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DESIGN OF A SCALABLE, RELIABLE, COST-EFFICIENT, AND MODULAR DE-ORBIT KIT FOR SPACECRAFT POST-MISSION DISPOSAL

Abstract

A major source of new space debris are spacecraft (S/C) which are not removed after the end of their operational lifetime. Many regulations require the removal of S/C at the end of operation (Post-Mission-Disposal, or PMD) with a success rate of 90%, but the rate of success has been in the range of 50% - 60%. This is due to the extra cost and effort needed to have a built-in PMD capability, the high likelihood of failure in the final stages of an S/C lifetime before a PMD can be commanded, and the tendency of S/C owners to extend operations as long as possible.

TeSeR (Technology for Self-Removal) is a European Commission funded project that aims to take the first step towards the development of a cost-efficient but highly reliable PMD module. This PMD module shall be attached to the S/C on ground and it shall ensure the PMD of the S/C at the end of the nominal operational lifetime or act as a removal back-up in case that the S/C can no longer be controlled. The PMD module shall be scalable and flexible, thus enabling the PMD of any future S/C in an Earth orbit (either de-orbiting or re-orbiting). The primary aim of TeSeR is to develop a PMD module beginning with the exploration of concepts, going for a functional design with the final project aim to manufacture and test an on-ground prototype of the PMD module. In parallel, three different removal subsystems (solid propulsion, drag sail, electrodynamic tethers) will be developed for easy plug-in/plug-out implementation to the PMD module in order to demonstrate the flexibility of the PMD module.

In this paper we describe the design of a versatile, scalable, reliable, cost-efficient, and modular PMD module. We first categorize spacecraft by size and orbit. For each of these cases we present a PMD module that utilizes each of the three removal subsystems given above. Based on the resulting design cases, or variants, we generate a modular design that can perform PMD for all the S/C size classes and orbits considered. We also give a concept of operations for each of the design cases for reliable PMD. Finally we describe the two common interfaces of the PMD module: a first for plugging in each of the three removal subsystems to a PMD platform, and a second for mounting this PMD platform to a host S/C.