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

NASA SBIR 2014 Phase I Solicitation

H9.03 Long Range Space RF Telecommunications

Lead Center: JPL

Participating Center(s): ARC, GRC, GSFC

This subtopic is focused on development of innovative deep space long-range and near-Earth RF telecommunications technologies supporting the needs of space missions.

In the future, robotic and human exploration spacecraft with increasingly capable instruments producing large quantities of data will be visiting the moon and the planets. These spacecraft will also support long duration missions, such as to the outer planets, or extended missions with new objectives. They will possess reconfigurable avionics and communication subsystems and will be designed to require less intervention from Earth during periods of low activity. Concurrently, the downlink data rate demands from Earth science spacecraft will be increasing. The communication needs of these missions motivate higher data rate capabilities on the uplink and downlink, as well as more reliable RF and timing subsystems. Innovative long-range telecommunications technologies that maximize power efficiency, reliability, receiver capability, transmitted power, and data rate, while minimizing size, mass, and DC power consumption are required. The current state-of-the-art in long-range RF deep space telecommunications is 6 Mbps from Mars using microwave communications systems (X-Band and Ka-Band) with output power levels in the low tens of Watts and DC-to-RF efficiencies in the range of 10-25%. Due to the applicability of communication components and subsystems with science instruments such as radar, technologies that can benefit both RF communication and advanced instruments are within the scope of this subtopic.

Technologies of interest:

- Ultra-small, light-weight, low-cost, low-power, modular deep space and near-Earth transceivers, transponders, amplifiers, and components, incorporating MMICs, MEMs, and Bi-CMOS circuits.
- MMIC modulators with drivers to provide a wide range of linear phase modulation (greater than 2.5 rad), high-data rate (10-200 Mbps) BPSK/QPSK modulation at X-band (8.4 GHz), and Ka-band (26 GHz, 32 GHz and 38 GHz).
- High DC-to-RF-efficiency (> 60%), low mass Solid-State Power Amplifiers (SSPAs), of both CW medium output power (10-15 W) and CW high-output power (15-35 W), using power combining and/or wide band-gap semiconductors at X-band (8.4 GHz) and Ka-band (26 GHz, 32 GHz and 38 GHz).
- Solid-state multi-function modules that can be commanded to toggle between amplifying conventional digital modulation format signals for communications to pulsed operation for synthetic aperture radar (SAR) with resolution on the order of few meters.
- Ultra low-noise amplifiers (MMICs or hybrid, uncooled) for RF front-ends (< 50 K noise temperature).
- High dynamic range (> 65 dB), data rate receivers (> 20 Mbps) supporting BPSK/QPSK modulations.
- MEMS-based integrated RF subsystems that reduce the size and mass of space transceivers and transponders. Frequencies of interest include UHF, X- and Ka-Band. Of particular interest is Ka-band from 25.5 - 27 GHz and 31.5 - 34 GHz.
- Novel approaches to mitigate RF component susceptibility to radiation and EMI effects.

- Innovative packaging techniques that can lead to small size, light weight compact SSPAs with integrated heat extraction for thermal stability and reliability.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path towards Phase II hardware/software demonstration with delivery of a demonstration unit or software package for NASA testing at the completion of the Phase II contract.

Phase I Deliverables - Feasibility study, including simulations and measurements, proving the proposed approach to develop a given product (TRL 3-4). Verification matrix of measurements to be performed at the end of Phase II, along with specific quantitative pass-fail ranges for each quantity listed.

Phase II Deliverables - Working engineering model of proposed product, along with full report of development and measurements, including populated verification matrix from Phase I (TRL 5-6). Opportunities and plans should also be identified and summarized for potential commercialization.