NASA SBIR 2014 Phase I Solicitation

H9.01 SCaN Testbed (CoNNeCT) Experiments

Lead Center: GRC

Participating Center(s): JPL

NASA has developed an on-orbit, reprogrammable, software defined radio-based (SDR) testbed facility aboard the International Space Station (ISS), to conduct a suite of experiments to advance technologies, reduce risk, and enable future mission capabilities. The Space Communications and Navigation (SCaN) Testbed Project provides SBIR recipients the opportunity to develop and field communications, navigation, and networking technologies in the laboratory and space environment based on reconfigurable, software defined radio platforms. Each SDR is compliant with the Space Telecommunications Radio System (STRS) Architecture, NASA's common architecture for SDRs. The Testbed is installed on the truss of ISS and communicates with both NASA's Space Network via Tracking Data Relay Satellite System (TDRSS) at S-band and Ka-band and direct to/from ground systems at S-band. One SDR is capable of receiving L-band at the GPS frequencies of L1, L2, and L5.

NASA seeks innovative software applications and experiments to run aboard the SCaN Testbed to demonstrate and enable future mission capability using the reconfigurable features of the software defined radios. Experiment software/firmware can run in the flight SDRs, the flight avionics computer, and on a corresponding ground SDR at the NASA Space Network, White Sands Complex. Unique experimenter ground hardware equipment may also be used. For the flight system on-orbit, experiments will consist of software/firmware provided to NASA by the SBIR recipient. This call will not provide a means to develop nor fly any new hardware in space.

Experimenters will be provided with appropriate documentation (e.g., flight SDR, avionics, ground SDR) to aid their experiment application development, and may be provided access to the ground-based and flight SDRs to prepare and conduct their experiment. Access to the ground and flight system will be provided on a best effort basis and will be based on their relative priority with other approved experiments. Please note that selection for award does not guarantee flight opportunities on the ISS.

Desired capabilities include, but are not limited to, the examples below:

- Cognitive applications.
- Spectrum efficient technologies.
- Multi-access communication.
- Space internetworking.
    - Disruption Tolerant Networking.
- Position, navigation and timing (PNT) technology.
- Aspects of reconfiguration.
    - Unique/efficient use of processor, FPGA, DSP resources.
    - Inter-process communications.
- Technologies/waveforms for formation flying.
- High data rate communications.

- Uplink antenna arraying technologies.
- Demonstration of mission applicability of SDR.
- RF sensing applications (science emulation).

Experimenters using ground or flight systems will be required to meet certain pre-conditions for flight including:

- Provide software/firmware deliverables (software/firmware source, executables, and models) suitable for flight.
- Document development and build environment and tools for waveform/applications.
- Provide appropriate documentation (e.g., experimenter requirements, waveform/software user's guide, ICD's) throughout the development and code delivery process.
- Software/firmware deliverables compliant to the Space Telecommunications Radio System (STRS) Architecture, Release 1.02.1 and submitted to waveform repository for reuse by other users.
- Verification of performance on ground based system prior to operation on the flight system.

Methods and tools for the development of software/firmware components that is portable across multiple platforms and standards-based approaches are preferred.

Documentation for both the SCaN Testbed system and STRS Architecture may be found at the following link:

(http://spaceflightsystems.grc.nasa.gov/SpaceOps/CoNNeCT/).

These documents will provide an overview of the SCaN Testbed flight and ground systems, ground development and test facilities, and experiment flow. Documentation providing additional detail on the flight SDRs, hardware suite, development tools, and interfaces will be made available to successful SBIR award recipients. Note that certain documentation available to SBIR award recipients is restricted by export control and available to U.S. citizens only.

For all above technologies, Phase I will provide experimenters time to develop and advance waveform/application architectures and designs along with detailed experiment plans. The subtopic will seek to leverage more mature waveform developments to reduce development risk in subsequent phases, due to the timeframe of the on-orbit Testbed. The experiment plan will show a path toward Phase II software/firmware completion, ground verification process, and delivering a software/firmware and documentation package for NASA space demonstration aboard the flight SDR. Phase II will allow experimenters to complete the waveform development and demonstrate technical feasibility and basic operation of key algorithms on SCaN Testbed ground-based SDR platforms and conduct their flight system experiment. Opportunities and plans should also be identified and summarized for potential commercialization.

Phase I Deliverables:

- Waveform/application architecture and detailed design document, including plan/approach for STRS compliance.
- Experiment Reference Design Mission Concept of Operations.
- Experiment Plan (according to provided template).
- Demonstrate simulation or model of key waveform/application functions.
- Feasibility study, including simulations and measurements, proving the proposed approach to develop a given product. Early software/firmware application source and binary code and documentation. Source/binary code will be run on engineering models and/or SDR breadboards (at TRL-3-4).
- Plan and approach for Commercialization of the technology (part of final report).

Phase II Deliverables:

- Applicable Experiment Documents (e.g., requirements, design, management plans)
- Simulation or model of waveform application.
- Demonstration of waveform/application in the laboratory on SCaN Testbed breadboards and engineering models.

- Software/firmware application source and binary code (including test software) and documentation (waveform contribution to STRS Repository for reuse by others). Source/binary code will be run on engineering models and/or demonstrated on-orbit in flight system (at TRL-5-7) SDRs. Documentation of development tool chain and procedure to build files.
- Results of implementing the Commercialization Plan outlined in Phase I.