NASA SBIR 2009 Phase I Solicitation

O2 Space Transportation

Achieving space flight can be astonishing. It is an undertaking of great complexity, requiring numerous technological and engineering disciplines and a high level of organizational skill. Overcoming Earth's gravity to achieve orbit demands collections of quality data to maintain the security required of the range. The harsh environment of space puts tight constraints on the equipment needed to perform the necessary functions. Not only is there a concern for safety but the 2004 Space Transportation Policy directive states that the U.S. must maintain robust transportation capabilities to assure access to space. Given this backdrop, this topic is designed to address technologies to enable a safer and more reliable space transportation capability. Automated collection of range data, acquisition of specialized weather data, and instrumentation for space transportation system testing are all required. The following subtopics are required to secure technologies for these capabilities.

Subtopics

O2.01 Automated Collection and Transfer of Launch Range Data (Surveillance/Intrusion, Weather)

Lead Center: KSC

Participating Center(s): GRC, GSFC

NASA is seeking innovative technologies for sensors and instrumentation technologies which expedite range clearance by providing real-time situational awareness for safe Range operations from processing to launch and recovery. These sensors and instruments are expected to operate, as a payload, on mobile or deployable Unmanned Aerial Systems (UAS), High Altitude Airships (HAA), buoys, etc. NASA is also seeking innovative technologies to remotely measure electric fields aloft in order to reduce the threat of destruction of a launch vehicle by rocket triggered lightning.

Purpose: NASA is embarking on a new era of space exploration with new launch vehicles and demands for availability to support launch times within hours of one another to ensure mission success. This availability requirement is allocated across the entire launch operations which includes the Range that provides clear corridor of land, air and sea for the vehicles to transit through, as they ascent or return. The current Range infrastructure is aging, labor intensive and independent, and would benefit from new sensors and instrumentation that improve the situational awareness (including weather) of those that are responsible for ensuring public safety, mission assurance and efficient operations.

To aid in this situational awareness the new sensors and instrumentation must be able to operate in the environment that takes advantage of mobile or deployable Unmanned Aerial Systems (UAS), High Altitude Airships (HAA), buoys, etc. Use of these vehicles as a platform is intended to increase the Ranges availability while reducing the cost of operations. Size, power, weight and stability of these systems, that operate on these platforms, will be a major constraint their use.

These sensors and instrumentation provide for the remote detection, recognition, and identification of persons and objects that have intruded into areas of the range that must be cleared in order to conduct safe launch operations. This would include a wide spectrum of optical, infrared, Radio Frequency (RF), and millimeter wave sensors for this purpose. In order to achieve accurate identification, time and position of intruding entities multiple sensors and instruments may be used, or combined through the use of neural networks and data fusion techniques. This will require the use of standards for communications, so that, data from individual sensors or instruments can be combined on a platform and processed on-board, or communicated to central location where a fused solution is processed.

The sensors, instrumentation and algorithms to remotely measure electric fields aloft will reduce the threat of destruction of launch vehicles during ascent by improving the prediction of potential lightning strikes to vehicles due to triggered lightning. Potential candidate technologies include new algorithms to take advantage of existing dual-polarized Doppler five-cm weather radar capability, or entirely new technologies for the remote sensing of electric fields. The ability to economically measure the incremental ballistic wind velocities along the predicted trajectory of launch vehicles at remote and evolving launch ranges at altitudes up to 100 kft via fixed and mobile LIDAR approaches is also highly desirable.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 hardware and software demonstration and delivering a demonstration unit or software package for NASA testing at the completion of the Phase 2 contract.

O2.02 Ground Test Facility Technologies

Lead Center: SSC

Participating Center(s): GRC, MSFC

NASA's Stennis Space Center (SSC) is interested with expanding its suite of test facility modeling tools as well as non-intrusive plume technologies that provide information on propulsion system health, the environments produced by the plumes and the effects of plumes and constituents on facilities and the environment.

Facility Modeling Tools and Methods

Developing and verifying test facilities is complex and expensive. The wide range of pressures, flow rates, and temperatures necessary for engine testing results in complex relationships and dynamics. It is not realistic to physically test each component and the component-to-component interaction in all states before designing a system. Currently, systems must be tuned after fabrication, requiring extensive testing and verification. Tools using computational methods to accurately model and predict system performance are required that integrate simple

interfaces with detailed design and/or analysis software. SSC is interested in improving capabilities and methods to accurately predict dynamic responses for transient fluid structure interactions, convective, conductive, and radiant heat transfer for propellant systems, exhaust systems and other components used in rocket propulsion testing. Also of interest is the modeling and prediction of condensation, diffusion, stratification, and concentration gradients for fluid mixtures commonly encountered in testing, such as propellants and purges.

Vacuum System Technologies

Stennis is constructing the new A3 test stand which is designed to test a very large (294,000 lbf thrust) cryogenic rocket engine at a simulated altitude of 100,000 feet. When the air in the engine test chamber is evacuated, the simulated altitude pressures inside the test chamber will be less than 0.20 PSIA. This will result in a very unique environment with extremely low pressures inside a very large chamber and ambient pressures outside this chamber. Due to the unique nature of this test facility, new technologies and measurement techniques will need to be developed to monitor and analyze this environment. These include but are not limited to instrument closeouts at vacuum pressures for hundreds of channels of instrumentation entering the chamber, new sealing technologies for large cryogenic piping entering this very large test cell wall to seal against this unique environment, material fatigue measurement and predictions, inspection techniques for the vacuum chamber structures and diffuser ducting, etc.

Component Design, Prediction and Modeling

Improved capabilities to predict and model the behavior of components (valves, check valves, chokes, etc.) during the facility design process are needed. This capability is required for modeling components in high pressure (to 12,000 psi), with flow rates up to several thousand lb/sec, in cryogenic environments and must address two-phase flows.

Challenges include: accurate, efficient, thermodynamic state models; cavitation models for propellant tanks, valve flows, and run lines; reduction in solution time; improved stability; acoustic interactions; fluid-structure interactions in internal flows.

Plume Environments Measurements

Advanced instrumentation and sensors to monitor the near field and far field effects and products of exhaust plumes. Examples are the levels of acoustic energy and thermal radiation and their interaction/coupling with test articles and facilities and measurements of the final exhaust species that will affect the environment.

Major challenge: Large scale engine plume dispersion modeling and validation.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 hardware and software demonstration and delivering a demonstration unit or software package for NASA testing at the completion of the Phase 2 contract. Expected TRL range from 3 to 5.