SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Issues (5)

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GETTING RID OF SPACE JUNK WITH LESS DANGER

Abstract

De-orbit concepts have been proposed for dealing with the growing problems posed by orbital debris despite numerous and pervasive debris mitigation policies enacted and followed internationally. The ability to de-orbit large objects, especially in highly used portions of space like sun synchronous orbits, is becoming critical. This is because a large object is not only more likely to be involved in an accidental collision due to its large collision cross-section but the large mass has the potential to be the source for thousands and thousands of smaller debris if involved in a collision. This issue was underscored by the 2009 collision of a defunct Russian military communications satellite with an operational Iridium spacecraft, which had been in orbit for less than 16 and 12 years, respectively.

Most proposed non-propulsive de-orbit devices use large structures that interact with the atmosphere, magnetic field or solar environment to de-orbit large objects more rapidly than natural decay. Some of these devices may be better than others relative to the likelihood of collisions during their use. Current guidelines attempt to address this risk applying the metric of Area-Time Product (drag area times orbit decay time) to compare the probability of a large object experiencing a debris-generating impact. However, this approach is valid only for collisions with very small debris objects. The peak in the distribution of the area of orbital debris occurs for objects with characteristic size close to 2 m. For collisions with such objects, some of which are operating satellites, it is important to incorporate the augmented collision cross-section area that takes into account the size of both colliding objects when computing Area-Time Product.

This approach to measuring risk leads to a more valid comparison among alternative de-orbit approaches, which now indicates that inflatable drag enhancement devices result in the least risk. In addition, use of this approach for measuring collision risk indicates that drag augmentation devices, in particular, should only be used near periods of high solar activity when they are more effective. Surprisingly, using residual propellant to lower the orbit to an altitude from which it will decay in 25 years has a higher risk of high-energy collisions than most other de-orbit methods. Finally, one de-orbit device, electromagnetic tether, is shown to have a very large collision cross-section for disabling operating satellites and therefore its use should be seriously reevaluated in light of potential liability issues.