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Modelling and Risk Analysis (2)

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IMPACTS OF LARGE CONSTELLATIONS AND MISSION DISPOSAL GUIDELINES ON THE FUTURE SPACE DEBRIS ENVIRONMENT

Abstract

Future constellations are being proposed by SpaceX, OneWeb, LeoSat, Theia, and others that may include hundreds to thousands of satellites, spread across multiple orbit altitudes in LEO, some of which are already highly populated. The long-term threat to the safe operational space environment's utility posed by these new constellations is not fully understood. The magnitude of debris generated via explosions and collisions with other space objects will be significantly influenced by the constellation characteristics, and the post-mission disposal policy followed by these satellite operators. This study models the future orbital environment for debris based on different levels and types of space activity and post-mission disposal success rates. The future constellation model (FCM) utilized in the study consists of numerous constellations representative of proposed systems. These constellations manifest a wide range of characteristics relevant to their impact on the future debris environment, including mission and disposal orbits, satellite counts, masses, and areas. This FCM is modeled along with (1) the background population of known space objects, (2) a future population of LEO through GEO satellites, upper stages, and mission-related debris generated at a similar rate to the last 10 to 15 years of launches, and (3) a population of continuously replenishing constellations (CRC) that includes Iridium, Globalstar, and Orbcomm in LEO, and MEO navigation satellites. In addition to varying the FCM characteristics, three separate post-mission disposal scenarios are modeled, with options to dispose within 25, 10, or 5 years of end-of-life. The probability of successful post-mission disposal is also varied from 100The scenarios are modeled and analyzed in a Monte Carlo simulation using the Aerospace Debris Environment Projection Tool (ADEPT), with all populations within a scenario interacting simultaneously to generate explosions and collisions. The accounting of the resultant debris for a specified population and disposal probability is done in post-processing, enabling many combinations of constellation traffic to be examined. Comparisons of the results lead to conclusions on (1) which characteristics of large future constellations influence the production of future debris, (2) whether or not modifying the 25-year disposal rule provides any significant benefit, and (3) what a reasonable disposal success probability level is for different launch traffic levels to ensure limited growth of the future space debris environment.