



NASA SBIR 2011 Phase I Solicitation

01.03 Game Changing Technologies

Lead Center: GRC

Participating Center(s): ARC, JSC

NASA seeks revolutionary, highly innovative, game changing communications technologies that have the potential to enable order of magnitude performance improvements for space operations, exploration systems, and/or science mission applications. Research is geared towards far-term research focused in (but not limited to) the following areas:

- Develop novel techniques for size, weight, and power (SWAP) of communications systems by addressing digital processing and logic implementation tradeoffs, dynamic power management, hardware and software partitioning. Address high-speed, high resolution, low power consumption, and radiation tolerance (e.g., SiGe) to support near Earth and deep space mission environments. Investigate and demonstrate novel technologies to alleviate the demanding requirements (3- to- 5X improvement in sampling rate/resolution over state-of-the-art) on analog to digital converters (ADCs) and digital signal processors (DSPs).
- Develop technologies to evolve NASA communication networking and radio capabilities to autonomously sense and adapt to their environment, detect and repair problems and learn as they operate. Nodes will be dynamically aware of state and configuration of other nodes and adapt accordingly. Communications and navigation subsystems on future missions will interpret their situation on their own, understand their options, and select the best means to communicate or navigate.
- High-performance, multifunctional, nano-structured materials are of interest for applications in human spaceflight and exploration. These materials (notably single wall carbon nanotubes) exhibit extraordinary mechanical, electrical, and thermal properties at the nanoscale and possess exceptionally high surface area. The development of nano-scale communication devices and systems including nano-antennas, nano-transceivers, etc. are of interest for nano-spacecraft applications.
- Quantum entanglement, quantum key distribution or innovative breakthroughs in quantum information physics. Address proposed revolutionary improvements in communicating data, information or knowledge. Methods or techniques that demonstrate extremely novel means of effectively packaging, storing, encrypting, and/or transferring information are sought. Significant development is needed in high flux single photon sources and entangled pair sources for highly efficient, free space communications.
- Small spacecraft, due to their limited surface area, are typically power constrained, limiting small spacecraft communications systems to low-bandwidth architectures. Technologies and architectures, which can exploit

commercial or other terrestrial communication infrastructures to enable novel smallsat missions to enable a wider variety of space missions are desired. Address how existing communications architectures can be adapted and utilized to provide routine, low cost, high bandwidth communications capabilities for spacecraft to ground, and spacecraft to spacecraft applications.

- Ultra wide-band (UWB) technology is sought to support robotic localization of surface assets. Whether two-way ranging (time -of-flight) or time-difference of arrival, the ability to synchronize the receivers determine the localization accuracy. Efficient Media Access Control (MAC) and networking protocols are paramount to ensure power efficiency and scalability. Integrating communications and positioning in an ad hoc network can indeed enable situational awareness, keeping track of location and relative position to other astronauts, robots, and vehicles at any time through visual and/or audio cues. Because initial synchronization or signal acquisition for Impulse Radio Ultra-Wide Band (IR-UWB) using equivalent-time sampling takes a long time especially for low pulse repetition rate systems, precise timing and coherent reception demand more power consumption and complexity than non-coherent IR-UWB. To maintain clock stability, most IR-UWB systems do not power down the receivers during operation. Narrower pulse width spreads the RF energy over a wider bandwidth but generation of precise low jitter (
- Develop methods for use of neutrinos for communications, timing, and ranging. Neutrinos are small, near light speed particles with no electric charge. Since neutrinos travel through most matter, they could be used for extreme long-distance signaling. Detection of neutrinos currently require massive underground liquid detectors. Highly innovative concepts, methods, techniques to enable neutrino based communication, ranging, timing, are sought.

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

Phase I Deliverables: Deliverables expected at the end of Phase I include trade studies, conceptual designs, simulations, analyses, reports, etc. at TRL 1-2.

Phase II Deliverables: Demonstrate performance of technique or product through simulations and models, hardware or software prototypes. It is expected that at the end of the Phase II award period, the resulting deliverables/products will be at or above TRL 3.