



NASA SBIR 2011 Phase I Solicitation

04.02 PNT (Positioning, Navigation, and Timing) Sensors and Components

Lead Center: GSFC

Participating Center(s): ARC, GRC, JPL, JSC

This subtopic seeks proposals that will serve NASA's ever-evolving set of near-Earth and interplanetary missions that require precise determination of spacecraft position and velocity in order to achieve mission success. While the definition of "precise" depends upon the mission context, typical scenarios have required meter-level or better position accuracies, and sub-millimeter-level per sec or better velocity accuracies. This solicitation is primarily focused on NASA's needs in four focused areas identified below.

Proposals are encouraged that leverage the following NASA developed state-of-the-art capabilities:

- GEONS:
 - NASA Copyright, licensable technology.
 - (http://ipp.gsfc.nasa.gov/ft_tech_geons.shtm).
 - AutoNav (NTR 43546 Deep Impact Autonomous Navigation (AutoNav) Flight Software 23-FEB-2006).

- Navigator:
 - US Patent 7,548,199.
 - <http://patft1.uspto.gov/netacgi/nph-Parser?patentnumber=7548199>.
 - http://techtransfer.gsfc.nasa.gov/ft_tech_gps_navigator.shtm.

- GIPSY:

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- <https://gipsy-oasis.jpl.nasa.gov/>.
 - Electra:
 - http://descanso.jpl.nasa.gov/Monograph/series9_chapter.cfm.
 - Blackjack:
 - <http://www.jpl.nasa.gov/releases/2000/blackjackgps.html>.

NASA is not interested in funding efforts that seek to "re-invent the wheel" by duplicating the many investments that NASA and others have already made in establishing the current state-of-the-art. We seek to maximize the work listed above in the new work sought for this subtopic.

General Operational Needs, Requirements and Performance Metrics:

Onboard Near-Earth Navigation Systems

NASA seeks proposals that would develop a commercially viable transceiver with embedded orbit determination software to provide enhanced accuracy and integrity for autonomous onboard GPS- and TDRSS-based navigation and time-transfer in near-Earth space via augmentation messages broadcast by the proposed TDRSS Augmentation for Satellites Signal (TASS; <http://www.gdgps.net/system-desc/papers/Bar-Sever.pdf>). Innovations that will increase the integration, reducing the size, weight, and power of such transceiver platforms, and improving their performance in high radiation environments, are sought. Proposers are advised that NASA's GEONS and GIPSY orbit determination software packages already support the capability to ingest TASS messages.

Onboard Deep-Space Navigation Systems

NASA seeks proposals to develop an onboard autonomous navigation and time-transfer system for reduction of DSN tracking requirements. Such a system should provide accuracy comparable to delta differenced one-way ranging (DDOR) solutions anywhere in the inner solar system, and exceed DDOR solution accuracy beyond the orbit of Jupiter. Proposers are advised that NASA's GEONS and AutoNav navigation software packages already support the capability to ingest many one way forward Doppler, optical sensor observation, and accelerometer data types. In addition, NASA is seeking innovative solutions in the area of planetary surface navigation.

Technologies Supporting Improved TDRSS-Based Navigation

NASA seeks proposals providing improvements in TDRS orbit knowledge, TDRSS radiometric tracking, ground-based orbit determination, and Ground Terminal improvements that improve navigation accuracy for TDRS users. Methods for improving TDRS orbit knowledge should exploit the possible future availability of accelerometer data collected onboard future TDRS. The goal is navigation and communications integrated into a single processor.

Navigation Payload Technology for Planetary Relay Satellites

NASA seeks planetary relay navigation payload technologies that can:

- Transmit accurate spread spectrum signals (emphasizing the stability of the frequency reference yielding accurate timing and chipping rate of the PN code and a low noise carrier).
- Receive same in return (either in coherent mode (the relay transmits and receives using the same frequency reference) or non-coherent mode (where the accurate frequency reference is on one end of link, either the transmit side or the receive side)).

This relay navigation payload should be capable of receiving a satellite-to-satellite link with similar signal properties. The relay navigation payload has to measure the range (two-way), pseudo-range (one-way), and both one-way and two-way Doppler. The relay navigation payload must be able to de-commutate data received from Earth and bases on other planetary surfaces to maintain time synchronization with a master time source, use the data onboard to either slave its frequency reference or to update its reference, and turn-around the data to modulate onto the user data stream.

Additionally, the relay navigation payload must have:

- 'Reasonable fidelity' autonomous filtered navigation capability to fuse all data types listed above as well as antenna gimbal angles, accelerometer data, and rendezvous radar data, to estimate the lunar relay state.
- Output data rates of 1 Hz for the states of multiple satellites and comprehensive fault detection and correction data.
- State outputs that can be modulated on transmitted data streams.
- TASS-like broadcast beacon capability for navigation. The data on the beacon can originate either at a base location (earth, moon), the relay, or another asset with which the relay communicates.
- Dissemination of time and navigation data for the local environment.

Proposals can either address a single subject as described above or a combination of subjects.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I (to reach TRL 3) and show a path toward Phase II hardware and software demonstration and delivering a demonstration unit or software package for NASA testing at the completion of the Phase II contract (to reach TRL 5).

Phase I Deliverables:

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- Midterm Technical Report.
 - Final Phase I Technical Feasibility Report with a Phase II Integration Path. Proof-of-concept bench top demonstration preferred.

Phase II Deliverables:

- Final Phase II Technical Report.
- Demonstration hardware/software/field test.