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THE SEMI-CONTROLLED RE-ENTRY: DEVELOPMENT OF A SIMULATOR AND FEASIBILITY STUDY

Abstract

These days, safeguarding Earth's orbital environment has gained a real attention: debris originated from former missions is accumulating in LEO area, mainly between 800 and 1000 km, and can prevent the use of this zone within the next 100 years if nothing is done.

One of ESA answers to this issue is Space Debris Mitigation, which declares that LEO altitudes are a protected region so that any satellite operating in this area has to abandon it after its EOL. Therefore satellites shall be deorbited respecting time and fatality risk constraints.

Since now satellites have been deorbited mainly through uncontrolled reentry: perigee is lowered down to a height where atmospheric drag will cause the reentry within the statutory 25 years: the maneuver can be performed with any kind of propulsion but there is no way of controlling the epoch and the zone of impact. Only small satellites, which are likely to completely burn during the reentry, can be deorbited in this way due to the fatality risk constraint.

Satellite heavier than 700 kg can satisfy this constraint by performing a controlled reentry which allows targeting a precise uninhabited area. This strategy requires a relatively high level of thrust, therefore chemical propulsion, which translates in a huge quantity of boarded propellant and high launching cost.

While uncontrolled reentry is unrealizable for heavy satellites, controlled reentry is too much expensive. In order to combine the economy coming from the exploitation of atmospheric drag and electric propulsion, to the possibility of managing impact footprint and therefore fatality risk, the concept of semi-controlled reentry has been introduced. This reentry is not based on a final maneuver enabling to master precisely where the debris will fall, but relies on controlling the satellite down to a low altitude that enables the prediction of the impact footprint with a sufficient precision (1-2 ground tracks) thus enabling a reduction of the fatality risk through orbit phasing.

In this paper and presentation we will discuss the assumptions underlying the construction of a Simulator for very low altitude orbits. We will then present a semi-controlled reentry strategy based on electric propulsion and its feasibility in terms of maneuver duration, power balance, thermal limits, controllability and compliance with the Space Debris Mitigation requirements as a new promising way to perform safe deorbitation for heavy satellites even with limited thrust capabilities.