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Author: Dr. Alexis Petit
IFAC-CNR, Italy

Dr. Alessandro Rossi
IFAC-CNR, Italy
Dr. Elisa Maria Alessi
IFAC-CNR, Italy

COLLISION RISK ASSESSMENT FOR THE PROPOSED LARGE CONSTELLATIONS

Abstract

The deployment of the first large constellation, named OneWeb, including 648 satellites, has started at the beginning of the year, and several other projects are already scheduled like Starlink or Telesat with respectively 11943 and 117 satellites. These unprecedented satellite formations are changing dramatically the space traffic with an enhanced collision risk which is a real threat for the stability of the space debris environment. If procedures are applied to avoid a collision or an explosion of a satellite, an unforeseen event is always possible, like a system failure or an unexpected collision with a space debris.

In this paper, we investigate the collision risk during the whole operational life of the large constellations OneWeb, Starlink and Telesat. We propose to determine the risk during a normal scenario of the operational life of the large constellation or with a stressful event like a breakup. We produce a background environment of space debris simulated for the next years with the space debris evolutionary model SDM. With the CUBE algorithm, we compute the collision rate of the satellites with space debris. We focus on each phase: (i) the deployment phase of the constellation where the satellites with their own electric propulsion system perform the orbit raising, (ii) the operational phase where the satellite are kept in station, (iii) the decommissioning phase where the satellites are extracted from the constellation, and the perigee is lowered to perform an atmospheric reentry within a given residual lifetime ranging from 0 to 25 years. For each satellite of the large constellations previously mentioned, we give the evolution of the collision rate for each phase, and the number of collision avoidance manoeuvres expected. In reason of the high number of satellites inside the large constellation, the risk of accident increases. We propose to investigate the impact of a breakup in the large constellations. On the short term, after a breakup, the fragments spread along the orbit and form a torus due to the differential mean motion. The collision risk is changing quickly during this phase. On the long term, the cloud spreads to form a shell due to the non-sphericity of the Earth and the differential variation of the right ascension of the ascending node. Then, the collision risk will be stabilized. This analysis give us strong constraints for the design of large constellations.