

## **STATEMENT OF WORK**

### **1. Objective/Requirements**

To support ground testing of future surface navigation networks, this Statement Of Work (SOW) includes procurement of two navigation sensors, one transmitter and one receiver, that are compatible with the LunaNet Augmented Forward Signal (AFS) definition. These radios will be used to assess and demonstrate the ability of this signal to be used in surface beacons.

### **2. Characteristics, Scope, and Specs**

The contractor shall perform the following duties:

- Provides two hardware elements that can be used for testing of transmission and reception of implemented navigation signal
  - Vendor can propose two identical units (that can each transmit and receiver) or individual dedicated transmission and receiver units.
  - These will be used in lab and limited outdoor testing with one unit acting as transmitter and one acting as a receiver. Initial testing will be conducted via direct hardware connection. Limited outdoor testing may be conducted, in which case external power amplification and antennas will be added.
  - Radios shall support Radio Frequency (RF) output/reception using SMA.
  - As intended, ground development hardware is acceptable, such as breadboard systems or engineering models.
  - Hardware must be derivative or compatible with vendor's existing flight platforms (i.e. common Field Programmable Gate Array (FPGA) or code-base with flight hardware).
- Implementation and utilization of LunaNet-compatible Augmented Forward Signal
  - Signal defined in LunaNet Interoperability Specification:
    - Modulations adopted will be in line with current GNSS signals, by utilizing Bi-Phase Shift Keying (BPSK) and/or Binary Offset Carrier (BOC) modulations. Two channels are foreseen, one in-phase (I) and one in quadrature phase (Q). The I-channel is intended to facilitate acquisition, navigation capabilities, and serve as a data channel. The I-channel will consist of a BPSK (1) modulation, utilizing a spreading code at 1.023 Mcps.
    - Signal shall utilize Global Positioning System (GPS) L1 C/A Code as defined in GPS-ICD-200 Section 3.2.1.3; vendor shall define Psuedo-Random Noise (PRN) Code used, it is preferred to use unallocated PRN values.
  - Note: new signal standard in work providing additional content on AFS and LunaNet Navigation Messages. The work requested herein is to simply generate the raw navigation signal and the ability to measure a received phase (with relation to an onboard signal synchronized with its clock).
  - Transmission Mode:
    - Radio shall sync the onboard code to be an input phase value to start transmission at start of a second rollover.
    - The signal shall then be modulated onto an S-Band signal as specified within the LunaNet Specification and in expected frequency ranges

(2200-2290 and 2483.5-2500MHz) for transmission and consistent with LunaNet Specification.

- Receiver Mode:
  - Radio shall be capable of receiving S-Band signals in the same band being transmitted (2200-2290, 2483.5-2500 MHz).
  - Radio shall compare the phase of an onboard generated code to that received from the transmitter to calculate a difference in phase, allowing for a representative one-way ranging measurement.
- Note: It is expected that there will be a residual time offset due to the two clocks not being synchronized. This will be addressed by controlling ground time references
- Radios shall be capable of being disciplined by external timing reference signal of either 10MHz or 10.23 MHz or 1.023 MHz Reference (per AFS-Specification)
- All units shall be controlled via RS-422 connections with 12-28V power inputs where the unit utilizes onboard power regulation, input of regulated voltages such as 3.3V or 5V are accepted.
- The Vendor shall coordinate with MSFC to schedule a product implementation and review meeting prior to shipment. After review, the hardware shall be delivered to MSFC. Delivery shall be via commercial freight or similar.
- Vendor shall provide ICD and limited documentation verifying command sequence, spectrum of transmitted signals, and verification of capability to measure phase on receiver end.
  - Note: Ability to correlate to an actual measured range will be conducted by MSFC personnel, assessing stability with various time references, and time synchronization across each unit

**3. Delivery Date:** No later than 1 year after order acceptance.