



# GAS STATIONS IN SPACE™

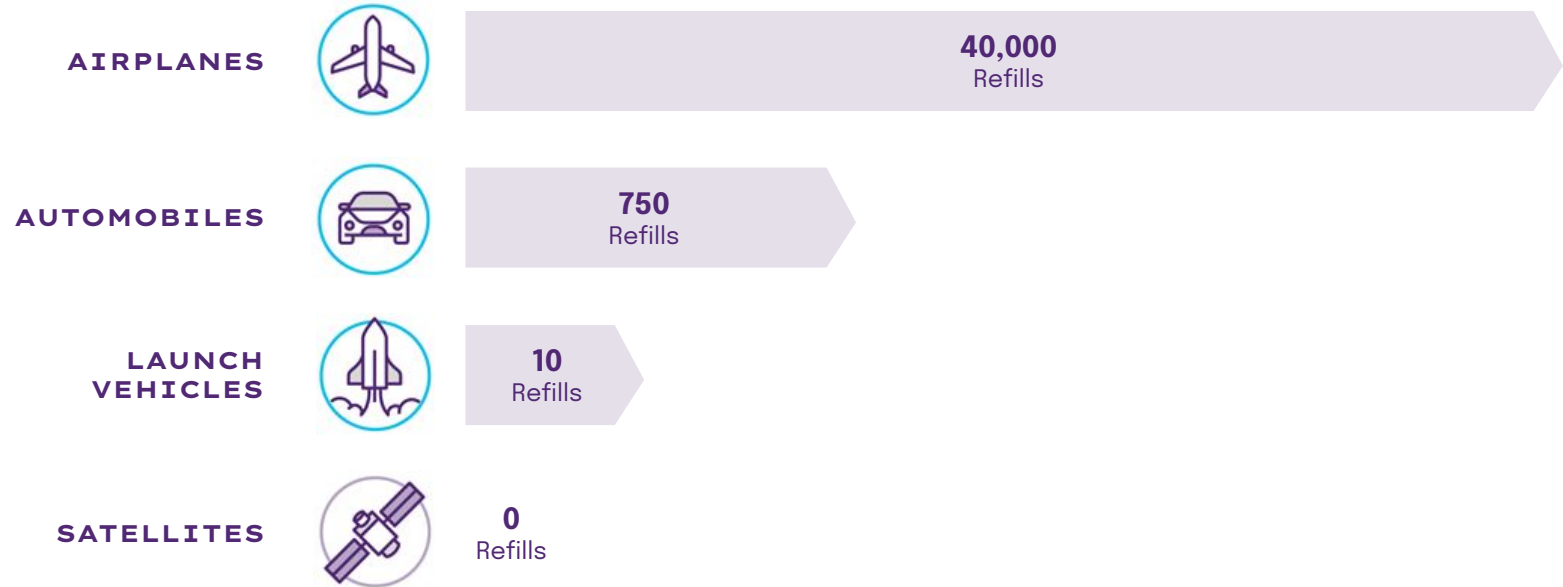
**Creating Environmental and Economic  
Sustainability In Space Through  
Commercial Satellite Refueling**

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Daniel Faber

Clean Space Industry Days  
*October, 2022*



# SATELLITE “SINGLE USE” PARADIGM



"Once a satellite is launched, there is only a single tank of fuel and no opportunity for maintenance. Because of this, \$100Bn worth of satellite were abandoned in the last 10 years."

**CATALYST ACCELERATOR, US SPACE FORCE**

Spring 2021 Promotional Materials, "On-orbit Servicing, Assembly, and Manufacturing"

## Insurance claim for failed Measat-3 satellite in dispute

by Jason Rainbow — August 4, 2022



Measat's teleport and broadcast center. Credit: Measat

TAMPA, Fla. — An insurance claim for a Malaysian satellite that ran out of fuel prematurely remains unsettled more than a year after the incident.

## Aging Telesat satellite running out of fuel as projected LEO costs soar

by Jason Rainbow — August 5, 2022



Source: SpaceNews

Phase 1, Telesat's first LEO satellite that launched in 2018, was supplied by SSTL. Credit: Telesat

TAMPA, Fla. — Canada's Telesat is bracing for a revenue hit in 2023 after being forced to retire its Anik F2 satellite from full service three years earlier than planned.

Throwing away satellites is  
not only *economically*  
*unsustainable*, it is  
**environmentally wasteful.**

# THE ORBIT FAB MISSION

To Build the In-Space  
Propellant Supply Chain

## THE ORBIT FAB VISION

A Bustling In-Space  
Economy Supporting Permanent  
Jobs in Space





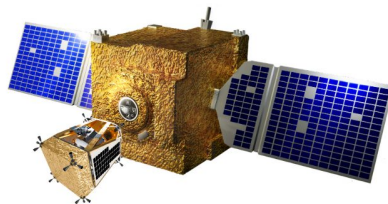
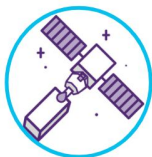
# Company Overview

**Orbit Fab was founded in 2018 to build the in-space propellant supply chain**

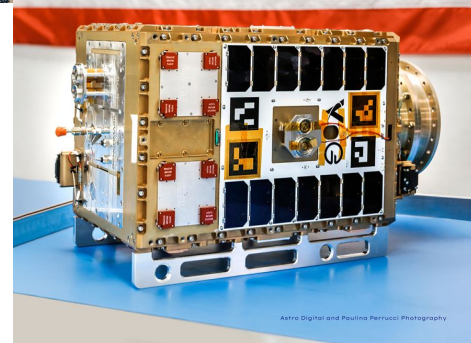
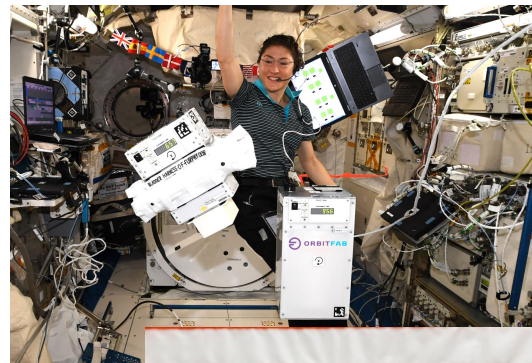
- Headquartered in Lafayette, CO, USA and with a UK office
- 50+ employees & growing globally
- Received investment from Lockheed Martin & Northrop Grumman
- Two successful space flight missions
- First private commercial company to resupply the ISS with water
- End-to-end refueling demonstration in LEO SSO scheduled for 2023
- RAFTI baselined on 4 DoD & 100+ commercial satellites
- First in-space commercial fuel sale deal signed with Astroscale early 2022



Sell RAFTI Service Valves



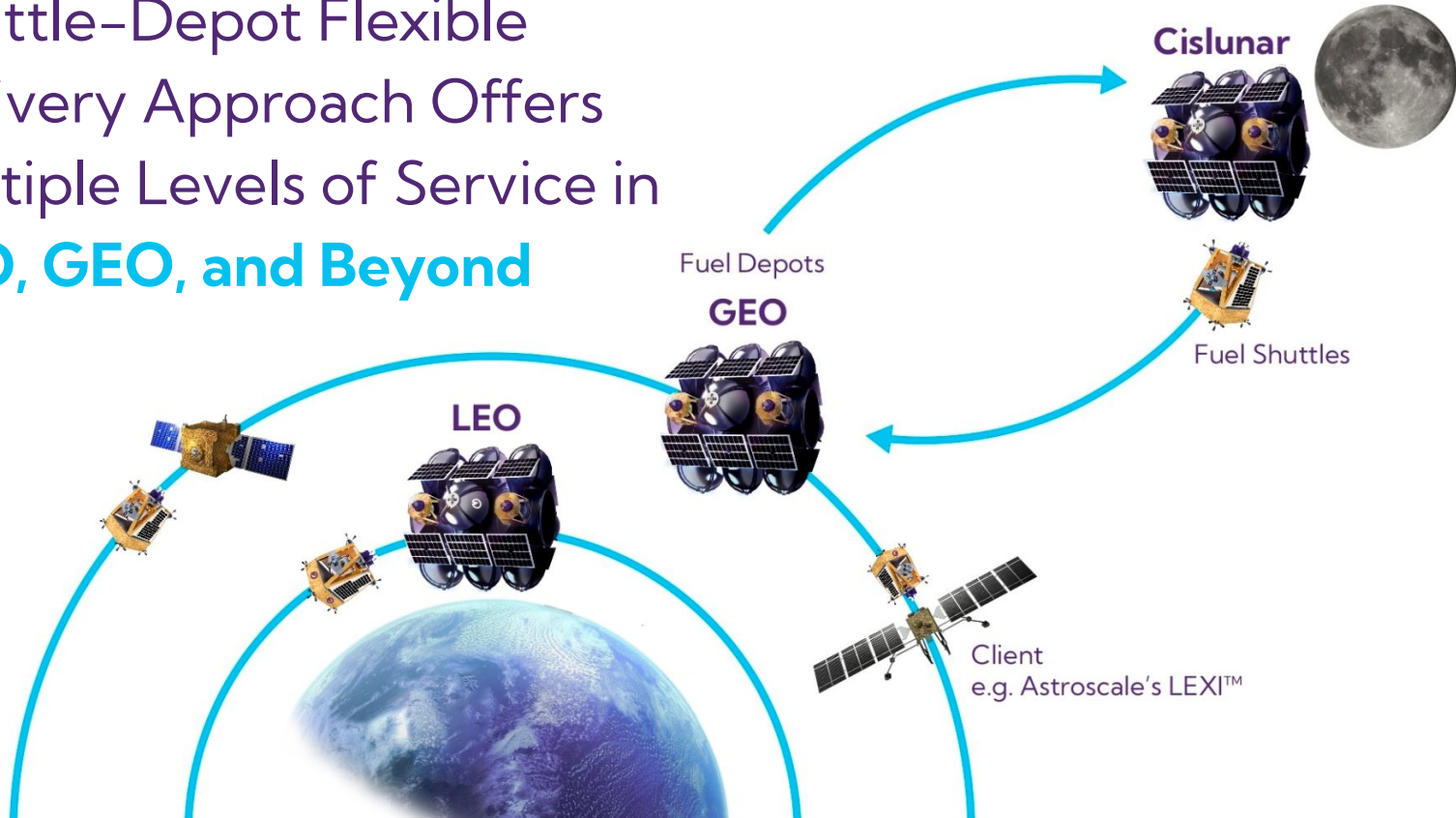
Sell Fuel In Space



Top: ISS water resupply mission, Furphy (2019)  
Bottom: First commercial fuel depot, Tenzing (2021)  
Left: Orbit Fab's refueling products and services

# Refueling Architecture

Shuttle-Depot Flexible  
Delivery Approach Offers  
Multiple Levels of Service in  
**LEO, GEO, and Beyond**



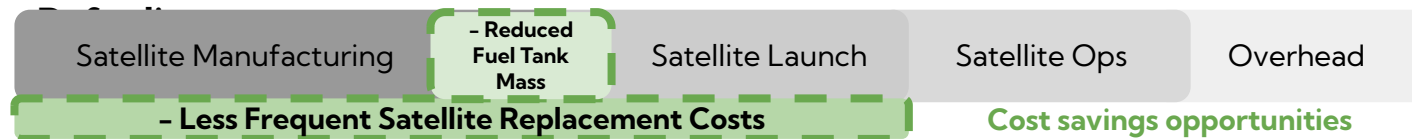


# Economic Advantage with Refueling

## Traditional Cost Structure



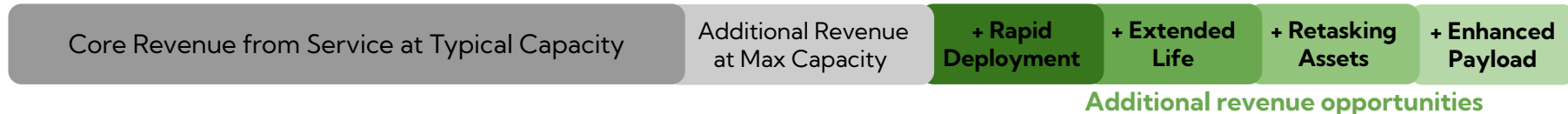
## Cost Structure with



## Traditional Revenue



## Revenue Structure with Refueling



The *economic advantages* of refueling enable the **expansion of space capabilities** – including those which have an **impact on Earth's environment, such as:**



**Tracking  
Wildfires**



**Mapping  
Deforestation**



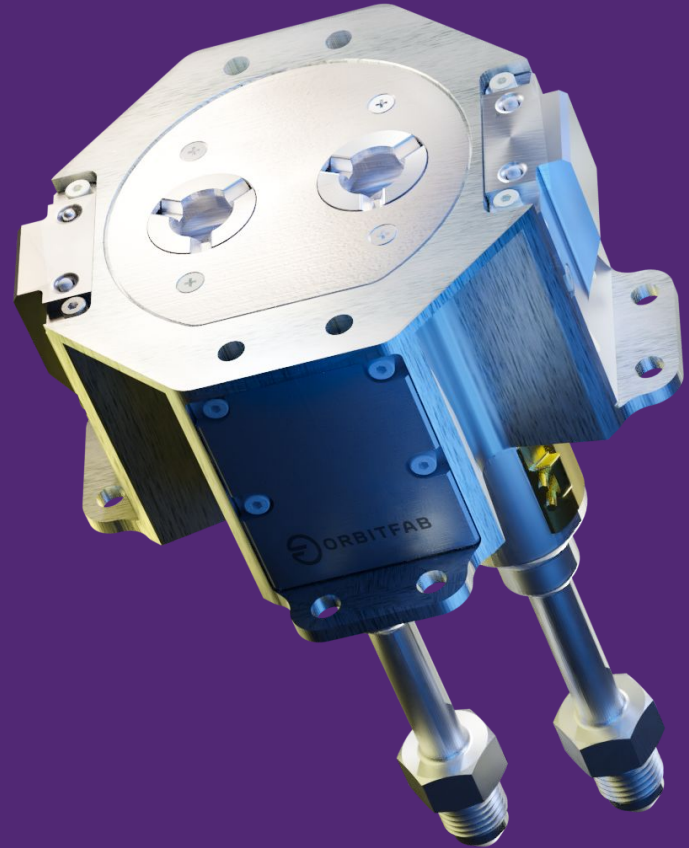
**Monitoring  
Coral Reefs**

...and many more



# RAFTI

Rapidly Attachable Fluid  
Transfer Interface



## Rapidly Attachable Fluid Transfer Interface (RAFTI™)

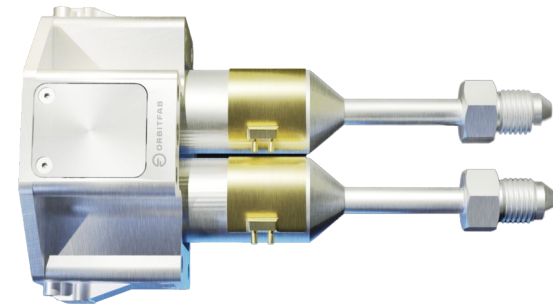
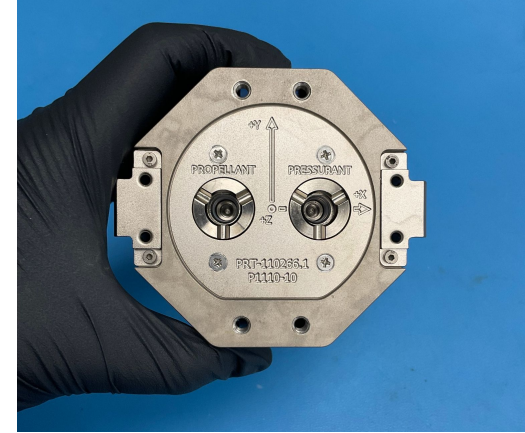
RAFTI is an open license TRL 8 refueling and docking interface that replaces a fill & drain valve to enable on-orbit and ground fueling.

### Size & Weight:

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

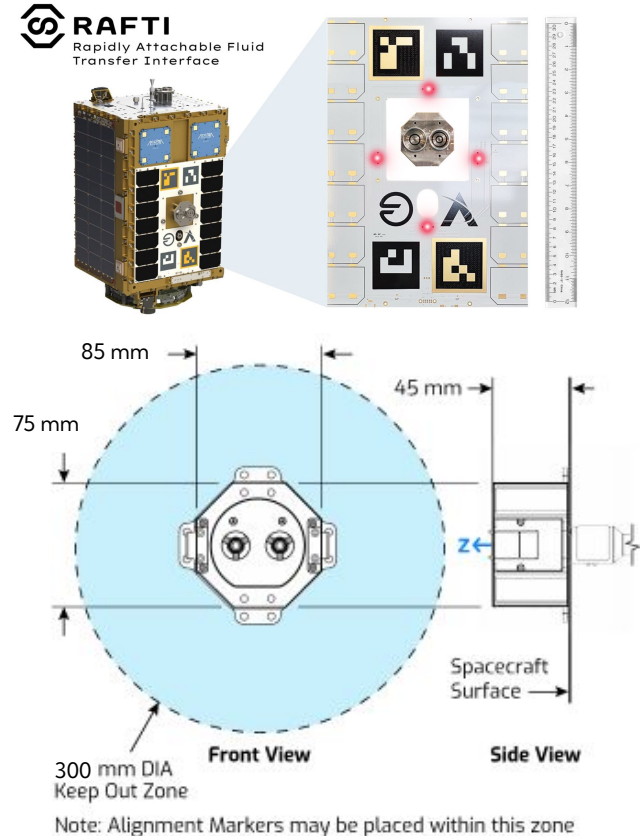
### Features:

- Common geometry for all fluids, with material changes as needed for compatibility (N<sub>2</sub>H<sub>4</sub>, Xenon, ASCENT, HTP, H<sub>2</sub>O, Krypton, etc.)
- Energized seals for fluid and radiation compatibility
- Passively actuated covers to mitigate radiation exposure
- Make-before-break geometry to minimize drip
- Three inhibits to overboard leakage
- Grasp features to allow direct-docking
- Can integrate with 3rd party docking interfaces for a larger docking capture box (e.g. ASPIN & PRM)



## Client Spacecraft Requirements

- RAFTI Service Valve (RSV) – Client SHALL mount the RAFTI Service Valve according to interface specifications in the Mechanical Interface Control Document and provide for a 300 mm keepout zone.
- Pointing Accuracy – The client spacecraft SHALL maintain pointing with the RSV with the client spacecraft's velocity vector with an accuracy of 4 degrees or better.
- Pointing Accuracy Drift – The client system SHALL maintain attitude drift rates less than 0.1 degrees per second during proximity operations.
- Fiducials – The client spacecraft SHALL incorporate CONFERS standard compliant fiducial markers on the same face of the spacecraft as the RAFTI docking port with side lengths of 10+ cm.





# Missions Overview

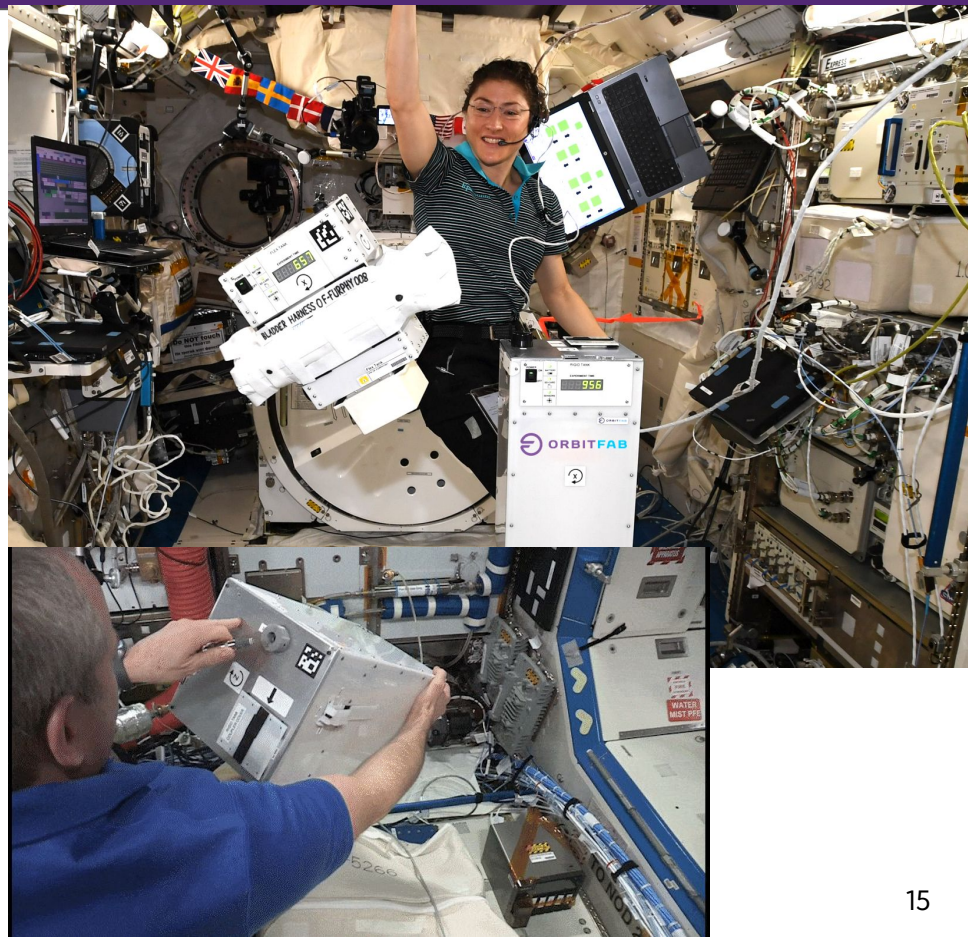




**First Private Company to  
Resupply Water to the ISS**

## Logistics

- 4.5 month program
- 2 tanker test beds testing fluid transfer in orbit
- First private company to supply water to the ISS

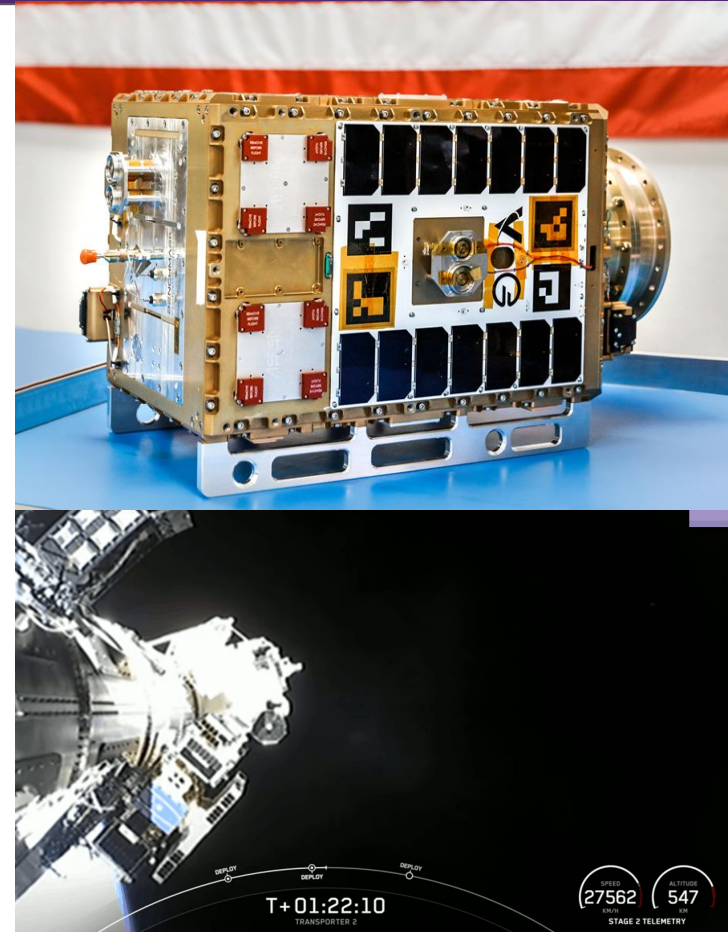


# Tanker-001 Tenzing - Mission Overview

**Demonstrated Ground Ops, Tanker Deployment,  
and Fuel Storage On Orbit**

## Logistics

- Launched and Deployed Q3 2021
- Operating at 550 km SSO
- 35 kg spacecraft carrying HTP
- Cameras to support RPO risk reduction
- Tank, valves, pressure transducers, RAFTI Block 1 all developed/assembled in house
- 9 months from ATP to launch



# \$12M STRATFI Program

## SPACE-RCO & AFRL SUPPORT



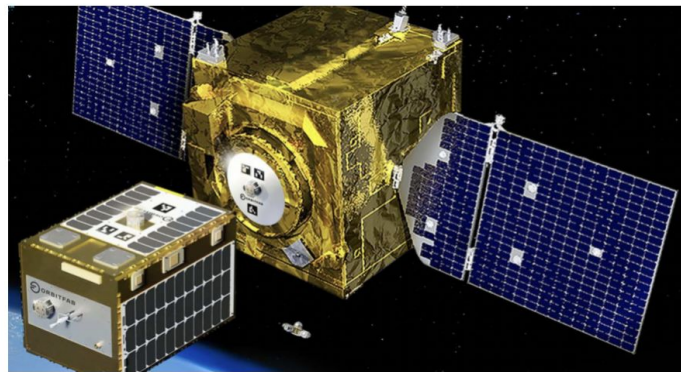
UNITED STATES  
SPACE FORCE

SPACEWERX

## SPACE NEWS

### Orbit Fab gets \$12 million to integrate refueling port with military satellites

by Sandra Erwin — March 17, 2022



Orbit Fab developed a refueling port for satellites called RAFTI, short for Rapidly Attachable Fluid Transfer Interface. Credit: Orbit Fab

The funding includes \$6 million from the U.S. Air Force and Space Force, and \$6 million from private investors

WASHINGTON — Orbit Fab, a venture-funded startup offering a refueling service in space, announced it has won a \$12 million deal to ensure its fueling interface works with U.S. military satellites.

The funding includes \$6 million from the U.S. Air Force and U.S. Space Force, and \$6 million from Orbit Fab's private investors. The contract is for the integration of Orbit Fab's fueling port, called RAFTI — short for rapidly attachable fluid transfer interface



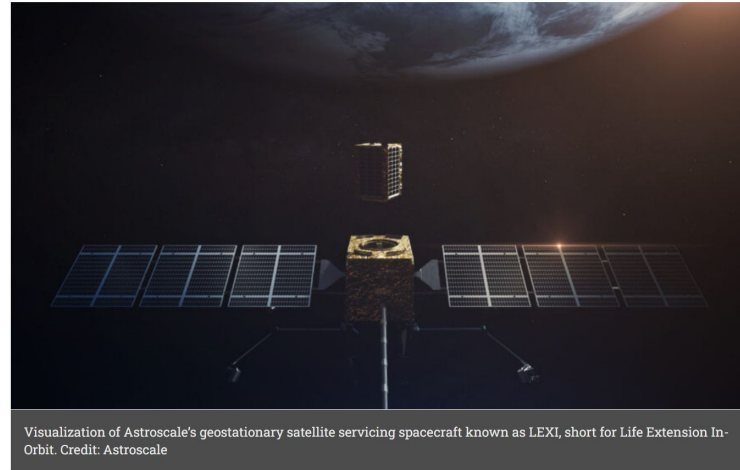
## Refuel Astroscale LEXI GEO Fleet



## SPACE NEWS

### Orbit Fab secures deal to refuel Astroscale's satellite-servicing robots

by Sandra Erwin — January 11, 2022



WASHINGTON — Astroscale U.S., a provider of on-orbit services to extend the life of satellites, has signed an agreement to use Orbit Fab's in-space refueling tankers, the companies announced Jan. 11.

Orbit Fab, a startup offering "gas stations in space," will refuel Astroscale's geostationary satellite servicing spacecraft known as LEXI, short for Life Extension In-Orbit.

The agreement commits Orbit Fab to supply up to 1,000 kilograms of Xenon propellant to refuel Astroscale's LEXI vehicles,

- 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



 **Managing  
Director**

**Manny Shar**

Special thank you to the







# Q&A Discussion

**Connor Geiman**  
**Manny Shar**

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