NASA seeks revolutionary, highly innovative, "transformational" communications technologies that have the potential to enable order of magnitude performance improvements for exploration systems, science, and space operations mission applications. The promise of high-performance, multi-functional, nano-structured materials has led to intense interest in developing them for near-term applications for human spaceflight and exploration. These materials, notably single wall carbon nano-tubes, exhibit extraordinary mechanical, electrical, and thermal properties at the nano-scale and possess exceptionally high surface area. The development of ultra-capacitors and nano-scale communication devices and systems including FET arrays, nano-antennas, nano-transceivers are of interest for nano-space applications.

Phase 1 must convincingly show the proposed technology will have performance better than the equivalent legacy technology. For example, for a fixed-SAW oscillator part replacement, specific objectives include low power consumption (10 dBm), low spurious output (harmonics attenuated by 30 dBc), low-voltage operation (}

Research interests focus on, but are not limited to, the following areas:

- Innovative methods of using X-ray or radio pulsar signals for precise navigation or positioning of spacecraft.
- Small, low mass, reliable detectors, improvements in position accuracy, digital signal processing advances for time of arrival, drift estimation, and position estimation.
- Development of nano-scale communication devices and systems (e.g., FET arrays, nano-antennas, nano-transceivers, etc.), which can enable nano-spacecraft applications.
- Quantum entanglement or other innovative breakthroughs in quantum information physics to specifically
address curious effects and critical unknowns relevant to revolutionary improvements in communicating data, information or knowledge between independent entities across space-time are sought.

- Methods and techniques to demonstrate extremely novel means of effectively packaging, storing, encrypting, and/or transferring information or knowledge.

- Breakthrough power-efficiency in communications brought about through the use of natural phenomenon (e.g., soliton pulse/wave/energy propagation).

- RF Micro Electro-Mechanical Systems (MEMS) devices. Besides low spatial volume, lightweight, and low-power consumption, these devices are also attractive to operate as high Q components and perform frequency selectivity - namely, agile pre-selectors, multi-couplers, and diplexers. Selectivity, or Q, for band pass filters currently comes at an unacceptably high penalty in size and mass. For example, most high rejection diplexers for space-based radios are almost as enormous as the modern radio package itself. To build and design high performance, tightly coupled, low volume space radios, compact selectivity-determining devices are a critical enabler. Most high Q filters above 400MHz, such as inter-digital filters and others involving resonant cavities, are wholly mechanical assemblies which can be “folded” in their design and lend themselves to micro machining techniques.

- Other rich areas of investigation may lie within the area between MEMS and Micro-Machined devices, including electromechanically tuned filters, 3D micro machined RF resonators, filter configurations consisting of cantilevered structures, as well as carbon nano-tube waveguides. Develop, apply and demonstrate advantages of RF MEMS circuitry that proliferate the implementation of next-generation lightweight communications systems (e.g., extravehicular activity (EVA) radios).