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CRATOS: A CIS-LUNAR REUSABLE SEMI-AUTONOMOUS TRANSPORT OPERATION SYSTEM

Abstract

NASA's proposed infrastructure for the next phase of space exploration places a heavy demand to operate in cis-lunar space. The Lunar Orbital Platform-Gateway will serve as the logistics hub of NASA's operations, and will be kept in a near-rectilinear halo orbit. However, currently there is no design in place to enable the further development of cis-lunar space beyond the Lunar Orbital Platform-Gateway. Developed as part of the Revolutionary Aerospace Systems Concepts Academic Linkage (RASC-AL) this paper details the Cis-lunar Reusable semi-Autonomous Transport Operations System (CRATOS) which is a multi-spacecraft system which utilizes a reusable Cis-lunar Transport Tug to bring a wide variety of non-crewed payloads between low lunar orbits and the Lunar Orbital Platform-Gateway. In addition to the tug, CRATOS also consists of an Auxiliary Fuel System with the purpose of refueling the Cis-Lunar Transport Tug to enable extended operations. The single use Auxiliary Fuel System will act as a fuel depot and refueling station, so as to extend the operational life of the tug. The Transport Tug will launch as a co-manifested payload on NASA's Space Launch System (SLS), while the Auxiliary Fuel System will launch separately aboard a readily available heavy-launch vehicle. The performance capabilities, design features, mission phases, use cases, trip frequency, and lifetime of the spacecrafts will further be addressed in this paper. Utilizing the Auxiliary Fuel System, the Transport Tug is designed to be able to move up to three 1000 kg payloads each year with a total life cycle of 15 years, with an extended capability to move a maximum of 9000 kg per trip between several possible lunar orbits, providing a flexible platform for a wide variety of missions and a lifetime commensurate with longer in-space assembly projects. The mission will also provide a safe, human free environment to test in-space refueling methods and automated docking algorithms, providing a real world system to verify software capabilities. Designed for a theoretical 2025 launch date, CRATOS provides a versatile infrastructure for future space projects which can enable satellite repositioning and the assembly of larger cis-lunar projects.