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Author: Dr. Carmen Pardini
ISTI-CNR, Italy

Dr. Luciano Anselmo
ISTI-CNR, Italy

REVISITING THE CATALOGED DEBRIS COLLISION RISK FOR THE IRIDIUM AND COSMO-SKYMED SATELLITE CONSTELLATIONS

Abstract

After two decades of slightly declining growth rate, thanks also to the advancing implementation of mitigation measures, the population of cataloged debris around the Earth increased by more than 56% in just a couple of years, from January 2007 to February 2009, due to two collisions in space involving the catastrophic destruction of three intact satellites (Fengyun 1C, Cosmos 2251 and Iridium 33) in high inclination orbits. Both events occurred in the altitude range already most affected by previous launch activity and breakups. In 2010-2011 a detailed analysis was carried out to analyze the consequences of these fragmentations, in particular concerning the evolution of the collision risk for the Iridium and COSMO-SkyMed satellite constellations. Five years after such first assessment, the cataloged debris environment affecting the two constellations was revisited to evaluate how the situation evolved due to the varying contribution of the above mentioned breakup fragments and the space activities carried out in the meantime. Being distributed, at 781 km, over six nearly polar orbit planes separated by just 30 degrees at the equator, the Iridium satellites represent a very good gauge for checking the evolution of the debris environment in the most critical LEO region. Disregarding the fragments from Fengyun 1C, Cosmos 2251 and Iridium 33, in approximately six years, from April 2010 to February 2016, the average debris flux on Iridium satellites remained basically stable, around $7.5 \cdot 10^{-6}\ m^{-2}$ per year per satellite, meaning that the combination of new space missions, solar activity, mitigation measures and debris evolution led to neither a better or worse situation. The same conclusion was applicable to the full population of debris with available orbit, i.e. including the fragments of Fengyun 1C, Cosmos 2251 and Iridium 33, which still account for half of the total flux, on average, leading to about $1.5 \cdot 10^{-5}\ m^{-2}$ per year per satellite. Concerning the mutual interaction among the Iridium 33 fragments and the parent constellation, the debris dispersion and relatively fast decay, coupled with a relatively slow differential plane precession, determined in six years, on average, a decline of the flux by more than 50%, i.e. to about $4.7 \cdot 10^{-7}\ m^{-2}$ per year per satellite. This decrease occurred steadily in each constellation plane, even though with different rates and percentages, due to the varying relative orbit geometry.