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A COMPREHENSIVE ASSESSMENT OF COLLISION RISK IN GEOSYNCHRONOUS EARTH ORBIT

Abstract

Knowing the collision risk of satellites operating in Geosynchronous Earth Orbit (GEO) is of extreme importance and interest to the global community and the operators of GEO spacecraft. This is especially true in GEO due to both the high cost to build, launch and operate GEO satellites, as well as the importance of maintaining the safety and commercial viability of the GEO orbit regime. Yet for all of its importance, a comprehensive assessment of GEO collision risk has not been accomplished to date. This is likely due to the complexities involved, including: (1) The synchronous nature of satellites in GEO, which presents problems for typical approaches to assessing collision risk; (2) orbit perturbations in GEO (primarily gravity wells, soli-lunar perturbations and Solar Radiation Pressure) that cause orbits to drift out of the equatorial plane and to drift in an East/West cycle that is longitudinally-dependent; (3) unknown/unpredictable operator operations and collision avoidance strategies; and (4) the lack of methods available to estimate long-term encounter rates independent from our Space Situational Awareness knowledge.

New methods for determining typical encounter rates for extant spacecraft sizes, coupled with statistics gleaned from diverse and comprehensive conjunction alert datasets, offer ways to address these technical complexities. In this paper, we employ many of these new methods to estimate GEO collision risk and compare the results. Taken in aggregate, these methods offer new insights into GEO collision risk that are consistent to within one order of magnitude. These results are then compared to a few previous estimates. The new results indicate that collision risk in GEO is higher than was previously estimated by as much as several orders of magnitude.