NASA SBIR 2008 Phase I Solicitation

O1.01 Coding, Modulation, and Compression

Lead Center: JPL

Participating Center(s): ARC, GRC, GSFC

This subtopic aims to develop components in digital communication systems that offer both spectrum and power efficient solutions to NASA's future near-Earth, deep-space science and exploration applications. This area comprises technology in three key areas: forward error-correction (FEC) coding, data compression, and modulation. The state-of-the-art in flight for coding is (1) Reed-Solomon code concatenated with a convolutional codes, (2) turbo codes, and just emerging, (3) Low Density Parity Check (LDPC) codes. The first two have flown many times, and the initial designs for (3) are just being begun now. The state-of-the-art in compression is the CCSDS standard http://public.ccsds.org/publications/archive/122x0b1c1_e1.pdf. The state-of-the-art for modulation is BPSK and QPSK for deep space, and BPSK, QPSK, SQPSK, and 8-PSK for near Earth (TDRS) applications. Technology development is needed and required in the following areas:

Coding

The need is to handle signal degradation due to weather impact in Ka-band, RFI interference, and multi-path fading in NASA's future missions. A major challenge is developing coding schemes to handle long bursts of errors, up to 100,000 symbols long, at high processing rate. FEC coding technology to protect against long bursts of erasures due to radio frequency interference (RFI), weather conditions, fading, etc. An entirely new protection mechanism is needed for this long-outage scenario -- existing FEC codes of up to 16,000 are insufficient for this purpose. This technology would be needed in time for a first Ka-band-only mission in the 2015 time-frame. The target is a finished product at TRL 5.

Data Compression

The need is for a real-time high-speed hardware decoder for CCSDS 122.0-B-1 (http://public.ccsds.org/publications/archive/122x0b1c1_e1.pdf). (A CCSDS 122.0-B-1 compliant encoder is already inserted into NASA's mission.) This hardware development effort would be a reference implementation of this standard, that could be used either as the basis for a flight unit, or as an independent validation test module for a flight unit or engineering model. The target is a finished product at TRL 6.

Modulation

Bandwidth efficiency is becoming increasingly important; missions desire simultaneous telemetry and ranging. Modulations and multiple access schemes for multiple spacecraft downlinking to a single antenna; expansion of SNIP code library â€“ find more good PN spreading codes compatible with SNIP library; bandwidth efficient ranging â€“ how to combine ranging with higher order modulations. Technology target is a demonstration at TRL 5.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 hardware and software demonstration and deliver a demonstration unit or software package for NASA testing at the completion of the Phase 2 contract.

The proposer to this subtopic is advised that the products proposed may be included in a future small satellite flight opportunity. Please see the SMD Topic S4 on Small Satellites for details regarding those opportunities. If the proposer would like to have their proposal considered for flight in the small satellite program, the proposal should state such and recommend a pathway for that possibility.