NASA SBIR 2015 Phase I Solicitation

Z4 Small Spacecraft Technology

Lead Center: ARC

This topic seeks innovative technologies for components and subsystems for small spacecraft ranging in size from cubesat-scale up to approximately 100 kilograms in mass. These spacecraft are intended for science, exploration, and other missions in Earth orbit and in regions of the inner solar system beyond Earth.Â

Proposals are sought for projects that can produce, by the end of Phase II, flight-quality hardware or at least proto-flight hardware for the designated components or subsystems that might then be integrated into spacecraft for technology demonstration flights. Several specific technology areas are of interest in this solicitation:

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- Solar arrays, energy storage, and integrated power systems for small spacecraft. The primary power requirement is for electric propulsion systems although these spacecraft might also utilize significant electrical power for communications and payload operations.
- Navigation and attitude determination systems for small spacecraft operating beyond low-Earth orbit to provide precise knowledge of the spacecraft state (position, attitude, and rates in all axes) without reliance on the Global Positioning System or similar Earth-orbit references or planetary magnetic fields.
- Structural design concepts for small spacecraft that offer significant advantages over conventional structures in one or more of the following ways:

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  - Reduce mass while maintaining adequate strength.
  - Provide thermal management features for the spacecraft such as enhanced heat transfer and heat rejection.
  - Provide radiation shielding to other spacecraft components.
  - Enhance the ease of assembly and integration of spacecraft. Â

Subtopics

Z4.01 Small Spacecraft in Deep Space: Power, Navigation, and Structures

Lead Center: ARC

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This subtopic seeks innovative technologies for components and subsystems for small spacecraft ranging in size from cubesat-scale up to spacecraft of approximately 100 kilograms in mass. These spacecraft are intended for science, exploration, and other missions in Earth orbit and, in particular, for operations in other regions of the inner solar system beyond Earth.Â

For all technology areas outlined below, the components and subsystems must be tolerant of typical launch vehicle loads and environments and operationally tolerant of the thermal and radiation environment that exists, as a minimum, in earth orbit at any altitude above 300 km, in cis-lunar space including lunar orbit, and in heliocentric orbit at 1 Astronomical Unit (AU) from the sun. It is desirable that these components and subsystems also be operationally tolerant of the thermal and radiation environment that exists in interplanetary space ranging from 0.7 AU to at least to 3 AU from the sun and in orbit around Mars and Venus. Components and subsystems must also be resistant to the atomic oxygen environment in low-Earth orbit.Â

For all technology areas below, proposals are sought for projects that can produce, by the end of Phase II, flight-quality hardware or at least proto-flight hardware for the designated components or subsystems that might then be integrated into spacecraft for technology demonstration flights, initially in low-Earth orbit. Initial flight demonstrations are likely to employ 3-unit or 6-unit cubesat spacecraft. For convenience in integration, components and subsystems should be designed to fit a standard cubesat unit (10 by 10 by 10 centimeters), a fraction of that unit, or multiples of that unit. The desired Phase I deliverables include a detailed description and plan for development and fabrication of the hardware to be produced by the end of Phase II.Â

Proposals are sought in several technology areas outlined below. Proposers should clearly state the technology area addressed by their proposal. Proposers may submit more than one proposal but each individual proposal must address only one of the technology areas below.Â

Power Systems for Small SpacecraftÂ

This area seeks innovative technologies for solar power generation and/or electrical energy storage systems for small spacecraft ranging in size from cubesat-scale up to spacecraft of approximately 100 kilograms in mass. The primary power requirement is for electric propulsion systems although these spacecraft might also utilize significant electrical power for communications and payload operations.Â

- Solar Array Systems: Solar array systems consisting of deployable panels or blankets with necessary structural support, mechanisms, and functional photovoltaic cell arrays. The arrays must be designed for unaided deployment in the space environment (micro-gravity and vacuum conditions) and provide for functional power generation. Innovations are sought in compact packaging of arrays for launch, reliable array deployment at a specified time after launch, and reliable power generation in space. Systems with low mass are desired but compact storage volume is the more important feature. The power generation goal for these systems is 100 to 500 watts per panel (power at beginning of life at 1 AU from the sun) for panels that can be packaged for launch within a volume of three cubesat units (3U) or less. Systems are sought which also incorporate the capability for rotation relative to the body of the spacecraft to allow the array to track the sun as the spacecraft moves through space.
- Energy Storage Systems: Batteries or other types of rechargeable energy storage systems with a capacity of 200 to 2000 watt-hours and with minimum volume and mass. Functional heat rejection requirements must also be addressed in the design and prototype hardware.
- Integrated Power Systems: Systems that include the solar array and energy storage as a system, ready for integration into a small spacecraft.Â

Navigation and Attitude Determination for Small Spacecraft beyond Earth OrbitÂ

This area seeks innovative technologies for navigation and attitude determination systems for small spacecraft ranging in size from cubesat-scale up to spacecraft of approximately 100 kilograms in mass, operating beyond low-Earth orbit. The relevant systems are required to provide precise knowledge of the spacecraft state (position, attitude, and rates in all axes) without reliance on the Global Positioning System or similar Earth-orbit references or planetary magnetic fields. Any reliance on Earth based communications and tracking systems must take into account the limited power and other capabilities of small spacecraft operating at great distances from Earth. Novel

concepts that minimize reliance on conventional navigation and tracking resources and techniques are desired.

The relevant navigation systems must be scaled for integration in small spacecraft with a target peak-power requirement of less than 100 watts and a volume of less than 3 cubesat units (approximately 10 by 10 by 30 centimeters) for the system. Lower volume, mass, and power usage is desirable. Requirements for heat rejection from the navigation system must be addressed in the design.Â

Structures for Small SpacecraftÂ

This area seeks innovative technologies for structural designs for small spacecraft ranging in size from cubesat-scale up to spacecraft of approximately 100 kilograms in mass, for operation in and beyond Earth orbit. Structures for cubesats in the 3U, 6U and 12U size range are of particular interest. Proposed concepts should offer significant advantages over conventional aluminum or composite structures in one or more of the following ways:Â

- Reduce mass while maintaining adequate strength.
- Provide thermal management features for the spacecraft such as enhanced heat transfer and heat rejection.
- Provide radiation shielding to other spacecraft components.
- Enhance the ease of assembly and integration of spacecraft.Â

The recurring cost of the structures and materials proposed should be consistent with the low-cost goals of small spacecraft projects.Â

Proposals must focus on the design and fabrication of flight-quality or at least proto-flight structures that might then be integrated into small spacecraft for technology demonstration flights. Proposals that address general innovations in advanced manufacturing, structures, or materials are not appropriate for this subtopic.Â

NASA Small Spacecraft Technology Program:Â

- (http://www.nasa.gov/directorates/spacetech/small_spacecraft/index.html).

Small Spacecraft Technology State of the Art Report:Â

- (http://www.nasa.gov/sites/default/files/files/Small_Spacecraft_Technology_State_of_the_Art_2014.pdf).