Collision Risk Assessment and Mitigation Strategy for the GSOC GEO Satellites

Saika Aida (1), Michael Kirschner (2), Florian Meissner (3)
(1) DLR German Space Operations Center (GSOC), Oberpfaffenhofen, 82234 Weßling, Germany
+49 8153 28-2158, saika.aida@dlr.de
(2) DLR German Space Operations Center (GSOC), Oberpfaffenhofen, 82234 Weßling, Germany
+49 8153 28-1385, michael.kirschner@dlr.de
(3) DLR German Space Operations Center (GSOC), Oberpfaffenhofen, 82234 Weßling, Germany
+49 8153 28-3494, florian.meissner@dlr.de

Keywords: Space debris, Collision risk, GEO satellites, Mitigation strategy

ABSTRACT

The ever increasing number of objects in the near Earth region has been causing growing concerns about the space environment and accordingly about the safety of future space missions. Since most of orbital debris stay in the orbit for years, even a single collision between space objects could seriously increase the debris population, making further collisions more likely. The sun-synchronous orbit is heavily used by spacecraft, and the altitude region in 750 - 850 km is most densely populated in the near Earth region, leading to the first satellite collision of Cosmos 2251 and Iridium 33 in 2009. In the higher altitude, the Geosynchronous Earth Orbit (GEO) is a useful and valuable region, where satellites share the same orbital path. The critical population could be reached quickly, because the objects remain in the same altitude range for a long period. The monitoring and mitigation of the space debris is therefore highly important.

The German Space Operations Center (GSOC) has been performing collision avoidance for the operational satellites, currently 6 in LEO and 2 in GEO. Contrary to locally operated satellites, high accurate orbital parameters are not available for the bulk of other space objects. The Conjunction Summary Message (CSM) provided by the US Strategic Command (USSTRATCOM) is currently the main source for an assessment of the collision risk against space objects due to the quality and timeliness of the available information. When a CSM is received, the close approach to the corresponding space object is carefully analyzed, and then an avoidance maneuver possibility is investigated, if a critical conjunction is confirmed. A proper mitigation strategy is required in advance to handle the critical situation correctly and promptly.

The typical collision avoidance maneuver, which has been already applied to the operational LEO satellites, is to increase the radial separation by an intrack thrusting half an orbit before the closest approach. A certain separation can be achieved in a short period and also with a relatively small maneuver in this way. Additionally, the satellite can easily come back to the nominal orbit shortly after the closest approach. When possible, an avoidance maneuver is combined with the orbit maintenance maneuver to reduce the fuel consumption as well as the mission cost. For the GEO satellites, an additional constraint needs to be considered because the satellites have to be kept inside the control box. An intrack thrusting for the radial separation causes a drift in the longitude direction, which could lead to a violation of the permitted region. For such cases, the possibility of the out-of-plane separation is also investigated. Another consideration is the orbit accuracy of the GEO objects. Compared with the LEO case, the estimated covariance available for the space object

is mostly larger, while its growth dependent on the propagation is smaller because of the less atmospheric influence. Therefore, the mitigation scenario needs to be planned carefully based on the possible separation requirements and maneuver options, as well as the suitable timeline.

In this paper, the operational collision avoidance experience is first shown, followed by the typical conjunction characteristics in the GEO case. The mitigation strategy for the GEO satellites is then discussed, and the performance is also evaluated using some conjunction examples in the past. The paper concludes with a discussion of the operational implications of the collision risk assessment and maneuver strategies for the GEO satellites.