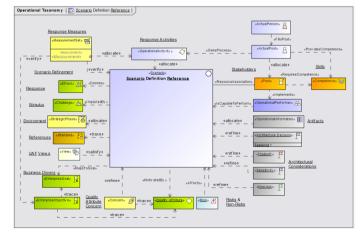
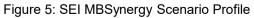


Figure 4: SEI MBSynergy SWP Model

MBSynergy SWP Scenario Model connects SWP information to UAF DMM v1.2 information and analyzes SWP scenarios using the MBSynergy Scenario Profile.





The MBSynergy Scenario Profile is a SEI model resource that provides capability for developing MBSynergy scenarios in Cameo Enterprise Architect based on the Architecture Tradeoff Analysis Method (ATAM)

Software Acquisition Pathway Scenarios

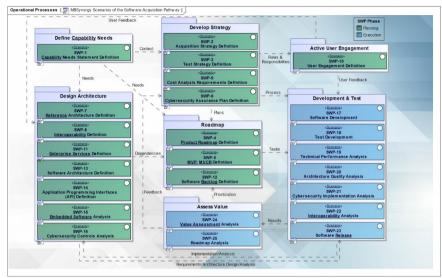


Figure 6: SEI MBSynergy SWP Scenarios

The model is a reference architecture for stakeholders of the SWP to use for understanding the mechanisms to efficiently use UAF for structuring information and performing analysis. Each scenario is analyzed for its set of activities, stakeholders' roles, UAF views consumed/produced, quality attributes, enterprise architecture considerations, measures, and risks/nonrisks.

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- Derived a set of scenarios where a model-based approach offers value based on enduring tasks and information artifacts defined for the SWP
- 25 Scenarios Identified. Organized by SWP Phase and Enduring Tasks: *Define Capability Needs, Develop Strategy, Design Architecture, Plan Roadmap, Engage Active Users, Develop & Test, and Assess Value*

#	Id	Name	Aligned Documentation	Source	Applicability
			OI164 Capability Needs Statement	Ca DODI 5000.87	Regulatory
1	SWP-1	Capability Needs Statement Definition	OI171 Clinger Cohen Act (CCA) Compliance	Clinger-Cohen Act (CCA)	Statutory
		 OI183 Software Initial Capabilities Document (SW-ICD) 			
			OI158 Acquisition Strategy	👫 🕯 10 USC 2431a	Statutory for major programs (> ACAT
2 SWP-2		OI168 Intellectual Property Strategy	CODI 5000.87	Regulatory	
	CIMD 2	O Acquisition Strategy Definition	OI163 Product Support Strategy	Clinger-Cohen Act (CCA)	Statutory
2	5VVP-2	O Adquisition strategy Delinition	OI160 Business Case Analysis		
			 OI171 Clinger Cohen Act (CCA) Compliance 		
			OI169 Periodic updates to strategies		
3 SWP-3		 OI150 Test Strategy 	E DODI 5000.87	Regulatory;Programs on DOT&E	
	SWP-3	O Test Strategy Definition	OI169 Periodic updates to strategies	CODI 5000.96	Oversight list may require a TEMP.
			-	-	Regulatory
			OI161 Initial Product Roadmap	DODI 5000.82, Subtitle III of Title 40	Statutory
4	SWP-4		OI153 Product Roadmap	CODI 5000.87	Regulatory
			 OI154 Program <u>Backlog</u> 		
5	SWP-5	O MVP, MVCR Definition	OI161 Initial Product Roadmap	DODI 5000.82, Subtitle III of Title 40	Statutory
<u> </u>	5001-5		OI154 Program <u>Backlog</u>	E DODI 5000.87	Regulatory
			OI156 Cybersecurity Plan	🕻 🗟 40 USC 11313	Statutory for Mission Critical and Missi
6 SWP-6	SWP-6	Cybersecurity Assurance Plan Definition	OI171 Clinger Cohen Act (CCA) Compliance	CODI 5000.87	Essential IT programs
		0	OI169 Periodic updates to strategies	Clinger-Cohen Act (CCA)	Statutory
				8 h p.	Regulatory Regulatory
			OI162 Information Support Plan	E かいのうしょう (10-417) E かいのうしょう	Statutory for programs > ACAT II;
7 SWP-7	SWP-7	Reference Architecture Definition	Ol167 Bandwidth Requirements Review	4 m	Regulatory for Others
			OI171 Clinger Cohen Act (CCA) Compliance	5000.87	Statutory
			OI157 System Architecture	Clinger-Cohen Act (CCA)	-
8	SWP-8		OI157 System Architecture	L DODI 5000.87	Regulatory Statutory for programs > ACAT II;
0	SVVP-8	Interoperability Definition	OI167 Bandwidth Requirements Review	51047, P.L. 110-417	Regulatory for Others

• Mapped scenarios to statutory and regulatory information needs

Figure 7: MBSynergy SWP Scenarios Aligned to Required Documentation

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Mapping Scenarios to UAF Views Capability Needs Statement (CNS)

Transforming document-based information to structured model elements expressed in standardized enterprise architecture views.

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Include key missions, processes, operations, direct users, additional beneficiaries of software		Performance Measure	Target State
capabilities, threads (from defense intelligence source), technical and operational risks (fitnests and opportunities), and related elements. This section could reference content from Joint or Component operational jubilities(me), e.g., Juhine Command Pilan, CoMAV(COMFAM), CONTS/S for strategic operational direction. Mentify any potential Joint, Allaed, Partner Interoperability, and Coalition Use.	Capability Area 1	Describe the specific capability / outcome measures (e.g., those related to time, speed, range, quality, detection, and/or # of personnel).	Describe the objective quantifiable measurement and if applicable minimum thresholds.
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By mapping the structured information to the scenarios, the flow of information across the lifecycle can be analyzed and the rationale for traceability from scenario to scenario can be established.

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Figure 11: Scenario Connectivity Diagram - UAF Information Flow Analysis

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1: Define <u>Capability</u> Needs	
r. Denne <u>Capability</u> Needs	
Step 1.1 Operational Context	1
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overarching operational mission, key Op-Tx Operational Taxonomy [OV-1]	
	m-If Information: Dictionary (AV-2)
the future environment "	In the morn about becomeny (RE-2)
En-Pm Strategic Environment [-]	
St-My Strategic Motivation [+]	
Step 1.2 Capability Needed	
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te operational missions. Include any St-Ix Strategic Taxonomy [CV-2]	A <u>Capability</u> Needs Statement (<u>CNS</u>) is a high-level capture of mission
specific timelines tied to capability	deficiencies, or enhancements to
eeds."	existing operational capabilities.
St-Rm-P Strategic Phasing (CV-3)	features, interoperability needs, legacy interfaces and other
	attributes that provides enough
Step 1.3 Performance Attributes	Information to define various
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Figure 9: Model View of CNS Scenarios

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Figure 10: SWP Scenario to UAF View Matrix

Mapping of the UAF views to the SWP scenarios was performed by comparing definitions in the UAF DMM 1.2 specification and the regulatory and statutory information requirements of the SWP.

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Conclusion & Next Steps

Summary:

- Presented a foundational concept for a consistent application of model-based systems engineering in DoD SWP programs using UAF
- Identified 25 scenarios for the operationalization of UAF as part of the SWP Planning and Execution phases
- Illustrated UAF view alignment with the Capability Needs Statement (CNS)
- For SWP programs, this study and related artifacts aim to be resource for achieving a part of their digital engineering strategy, providing the ability to:
 - Structure and aggregate lifecycle information in a well-organized model, moving away from document-based information, to streamline communication and better understand interfaces between information needs
 - Generate robust traceability in lifecycle artifacts to support the concept of digital threads
 - Provide a foundation for analysis to occur early in the SWP, enabling more informed decision-making and higher levels of assurance for the desired quality attributes of the enterprise and the software capability being developed
 - Align with policy (DODI 5000.97) and digital engineering directives from each of the DoD military departments

Next Steps

- SEI plans to develop a technical report capturing the full breadth of content related to the scenarios developed for the SWP
- SEI is interested in pilot projects to demonstrate the use of the UAF views and to explore the required resources needed to fully operationalize the approach
- Conduct future research into the use of models as part of the SWP, including how models can be continuously developed/monitored alongside software, and developed using AI-Assisted tools

Biography & Contact Information



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Colin Dempsey is a Senior Model-Based Engineering Project Manager for the Assuring Cyber-Physical Systems division and Model-Based Engineering team at Carnegie Mellon University's Software Engineering Institute (CMU SEI). He holds an MSE in Systems Engineering from Johns Hopkins University. His area of expertise and research focus on the practical application of model-based systems engineering (MBSE) methodologies to facilitate the design, development, and analysis of softwareintensive systems for the DoD. Prior to joining CMU SEI, he was a systems engineering professional in DoD industry leading efforts in MBSE, Product Line Engineering (PLE), and Digital Engineering transformation.



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