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

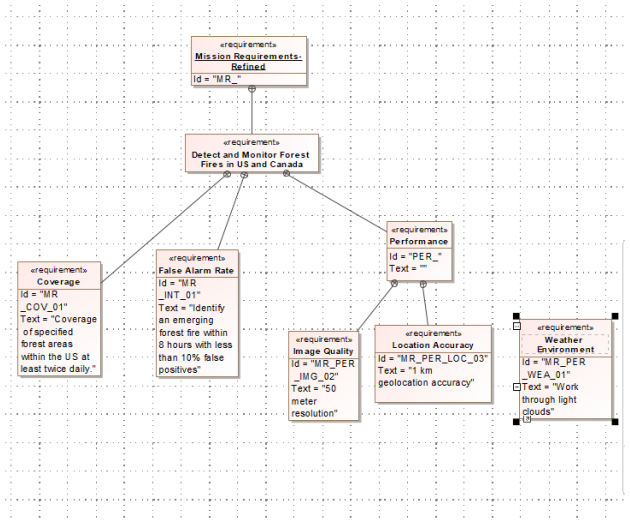
- Implemented value-based approach based on customers' needs
  - *Routine engagement with government customer identify key questions/decisions that the model can help answer*
  - *Small and continuous modeling effort that grows the model over time to provide expanding value*
    - Create and update traceability 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*

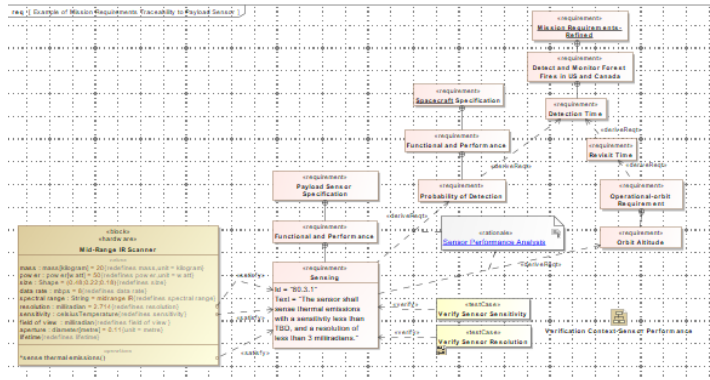
Best Practices

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

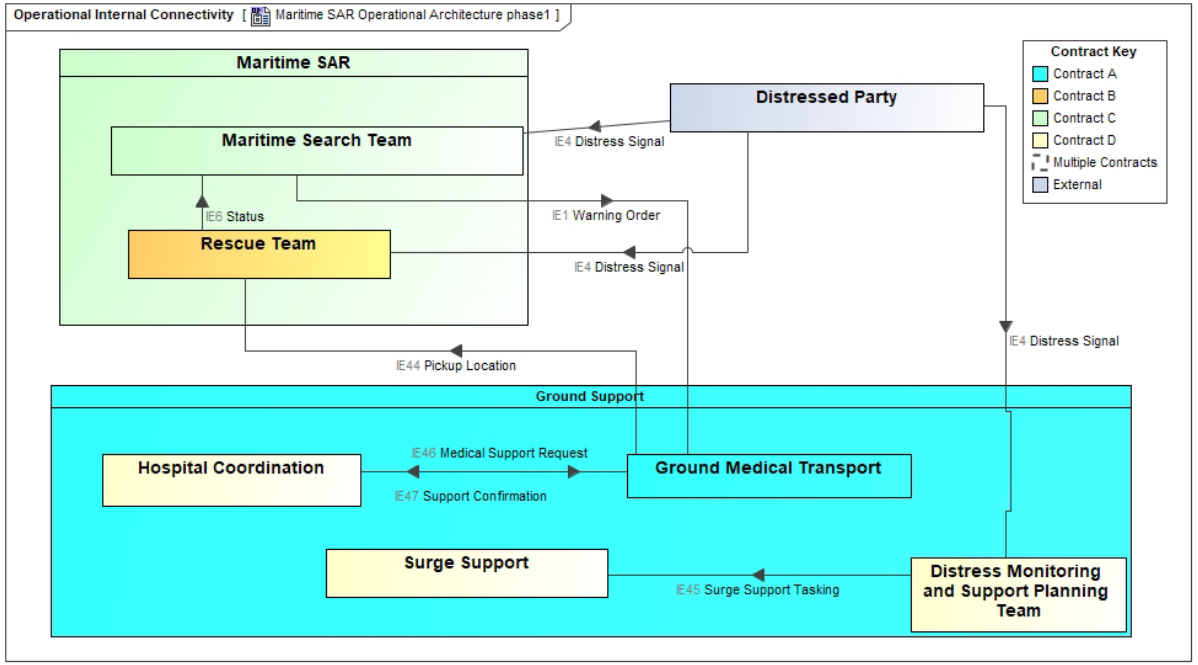
ID	CDRL	Requirement
This Table is Unclassified		
MR_PER_WEA_01		Work through light clouds
MR_PER_RES_01		50 meter resolution
MR_PER_GEO_01		1 km geolocation accuracy
MR_PER_COV_01		Coverage of specified forest areas within the US at least twice daily.
MR_PER_INT_01		Identify an emerging forest fire within 8 hours with less than 10% false positives





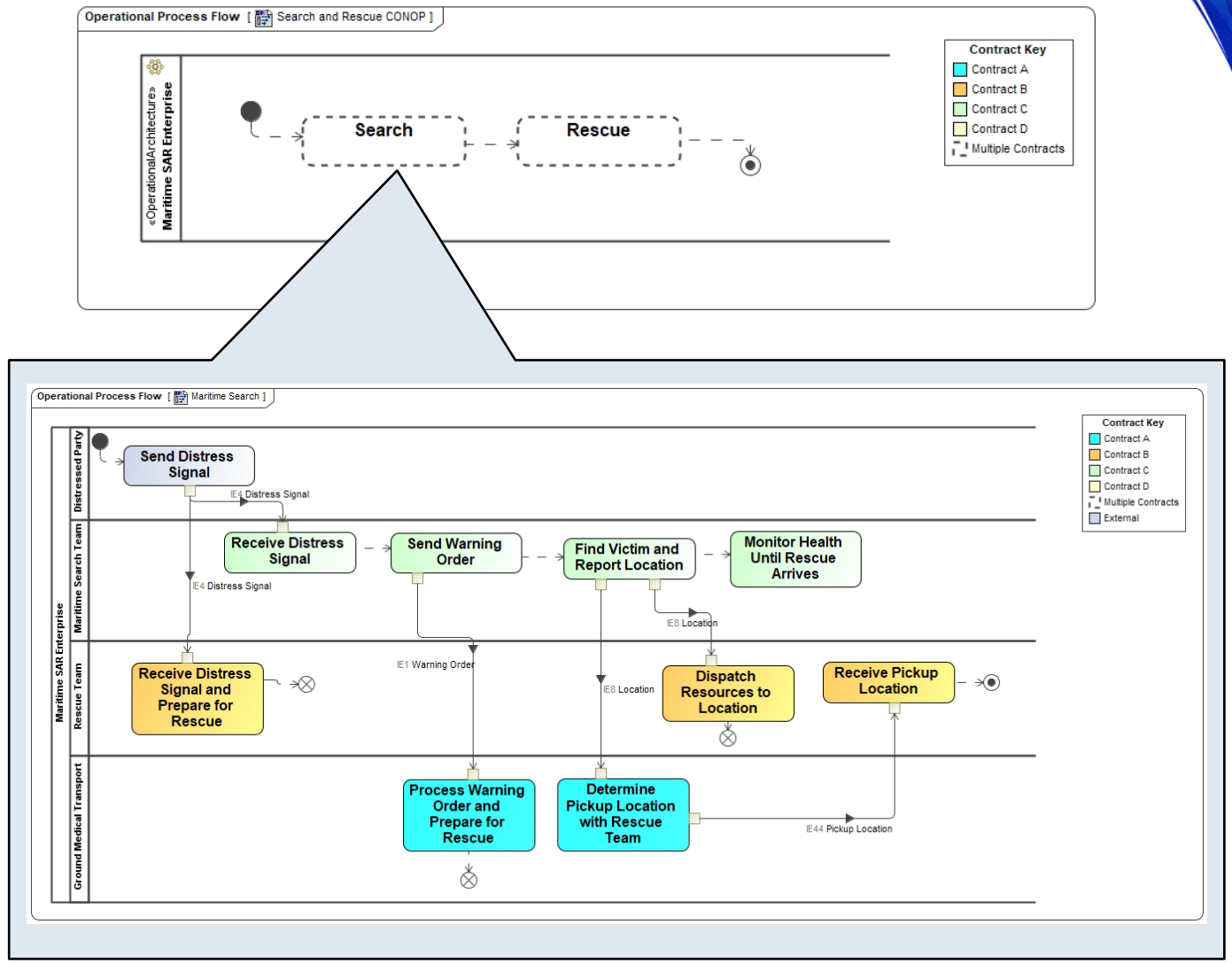
Architecture as Communication Medium

- 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*



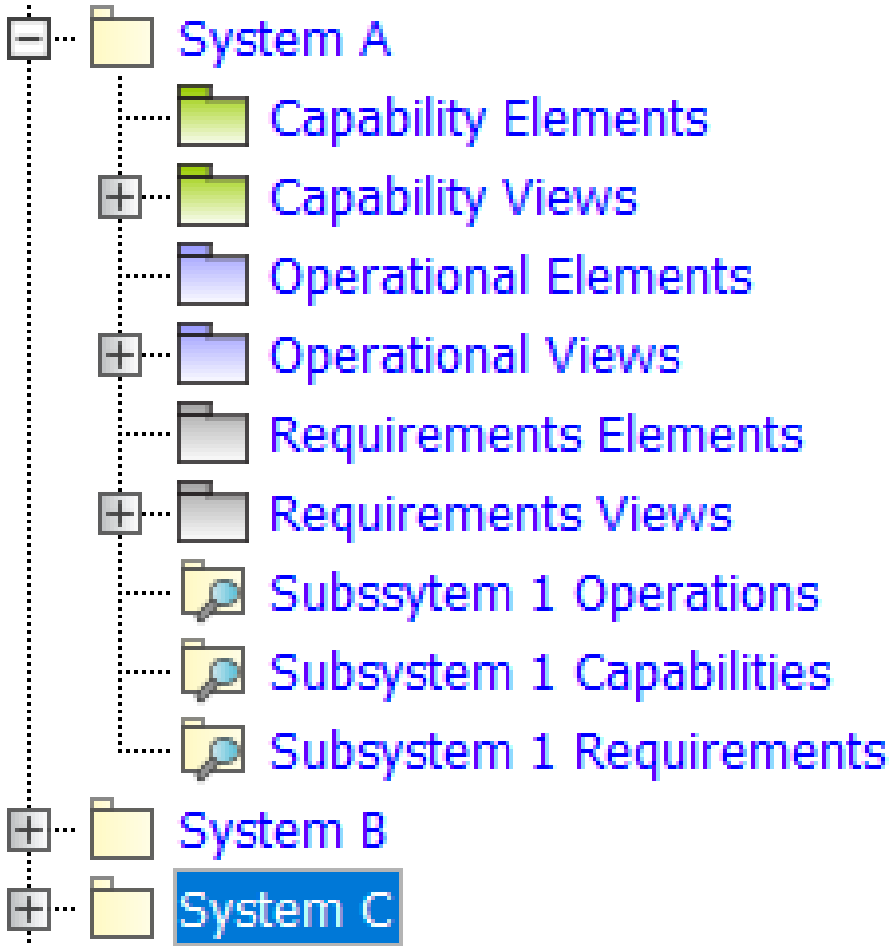
Achieving enterprise user stories

- 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

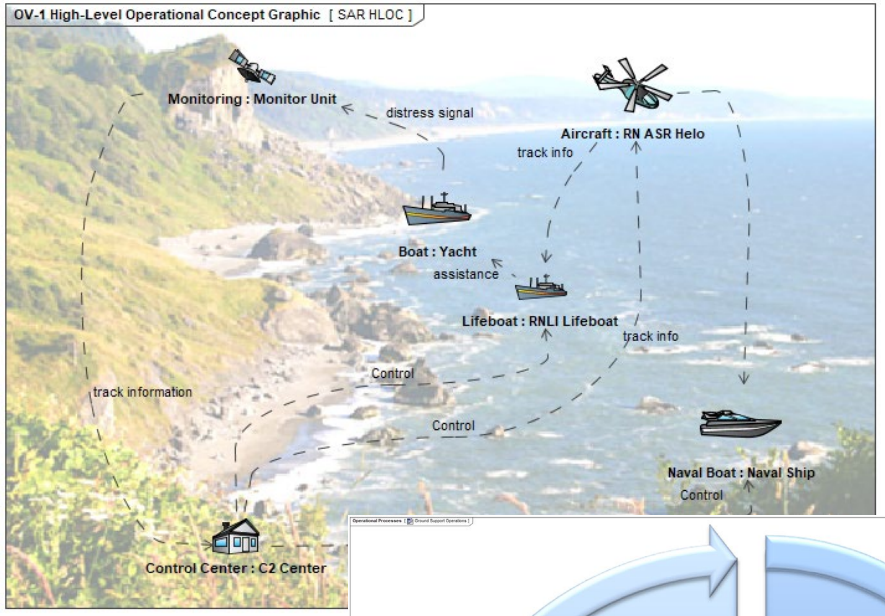
- Model organization was critical to help find, locate, and reuse data and avoid creating duplicative element
- Model organization approach
  - *Overall structure based on enterprise and its systems*
  - *Leveraged common model elements library package for model elements that are reused across several 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

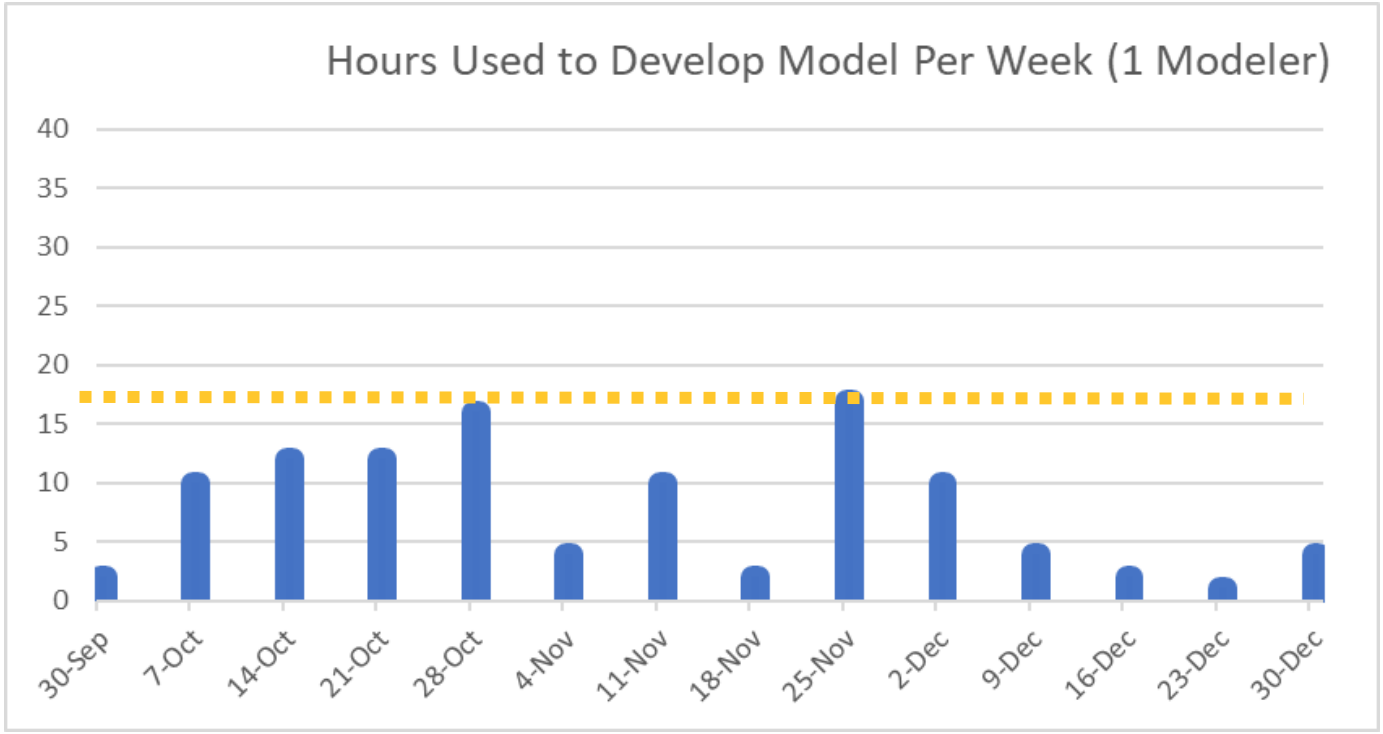
Model Diagram Aesthetics

- 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



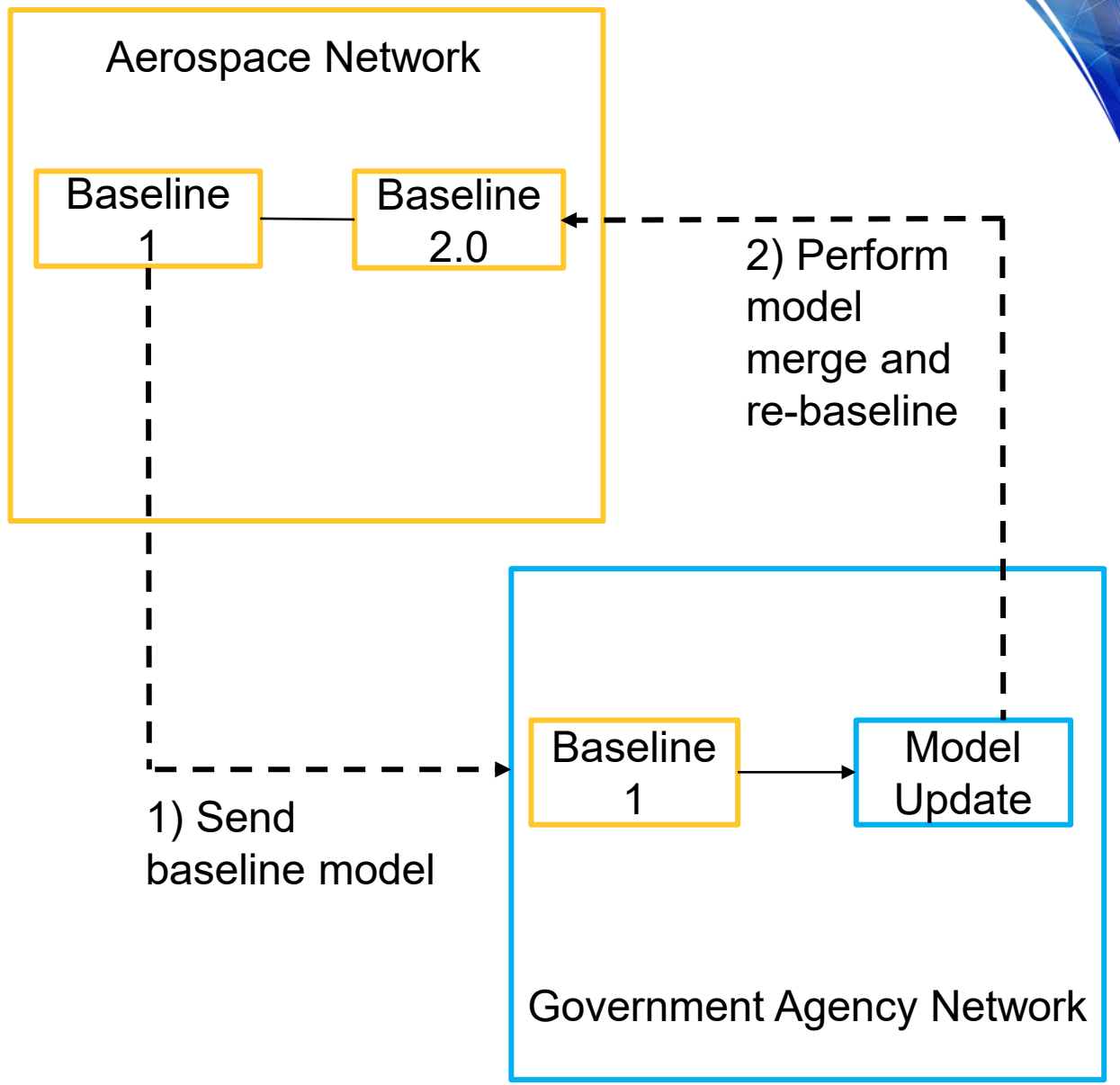
Model Maintenance

- 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*



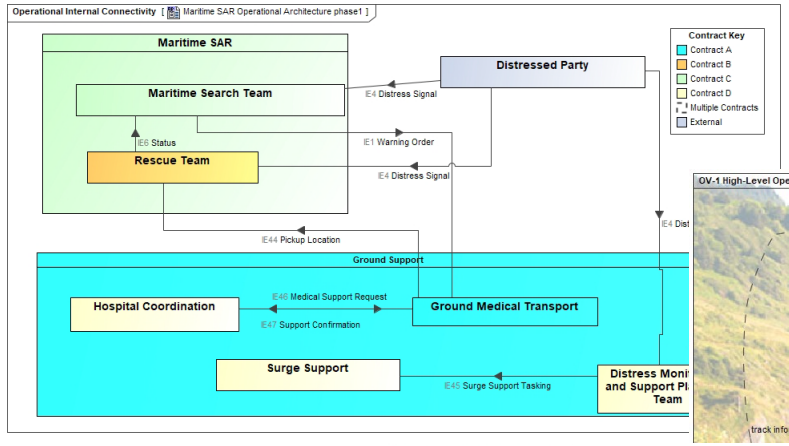
Managing Model Collaboration Challenges Across Networks

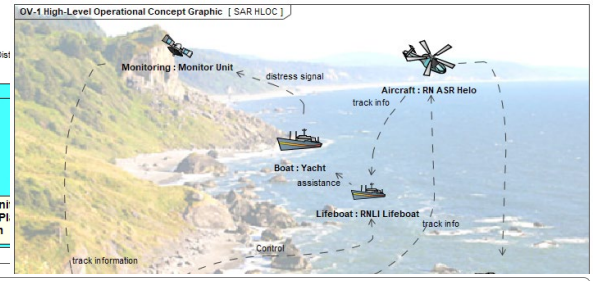
- Model collaboration across disparate networks can pose challenges, but was made possible through frequent discussions and engagements between Aerospace and the government agency
  - *Model is maintained on Aerospace's network*
  - *Model exports are sent to the government agency to perform model changes 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*

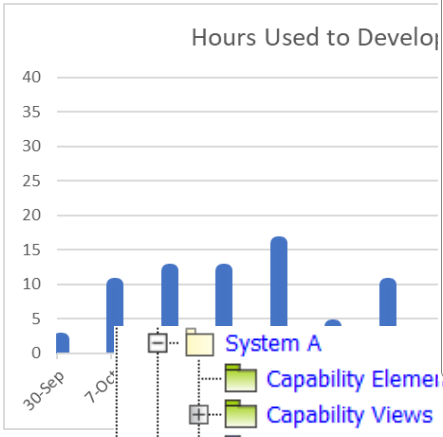


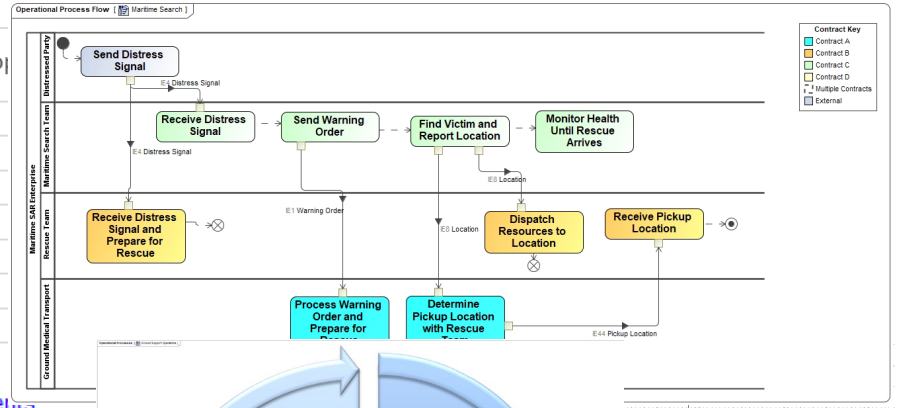
Conclusions

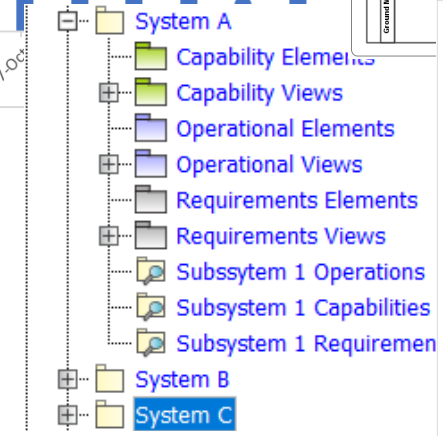
- The MBSE approach provided great value including:
  - *Requirements Generation and Requirements Gap Analysis - Tracing*
  - *Architecture Model as a Communications Medium Across Government, Contractors, Bidders – Exports*
  - *Understanding how the enterprise achieves user stories – communicating with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

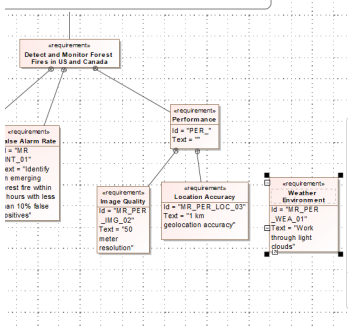












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