



NASA STTR 2016 Phase I Solicitation

T5.01 Autonomous Ka-band Spacecraft Terminals

Lead Center: GRC

Participating Center(s): GSFC

This subtopic focuses on the ability of small spacecraft to autonomously connect and communicate with other approved spacecraft, relays, and ground terminals in a manner that ensures compliance with NASA communications and software defined radio standards, access protocols, and frequency spectrum constraints. Innovations are sought to increase the autonomy, flexibility and performance of Ka-band spacecraft terminals while reducing their cost, size, mass, power consumption and thermal and vibrational impact on user spacecraft. Advances in compact directional antennas, flexible software defined radios (SDR) or software transceivers (SDT), and autonomous communications terminal operations will enable small spacecraft to establish communications with existing and emerging NASA space relays and ground terminals, as well as other approved spacecraft within the network. Automation embedded into the user terminals will help ensure efficient use of all available Ka-band communications capacity and mitigate potential for interference.

Background

Future missions will need higher data rates, more opportunities to transmit and receive data, lower communications burden on the spacecraft, and flexibility and automation where practicable to reduce human intervention. To reduce life-cycle development cost and schedule, NASA missions are trending toward smaller spacecraft and clusters of spacecraft to accomplish mission objectives. Autonomous communications operations in Ka-band frequencies will enable higher data rates, better utilization of existing and emerging NASA and commercial infrastructure, increase instantaneous use of available relay and ground network capacity, mitigate potential for interference.

Programmatic Relevance

NASA's Space Communications and Navigation (SCaN) Program has been deploying Ka-band service capabilities into near Earth relays and near Earth and deep space ground terminal infrastructure to enable NASA missions to help reduce congestion in lower frequency bands. This migration also leverages significant commercial investments in Ka-band communications technologies over the past two decades. However, the lack of innovative, commercially sourced low-cost, autonomous user terminals has hindered mission movement into Ka-band with the exception of a few custom, one-of-a-kind, mission specific terminals. Compliance with SCaN's Space Network (SN) and Near Earth Network (NEN) User Guides and NASA Space Telecommunications Radio Systems (STRS) standards will enable new missions based on small spacecraft and clusters of spacecraft to operate with high performance and lower cost than one-of-a-kind solutions. Compact, agile Ka-band antennas will enable uplinks, crosslinks and downlinks with a wide range of space and ground assets. Enabling cost-effective operations especially for small spacecraft in NASA's Ka-band frequency spectrum allocations will help ease congestion in current bands (e.g., UHF/VHF, S-band, X-bands and unregulated spectrum), and enable higher data rates and a higher return on NASA and commercial investments in Ka-band geostationary relays and ground terminals.

Technology Advancement Goals

Proposed advancements are encouraged in, but are not limited to, any or several of the following capabilities. Autonomous integrated terminals: Agility across and compliance with NASA Ka-band space-space and space-ground frequency spectrum allocations autonomous pointing, tracking, and communications with known or discovered relay, ground and/or proximity assets; autonomous optimization of data throughput based on predicted or sensed link conditions; flexible use of antenna and transceiver gains to cover a range of operating conditions; minimal impact on user spacecraft; cost-effective implementation; clear path to space qualifiable implementation. SDTs: NASA STRS compliant implementation; NASA space and ground infrastructure compliant; variable and/or adaptive coded modulation and data rates; autonomous link margin optimization; compact, low-mass, power efficient. Ka-band Antennas: electronically steered, scanned or switched directional beams; potential for multiple simultaneous beams; isoflux beams for space-ground links; hemispherical or omni coverage for proximity and non-directional conditions; small size or compact deployable; low mass, low power consumption; low cost.

Research Institution (RI)/Small Business (SB) Collaboration Goals:

The goals of this collaborative effort are to:

- Select practical advancements from a range of autonomous operations technologies, SDT approaches, and innovative antenna concepts; and
- Refine, integrate and demonstrate the potential of those advancements in response to the unique needs and practical constraints of small spacecraft operating within NASA's Ka-band space and ground infrastructure.

Collaboration between the RI and SB should allow for rapid TRL advancement into practical autonomous communications terminals that are flexible and commercially realizable.