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SPACE DEBRIS SYMPOSIUM (A6)
Mitigation and Standards (4)

Author: Dr. Hugh G. Lewis
University of Southampton, United Kingdom

Mr. Adam White
University of Southampton, United Kingdom
Prof. Richard Crowther
Rutherford Appleton Laboratory, United Kingdom
Dr. Hedley Stokes
PHS Space Ltd, United Kingdom

SYNERGY OF DEBRIS MITIGATION AND REMOVAL

Abstract

At the beginning of the twenty-first century there was considerable effort made using evolutionary models to assess the effectiveness of post-mission disposal (PMD) and other mitigation measures to stabilise the growth of the debris population in low Earth orbit (LEO). Subsequently, this activity led to the recommendation of a "25-year rule" for the post-mission disposal of spacecraft and orbital stages intersecting the LEO region. At the time, it was anticipated that the 25-year rule, together with passivation and suppression of mission-related debris, would be sufficient to prevent the continued growth of the LEO debris population. However, in the last decade both the LEO debris environment and the debris modelling capability have seen significant changes. In particular, recent population growth has been driven by a number of major break-ups, including the intentional destruction of the Fengyun-1C spacecraft and the collision between Iridium 33 and Cosmos 2251. State-of-the-art evolutionary models now indicate that mitigation measures alone are insufficient to stabilise the LEO debris population. Consequently, this has led to considerable interest in the remediation of the debris environment and, especially, in debris removal. Yet there is a reluctance to revisit the role of post-mission disposal within the wider goal of remediation even though it does not provide the solution that was expected. Thus, there is a risk that the approach to remediation will follow a sequential philosophy, which tends to deliver costly, and less than optimal solutions.

In this paper, we present a new and large study of debris mitigation and removal using the University of Southampton's evolutionary model, DAMAGE, together with the latest MASTER model population of objects > 10 cm in LEO. Here, we have employed a concurrent approach to remediation, whereby changes to the post-mission disposal rule and the inclusion of other mitigation measures have been considered alongside multiple removal strategies. In this way, we have been able to demonstrate the synergy of these measures and to identify aggregate solutions to the space debris problem. The results show that reducing the PMD decay rule offers benefits that include an increase in the effectiveness of debris removal, regardless of the yearly removal rate, and a corresponding increase in the confidence that these combined measures will lead to the stabilisation of the LEO debris population. Whilst a cost-benefit analysis remains to be performed, ostensibly implementing select changes to key mitigation measures should be achievable for industry.