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Modelling and Risk Analysis (2)

Author: Mr. Samuel Diserens
University of Southampton, United Kingdom, s.d.diserens@soton.ac.uk

Prof. Hugh Lewis
University of Southampton, United Kingdom, hglewis@soton.ac.uk
Prof. Jörg Fliege
University of Southampton, United Kingdom, J.Fliege@soton.ac.uk

NEWSPACE AND ITS IMPLICATIONS FOR SPACE DEBRIS MODELS

Abstract

Until two decades ago, the dominance of the space industry by national governments shaped the key characteristics of the spacecraft population and hence the space debris models used to anticipate future orbital populations. The rise of 'NewSpace' with the growth of private sector involvement has brought innovations, disrupting the status quo and changing to the physical characteristics and mission orbits of commercial spacecraft. Our analysis of shifts in mass and launch traffic suggests significant impacts for debris modelling assumptions and results.

We analysed physical and orbital characteristics for spacecraft launched between 1980 and 2017 considering variations in spacecraft orbit, size, mass, cross-section and area-to-mass ratio which are important for orbit propagation, break-up modelling, and collision risk assessment (source: ESA's DISCOS database). We also investigated population statistics including the type of operator (government, commercial etc.), launch rate and number of spacecraft per launch.

Our results emphasise the ongoing change towards a more commercially focused space sector. 1980 to 1984 show 303 spacecraft launched, of which we labelled two as commercial. In contrast, the 2013 to 2017 period saw 674 commercial missions out 1190 launched - an increase from 0.7% to 56.6%. The same interval saw a smaller but significant rise from 1.7% to 15.3% in the proportion of spacecraft owned by academic institutions. These increases correlate with a rise in the number of different organisations operating spacecraft.

We observed a clear trend towards smaller, lower mass spacecraft. This is likely to alter the distributions of fragments generated in collisions compared with the distributions obtained from empirical methods, such as the NASA Standard Breakup model, derived from the fragmentation of larger spacecraft in the $600 - 1,000kg$ range. A key implication of this is the potential to over-estimate the number of debris released in such events.

There was also an increase in the number of spacecraft deployed by launch vehicles into similar target orbits and with the planned deployments of large constellations of satellites in the near-future, this trend is set to continue. However, the shift away from a more random spatial distribution of objects to a situation with more spatial structure may result in an overestimation of the collision risk when using current collision methods like the CUBE approach.

In light of the potential over-prediction of the growth of the debris population we believe that common breakup and collision models should be re-validated for the changing characteristics of the spacecraft

population.