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CONSIDERING COST OF DE-ORBITING MANEUVERS IN LONG-TERM SCENARIOS

Abstract

The removal of large, heavy and long-lived objects from Earth orbits is a reasonable measure to suppress a possible collision chain reaction effect. This measure is particularly important if such objects are located on orbits, which already have a relatively high spatial debris density. There are two ways to remove spacecraft from orbit. One is the direct de-orbiting after the end of the mission. The other is the retrospective active debris removal. The de-orbiting immediately after the end of the operation makes sense. However, such mitigation measures are associated with cost. An additional or enlarged propulsion system is required for de-orbiting. This has an impact on the mass of the spacecraft. Subsequently, it also increases the launch costs. These propulsion systems can have a different complexity and therefore, also have different hardware costs. Within the scope of this paper, the estimation of the order of magnitude of the costs of such propulsion systems is investigated. It is compared whether the expenditure for propulsion systems is in an economic relationship to the costs that would otherwise be caused by damage to satellites. The aim of this work is to investigate the influence of certain parameters on the order of magnitude of the cost estimate. The results can serve as a means of recognizing gross tendencies and estimating magnitudes. Within the framework of a currently ongoing study, long-term simulations of the evolution of the space debris environment are being carried out. Different scenarios with different mitigation measures are investigated. In this work, a variant of a previously used cost model for de-orbiting is applied. Here, a propulsion system is dimensioned for each individual spacecraft, for which a maneuver is required, depending on the velocity requirement, in order to be able to carry out this maneuver. The additional costs of each individual maneuvered spacecraft are taken into account in the relevant scenario and compared with other scenarios. A revised version of the cost model is presented. The cost model is converted into an applicable form which uses simple parameters, such as the mass of the spacecraft and the velocity requirements for the maneuver and derives the effort required for the propulsion system. Only the additional costs for hardware and launch are investigated while possible opportunity costs are not to be considered here. Various scenarios are presented and compared.