23rd IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 23rd IAA SYMPOSIUM ON SPACE DEBRIS (IP)

Author: Mr. Bryan Lovrinovic
DLR (German Aerospace Center), Germany

Ms. Livia Ordonez Valles
German Aerospace Center (DLR), Germany
Mr. Dominik Quantius
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
Prof.Dr. Ali Gülhan
DLR (German Aerospace Center), Germany

THE SELECTION PROCESS OF REFERENCE MISSIONS FOR A DESIGN FOR DEMISE PROJECT

Abstract

The number of spacecraft on orbit is continuously growing and with the emergence of large-scale satellite constellations for communication in the late 2010s the orbit population has surged significantly. A higher density of objects on orbit leads to an increased collision and fragmentation risk, which further increases the number of objects. While active and controllable spacecraft have a limited collision risk, decommissioned satellites and derelict upper stages pose higher risks.

Reaching the end of their operational lifetime, satellites need to vacate highly populated orbits. Components of the spacecraft that do not burn-up during re-entry and reach Earth's surface pose a significant risk to infrastructure, property, environment, health, and life. New satellites that follow a Design for Demise (D4D) approach minimise the number and size of components that can survive re-entry. In the DLR project TEMIS-DEBRIS, alternative materials and new technologies and concepts are investigated and developed to improve spacecraft demisability. By selecting representative reference missions, the developed technologies can be assessed by addressing their impact with respect to the selected scenarios.

This paper analyses the various aspects of a mission that determine its suitability to serve as a reference mission for a D4D project. Within this context, different criteria such as platform size, orbit type, and spacecraft components are assessed in order to identify representative use cases for the implementation of D4D technologies. Concerning critical components for demise, these typically have a high density or are made up of heat-resistant materials, e.g. propellant tanks, optical benches, or batteries. Indeed, use of critical components can be determined by mission types, e.g. an Earth observation satellite might be equipped with several large optical payloads. Communication satellites, on the other hand, can be found in large numbers in highly frequented orbits. Due to the high population density, a satellite in LEO is more relevant to investigate, whereas satellites in geostationary orbit will be transferred to a graveyard orbit rather than de-orbit. Finally, the satellite's mass, size, and aerodynamic properties greatly influence re-entry and demisability. The design of satellites from large constellations by major commercial operators can potentially be less directly influenced by a D4D project than public missions. Following these criteria, the European/Japanese Earth observation satellite EarthCARE and the German experimental compact satellite Eu:CROPIS were identified as suitable reference missions for TEMIS-DEBRIS since they represent examples of a smaller high-altitude LEO satellite and a larger satellite at lower altitudes.