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COST-EFFECTIVE IN-ORBIT TRANSPORTATION SYSTEM FOR PRECISE DEPLOYMENT OF PAYLOADS

Abstract

This paper presents the systems engineering of a novel in-orbit transportation system intended for secondary payloads of rideshare launch vehicles. Space rideshare services can transport smaller-sized payloads to orbit on a launch vehicle that is mostly paid for by the entity that contracts and pays for the primary launch. As such, rideshare services provide a less expensive solution to delivering satellites into orbit as secondary payloads. Taking advantage of rideshare options, however, requires tradeoffs since the customer cannot control the orbit or the schedule. Therefore, the secondary payloads most likely end up in orbits that are not ideal for their operations. Instead, the satellites are expected to perform orbital maneuvers using their own propulsion system (if such a capability exists), which are often complex and costly in terms of propellant, and can take a considerable time to reach their target orbits. The novel solution that is proposed in this paper is focused on transferring satellites from where the launch vehicle inserts them into orbit, to where their actual desired final orbits are. This way, the client satellites can avoid the operational complexities inherent to orbital transfer maneuvers, and, more importantly, can conserve their propellant for valuable mission operations and extend their useful mission lifetime, or utilize the freed propellant volume and mass for payload instruments. The proposed spacecraft is equipped with all the necessary sensors and actuators to successfully insert the payload satellites into their precise orbit of interest, and can reach very high altitudes in LEO owing to the onboard low-thrust propulsion system. Also, by virtue of its design, the proposed solution can perform vital services on the payload satellites (while stowed within its bus) such as recharging their batteries, transmitting their telemetry data to ground stations, and regulating their thermal environment. Such a capability would open up venues for additional niche applications such as in-orbit warehousing of payloads (particularly attractive for constellations) as well as removal of dysfunctional satellites from orbit. In this paper, the proposed concept is described in detail, and several numerical simulations are provided to evaluate the viability of such in-orbit transportation services, both from technical and commercial perspectives.