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THE PHOBOS L-1 OPERATIONAL TETHER EXPERIMENT

Abstract

The Phobos Lagrange-1 Operational Tether Experiment (PHLOTE) is a mission study that was selected by the NASA Advanced Innovative Concepts (NIAC) program for a Phase 1 study in 2017. The PHLOTE concept places a spacecraft in orbital hover mode at the Mars-Phobos L1 point just a few kilometers above the Mars facing side of Phobos. From this location it can perform long term science observations of both Mars and Phobos. For direct measurements of Phobos, the spacecraft will lower a tethered sensor package that can be temporarily parked at different locations below the L1 point. The PHLOTE mission utilizes new technologies such as the Navigation Doppler Lidar (NDL), Electrospray Thrusters, and tether length control to enable long term operations at this unstable orbital location. While the tethered sensor platform is parked on the surface of Phobos, PHLOTE is in a configuration that could perform an actual demonstration of an operational space elevator. This demonstration would be an important technology first and provide an important testbed for verifying existing space elevator simulations and models. The PHLOTE NIAC Phase I study developed a credible mission and spacecraft design and also provided analysis results that provide confidence that a PHLOTE spacecraft could perform long term hover mode station keeping at the Mars-Phobos L1 point using new technologies that have become available. Low level simulations were developed that utilize a novel method of "tether length control" to manage the periodic motion of the L1 point due to Phobos' slightly eccentric orbit without expending large amounts of propellant. During the study, spacecraft models were developed based on existing components so that credible mass, power and cost estimates could be developed. The spacecraft design developed in Phase 1 provides a foundation for the development of higher fidelity spacecraft models and higher fidelity simulations of L1 station keeping. Since a PHLOTE mission would have great benefits to the science, exploration and technology development communities, it is believed PHLOTE would be a strong candidate for a future mission opportunity.