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ENHANCING TECHNOLOGIES AND OPERATIONS FOR SERVICE TRANSPORTATION IN CISLUNAR ENVIRONMENT

Abstract

Future space exploration missions are intended to exploit cislunar environment as effective outpost to advance technology readiness in view of human presence beyond Earth. The forthcoming space projects entail modular large space infrastructures to be available in non-Keplerian orbits, in the Moon vicinity, to run manned and robotic activities. The realization of such a complex space system will require enhanced technologies and operations for the service transportation vehicles, which will be involved as cargo and Earth-Moon transfer spacecrafts.

The paper discusses the peculiarities and the novelties of service missions in Cislunar space, in particular compared to analogous service missions in Low-Earth Orbits (LEO). In fact, the operational orbit in the new space scenario is going to be a Near-Rectilinear Halo Orbit (NRHO), which is dynamically distinct from any existing Keplerian trajectory. Thus, figures of merit of the future service missions are much different from the ones that are known from International Space Station (ISS) heritage. The discussion will be particularly focused on the proximity phases of service transportation missions, including the phasing with the target's staging orbit. Time and delta-V budgets will be presented and compared to those of LEO missions, such as Soyuz, ATV and Dragon. The terminal rendezvous phase will be described, highlighting the sequence of required operations to approach the Cislunar space station. A section of the paper will be analyzing the undocking phase, with the subsequent departure from the target and its NRHO. This sequence of proximity operations is peculiar and somehow different from the approaching one, especially considering the natural Cislunar dynamics that may be leveraged to support the undocking and departure operations.

The discussion is also considering the enabling technologies to support the proposed Cislunar operations. The service transportation system architecture and design are considered, discussing some preliminary requirements for the GNC and the Propulsion subsystems.