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THE ECONOMIC CONTEXT OF THE "RECYCLER" SPACECRAFT, A TOOL TO OVERCOME
THE SPACE DEBRIS FREE-RIDER PROBLEM

Abstract

Space debris are a challenge for the space industry; eventually, the earth orbit could get out of control. Accelerating factors (private constellations, political threats etc.) make the prospect of the Kessler syndrome even more urgent. This paper develops a game theory model of the reaction of the industry against debris. It confirms how taking in account long-term costs helps overcoming these challenges. Regardless of the organizations' budget and cost constraints, the solution lies in the durable containment of probabilities of collision. However, a development of the model shows that today's space industry is unable to override the expansion of negative externalities. Nobody wants to cooperate and take care of this common good which is the earth orbit. This article draws on these fundamental findings to suggest a techno-economic solution applied to the geostationary orbit (GEO). While the debris trend is not exponential in GEO, the problem repeats itself there. The model suggests that it is possible to overcome the "free-rider" problem if the industry take care of debris while generating private profits. The Recycler is a hypothetical spacecraft able to accomplish this task. It is being designed to recycle or, in the short-term, re-purpose components in orbit. The game theory model is extended to a wider range of scenarios, including in-orbit recycling. It is found that even during the rise of the Kessler syndrome, the Recycler's strategy is still able to get the industry back on the right track. Although there is still a need for industry-wide cooperation, the private profits generated by this type of project can change the game Nash Equilibrium (NE). In the meantime, the Recycler and its Active Debris Removal (ADR) variants to all orbits need to be implemented as soon as possible to avoid the rise of the Kessler syndrome in a commercially-led space industry.