SBIR/STTR
Small Business Innovation Research / Small Business Technology Transfer

NASA SBIR 2019 Phase I Solicitation

S3.08 Command, Data Handling, and Electronics

Lead Center: GSFC

Participating Center(s): JPL, LaRC

Technology Area: TA11 Modeling, Simulation, Information Technology and Processing

NASA's space-based observatories, fly-by spacecraft, orbiters, landers, and robotic and sample return missions require robust command and control capabilities. Advances in technologies relevant to command and data handling and instrument electronics are sought to support NASA's goals and several missions and projects under development.

The 2019 subtopic goals are to develop platforms for the implementation of miniaturized highly integrated avionics and instrument electronics that:

- Are consistent with the performance requirements for NASA science missions.
- Minimize required mass/volume/power as well as development cost/schedule resources.
- Can operate reliably in the expected thermal and radiation environments.

Successful proposal concepts should significantly advance the state-of-the-art. Furthermore, proposals developing hardware should indicate an understanding of the intended operating environment, including temperature and radiation. It should be noted that environmental requirements can vary significantly from mission to mission. For example, some low earth orbit missions have a Total Ionizing Dose (TID) radiation requirement of less than 10 krad(Si), while some planetary missions can have requirements well in excess of 1 Mrad(Si).

Specific technologies sought by this subtopic include:

- *Fault tolerant Implementation System-on-a-Chip (SOC) Architectures* – Technologies are sought that implement fault tolerant SOC architectures, while leveraging emerging industry standard processor instruction set architectures (ISAs) and on-chip busses. Of particular interest is the RISC-V processor ISA. Offerors should identify coding language of IP cores, use of architecture-specific modules which would limit the ability to embed code into differing chipsets, options for scaling fault tolerance, code size and features versus power and speed. Offerors should identify operating system/toolchain support. Fault tolerant SOC architectures are relevant to increasing science return for missions across all Science Mission Directorate (SMD) divisions. However, the benefits are most significant for miniaturized instruments and subsystems that must operate in harsh environments. These missions include interplanetary cubesats and smallsats, outer planet instruments, and heliophysics missions to harsh radiation environments. For these missions, the inherent fault tolerance would provide an additional level of protection on top of the radiation tolerance of the FPGA or ASIC on which the SOC is implemented. Additionally, for missions with large communication delays, the inherent fault tolerance can limit the need for ground intervention.

- *Radiation Tolerant Onboard Wireless Networks* – Technologies are sought to enable onboard wireless networks that can operate reliably in space environments. Potential applications of interest include monitoring of passive wireless sensor nodes for housekeeping, point-to-point links to communicate to instruments on booms and rotating assemblies, as well as the full implementation of a spacecraft onboard network via wireless. Offerors should identify the concept of operations for the proposed onboard network, and also describe the proposed methodology for ensuring the wireless sensor nodes (transceiver and antenna) will operate reliably in the space environment (especially radiation). Offerors should identify network type (point to point, mesh), frequencies, bandwidth, and power dissipation. Onboard wireless networks can have relevance across all SMD divisions. However, the most immediate benefits can be for earth science with rotating instrument assemblies. For these applications, wireless networks can significantly simplify communicating high rate data from instruments such as radiometers. Additionally, heliophysics and astrophysics missions using instruments or telescopes on deployable booms could benefit by reducing the amount of wiring that must be integrated into those boom assemblies.
- *System-In-Package Integrated Assemblies* – Technologies are sought enabling highly integrated System-In-Package (SIP) assemblies integrating multiple die from different processes and foundries, enabling implementation of miniaturized, highly-reliable embedded processing, sensor readout, or motor/actuator control modules. The offeror should propose both the SIP technology to be developed, as well as a proof of concept application (relevant to spaceflight subsystems or instruments) that demonstrates the technology. The offeror should address key technical issues in the SIP implementation including thermal management, reliability, and signal integrity. Of particular interest is SIP utilizing 2.5D technology where existing die are integrated using a silicon interposer. SIP has relevance to missions across all SMD divisions where onboard resources are at a minimum. Specifically, SIP can reduce board level functions to the size of a small module, which would be especially relevant to instruments and subsystems on cubesats and outer planet missions.

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

References:

- For descriptions of radiation effects in electronics, the proposer may visit http://radhome.gsfc.nasa.gov/radhome/overview.htm.