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EVALUATING THE SHORT AND MEDIUM TERM IMPACT OF SPACE ACTIVITIES IN LOW EARTH ORBIT

Abstract

Space activities in Low Earth Orbit (LEO) are undergoing an authentic revolution, quietly heralded, around the middle of the last decade, by the sudden and rapid increase in the launch rate of small satellites, and currently made evident and brought to the fore by the deployment of the first large constellations of satellites. Between the beginning of 2014 and the beginning of 2020, i.e. in just six years, the total mass of the artificial objects in orbit around the Earth has grown by approximately 22%, but the number of operational spacecraft has more than doubled, reaching a value close to 2350 and still rapidly increasing. Moreover, taking into account all the applications filed by satellite operators to the relevant licensing authorities, more than 50,000 new spacecraft might be launched in orbit by 2030. And even if only 20% of these plans were realized, as several economists believe, another 10,000 operational satellites could still be added to those currently in service, multiplying by at least a factor of ten the number of functioning spacecraft present at the beginning of 2014.

Since the mitigation measures currently applied internationally were conceived and evaluated when space activity was very different from the current one, and the changes underway are very rapid and not well suited to the time needed to reach thoughtful, balanced and effective agreements with a broad consensus base in the appropriate international fora, the need to have fast and easy to use approaches and procedures that can provide realistic assessments to analyze traffic and Earth orbit usage scenarios in constant change is of utmost practical importance.

For these reasons, for several years now, we have been involved in the development of new approaches and procedures for evaluating the operational and environmental impact of massive satellite deployments in LEO, and providing preliminary quantitative assessments with no need of complex models and computations. Specific indices were introduced for gauging the environment criticality and the approaches were applied to several scenarios involving the launch of many small satellites and several large constellations, focusing the attention on the consequences of their level of compliance with appropriate end-of-life disposal, including spacecraft failures.

This paper further develops this line of research, proposing a new combination of indicators to predict the effectiveness, especially in the short and medium term, of the mitigation measures applied to the operations and disposal of large satellite constellations.