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THE PRELIMINARY ANALYSIS OF THE RE-ENTRY ORBITS OF BEIDOU INCLINED GEOSYNCHRONOUS SATELLITES

Abstract

In this paper we present the basic features and preliminary analysis of the re-entry orbits of Beidou inclined geosynchronous satellites. The idea of re-entry orbit as an optional disposal strategy for end-of-life satellites originates from the fact that the eccentricity growth of specific satellite orbits could become dramatic in decades. Former researches of this instability lead to the investigation of secular or semi-secular resonances due to the Earth's geopotential and lunisolar perturbations.

The search practice for the fastest re-entry orbit with minimum fuel cost for a target satellite is formulated as a multi-objective optimization problem by Armellin et al which was solved with a semi-analytical orbit propagator and an evolutionary algorithm. This method has been applied in the case of INTEGRAL and the Galileo constellation. A detailed analysis of the eccentricity build-up in the case of Galileo was carried out therein.

In this paper seven operational Beidou inclined geosynchronous satellite orbits (IGSO) are treated with basically the same method to evaluate the feasibility of re-entry orbit as a disposal option. The initial phases of the satellites, the ascending node and the argument of perigee, vary from 0 to 2Π to show its effect on the solutions. The initial epoch varies in one nodal period of the Moon (close to 18.6 years) to show the solutions' dependence on the configuration of the Earth-Moon-Sun system. The result is presented in the form of Pareto front which is a set of un-dominated solutions in the multi-objective optimization problem. It serves as the basis for the feasibility study. The change of the orbital elements due to the manoeuver are presented to show the basic features and commonalities of the re-entry orbits. The results show both agreement and difference with those of the Galileo case. An important difference is that the reduction of the semi-major axis is selected by the optimizer while the initial ascending node varies.

For further insight into the re-entry orbits, similar to the Galileo case, the analysis of the eccentricity build-up is carried out. The ephemeris of the re-entry orbit is projected to different types of 2-Dimensional planes to show the different roles of five resonance arguments in the growth of the eccentricity. The transport along the dynamical backbone of the phase space is detected among the solutions. The FLI (Fast Lyapunov Indicator) maps of the neighborhood of specific orbit are also presented to show the re-entry orbit's predictability and stability.