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 the implementation of Model-based Institutional Management, as an example, where outputs from one functional model become real-time inputs to another functional model, resulting in a digital workflow for knowledge transfer and holistic decision making; thus enabling transformative gains in engineering, institutional, and management practices. Ultimately, functional area models will be digitally integrated to form a model-based enterprise.

NASA is seeking specific innovative, transformational, model-based solutions in the area of “Digital Twin” Institutional Management of Health/Automated Decision Support of Agency Facilities that would greatly enhance operational efficiencies, the quality and robustness and trustworthiness of information, the ability to identify and analyze risks earlier, and the overall velocity and robustness of knowledge transfer and decision making across the Agency, including interactions with internal/external partners and supply chain that are made possible through overarching an MBx Digital Twin Enterprise model(s).

Health/Automated Decision Support of Agency Facilities represents an opportunity to make revolutionary changes in how our Agency conducts business by investing in nascent technologies. The Agency’s newly minted Digital Transformation Office is interested in how this initiative can 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, autonomous transportation and traffic management, industrial automation, etc. As we mature our understanding and make progress toward these ends at individual centers, we need to align our efforts and share lessons learned to help expedite NASA’s learning curve.

Smart city technologies often rely on interconnected systems and interoperability of those systems, making it all the more important that we have a common approach and standards (e.g., around information
technology (IT)/operational technology (OT) network architecture, communication protocols, and data management) to ensure interoperability of systems within and across centers. Without a cohesive approach, we risk limiting what NASA can achieve in terms of economies of scale and affordability, as well as interorganizational data integration.

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.

Explore recent technologies in modeling (e.g., digital twin techniques).

Explore how we can take advantage of the proliferation of emerging technologies, use a structured measurement and verification technique in and aim to vet them to determine if they will bring sufficient value, and broadly deploy them across the Agency if proven effective.

Set up a "proving ground," model, in the same spirit as GSA's emerging building technologies program.

Determine how well technologies using this model can be broadly deployed across NASA.

**Expected TRL or TRL Range at completion of the Project:** 4 to 6

**Primary Technology Taxonomy:**

- Level 1: TX 11 Software, Modeling, Simulation, and Information Processing
- Level 2: TX 11.X Other Software, Modeling, Simulation, and Information Processing

**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. 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. Real-time collaboration and refinement of these validated libraries into either “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 life cycle. 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, timelier, 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.

**References:**

1. [https://www.sae.org/standards/content/as9100/](https://www.sae.org/standards/content/as9100/)
2. [https://www.nasa.gov/offices/FRED](https://www.nasa.gov/offices/FRED)
3. [https://www.omg.org/](https://www.omg.org/)
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