Paper ID: 23806
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SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Concepts (6)

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EDDE SPACECRAFT DEVELOPMENT FOR ACTIVE LEO DEBRIS REMOVAL

Abstract

EDDE, the ElectroDynamic Debris Eliminator, is a persistently maneuverable propellantless vehicle for low Earth orbit (LEO). EDDE is designed for wholesale removal of large debris from congested altitudes, and it also has applications in delivery of secondary payloads to custom orbits, and delivery and retrieval of service modules for LEO spacecraft. This paper focuses on wholesale debris removal from LEO. 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. EDDE's thrust comes from the tape current crossing geomagnetic field lines. 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 and controlled thrust even in polar orbit, and lets EDDE capture and relocate one object after another for years. Good rotation control also enables gentle capture of large debris in expendable gossamer nets. If EDDE captures ton-class objects at 750-1000 km altitude and releases them into short-lived orbits below the ISS, the average throughput is roughly EDDE's own mass per day, or 30 tons/year for an 80 kg EDDE vehicle. A pair of such EDDEs can fit in one ESPA slot, for secondary payload launch on any Delta 4, Atlas 5, or Falcon 9 launch with payload margin. A full ESPA ring with 12 EDDEs could deorbit most LEO debris mass in well under a decade. We have matured EDDE under a two-year contract with the NASA Space Technology Mission Directorate at Langley Research Center, reaching preliminary design review in March 2014. We developed designs for bifacial terrestrial solar arrays and hot-wire electron emitters, ways to detect and quench high-voltage arcs, and new stowage and deployment concepts. With the Naval Research Lab and Boeing Advanced Space Systems as subcontractors, we also developed ways to track and communicate with agile multi-kilometer spacecraft. This paper describes EDDE's updated modular design, components, operations, and flight test plans for a 12U-class orbital flight experiment from the ISS. That test involves repeated close approaches to selected debris, to quantify rendezvous errors and allow inspection imaging. This should clear the way for later capture tests and use for wholesale debris removal.