Paper ID: 35062
student

14TH IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Modelling and Risk Analysis (2)

Author: Mr. Shiki Kitajima
Kyushu University, Japan

Dr. Shuji Abe
Kyushu University, Japan
Prof. Toshiya Hanada
Kyushu University, Japan
Ms. Satomi Kawamoto
Japan Aerospace Exploration Agency (JAXA), Japan

INFLUENCES OF MEGA CONSTELLATIONS ON THE ORBITAL ENVIRONMENT

Abstract

From the beginning of 2015, several companies have been developing space broadband or other space communications systems, which will form large constellations of thousands of satellites in LEO (Low-Earth Orbit). Such large constellations are called MEGA constellations. IADC (Inter-Agency Space Debris Coordination Committee) established space debris mitigation guideline in 2002, and now space agencies or companies are trying to follow some rules given in this guideline represented by 25-year rule. However, this guideline doesn't consider the influences of MEGA constellations. For sustainable space development, we have to know how such MEGA constellations will affect the orbital environment and make a new guideline.

The objective of this study is evaluating the influences of MEGA constellations on the orbital space environment.

This study particularly considers a PMD (Post Mission Disposal) success rate, collision avoidance, and constellation types. First, three scenarios with different PMD success rate of 30%, 60%, and 90%, respectively, were projected. Second, two more different scenarios were compared to each other. The first scenario assumed that MEGA constellation satellites didn't make any collisions during their missions. The other allowed satellites to collide with other satellites even if they were on the missions. Finally, two different constellation types were projected to compare. One adopted polar orbits with an inclination of 88 degrees. The other adopted a Walker constellation with an inclination of 75 degrees. Both constellations had the same number of orbital planes and satellites.

The orbital debris evolutionary model used in this study was NEODEEM (Near-Earth Orbital Debris Environment Evolutionary Model) jointly developed by Kyushu University and JAXA. For each scenario, 100 Monte-Carlo computations were conducted and orbital space environment was evaluated throughout 100 years, from 2013/1/1 to 2112/12/31.

Projections show that each factor influences the resulting environment on 2112/12/31. PMD success rate affects the rate of change in number of on-orbit objects and collisions. With lower PMD success rate, the number of collisions increases larger and faster, resulting in much worse environment. Also, this study shows that MEGA constellation satellites should take collision avoidance maneuver because collision fragments from MEGA constellation satellites during their missions may remain on-orbit even after their missions or services. Finally, polar orbit constellation makes more collisions and fragments than Walker constellation, but not so big difference in comparison to PMD success rate and collision avoidance.