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TOWARDS A BOTTOM-UP APPROACH TO SPACE DEBRIS REMOVAL: ON THE ECONOMIC CONVENIENCE BEHIND DEBRIS MITIGATION STRATEGIES

Abstract

The number of space objects mainly in low Earth's orbit (LEO) is rapidly increasing, and this congestion is enhancing the risk of collision between active satellites and debris. Reasons for this sharp growth are to be found in the development of commercial launchers, the miniaturization of satellite components and the emergence of new transport means for small satellites, to mention a few. Despite the existence of internationally recognized voluntary debris mitigation guidelines and few guidelines in the Long-term sustainability ones are devoted to space debris, not necessarily all the satellite operators are adopting risk mitigation measures, and, sometimes, unexpected situations occur.

In this paper, we present a cost model assessing satellite operators' economic convenience of adopting mitigation measures to reduce the risk of collision between their active satellites and space debris. The cost model, building on a statistical analysis of the relationship between the mitigation measures' adoption rate and the number of future collisions, describes the impact of the mitigation measures' costs on the (active) removal of assets by space operators. The first part of the study investigates potential debris growth scenarios in LEO according to different hypotheses of launch rates, different mitigation and remediation measures and periodically revised adoption rates of the selected mitigation measures. The space environment is simulated using the Italian National Research Council's (CNR) SDM 5.0 evolutionary model to estimate the effectiveness of the adopted measures and, ultimately, the rate of adoption by satellite operators needed to stabilize the LEO orbits that are more exposed to the risk of collisions. The second part gauges the costs of adopting the identified mitigation strategies and compares them to those currently incurred by satellite operators, distinguishing between different size classes of satellites.

As a result, our paper aims at furthering the qualitative definition and quantitative assessment of mitigation measures' cost items also through interviews with industry experts. At the same time, it aims at providing quantitative demonstrations that might guide satellite operators' future choices about mitigation measures' adoption, and public actors' decisions regarding the deployment of policies and economic

incentives to enable the removal of some satellite classes. Moreover, it aims to give strategic takeaways to the suppliers who are developing innovative technologies for satellites removal, and at becoming an important tool for satellite industry and operators for better defining the economics of their business models and system developments.