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UTILITARIANISM IN-ORBIT: IMPLICATIONS OF SAFE AND SUSTAINABLE DECISION-MAKING STANDARDS

Abstract

In the dynamic expansion of the space economy, Earth's orbits are growing ever more congested, driven by the proliferation of debris and the ongoing deployment of additional satellites, including mega-constellations. This congestion poses a risk to crewed spacecraft (such as the International Space Station) and vital satellite infrastructure supporting a variety of services on Earth, including global banking, communications, and environmental monitoring systems. These effects have been widely analysed from an economic perspective in the present literature, assessing the potential impacts or damages to critical in-space infrastructure. However, as norms and standards are progressively being established for in-orbit manoeuvring, further analysis will be necessary from an interdisciplinary view to comprehend how operators act and cooperate to responsibly ensure orbital safety while considering the potential externalities of their in-orbit behaviour. This research aims to examine the decision-making processes behind the execution of Collision Avoidance Manoeuvres (CAMs), exploring the impact of a utilitarian perspective on space resource utilisation through the analysis of emerging cooperative practices and their potential socio-economic impact on ground-based users.

We employ real and speculative orbital case studies to probe orbital decision-making factors. These scenarios are instrumental in considering trade-off situations in which standard practices in orbit intersect with challenging scenarios, in which the execution of an in-orbit manoeuvre might lead to loss of critical data for ground-based operations. For instance, in 2023 ESA's Sentinel-1 satellite operators faced a choice between providing disaster relief data during a natural disaster and avoiding collisions and preventing debris generation. While this conjunction alert did not ultimately result in an avoidance manoeuvre, operators (particularly in LEO) may increasingly be faced with risking near collisions with data gathering. The qualitative analysis of case studies is accompanied by an examination of some potential economic impacts, to make the argument for cooperative practices facilitating orbital manoeuvring, including conjunction data sharing, joint manoeuvre planning and cross-country standards coordination.

We ultimately argue that interdisciplinary analysis is fundamental for developing norms and standards for space safety and sustainability. Analysing potential scenarios and decision-making approaches not only from a technical perspective but also from an anthropological and socio-economic point of view, allows us to consider the multifaceted impacts and complexities involved in in-orbit operations. This comprehensive approach is essential for developing inclusive strategies that address the diverse needs and concerns of stakeholders while ensuring the long-term viability and equitable utilisation of space resources.