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# IO activities

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CTO

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The logo for Infinite Orbits features a large, thin, black curved line that starts from the bottom left, curves upwards and to the right, and then curves back down and to the left, forming a shape reminiscent of a stylized 'S' or a comet's path. A solid black circle is positioned in the center of this curve, acting as a focal point.

**INFINITE ORBITS**

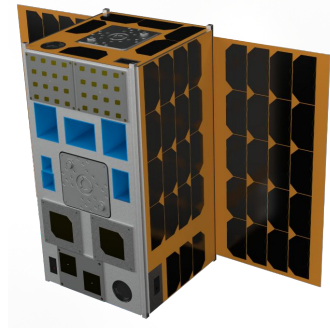
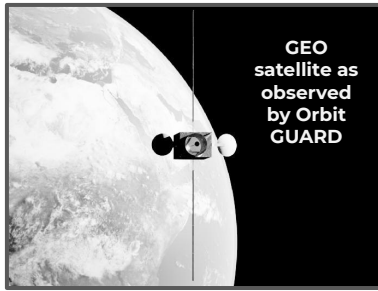
# Background

- Infinite Orbits (IO) was created in 2017 to **build space technologies to eventually tap the Trillion dollar plus markets of asteroid mining and, deep space services**
- Our core competence is **autonomous navigation technologies (AutoNav)**, is built on the latest deep learning algorithms with data sets validated by previous DLR missions
- We are **testing AutoNav in space on a mission** launching from a SpaceX Falcon Heavy (direct GEO insertion) scheduled for **Q1 2022** to test debris detection & autonomous collision avoidance systems
- Entities in Singapore, France and the UK



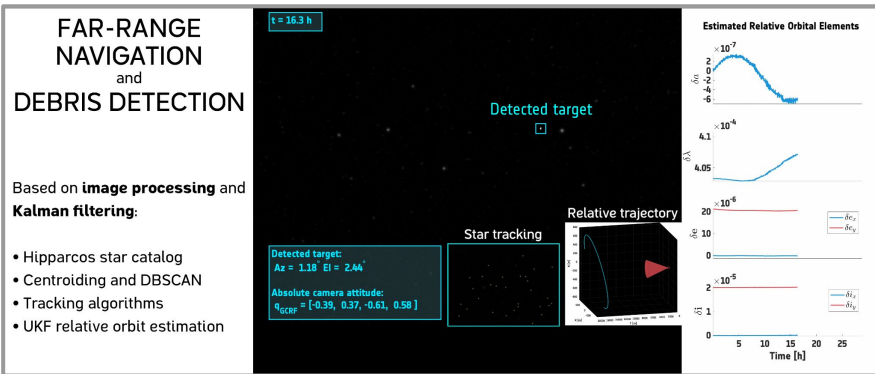
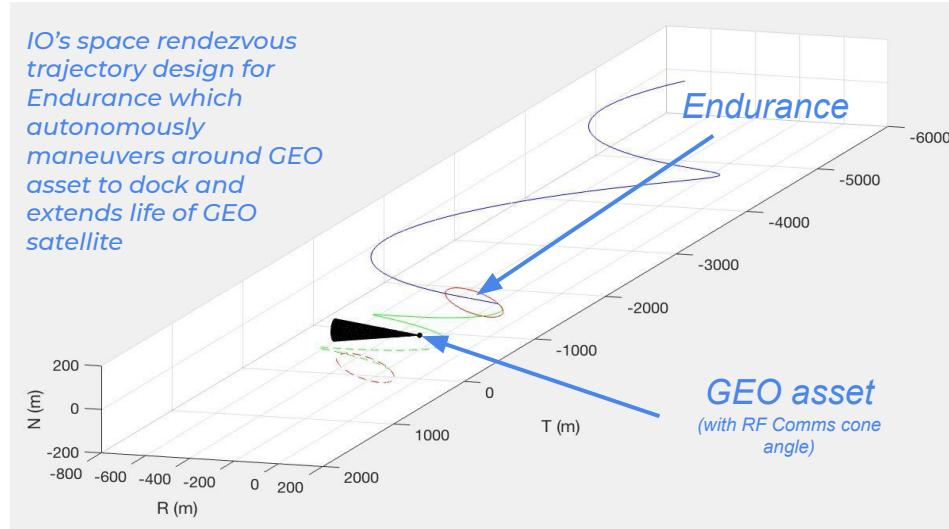
*IO's lab and clean room facilities  
in Singapore*

# IO's state of the art algorithms enable in-orbit services!



Orbit GUARD

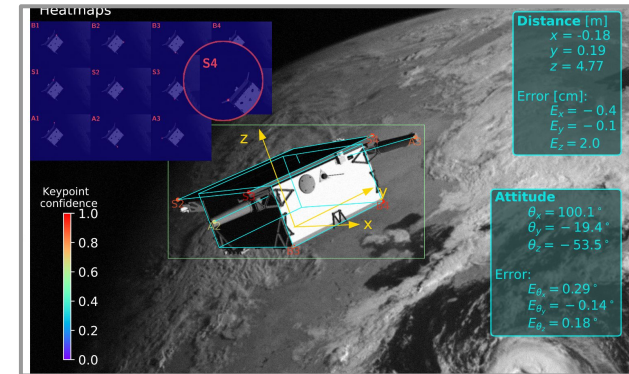
- **Orbit GUARD** (Space Situational Awareness Debris/ Threats detection and avoidance): IOD by end 2021
- **Endurance** (Satellite Life Extension Tug): Starting 2023



## NEAR-RANGE NAVIGATION

for rendezvous and inspection

Based on **deep learning** and **geometric optimization**:



# IO's first product - Orbit GUARD

## Orbit GUARD's capabilities:

- Star tracking
- Space Debris/Threats detection and avoidance
- GEO Satellite inspection
- Formation flying

The status of development as of Apr 2021

## Software:

- Space debris detection software has been tested and performing as expected.
- Star Tracking tested partially. Lost In Space functionality currently being developed.
- Software is being ported to flight computer RTOS

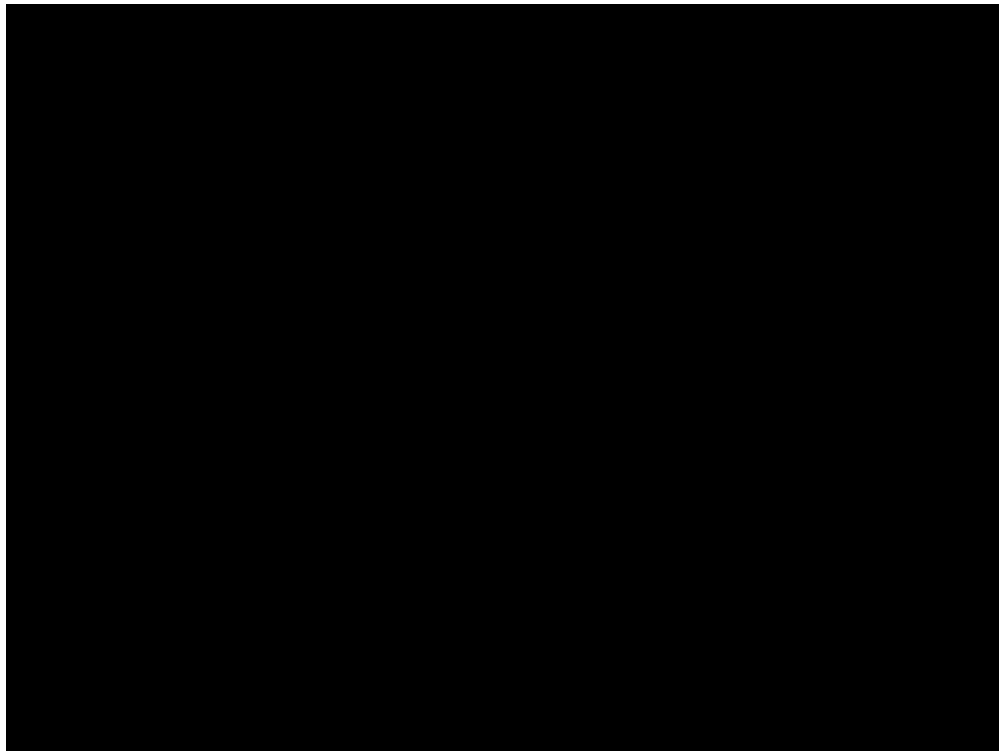
## Hardware:

*Version 1 (FM ready by Q3 2021)*

Orbit Guard software on COTS flight computer using industrial cameras, suitable for 3 yrs in LEO

*Version 2 (FM ready by Q2 2022)*

IO's own camera and flight computer optimised for Orbit Guard algorithms, suitable for 10+ yrs in LEO and 5+ yrs in GEO



*Video demonstrating star tracking, RSO detection & tracking.  
Relative orbital parameters tracked with high accuracies*

# Orbit GUARD - Autonomous Protection for Space Assets

- **Emerging Threats:**

- Hostile attacks - Declared attacks on Athena-Fidus by Olymp-K, Chinese co-orbiting capability, Russian Nesting Dolls Kosmos 2543/45915, Previous manoeuvres of Olymp-K around Intelsat assets, Weiner-2, Indian ASAT demo,
- Benign threats – Debris collision, [traffic]

**Concept:** A GEO guardian spacecraft, flown at some distance from an operational GEO spacecraft ('The Client'), able to image it continuously (Situational Awareness). The service, again using a smaller spacecraft, would be intended to protect the next generation of spacecraft from a number of threats and provide reconnaissance abilities

- Proximity Operations **previously** required:
  - Significant Cooperation between The Client and Guardian
  - Man-in-loop
  - Navigation limitations (e.g. instrumentation)
- Previous barriers can now be **eliminated** due to IO proprietary capability:
  - Software algorithms using machine learning and computer vision allowing for flying formation
  - GEO small sat platform

# Orbit GUARD - Autonomous Protection for Space Assets

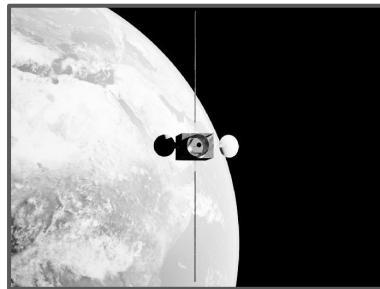
*Mission: Asset monitoring, threat detection, avoidance, & suppression*

## Proposed Orbit GUARD configuration

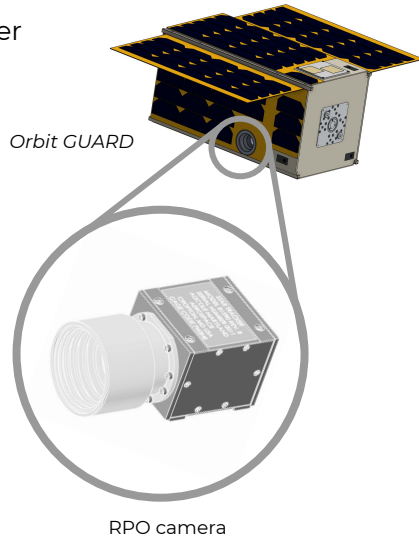
- 16U satellite, 24 kgs
- Four thrust vectoring EP units

## Multiple Payloads

- RPO GNC (Rendezvous and Prox Ops.) & cameras
- RSO Tracker
- SIGINT & Anti-jammer
- Intersatellite link



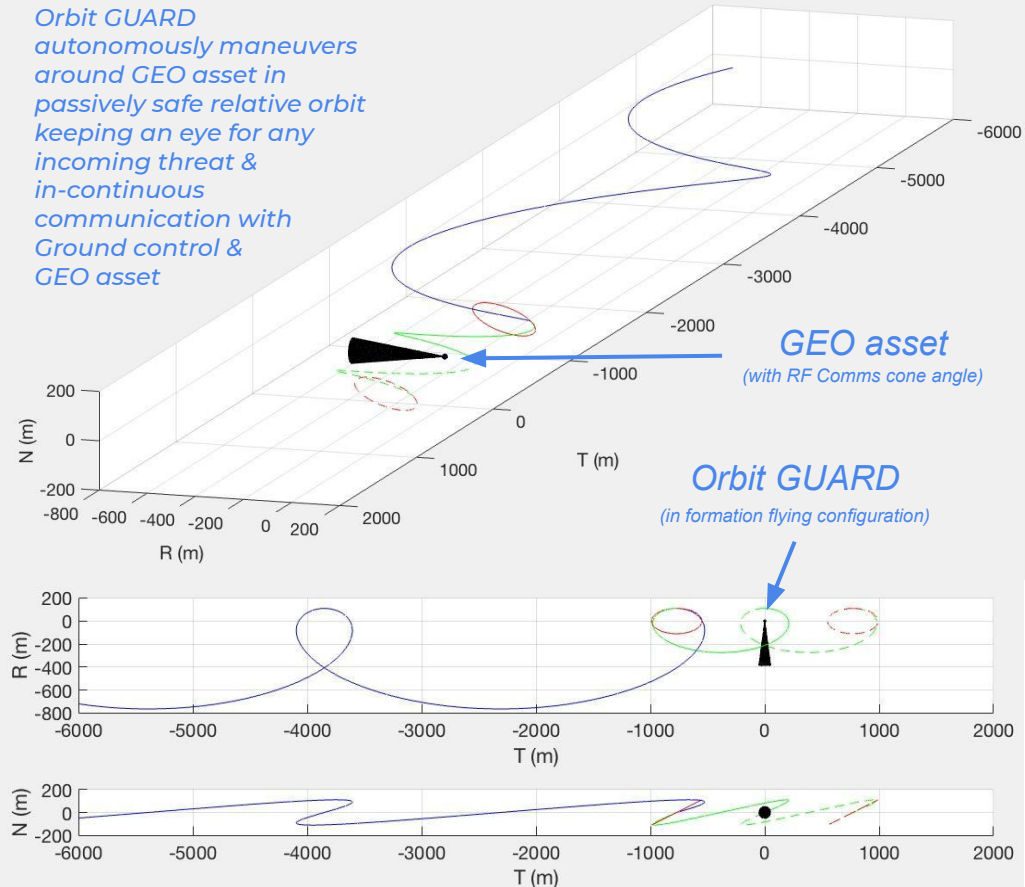
GEO satellite as observed by  
RPO payload



Orbit GUARD

RPO camera

*Orbit GUARD  
autonomously maneuvers  
around GEO asset in  
passively safe relative orbit  
keeping an eye for any  
incoming threat &  
in-continuous  
communication with  
Ground control &  
GEO asset*





INFINITE ORBITS