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IN-FLIGHT DEPLOYED PAYLOAD SWARMS FOR LUNAR SURFACE EXPLORATION

Abstract

Through observational data collected by lunar orbiting spacecraft including Clementine, Kaguya, and Chandrayaan-1, remote-sensing missions have collected some evidence of proposed water ice deposits in craters and permanently shadowed regions (PSRs) at the Moon's poles. This information has been crucial to promoting ground truth data collection across the lunar surface, a key enabler to a sustainable lunar architecture. The initiative, however, has been constrained by past rover and human exploration missions which have been primarily destined to the equatorial and low latitude regions of the Moon. Polar cold traps and some PSRs offer higher probability of containing water ice, sites mainly located at the lunar poles that require further investigation. U.S. policy calls for NASA, with commercial and international partners, to deliver "the first woman and next man" to the lunar south pole. In order to fulfill this directive and support the furthering of humans in deep space, the identification and classification of resources along with the characterization of the surface and underlying layers must be accessed in order to promote this initiative going forward.

The deployment and distribution of Deployed Untethered Swarm Trackers and Expendable Explorers (DUSTEE), a lunar payload stowed and launched in-flight via a CubeSat deployer, can provide NASA along with international and commercial partners a new service for gaining access and collecting data on the extreme lunar terrains. Deployed across the surface, these low-mass spherical payloads are designed to survive high impact forces from various altitudes during a spacecraft's powered descent phase. Once on the surface, the system's swarm-based communications mesh network is equipped to handle an array of autonomous surface and subsurface capabilities, driving expansive regional coverage for acquiring remote data and telemetry on various science targets and security commodities (e.g. navigation, communications, surface power, space situational awareness). Each DUSTEE payload is designed to be easily configurable to the customer's needs, from the system-level swarm count to the sensor suite assignment for each individual payload, promoting customizable and cost-effective options for exploring vast stretches of the Moon from a variety of surface-bound spacecraft.