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ASSESSING THE EFFECTIVENESS OF DEBRIS MITIGATION GUIDELINES TO PRESERVE THE SPACE ENVIRONMENT GIVEN FUTURE PROPOSALS FOR LARGE SATELLITE CONSTELLATIONS

Abstract

Through the publication of guidelines informed by technical, scientific and legal expertise, committees such as the IADC and UNCOPUOS have coordinated international efforts to minimize the creation of new space debris objects. Current research shows that although some mitigation policies, such as the passivation of spacecraft to prevent accidental explosion, have helped to reduce the creation of new explosion fragments, the number of debris created by accidental or intentional collisions is predicted to increase in the long term. Fragmentation events, caused by the collision of two objects in space, have been a significant source of space debris objects over a cumulative five decades of human space exploration. The occurrence of such events is highly dependent on the density of space objects, driven by the rate of future launch traffic. Current proposals by different commercial entities aim to launch constellations comprising thousands of satellites in Low Earth Orbit (LEO), which would result in an increase of more than five times the number of currently active satellites in a region where debris objects are most concentrated.

The IADC has already recognized the potential influence of large constellations on the LEO environment and the subsequent need to assess whether current mitigation guidelines will be adequate moving forward. Given developments for such constellations are already underway, independent research efforts ahead of any revision to current IADC guidelines could be of great value not only to the organizations involved in their operation, but also to policymakers and existing space users. This paper examines the potential impact of mega-constellations on the collision probabilities of space objects in LEO under best and worst-case implementation of current mitigation guidelines. Simulation studies are performed using ESA's *MASTER-2009* debris evolutionary model, and the specifications of the proposed SpaceX constellation as an example mega-constellation. Multiple scenarios are then tested to assess mitigation measures and their ability to minimize the probability of fragmentation events and the creation of new debris in LEO.