Paper ID: 40381
oral

15th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Modelling and Risk Analysis (2)

Author: Dr. Hugh Lewis
University of Southampton, United Kingdom

Mr. Benjamin Bastida Virgili
European Space Agency (ESA), Germany
Mr. Jonas Radtke
Technische Universität Braunschweig, Germany
Dr. Alessandro Rossi
IFAC-CNR, Italy
Dr. James Beck
Belstead Research Ltd, United Kingdom
Dr. Holger Krag
European Space Agency (ESA), Germany

MITIGATION MEASURES FOR LARGE CONSTELLATIONS

Abstract

Large constellations of satellites in Low Earth Orbit (LEO) will provide important communications and broadband internet services to large parts of the world where the necessary terrestrial infrastructure is lacking. These services are also likely to disrupt the existing broadband market and to have a significant effect on the space economy. At the same time, there is considerable potential for negative impacts on the space environment and other space users unless appropriate space debris mitigation measures are incorporated into the design and operation of the constellations. Recent modelling work by the authors has shown that the robust implementation of post-mission disposal (PMD) to orbits with short lifetimes, in combination with other constellation and satellite design decisions, can help to reduce the negative impacts of large Walker-Star and Walker-Delta type constellations operating for several decades in LEO. However, proposals for several large constellations continue to move forwards so further modelling work is needed to understand the possible impacts emerging from the simultaneous operation of multiple constellations at relatively similar altitudes in LEO. In addition, it is likely that these constellations will move away from Walker-type geometries in an effort to reduce the collision risk between satellites in the same constellation, so the previous findings may not be fully applicable. Consequently, a new simulation study was performed using three evolutionary models, with the aim of addressing the issues arising from the operation of several large, non-typical constellations in LEO.

Whilst the previous work by the authors considered a broad range of constellation parameters, such as the constellation size, geometry, lifetime, orbit, deployment, spacecraft mass, area and propulsion, the new study was focused primarily on the arrangement of orbital planes in two large constellations. In particular, parameters including the orbit shape, the separation in altitude and the inclination were evaluated for their influence on the collision risk to other same-constellation satellites and non-constellation objects, and to assess the potential for collisions between satellites from the different constellations.

The evolutionary models were used to evolve the population of objects > 10 cm in LEO from 1 January 2013 over a 200-year projection period taking into account the constellations, variations in the background launch traffic and behaviour with respect to the commonly adopted debris mitigation measures. The results from these projections will be presented, together with a set of recommendations that also take into account the previous work performed by the authors.