NASA SBIR 2008 Phase I Solicitation

O1.08 Lunar Surface Communication Networks and Orbit Access Links

Lead Center: GRC

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

This solicitation seeks to develop a highly robust, bidirectional, and disruption-tolerant communications network for the lunar surface and lunar orbital access links. Exploration of lunar and planetary surfaces will require short-range (~1.6 km line-of sight, ~5.6 km non-line-of-sight) bi-directional, and robust multiple point links to provide on-demand, disruption and delay-tolerant, and autonomous interconnection among surface-based assets. Some of the nodes will be fixed, such as base stations and relays to orbital assets, and some transportable, such as rovers and humans. The ability to meet the demanding environment presented by lunar and planetary surfaces will encompass the development and integration of a number of communication and networking technologies and protocols. NASA lunar surface networks will be dynamic in nature, and required to deliver multiple data flows with different priorities (operational voice, command/control, telemetry, various qualities of video flows, and others). Bandwidth and power efficient approaches to mobile ad hoc networks are desired. Quality of Service (QoS) algorithms in a Mobile Ad hoc NETwork (MANET) setting will need to be developed and tailored to NASA mission specific needs and for the lunar surface environment.

These lunar and planetary surface networks will need to seamlessly interface with communications access terminals and orbiting relays that also can provide autonomous connectivity to Earth based assets. The access link communications system will encompass the development and integration of a number of communications and networking technologies and protocols to meet the stringent demands of continuous interoperable communications. Human exploration, therefore, requires the development of innovative communication protocols that exploit persistent storage on mobile and stationary nodes to ensure timely and reliable delivery of data even when no stable end-to-end paths exist. Solutions must exploit stability when it exists to nearly approximate the performance of conventional MANET protocols. The lunar surface communications network must support 15 simultaneous users with aggregate bandwidth of 80 Mbps. It must also support minimum data rates of 16 kbps and maximum data rates of 20 Mbps and be IP compatible with a BER of 10e-8 or less, and graceful degradation. Frequency bands of interest are UHF (401 - 402 MHz, 25 kHz bandwidth), S-band (2.4 - 2.483 GHz), and Ka-band (22.55 - 23.55 GHz).

Core capabilities:

- Short range access point, base stations, and wireless router bridges for extending surface network coverage;
- Non-line-of-sight communication between stationary and moving assets, outside or inside lunar craters without using orbiting assets;
- Analog voice-only radio service to the lunar outpost and the lunar relay satellite at the highest network priority for HF, UHF, or S-band for reliability;
- Support multiple bandwidths for telemetry, voice, and high-rate video;
- Ability to determine the QoS, channel, and interference information;

- Autonomously reconfigurable receivers capable of automatic link configuration and management;

Proposals should address the following areas:

- Disruptive and delay-tolerant networking (DTN);
- Networking algorithms and adaptive routing;
- Extra-Vehicular Activity (EVA) radio.

The following technologies are addressed under other SBIR Subtopic solicitations:

- Antennas for surface and orbital access communications required for the aforementioned goals shall be developed under subtopic O1.02;
- Radios for surface and orbital communications required for the aforementioned goals shall be developed under subtopic O1.03;
- Optical transceivers required for the aforementioned goals shall be developed under subtopic O1.06;
- Any high rate, low power, efficient amplifiers or transponders required for the aforementioned goals shall be developed under subtopic O1.07.

Development Timeline: After a possible Phase 3 development activity, these technologies are expected to ready for insertion at TRL 6 by 2014. To meet the schedule for NASAâ€™s Vision for Space Exploration (VSE), a TRL progression from an entry TRL of 1-2 for Phase 1 in January 2009 followed by an exit TRL of 3 - 4 after Phase 2 is required.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward Phase 2 hardware and software demonstration and delivering a demonstration unit or software package for NASA testing at the completion of the Phase 2 contract.

Phase 1 Deliverables:

Propose a robust lunar surface and orbit access communications network suitable for the applications and environment. Address all technical challenges, pitfalls, and tradeoffs of the network size, assets, and power as well as reliability, complexity, and performance. Solutions should encompass a notional architecture, functional requirements, and building block concepts, demonstrating a reliable and simultaneous voice, telemetry, and video transmission as well as reconfigurability across multiple applications and frequency bands.

Develop suitable communication algorithms capable of demonstrating the feasibility of the approach. Based on a minimum of three (3) nodes, simulate the performance of the proposed integrated communications network architecture and analyze the selected implementation strategy. Identify required parameters for the network architecture and quantify performance in terms of energy savings, connectivity, and throughput in a mobile ad hoc network.

Phase 2 Deliverables:Â

Develop a communications network with multi-functional capabilities described in above. Further enhance the concepts investigated in Phase 1 and demonstrate the feasibility of the approach on an actual platform.

Fabricate and test a prototype communications network with a minimum of three (3) nodes using an active integrated communication network. Simulate and refine power software algorithms for real time robust operations and characterize system performance in compliance with the design goals outlined in Phase 1.

The proposer to this subtopic is advised that the products proposed may be included in a future small satellite flight opportunity. Please see the SMD Topic S4 on Small Satellites for details regarding those opportunities. If the proposer would like to have their proposal considered for flight in the small satellite program, the proposal should state such and recommend a pathway for that possibility.