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

Author: Ms. Noelia Sánchez-Ortiz
Deimos Space S.L., Spain

Mr. Raúl Domínguez-González
Deimos Space S.L., Spain
Dr. Holger Krag
European Space Agency (ESA), Germany
Mr. Johannes Gelhaus
Technische Universität Braunschweig, Germany

ANALYSIS OF UNCERTAINTIES OF CATALOGUED ORBITAL DATA FOR THE UPDATE OF THE ESA DRAMA ARES TOOL

Abstract

In order to enable ESA space programs to assess their compliance with the recommendations in European Code of Conduct for Space Debris Mitigation, the DRAMA (Debris Risk Assessment and Mitigation Analysis) tool was created in the past.This tool is currently updated by TUBS and DEIMOS, under ESA/ESOC contract, to include additional capabilities and improve the performances of existing features. Updated DRAMA is composed of six individual software applications. The individual applications have been designed and developed to address different aspects of debris mitigation (collision avoidance manoeuvres, collision flux and damage statistics, disposal manoeuvres at end-of-life, reentry survival, re-entry risk analysis and cross-section evaluation).

This paper focuses on the update of ARES (Assessment of Risk Event Statistics) module. ARES allows the computation of statistical collision probability between an operational spacecraft and objects orbiting the Earth, the mean number of required manoeuvres, risk reduction and residual risk, false alarm rate, required Delta-V and propellant mass fraction. The collision probability depends on the geometry of the encounter, the collision cross section and the uncertainty in the knowledge of state vector of two involved objects. A brief description of the mathematical theory is provided.

ARES capabilities are improved to account for an updated population model using MASTER 2009 down to small objects, with the option to include user-defined population clouds, including percentage of objects as a function of catalogue and improved default values for orbital uncertainties associated to the catalogued objects. The user can select different catalogue performances and define the uncertainties per orbit group and size.

Special attention is devoted in the paper to the analysis of accuracy of catalogued orbits for the generation of the uncertainty values included in the tool. This analysis is based on large number of reference orbits computed at ESA/ESOC with dedicated tracking of particular objects and the comparison of these reference orbits with TLE catalogue. The analysis is intended to provide the uncertainty of catalogued data as a function of the orbit type, object size and prediction time. The prediction time plays an important role in the ARES computation, since it determines the size of the predicted covariance matrix at the time of event, and then limits the collision probability and eventual need of maneuvering. The method used for the comparison of reference orbits and TLE data and the results for the available data sets are presented in detail.