THE IMPACT OF NEW TRENDS IN SATELLITE LAUNCHES ON ORBITAL DEBRIS ENVIRONMENT

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The main goal of this study is to examine the impact of new trends in satellite launch activities on the orbital debris environment and collision risk.

Starting from the launch of the first artificial satellite in 1957, space borne technology has become an indispensable part of our lives. More than 6,000 satellites have been launched into Earth orbit. Though the annual number of satellites launched stayed flat for many decades, the trend has recently changed. The satellite market has been undergoing a major evolution with new space companies replacing the traditional approach of deploying a few large, complex and costly satellites with an approach to use a multitude of smaller, less complex and cheaper satellites. This new approach creates a sharp increase in the number of satellites and so the historic trends are no longer representative.

As a foundation for this study, a scenario for satellite deployments based on publicly announced future satellite missions has been developed. These constellation-deploying companies include, but are not limited to, Blacksky, CICERO, EROS, Landmapper, Leosat, Northstar, O3b, OmniEarth, OneWeb, Orbcomm, OuterNet, PlanetIQ, Planet Labs, Radarsat, RapidEye Next Generation, Sentinel, Skybox, SpaceX, and Spire. Information such as the annual number of launches, the number of orbital planes to be used by the constellation, as well as apogee, perigee, inclination, spacecraft mass and area were included or approximated. Besides the production of satellites, a widespread ongoing effort to enhance orbital injection capabilities will allow delivery of more spacecraft more accurately into Earth orbits. A long list of companies such as Microcosm, Rocket Lab, Firefly Space Systems, Sierra Nevada Corporation and Arca Space Corporation are developing new launch vehicles dedicated for small satellites. There are other projects which intend to develop interstages with propulsive capabilities which will allow the deployment of satellites into their desired orbits beyond the restrictions of the launch vehicle used. These near future orbital injection technologies are also covered in the developed scenario.

Using the above-mentioned background information, this study aims to examine how the orbital debris environment will be affected by the new dynamics of the emerging space markets. We developed a simulation tool that is capable of propagating the objects in a given deployment scenario with variable-sized time-steps as small as one second. Over the course of the run, the software also detects collisions; additional debris objects are then created according to the NASA breakup model and are fed back into the simulation framework.

Examining the simulation results, the total number of particles to accumulate in different orbits can be monitored and the number of conjunctions can be tracked to assess the collision risks. The simulation makes it possible to follow the short- and long-term effects of a particular satellite or constellation on the space environment. Likewise, the effects of changes in the debris environment on a particular satellite or constellation can be evaluated. It is the authors' hope that the results of this paper and further utilization of the developed simulation tool will assist in the investigation of more accurate deorbiting metrics to replace the generic 25-year disposal guidelines, as well as to guide future launches toward more sustainable and safe orbits.