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DESIGN OF A RIGID BOOM ELECTRO DYNAMIC/ DRAG-SAIL (RBEDDS) HYBRID DEORBITING SYSTEM

Abstract

The measured and projected growth of space debris makes it clear that technology for the removal of spacecraft at the end-of-life is an absolute necessity if we are to prevent the Kessler syndrome of catastrophic collisional cascading. Electro-dynamic tethers (EDTs) have been proposed as an effective means of deorbiting spacecraft – particularly from low Earth orbit (LEO). Such systems rely on the Lorentz force developed by a long conductive tether cutting through the Earth's magnetic field due to the host spacecraft's orbital motion. The electro-motive force generated drives a current through the tether, which is returned through the local space plasma by some form of active or passive plasma-contacting electrode. This removes (or adds) energy from the spacecraft's motion, causing it to lose (or gain) altitude. As such, EDTs have the advantage of been self-powered, and propellantless, however, to be effective, the tethers typically have to be several km long, and be very thin to save mass. They are therefore flexible and derive their stability through the gravity gradient effect. This leads to such systems being most effective in low-Earth equatorial orbits, and unfortunately, much less effective in near polar orbits (e.g. Sun-synchronous orbit) or for orbits beyond LEO. To this end, we have developed a novel concept for an uncontrolled removal system based on electro dynamical principles. Instead of a long flexible tether (which have proven problematic to deploy), we propose the use of long (150m-300m) rigid electro-dynamic booms in a "bar" or "cross" formation, actively powered, and coated with an electron emissive material. The main advantage of such a structure is that, for satellites in polar orbits, it leads to a larger Lorentz force. Also, the deployment is more reliable and the attitude control is greatly simplified (compared to the use of a flexible tether). To complete the circuit, electrons will be passively collected by a conductive deployable "sail", which will also act as a drag sail at low altitudes. A ground demonstrator is under development based around a 6U CubeSat structure, which could form the basis for a later in-orbit demonstrator. This work is conducted as a part of the European Commission funded Horizon-2020 TeSeR (Technology for Self-Removal) project, which aims to demonstrate the feasibility of a scalable post mission removal system which should be able to be connected to different satellites via a standard interface.