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Digital Engineering to Improve the Quality of a Capability Needs Statement

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Fred Schenker
Software Acquisition Generalist

Document Markings

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BLUF

An acquisition program on the Software Acquisition Pathway (SWP) can elaborate its software Capability Needs Statement (CNS) in a model

Model-Based System Engineering (MBSE) principles transform the CNS from a static description into an authoritative, model-based view of mission deficiencies, required enhancements, interfaces, and interoperability

Principal benefits are to:

(1) review the capability definition with stakeholder(s) to ensure adequate validation is built into the process

(2) develop a higher quality artifact for negotiating with the project team

This approach represents a potential best practice for connecting stakeholder needs with practical reality using a digital engineering model as a facilitation tool.

Policy Math

What is the sum of:

$$5000.87 + 5000.97$$

At the SEI, we have two research initiatives:

10000.84?

SW ACQ Go Bag + MBSynergy

Introducing the Software Acquisition Go Bag

It is [a truth among warfighters](#) that the first step in completing a mission depends on the load they carry on their back. Acquisition is no different. We're here to get you the right gear.

With that in mind, the SEI announces the launch of the [Software Acquisition Go Bag](#).

The Software Acquisition Go Bag (or Go Bag for short) is an extensible collection of tailorable kits that program teams can use to enable the delivery of software capabilities at the speed of need.

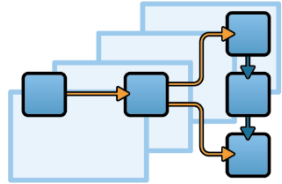
The first kit to be released is the **SWP Essentials Kit**, which will focus on 5 essential questions for launching a SWP program.

1. Are we really ready to adopt the SWP?
2. **What is a Capability Needs Statement (CNS), and how exactly do we develop one that fits our situation?**
3. How do we assess progress and identify risks early enough to make corrections and prevent issues?
4. How do we build a robust user agreement (UA) and connect it to value assessments (VAs)?
5. How do we scope and sequence a minimum viable product (MVP), minimum viable capability release (MVCR), and subsequent releases?

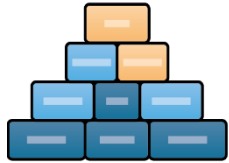
Visit www.sei.cmu.edu/projects/gobag to Pack Your Go Bag, send us questions and feedback, and to sign up for notifications!



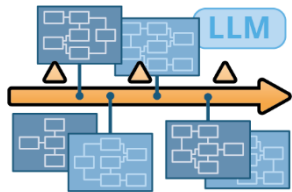
MBSynergy: Efficient/Proficient MBSE for Mission Success



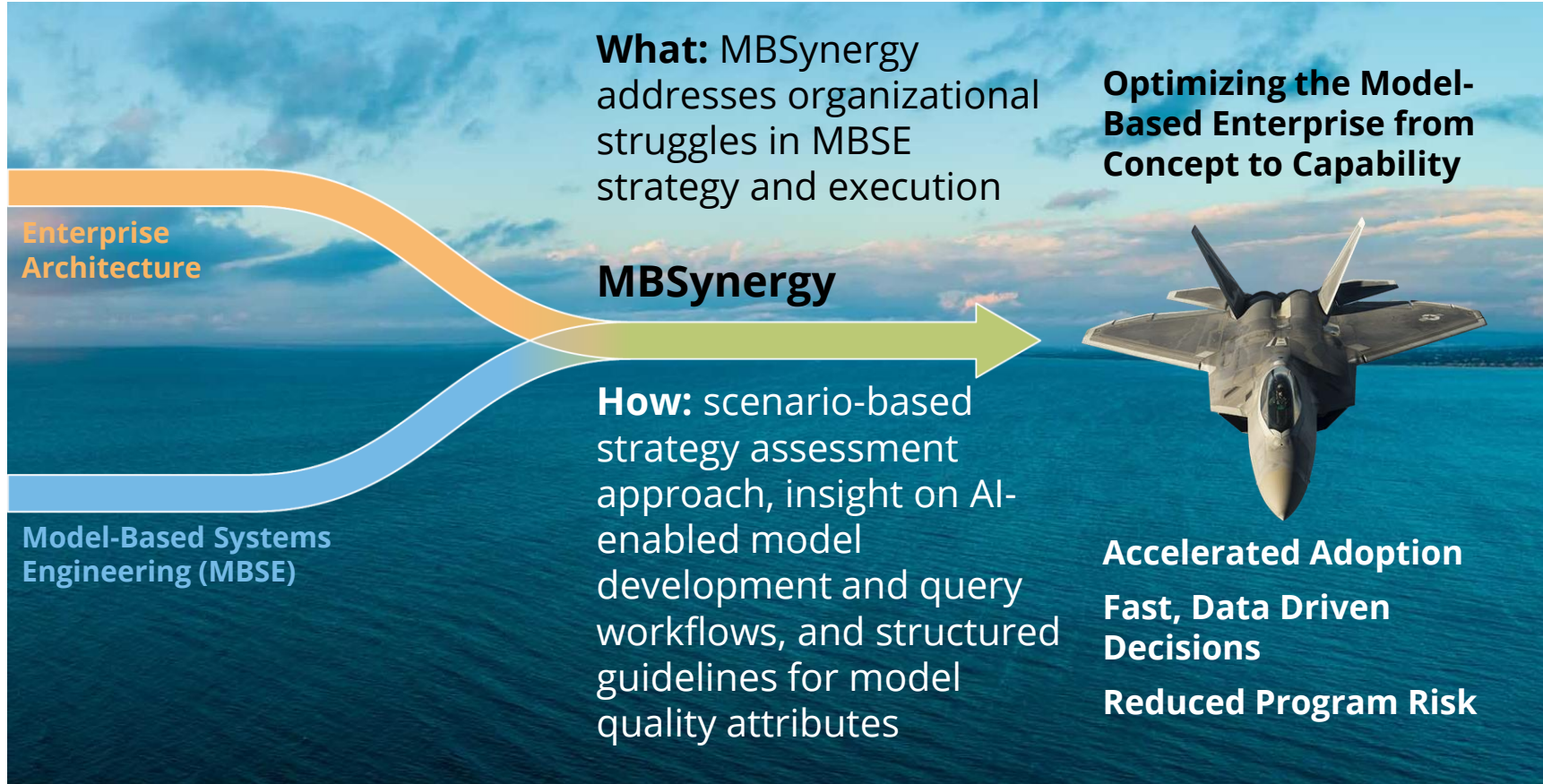
Scenario-Based Strategy
Optimize Processes



Model Quality Taxonomy
Evaluate Quality



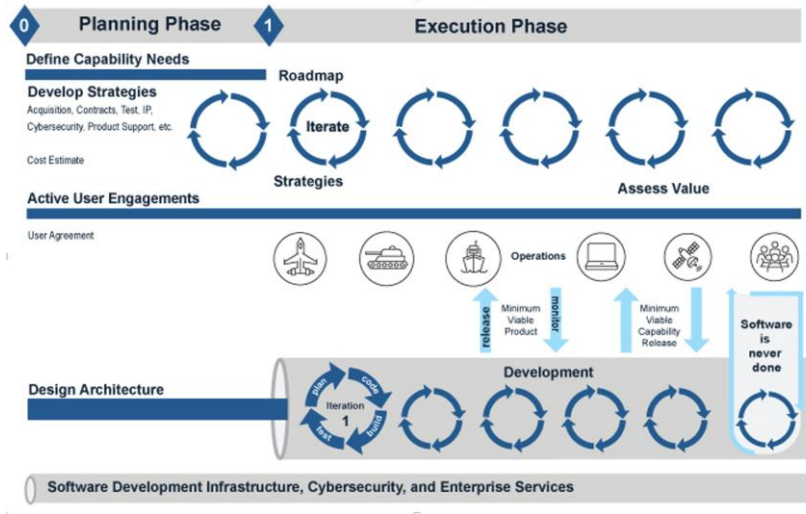
AI-Assisted Workflows
Accelerate Insight



Agenda

- Software Pathway Guidance
- Capability Needs Statements
- Agile Development Applicability
- Capability Definition and Capability Evolution
- Digital System Models
- Government Reference Architecture
- Notional Model-Based Capability Lifecycle
- Use Case and Scenarios
- Conclusion

Software Acquisition Pathway – Context



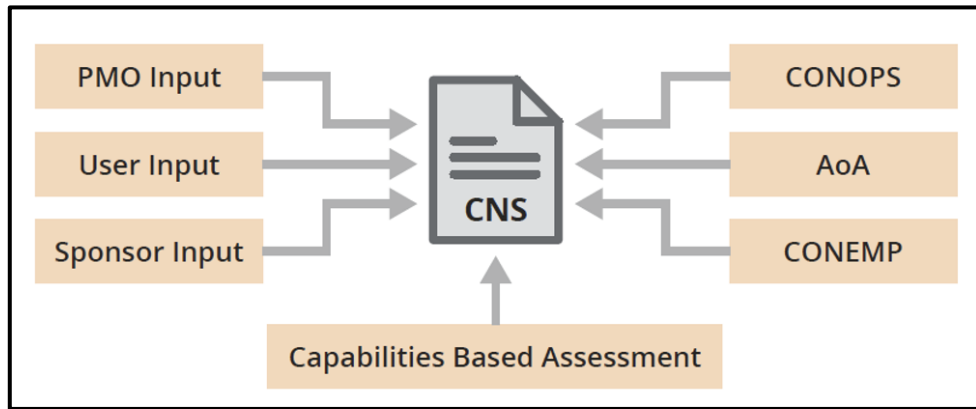
The Software Acquisition Pathway ©2020 by Department of Defense. Reprinted with permission

- Part of the Adaptive Acquisition Framework (AAF)
- Created in response to findings identified in high-level reports
 - 2019 Defense Innovation Board Software Acquisition and Practices
 - FY18 National Defense Authorization Act (NDAA) Section 873 and 874 Agile pilot programs
- Emphasized by SecWar Hegseth

“...I am directing all DoD Components to adopt the Software Acquisition Pathway...”
- Requires a “Capability Needs Statement”
- Requires modern development practices, i.e., Agile and DevSecOps

Primary Goal – To accelerate the delivery of software-related capability to the warfighter

Capability Needs Statement (CNS) – A Representation



The program's sponsor is responsible for creating a draft CNS with input from Users.

A CNS is a key acquisition artifact that documents the high-level capabilities expected to be provided by the software.

It is a living document and should be updated as needed after each value assessment.

To enter the SWP, a program must have a draft CNS. This is needed to get an SWP Acquisition Decision Memorandum (ADM) from its Decision Authority (DA).

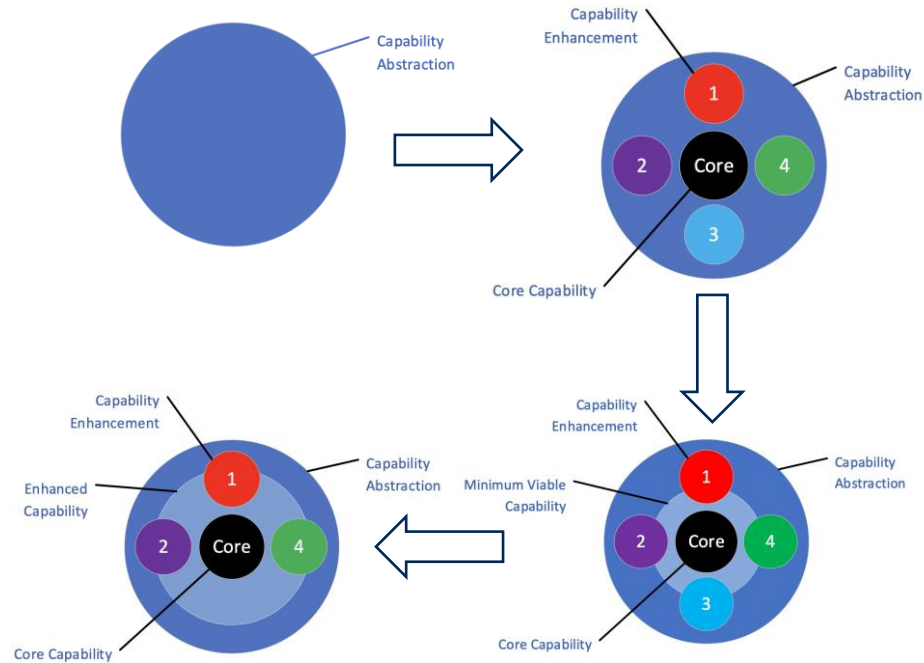
Agile Development

Agile increments (i.e., sprints) are typically very short and produce capabilities that are testable. Project stakeholders (e.g., users, testers, developers) review the product at the conclusion of a sprint and can assess what is needed (if anything) to enhance the capability.

Key Concepts:

- **Product Backlog** – An inventory of work to be done
- **Minimum Viable Product (MVP)** – a version of a product with just enough capability to be evaluated by stakeholders (who can provide feedback for future product development)
- **Value Assessment** – an outcome-based evaluation of delivered software to determine if its benefits (e.g., efficiency, revenue) justify the investment

Capability Definition and Evolution



Capability evolves naturally

- Start with a user-generated description of what is required
- Obtain agreement on what is “core” and what the enhancements are
- Build an MVP, anticipate and plan for the enhancements, evaluate it with project stakeholders
- Enhance as a function of priority, risk, cost, schedule
- Review new technology and identify future enhancements

Capability evolution aligns perfectly with core elements of Agile, such as MVP and product backlog

Digital System Model (DSM)

Digital Engineering is becoming pervasive in the development of software

- Initial DoD guidance issued in 2018, updated in 2023 as DODI 5000.97
- Handbook of Digital Engineering and Modeling practices released in March 2026

The basic value proposition for a DSM is to trade off early investment in a “model” to offset the huge costs of late identification of defects or issues.

- Often referred to as “shifting left”
- Cost of correcting a defect that “escapes” is 300-1000X compared to in-phase

DSMs are often used to document requirements and their elaborations, which are typically the starting point of the initial product design. The most common form for this is to use a systems modeling language (SysML).

Digital Models Can Be Used to Represent Capabilities (or a CNS)

Government Digital System Model

A Government Reference Architecture



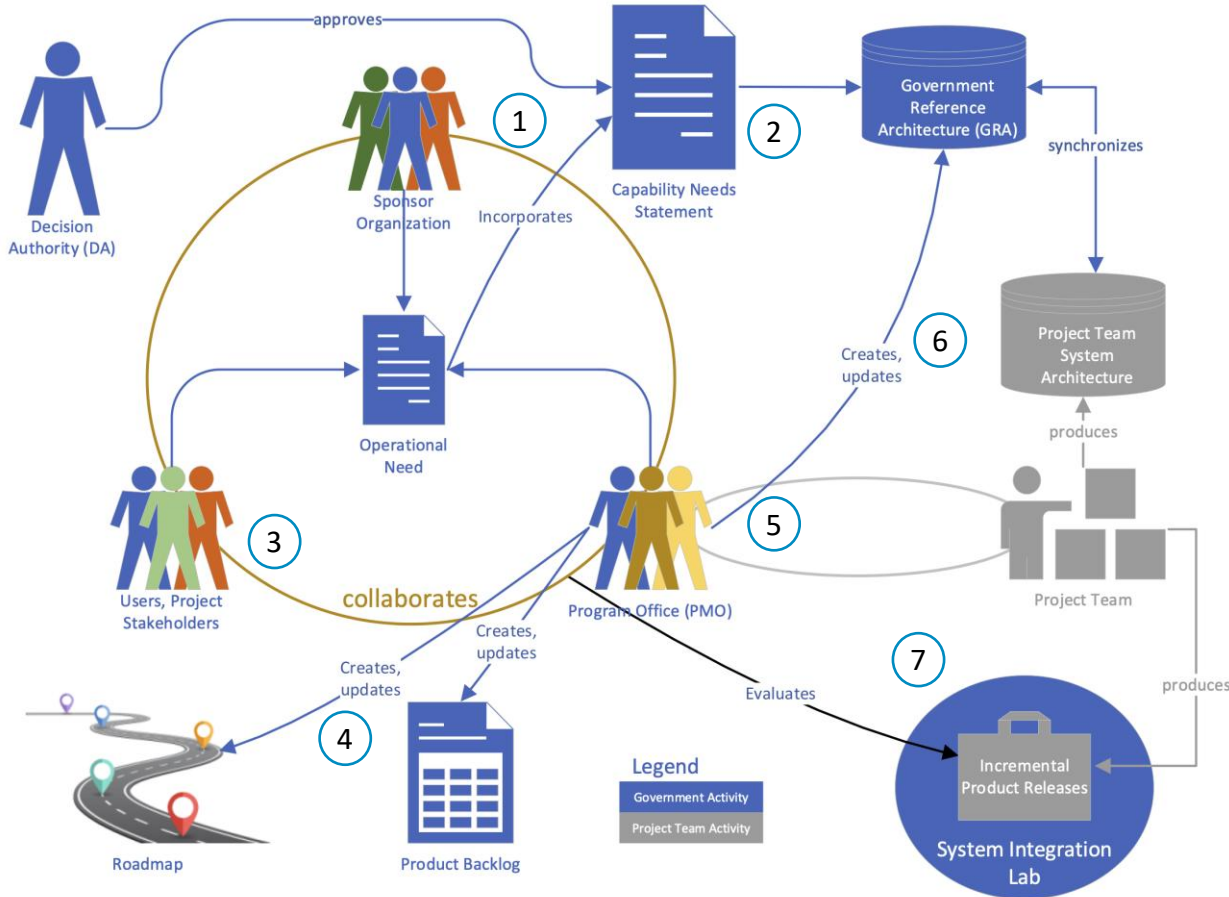
Government Reference
Architecture Model

If a Program chooses to model their CNS in a GRA, what could they use the model for?

- **Validate User Needs.** The PMO will use its domain knowledge to build a notional model-based representation of each user need and validate this with project stakeholders. As part of the validation, the PMO attempts to characterize the relative priority of each user need. Documenting specific constraints (e.g., performance, cost, schedule, technology dependencies) should also be incorporated.
- **Communicate User Needs to the Project Team.** The PMO incorporates the GRA into the contract it negotiates with its development contractor.
- **Serve as a Communication Mechanism.** The PMO uses the GRA to communicate with users and the project team as development progress is made and priorities change.
- **Provide Traceability Between User Needs and Project Backlog.** The PMO translates from the CNS into the GRA, identifying elements that need to be implemented. The work associated with building the capability traces from the GRA to the Project Backlog tool.

Model-Based Capability

A Notional Process



1. Capability Abstraction
2. Model-Based Capability Translation
3. Capability Definition Validation
4. Updating the Roadmap and Product Backlog
5. Model-Based Acquisition
6. GRA to Program-Specific Model Synchronization
7. Project Product Validation

Use Case Overview, Evaluation Criteria

The following use case illustrates how a digital-engineering-based CNS can be integrated into the normal operations of an acquisition program.

Here are some criteria you might use to assess the different implementation scenarios:

- Elapsed time for the capability to get to the warfighter (Faster = Higher)
- Reliance on PMO technical competency (More Reliance = Lower)
- Programmatic risk (i.e., cost, schedule, technical) (More Risk = Lower)
- Quality of the technical solution (Higher Quality = Higher)

New Capability Use Case

Counter UAS for Ground Vehicle

The user community for infantry fighting vehicles has observed an increase in the number of vehicles that have been damaged by undetected SUAVs and needs to deploy a capability that protects the vehicle against this emerging threat.

This community communicated this need to the sponsor of one of the PMOs for the ground vehicles, and the sponsor updated the capability needs statement for the vehicle.

The CNS update was provided on the normal update cycle. There were no other significant changes in the updated CNS.

New Capability Use Case -2

Counter UAS for Ground Vehicle

The PMO was already aware of this threat and had begun investigating alternatives for SUAV detection and mitigation on the vehicle.

The PMO has established a roadmap for the software effort with biannual releases of the platform software into its systems integration lab.

The software project team has adopted an Agile software development lifecycle with sprints every two weeks.

For this capability upgrade, the PMO assigns a team to investigate the alternatives.

The identified options include:

- a modification to a legacy piece of equipment,
- a new piece of equipment, and
- a combination of a new piece of equipment and a modification to a legacy piece of equipment.

Model-Based Process Alternatives

Scenario 1: Organic Model-Based Engineering

This scenario relies on the competency of the PMO staff to identify the technical solution(s) and to provide the DE skills to develop the GRA. Assuming these competencies were properly provided, this approach should get a higher quality technical solution to the warfighter quicker. However, there is some risk, as the Project Team will need to cooperate.

Scenario 2: Using an External Software Architect

This scenario is less reliant on PMO competency but requires a contract action (to get the external software architect tasked to support this). This might add a bit more time when compared to the first scenario.

Scenario 3: Software Architect Provided by Project Team (Contractor)

This scenario relies on the Project Team to provide the independent high-level design. This would also require a contract action of some kind to get them working on the new capability. The potential impact to the overall project might be higher in this case, as there is the possibility that the firewalled design team might not be as firewalled as we expect, which increases the likelihood for COI.

Conclusion

We believe that **5000.87 + 5000.97** provides the Government with the environment to acquire higher quality technical solutions and provide them to the warfighter quicker.

This is accomplished by using a model-based process to define the capabilities identified in the CNS:

- Improved requirements (or capability) validation
- More authoritative and complete source of mission deficiencies, enhancements, interfaces, and interoperability to use for the acquisition
- Better context for technical negotiations and communications

There are different ways this process could be implemented by the programs. Programs should assess alternatives and select an implementation approach based on criteria, i.e., (1) speed of delivery of new capability, (2) technical competency of internal resources, (3) programmatic risk, and (4) quality of technical solution

Contact Information



Fred Schenker
Software Acquisition
Generalist

Telephone: +1 412.389.8484

Email: info@sei.cmu.edu

