DE-ORBIT STRATEGIES WITH LOW-THRUST PROPULSION

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ABSTRACT

In the framework of the French Space Operations Act (FSOA), it is now necessary to take into account the orbit lifetime of the satellites, in particular for the Low Earth Orbits (LEO), whose population is increasing. But after 2020, it will be mandatory to foresee a controlled re-entry, except if it is actually unfeasible. Currently, only few spacecraft, like the ATV (Automatic Transfer Vehicle), are able to perform such de-orbit maneuvers for a controlled re-entry. For more classical satellites, such maneuvers will imply a too important amount of propellant. Thus, it could be interesting to analyze de-orbit strategies with low-thrusts provided by an electric propulsive system. Indeed, even though these low-thrusts do not allow to bring the satellite on a directly re-entering orbit, it may be envisaged to position the spacecraft on an orbit whose altitude is low enough to be able to predict its re-entry within some hours, therefore limiting the debris fallout zone to a small number of orbit ground-tracks, chosen in order to decrease the risk on ground for human population.
Then, the main objective of this paper is to quantify this risk associated to such de-orbit strategies, and to prove that it is possible to decrease it with respect to an uncontrolled re-entry. For this purpose, ELECTRA software, developed by CNES, has been used. ELECTRA allows to assess the risks of doing victims on ground in case of launches or spacecraft re-entries failures, but also during an uncontrolled re-entry either for a long term re-entry of several years, but also for the last orbits preceding this uncontrolled re-entry.
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FSOA: French Space Operation Act
LEO: Low earth Orbit
ATV: Automatic Transfer Vehicle
CNES: French Space Agency
ELECTRA: Launch and Re-entry Risk Analysis Tool