



NASA SBIR 2009 Phase I Solicitation

01.03 Reconfigurable/Reprogrammable Communication Systems

Lead Center: GRC

Participating Center(s): AFRC, ARC, GSFC, JPL, JSC

NASA seeks novel approaches in reconfigurable, reprogrammable transceiver systems for Space Operations, Exploration, Science, and Aeronautics research. Exploration of Lunar and Mars environments will require advancements in radio communication systems to manage the demands of the harsh space environment on space electronics, maintain flexibility and adaptability to changing needs and requirements, and provide flexibility and survivability due to increased mission durations. NASA missions can have vastly different transceiver requirements (e.g., 1's to 10's Mbps at UHF- and S-band frequency bands up to 10's to 1000's Mbps at X- and Ka-band frequency bands.) and available resources depending on the science objective, operating environment, and spacecraft resources. For example, deep space missions are often power constrained; operating over large distances, and subsequently have lower data transmission rates when compared to near-Earth or near planetary satellites. These requirements and resource limitations are known prior to launch; therefore, the scalability feature can be used to maximize transceiver efficiency while minimizing resources consumed. Larger platforms such as vehicles or relay spacecraft may provide more resources but may also be expected to perform more complex functions or support multiple and simultaneous communication links to a diverse set of assets.

This solicitation seeks advancements in reconfigurable transceiver and associated component technology. The goal of the subtopic is to provide flexible, reconfigurable communications capability while minimizing on-board resources and cost. Topics of interest include the development of software defined radios or radio subsystems which demonstrate reconfigurability, flexibility, reduced power consumption of digital signal processing systems, increased performance and bandwidth, reduced software qualification cost, and error detection and mitigation technologies. Complex reconfigurable systems will provide multiple channel and multiple and simultaneous waveforms. Areas of interest to develop and/or demonstrate are as follows:

- Enable advancements in bandwidth capacity, reduced resource consumption, or adherence to the Space Telecommunications Radio System (STRS) standard and open hardware and software interfaces. Techniques should include fault tolerant, reliable software execution, reprogrammable digital signal processing devices.
- Reconfigurable software and firmware which provide access control, authentication, and data integrity checks of the reconfiguration process including partial reconfiguration which allows simultaneous operation and upload of new waveforms or functions.

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- Operator or automated reconfiguration or waveform load detection failure and the ability to provide access back to a known, reliable operational state. An automated restore capability ensures the system can revert to a baseline configuration, thereby avoiding permanent communications loss due to an errant reconfiguration process or logic upset.
 - Develop dynamic or distributed on-board processing architectures to provide reconfigurability and processing capacity. For example, demonstrate technologies to enable a common processing system capacity for communications, science, and health monitoring.
 - Adaptive modulation and waveform recognition techniques are desired to enable transceivers to exchange waveforms with other assets automatically or through ground control.
 - Low overhead, low complexity hardware and software architectures to enable hardware or software component or design reuse (e.g., software portability) that demonstrates cost or time savings. Emphasis should be on the application of open standards architecture to facilitate interoperability among different vendors to minimize the operational impact of upgrading hardware and software components.
 - Software tools or tool chain methodologies to enable both design and software modeling and code reuse and advancements in optimized code generation for digital signal processing systems.
 - Use of reconfigurable logic devices in software defined radios is expected to increase in the future to provide reconfigurability and on-orbit flexibility for waveforms and applications. As the densities of these devices continue to increase and feature size decreases, the susceptibility of the electronics to single event effects also increases. Novel approaches to mitigate single event effects in reconfigurable logic caused by charged particles are sought to improve reliability. New methods should show advancements in reduced cost, power consumption or complexity compared to traditional approaches such as voting schemes and scrubbing.
 - Techniques and implementations to provide a core capability within the software defined radio in the event of failure or disruption of the primary waveform and/or system hardware. Communication loss should be detected and core capability (e.g., "gold" waveform code) automatically executed to provide access control and restore operation.
 - Innovative solutions to software defined radio implementations that reduce power consumption and mass. Solutions should enable future hardware scalability among different mission classes (e.g., low rate deep space to moderate or high rate near planetary, or relay spacecraft) and should promote modularity and common, open interfaces.
 - In component technology, advancements in analog-to-digital converters or digital-to-analog converters to increase sampling and resolution capabilities, novel techniques to increase memory densities, and advancements in processing and reconfigurable logic technology each reducing power consumption and improving performance in harsh space environments.
 - Development of radio technology that allows the incorporation of Space Network (SN) waveforms and candidate Lunar Surface System (LSS) wideband waveforms such as 802.11 and 802.16 into a single multimode radio capable of supporting simultaneous communications with space and lunar network assets. Development and implementation of direct RF to digital technologies that are currently emerging and can offer significant improvements in the flexibility of software or multi-mode radios. The goal is to maximize flexibility and capability to share lunar communications infrastructure and therefore minimize mass of radio components that must be delivered to the lunar surface.
 - Small, lightweight all-digital reconfigurable radios and transceivers that eliminate analog front ends that operate across multiple bands, are sought for applications that involve network enhanced telemetry, leading towards adaptive and cognitive radio applications. Application of reconfigurable systems in airborne and terrestrial systems is of interest.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward Phase

2 hardware and software demonstration and delivering a hardware demonstration unit or software package for NASA testing at the completion of the Phase 2 contract.