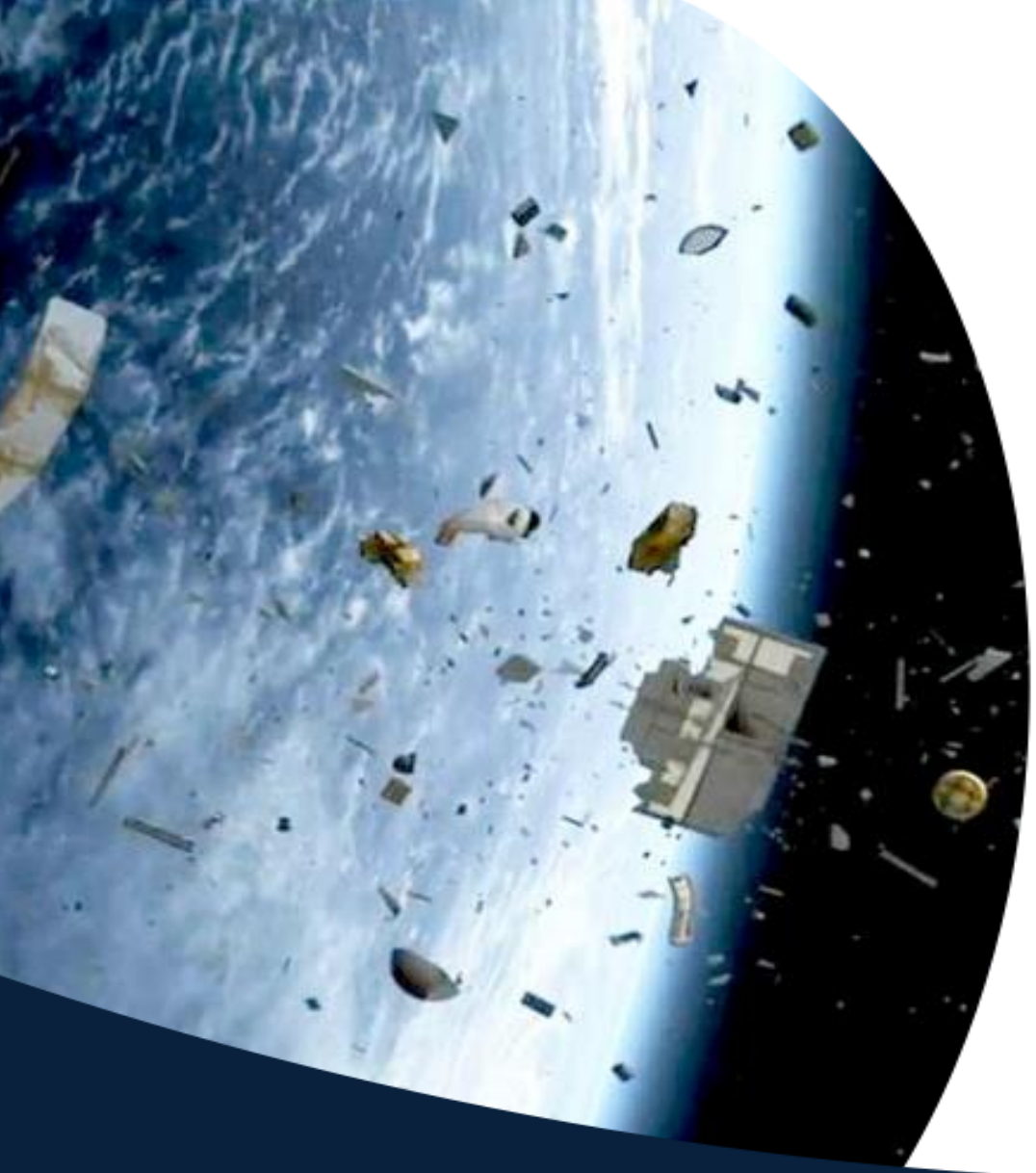


ELSA-d: Mission design and performance to date

Speaker

Dr Stephen Wokes

Director of Engineering, Astroscale UK

Co-authors

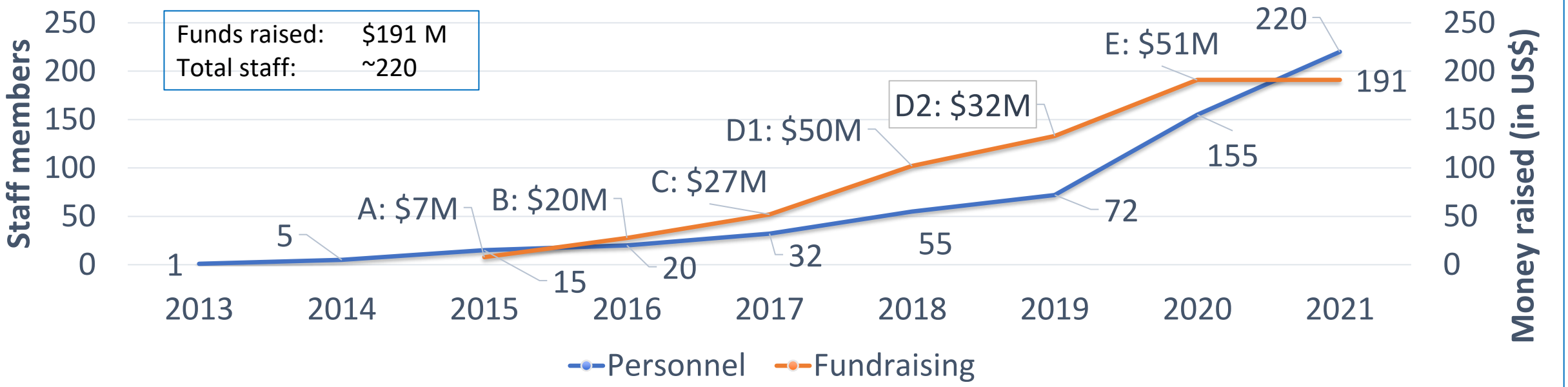
Jason Forshaw, John Auburn

2021 ESA Clean Space Industrial Days

Astroscale: An International Company Solving a Global Problem

- Astroscale's vision is Safe and sustainable development of space for the benefit of future generations.
- Our services include End of Life (including large constellations), Active Debris Removal and GEO Life Extension.

Growing Team, Increased Fundraising and Expanded Global Presence



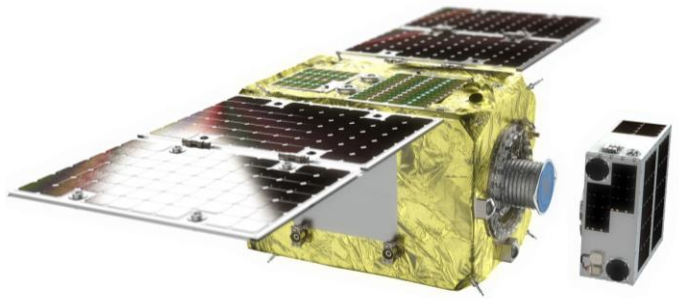
Astroscale Singapore
May 2013

Astroscale Japan - Tokyo
May 2015

Astroscale UK - Harwell
May 2017

Astroscale US – Denver, April 2019
Astroscale Israel – Tel Aviv, 2020

Our Activities

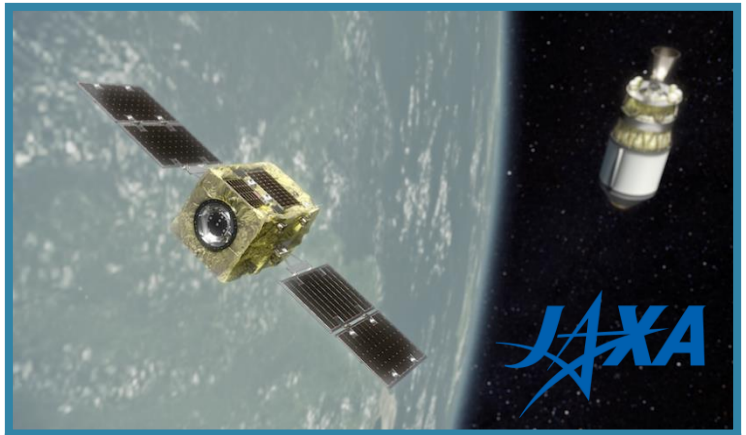


ELSA-d Mission – the world's first commercial demonstration of ADR

OneWeb

esa

Working on ESA Sunrise Programme with OneWeb towards a future large constellation EOL service.

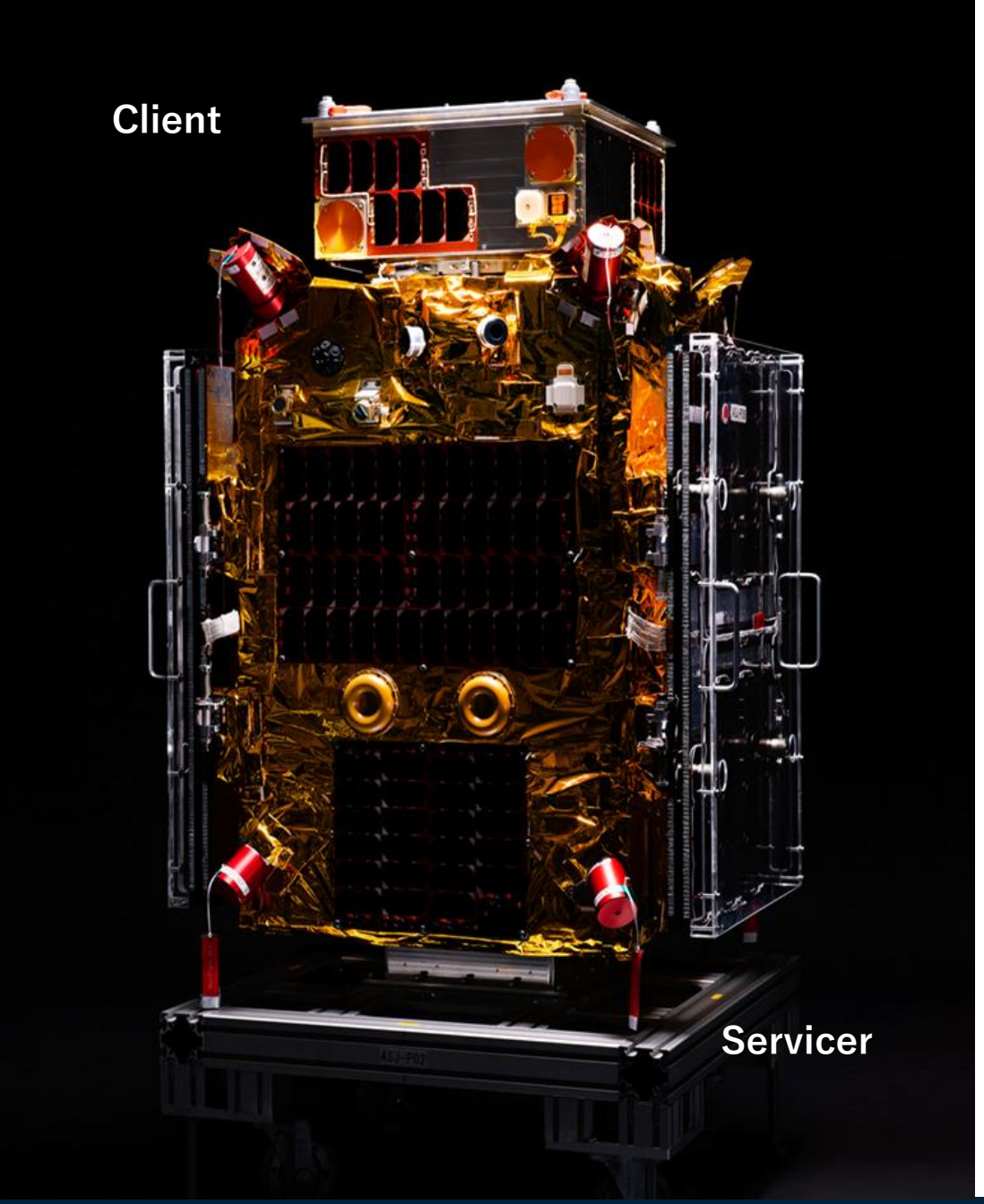


Astroscale selected as prime provider of ADRAS-J inspection mission, paving way for CRD2 ADR

Recent acquisition of Effective Space assets into Astroscale Israel, moving towards GEO LEX missions

Prime developer for UK National IOS Facility, Catapult, Harwell

Totsuka Ground Station, Yokohama, Japan

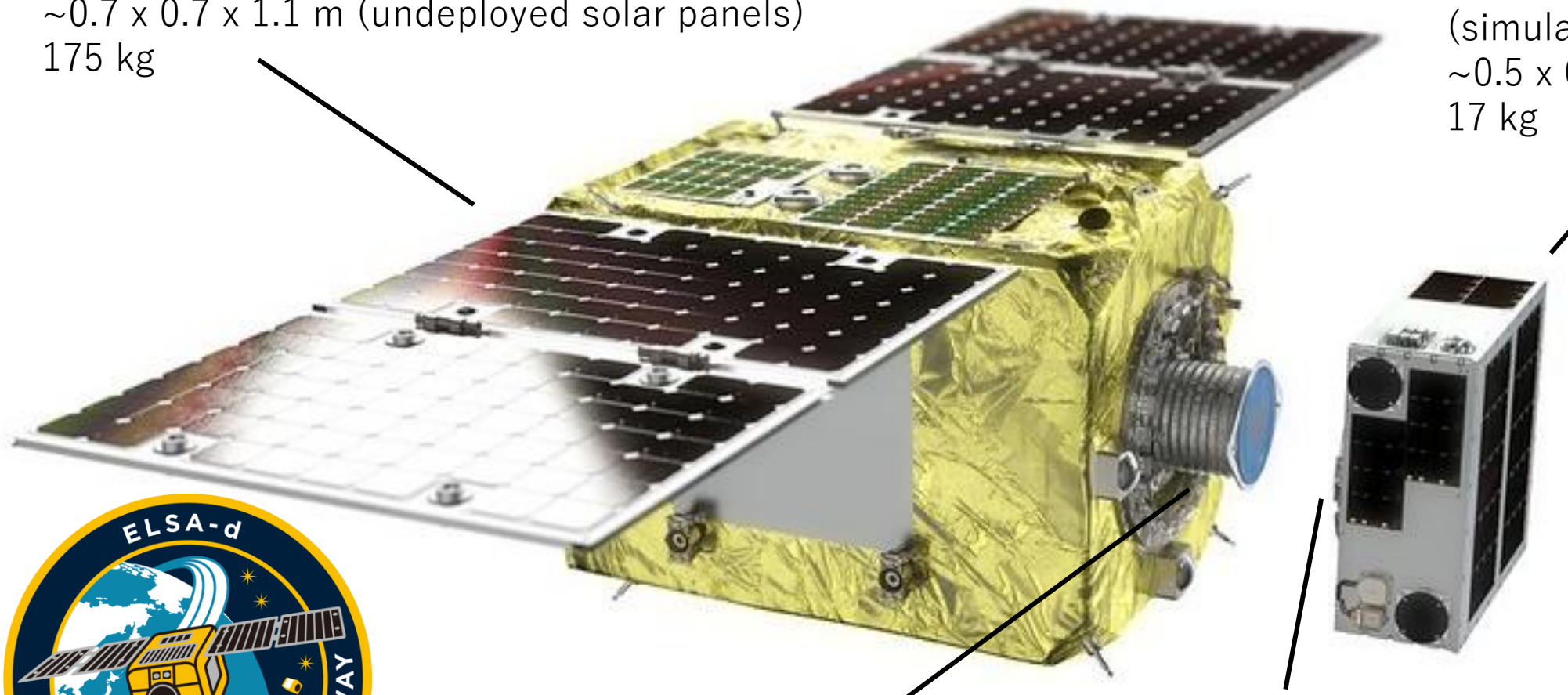


ELSA-d – In-orbit Demonstration

- ELSA-d consists of a servicer and small client launched together which dock and undock in a series of demonstrations to mature capability.
- **World's first** commercial Active Debris Removal (ADR) demonstration mission which goes through the full CONOPS of an end of life mission.
- **Demonstrations:** test capture, non-tumbling capture, tumbling capture, inspection, search & approach, de-orbit.
- Developed primarily from Japan and built in our Tokyo cleanroom.
- Launch in March 2021, **1st test phase completed** demonstrating release and rapid re-capture of client in preparation for non-tumbling capture.
- **Mission video**: https://youtu.be/HCWxdK7I0hI

Servicer
The satellite doing the rendezvous
~0.7 x 0.7 x 1.1 m (undeployed solar panels)
175 kg

Client
The satellite being captured
(simulating a space debris)
~0.5 x 0.5 x 0.2 m
17 kg



Capture System
Magnetic capture system
which extends

Docking Plate (DP)
Future proofing satellites
to enable easy docking

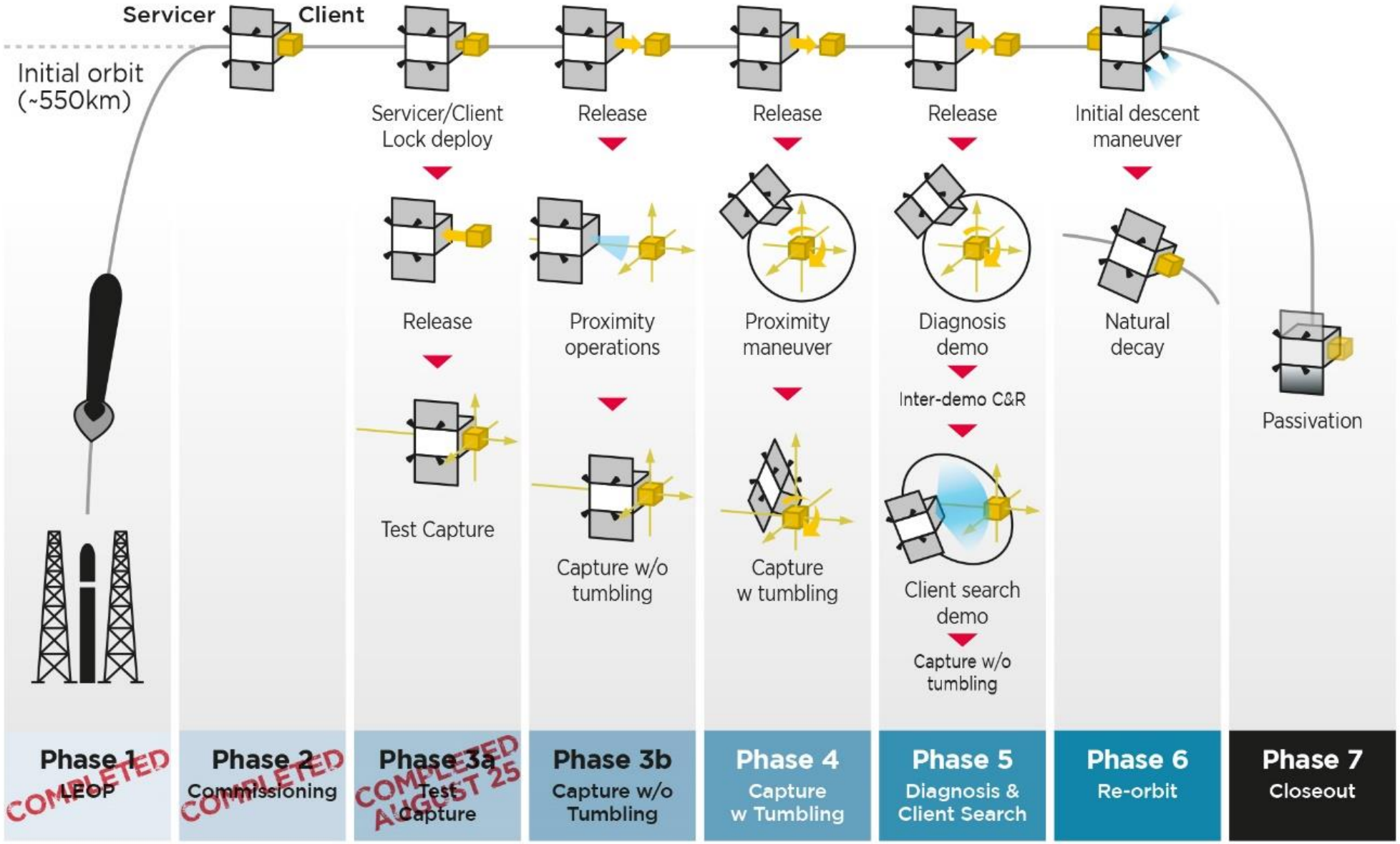
Mission Partners

- ELSA-d brings together a wide supply chain and numerous entities.

- We are working with space and regulatory agencies around the globe:
  - UKSA – Mission is licensed by the UKSA.
  - ESA – Astroscale has a strategic agreement with ESA to provide mission data in exchange for laser tracking services and engineering analysis.
  - JAXA - joint research agreement with JAXA to utilise their test facilities.

- Key partners & suppliers:
  - SSTL – manufacturer of client.
  - Ground Segment providers – Catapult, RHEA, GMV, CGI.
  - Ground Station providers – KSAT, SSC, Viasat, ATLAS.

Mission CONOPS

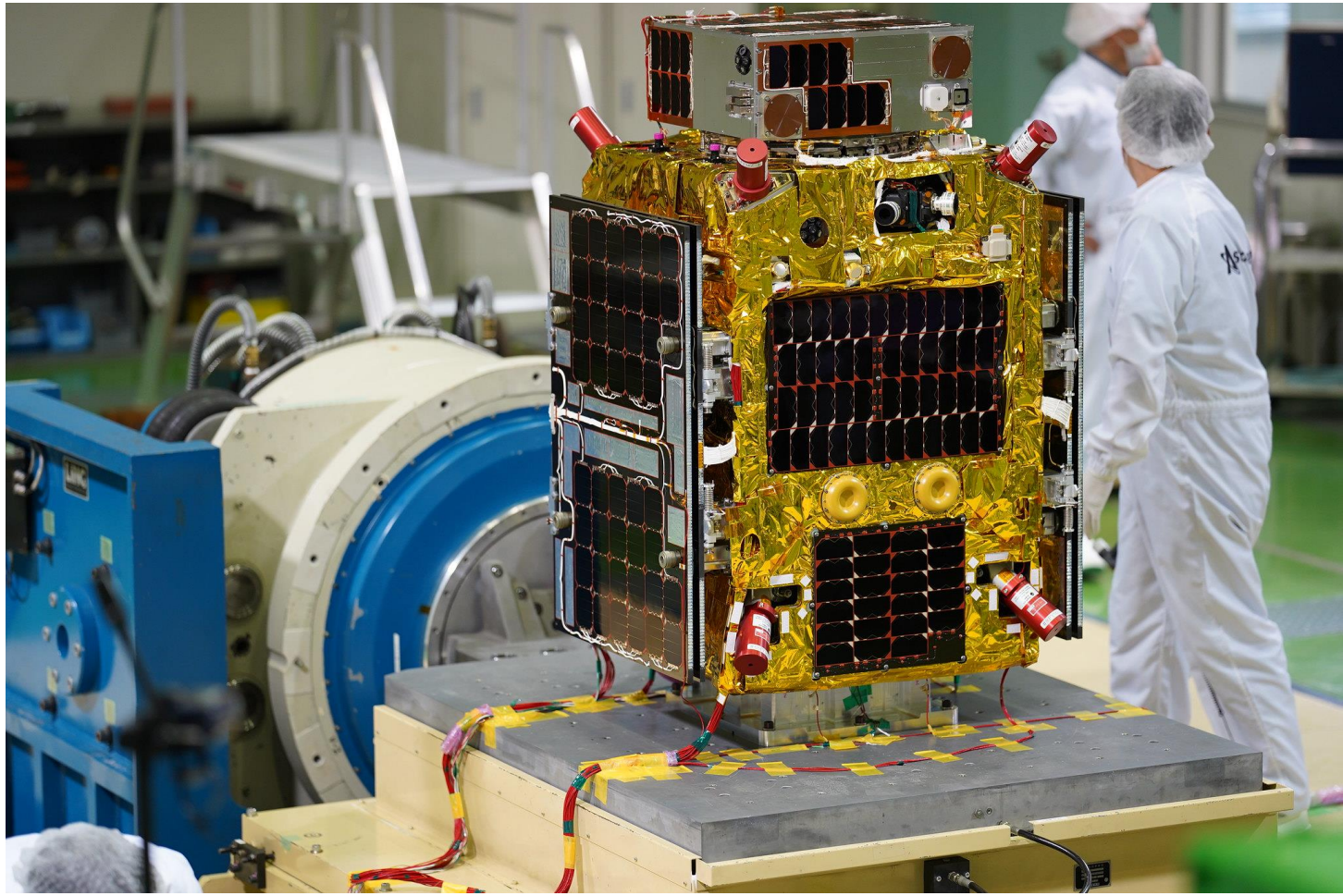


Mission Design – Propulsion

Attitude and orbit control are of critical importance to the mission. Central to this is the propulsion system.

ELSA-d uses a green chemical propulsion system from ECAPS. The propellant (LMP-1035) has low toxicity, whilst having comparable performance to hydrazine.

The architecture uses 8 thrusters located near the corners of the servicer chassis and aligned to the CoG. This layout provides the ability to thrust in any direction even in a one thruster failure case.

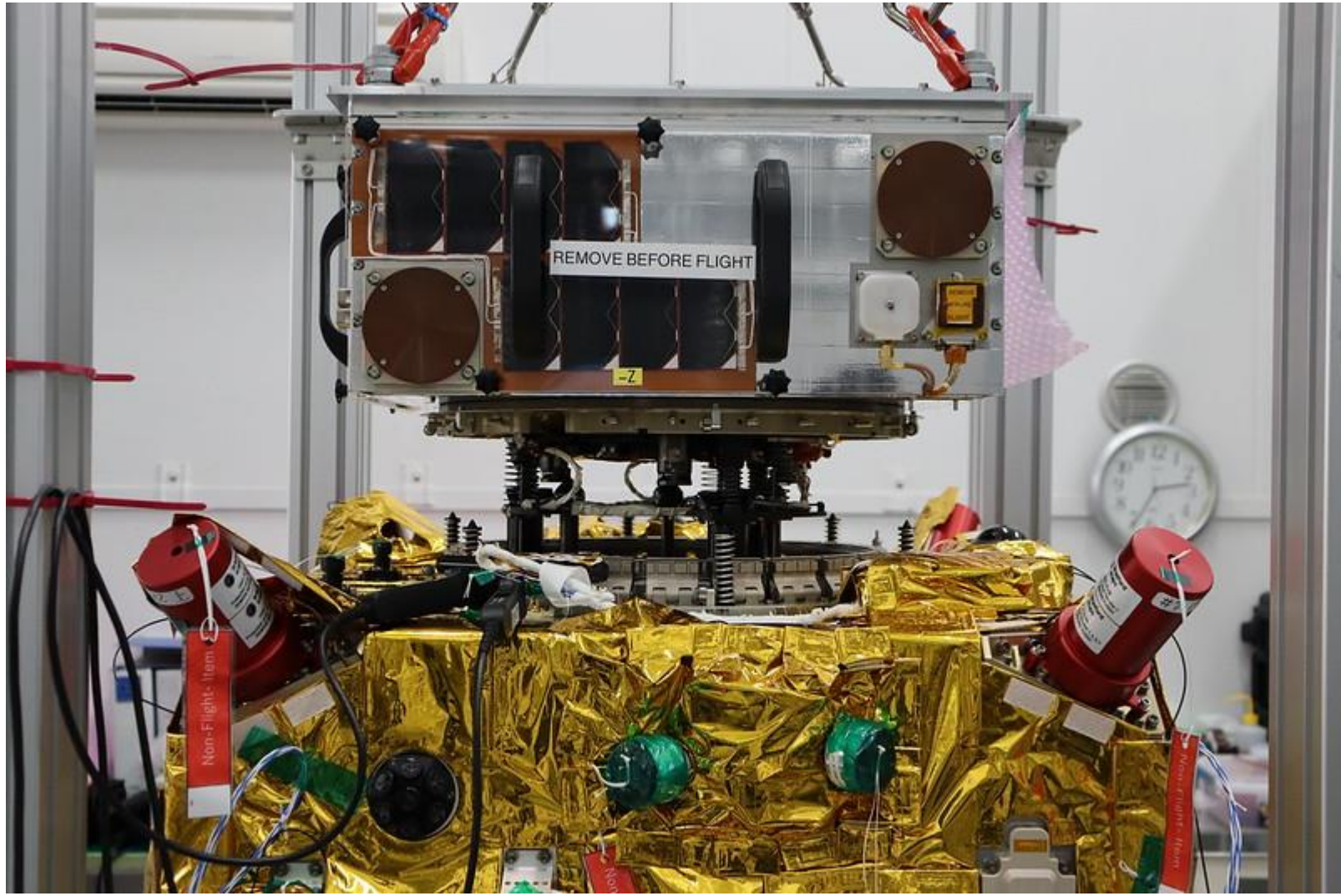


Mission Design – Capture System

ELSA-d uses a magnetic capture system.

The client is fitted with a magnetically reactive plate.

The servicer uses an Astroscale designed and built capture device. This device extends a capture surface which contains a number of small permanent magnets. It has a mechanical means of breaking the magnetic bond between servicer and client.



Launch & Operations

- **Launch** Launched by GK Launch Services into a 550 km orbit on a Soyuz rocket from the Baikonur Cosmodrome in Kazakhstan on Monday, March 22, at 6:07 am (UTC).

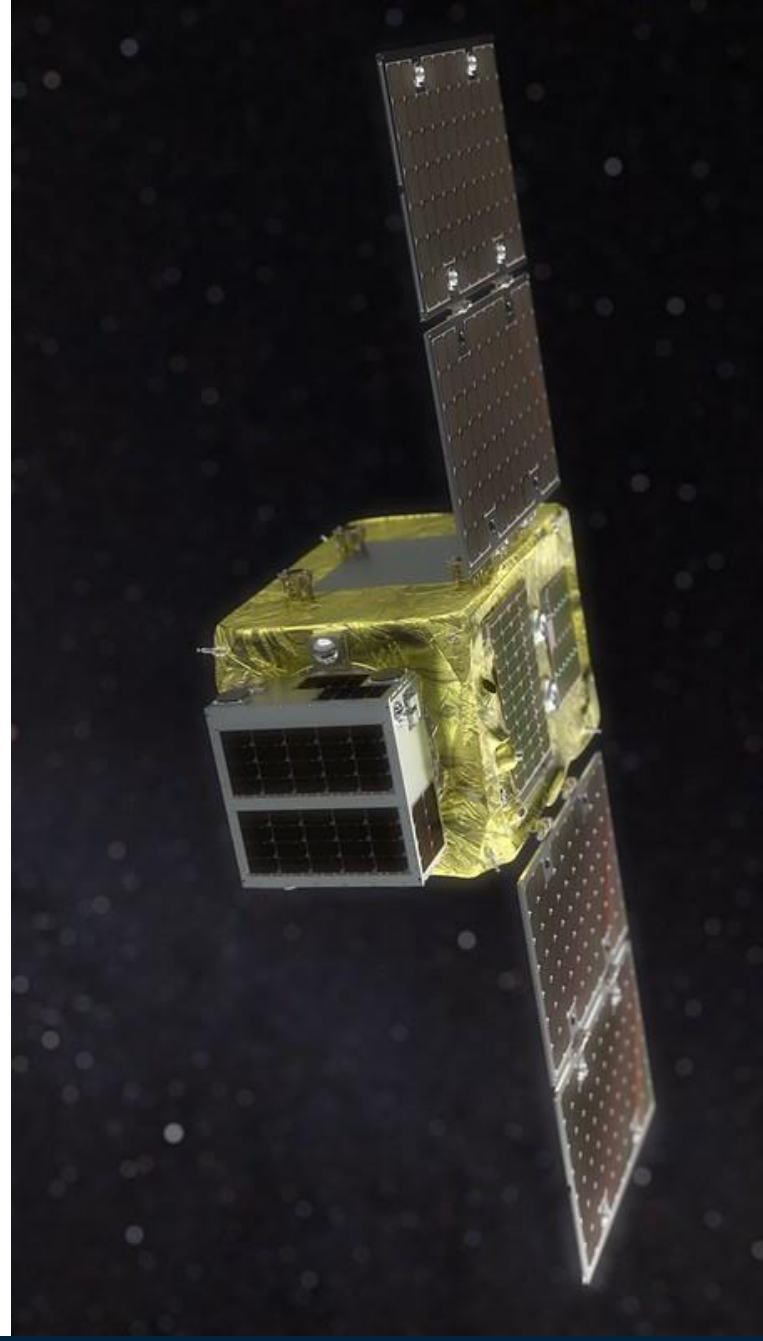
- **UK-led operations** from the National In-orbit Servicing Control Centre, which was developed by Astroscale as prime contractor.

Pre-launch Tests, Feb 2021

Conclusions

- This presentation has reviewed
  - Mission concept
  - Mission design
  - Key aspects of the system design, including
    - Propulsion system
    - Capture device

- ELSA-M (where “M” stands for “Multi-client”) is Astroscale’s commercial end-of-life service derived from ELSA-d technology which is a servicer capable of multiple client removals in a single mission.
  - See separate IAC paper on ELSA-M.



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