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ENVIRONMENT CAPACITY AS AN EARLY MISSION DESIGN DRIVER

Abstract

In the past years, several authors have dealt with the formulation of metrics and concepts to quantify the impact of a mission on the space debris environment. In our work, we developed such an index and introduced the environmental capacity as the number and typology of missions that are compatible with the stable evolution of the debris environment. This concept enables us to evaluate the effectiveness of mitigation guidelines by looking at the use of environmental capacity due to existing missions. The current work will investigate how the same concept can also be applied as a tool during the design of a mission and facilitates the comparison of different mission architectures depending on their overall contribution to the debris environment.

First, the paper will present the last updates to the index used as a metric of the environment capacity, including the inclusion of a penalisation for objects with low trackability and an improved model for the break-up probability.

Then, several application cases will be discussed to demonstrate its use as design driver. First, the relevance of adopting operational best practices (i.e. collision avoidance and disposal manoeuvre) will be studied for different spacecraft classes as a way of quantifying *better than required* behaviour. Then, the criticality of a mission will be analysed considering the case when the mission is realised through a single large satellite or through a constellation of smaller satellites. Taking this one step further, the impact of a mission consisting of a constellation and associated launches can be parametrically examined to derive the dependence on the design parameters.

Finally, different end-of-life scenarios will be assessed to demonstrate the use of the method to discriminate between various technologies on a case-by-case basis. The adoption of passive de-orbiting systems will be compared to conventional disposal through de-orbit burns or operations at lower altitudes to get an insight on how two options to be compliant to existing guidelines differ in terms of the resulting environmental criticality. Last, a scenario with active-debris-removal will be considered, showing how the quantification of the impact on the debris environment can support the selection of parameters such as the rendez-vous altitude depending on the expected success rate of the capture and final disposal phase.