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# AUTONOMY AND OPERATIONAL CONCEPT FOR SELF-REMOVAL OF SPACECRAFT: STATUS DETECTION, REMOVAL TRIGGERING AND PASSIVATION.

**Abstract**

As a counter measure to producing more and more space debris, to be included in future Earth orbiting spacecraft of any size, mass and orbit, the Technology for Self-Removal project proposes a post mission disposal (PMD) module to be carried into orbit by each future spacecraft. Thus, the spacecraft's proper disposal after ending its operational lifetime for whatever reason (nominal end of mission, fuel outage, severe spacecraft failure, mission loss) shall be ensured. In order to do so, the PMD module provides a robust, reliable and highly autonomous operations concept that enables the PMD module to detect the hosting spacecraft's faulty - and supposedly mission ending – status, to secure the spacecraft by passivation and to trigger either a safe de-orbit or re-orbit and final disposal of the spacecraft.

This paper focuses on the PMD module's on-board autonomy, highly reliable health status detection of the hosting S/C on-board the PMD module, the passivation and removal triggering even in case of lost link to the ground for the novel concept of self-removal.

Different levels of autonomy with respective operational approaches including the appropriate removal triggering process are defined. Especially when it comes to mega constellations, the highly autonomous approach for the self-removal with an attached PMD module is an attractive solution for orbital debris mitigation: the workload of ground operators can potentially be reduced and thus, the overall operational cost go down by using a standardized, series production removal module that takes care of the entire removal process, starting with the detection of the spacecraft's mission ending status.

A list of detectable symptoms is provided that indicate a non-healthy spacecraft. Different types of sensors are investigated with respect to their potential contribution to detect those symptoms of the host spacecraft on-board the PMD module. The sensors are traded systematically considering their additional benefit, weight and power consumption and the best combination of sensors for the status detection purpose is proposed.

The passivation of the host S/C is a crucial aspect before its removal and shall prevent its accidental break-up, which would cause even more space debris. The paper informs about relevant space debris mitigation guidelines, gives the definition of passivation and summarizes the most frequent solutions. An analysis about the possible passivation measures for the host S/C from the PMD module without additional hardware and consequences with respect to the successful removal, if passivation fails, concludes the paper.