Instability of the Future LEO Environment

Comments to the content of the IADC AI 27.1, Rev 1, report
"Stability of the Future LEO Environment"

A.I. Nazarenko, I.V. Usovik
Scientific Technological Center "KOSMONIT", Roscosmos

1. Introduction

The issues, considered in the AI 27.1, Rev 1, report, were outlined in our reports at the 29-th and 30-th IADC sessions [1, 2]. The results presented in these reports have not been taken into account at preparing the AI 27.1, Rev 1 report. Possible reasons of this lie, apparently, in the fact that the situation forecasting technique, applied in the Russian SDPA model [3, 4, 5], essentially differs from the procedure of preparation of considered report's materials.

The Space Debris Prediction and Analysis (SDPA)model is a semi-analytical stochastic model designed for mid-term and long-term forecasting of man-made space debris (SD) of size larger than 1 mm in the LEO and GEO regions, for constructing spatial distributions of density and velocity characteristics, as well as for estimating the risk of collisions. The model development was started at ≈ 1990. It has been permanently updated and renewed during the recent 23 years. The summary data on various-size SD are considered (without their "attribution" to particular contamination sources). The current state of space of the near-earth space (NES) contamination is characterized by: a) the SD density dependence on the altitude and latitude of a point, and b) statistical distributions of the value and direction of particles' velocities in the inertial coordinate system These characteristics were constructed on the basis of complex utilization of available measurement information and various a priori data.

Characteristic features of the technique applied in the model are as follows:

- The original technique of accounting for mutual collisions of space objects (SOs) of various sizes is developed. Their fundamentals were outlined in the monograph [4].

- The collisions of non-catalogued objects (smaller than 10 – 20 cm in size) are taken into account.

- The parameters of the model of fragmentation at collisions are updated based on the available experimental data. Here, the specific collision energy estimate is used for determining the minimum size of fragments.

- In the situation forecasting process the model uses, instead of the Monte Carlo technique, the averaged collision consequences' matrix that is calculated according to the original technique before performing forecasts. Its utilization is equivalent to application of ≈100000 traditional implementations of the Monte Carlo technique.

- The assumption is used, that the lower boundary of sizes of catalogued SOs is "blurred". This implies that not all objects of size larger than 10 cm are catalogued.