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INSIDER: A SCALABLE SOLUTION FOR ACTIVE DEBRIS REMOVAL

Abstract

The increasing number of objects in Low Earth Orbit (LEO), driven by the deployment of satellite constellations and higher frequency of space launches, underscores the urgent need for effective post-mission disposal and active debris removal (ADR) solutions. However, existing ADR concepts concentrate on dedicated servicing missions, which are constrained by high risks, complex mechanisms, and significant costs, slowing their development and adoption.

To respond to this need, INSIDeR (Innovative Net Space Inflatable Structures for Active Debris Removal) is being developed as a modular and scalable ADR solution that can function as a secondary payload on existing space platforms, enabling them to capture debris after completing their primary mission. By deploying a flexible net using an inflatable structure, INSIDeR allows for capturing nearby debris through a tethered mechanism. Once the debris is secured, the hosting platform can perform a deorbiting maneuver, integrating ADR directly into its post-mission disposal routine.

The primary advantages of this solution include its scalability in terms of targeted debris size and geometry, its reduced mass and volume, which enhance compatibility with host platforms, and its ease of integration with various space assets, including satellites, in-orbit servicing (IOS) platforms, and launcher upper stages. Additionally, INSIDeR offers a significant cost advantage, with total expenses estimated to be four times lower than competing ADR solutions, accounting for both development and operational phases. These advantages present a viable and promising solution that a wide range of space actors could eventually use to contribute to reducing the amount of debris, ranging from nanosatellites to larger objects that pose significant risks.

This paper presents the most recent updates regarding the design and development of INSIDeR, focusing on its system-level architecture and the design criteria for its deployment system and capture mechanism. It examines the engineering challenges associated with its integration on different hosting platforms, including interface compatibility and deployment constraints. Furthermore, this work discusses structural and materials considerations, evaluating the performance of lightweight, high-strength materials such as Mylar for the inflatable structure and Dyneema for the netting system. Furthermore, the development plan for INSIDeR will be presented, outlining the stages leading up to its deployment in space in 2026, the first debris capture at the end of 2027, and its commercial availability in 2028.

By presenting the details regarding the technical development of INSIDeR, this work emphasizes the ongoing efforts by the European Space Ecosystem to advance ADR technologies.