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SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Risk Analysis (2)

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DEVELOPING A TACTICAL ADJUNCT TO ADR TO INSURE A SUSTAINABLE SPACE ENVIRONMENT

Abstract

While active debris removal (ADR) is seen as an essential long-term component of debris remediation, there is a need to have a more responsive mechanism to work in tandem with ADR. Five key facts about ADR provide an impetus for this pursuit of a tactical adjunct. First, ADR does not eliminate risk; it merely transforms orbital risk into a reentry risk. Second, ADR systems will take years for the process to accrue benefits due to the number of removals needed to statistically prevent a single collision. Third, currently there is no operational ADR system. Fourth, ADR requires putting more mass into orbit to remove mass from orbit. Last, it will not provide any assistance in the case of two derelicts on an imminent (hours to days) collision course.

The collision dynamics of clusters (tens of objects within tens of kilometers altitude) of massive (greater than 1,000kg) derelict objects (e.g. spent SL-16 and SL-8 rocket bodies) are further analyzed. As the likelihood of a collision between two massive objects increases, the need for both ADR and a tactical mechanism to prevent an imminent massive-on-massive collision also increases.

As a result, we need to examine other approaches to derelict collision prevention that can be employed when such an event is imminent as a complement to ADR's more long-term, statistical approach. One such potential solution is just-in-time collision avoidance (JCA). JCA would nudge one of the two derelicts out of the collision path of the other object by producing a locally-induced drag effect (possibly through a puff of air) delivered by a ballistic launch. In this way the orbital collision might be prevented without putting any more mass into orbit.

Moving JCA from concept to operations has its own technical challenges to overcome but it represents a broad set of solutions that need to be considered if timely prevention of specific collisions proves more relevant than approaches based on long-term statistical remediation such as ADR. Engineering analyses are summarized for the three major components of the JCA solution: (1) "nudger" design; (2) responsive launch vehicle capabilities; and (3) enhancement to orbital element set accuracy.

Alternatives to both ADR and JCA are introduced in an attempt to open up the aperture of potential solutions to debris remediation.