



NASA SBIR 2017 Phase I Solicitation

Z8.02 Small Spacecraft Communication Systems

Lead Center: GRC

Participating Center(s): ARC, GSFC, JPL, JSC, LaRC, MSFC

Technology Area: TA5 Communication and Navigation

Space communications is an enabling capability to conduct NASA missions. Communications systems should impose the least possible constraints on mission spacecraft in order to meet required performance. Innovations and novel approaches are sought to reduce the mass, power consumption, volume, and operational constraints in order to increase the total data return, advance the technology readiness level, and reduce the cost and risk of communications systems for small spacecraft (generally considered to be on the order of 180 kg or less). Small spacecraft communication systems must be increasingly robust, flexible and diverse to support a wide variety of stand-alone and interconnected missions used by NASA to conduct space science, Earth science and exploration of the universe. Communication system components need to be able to operate over a range of environmental conditions, such as those imposed by launch vehicles and operations in space with appropriate levels of radiation tolerance. Infusion of new technologies or best commercial standards and practices (e.g., DVB-S2 standard, CubeSat form factors) that can demonstrably improve performance and be applied or adapted for use in Government, non-Government or commercial networks is desirable.

Proposals for innovations and advancements in technology readiness are sought in any of the following areas of small spacecraft communications systems:

- *High-gain Antennas (HGAs)* - Development of HGAs are sought across a broad range of technologies including but not limited to deployable parabolic or planar arrays, active electronically steered arrays, novel antenna steering/positioning subsystems, and others suitable for use in high data rate transmission to, from and among small spacecraft. Operations compatible with NASA's space communications infrastructure¹ and Government exclusive or Government/non-Government shared frequency spectrum allocations (e.g., 25.5-27.0 GHz) is required. However, applicability or adaptability of the HGA technologies to non-Government use spectrum is also desirable [See References for applicable Government frequency spectrum allocations in the near Earth and deep space regions].
- *Transceivers and Radios* - This area includes but is not limited to: radio frequency (RF) transmitters; amplifiers; low noise receivers, full duplex frequency selectable RF front-ends, integrated Global Navigation Satellite Service (GNSS) receivers, software defined or reconfigurable radios, or integrated transceivers and radios for links to relay satellites or direct to ground stations. In addition to reductions in mass, power consumption, volume and cost, increases in power and bandwidth efficiency, operational flexibility and frequency select-ability are sought. Small spacecraft transceivers and radios must be compatible with the operations of NASA's space communications infrastructure.¹ [See References for applicable NASA near Earth and deep space infrastructure guidelines and specifications].
- *Network and Application Service Protocols* - Standard Internet protocols don't work well over communication links that are subject to the frequent, transient service outages and/or long signal

propagation delays that are characteristic of space flight communications. Innovations or advancements are sought in software and hardware systems that implement NASA's delay/disruption tolerant networking (DTN) standards to support scalable, robust mission communications for small spacecraft missions. Implementation of protocols to enable low-power application communications among clusters of small spacecraft are also invited (e.g., Constrained Application Protocols, CoAP) [See References for applicable NASA and commercial networking standards].

- *Optical Communications* - One-way optical communications for direct data downlink from small spacecraft can provide a useful communications mode for NASA and non-government missions while avoiding some of the complications associated with a two-way optical link (i.e., requiring an uplink beacon). Technology advancements or system-level solutions (i.e., space and ground segment components) are sought that increase the data rate or availability of optical communications for small spacecraft, or reduce mission risk, complexity or cost.

A typical approach to advance the technology readiness level (TRL) leading to future flight hardware/software demonstration of any of the small spacecraft communications technologies would include:

Phase I - Identify, evaluate and develop candidate small spacecraft communications technologies that offer potential advantages over the state of the art, demonstrate their technical feasibility, and show a path towards a hardware/software infusion into practice. Bench-level or lab-environment level demonstrations or simulations are anticipated deliverables. The Phase I proposal should outline a path that shows how the technology can be developed into space-qualifiable and commercially available small spacecraft communications systems through Phase II efforts and beyond.

Phase II - Emphasis should be placed on developing and demonstrating the candidate technologies under simulated small spacecraft spaceflight conditions or in the relevant environment. A demonstration unit for functional and environmental testing is an anticipated deliverable at the completion of the Phase II contract. Some of the products resulting from this subtopic may be included in a future flight opportunity for on-orbit testing or application demonstration.

All technologies developed under this subtopic area should be compatible with existing NASA space communications infrastructure¹, frequency spectrum allocations, and applicable standards. However, applicability or adaptability to non-Government and commercial use as well is desirable.

(1) NASA's space communications infrastructure includes the Near-Earth network (NEN) of ground stations, the Space Network (SN) of tracking and data relay satellites in geostationary Earth orbit, NASA's Deep Space Network (DSN) of ground stations, and other assets such as the Wallops range ground station.

References – Please see the following references for more details:

- NASA Spectrum Policy: http://www.nasa.gov/directorates/heo/scan/spectrum/policy_and_guidance.html.
- Spectrum Guidance for NASA Small Satellite Missions: http://www.nasa.gov/sites/default/files/atoms/files/spectrum_guidance_smallsats_cubesats_2015.pdf.
- Near Earth Network (NEN) Users Guide: <https://esc.gsfc.nasa.gov/space-communications/nimo/reference.html>.
- Space Network Users' Guide (SNUG): <https://esc.gsfc.nasa.gov/space-communications/nimo/reference.html>.
- Deep Space Network (DSN): <http://deepspace.jpl.nasa.gov/advmiss/missiondesigndocs/>.
- Delay/Disruption Tolerant Networking (DTN):
 - NASA DTN: <http://www.nasa.gov/content/dtn>.
 - InterPlanetary Networking Special Interest Group (IPNSIG) DTN www.ipnsig.org.
- Constrained Application Protocol (CoAP):
 - Internet Engineering Task Force (IETF) Constrained RESTful environments (CoRE) Working Group: <http://datatracker.ietf.org/wg/core/charter/>.
 - IETF RFC 7252: <http://tools.ietf.org/html/rfc7252%20h>.