NASA SBIR 2008 Phase I Solicitation

O1.05 Communication for Space-Based Range

Lead Center: GSFC

Participating Center(s): ARC, GRC

Space-Based Telemetry Transceivers may replace Line-of-Sight (LOS) and RADAR based Tracking, Telemetry, and Command (TT&C) flight and ground systems for sub-orbital platforms and orbit-insertion launch vehicles. In order to do so, the transceivers must be capable of providing real-time or near real-time return (data) and forward (command) links of varying bandwidths with industry accepted Quality of Service (QoS) levels. Some applications require the coupling of embedded GPS receivers and attitude determination units, while others require high bandwidth links with common interfaces (i.e., Ethernet). In all cases it is desired to utilize an existing commercial satellite provider with fee-for-service to reduce operating and overhead expenses.

Note: The proposer should be aware of subtopic O4.01, which seeks advancements in GPS metric tracking. This proposal primarily focuses on space-based transceivers. However, advancements made under O4.01 could be incorporated with space-based transceivers in the future.

Purpose

The vision of Space-Based Range architecture is to assure public safety, reduce the costs of launch operations, enable multiple simultaneous launch operations, decrease response time, and improve geographic and temporal flexibility. It is desired to reduce or eliminate the need for redundant range assets and deployed down-range assets that are currently used to provide for LOS TT&C with sub-orbital platforms and orbit-insertion launch vehicles. This solicitation seeks to achieve this by focusing on specific needed advancements in TT&C.

There are varying applications for space-based transceivers, each necessitating a different set of requirements. Low data rate and very low cost transceivers coupled with highly accurate GPS receivers may be used to measure wind velocities to determine flight conditions and accurate trajectory predictions. These could also be used to track low risk payload or vehicle components for recovery purposes. Higher dynamic vehicles require a more robust transceiver with embedded position and attitude determination units to track vehicle trajectories through space insertion or for recovery purposes. High data rate transceivers with a commonly used interface could be used across multiple platforms for primary or redundant data dispersion and command control.

The proposer should address one of the following three need areas below:

Low Cost and Low SWAP Transceiver with Integrated GPS Receiver

Core Capabilities should include:

- Utilize existing commercial satellite provider with fee for service. Limit the user burden to provide adequate

effective isotropic radiated power (EIRP) for providing acceptable link margins.

- Low Cost: several hundred dollars or less (throw-away).
- Low size, weight, and power (SWAP): 10 cubic inches or less, weigh less than 0.25 lbs, consume less than 1W (on avg).
- Ability to operate up to +/- 70 deg latitude (all latitudes preferred).
- Ability to sample time, position (x, y, z), and velocity (x., y., z.) solutions at a min of 10Hz.
- Ability to downlink the 10Hz or better sampled data with low latency (several seconds or better) and little to no loss (not to include ground infrastructure latency, i.e., internet latency).
- Ability to receive data and send commands from one location anywhere in the world via IP. However, an RF link could be used as a backup for remote locations.
- Ability to accept near real-time commands (latency of several seconds or better) and provide firmware level actions/responses (e.g.: to select alternate downlink data format).
- Highly accurate GPS solutions. Commercial-off-the-Shelf (COTS) embedded units may be utilized but repackaging may be needed to provide a single, integrated Over-the-Horizon (OTH) tracker. Independent Kalman Filtering techniques may need to be developed. Velocity jitter is highly undesirable. The ability to lift altitude and velocity (COCOM) restrictions is needed.
- Environmental considerations: Operability from sea level to 160,000 ft with operating temperatures ofÂ -20Â°C to +60Â°C. Vehicle dynamics are relatively benign. Duration of mission operation is several hours.
- Ground Software to view the telemetered data.

Optional Capabilities: The ability to operate at all latitudes. The ability to interface a small number of sensors (TTL, Analog-to-Digital, and/or serial interfaces) for sampling and transmit. Operating temperatures of -40Â°C to +85Â°C. The ability to allow uplink commands to change the state of on-board TTL level outputs. Ability to receive data and send commands from multiple locations via IP. Open source or factory customizable firmware.

Highly Dynamic Transceiver with Integrated GPS Receiver and Attitude Determination

Core Capabilities should include:

- Utilize existing commercial satellite provider with fee for service. Limit the user burden to provide adequate EIRP for providing acceptable link margins.
- Low cost, size and weight commensurate with materials and techniques used. Power consumption less than 5W (on avg).
- Ability to operate up to +/- 70 deg latitude (all latitudes preferred).
- Ability to sample time, position (x, y, z), velocity (x., y., z.), and vehicle dynamics (accelerations, pitch, and roll) at a min of 20Hz.
- Ability to downlink the 20Hz or better sampled data with very low latency (preferably sub-second) and little to no loss (not to include internet latency).
- Ability to accept commands on a real-time basis (preferably sub-second latency) and provide firmware level responses to those commands.
- Ability to receive data and send commands from one location anywhere in the world via IP. However, an RF link could be used as a backup for remote locations.
- Highly accurate integrated position and solid-state attitude solutions. COTS units may be utilized but repackaging may be needed to provide a single integrated OTH tracker. The ability to lift altitude and velocity (COCOM) restrictions is needed.
- Environmental considerations: Operability from sea level up to space insertion is desired (note that radiation hardening is not required). Operating temperatures of -20Â°C to +60Â°C are needed. Ability to operate on spin stabilized rockets (up to 7 rps), under sudden acceleration, and under high jerk environments (e.g., launch conditions and separation / jettison events). Duration of mission operation is several hours.
- Ground Software to view the telemetered data.

Optional Capabilities: The ability to operate at all latitudes. The ability to interface a small number of sensors (TTL, A to D, and/or serial interfaces) for sampling and transmit. Operating temperatures of -40Â°C to +85Â°C. The ability to allow uplink commands to change the state of on-board TTL level outputs. Ability to receive data and send commands from multiple locations via IP. Open source or factory customizable firmware.

High Data Rate Transceiver

Core Capabilities should include:

- Utilize existing commercial satellite provider with fee for service. Limit the user burden to provide adequate EIRP for providing acceptable link margins.
- Cost and SWAP commensurate with performance, but all should be kept minimal.
- Ability to operate up to +/- 70 deg latitude (all latitudes preferred).
- The minimum return bandwidth (data) is 50 kbps but several hundred kbps is desired. The minimum forward bandwidth (command) is 1 kbps but several kbps is desired.
- Ability to downlink data with very low latency (preferably sub-second) and little to no loss (not to include ground infrastructure latency, i.e., internet latency).
- Ability to receive commands with very low latency (preferably sub-second) and little to no loss from an IP based ground terminal.
- Ability to receive data and send commands from one location anywhere in the world via IP. However, an RF link could be used as a backup for remote locations.
- The transceiver I/O interface should allow for easy interfacing to multiple platforms. An Ethernet interface is preferred, but lower data rates may allow for an asynchronous serial interface. Depending on the satellite platform chosen, the proposer may have to provide internal buffering and clocking mechanisms to smooth an asynchronous input for proper ground receipt.
- Environmental considerations: Operability from sea level up to space insertion is desired (note that radiation hardening is not required). Operating temperatures of -20Â°C to +60Â°C are needed. The initial prototype could be tested on low dynamics vehicles, thereby concentrating the focus on performance. However, the ultimate goal is the ability to operate on spin stabilized rockets (up to 7 rps), under sudden acceleration, and under high jerk environments (e.g., launch conditions and separation / jettison events). Duration of mission operation is several minutes to several months.
- Ground Software to view the telemetered data.

Optional Capabilities: The ability to operate at all latitudes. Operating temperatures of -40Â°C to +85Â°C. Ability to receive data at multiple locations simultaneously via IP. Open source or factory customizable firmware.

In all cases, research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward 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.

The proposer to this subtopic is advised that the products proposed may be included in a future small satellite flight opportunity. Please see the SMD Topic S4 on Small Satellites for details regarding those opportunities. If the proposer would like to have their proposal considered for flight in the small satellite program, the proposal should state such and recommend a pathway for that possibility.

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