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CONCEPTUAL DESIGN OF A RE-USABLE MULTIPURPOSE TUG WITH GRAPPLING MECHANISM FOR SPACE DEBRIS MITIGATION

Abstract

Commercialization of orbit is on the rise with the increasing potential of Earth Observation data and In-space service commercially and miniaturization of Spacecraft components technically. This caused a steep rise in the number of satellites launched into space as Cubesats of different sizes. This is making the orbits crowdier increasing the chances of collisions making human settlement difficult leading to Kessler syndrome. This paper deals with the conceptual design of a re-usable Space tug to be used as a multipurpose vehicle in Orbital debris removal Orbit transfer vehicle. To reduce the mass at launch of the satellite system, an element pre-deployed on orbit, i.e. the space tug, can be exploited to perform the transfer maneuvers; this allows simplifying the propulsion requirements for the satellite, with a consequent decrease of mass and volume, in favor of larger payloads. The space tug presented here is conceived to be used for the transfer of debris and satellites from low to high orbits, and vice versa, if needed. To support these maneuvers, dedicated refueling operations are envisaged. The paper starts with an overview of the mission scenario, the concept of operations and the related architecture elements. Here the main focus of the design of the space tug is based on the type of propulsion system onboard used with an estimation of availability of resources in space after the commercialization of LEO. Then a detailed requirements analysis is performed to give it capabilities of a multi-purpose vehicle with an innovative grappling mechanism designed by us to capture debris and also load it with satellites to act as a tug. This entire mission design and Space tug design goes through an iterative and recursive design process optimizing according to orbits(for LEO and GEO). The ultimate objective of the research was to create a family of modular, economically feasible space tugs that use a common platform and shared various components, which would allow providing relatively inexpensive and responsive on-demand debris removal and tugging services.