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Modelling and Risk Analysis (2)

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THE EFFECT OF THE GNSS DISPOSAL STRATEGIES ON THE LONG TERM EVOLUTION OF THE MEO REGION

Abstract

The analysis of different disposal strategies for the spacecraft belonging to the Global Navigation Satellite Systems (GNSS), with particular emphasis on the European Galileo system, is the aim of this study. The possibility to store the disposed spacecraft in stable circular orbits above the operational orbits is the currently adopted strategy and seems, at first sight, the most viable one. Nonetheless, this procedure is hindered by a few drawbacks. First, the accumulation of a significant number of spent uncontrolled spacecraft in a limited region of space can give rise to a local collisional activity, with no possibility to control it from the ground with space surveillance means and avoidance manoeuvres. Moreover the noted instability of the GNSS disposal orbits can lead the disposed spacecraft back to dangerous crossings with the operational orbits in a not too distant future.

The results of numerical simulations of the long term evolution scenarios, implementing different disposal strategies, are shown and discussed. A detailed analysis of the collision risk and manoeuvres need, related to the different scenarios, was performed.

In terms of the long term evolution, the scenarios where the orbital instabilities are exploited to remove the objects from the operational regions seems favourite. That is, if the focus is on the long term sustainability of the space environment, the possibility to dilute the collision risk and to aim at the re-entry in the atmosphere of a subset of the disposed GNSS spacecraft is the most attractive. The most "problematic" constellations are Glonass and Beidou. This conclusion is driven by the future launch traffic hypothesized for these constellations and by the past practices that left already a significant number of

large uncontrolled spacecraft in the constellation orbital zone, in the case of Glonass. On the other hand, the Galileo constellation is well detached from the others and faces the lowest collision risks.

The Stable scenarios seems to minimize the interactions (crossings) with the operational constellations and, therefore, might be preferred for operational reasons. In particular, in the Stable scenarios the inter-constellations interaction is negligible.

Particular care should be devoted to the efficiency and reliability of the disposal manoeuvers. A significant share of the collision risk faced by the operational satellites in every simulated scenario can be traced back to the failed satellites (the success rate of the disposal manoeuvers was assumed to be 90 % for all the constellations). Study performed under ESA Contract 4000107201/12/F/MOS.