CAL POLY

SAN LUIS OBISPO

AERO 447-449

AY2019-2020 - Request For Proposal

NASA Small Spacecraft Technology Program[†]

Infrastructure Development In Support Of Lunar Settlement

NASA Small Spacecraft Technology Program's primary objective is to identify and support the development of new subsystem technologies to enhance or expand the capabilities of small spacecraft, while also supporting flight demonstrations of new technologies, capabilities, and applications for small spacecraft. Small spacecraft can be used as platforms for testing and demonstrating technologies and capabilities that might have applications in spacecraft and systems of any size.

As part of NASA efforts to have human and commercial operations on the Moon by 2024 through the Gateway program, the Small Spacecraft Technology Program is supporting research efforts to develop innovative and low cost approaches to telecommunication and navigation capability at the Moon. The first lunar capability of interest is to provide full coverage telecommunications at any time between the Moon and Earth. The second capability of interest is to provide full coverage navigational information for assets on the lunar surface. Initial operational capability shall be reached by CY2023 and full operational capability shall be reached by CY2025.

For each capability, participants will identify critical operational and technological gaps in existing spacecraft technologies; formulate innovative cross-disciplinary approaches for addressing technology challenges, demonstrate the proposed methodology to design and development through novel, transformative and cost-effective technological solutions that achieve significant improvement in performance over current state-of-the-art spacecraft technology.

For the full coverage telecommunications capability, the performances sought after are global (99.8% of surface, allowing for exclusion steep pit craters) and continuous (99.9% up time) of telecom coverage with:

- Real time (light-time delay + less than 0.25 seconds) relay of data from an antenna on or within +100 meters of lunar surface, to an antenna on the Earth surface with parameters as described below.
  - *Full operational capability* - Simultaneous support of six sites distributed about the Moon, with each site having three separate co-located sources of 5 Mbps (video + data) uplink (from Moon) and 500 kbps downlink (to Moon).
  - *Initial operational capability* - A single site with two separate co-located sources of 5 Mbps (video + data) uplink (from Moon) and 500 kbps downlink (to Moon).
  - Real time BER of 10^{-7}.
- Non-real time store and forward (within two hours of transmission) relay of data between an antenna on or within +100 meters of lunar surface to an antenna on the Earth surface with parameters as described below.
  - *Full operational capability* - Simultaneous support of ten sites distributed about the Moon, with each site having ten separate co-located sources and sinks for 2 Mbps uplink and downlink with up to 100 Gb per 24 hour period.
  - *Initial operational capability* - Simultaneous support of two sites distributed about the Moon, with each site having four separate co-located sources and sinks for 2 Mbps uplink and downlink with up to 100 Gb per 24 hour period.
  - No data loss across the space link.

[†]This request for proposal was not written by NASA Small Spacecraft Technology Program. The program name is used as a 'simulated customer' for the 2019-20 senior spacecraft design class of California Polytechnic State University, San Luis Obispo, CA.

For the full coverage navigational information capability, the performances sought after are global (99.8% of surface, allowing for exclusion steep pit craters) and continuous (99.9% up time) of navigation coverage with real time position within:

- +/- 5 meters for latitude and longitude;
- +/- 8 meters altitude above lunar geoid; and
- +/- 1 degree heading error from lunar spin axis.

Note 1 **-** *A proposal that can reach mobile communication antennas up to 1000 km altitude above the surface (orbital or on ascent/descent to the surface) will receive an additional score during evaluation, based on throughput of real time vs non-real time capability (communications), accuracy (navigation), and altitude (both communications and navigation).*

Note 2 **–** *Regarding the handling of the system's ownership, the proposed solution shall include evaluation of both a deliverable system to NASA and fee-for-service system.*

The participants will also work collaboratively to identify and define the scope of the engineering and technology challenges relating to the outer space ethics and policy.

A system requirements review will be held for both capabilities at the end of November (exact date is TBD) and the capabilities' preliminary design review will be held on June 5, 2020.

For further inquiry, contact Mahina Coleman, Lunar Services Program Executive, at the following email address: aerocustomer@calpoly.edu.

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