NASA SBIR 2019 Phase I Solicitation

H6.04 Model Based Systems Engineering for Distributed Development

Lead Center: ARC

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

As NASA looks to develop a cis-lunar infrastructure, starting with components like the Gateway, there will be considerable interest in partnerships with a wide variety of communities. Building from the success of the international partnerships for ISS, space agencies from multiple governments are looking for roles on the Gateway. The rapidly growing commercial space industry is also likely to seek roles in supporting this infrastructure. All of these potential partners will have their own design capabilities, their own development processes, and internal constituencies to support. Enabling disparate systems built in different locations by different owners to all work cohesively together will require a significant upgrade to NASAâ€™s core systems engineering toolset.Â

Model Based Systems Engineering holds considerable promise for facilitating this type of distributed development process, but we need to significantly improve and expand the engineering support infrastructure to enable the systems we will need for lunar exploration. Methodologies that support integration amongst tools and exchange of information between multidisciplinary artifacts are important development opportunities. The definition of interface standards and tools that enable inspection of distributed models across domains are very important. Tools or systems that allow models to be shared across development environments and trace the resulting systems back to contributions from multiple partners are also of high interest. SysML related tools are relevant to this subtopic, but need to address distributed development, multi-disciplinary system development, and the engineering of interfaces between subsystems built by different communities from requirements through testing, verification, and validation.

Model Based Systems Engineering for distributed development is relevant to all Human Exploration Operations Mission Directorate (HEOMD) missions, and of timely interest for Gateway development. Over the next 3 to 5 years, there will be considerable opportunity for small business contributions to be matured and integrated into the engineering support infrastructure as Gateway evolves from concept to development program.

During Phase I, research should be conducted to demonstrate methodologies and tools that support distributed multi-disciplinary development efforts, theirÂ technical feasibility, and NASA relevance.Â

Phase I proposals should clearly indicate how the research will go beyond state of the art engineering practices. Prototypes are strongly encouraged and could take several forms such as augmentations/plugins to existing SySML tools. Phase II deliverables should include at a minimum demonstration of a prototype tool or methodology on a small system(s) that is representative or analog of a portion of lunar infrastructure, and documentation with source for NASA to explore use of the tool.Â The expected TRL for this project is 5 to 7.

References:

References documenting current State of Practice within NASA - proposals shall address technology advances beyond state of practice:

- NASA Office of Safety and Mission Assurance: Model-Based Mission AssuranceÂ https://sma.nasa.gov/sma-disciplines/model-based-mission-assurance
- NASA Engineering and Safety Academy: Systems EngineeringÂ https://nescacademy.nasa.gov/category/3/sub/17
- NASA/SP-2016-6105/SUPPL/Vol 2: Expanded Guidance for NASA Systems Engineering. Volume 2: Crosscutting Topics, Special Topics, and Appendices. Section 8.2 Model Based Systems EngineeringÂ https://ntrs.nasa.gov/search.jsp?R=20170007239

General References for Model-Based System Engineering for Distributed Development,Â and relevant NASA Missions:

- Research Challenges in Modeling & Simulation for Engineering Complex SystemsÂ http://trainingsystems.org/publications/Research-Challenges-in-Modeling-and-Simulation-for-Engineering-Complex-Systems.pdf
- https://ieeexplore.ieee.org/document/6899129/
- https://www.incose.org/docs/default-source/space-systems-working-group/2015-gsfc-se-seminar---incose-sswg-cubesat-model-status.pdf?sfvrsn=4d3087c6_0
- https://www.sae.org/publications/technical-papers/content/2011-01-2664/
- https://www.nasa.gov/feature/deep-space-gateway-to-open-opportunities-for-distant-destinations
- https://www.nasa.gov/topics/moon-to-mars/lunar-outpostÂ

Papers where MBSE was implemented asÂ a pathfinder on a NASA project:

- Modeling to Mars: a NASA Model Based Systems Engineering Pathfinder EffortÂ https://ntrs.nasa.gov/search.jsp?R=20170009110
- Using A Model-Based Systems Engineering Approach for Exploration Medical System DevelopmentÂ https://ntrs.nasa.gov/search.jsp?R=20170008864
- Using Model-Based Systems Engineering to Provide Artifacts for NASA Project Life-Cycle and Technical ReviewsÂ https://ntrs.nasa.gov/search.jsp?R=20170008864

Forward-looking documents describing challenges and opportunities for using MBSE at NASA:

- NASA/TM-2017-219633, M-1435: Digital Model-Based Engineering: Expectations, Prerequisites, and Challenges of InfusionÂ https://ntrs.nasa.gov/search.jsp?R=20170006995

Research Challenges in Modeling & Simulation for Engineering Complex SystemsÂ http://trainingsystems.org/publications/Research-Challenges-in-Modeling-and-Simulation-for-Engineering-Complex-Systems.pdf