NASA SBIR 2009 Phase I Solicitation

S4 Low-Cost Small Spacecraft and Technologies

This subtopic is targeted at the development of technologies and systems, which can enable the realization of small spacecraft science and exploration missions. While small spacecraft have the benefit of reduced launch costs by virtue of their lower mass, they may be currently limited in performance and their capacity to provide on-orbit resources to payload and instrument systems. With the incorporation of smaller bus technologies, launch costs, as well as total life cycle costs, can continue to be reduced, while still achieving and expanding NASA's mission objectives.

The Low-Cost Small Spacecraft and Technologies category is focused on the identification and development of specific key spacecraft technologies in the areas of avionics, attitude determination and control, and spacecraft integration planning and management. The primary thrust of this topic is directed at reducing the footprint and resources that these bus subsystems require (power, mass, and volume), allowing more of these critical resources to be shifted to payload and instrument systems, and to further reduce the overall launch mass and volume requirements for small spacecraft.

Proposals should show an understanding of one or more relevant science needs, and present a feasible plan to fully develop a technology and infuse it into a NASA program.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 hardware and/or software demonstration, and when possible, deliver a demonstration unit or software package for NASA testing at the completion of the Phase 2 contract.

Subtopics

S4.01 Radiation Hardened High-Density Memory, High Speed Memory Controllers, Data Busses

Lead Center: ARC

There has been considerable progress in the development of low cost high-density memory in the consumer electronics industry. However, spacecraft memory capacities can be orders of magnitude smaller than a desktop

computer hard drive. Therefore, NASA has an interest in the development of low cost, high-density memory suitable for spaceflight applications including operations in near and deep space radiation and temperature environments. High-density, radiation-tolerant memory can be beneficial for Astrophysics, Earth Sciences, Heliophysics and Planetary missions where instruments, such as large-scale imagers and spectrometers can quickly produce large amounts of data.

Proposals are sought for radiation-tolerant high-density memory systems that can address or consider the following performance parameters:

- Storage capabilities of up to 192 Gigabytes of data on single 3U card form factor, suitable for inclusion within integrated avionics units and 3U chassis;
- Units that utilize the Space Plug and Play Architecture (SPA) developed at AFRL (See http://www.dukeworks.org);
- Tolerate standard internal spacecraft bus operating temperatures of -25ÂºC to 40ÂºC;
- Tolerate space radiation with Total Ionizing Dose (TID) of 10-400kRad (Si) with an average goal of 100kRad (Si);
- Capable of surviving space launch environments.

Although these are baseline goals, proposals that are able to achieve near comparable values will also be considered.

The proposer to this subtopic is advised that the products proposed may be included in a future small satellite flight opportunity.

S4.02 Radiation Hardened Integrated Unit: GPS/IMU/Time/Processor

Lead Center: ARC

Participating Center(s): GSFC

Many subsystems and components are gaining benefit from miniaturization and reduction in mass and power requirements. Often many different avionic control system components are necessary for small spacecraft missions with stringent pointing requirements. A considerable saving in mass, power, and system complexity can be obtained by integrating components into a single unit. Of particular interest is a GPS, IMU, and timing signal combination in a single unit with an internal low-power processor to perform the internal calculations to provide the spacecraft with the necessary location and attitude knowledge.

Proposals are sought for an integrated GPS, IMU, and timing signal unit coupled with a low power processor to

provide the necessary signals to spacecraft components.

The integrated unit should address or consider the following performance parameters:

- Mass less than 2.5kg
- Average power usage less than 15W
- GPS:
    - Position accuracy:1-5m
    - Velocity accuracy: 1m/s
    - Time to first fix: 1 minute
    - Use L1 signals; desirable to incorporate L2 signals
- IMU:
    - Rate Range: 500 deg/sec
    - Bias repeatability: 0.005 deg/hr
    - Scale Factor Accuracy:1 to 5 ppm
    - Angle random walk: 0.005 deg/rt-hr
- Timing:
    - 10^{-8} to 10^{-10} Allan deviation
- Able to tolerate an acceleration load of ~25g
- Stable over standard internal spacecraft bus operating temperatures of -25ÂºC to 40ÂºC
- Radiation tolerant with Total Ionizing Dose (TID) of 10 - 400 kRad (Si) with an average goal of 100 kRad (Si)
- Compatible with the Space Plug and Play Architecture (SPA) developed at AFRL (See http://www.dukeworks.org for information on SPA)
- Capable of surviving space launch environments

Although these are baseline goals, proposals that are able to achieve near comparable values will also be considered.

The proposer to this subtopic is advised that the products proposed may be included in a future small satellite flight opportunity.

S4.03 Wireless Data and/or Power Connectivity for Small Spacecraft

Lead Center: ARC

Participating Center(s): GSFC, JPL

New advances in wireless connectivity for mobile computing and other electronic devices have opened up the possibilities for wireless spacecraft busses. There are two potential applications, the transfer of data, commands, and signals and delivery of power to components. The use of wireless technology can be beneficial to small spacecraft designs by eliminating the need for data and power connects, thus reducing spacecraft overall mass and volume requirements. Wireless applications for a spacecraft bus must also ensure that the many different signals do not interfere and there is complete transfer of data and power.

The proposed wireless technologies should address or consider the following performance parameters:

- Data transmission capability from 5 - 100 unique devices within the spacecraft;
- Data transfer rates of 500 Megabits per second to 1 Gigabit per second per device;
- Scalable wireless power transfer from ~1mW up to ~20W;
- Overall wireless architecture mass from 3-50kg dependent on the size of the spacecraft bus;
- Both systems (power and data) should be capable of utilizing the Space Plug-and-Play Architecture (SPA) developed by the AFRL. See http://www.dukeworks.org for information on SPA;
- Power and data architectures should be tolerant to the space environment including temperatures (25ÂºC to 40ÂºC) and radiation ;
- Capable of surviving space launch environments.

Although these are baseline goals, proposals that are able to achieve near comparable values will also be considered.

The proposer to this subtopic is advised that the products proposed may be included in a future small satellite flight opportunity.

S4.04 Low Cost, High Accuracy Timing Signals

Lead Center: ARC

Participating Center(s): GSFC

Radio science is an important element of many missions, including small spacecraft missions, to planetary bodies and asteroids where mass determination is derived from perturbations of the spacecraft trajectory by the body. Traditionally these missions have required the inclusion of an Ultra Stable Oscillator (USO) with timing signal accuracy on the order of 10^{-12} to 10^{-13} Allan Deviation. Unfortunately these devices are currently prohibitively expensive for low cost missions. Other devices such as precision clocks can provide accuracy on the order of 10^{-8} Allan Deviation. It is envisioned that recent improvements in timing signal devices from other industries or new developments can provide a significant reduction in cost while still providing the necessary accuracy in the timing signal.

Proposals are sought for highly accurate timing signals that address or consider the following performance parameters:

- Provide timing signals with an accuracy of 10^{-10} to 10^{-12} Allan deviation;
- Be capable of utilizing the Space Plug-and-Play Architecture (SPA) developed at AFRL (See http://www.dukeworks.org);
- Small enough to fit within a 3U form factor or integrated avionics chassis;
- Mass less than 1kg;
- Power draw less than 5W;
- Stable over standard internal spacecraft bus operating temperatures of -25ÂºC to 40ÂºC;
- Radiation tolerant with Total Ionizing Dose (TID) of 10 - 400 kRad (Si) with an average goal of 100 kRad (Si);
- Capable of surviving space launch environments.

Although these are baseline goals, proposals that are able to achieve near comparable values will also be considered.

The proposer to this subtopic is advised that the products proposed may be included in a future small satellite flight opportunity.

S4.05 High Torque, Low Jitter Reaction Wheels or Control Moment Gyros

Lead Center: ARC

NASA is becoming increasingly interested in using small spacecraft to execute space missions where possible. Many of these missions will require low cost, high torque and low jitter reaction wheels or control moment gyros. Currently there are limited sources of these systems applicable for small spacecraft. Therefore, development of a family of reaction wheels with the appropriate characteristics for nano- and small spacecraft (5 to 100 kg spacecraft mass) with reduced lead times will result in significant benefits to a number of NASA programs and missions.

Proposals are sought for the development of reaction wheels and/or control moment gyros with the following performance parameters:

- Mass less than 2 kg
- Average power usage less than 5W
- Compatible with the Space Plug-and-Play Architecture (SPA) developed at AFRL (See http://www.dukeworks.org)
- Reaction wheels
    - Angular momentum capacity of 1 to 2 Nms
    - Torque capacity greater that 50mN-m
    - Speed range greater than Â±20000rpm
- Control Moment Gyros
    - Torques of 0.1 to 5 Nm
- Induced jitter noise TBR:
    -
    -
    -
- The use of built in control electronics with rate sensor abilities is also desirable
    - Rate sensor should have a range of 500 deg/sec

- Drift rate 0.5 deg/hr

- Stable over standard internal spacecraft bus operating temperatures of -25ÂºC to 40ÂºC
- Radiation tolerant with Total Ionizing Dose (TID) of 10 - 400 kRad (Si) with an average goal of 100 kRad (Si)
- Capable of surviving space launch environments

Although these are baseline goals, proposals that are able to achieve near comparable values will also be considered.

The proposer to this subtopic is advised that the products proposed may be included in a future small satellite flight opportunity.

S4.06 AI&T Planner and Scheduler

Lead Center: ARC

Proposals are sought for the development of a software tool (or suite of integrated tools) to assist in the planning, scheduling, and operations activities that occur during small spacecraft Assembly, Integration and Test (AI&T). AI&T is a complex period for small spacecraft with many different procedures, dependencies, operations, and tests occurring in parallel. To streamline the process and ensure compliance with mission and science requirements, NASA is interested in a software tool to support planning, scheduling, and management of the small spacecraft AI&T flow. The tool must be scalable for a variety of different mission and spacecraft classes from nanosatellites, which are typically secondary payloads weighing around 5 - 10 kg, up to primary sciences missions, which may weigh more than 100 kg.

Proposals are sought for the development of an AI&T tool with the following capabilities:

- Resource(s) availability determination and planning function
    - Facilities
    - Personnel
    - GSE
- Requirement mapping for qualification tests along with verification and validation functions

- Compatible with NASA proposal development processes to assist in a Phase A schedule and cost generation for the AI&T flow
- Compatible with NASA NPR 7120.5D Program and Project planning requirements