NASA STTR 2022 Phase I Solicitation

T11.05  Model-Based Enterprise

Lead Center: ARC

Participating Center(s): HQ, LaRC, MSFC, SSC

Scope Title

Model-Based Enterprise, Digitally Interacting Comprehensive Frameworks and Models, and Automated Decision Making for Agency Operations

Scope Description

Model-based enterprise targets the use of models in any function, from engineering to safety to finance to facilities and more (i.e., Model-Based "Anything" or MBx), to enable high-complexity decision making embodying agile processes to achieve efficiency, accuracy, confidence, and adaptability in support of NASA's mission, programmatic development, and institutional activities.

Consider an example of how Model-Based Systems Engineering (MBSE) is increasing in importance to future projects and programs as demonstrated by the strategic thrust towards "Model-Based Anything" of the Digital Transformation Initiative. At the same time, the nature of work at NASA is increasingly distributed with a workforce that may continue partial telework even after pandemic-related restrictions are relaxed.

As previously indicated, the Agency will need to focus on efforts associated with the new changes in the "Future of Work" at NASA (reference provided in the section below). NASA will likely have fewer people working in buildings post-pandemic, and such buildings may be used differently than at present because many people will be working offsite and less frequently working in NASA facilities except for special activities and needs. We will need to restructure our present older facilities for this type of change and/or plan to design differently for any new facilities, and we will need models for that.

NASA is seeking specific innovative, transformational, model-based solutions in the area of Institutional Management of Health/Automated Decision Support of Agency Facilities, which represents an opportunity to make revolutionary changes in how the Agency conducts business by investing in nascent technologies. The Agency's newly minted Digital Transformation Office is interested in how to help reposition and accelerate the modernization of digital systems that support modern approaches to managing the Agency's aging infrastructure. Recent initiatives in smart city technologies focus on condition-based/preventive maintenance, smart buildings, and smart lighting, which will address pressing Agency facility needs.

The STTR vehicle offers the small business community an opportunity to have a hand in this process towards repositioning and accelerating the modernization of digital systems supporting the Agency's aging infrastructure to:
- Save energy costs due to water and electricity usage that is poorly measured and managed.
- Enable the deployment of nascent technological trends in data-driven decision making and support tools based upon statistical methods to help streamline and improve the efficiency of facility operations and maintenance activities.
- Determine how well technologies using techniques from the previous bullet can be broadly deployed across NASA.
- Enabling new agency-centric insight and management capabilities (building upon center models) to meet evolving future-of-work and other challenges in a more proactive and seamless manner.

At the conclusion of a Phase II effort, we anticipate that offerors should deliver a means to develop a model that is capable of context switching among various categorical factors established according to various levels of granularity including but not limited to the following: independent facility needs, facility inventory lifecycle balancing needs, workforce needs, etc.

For example, such a model should use past years’ data to predict the condition of certain facility systems, and which ones should be invested in first for repairs to improve the return on investment or improve the overall condition and reliability of the facility. A deferred maintenance assessment is conducted at NASA every year or on a 2 to 3 year cycle, where the inventory of buildings at every center is considered, for 27 systems total. A comparison of the current condition of those systems to previous years for each of those building systems is conducted. At the moment, there is a (sometimes categorical, sometimes numerical) mission dependency index (MDI) that comprises six factors (ref. 7), which is used to decide the highest priority for investments.

By the end of Phase II, offerors should have developed a model capable of identifying which of these 27 systems to invest in to increase the overall MDI. For example, given a specific building and the relative condition of its 27 systems, the model should make a recommendation on which systems to focus on for the highest return on investment (ROI) and fastest payback, as not all systems will feasibly be invested in for concurrent improvements.

The model should also be capable of the following:

1. Identifying an optimal sequence of investments for which systems and which projects should be undertaken first.
2. Be scalable and be capable of prioritizing project(s) by looking at 27 systems to identify the best investments based on a large number of buildings (e.g., 100 or more).
3. Capable of identifying macro-level systemic issues throughout the entire facility inventory from independent predictions made at the local level.

Several years worth of data (potentially up to 10 years) can be supplied to support the development of these enhanced features of such a model as well.

However, it should be noted that it is easier to provide data for specific facility-level improvements rather than for facility inventory optimization due to the diverse and nontraditional set of facility functions that NASA as an Agency is challenged with due to unique mission needs and requirements. Data to support this type of macro-level analysis is not readily available, e.g., on the quality of the spaces.

However, at the local level, there are a limited number of high-performance modern facilities in the Agency that may offer very granular levels of detail to inform the development of a model that could effectively be used to address post-pandemic facility layout optimization needs, e.g., due to social distancing requirements, etc.

**Expected TRL or TRL Range at completion of the Project**

4 to 6

**Primary Technology Taxonomy**
Desired Deliverables of Phase I and Phase II

- Research
- Analysis
- Prototype
- Hardware
- Software

Desired Deliverables Description

Phase I Deliverables—Reports identifying use cases, proposed tool views/capabilities, identification of NASA or industry leveraging and/or integration opportunities, test data from proof-of-concept studies, and designs for Phase II.

Phase II Deliverables—Delivery of models/tools/platform prototypes that demonstrate capabilities or performance over the range of NASA target areas identified in use cases. A Working integrated software framework capable of direct compatibility with existing programmatic tools.

State of the Art and Critical Gaps

Outside of NASA, industry is rapidly advancing Model-Based Systems Engineering (MBSE) tools and scaling them to larger, more complex development activities. Industry sees scaling as a natural extension of their ongoing digitization efforts. These scaling and extension efforts will result in reusable, validated libraries containing models, model fragments, patterns, contextualized data, etc. They will enable the ability to build upon, transform, and synthesize new concepts and missions, which has great attraction to both industry and government alike. A Real-time collaboration and refinement of these validated libraries into either a single source or authoritative sources of truth provide further appeal as usable knowledge can be pulled together much more quickly from a far wider breadth of available knowledge than was ever available before.

One example of industry applying MB/MBe/MBSE is through Digital Thread, a communication framework that helps facilitate an integrated view and connected data flow of the product's data throughout its lifecycle. In other words, it helps deliver the right information at the right time and at the right place. Creating an identical copy (sometimes referred to as a “digital twin”) is another use, a digital replica of potential and actual physical assets, processes, people, places, systems, and devices that can be used for various purposes. These twins are used to conduct virtual cost/technical trade studies, virtual testing, virtual qualification, etc., that are made possible through an integrated model-based network. Given the rise of MBSE in industry, NASA will need to keep pace in order to continue to communicate with industry, manage and monitor supply chain activities, and continue to provide leadership in spaceflight development.

Within NASA, our organization is faced with increasingly complex problems that require better integration and synthesis of both models and larger sets of data, not only in the systems engineering or MBSE realm, but in the broader MB Institution, MB Mission Management, and MB Enterprise Architecture. NASA is challenged to sift through and pull out the particular pieces of information needed for specific functions, as well as to ensure requirements are traced into designs, tested, and delivered; thus, confirming that the Agency gets what it has paid for. On a broader cross-agency scale, we need to ensure that needed information is available to support critical decisions in a timely and cost-effective manner. All of these challenges are addressed through the benefits of model-based approaches. Practices such as reusability, common sources of data, and validated libraries of authoritative information become the norm, not the exception, using an integrated, model-based environment. This model-based environment will contribute to a diverse, distributed business model.
encompassing multicenter and government-industry partnerships as the normal way of doing business.

**Relevance / Science Traceability**

MBx solutions can benefit all NASA Mission Directorates and functional organizations. NASA activities could be dramatically more efficient and lower risk through MBx support of more automated creation, execution, and completion verification of important agreements, such as international, supply chain, or data use.

1. **References:**

   1. Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing: [https://www.sae.org/standards/content/as9100/](https://www.sae.org/standards/content/as9100/)
   2. Facilities and Real Estate Division (FRED): [https://www.nasa.gov/offices/FRED](https://www.nasa.gov/offices/FRED)