



COSMIC, UK's first Active Debris Removal mission and Europe's latest gem to the In-Orbit Servicing ecosystem

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2023 ESA CleanSpace Industry Days





Introduction



Astroscale: An International Company Solving a Global Problem

Astroscale's vision is the safe and sustainable development of space for the benefit of future generations.



6 Offices



>480 Diverse Team Members



70% Engineers
35% Women



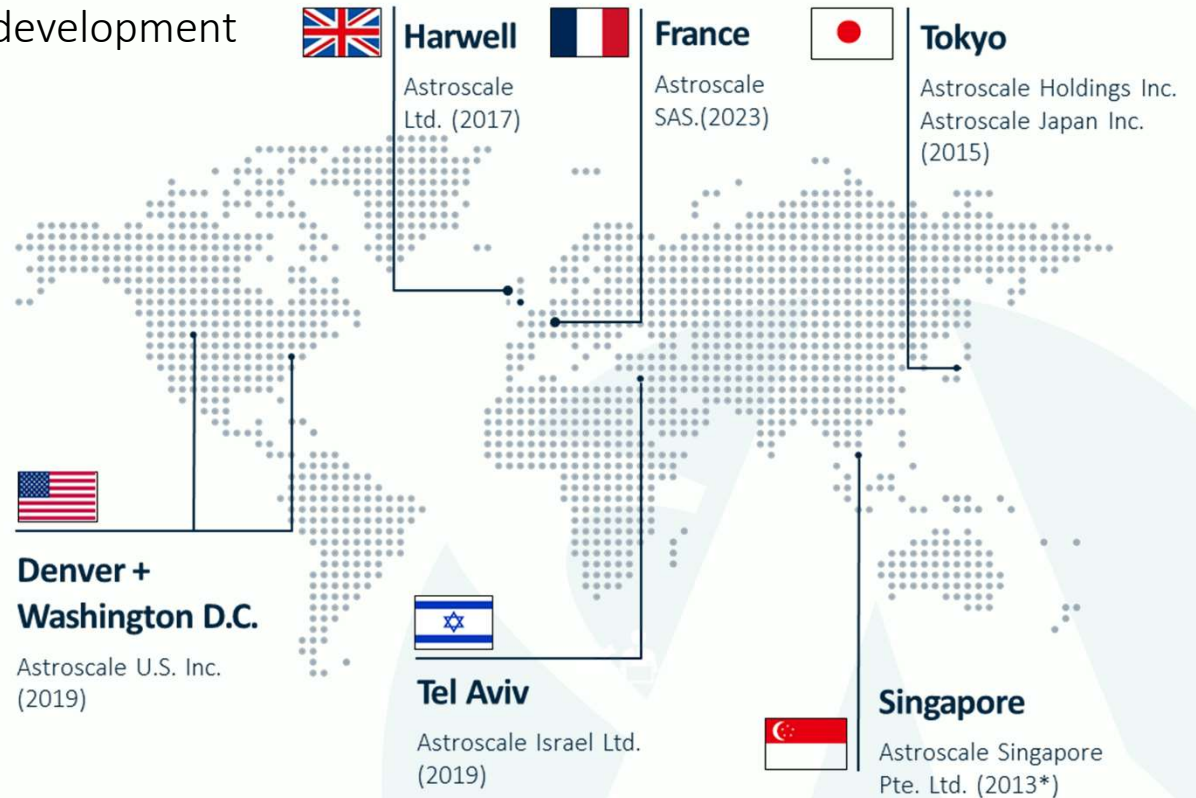
30+ Awards



Expansive Global Leadership



US ~\$380M Raised



Astroscale's Heritage Pathway – I

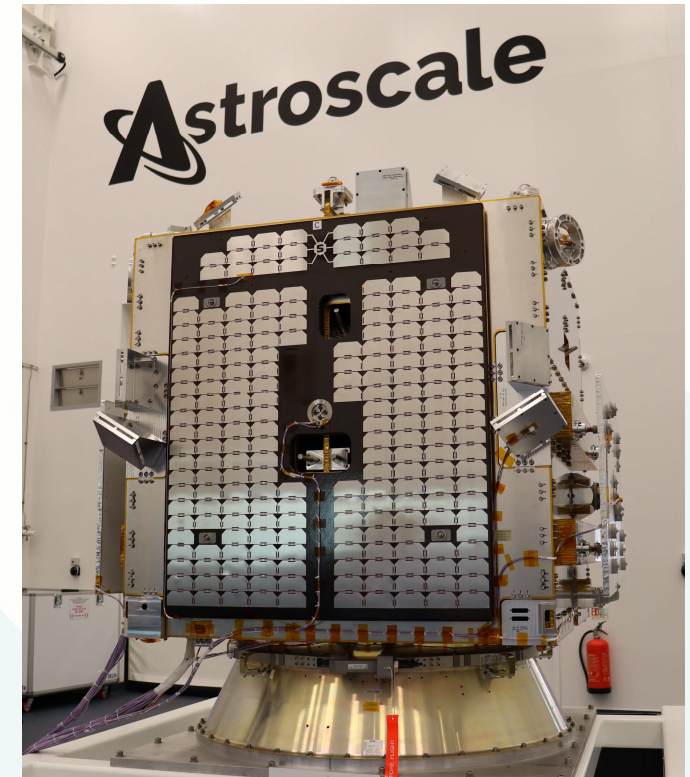


ELSA-d

- ELSA-d consists of a servicer and small client launched together which dock and undock in a series of demonstrations to mature capability.
- Design and integrated in Astroscale Japan. Operations by Astroscale UK.
- Launched in March 2021 by Soyuz from Baikonur.
- Working with a range of partners, space and regulatory agencies including UKSA (mission license), ESA (strategic agreement), JAXA (joint research agreement), SSTL (client manufacturer).

ELSA-M

- ELSA-M the commercial successor to ELSA-d, has been in development for 5 years with ESA and OneWeb, under the Astroscale's Sunrise Project awarded contract.
- The Sunrise Project, which is a part of the ESA ARTES programme, was created to advance Active Debris Removal (ADR) capabilities in low Earth orbit.
- The first ELSA-M commercial preliminary servicing is planned with OneWeb for 2025 to service one of their assets.



ELSA-M SQM – Credits: Astroscale UK

Astroscale's Heritage Pathway – II



Long-range RPO. Ability to undertake a long-range search, approach and rendezvous.

Relative Navigation. Successful closed-loop control and station keeping using on-board relative navigation sensors. Successful transition from absolute navigation to relative navigation operating regimes.

Docking. Successful validation of in-flight magnetic docking with a magnetic capture system to a docking plate.

Safety in RPO. Successful demonstration of safety abort manoeuvres and operations under contingency conditions with reduced propulsive capability.

SST Usage. Understanding of the limits and shortcomings of ground-based SST data in the context of RPO missions, and iteration with providers to alleviate those

RPO Operations. Synchronized operations of two spacecraft while in simultaneous communication with spacecraft team in Japan, SSTL spacecraft team in London, and multiple ground station providers.

Importance of Space Sustainability Regulation / Debris Removal

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NEWS

US issues first ever fine for space junk to Dish Network



Source: BBC News

Precedence settlement : First ever fine for the creation of Space Debris during the week of the 2nd of October 2023, which shall help the space industry understand the importance of its commitment to space sustainability regulations

The New York Times

Dish Is First Company to Be Fined by F.C.C. Over Space Junk Rule

Dish, the television provider, failed to move its dead satellite into a higher orbit, where it would pose little threat to active satellites, the agency announced. The company agreed to pay a \$150,000 fine.

Source: The New York Times

World Leading Commercial Technology



COSMIC

Cleaning up the Past

- World's first institutional multi-removal, Active Debris Removal (ADR) mission of unprepared objects
- Robotic technology to remove legacy unprepared objects
- Refuellable for future servicing

ELSA-M

Preparing for the Future

- World's first End-of-Life (EOL) service of a full-sized commercial end customer
- Magnetic removal of prepared satellites
- Multi-client removal to achieve strong business case





COSMIC – Introduction

COSMIC – An Overview

- COSMIC stands for “Cleaning up Outer Space Mission through Innovative Capture”.
- The mission is advancing in late 2023 to a Phase B (PDR) maturity.
- COSMIC is a variant of ELSA-M, meaning it will rely on the operational heritage from ELSA-M which flies prior to COSMIC (and other past missions such as ELSA-d).
- The COSMIC consortium consists of 13 entities in Phase B. This will be expanded to a European supply chain in Phase C, with expected contributions from Belgium, France, Germany, Ireland, Italy, Netherlands, Norway, Switzerland, Spain and the UK.

Phase 0/A

Less parties are needed for the study phase.



Subcontractors:

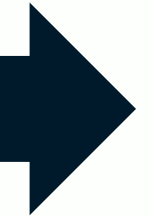


Phase B

Supply chain is expanded with key partners and subcontractors.

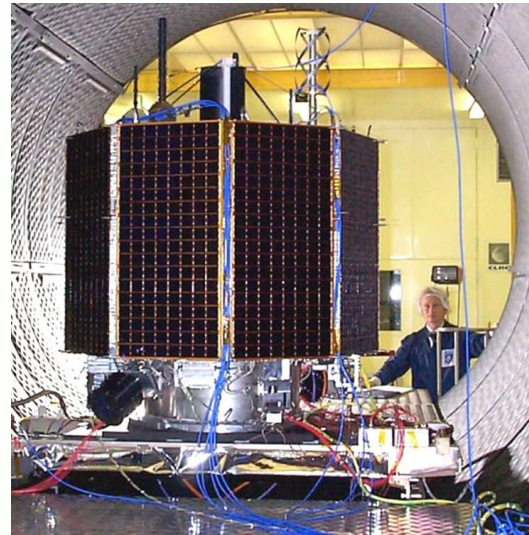


Subcontractors:



Client Selection

- Some of the considered factors:
 - Age of client and structural knowledge
 - Orbital information
 - Client tumbling rate
 - Ownership and legality
 - Technical feasibility
- No final decision has been made yet on the chosen clients, and clients could change based on new data obtained in future.



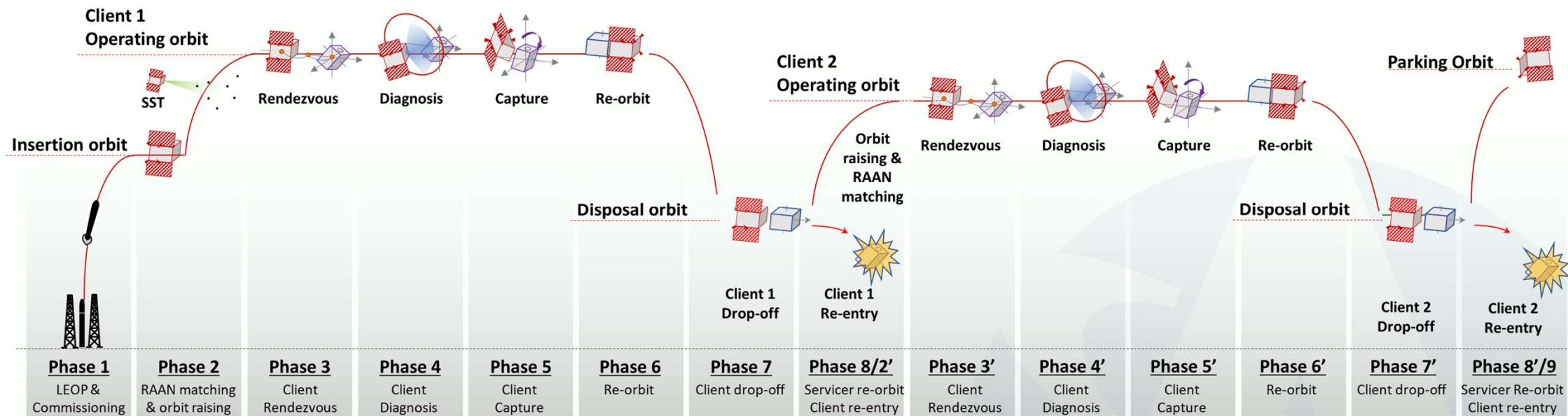
Example Client – UoSat 12
Launch: 1999
Orbit: 650 km
Mass: ~300 kg

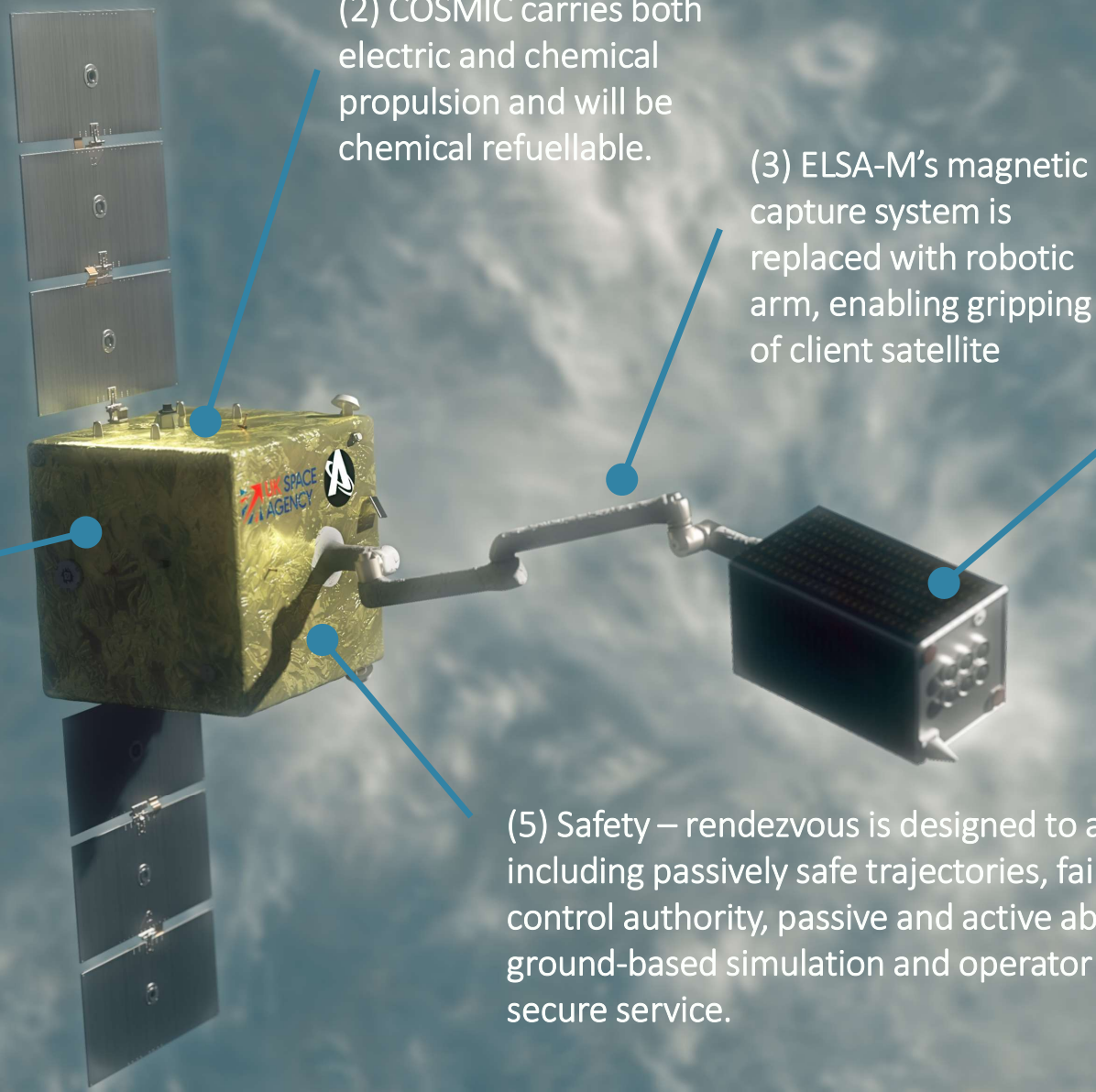


Example Clients – UoSat 3 to 5
(5 shown in image)
Launch: 1990 – 1991
Orbit: 750 – 800 km
Mass: ~50 kg



Concept of Operations (ConOps)





(1) An ELSA-M variant, COSMIC is designed with commercialisation in mind for future removal of existing in-space assets or robotic commercial removal.

(2) COSMIC carries both electric and chemical propulsion and will be chemical refuellable.

(3) ELSA-M's magnetic capture system is replaced with robotic arm, enabling gripping of client satellite

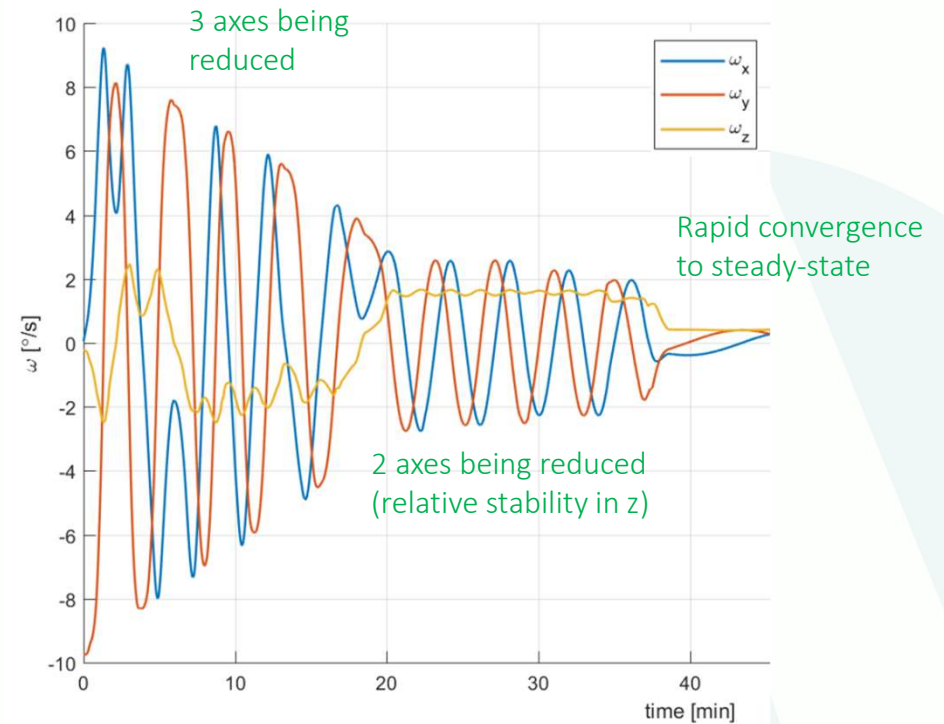
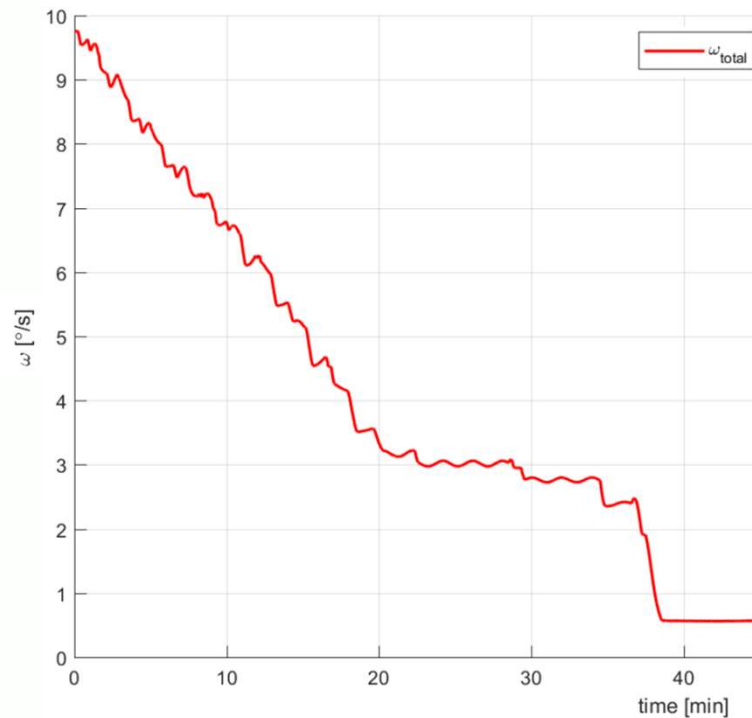
(4) Client Satellite: Existing UK-owned debris in the tens of kilograms class, mostly launched over 30 years ago

(5) Safety – rendezvous is designed to assure client safety, including passively safe trajectories, fail-safe multi-level control authority, passive and active aborts, high-fidelity ground-based simulation and operator training, and a cyber-secure service.



Focus Area – Detumbling Capabilities

- Astroscale is working with partner GMV to develop capability in detumbling client spacecraft. Current simulation shows capability of reducing tumble rates from up to 10°s^{-1} , down to less than 1°s^{-1} in under an hour.
- The capability is based on plume impingement using thrusters to thrust on the client spacecraft to reduce the tumbling.





Focus Area – Refueling Capabilities

- Astroscale is working with partners TAS (Thales Alenia Space), Nammo and Orbit Fab to develop the refueling subsystem.
 - This will enable COSMIC to be refuellable for chemical propellant (i.e. for another servicer to refuel COSMIC).
 - There is more complexity in this than just fitting a refueling coupling – as a whole subsystem is needed to manage the fluid flows during fuel transfer.
 - RAFTI has been selected as the fuel coupling.
- Lately, there is a growing interest in seeing COSMIC being adapted to provide refueling capabilities in LEO (and not only being refuellable) and as such, current studies are assessing the feasibility and market value of such an evolution of the servicer



Credit: Orbit Fab from www.orbitfab.com



Opening

Astroscale – World Class Pioneering In-Orbit Servicing Missions

ELSA-d



2021-2023 World's first ADR demonstrator of RPO and magnetic capture

2021

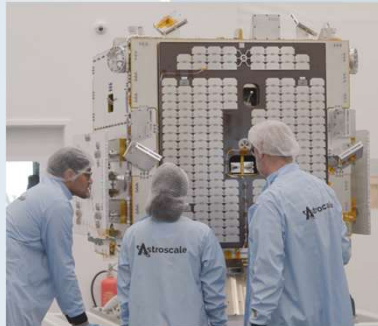
ADRAS-J



2023 World's first institutional inspection of an upper stage (JAXA)

2023

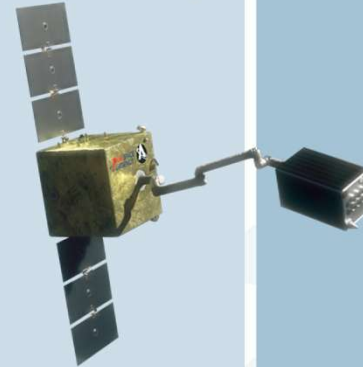
ELSA-M



2025 World's first ADR servicing of a full-size constellation satellite (OneWeb, ESA)

2025

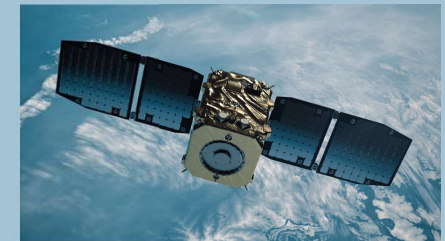
COSMIC (UK ADR)



2026 World's first institutional multi-removal ADR mission (UKSA)

2026

Commercial Debris Removal Servicing



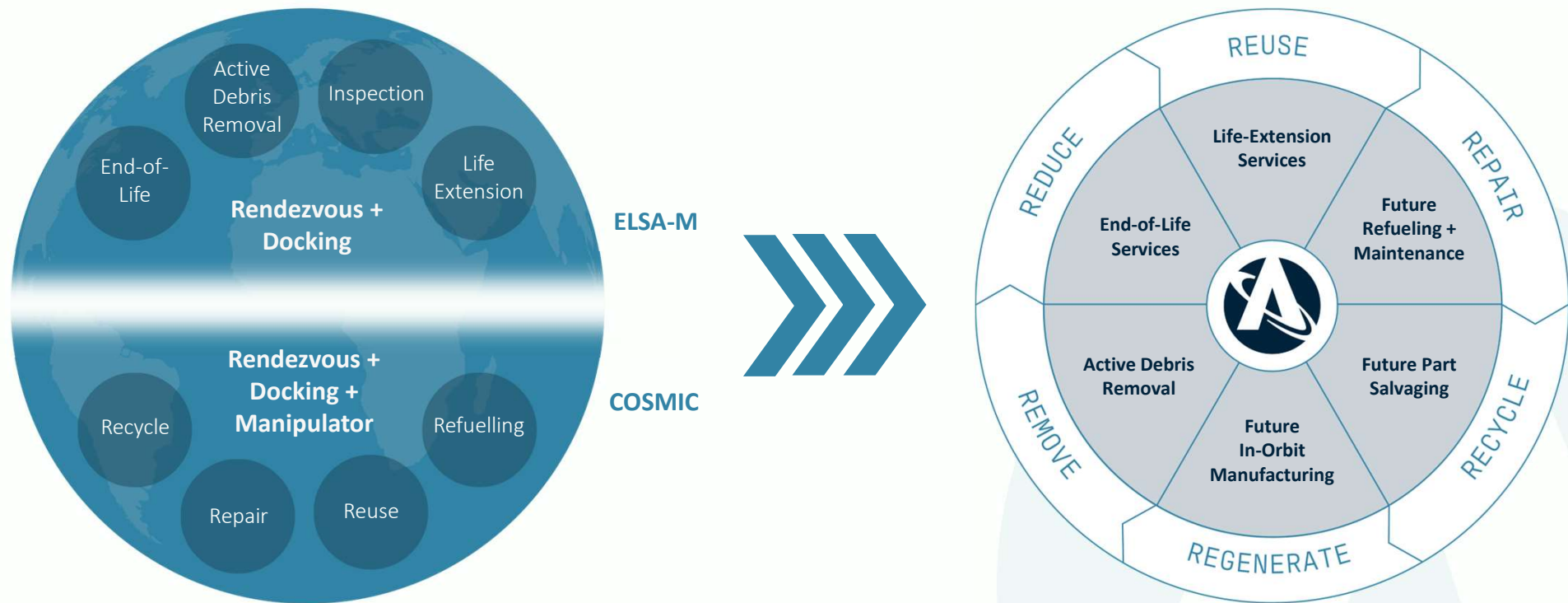
2026/7+ Scale up of ELSA-M commercial offerings to constellation customers

2028

Heritage: Three Astroscale in-orbit servicing missions developed by the time of COSMIC.

Sustainable Space

Astroscale's services enable a circular economy in space, all while mitigating risk and maximizing value



Questions?



#Space Sustainability

宇宙ゴミの大掃除、はじまる。  **Astroscale**



Appendix