NASA SBIR 2015 Phase I Solicitation

H9.03 Flight Dynamics and Navigation Technology

Lead Center: GSFC

Participating Center(s): GRC

NASA is investing in the development of software tools, systems and devices to enhance its capabilities for providing position, attitude, and velocity estimates of its spacecraft as well as improve navigation, guidance and control functions to these same spacecraft. Interest includes software tools, ground facilities as well as system concepts and on-board devices to support organic capabilities for its deep-space missions. Products developed under this sub-topic can be in support of any mission phase from design and development through operation and disposal. Proposals can be for either near-Earth or interplanetary missions. Specific application areas that will be considered under this subtopic are:Â

- Software that fuses and analyzes spacecraft sensor data and other spacecraft tracking data available at ground/mission operations centers (i.e., facility software). Proposals for algorithms and software for flight dynamics GNC technologies can support mission engineering activities at any stage of development from the concept-phase/pre-formulation through operations and disposal. Proposals that could lead to the replacement of the Goddard Trajectory Determination System (GTDS), or leverage state-of-the-art capabilities already developed by NASA such as the General Mission Analysis Tool (http://sourceforge.net/projects/gmat/), GPS-Inferred Positioning System and Orbit Analysis Simulation Software, (http://gipsy.jpl.nasa.gov/orms/goa/), Optimal Trajectories by Implicit Simulation (http://otis.grc.nasa.gov/) are especially encouraged. Proposers who contemplate licensing NASA technologies are highly encouraged to coordinate with the appropriate NASA technology transfer offices prior to submission of their proposals. In particular this solicitation is primarily focused on NASAâ€™s needs in the following focused areas:
    - Applications of optimal control theory to high and low thrust space flight guidance and control systems.
    - Numerical methods and solvers for robust targeting, and non-linear, constrained optimization.
    - Addition of novel guidance, navigation, and control improvements to existing NASA software that is either freely available via NASA Open Source Agreements, or that is licensed by the proposer.
    - Interface improvements, tool modularization, APIs, workflow improvements, and cross platform interfaces for software that is either freely available via NASA Open Source Agreements, or that is licensed by the proposer.
    - Applications of cutting-edge estimation techniques to spaceflight navigation problems.
    - Applications of estimation techniques that have an expanded state vector (beyond position, velocity, and/or attitude components) or that combine measurements from multiple sensor suites in a highly-coupled manner to improve upon the overall system accuracy.
    - Applications of advanced dynamical theories to space mission design and analysis, in the context of unstable orbital trajectories in the vicinity of small bodies and libration points.
- Advanced celestial navigation techniques including devices and systems, especially those that support of

deep-space, planetary missions. System concepts should support significant advances of independence from Earth supervision including the ability to operate effectively in the absence of Earth-based transmissions or transmissions from planetary relay spacecraft with those that operate in the complete absence of human intervention or Earth-based transmissions are preferred. Proposed solutions should meet objectives while minimizing spacecraft burden by requiring low power and minimal mass and volume. User spacecraft impact is of significant importance and proposed solutions include assessments of mass, power, thermal impact on targeted mission spacecraft as well as identifying any requirements placed on the user spacecraft by the proposed design. Of particular interest are concepts that support pointing of high rate optical communications terminals to earth terminals that do not rely on the use of optical uplinks or beacons for achieving proper pointing of the communication beam. However, concepts which are capable of supporting planetary missions of any type are of interest. Proposals that include re-purposing/cross-purposing of advanced sensors contemplated for future deep-space missions such as x-ray telescopes are preferred. In addition to advances in positioning, attitude estimation, orbit determination, guidance, navigation and control particular interest in the area of deep-space celestial navigation lies in the following focus topics:

- Time and frequency keeping and dissemination.
- Advanced methods and sensors for optical/IR detection of star fields (i.e., star cameras).
- Advanced methods and sensors detecting RF and x-ray pulsars.
- Methods to process celestial observations to perform Orbit Determination (OD) and precision attitude estimation.

Phase I research should be conducted to demonstrate technical feasibility, with preliminary software being delivered for NASA testing, as well as show a plan towards Phase II integration. For proposals that include hardware development, delivery of a prototype under the Phase I contract is preferred, but not necessary.

With the exception listed below for heritage software modifications, Phase II new technology development efforts shall deliver components at the TRL 5-6 level with mature algorithms and software components complete and preliminary integration and testing in an operational environment. For efforts that extend or improve existing NASA software tools, the TRL of the deliverable shall be consistent with the TRL of the heritage software. Note, for some existing software systems (see list above) this requires delivery at TRL 8. Final software, test plans, test results, and documentation shall be delivered to NASA.