



NASA STTR 2016 Phase I Solicitation

T11 Modeling, Simulation, Information Technology and Processing

Modeling, Simulation, Information Technology and Processing consists of four technology subareas, including computing, modeling, simulation, and information processing. NASA's ability to make engineering breakthroughs and scientific discoveries is limited not only by human, robotic, and remotely sensed observation, but also by the ability to transport data and transform the data into scientific and engineering knowledge through sophisticated needs. With data volumes exponentially increasing into the petabyte and exabyte ranges, modeling, simulation, and information technology and processing requirements demand advanced supercomputing capabilities.

Subtopics

T11.01 Information Technologies for Intelligent and Adaptive Space Robotics

Lead Center: ARC

The objective of this subtopic is to develop information technologies that enable robots to better support space exploration. Improving robot information technology (algorithms, avionics, software) is critical to improving the capability, flexibility, and performance of future NASA missions. In particular, the NASA "Robotics, Tele-Robotics, and Autonomous Systems" roadmap (TA04) indicates that extensive and pervasive use of robots can significantly enhance exploration missions that are progressively longer, complex, and operate with fewer ground control resources.

The performance of space robots is directly linked to the quality and capability of the information technologies that are used to build and operate them. Thus, proposals are sought that address the following technology needs:

- Advanced robot user interfaces that facilitate distributed collaboration, geospatial data visualization, summarization and notification, performance monitoring, and physics-based simulation. The primary objective is to enable more effective and efficient interaction with robots remotely operated with discrete commands or supervisory control. Note: proposals to develop user interfaces for direct teloperation (manual control) are not being solicited and will be considered non-responsive.
- Navigation systems for mobile robot (free-flying and wheeled) operations in man-made (inside the International Space-Station) and unstructured, natural environments (Earth, Moon, Mars). Emphasis on multi-sensor data fusion, obstacle detection, and proximity ops. The primary objective is to radically and significantly increase the performance of mobile robot navigation through new sensors, avionics (including COTS processors for use in space), perception algorithms and software. Proposals for small size, weight, and power (SWAP) systems appropriate for quad-copters, Astrobee/SPHERES free-flying robots, and Spirit/Opportunity scale rovers are particularly encouraged.
- Robot software systems that support adaptive autonomy, automated instrument/sensor targeting, payload

data triage, and planning. The primary objective is to facilitate the creation, extensibility and maintenance of complex robot systems for use in the real-world. Proposals that address autonomy for planetary rovers operating in rough terrain or performing non-traditional tasks (e.g., non-prehensile manipulation) are particularly encouraged.

Deliverables to NASA:

- Identify scenarios and use cases.
- Define specifications based on design trades.
- Develop concepts to address use cases.
- Build, test, and demonstrate prototype sub-systems or systems.
- Deliver prototypes to NASA.

T11.02 Distributed Spacecraft Missions (DSM) Technology Framework

Lead Center: GSFC

A Distributed Spacecraft Mission (DSM) is a mission that involves multiple spacecraft to achieve one or more common goals; some DSM Instances include Constellations, Formation Flying missions, or Fractionated missions. Apart from Science goals that can only be attained with DSM, distributed missions are usually motivated by several goals, among which: increasing data resolution in one or several dimensions (e.g., temporal, spatial, spectral or angular), decreasing launch costs, increasing data bandwidths, as well as ensuring data continuity and inter-mission validation and complementarity. Constellations have been proposed in several NASA Decadal Surveys and recent studies; in Earth Science (e.g., a multi-spacecraft Landsat for increasing temporal resolution), in Heliophysics (e.g., the Geospace Dynamics Constellation) or in Planetary Science (e.g., the Lunar Geophysical Network). Many constellations and Formation Flying missions have also been proposed more recently in cubesat-related research projects. For the purpose of this subtopic, we do not assume the spacecraft to be of any specific sizes, i.e., we do not restrict this study to cubesats or smallsats.

The goal of this subtopic is to mature NASA capabilities to formulate and implement novel science missions based on distributed platforms. Technologies solicited in this call are the following:

- Novel DSM-enabling technologies such as:
 - Technologies for high-bandwidth and efficient inter-satellite communication;
 - Metrology systems capable of sensing and controlling relative position and/or orientation of multi-element DSMs to sub-milli-arcsecond angular resolution and sub-micro-meter positional accuracy;
 - Autonomous and scalable ground-based constellation operations approaches including science operations and data management, and compatible with the Goddard Mission Services Evolution Center (GMSEC) (open source software developed at NASA Goddard).
- Scalable DSM flight software systems such as:
 - Software components compatible with the Core Flight System (CFS) (open source software developed at NASA Goddard), enabling to control and navigate DSM formations and constellations; for example, discrete event supervisors offering a means to autonomously control systems based on selected mission metrics (e.g., spacecraft separation distance, number of active spacecraft, etc.);
 - Technologies for onboard collaborative processing and intelligence, including but not limited to, inter-spacecraft collaboration for collecting, storing and downloading data as well as multi-platform Science observation coordination and event targeting.

Research proposed to this subtopic should demonstrate technical feasibility and should discuss how it relates to NASA programs and projects. Proposed work is expected to be at an entry Technology Readiness Level (TRL) between 2 and 5, and to demonstrate a TRL increase of at least one level during each phase of the project. Proposals will be evaluated based on their degree of innovation and their potential for future infusion.

