Lessons Learned from Managing Complex MBSE Models

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Agenda

• Introduction to the project and MBSE value-based approach
  – Government reference model with traceability from user stories and requirements to subsystems

• Best Practices
  – Requirements Generation and Requirements Gap Analysis - Tracing
  – Architecture Model as a Communications Medium Across Government, Contractors – Exports
  – Understanding how the enterprise achieves user stories
  – Locating and Filtering Data

• Lessons Learned
  – Model Diagram Aesthetics
  – Model Maintenance and Technical Debt
  – Model Collaboration Across Networks

• Conclusion
Introduction

• This MBSE project involved creating a government reference model of the enterprise with traceability from user stories and requirements to subsystems to support RFP development

• Scope
  – *Implemented value-based approach based on customers’ needs*
    • Focus modeling efforts in prioritized areas of interest
    • Small and continuous development effort that provides growing value
    • Small number of Cameo licenses for core modeling team
    • Model is accessible to whole team through HTML exports
  – *Started out small within one group, but quickly expanded to the enterprise due to the value it provides*

• Goals
  – *Identify contractual responsibilities and boundaries for different contractors*
  – *Ensure the high-level user stories can be achieved using the architecture*
  – *Help ensure the requirements generated for the RFP are complete*
**Modeling Approach**

- Implemented value-based approach based on customers' needs
  - **Routine engagement with government customer** identify key questions/decisions that the model can help answer
  - **Small and continuous modeling effort** that grows the model over time to provide expanding value
    - Create and update traceability along the way using established traceability patterns from warfighter CONOPS to requirements to functional capabilities
  - **Frequent iterations with SMEs**
    - Identified deficiencies (e.g. unclear responsibilities, requirements gaps, etc.) when developing model views
    - Working sessions with SMEs to resolve deficiencies
    - Validate the model and to keep the model up-to-date
  - **Updated with contractual SOWs**

- Value based approach and frequent interactions helped facilitate adoption
- Technical specifications
  - **Cameo Systems Modeler/Cameo Enterprise Architecture 19 SP4 and transitioned to 21X**
  - **Unified Architecture Framework (UAF) 1.1 and Department of Defense Architecture Framework (DoDAF) 2.0 Profile**
  - Model configuration management performed in Aerospace’s Teamwork Cloud environment
- Next, we will discuss the best practices that worked well and lessons learned we had to overcome
  - Example diagrams will be presented using publicly available models
Best Practices
Requirements Generation and Requirements Gap Analysis - Tracing

• Early goal was to make sure the concepts being developed are all reflected in the RFP SOW requirements

• To accomplish this goal,
  – Architecture built to refine the concepts and to help identify contractual boundaries
  – Then the RFP SOW requirements were generated by Subject Matter Experts (SMEs)
  – SME Requirements were imported and traced within Cameo to identify gaps:
    • Traced to architecture to identify missing functionality, performance, and interfaces
    • Traced up higher level enterprise requirements to ensure enterprise objectives are met and monitor impacts to enterprise objectives if requirements change
    • Ensure interface requirements had requirements on both contractual ends of the interface
  
• Traceability analysis presented in various formats (e.g. tables, matrices, and requirement diagrams) to communicate findings to different stakeholders

<table>
<thead>
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<th>ID</th>
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<th>Requirement</th>
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<tr>
<td>MR_PER_WEW_01</td>
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<td>Work through light clouds</td>
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<tr>
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<td>meter resolution</td>
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<tr>
<td>MR_PER_GEO_01</td>
<td></td>
<td>1 km geolocation accuracy</td>
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<tr>
<td>MR_PER_COV_01</td>
<td></td>
<td>Coverage of specified forest areas within the US at least twice daily.</td>
</tr>
<tr>
<td>MR_PER_INT_01</td>
<td></td>
<td>Identify an emerging forest fire within 8 hours with less than 10% false positives</td>
</tr>
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</table>
Architecture as Communication Medium

• Initially the different groups produced their artifacts independently and using different formats. So, it was challenging to really understand contractual boundaries, interfaces, and responsibilities

• Sharing the model views improved communication across government and contractor teams
  – Cameo provide unified views combining inputs from multiple teams
  – Functional allocation, swim lanes, stereotypes, and common color schema made it clear where contractual boundaries fell

• Minimal Cameo licenses required
  – Only the core modeling team needed full licenses
  – Model exports routinely shared that do not require licenses
    • Read-only navigable model exported in HTML viewable in web browsers
    • Power Point presentations of material
  – TEMs with SMEs using Cameo over screen share
  – Model change requests are sent to the core modeling team to implement in the architecture
Achieving enterprise user stories

- MBSE Reference Architect focuses on the "what" the enterprise needs to do
  - Leveraged Operational Performers and multiple levels of abstraction of Operational Activities to define "what" the various parts of the enterprise need to do to achieve a large enterprise scenario
  - Warfighter CONOPS for different parts of the enterprise are responsible for specific operational activities
  - Sometimes, Operational Activities were decomposed into additional details to understand interactions at finer level of granularity when it was needed to refine roles and responsibilities between contracts
    - Added details on the hardware implementations by the contractors and linked to the overall architecture
    - Added details on the software development processes
Locating and Filtering Data

• Model organization was critical to help find, locate, and reuse data and avoid creating duplicative element

• Model organization approach
  – Overall structure based on enterprise and its systems
  – Leveraged common model elements library package for model elements that are reused across several systems to promote reuse
  – Within the systems leverage the Cameo UAF/DoDAF package template to group by diagram types
  – Glossary of acronyms, terms, and synonyms to facilitate communication and understanding

• Use smart package queries to easily find nested diagrams that are embedded in model elements
  – Use smart package queries to easily find model elements based on custom stereotype
Lessons Learned
Model Diagram Aesthetics

- For high level concepts, the traditional SysML/UAF/DoDAF looking diagrams that use block were not always well received by stakeholders

- To overcome this challenge, the team changed the aesthetics of the diagrams look more visually appealing while maintaining the traceability and linkages within Cameo
  - Import in a background image or process diagram outline
  - Use externally created images and icons to replace the traditional blocks on Cameo elements
  - Suppress the display of stereotypes and other properties to focus on the imported element images

- These versions were better received than traditional Cameo diagrams, but can be time consuming to create
Model Maintenance

• Requires consistent maintenance to remain relevant and keep pace with the evolving architecture
  – *Does not require high levels of STE*
  – *Slow and steady burn rate*
  – *Cannot “model once and forget”*
• Short iterations for real-time updates to the architecture
  – *Frequent interactions and engagement with SMEs to enrich focus area of the model*
Managing Model Collaboration Challenges Across Networks

• Model collaboration across disparate networks can pose challenges, but was made possible through frequent discussions and engagements between Aerospace and the government agency:
  – Model is maintained on Aerospace’s network
  – Model exports are sent to the government agency to perform model changes on their own network and then merged back into Aerospace’s network
  – Created development branches

• If the model needs to be changed on the customer network, the changes will need to be properly managed in order for the model to maintain its integrity:
  – This would require restructuring the model to federate out the portion that will be changing more regularly on the customer’s network
  – Then main model on the Aerospace network can point to the federated model
Conclusions

• The MBSE approach provided great value including:
  – Requirements Generation and Requirements Gap Analysis - Tracing
  – Architecture Model as a Communications Medium Across Government, Contractors, Bidders – Exports
  – Understanding how the enterprise achieves user stories – communicating with the warfighter
  – Locating and Filtering Data

• MBSE can be implemented successfully with steady and consistent low burn

• MBSE models can be made to be accessible and useful to all members of a project team using only a small number of licenses for Cameo

• Lessons learned provide advice on overcoming some the MBSE challenges we faced
References

• Cameo Systems Modeler – DODAF Example Model
• Cameo Systems Modeler – UAF Example Model