

GVSETS 2024

MODELS-BASED SYSTEMS ENGINEERING

A TECHNICAL REVIEW

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PdM Prototype Development

XM30 Combat Vehicle

14 August 2024

DELIVER MODERNIZED GROUND COMBAT SYSTEMS TO TRANSFORM AND SUSTAIN THE ARMY

AGENDA

- Definitions
- MBSE
 - How does DOORS method compare to Cameo?
 - Complexity: How do you start to evaluate a full systems Architecture Model?
 - Allocated Baseline Criteria Tool
- Lessons Learned
- Future Opportunities
- Closing Remarks
- Q&A

DEFINITIONS

DIGITAL ACQUISITION = **Digital Engineering** + Integration of Sustainment / Production / Acquisition Processes into **Digital Threads**

DIGITAL ENGINEERING = **Models-Based Systems Engineering (MBSE)** + extensive use of validated M&S tools to find errors early and reduce physical testing

MBSE = **Systems Engineering** + visual, relational modeling language (i.e., SysML) to provide additional context on system design

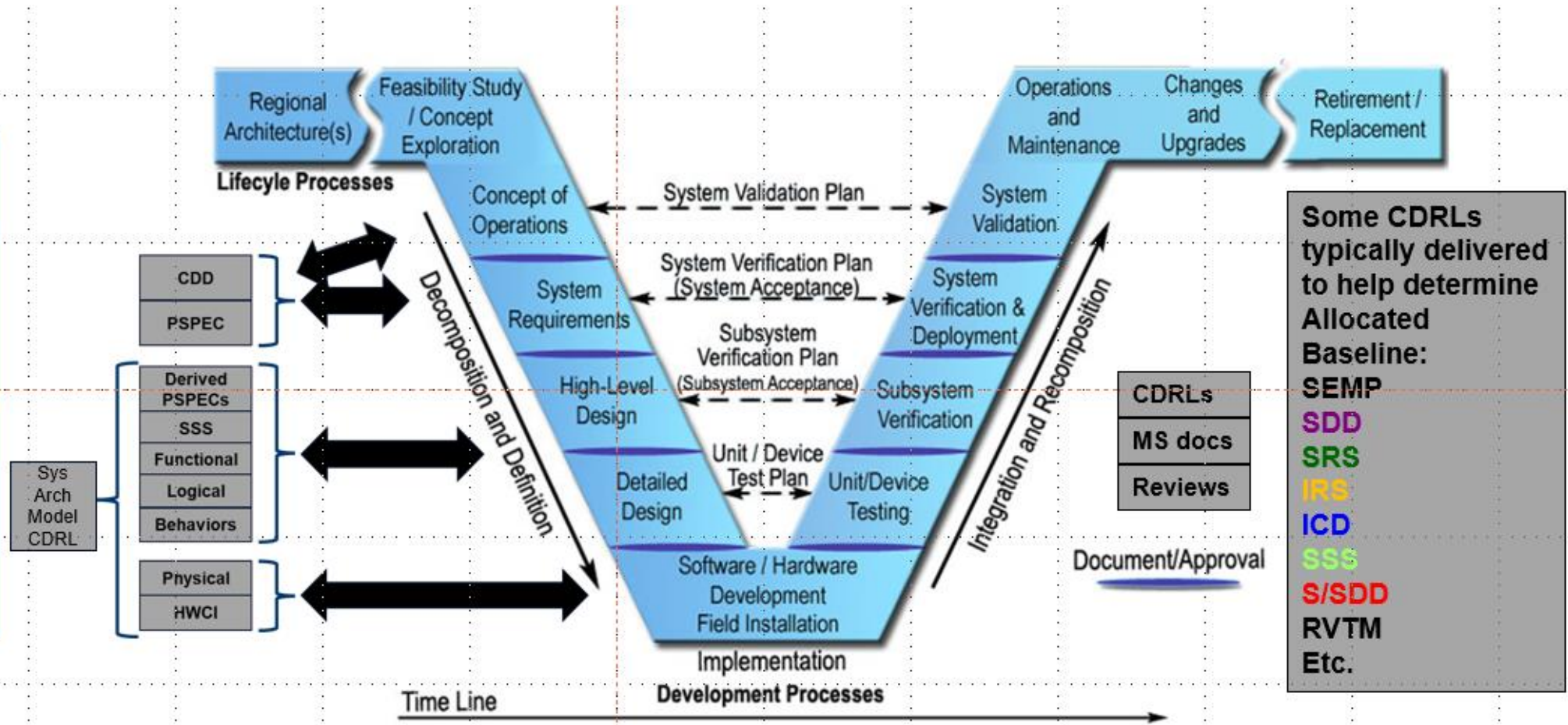
Digital Threads = a relational link, across many applications, of the specific data from an **Authoritative Source of Truth**

Authoritative Source of Truth = the single *real data* element for a design which is only represented in a single location / element (never duplicated.....relationally linked)

HOW DOES MBSE APPLY TO ACQUISITION?

Let's go back to basics

A fundamental change in approach required revisiting the baseline, identifying programmatic needs, and exploring how it could be done in a digital environment



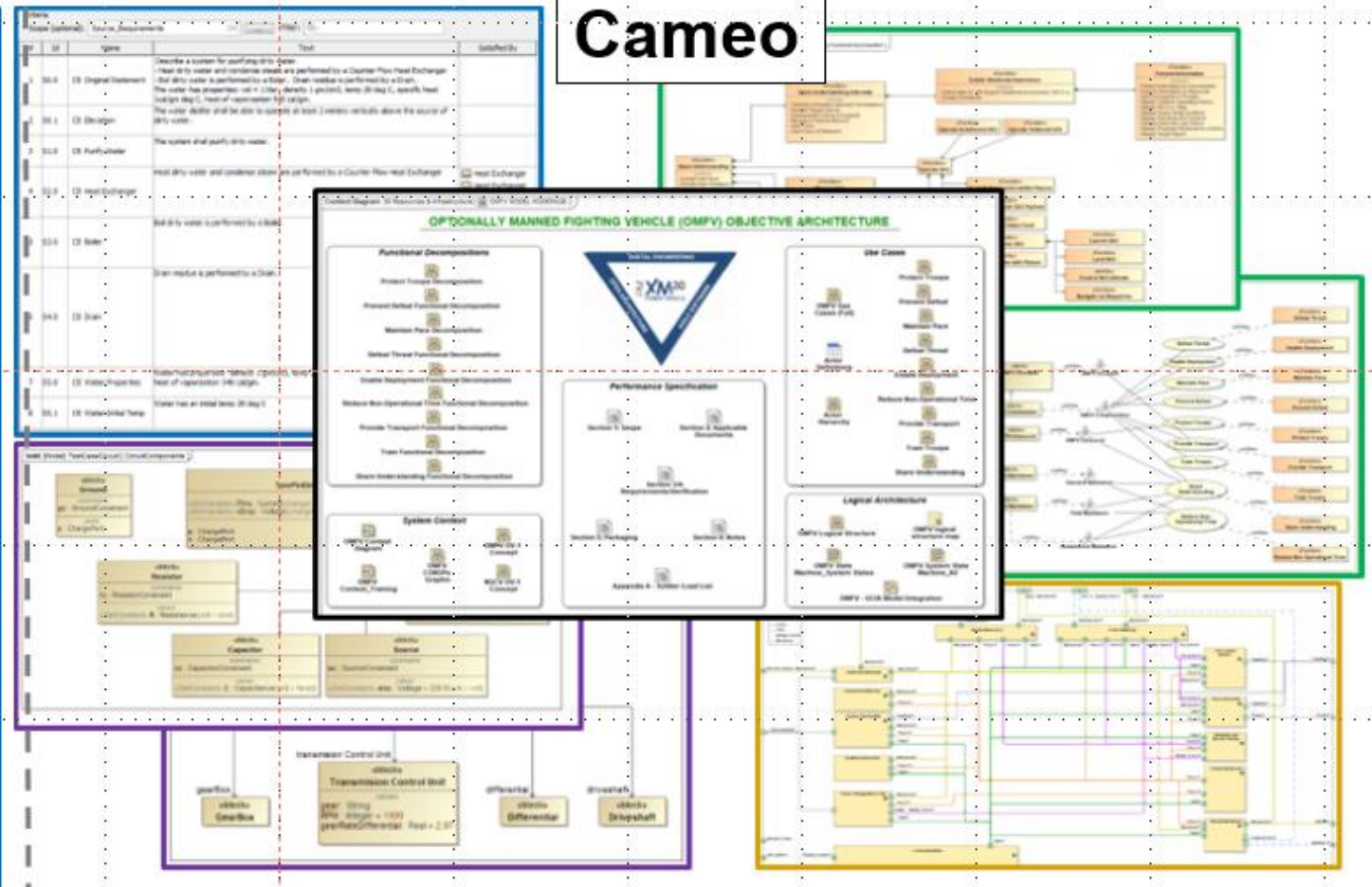
HOW DOES DOORS COMPARE TO CAMEO METHOD?

Requirements > Functional > Logical > Physical

DOORS

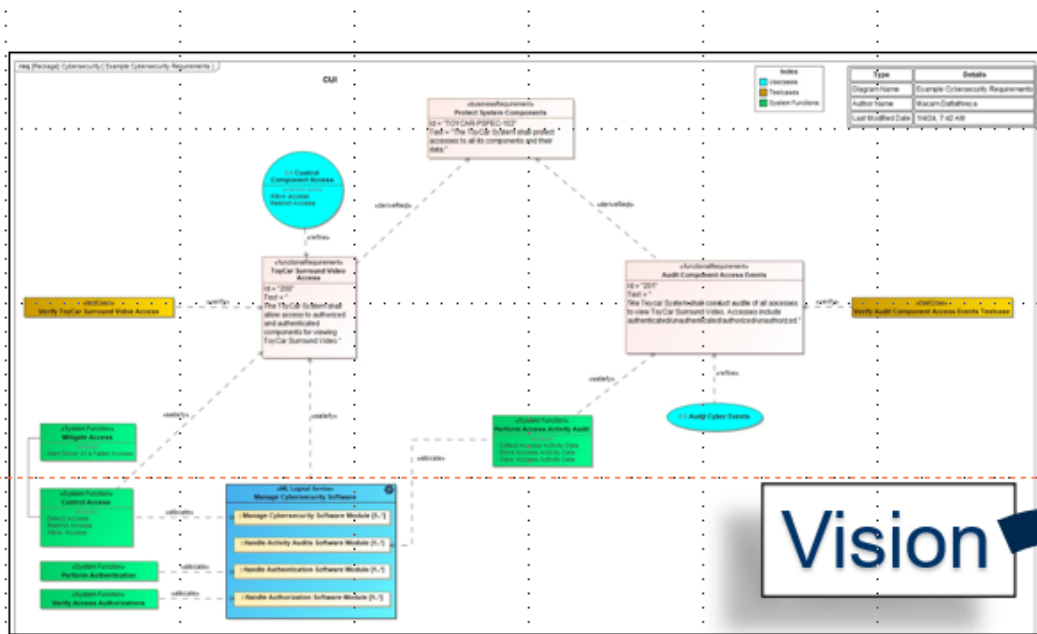
Source ID	1 Re
OMFV-PSPEC-1	NOTICE: For requirements annotated as [VI] (Vendor Input) in Section 3, the vendor shall define the achievable Threshold (T) and Objective (O) values.
OMFV-PSPEC-147	1.1 Functional Capabilities
OMFV-PSPEC-148	1.1.1 Survivability
OMFV-PSPEC-702	1.1.1.1 Avoid Detection
OMFV-PSPEC-608	1.1.1.1.1 Silent Watch
OMFV-PSPEC-2278	The OMFV shall operate in Silent Watch Mode for a period of no less than
OMFV-PSPEC-610	The OMFV, while in Silent Watch, shall power and operate.
OMFV-PSPEC-612	The OMFV, while in Silent Watch, shall power and operate. (T=O)
OMFV-PSPEC-613	The OMFV, while in Silent Watch, shall power and operate. (T=O)
OMFV-PSPEC-614	The OMFV, while in Silent Watch, shall power (T=O)
OMFV-PSPEC-615	If the OMFV employs an active protection system (APS), the OMFV, while in Silent Watch, shall power and operate APS. (T=O)
OMFV-PSPEC-616	The OMFV, while in Silent Watch, shall reserve energy (T=O)
OMFV-PSPEC-618	The OMFV, while in Silent Watch, shall provide the battery health status to the crew by visually (T=O)
OMFV-PSPEC-1996	The OMFV shall provide a silent maneuver capability for a distance over cross-country terrain at a speed of (O)

Cameo



CDRL E041 ALLOCATED BASELINE REVIEW

Step Approach



- The initial vision was to have one “summary” view for each PSPEC requirement that shows the trace to each child requirement and all of the related functions, logic, design parameters, etc.
- However, due to the size and complexity of the models, having that full trace in one view, even for just one PSPEC requirement, quickly becomes unreadable (screenshot below is JUST requirements from one PSPEC)
- The contracted assessment tool framework solves this problem by breaking down the allocated baseline assessment into smaller parts – driving a step approach to the review



Vision

Reality

ALLOCATED BASELINE CRITERIA TOOL

Structured by PSPEC

- 1. Validating allocation and traceability (systems engineer) of the PSPEC to vendor platforms spec / functions
- 2. Validating allocation and traceability of the vendor platform spec to SSS / functions
- 3. Validating allocation and traceability of the SSS to component spec / functions
- 7. Ensuring CSPEC requirement verification plans are in place at each requirement level

Structured by Subsystem

4. Checking that all interfaces are clearly defined and agreeable, including data and information I/Os between Configuration Items (CIs)

Structured by Configuration Item (CI)

5. Checking that all interfaces are clearly defined and agreeable, including data and information I/Os between CIs

Open Ended

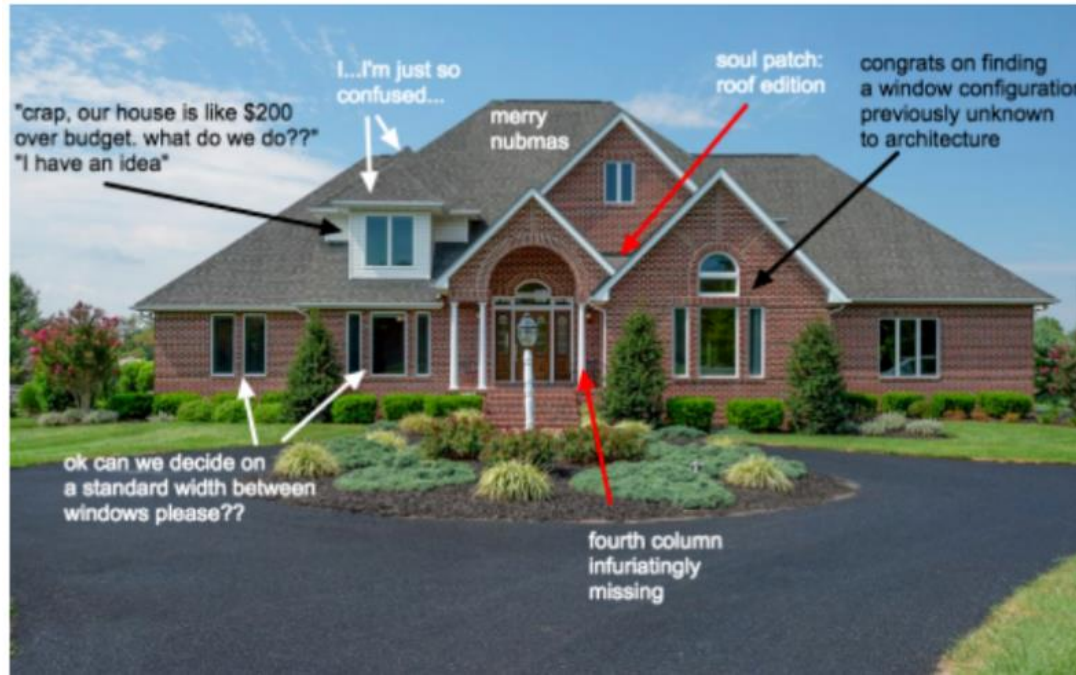
6. Checking that all interfaces are clearly defined and agreeable, including data and information I/Os between Configuration Items (CIs)

8. Reviewing comprehensive design for risks

SYSTEM ARCHITECTING vs. JUST SYSTEM MODELING

- Architecting enables uncovering real risks the system being built!
- Modeling just looks like a document!

Check out <http://www.mcmansionhell.com/>



JUST SYSTEM MODELING & NOT SYSTEM ARCHITECTING??

- **Just System Modeling**

- Lack of applied model-based systems engineering principles
- Contains disconnected requirements and their derivations
- Lack of reasoning about the structures and functional behaviors
- Misunderstood requirements or missing crosscutting requirements

- **System Architecting**

- Applied systems engineering principles
- Clearly defined reasoning about the structures & functional behaviors
- Revealing risks and qualities of the system
- Addressing all functional and non-functional (architectural) requirements
- NO missing requirements; all crosscutting requirements addressed

LESSONS LEARNED EXECUTING AN MBSE CONTRACT

1. MBSE Training without the context of a combat vehicle was ineffective
2. Ground combat vehicle *models-based template is needed*
 1. Clearly defined model expectations to vendors (*what does 'right' look like*)
 2. Consistent structure reduces workforce learning curve
 3. Allows for development of standardized evaluation tools/metrics across programs
3. Given the size and complexity of this type program, *manning model for a PMO needs to be reevaluated*
4. *Upskilling of workforce is essential* (USG and vendors)
 1. SysML knowledge
 2. Basic Systems Engineering competency has atrophied
 3. Immersive vs. distributive training is essential
5. Heuristics for PDR/ CDR dates and CDRL deliveries do not support a models-based approach.
6. Contractor format is the enemy of models-based approach/ digital engineering
7. Numerous vendor touchpoints/ opportunities for direct feedback required to change behavior

FUTURE OPPORTUNITIES

- *Legacy platforms* could benefit from a documented, SysML-based, physical architecture focused on CDR-level detail
- *S&T projects need to start* in a models-based manner to ease development and future integration
- Modeling out processes and data requirements for downstream acquisition activities
 - Manufacturing
 - Product Support
 - Milestone documentation
- Models-based approach *supports parametric analysis* across multiple disciplines
- Models-based approach may streamline some *contracting/ SSEB* activities
- Validated that we can *eliminate some legacy paper-CDRLs* with improved contract language for models-based deliveries
 - CDRLs can remain separate entities, just delivered in SysML
 - SysML models could be constructed to extract the CDRL data in a DID-style format, as required
- Opportunity to *validate PSPEC language* synchronized to the design *based on test results*

CLOSING REMARKS

1. MBSE approach *drives better engineering* that takes longer but will deliver better prototypes (validated across multiple commercial industries).
2. MBSE approach may be the *only way to validate compliance* to GCIA b/c of synchronized visibility into data interfaces and connectivity.
3. Once you know HOW a system is put together (requirements + interfaces + data model) then you can make better, *independent assessments* of the LOE required to change.
4. How did we (USG) ever really know a *design was synchronized?* Synchronization, or lack there of, is now transparent.
5. A systems architecture model is *foundational to synchronized, digital transformation.*



Q&A