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COLLISIONS PROBABILITIES AND MITIGATIONS STRATEGIES OF THE QB50 NETWORK

Abstract

Longevity of derelict spacecraft and fragments of collisions in space has massively increased the amount of space debris in the recent past. Although significant emphasis has been dedicated towards issues on space debris, collisions and mitigation strategies typically remain isolated topics during space mission design. The Delft University of Technology has two operational nano-satellites in space – Delfi-C3 and Delfi-n3xt. The United States Joint Space Operations Center (JSpOC) identified a predicted conjunction between Delfi-n3xt and a secondary object (SCC 34032) on 16th of February with an overall miss distance of 572 m. This situation highlights the realistic threat of collisions in space and the need to consider mitigation strategies. Furthermore, new types of missions originate that involve large number of (small) satellites in the form of constellations, swarms and fractionated systems. This larger number increases the collisions probability and therefore collisions mitigation strategies, for these type of missions, have to be determined. In this paper, methods to assess collision probability of a network of satellites and mitigation strategies for such networks are identified and developed. Upcoming DelFFi mission of the Delft University of Technology involves two formation flying nano-satellites within the QB50 network, a system of nano-satellites for in-situ measurements of the lower thermosphere and reentry research. As a case study, the collision probability for this network is investigated in this paper, especially collisions threats between the satellites in the network. Key drivers for collision probability and mitigation measures realistic to CubeSats are addressed. The collisions probability throughout the QB50 network's lifetime is identified. A thorough simulation is performed to determine the collision probability. Furthermore, collisions mitigation strategies, for different type of velocity impacts, are identified which are most suitable for the QB50 network. This is done by analyzing the CubeSat's capabilities and, subsequently, trading-off strategies which are most applicable.