



NASA SBIR 2019 Phase I Solicitation

Z8.07 Spacecraft Model-Based Systems Engineering

Lead Center: JPL

Participating Center(s): JPL, LaRC

Technology Area: TA11 Modeling, Simulation, Information Technology and Processing

NASA continues to pursue improvements in small spacecraft capabilities and reliability, especially for the deep space environment. Small spacecraft can help NASA achieve science and exploration goals with novel and more affordable mission architectures, including architectures based on ensembles of small spacecraft or that augment larger conventional spacecraft with small spacecraft. NASA seeks innovative model-based systems engineering (MBSE) methods and tools to:

- Define, design, develop, analyze, execute, and validate future small spacecraft missions through development of advanced methods and tools that enable more rapid, comprehensive, deeper, and integrated spacecraft design across the entire project lifecycle from concepts through system operations and end of mission disposal. The capabilities should leverage MBSE approaches being piloted across NASA and enable agile integration of disparate model types and various discipline tools.
- Enable disciplined system analysis for the design of future missions, including modeling of decision and programmatic support for those missions. Such models might also be made useful to evaluate technology alternatives and impacts, science valuation methods, and programmatic and/or architectural trades, including potential mission architectures comprised of multiple spacecraft.

Specific areas of interest are listed below. Approaches that emphasize or address multiple areas are encouraged. Proposers are recommended to be familiar with the state of the art and leverage existing standards where possible:

- Support for rapid trade space evaluations and capabilities for visualization, comprehension, and comparison of results/options.
- User-centered model interaction approaches for engaging domain experts that do not have significant MBSE expertise.
- Automated generation of traditional systems engineering artifacts including requirements and interface documents.
- Simulation and execution of spacecraft missions, leveraging advances in behavior modeling and execution in ALF, FUML, PSSM, PSCS, etc.
- Evaluation of systems performance margins (technical and programmatic).
- Model interchange, traceability, and configuration management between systems and discipline specific models, e.g., integration with CAD, FEM tools, etc.
- Integration of systems models with data analytics platforms for reporting and querying on model

information.

As NASA continues its move into greater use of models for formulation and development of NASA projects and programs, there are recurring challenges to address. This subtopic focuses on encouraging solutions to these cross-cutting modeling challenges, including greater modeling breadth (e.g., cost/schedule), depth (scalability), variable fidelity (precision/accuracy vs. computation time), trade space exploration (how to evaluate large numbers of options), interaction (how users interact with the tools) and the processes that link them together. The focus is not on specific tools, but demonstrations of capability and methodologies for achieving the above. While the current focus is on small spacecraft, these tools and techniques will become more and more applicable to NASA's large missions.

The expected Technology Readiness Level (TRL) range at completion of this project is 3 to 5. Desired deliverables at the end of Phase I include new prototypes for tool integrations, visualization and access approaches, best practice patterns, reusable libraries, and model validation frameworks.

References:

- SysML - <http://www.omg.sysml.org/SysML-2.htm>
- Open MBEE (Model-Based Engineering Environment) - <http://www.openmbee.org/>
- Alf (Action Language for Foundational UML) - <https://www.omg.org/spec/ALF/1.1/>
- OSLC (Open Services for Lifecycle Collaboration) - <https://open-services.net/>
- PSSM (Precise Semantics of UML State Machines Specification) - <https://www.omg.org/spec/PSSM/About-PSSM/>
- PSCS (Precise Semantics of UML Composite Structures) - <https://www.omg.org/spec/PSCS/About-PSCS/>
- fUML (Foundational UML) - <https://www.omg.org/spec/FUML/About-FUML/>
- FMI (Functional Mock-Up Interface) - <https://fmi-standard.org/>
- OpenAPI - https://en.wikipedia.org/wiki/OpenAPI_Specification