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WHOLESALE LEO DEBRIS CAPTURE AND REMOVAL USING EDDE

Abstract

"EDDE" (the ElectroDynamic "Delivery Express" and "Debris Eliminator") is a new kind of non-rocket space vehicle. It is solar-powered, propellantless, and persistently maneuverable throughout low Earth orbit. EDDE consists mostly of reinforced aluminum foil tape to collect and conduct electrons, plus solar arrays to drive this current. Tape current crossing earth's magnetic field causes the maneuver force. The ambient plasma closing the current loop sees an opposite force. EDDE slowly rotates end-over-end to stiffen itself. This allows sustained high thrust without dynamic instability. Rotation also improves agility, by providing a wider range of thrust directions normal to both tape and magnetic field. The paper discusses recent EDDE design changes that reduce power needs for collecting and emitting electrons, and ease detection and quenching of plasma arcing.

Air drag sets a minimum altitude near ISS (350-420 km). There is no hard ceiling, but current and thrust decrease with plasma density at high altitude. Orbit plane changes are fastest near 500 km. An 80 kg EDDE can support up to 100 kg of payloads in an ESPA slot. EDDE's total orbit change capability far exceeds any single orbit change needed in LEO. After distributing payloads far from a primary payload orbit, EDDE can inspect objects throughout LEO, to image impact features and other anomalies. With suitable capture interfaces, EDDE can repeatedly relocate service vehicles, so they can service far more LEO satellites without running out of propellant.

EDDE's most valuable use may be wholesale removal of orbital debris from LEO. Most of the non-maneuverable mass in LEO that will create most future debris by accidental collision is in 500-3000 kg satellites and spent stages, mostly in long-lived near-polar orbits at 750-1000 km altitude. EDDE can rendezvous with and capture nearly all those objects, using expendable nets. Each net is 15x15 m but weighs only 50 grams, and automatically deploys when the last one is released. EDDE's rotation allows capture even of ton-class objects spinning up to 2 rpm, since the spin energy is too low for the object to climb out of the net. After capture, EDDE can drag an object down and then sling it below ISS while reboosting itself, or deliver it to tethered assemblies at less congested altitudes, for later recycling and/or deorbit. Average removal throughput is roughly EDDE's own mass each day. The paper includes capture dynamics analyses, and we plan capture tests during the presentation.