Astroscale's Active Debris Removal Services - A Review

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The Global In-Orbit Servicing Company

6 Offices

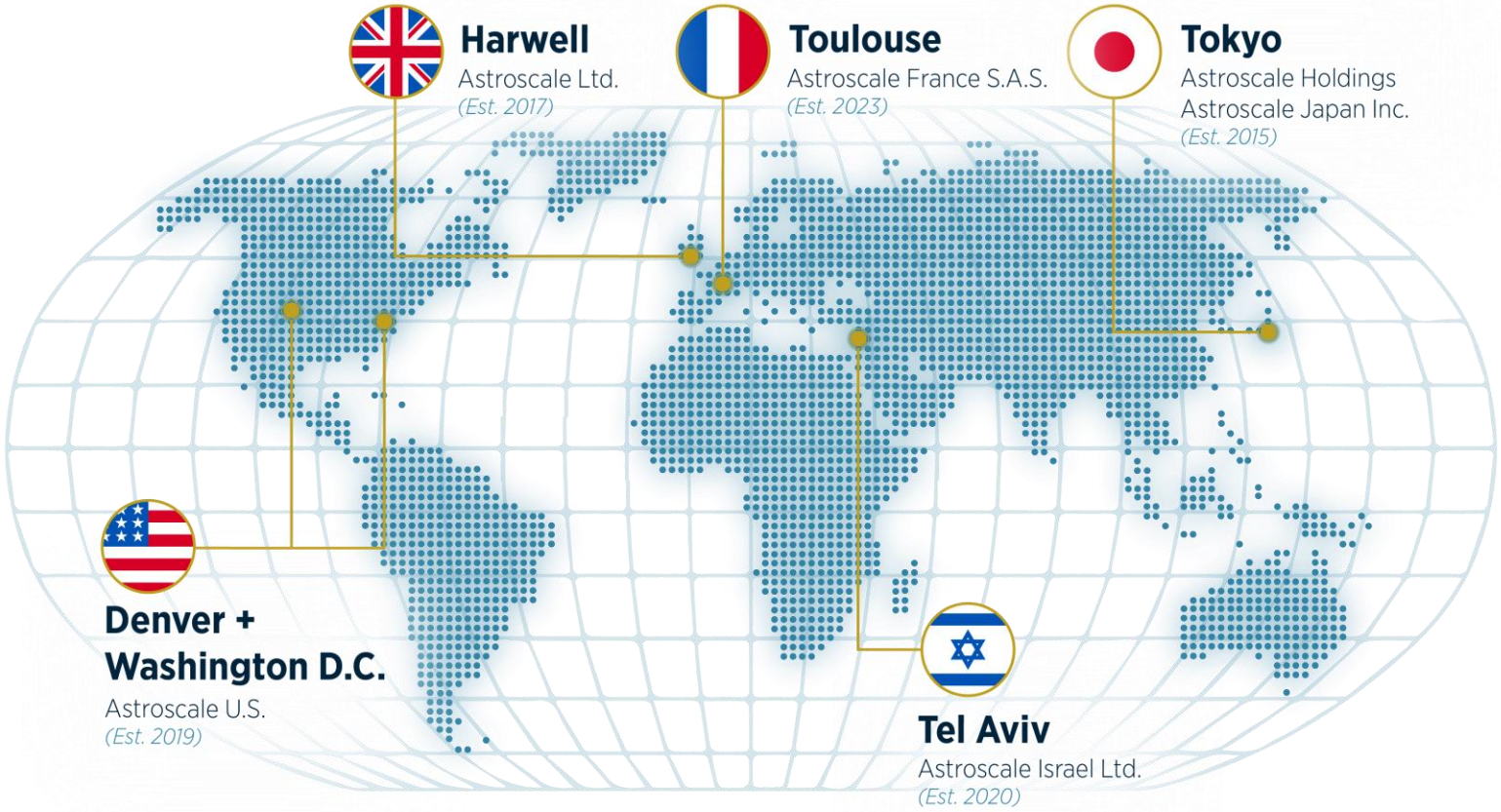
600+ Team

Influential Global Leadership

In-House Development & Operations

30+ Awards

$383M Raised[1], IPO June 2024

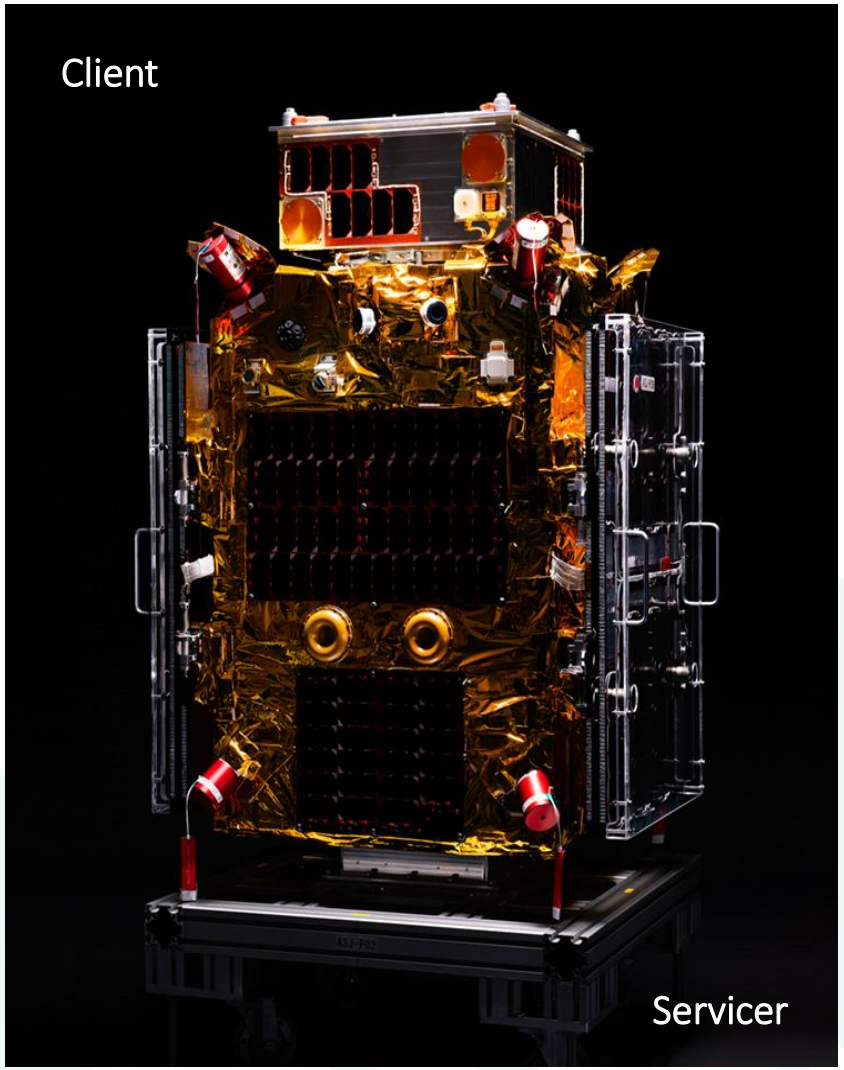


[1] Represents total amount of equity raised up to Series G, showing the amount as of November 2023.

ELSA-d Mission

ELSA-d – Introduction

- 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:
  - UKSA – Mission license for ELSA-d.
  - ESA – strategic agreement with ESA to provide mission imagery data in exchange for laser tracking services, collision avoidance analysis.
  - JAXA – joint research agreement to utilise their test facilities.
  - UKRI – £4.2 M funding for development of In-orbit servicing control Centre (IOCC) Harwell with Satellite Applications Catapult (SAC).
  - SSTL – manufacturer of client.
  - Mission Operations providers – RHEA, GMV, CGI, SAC.
  - Ground stations – KSAT, SSC, ViaSat.



ELSA-d – Debris Removal Demonstrator

Technical Successes

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.

Reference: Forshaw, J., Colebourn, A., Walker, C., Hutchinson, E., Shave, N., Iizuka, S., Seto, Y., Ota, Y., Lidtke, A. A., Kobayashi, Y., Fujii, G., Blackerby, C., Okada, N. (2022). Operational Progress Update on the ELSA-d Debris Removal Mission. 73rd IAC, Paris. IAC-22,A6,5,x69288

ELSA-M and COSMIC (UK ADR) Missions

World Leading Commercial Technology

COSMIC

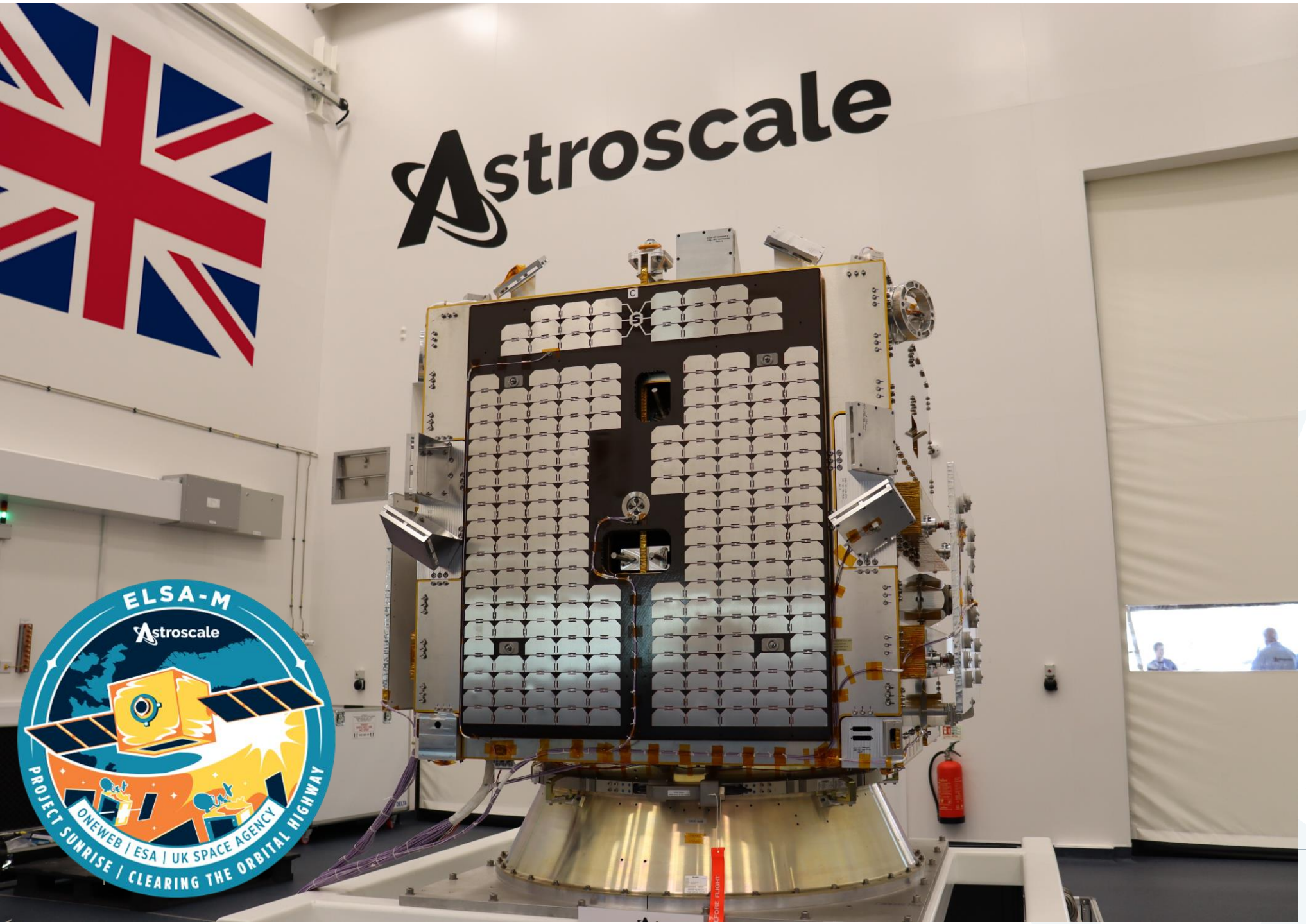
Cleaning up the Past

- 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

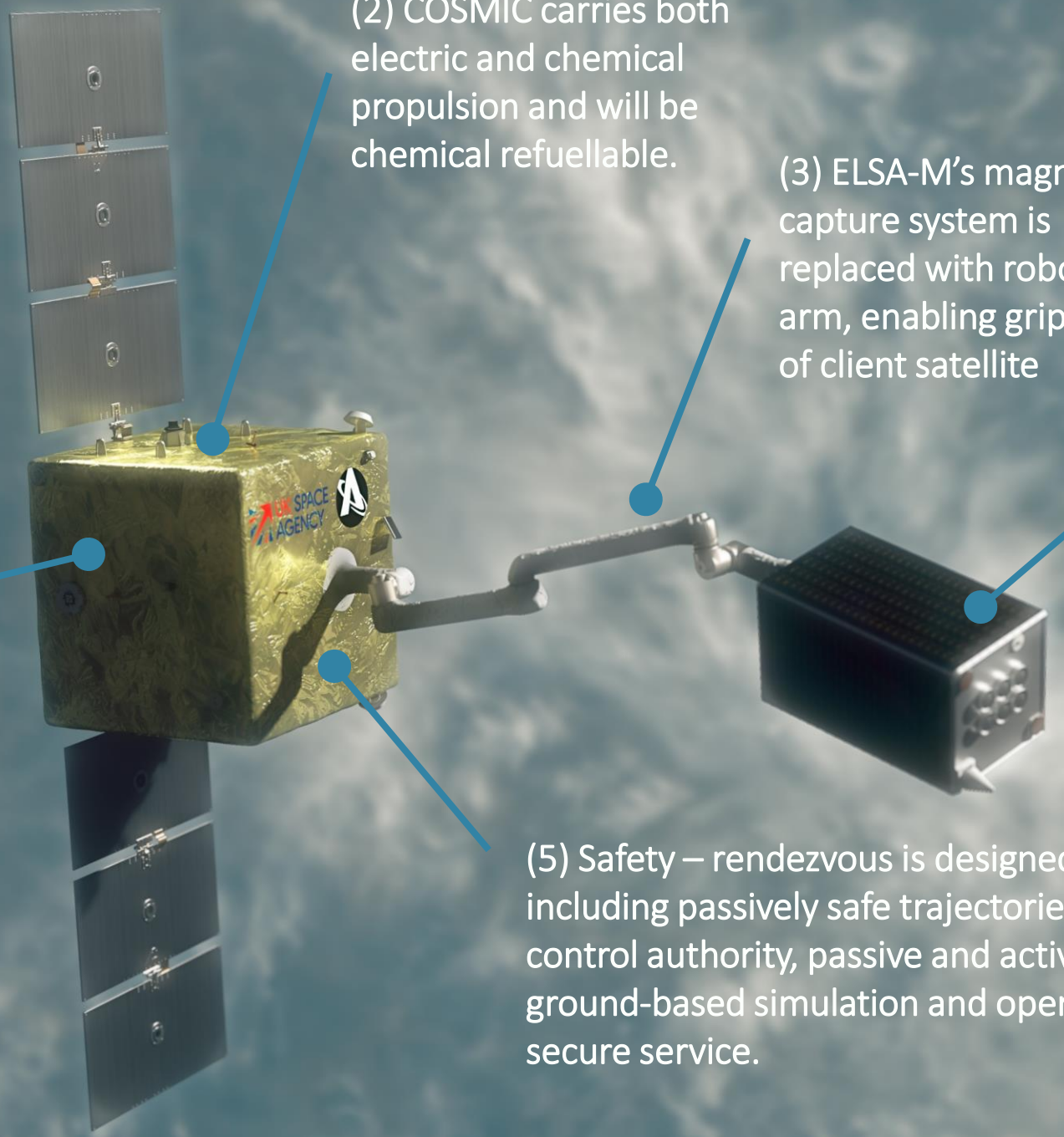
- World's first End-of-Life (EOL) service of a full-sized commercial end customer
- Magnetic removal of prepared satellites
- Multi-client removal to achieve strong business case



ELSA-M

Commercial Debris Removal

- ELSA-M the commercial successor to ELSA-d, has been in development for 5 years as a PPP with ESA and Eutelsat OneWeb.
- The first ELSA-M preliminary servicing offering is planned with Eutelsat OneWeb for early 2026 to service one of their assets.



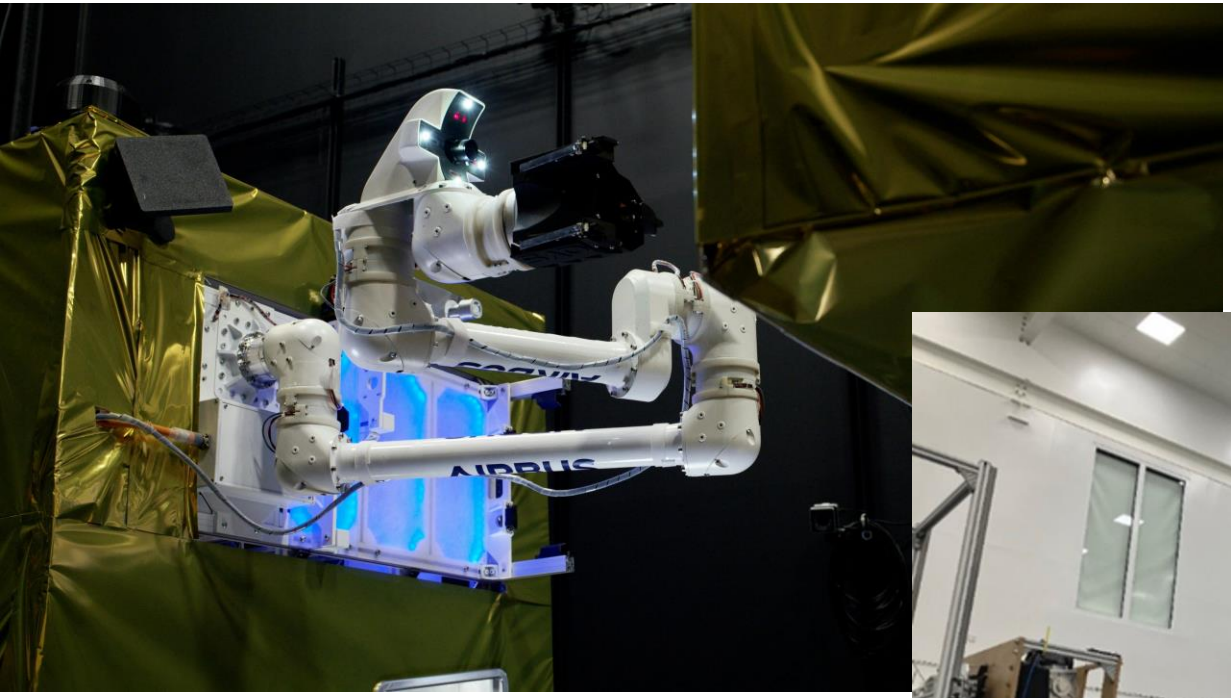
(1) An ELSA-M variant, COSMIC is designed with commercialisation in mind for future removal of existing in-space assets or robotic commercial removal.

(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.



Robotics testing in COSMIC Phase B
(courtesy Airbus)

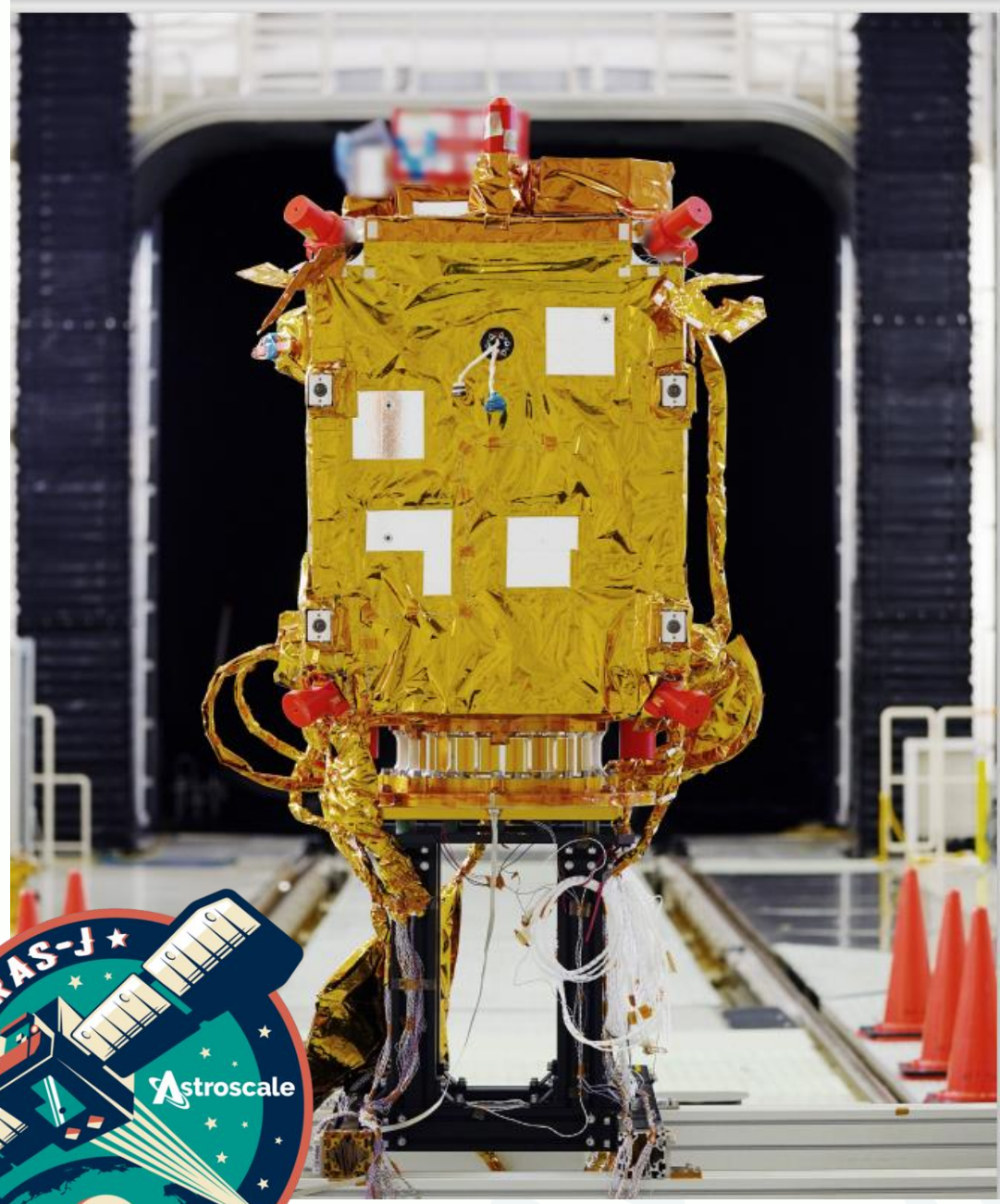
ELSA-M system and subsystems
testing with OneWeb Gen 1 Mock-up

ELSA-M SQM in
Astroscale Cleanroom

ADRAS-J1 and J2 Missions

ADRAS-J – Institutional Inspection

- ADRAS-J(1) is a groundbreaking mission as the world's first attempt to safely approach, characterize and survey the state of an existing piece of large debris through RPO.
  - Majority ground segment and FDS are from our UK office.
- The ADRAS-J2 mission is being developed under prime Astroscale to undertake the full satellite removal expected in ~2027 timeframe.
  - JAXA has awarded Astroscale Japan in August EUR 81 M contract to perform the de-orbit.
- Client: 3 tonnes, altitude 500 – 600 km
- Feb 2024 – launch by Rocket Lab, commissioning, start of the rendezvous phase.
- Apr 2024 – start of AON and proximity approach from several hundred km and approach to the client within several hundred meters.
- May 2024 – rendezvous down to 50 m with inspection.
- Jul 2024 – three fly-around observations performed to date (videos on YouTube!)

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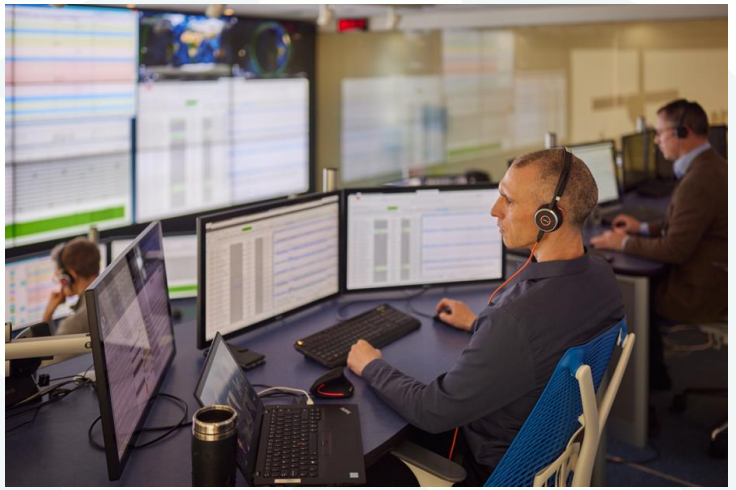
Conclusions

- Today we have looked at some of key Astroscale services we have been developing in UK/Europe.
- Astroscale UK has been growing considerably as a business and have over 200 staff. We are one of the largest commercial space companies in the Harwell area. Astroscale FR is also growing rapidly and is based in Toulouse.
- We have a clear dedication to deliver global services, growing our supply chain and developing key partnerships on our IOS journey. >85% of our mission supply chains are based in the UK or Europe.
- In 2022 we opened Zeus, a 20,000 sqft satellite integration facility in the UK, with clean room and operations room, capable of producing several servicer satellites.



Zeus Main Building (top) and Operations during ELSA-d (bottom).

Questions?

#Space Sustainability

宇宙ゴミの大掃除、はじまる。 Astroscale