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SELENE: A NOVEL CONCEPT FOR AUTOMATIC TRANSPORT SYSTEM FROM LOP-G TO THE MOON

Abstract

SELENE (Spacecraft and payloads deployment in Lunar environment from LOP-G) project aims to

develop a novel transport system for Lunar exploration, in response to the growing interest in the Lunar Space Economy. The innovative system is conceived as an additional automatic module of the Lunar Orbital Platform-Gateway (LOP-G). Consisting of a double module spacecraft, its primary function is to execute payload deliveries within both Lunar orbits and South Pole surface. In short, for a scientific company or a university interested in sending their CubeSats in Lunar orbits or Rovers to the Lunar South Pole, SELENE stands as a convenient solution: it is a reusable "taxi" with the scope of offering customer payloads a ride, departing and coming back at the LOP-G, and ready then to accommodate the next shipment of payloads. Tailored to meet the requirements of a diverse range of clients, including international research institutions, government agencies, and businesses, the idea is to provide a reliable and cost-effective solution for numerous missions, spanning from scientific research to technological demonstrations. As part of this initiative, the lander module is able to transport up to $100kg$ of rovers to the South Pole surface and up to $5kg$ of samples to return to the LOP-G. On the orbiter module, instead, $100kg$ of CubeSats are accommodated and then deployed in Elliptical Lunar Orbits and Low Lunar Orbits. An extra $50kg$ of scientific payloads can be placed onboard, to collect data in orbit or on the surface. A cornerstone of the system design is its emphasis on reusability, aimed at tackling the challenge of space environment pollution and facilitating round-trip missions. This requires meticulous mission profile planning, considering the Circular Restricted Three-Body Problem and leveraging the capabilities of orbital simulators such as the General Mission Analysis Tool (GMAT). Furthermore, the project places a strong emphasis on standardizing accommodation and interface components. It incorporates a comprehensive set of external interfaces that conform to the International Docking System Standard Interface Definition Document and uses reliable solutions to integrate payloads on-board. While SELENE leverages standardized components with proven flight records, it also introduces modifications to enhance the performance and reliability of specific commercial Liquid Rocket Engines and accommodation components to match Lunar travel requirements. Finally, SELENE carefully balances Technology Readiness Level, Reliability, Cost, and Risk Mitigation resulting in a maximum of five annual mission deliveries for a lifetime of 10 years.