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Author: Mr. Alex Godfrey  
Astroscale Ltd, United Kingdom, a.godfrey@astroscale.com

Dr. Adrian Dumitrescu  
Astroscale Ltd, United Kingdom, a.dumitrescu@astroscale.com

Dr. Jason Forshaw  
Astroscale Ltd, United Kingdom, j.forshaw@astroscale.com

Dr. Daniele Frollani  
Astroscale Ltd, United Kingdom, d.frollani@astroscale.com

Ms. Zoé Tenacci  
Astroscale Ltd, United Kingdom, z.tenacci@astroscale.com

Mr. Neil Yarr  
Astroscale Ltd, United Kingdom, n.yarr@astroscale.com

Dr. Stephen Wokes  
Astroscale Ltd, United Kingdom, s.wokes@astroscale.com

Mr. Nick Shave  
Astroscale Ltd, United Kingdom, n.shave@astroscale.com

Mr. Chris Blackerby  
Astroscale Ltd, Japan, c.blackerby@astroscale.com

Mr. Nobu Okada  
Astroscale Pte. LTD, Japan, nobu@astroscale.com

BEYOND ELSA-D – DEVELOPING COMMERCIAL VIABILITY OF MULTI-CLIENT SERVICING  
WITH ELSA-M

**Abstract**

Large commercial satellite constellations in low Earth orbit (LEO) provide essential services but increase the number of objects in key orbits. This raises the risk of further debris creation and could ultimately make these orbits unusable for future generations. Commercial services for post-mission disposal are widely encouraged through government and agency policies (such as ESA's Zero Debris policy) to maintain the safe use of LEO orbits for the benefit of humankind.

Astroscale launched its ELSA-d mission in March 2021 to perform in-orbit demonstrations of core Rendezvous and Proximity Operation (RPO) capabilities necessary to achieve debris removal. The successor mission, ELSA-M, will build upon ELSA-d to develop a service which can remove multiple clients. It involves moving to clients sequentially to dock with them via a prepared docking plate interface, lower their orbits, and drop them off for uncontrolled re-entry before moving on to the next client. ELSA-M has been developed with prime OneWeb as part of the ESA Sun-rise programme, which has been under development since 2018 and is currently working towards Critical Design Review.

This paper explains the critical technical developments (space segment and ground segment) that have been required to mature from ELSA-d to the ELSA-M commercial servicer. Details are provided on the following mission enabling elements: a concept of operations to realise the capture of a OneWeb client spacecraft; the RPO sensor suite to support short- and long-range RPO manoeuvres; Guidance Navigation and Control and Computer Vision algorithms essential for supporting closed-loop RPO manoeuvres;

Astroscale's magnetic capture system to ensure safe docking and compatibility with client spacecraft; supporting ground segment capabilities, such as the Flight Dynamics System to determine the position and the orientation of satellites; and the operations support required to plan and execute manoeuvres in-orbit.

In addition to the core mission, Astroscale will also be demonstrating the capability of an intersatellite link through the BGAN network to provide constant coverage and support long-range RPO manoeuvres. This paper provides further details on this aspect and also explains how Astroscale has approached enabling services (such as insurance), regulation, and policy, which in some instances are being addressed for the first time for debris removal services.

The ELSA-M in-orbit demonstration is planned to launch in the 2025 timeframe and would result in the world's first prepared satellite debris removal mission conducted with a full-sized representative constellation customer in One-Web.