

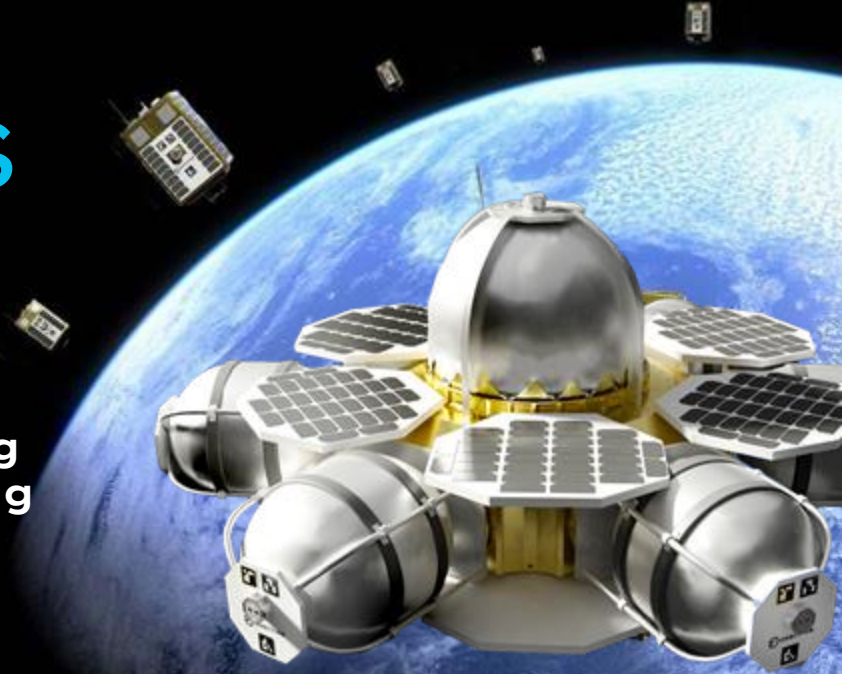


GAS STATIONS IN SPACE™

Orbit Fab Podracer mission: an on-orbit testbed proving out the building blocks of sustainable orbital refueling

Connor Geiman

Clean Space Industry Days
October, 2023



Background

- Founded in 2018 in Silicon Valley
- Venture-backed with 4 rounds of investment closed
- Mission: To Build the In-Space Propellant Supply Chain
- Vision: A Bustling In-Space Economy Supporting Permanent Jobs in Space

Company Highlights

- Headquartered in Lafayette, Colorado, USA
- International office in Harwell, UK
- 50+ employees and growing globally
- 2x space flight missions completed, 3x more funded and in development
- Over \$30M USD in government and commercial contracts closed
- First private company to resupply the ISS with water in 2019
- First DoD GEO refueling mission on contract for 2025
- RAFTI refueling interface baselined on multiple gov't and commercial missions

Orbit Fab HQ Facility



- 56,000 Sq. Ft. of office, manufacturing, assembly, integration, and test space
- Prototyping, Electronics Lab
- Machine Shop
- Clean Rooms (ISO-7 rated)
- Thermal Vacuum chambers

UK Orbit Fab Facility

- Office + Development Lab in Harwell



Space insurers brace for more claims after propulsion trouble on four GEO satellites

Jason Rainbow October 9, 2023



The PPU issue only affects the hybrid propulsion version of the GeoStar 3 satellite platform illustrated here. Credit: Northrop Grumman

TAMPA, Fla. — Propulsion problems on four satellites using the same kind of power modules are expected to result in at least \$50 million in claims for insurers already facing more than \$800 million in losses this year following two major spacecraft failures.

Space debris investigation results in fine and an ‘admission of liability’ by satellite TV company

By Jackie Wattles, CNN

Updated 10:16 PM EDT, Mon October 2, 2023



David Paul Morris/Bloomberg/Getty Images/FILE

Dish Network is the first company to be fined by the FCC for improper satellite disposal. One of the company's satellite dishes is seen on the roof of a home in Crockett, California, on July 31.

Sign up for CNN's Wonder Theory science newsletter. [Explore the universe with news on fascinating discoveries, scientific advancements and more.](#)

(CNN) — Satellite television company Dish Network has been hit with a \$150,000 fine for failing to properly dispose of one of its satellites, marking the first time federal regulators have issued such a penalty.

Source: SpaceNews and CNN

Rapidly Attachable Fluid Transfer Interface (RAFTI™)

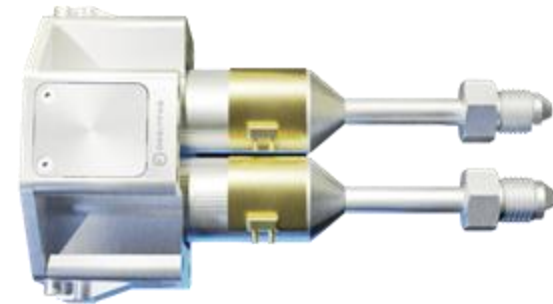
RAFTI is an open license TRL 8 refueling and docking interface that replaces a fill & drain valve to enable on-orbit and ground fueling.

Size & Weight:

- Size: 85mm x 75mm x 45mm (external to spacecraft)
- Mass: ~500g

Features:

- Common geometry for all fluids, with material changes as needed for compatibility (N₂H₄, Xenon, ASCENT, HTP, H₂O, Krypton, N₂O etc.)
- Grasp features to allow direct-docking
- Can integrate with 3rd party docking interfaces for a larger docking capture box



A new mindset for spacecraft design

Economic Savings

More sustainable satellite deployment with refueling



Less frequent satellite replacement costs



Reduce required fuel tank volume

Sustainability Benefits

Circularizing the economy in space with refueling



Rapid Deployment



Re-tasking Assets



Enhanced Payload Capacity



Life Extension

Shuttle-Depot Architecture

Orbit Fab Interfaces:



RAFTI

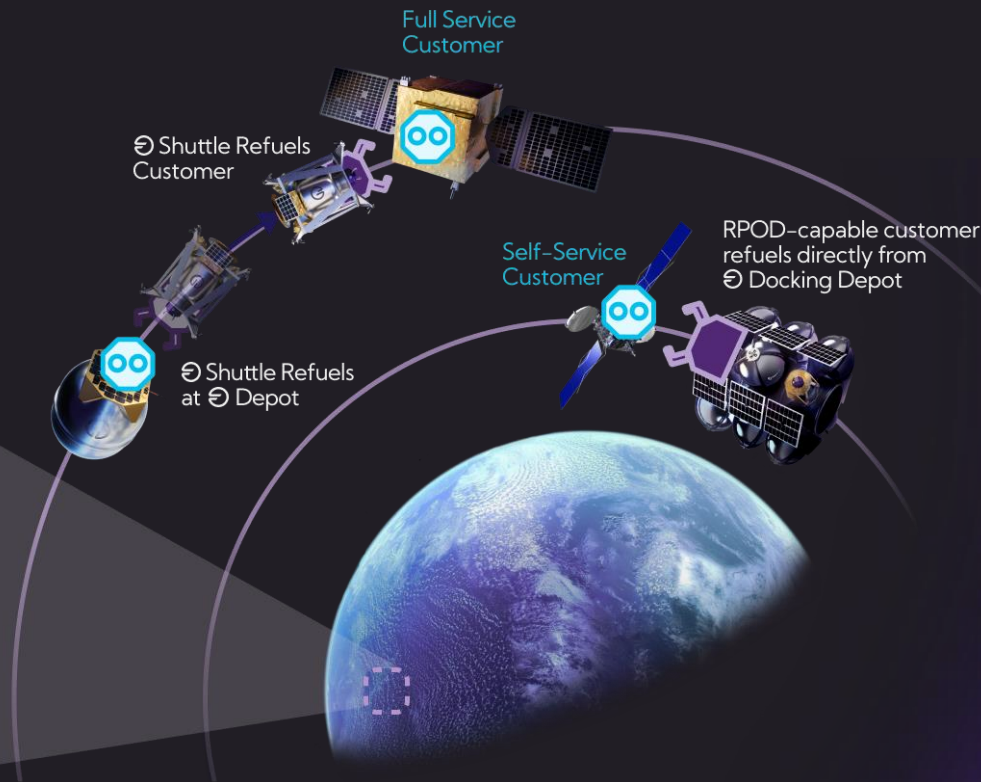


GRIP/GRASP

Manual Ground Fueling with RAFTI Ground Coupling



Automated Ground Fueling



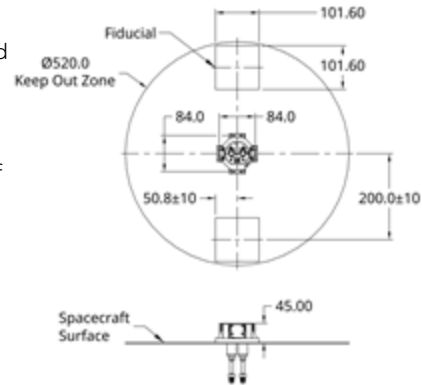
A Collaborative Platform to Demonstrate Rendezvous and Close Proximity Operations

- Clean space stepwise approach de-risks high-risk refueling components
- Enable an ecosystem of companies working together to pioneer sustainable in-space economy
- Orbit Fab's Podracer spacecraft is equipped with RPO and hydrazine prop system with RAFTI
- Launch in 2024
- Partner spacecraft to be equipped with RAFTI and fiducials
- Joint spacecraft operations could occur post-primary mission objective completion

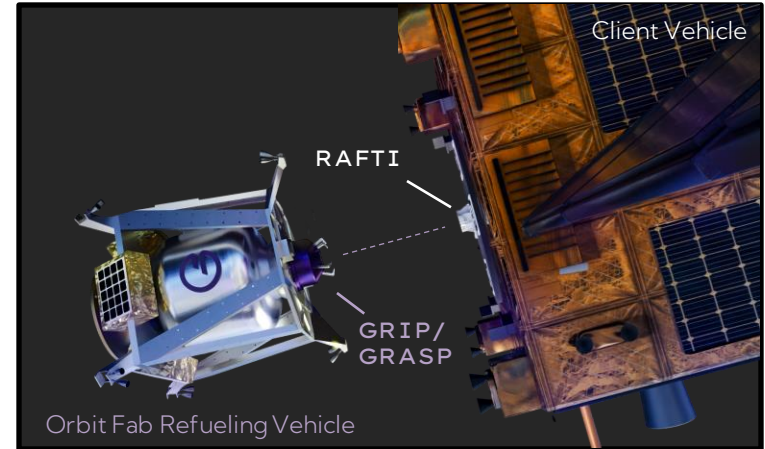


Mount RAFTI & Fiducials

- **RAFTI** – Mount RAFTI on Client spacecraft according to specifications in the MICD and provide for a 520 mm keep out zone.
- **Fiducials** – Incorporate LWIR compatible fiducial ArUco markers on the same face of the spacecraft as RAFTI (offered by Orbit Fab).



Maintain Stable Attitude



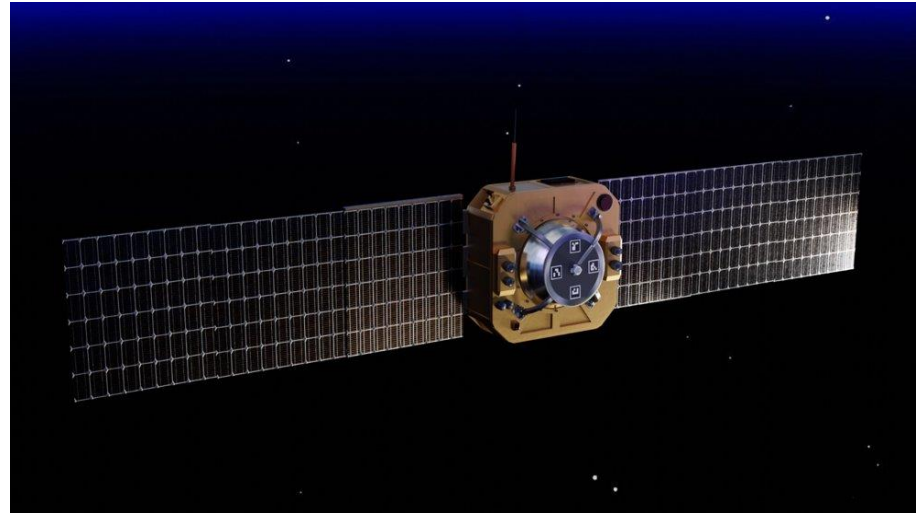
- **Pointing Accuracy** – Maintain pointing with RAFTI along Client spacecraft's velocity vector with an accuracy of 4 degrees or better.
- **Control Stability** – <0.1 degrees over 1 second, 1 σ .



Fiducials

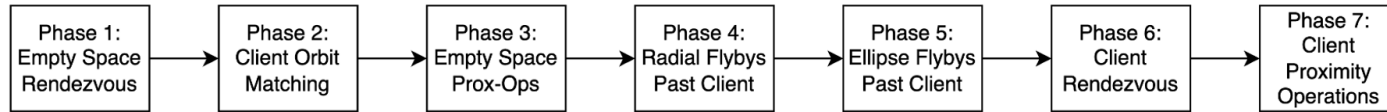
Example fiducial mounting on Orbit Fab's Tenzing spacecraft

- Multiple end-of-life options including passive deorbit, propulsive deorbit, and active deorbit via the Astroscale docking plate
- Stepwise approach to rendezvous and proximity operations to ensure safe operations and zero debris
- Sharing and documenting mission efforts to implement clean space standards, and collaborating with partners to bring sustainability across the industry



Furphy (ISS) → Tenzing Depot → Podracer → docking depot...

Podracer conops:



Flows into future refueling missions:

- Orbit Fab Rancor and Kamino refueling payloads
- First in-space docking and grappling between RAFTI and GRIP
- Refueling vehicles in GEO and beyond

Podracer will enable key technologies for refueling to be demonstrated in a manner that upholds upholds clean space standards, including a zero-debris approach and responsible end-of-life management. This allows Orbit Fab to continue lowering technical risk to refueling operations building on Podracer, while moving towards a more circular in-space economy.

Collaboration & Open Dialogue

Payload integrates Astroscale docking plate to enable active deorbit

Opportunity for collaboration with client satellites for RPO

Public announcements of RPO operations planned similar to aviation NOTAMs

Collaborative in-space test platform for satellite servicing technology development





- The Orbit Fab Podracer mission is not just about technological achievements, but also about fostering a sustainable and circular economy in space.
- The ability to refuel satellites can prevent them from becoming space debris, ensuring they are disposed of responsibly.
- The dual objectives of the mission underscore a vision for the future: combining technological advancement with sustainable practices for space exploration.

- Orbit Fab office in the United Kingdom opened in 2022 in Harwell
- Orbit Fab is part of UK Active Debris Removal (ADR) programme to provide a refueling element
- Continuing to hire in the UK for both technical and nontechnical roles

Special thank you to the



 Managing Director

Manny Shar

10+ years of experience in analytics, space business, and management



 Head of Engineering

Sebastian Hill

5+ years of experience in spacecraft propulsion and refuelling systems



Q&A
Discussion

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