SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Risk Analysis (2)

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MASSIVE COLLISIONS IN LEO - A CATALYST TO INITIATE ADR

Abstract

Sustainability (as defined in "Our Common Future" by Brundtland Commission of the United Nations, 1987) is "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs." Are our current debris growth control initiatives sufficient to insure sustainability of the space environment in low Earth orbit (LEO)? While in answering this question most researchers focus on either the number of collision events or the trackable debris population, this analysis focuses on the lethal nontrackable (LNT) debris hazard. The LNT collision risk is the predominant factor leading to the degrading of flight safety performance. The current maximum LNT impact hazard is estimated to be less than 1 percent per year in the most debris-populated region of LEO (i.e. around 840-880km), well below the 1.5 percent per year failure rate currently used by the space insurance community to assign annual failure rates in LEO due to all causes. This analysis (1) proposes that a 2.5 percent per year LNT collision impact probability be prescribed as an unacceptable risk level (as it would significantly reduce the operational lifetime for a typical satellite) and (2) examines potential single massive collision events that might lead to this state of the environment. Clusters of common derelict hardware in the core of LEO (i.e. 700-1000km) are evaluated. Results show that a single "massive collision" could create a collision hazard near or above the 2.5 percent per year LNT critical threshold proposed. This analysis shows that deterioration of the space environment due to LNT growth may happen well before the environment becomes visibly unstable, commonly signified by cascading breakups and, thus, should motivate the community to remove the most massive of derelicts from LEO as soon as possible (i.e. start active debris removal (ADR) operations). A study of detailed interactions of the SL-16 rocket body cluster in the 800-900km region highlights the episodic characteristics of the derelict-on-derelict collision dynamics. The observations further reinforce the large range of possibilities for massive collisions in LEO.