



## NASA SBIR 2020 Phase I Solicitation

### S5.04 Integrated Science Mission Modeling

Lead Center: JPL

Participating Center(s): GSFC

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

#### Scope Title

Innovative System Modeling Methods and Tools

#### Scope Description

NASA seeks innovative systems modeling methods and tools addressing the following needs:

- Define, design, develop, and execute future science missions by developing and utilizing advanced methods and tools that empower more comprehensive, broader, and deeper system and subsystem modeling, while enabling these models to be developed earlier in the lifecycle. Ideally, the proposed solutions should leverage MBSE (Model-Based Systems Engineering)/SysML (System Markup Language) approaches being piloted across NASA, allow for easier integration of disparate model types, and be compatible with current agile design processes.
- Enable disciplined system analysis for the design of future missions, including modeling of decision support for those missions and integrated models of technical and programmatic aspects of future missions.
- Evaluate technology alternatives and impacts, science valuation methods, and programmatic and/or architectural trades.

Specific areas of interest are listed below. Proposers are encouraged to address more than one of these areas with an approach that emphasizes integration with others on the list:

1. Conceptual phase models and tools that allow design teams to easily develop, populate, and visualize very broad, multidimensional trade spaces; methods for characterizing and selecting optimum candidates from those trade spaces, particularly at the architectural level. There is specific interest in models and tools that facilitate comprehensive comparison of architectural variants of systems.
2. Capabilities for rapid generation models of function or behavior of complex systems, at either the system or the subsystem level. Such models should be capable of eliciting robust estimates of system performance given appropriate environments and activity timelines, and should be tailored:
  1. To support emerging usage of autonomy, both in mission operations and flight software as well as in growing usage of auto-coding.
  2. To operate within highly distributed, collaborative design environments, where models and/or infrastructure that support/encourage designers are geographically separated (including Open Innovation environments). This includes considerations associated with near-real-time (concurrent)

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- collaboration processes and associated model integration and configuration management practices.
3. To be capable of execution at variable levels of fidelity/uncertainty. Ideally, models should have the ability to quickly adjust fidelity to match the requirements of the simulation (e.g., from broad-and-shallow to in-depth and back again).
  3. Target models (e.g., phenomenological or geophysical models) that represent planetary surfaces, interiors, atmospheres, etc., and associated tools and methods that allow for integration into system design/process models for simulation of instrument responses. These models may be algorithmic or numeric, but should be useful to designers wishing to optimize remote sensing systems for those planets.

Note that this topic area addresses a broad potential range of science mission-oriented modeling tools and methods. This includes the integration of these tools into broader model-based engineering frameworks, and also includes proposals with MBSE/SysML as the primary focus.

## References

Large Ultraviolet Optical Infrared Surveyor (LUVOIR): <https://asd.gsfc.nasa.gov/luvoir/>

Origins Space Telescope (OST): <https://asd.gsfc.nasa.gov/firs/>

Habitable Exoplanet Observatory (HabEx): <https://www.jpl.nasa.gov/habex/>

Lynx: <https://www.wastro.msfc.nasa.gov/lynx/>

Laser Interferometer Space Antenna (LISA): <https://lisa.gsfc.nasa.gov/>

Wide Field Infrared Survey Telescope (WFIRST): <https://www.nasa.gov/content/goddard/wfirst-wide-field-infrared-survey-telescope>

Mars Exploration/Program & Missions: <https://mars.nasa.gov/programmissions/>

JPL Missions: <https://www.jpl.nasa.gov/missions/>

**Expected TRL or TRL range at completion of the project:** 3 to 5

## Desired Deliverables of Phase II

Prototype, Software

## Desired Deliverables Description

At the completion of Phase 2, NASA desires a working prototype suitable for demonstrations with "real" data to make a compelling case for NASA usage. Use and development of the model - including any and all work performed to verify and validate it - should be documented.

## State of the Art and Critical Gaps

There currently are a variety of models, methods, and tools in use across the Agency and with our industry partners. These are often custom, phase-dependent, and poorly interfaced to other tools. The disparity between the creativity in the early phases and the detail-oriented focus in later phases has created phase transition boundaries, where missions not only change teams but tools and methods as well. We aim to improve this.

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 sub-topic focuses on encouraging solutions to these cross-cutting modeling challenges. These cross-cutting challenges include: 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), and processes that link them together. The focus is not on specific tools, but demonstrations of capability and methodologies for achieving the above.

The explosion of MBX (Model Based Everything) has led to a proliferation of models, modeling processes, and the

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integration/aggregation thereof. The model results are often combined with no clear understanding of the fidelity/credibility. While some NASA folks are looking for greater accuracy and "single source of truth," others are looking for the generation and exploration of massive trade spaces. Both greater precision and greater robustness will require addressing the cross-cutting challenges cited above.

### **Relevance / Science Traceability**

Several concept/feasibility studies for potential large (flagship) Astrophysics missions are in progress: LUVOIR, OST, HabEx and Lynx. Following the 2020 Astrophysics decadal rankings, one of these will likely proceed to early Phase A where the infusion of new and advanced systems modeling tools and methods would be a potential game-changer in terms of rapidly navigating architecture trades, requirements development and flow-down, and design optimization.

A variety of planetary missions requires significant modeling and simulation across a variety of possible trade spaces. The portions of this topic area focused on breadth and variable fidelity will support them..