

Engineering Challenges for Active Debris Removal

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Recent modeling studies on the instability of the debris population in the low Earth orbit (LEO) region and the collision between Iridium 33 and Cosmos 2251 have underlined the need for active debris removal. A 2009 analysis by the NASA Orbital Debris Program Office shows that, in order to maintain the LEO debris population at a constant level for the next 200 years, an active debris removal of about five objects per year is needed. The targets identified for removal are those with the highest mass and collision probability products in the environment. Many of these objects are spent upper stages with masses ranging from 1 to more than 8 metric tons, residing in several altitude regions and concentrated in about 10 inclination bands. To remove five of those objects on a yearly basis, in a cost-effective manner, represents many challenges in engineering, technology development, and operations. This paper outlines a conceptual end-to-end debris removal operation, including launch, precision tracking, rendezvous, stabilization (of the tumbling targets), capture, and deorbit of the targets; and highlights major challenges associated with the operations. Pros and cons of several proposed removal techniques are also evaluated.