SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Risk Analysis (2)

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ANALYSIS OF THE RESIDUAL RISK OF LETHAL COLLISIONS FOR LEO SATELLITES DUE TO NON CATALOGUED OBJECTS

Abstract

Providing Europe with an autonomous access to information about objects orbiting around Earth is a major issue and one of the reasons for the foreseen development of an European Space Situational Awareness System. In this framework, one key element of the system's architecture will be a surveillance radar. Its specifications are a major issue, widely impacting its cost and design. Therefore, the focus is brought back on the main mission to achieve a significant reduction of the lethal collision risks for LEO satellites, with respect to the current lethality risk level. That is why CNES has funded this study for the analysis of the residual risk of lethal collisions due to non catalogued objects. One problem here is to succeed in defining and estimating lethality for different satellites, without needing the knowledge of too many details about their design, in order to be generic enough.

In this paper, a method for estimating the lethality of a given satellite is proposed, lethality being understood as the risk for the functional loss of the mission. It is then used to study the residual lethality risk resulting from non catalogued objects. The hypotheses and the four different steps of the method will be presented and detailed. The method is based on the combination of Master 2005 flux data with general information about satellite design and curves giving the probability of loss of each satellite element when impacted, depending on the diameter of the impacting object. The selected design enables to estimate the probability of loss of the mission for an impact with a given size of objects. This information is then combined with the flux data in order to estimate the cumulated probability of loss for all the objects within a given size range or below a given size. This result could then be used in order to define the theoretical size of the smallest objects that need to be catalogued in order to fulfil the required reduction of lethality.

Numerical results will be presented for three configurations of LEO satellites. Sensitivities are achieved on the input lethality curves to test their validity and analyze their influences on the final result. A consistency analysis of the results is performed with respect to known losses of satellites. Different possible adjustments for the lethality curves are proposed. The potential effect of satellite architecture (redundant device segregation) and the mass distribution of MASTER 2005 are challenged.