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

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FAILURE ANALYSIS OF SATELLITE SUBSYSTEMS TO DEFINE SUITABLE DE-ORBIT DEVICES

Abstract

Space missions in Low Earth Orbit (LEO) are severely affected by the build-up of orbital debris. A key practise, to be compliant with IADC (Inter-Agency Space Debris Coordination Committee) mitigation guidelines, is the removal of space systems that interfere with the LEO region not later than 25 years after the End of Mission. It is important to note that the current guidelines are not legally binding but recommended, even if different Space Agencies are now looking at the compliance for their missions. If the guidelines will change in law, it will be mandatory to have a post mission disposal system for all satellites, including micro and smaller classes. A potential increased number of these satellites is confirmed by different projections, in particular in the commercial sector. Micro and smaller spacecraft are, in general, not provided with propulsion capabilities to achieve a controlled re-entry, so they need different de-orbit disposal methods. When considering the utility of different debris mitigation methods, it is useful to understand which spacecraft subsystems are most likely to fail and how this may affect the operation of a de-orbit system. This also helps the consideration of which components are the most relevant or should be redundant and included depending on the satellite mass class. This work is based on a sample of recently launched LEO satellites with mass lower than 500 kg. Failure analysis of satellite subsystems is performed using a statistical approach. The study is carried out by using the satellite database SpaceTrak^{TM} which provides anomalies, failures, and trends information for spacecraft subsystems and launch vehicles. The database identifies five states for each satellite subsystem: three degraded states, one fully operational state, and one failed state (complete failure). The results obtained can guide the identification of the activation procedure for a de-orbit mechanism and the level of integration it should have with the host satellite in order to be activated before a total failure. At Cranfield Space Research Centre two different solutions have already been developed as de-orbit sail payloads for micro satellites (Icarus-1 on TechDemoSat-1, DOM for future ESA ESEO mission). This study will provide a useful input to improve and refine the current de-orbit concepts for future satellite missions.