NASA SBIR 2019 Phase I Solicitation

Z8.03 Low Cost Radiation Hardened Integrated Circuit Technology

Lead Center: LaRC

Participating Center(s): ARC, GRC, GSFC, JPL

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

Over recent years, the small spacecraft industry has developed into an economic factor for space business. As these small spacecraft develop in capability and developers plan both for longer missions and usage beyond Low Earth Orbit (LEO), they have the need for more advanced electronic solutions beyond what is normally available in existing space-qualified product lines. Designers need these solutions to serve government, commercial, and academic small spacecraft in these higher radiation environments. In keeping with the small spacecraft design philosophy and general mission costing profiles, solutions associated with state-of-the-art Integrated Circuit (IC) devices offer a significant potential for improved functionality in space capabilities and cost reduction, especially by combining complementary functions or providing "smart" capabilities. However, commercial solutions usually have not been certified for use in the space environment and often have issues with the radiation environment found beyond LEO environments.

This subtopic is requesting proposed solutions for supplying this improved functionality while mitigating the radiation environment beyond LEO including, but not limited to:

- Radiation hardened ICs based on commercial, terrestrial applications
- Low-mass/small volume shielding, including shielding with structure or power supply elements, without causing damage from secondary emission
- Affordable low-mass/small volume redundancy with voting and switching mechanisms
- Utilization of Model Based Systems Engineering (MBSE) techniques for modeling the environment, failure modes and effects, and for modeling and evaluating the effectiveness and risks of various proposed mitigation scenarios

Because the entire suite of avionics functions, power systems, and many instrument support functions can benefit from taking commercial IC concepts and making them space-ready, capabilities and requirements are not specified in this subtopic. Proposers should consider functions normally found within spacecraft systems (such as avionics, power systems, etc.) and propose solutions to make available innovative new approaches with added capabilities for new spacecraft designers. In particular, the proposer should:

- Identify the specific function to be advanced and demonstrate how it is not currently available at the full level performance needed.
- Identify the intended application environment(s), e.g., Geosynchronous Earth Orbit (GEO), Cis-lunar space, deep space, etc.
- Explain how the proposed approach exceeds the state of the art in key metrics such as available

functionality, power requirements, mass, radiation resistance, temperature range, risk, etc.

For IC development, proposers should identify the technology development necessary to get the proposed IC to the performance needed for the proposed environment and application. The proposal’s technology development plan needs to include test and verification to include full environmental testing so that the end customer can readily incorporate the chipsets into new vehicles without additional testing. Low-cost chipsets that are used both for space applications as well as terrestrial applications such as DoD, commercial aircraft, etc. are the primary emphasis for this call.

For redundancy solutions, the proposal should describe how the failure effect mitigations are feasible both economically and within the severe mass budgets typical of small spacecraft.

For shielding solutions, the proposal should provide the necessary initial analysis to demonstrate that the proposed approach in the candidate structural and physical environment will mitigate the radiation effects of the chosen environment without damage from secondary emissions. Because mass budgets are especially constrained in small spacecraft, supporting evidence should be provided to show how the benefits from shielding outweigh any mass penalty.

For MBSE development, proposers should identify the candidate small spacecraft configurations (including for constellations of cooperative small spacecraft) and the methodology for capturing the intended environmental variables, the mitigation approaches they will incorporate to reduce the radiation risk, and how they will perform the risk assessment. The proposal should specify the modeling elements and tools are required. The development plan must also include methods for validating the model and its results.

General-purpose computing processors are explicitly excluded in this subtopic.

NASA has plans to purchase services for delivery of payloads to the Moon through the Commercial Lunar Payload Services (CLPS) contract. Under this subtopic, proposals may include efforts to develop payloads for flight demonstration of relevant technologies in the lunar environment. The CLPS payload accommodations are yet to be precisely defined, however at least for early missions, proposed payloads should not exceed 15 kilograms in mass and not require more than 8 watts of continuous power. Smaller, simpler, and more self-sufficient payloads are more likely to be accommodated. Commercial payload delivery services may begin as early as 2020 and flight opportunities are expected to continue well into the future. In future years it is expected that payloads of higher mass and with higher power requirements might be accommodated. Selection for award under this solicitation will not guarantee selection for a lunar flight opportunity.

This subtopic is aimed at enhancing the small spacecraft market. This falls within the portfolio domain of the Small Spacecraft Technology program within NASA's STMD (Space Technology Mission Directorate). This small spacecraft portfolio has often supported commercial development to enhance the technology for this class of satellites. Missions longer than one year, at higher orbital altitudes, and missions beyond Earth's orbit will all need improved radiation protection for critical electronics in avionics and instruments. Missions in this class are of strong interest to STMD as well as NASA's Science Mission Directorate (SMD). This technology will also be useful to commercial and academic developers.

The expected Technology Readiness Level (TRL) range at completion of this project is 3 to 5.