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THE SOUTH POLE UTILITIES AND DATA INFRASTRUCTURE (SPUDIS)

Abstract

The next grand challenge for the Moon (as the challenge of transportation is overcome) is survival and operations in the cold darkness, during the lunar night, and in regions that are shaded, permanently or intermittently. Solar Power and Communication Relay towers (SPOTS) are robotic systems that deploy large reflectors and solar arrays, unfolding from compact packages to become heliostats that redirect and control sunlight, or concentrate, convert or project energy to power and heat robots and human habitats/bases; could also act as communication relays.

A network of SPOTS placed at favorable sunlight locations, in the South Pole region of abundant sunlight, supplemented by energy storage solutions could ensure practically uninterrupted energy over tens of kilometers of a solar power infrastructure at the Moon's South Pole, - referred here as the South Pole Utilities and Data Infrastructure (SPUDIS).

The energy projected by SPOTS extends lifetime of assets in the shade or night; it would power prospector rovers sent to characterize water reservoirs, ISRU equipment, or construction equipment, in shaded regions, or in general where more heat and power is needed, kilometers away from towers. They enable the exploration of permanently shadowed regions, such as Shackleton Crater (SC).

Our vision is to advance the technology of SPOTS that passively redirect sunlight (or concentrate, convert and project energy at longer distances) to power and heat robots and human habitats or bases, therefore providing an enabling critical link in the lunar exploration architecture. In long term SPUDIS would be an enabler for a future lunar economy, by lowering the barriers of entry to many companies that would be able to fly to the Moon lower cost equipment, which would be designed for benign rather than for extreme environment, as heat and power would be provided as a utility. As opposed to the existing mode of operation in which every asset comes with its own power and heater, a new business model emerges where power and thermal is provided as a utility service and payment is at use time, based on need or consumption. Businesses entering the lunar economy would not incur upfront costs for thermal and energy needs, charged regardless the mission arrives successfully at destination or crashes at landing, but instead start incurring costs only when mission is on the lunar surface and ready to operate.

The paper presents design consideration for a small SPOT prototype that would provide a technology advancement to TRL 5 in preparation for flight demo. The mini-SPOT in intended to fit the requirement of small landers, through funding via Commercial Lunar Payload Services (CLPS) Program. In particular this is targeted to be below 10 kg, with a combined total surface of reflector and solar panel of over 6 square meters, and a mobility platform able to take it in a few km traverse from a landing location on the Spudis Ridge to the rim of Shackleton Crater. At a distance of 3 km away the SPOT should reflect sufficient heat to keep a small (Sojourner-size) rover, or a payload, hibernating without freezing during the lunar night (about 15W).