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DELIVERY OF SECONDARY PAYLOADS TO CUSTOM ORBITS USING EDDE

Abstract

"EDDE" (the ElectroDynamic Delivery Express) is a persistently maneuverable propellantless vehicle for low earth orbit (LEO). EDDE has at least 2 major applications: delivery of secondary payloads to custom orbits, and removal of large debris from congested altitudes. This paper focuses on payload delivery. A paper in session A6.6 focuses on debris removal.

EDDE consists mostly of a multi-kilometer reinforced aluminum foil tape that collects and conducts electrons, plus solar arrays to drive the current. Hot tungsten wires emit electrons back into the ambient plasma, closing the current loop. Thrust comes from the tape current crossing geomagnetic fieldlines. EDDE slowly rotates to tension and stabilize itself. Changing the current around each rotation and each orbit lets EDDE adjust all 6 orbit elements and its rotation axis and rate. This allows persistent thrust without propellant use, and enables precise payload placement and affordable active avoidance of all tracked LEO objects.

Efficient operation requires large electron collection areas and multi-kilometer tape lengths. Air drag sets a minimum altitude near ISS altitude. There is no hard ceiling, but efficient thrust at higher altitudes requires longer and heavier EDDEs. EDDEs as light as 20 kg can do payload delivery, but efficient relocation of ton-class objects from the congested 750-1000 km altitude band may require 80 kg EDDE vehicles.

Secondary payload delivery by EDDE may often start in an orbit near the ISS (51.6 degree inclination, 350-420 km altitude) and end with release of payloads at any desired altitudes, nodes, and inclinations, including 97-99 degree sun-synch orbits. Large inclination and node changes take months and can be done at ISS altitude but anti-phased with ISS, or 100 km above ISS. Once near the desired orbit plane, EDDE can quickly climb to payload release altitudes up to 1000 km. Total secondary payload delivery times of months seem undesirably long, but may be better than months to years of delay and/or uncertainty waiting for a suitable launch directly to a specific desired orbit.

This paper describes EDDE's recently updated modular design, components, and operations; options for stowing and delivering secondary payloads; and current plans for a flight test. The most attractive thing about EDDE to smallsat owners may be "custom orbits without dedicated launch." The payoff to launch service providers is that EDDE makes most surplus payload capacity far more usable.