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

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DISPOSAL STRATEGIES ANALYSIS FOR MEO ORBITS

Abstract

Current Medium Earth Orbit (MEO) population comprises a set of objects, including the Global Navigation Satellite Systems (GNSS) constellations. Apart from them, upper stages which ingest satellites in near-operational orbit and transiting objects crossing this region on high eccentricity orbits like geostationary transfer orbits (GTO), Molniya and Tundra orbits share this orbital regime.

Although this orbital regime is not very populated yet, the new constellations and the absence of orbital perturbations efficiently removing the objects from the operational orbits will impose to define debris prevention policies. This paper addresses the definition of the optimum disposal at this regime. For this purpose, it is very relevant to clearly understand the evolution of the MEO orbits in the long-term in order to be able to set up a number of disposal solutions which are compatible with the spacecraft operational constraints, the safety of the operational assets (minimum risk) and the stability of the long term solution. In order to analyse the optimum strategies, this paper focuses on two different aspects: object population evolution analysis and collision risk and manoeuvre statistics for different disposal strategies for GNSS satellites with a focus on Europe's Galileo constellation are analysed.

The aim of this analysis is to quantify and analyse the probable evolution of collisions between specific object groups such as disposed and active GNSS spacecraft but also possible collisions with objects in LEO or in GEO. Collisions with the latter groups may occur if the spacecraft are decommissioned into so called 'maximum eccentricity growth' orbits. Such orbits can be achieved through specific combinations of initial orbit parameters. These values are furthermore a function of the time of year as the eccentricity growth is a resonance effect resulting from cross-coupling of luni-solar and Earth gravity perturbations.

Regarding the object population evolution analysis, a study on the long-term evolution of the object population in the vicinity of the GNSS' operating altitude for different disposal scenarios (minimum eccentricity growth, maximum eccentricity growth, no disposal as background scenario) is presented. This analysis takes into account constellation maintenance rules (constellation lifetime, replenishment schedule, disposal success rate).

In regards to the collision risk and avoidance manoeuvre analysis, the study addresses the overall collision risk and expected avoidance manoeuvre rate per satellite and year for different disposal scenarios, taking into account orbit determination accuracies, object cross sections and the object population evolutions presented in the first part of the paper.