NNA12426727R

STATEMENT OF WORK

DEVELOPMENT OF .5 U SCIENTIFIC PAYLOADS FOR MULTIPOINT SPACE PHYSICS MEASUREMENTS ON A NANOSAT SPACECRAFT OF 1.5 CUBESAT FORM FACTOR

1. Introduction / Background

NASA Ames Research Center (ARC) is currently developing EtherSat, a project sponsored by the NASA Office of Chief Technologist's Edison Program, for launch in mid-2013. EtherSat is a fleet of 14 to 20 nanosatellites, of 1.5U Cubesat form factor, developed at a very low cost and extremely fast development cycle. The nanosatellites are constructed using commercial grade components (including the use of a consumer smart phone as avionics). EtherSat will demonstrate advanced cross-link and down-link communications, attitude control, and other emerging technologies, validating the suitability of such a very low cost constellation for multipoint heliophysics/space weather and other science missions from low Earth orbit. The subject of this procurement is for a quantity of identical, flight-qualified science instrument payloads, to be hosted on the EtherSat bus, for demonstrating distributed, multi-point physics measurements using the EtherSat swarm.

2. Scope of Work

NASA requires a minimum of 14 units, with options for up to 6 additional units, for a maximum of 20, identical flight-qualified payload instrument packages. These packages must be designed to interface with the Government-furnished EtherSat bus for the purpose of demonstrating distributed multipoint space physics measurements hosted by the Ethersat constellation. A provision of 25% spare parts/units (detailed in Delivery section) is additionally to be provided. One "engineering development unit"(EDU) (for evaluation purposes) is also to be delivered, near mid-term. The period of performance is to be less than 7 months total duration, with delivery required in November 2012 to meet NASA's satellite integration schedule. The provider will also propose to deliver up to 120 hours of technical support, in 40 hour increments. This support, if required by NASA, will be exercised as option items. Support to be proposed by contractor may include: NASA training, test support, and operations support after package delivery. Detailed delivery items and milestones are shown in section 5, below.

3. Applicable Documents / Background:

Data sheets and technical documentation for the Nexus smart phone, Parallax Inc, Propeller P8X32A serial router board, and other EtherSat bus technical data are available upon request.

4. **Technical Requirements:**

Each of the payload instrument packages delivered to NASA ARC must meet the following technical requirements:

4.1. Physical
- 4.1.1. Total mass less than or equal to 636 grams
- 4.1.2. Total volume less than or equal to approximately 4cm x 10cm x 10cm
- 4.1.3. External spacecraft surface area required for payload antennas, windows, sensor ports, deployment mechanisms, etc. shall be negotiated before award.

4.2. Electrical
- 4.2.1. Average continuous electrical power required on orbit less than or equal to 78.5 mW at 3.3 VDC
- 4.2.2. Maximum peak electrical power required less than 1000 mW at 3.3 VDC for 113 minutes per day.

4.3. Data
- 4.3.1. Average data downlink rate required less than or equal to ~5 Mbits/day
- 4.3.2. Average data uplink rate required less than or equal to ~5.7 Mbits/day

4.4. Attitude
- 4.4.1. The payload shall collect valid science data with spacecraft pointing accuracy no better than 8 degrees and spacecraft attitude knowledge no better than 1 degree.

4.5. Interface Requirements & Assumptions
- 4.5.1. Payload shall interface with a Government-furnished open source serial router board containing a Parallax Inc, Propeller P8X32A microcontroller for control and data interfaces with the Android Smartphone-based avionics of the spacecraft (SC). More information about this interface can be provided upon request.
- 4.5.2. NASA will provide the Android bus (CPU, memory, usb port via the Propeller board, cameras, magnetometers, gyros, radios) subject to overall spacecraft overhead.
- 4.5.3. NASA will provide reaction wheels, magnetic torque coils and coarse sun sensor controlled via the android bus.
- 4.5.4. The master clock and Novatel GPS will be carried aboard the SC external to the payload instrument and these clock and GPS data will be available to applications running on the android bus, as well via the propeller chip at lower latency, though the latency of these data are presently unknown. Proposer shall specify a method of obtaining time and position data to the accuracy required by their instrument. Independent low latency access to these data will be negotiated before award.
- 4.5.5. The proposed instrument shall be testable by NASA with a "flat sat" SC on the ground.
- 4.5.6. The proposed instrument shall be designed to meet the launch and space environment, as described in the GSFC –STD-7000 General Environmental Verification Standard (GEVS) values for thermal, vibration, and acceleration (available at http://standards.gsfc.nasa.gov/gsfc-stds.html). Note: NASA will inspect the design at Mid-Term and Pre-delivery reviews to determine if the design will meet environmental requirements. NASA will perform environmental tests after receiving the delivered instruments. The provider is not required to perform environmental tests prior to delivery.

5. Deliverables

5.1.1. **Note:** Any data successfully collected from the payload on-orbit during the Ethersat mission will be made available by NASA during or shortly after the mission completion to the payload provider, the public, and science community at large.

5.1.2. A detailed description of the instrument's capabilities and its software interface will be made available to the public in the course of conducting the Ethersat mission.

	Deliverables	**Milestone/Date**
1.	Complete detailed design of the instrument as well as software source code for the instrument, Engineering and Build Data for NASA review/concurrence	Mid-term Review
2.	Design Data (Analysis or Design) predicting the compatibility/survival with exposure to the test (Thermal Vacuum, & Vibration), Launch and Space Operations Environments specified in requirement 4.5.6. (Note: NASA will review the Design Data to determine if the design is compatible with environmental requirements. Environmental tests are not required as part of the deliverables. NASA will conduct environmental tests after delivery.)	Mid-term Review
3.	Engineering Development Unit(s) (EDUs): One Unit : Mass/Volume/Electrical , or One Mass/volume unit + One Electrical/data interface test unit (not in flight form factor)	Mid-term Review
4.	14 flight units with options for up to 6 additional, for a maximum 20 total flight units	Final delivery
5.	Material properties and design data required for NASA to complete flight safety requirements for a nanosat launched from a standard cubesat dispenser Launch Vehicle interface.	Final delivery
6.	Spares : 25% of flight units: provide sparing plan/philosophy at Requirements Review: e.g. Parts, fully assemble units, or other scenario	Final delivery

	Software (SW) Deliverables (Flight or Ground, including any Post-Flight Processing)	
7.	The executable payload application SW	Interim delivery: Mid-term Review (EDU); Final delivery
8.	Source Code	Interim delivery Mid-term Review (EDU); Final delivery
9.	SW Documentation	Interim delivery Mid-term Review (EDU); Final delivery
	Test, Test Data / Reports	
10.	Interface Agreement / Specification	Requirements Review
11.	Payload Mass Properties	Interim delivery Mid-term Review; Final delivery
12.	Payload Power Draw	Interim delivery Mid-term Review; Final delivery
13.	Material Properties Report (in support of flight safety)	Interim delivery Mid-term Review; Final delivery
14.	Reports that demonstrate the functional test of the flight units before delivery to the government	Pre-ship Review
15.	Up to 120 hours of Technical Support Via teleconference, email, or on-site visit to contractor's facilities Actual support to be proposed by contractor. May include: training, test support, operations support, post-flight processing support.	At least 6 months after Final Delivery
16.	Payload instrument final report	3 months after completion of EtherSat operations
	Reviews/Milestones	
17.	Requirements Review	2 weeks after award
18.	Mid-term Review/ Design Review (EDU delivery)	4 months after award
19.	Pre-ship Review	2 weeks before Final Delivery
20.	Final Delivery	November 2012
21.	EtherSat Launch	mid-2013
22.	EtherSat End-of-Operations	60 days after Launch