ELSA-d – A Novel End-of-life Debris Removal Mission: Mission Overview, CONOPS, and Launch Preparations

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ABSTRACT

The rise of large commercial satellite constellations in low-Earth orbit (LEO) will lead to an increase in the number of objects in key orbits and will raise the risk of potential collision. Systematic spacecraft end-of-life (EOL) management strategies assuring post-mission disposal (PMD) are required to maintain the utility of key LEO assets.

The novel End-of-Life Services by Astroscale demonstration (ELSA-d) mission promises to be a major step forward in proving technology necessary for rendezvous and proximity operation (RPO), capture, and removal of orbital debris. The ELSA-d mission, which is in its assembly, integration and test (AIT) stages and is due to launch in 2020, will demonstrate key technologies and procedures for the rendezvous, capture, and eventual de-orbit of a piece of debris.

ELSA-d will consist of two satellites launched together – a servicing satellite that will perform the RPO and capture capabilities and a small client satellite that will serve as a model for a piece of orbital debris. After launching together, the two satellites will repeatedly separate and dock in orbit, each time showcasing a different capability that will be applicable to the commercial market. The servicing satellite will be equipped with rendezvous guidance, navigation, and control (GNC) technologies and a magnetic docking mechanism, whereas the client has a docking plate (DP) which enables it to be captured.

In this paper, the technologies behind each phase of the concept of operations (CONOPS) and how these align with future servicing missions will be discussed. Whereas previous similar missions have performed RPO with cooperative and stable targets, ELSA-d will demonstrate semi-autonomous capture of both non-tumbling and tumbling targets, the latter being novel in the space environment. ELSA-d will also demonstrate search and inspection capabilities in which we will intentionally place the client satellite outside of the field of view of the relative navigation sensors on the servicer. The use of a walking safety ellipse, a passively safe trajectory, and the combination of sensor scanning and absolute-to-relative navigation handover are key RPO capabilities that will be validated. Additionally, the autonomy of the ELSA-d mission, assessing which aspects are performed autonomously on-board and which are performed by an operator, are described. This will have implications on utilization of both the space and ground segments of future missions.

As ELSA-d is finalized for its upcoming launch, this paper will give an overview of the latest updates from Astroscale Japan's clean room and provide a description of the technologies that will lead to safe and effective solutions for maintaining orbital sustainability and accessibility of LEO.