NASA SBIR 2017 Phase I Solicitation

Z8.05 Small Spacecraft Avionics and Control

Lead Center: GSFC

Participating Center(s): ARC, JPL, MSFC

Technology Area: TA5 Communication and Navigation

Smallsats and cubesats offer several new opportunities for space science, including multipoint in-situ measurements and disaggregation of larger science missions into constellations. These missions require reliable operation for several years in potentially harsh radiation environments. Industry has developed numerous cubesat components, but they lack the robustness needed for long duration missions in harsh mission environments. To address this capability gap, this subtopic will develop high reliability smallsat avionics and control technologies that meet the performance and resource requirements of upcoming missions, while maximizing flexibility.

This subtopic solicits the development of smallsat and cubesat single board avionics with the following specifications:

- Minimum 100 DMIPS processing performance.
- 3W power dissipation.
- Maximum board size of 90 mm x 90 mm.
- 16 Mbytes of EDAC protected RAM.
- 4 Gbytes ofnon-volatile memory storage.
- 256 kbytes on non-volatile memory for boot software.
- Optionally supports I2C, CAN, SPI, and SpaceWire busses.
- 4 8b/10b SERDES interfaces.
- Provides FPGA to implement mission specific processing functions and interfaces (including general purpose I/O), either in combined in a System-On-a-Chip (SOC) or separate from the processor package.
- Accepts and digitizes 16 thermistor inputs and 8 active analog inputs.
- Provides watchdog timer and external reset signal

This subtopic also solicits ACS/GN&C component hardware that has a minimum of 3-year operational life as well as radiation-hard and low mass implementation to survive the typical LEO radiation environment for the same duration. Specific component technologies include:

- Integrated Attitude Detection and Control Systems (ADCS) for 3U and 6U CubeSat:
    - Minimum Target Pointing Spec:
        - Knowledge 10.0 arc-second - 3 sigma.
        - Control 40.0 arcsec - 3 sigma.
        - Stability 0.3 arcsec over 1.0 sec - 3 sigma.
    - 10.0 Hz ctrl cycle.

- Desired Target Pointing Spec:
    - Integrated Attitude Detection and Control Systems (ADCS) that can provide pointing for 3U and 6U CubeSat:
        - Knowledge 1.0 arc-second - 3 sigma.
        - Control 4.0 arcsec - 3 sigma.
        - Stability 0.05 arcsec over 1.0 sec - 3 sigma.
    - 10.0 Hz ctrl cycle
- Actuators.
- Slew rate on the order of 1 deg/sec.
- Momentum capacity: 4 orbits.
- Handle tipoff rates on the order of 5.0 deg/sec per axis:
    - Ensure a stable platform can be achieved after separation.
- Low jitter reaction wheels or reaction control systems (RCS).
- Sensors:
    - Small, low power (<1 W) star trackers and innovative baffle design.
    - Low Noise Gyro:
        - Can propagate on Gyro for 4 orbits.

To allow infusion into multiple smallsat architectures, it is highly desirable for ACS/GN&C components to provide options to support multiple onboard data busses (i.e., I2C, SPI, CAN).

For the above components, the environmental specifications are; operating temperature -40 to- +85°C, radiation hard to at least 40 krad TID, latch up immune to an LET of at least 80, and a device SEE rate of not greater than 0.01 event/day in Adams 90% worst case GEO environment. Successful proposals for the above technologies will address reliability and radiation tolerance at the part level all the way up through their component/subsystem implementation. For descriptions of radiation effects in electronics, the proposer may visit http://radhome.gsfc.nasa.gov/radhome/background.htm.

Beyond the higher reliability technologies listed above, this subtopic also solicits technologies offering significant improvements in cubesat/smallsat capabilities. These technologies would not need to have sufficient reliability and radiation tolerance to be directly infused into long duration missions. However, there should be a viable path by which these technologies could be matured for such missions. Technologies solicited include:

- Low power, high throughput processors, SoC or MPSoC with an order of magnitude performance improvement over state-of-the-art.
- Radiation resistant, self-repairing technologies (both in hardware and software).
- Modular, reconfigurable flight software environments and architectures.
- Technologies that enable rapid software integration, test and validation.
- Radiation tolerant GN&C systems and components with an order of magnitude performance improvement over state-of-the-art.
- Small, low thrust RCS systems for smallsats with an order of magnitude performance improvement over state-of-the-art.
- Alternate technologies for attitude determination (i.e., navigation via x-ray sources, or planetary bodies).
- Technologies to isolate sources of spacecraft vibration from sensors or payloads.
- Advanced GN&C software programs and algorithms.
- Miniature rate gyros with an order of magnitude performance improvement over state-of-the-art MEMS gyros in drift and noise.
- Innovative miniature angular momentum exchange devices that are not susceptible to reliability issues associated with bearing wear.
- Miniature sensors and actuators for smallsat rendezvous, docking and spacecraft servicing, including include vision systems, miniature robotics, and docking actuators.