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. As NASA moves towards an integrated network architecture, infusion of critical, enabling technologies will be key to meeting user needs and offering standardized services. Emphasis for this subtopic is on the mid - (3-8 yrs.), and far-term (>8 yrs.) with focused research in 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 reliability, robustness, and radiation tolerance for missions beyond low Earth orbit. Investigate and demonstrate unique, innovative electronic or optical technologies to alleviate demanding mission requirements (at least 10X improvement over state-of-the-art) in areas such as chip speed, compression, encoding/decoding, etc. Communication systems optimized for energy efficiency (information bits per unit energy) will be increasingly important for low energy communication systems.

Small spacecraft, due to their limited surface area, are typically power constrained, limiting small spacecraft communications systems to low bandwidth architectures. Technologies and architectures that can exploit commercial or other terrestrial communication infrastructures to enable novel small satellite (e.g., CubeSat) missions are desired. Identify advanced solutions for higher density integration techniques and packaging. Address how existing communications architectures can be adapted and utilized to provide higher bandwidth communications capabilities with better performance and at lower cost for spacecraft to ground, and spacecraft to spacecraft applications.

Novel approaches to addressing extremely high bandwidth, high data rate signaling using RF, mm-wave (Kα- to W-band), and/or optical (1550 nm) links.) Purely optical links are subject to atmospheric interference (clouds, rain, snow, fog, etc.) and can restrict operations for Earth-based optical terminals, so hybrid RF/optical systems are intriguing. Technologies that address flexible, scalable digital/optical core processing topologies to support both RF and optical communications in a single dual-feed terminal, such as: programmable modulation/coding, multi-rate clocking and data recovery, system-on-a-chip integration, memory management, multi-processor architectures, etc. are sought to mitigate risk of such a system.
For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path towards Phase II demonstration with delivery of a demonstration unit or package for NASA testing at the completion of the Phase II contract.

Opportunities and plans should also be identified and summarized for potential commercialization.

*Phase I Deliverables* - Phase I deliverables shall include a final report describing design studies and analyses, system, sensor, or instrumentation concepts, prospective formulations, testing, etc. Prototype systems, components, sensors, instruments or materials can be developed in Phase I as well. The designs or concepts should have commercialization potential. For Phase II consideration, the final report should include a detailed path towards Phase II proof-of-concept system or component or testing as applicable. The technology concept at the end of Phase I should be at a TRL range of 2-3.

*Phase II Deliverables* - Phase II deliverables shall consist of working proof-of-concept systems, samples, component, sensor, or instrumentation hardware, etc. which have been successfully demonstrated in a relevant environment and delivered to NASA for testing and verification. The technology at the end of Phase II should be at a TRL range of 3-4.

Potential NASA Customers include:

- Deep Space Planetary Missions.
- Extra Vehicular Activity Office.
- Space Suit Communications.
- Space Communications and Navigation (SCaN) Program.