Utilizing The SPACE DRONE™ Spacecraft For ADR

Clean Space Industry Days
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Effective Space Solutions

Pioneering last-mile logistics in space

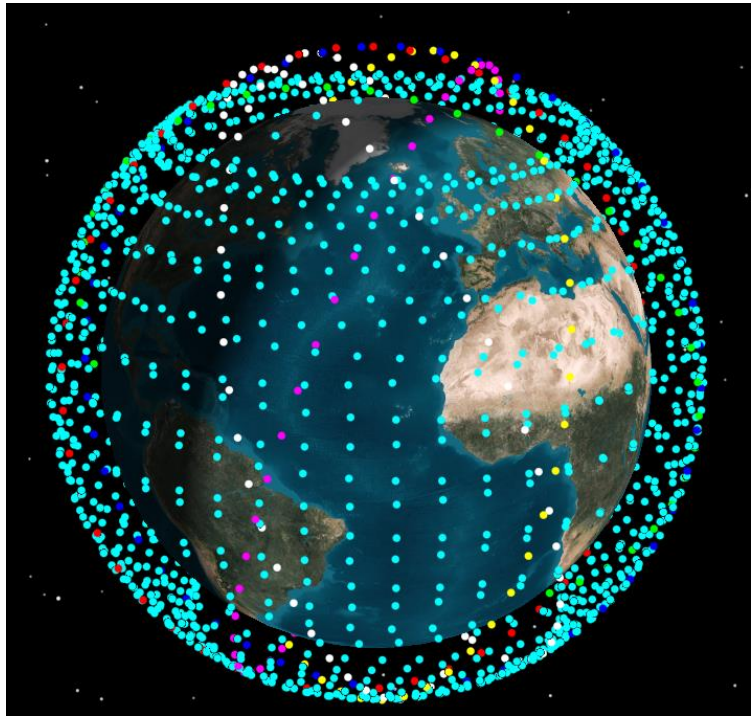
- Space is the last untapped commercial frontier - we are building last-mile logistics services in space that will power this new economy
- Fleet of SPACE DRONE™ spacecraft to position, maintain, monitor and guarantee space assets
  - GEO & LEO Satellite Servicing
  - Active debris removal (ADR)
  - Logistic support of space exploration

Phase one deployment: Extending the life of GEO satellites in orbit

- SPACE DRONE™ spacecraft acts as an external ‘jet-pack’ to the host satellite

The Near-Future: Mega Constellations & Active Debris Removal

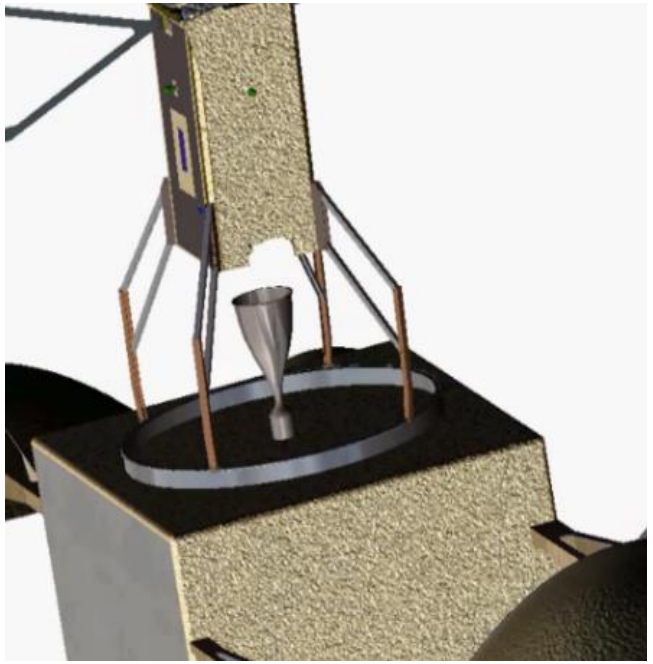
- Rise in mega constellations developments
  - More than 14,000 satellites in LEO if all come to fruition
- On orbit servicing and post mission disposal strategy is essential
- Reliability concerns require technological investments in active debris removal technologies



Satellite Servicing \ Active Debris Removal

Similarities in Technologies

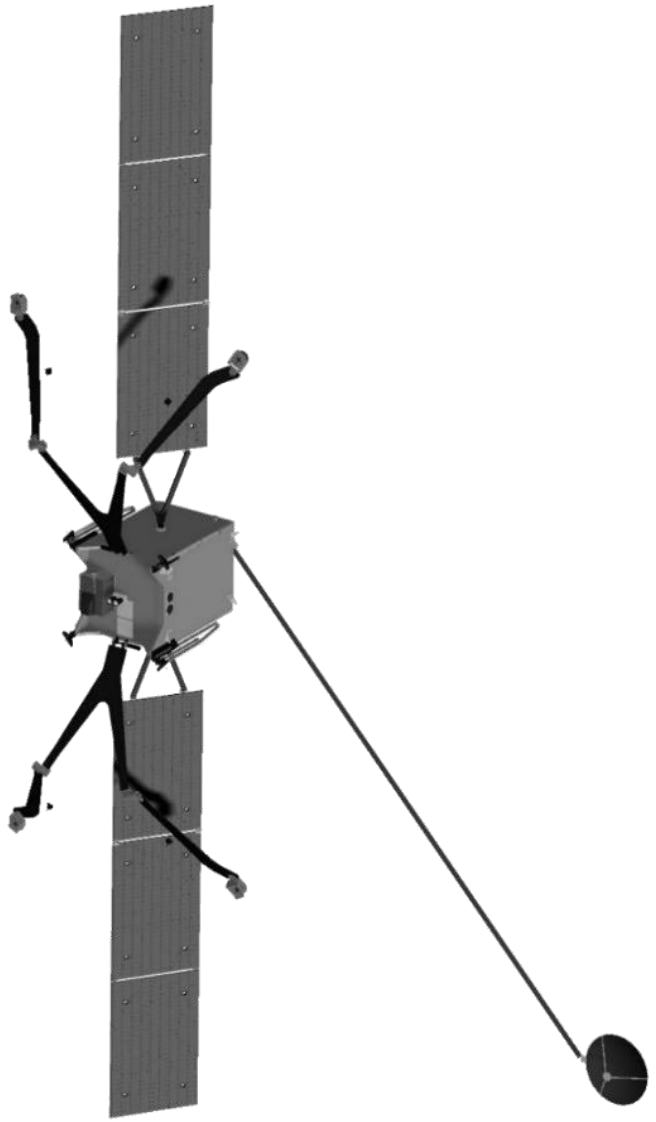
- Autonomous rendezvous and docking
  - Image processing payload and algorithms
  - Orbit control rendezvous algorithms
  - Docking system
- Orbit and attitude control of tandem configuration
- High ΔV requirements for the transfer and servicing of several satellites
- Adaptations for a variety of satellite platforms



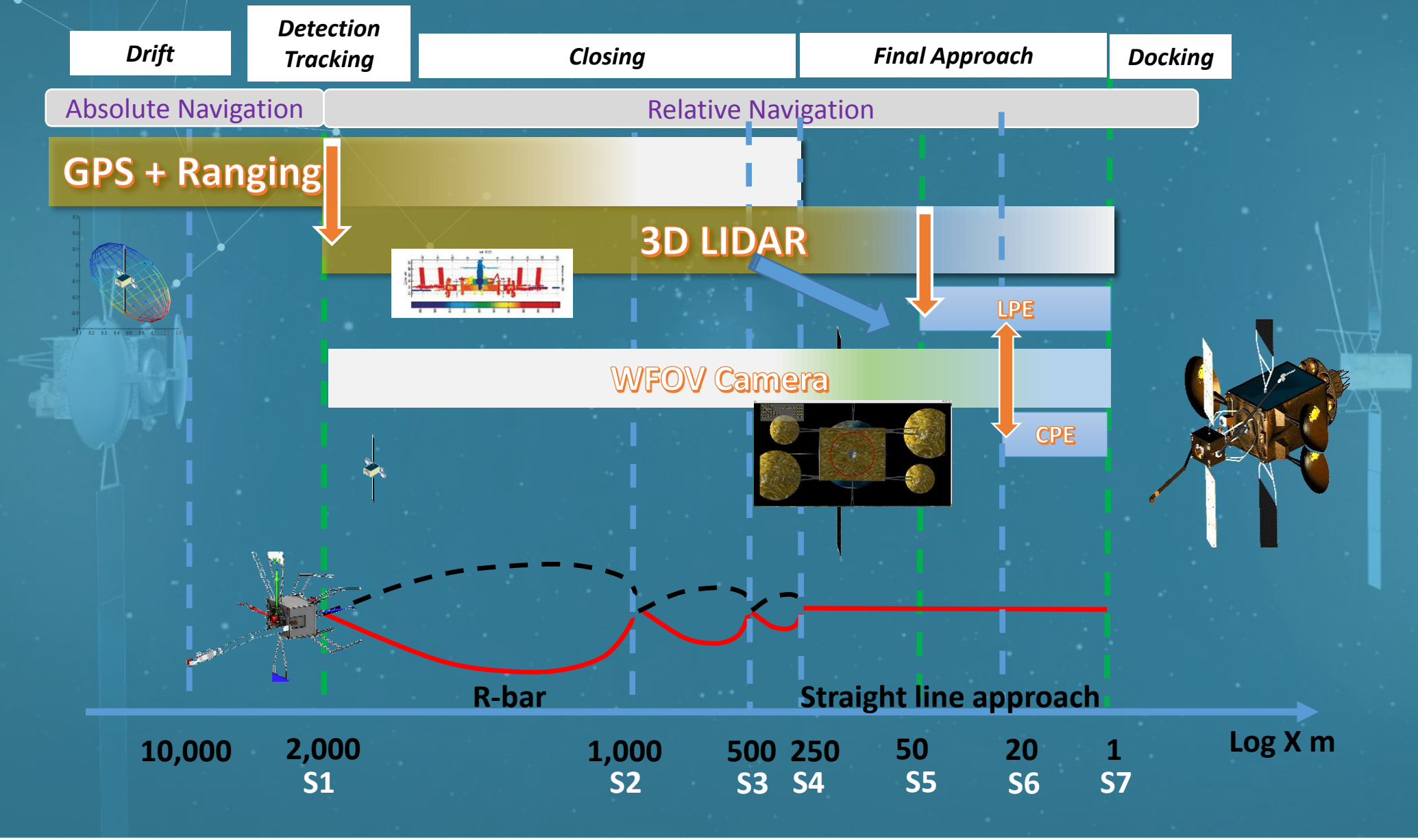
Technological solution that can be adapted for both GEO and LEO missions

SPACE DRONE™ Spacecraft

- Capable small spacecraft (350kg). Rideshare compatible
- High efficiency Electric Propulsion- High ΔV capability & high total impulse
- Patent-pending docking arms: non-intrusive, simple and safe, straight-forward design based on “Four bar linkage”
- Orbit and attitude control of tandem configuration
- Multiple docking, up to 15 years of service for typical 2 ton GEO satellite

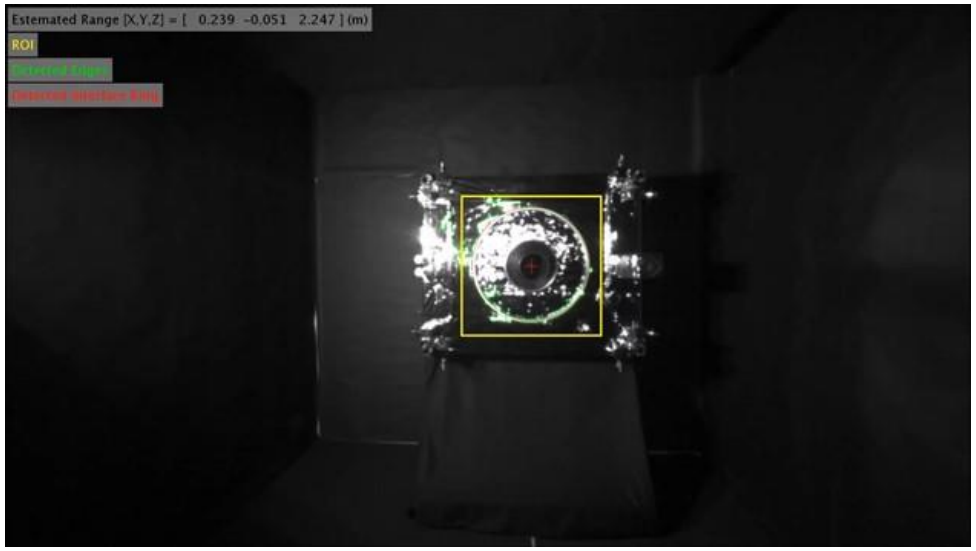


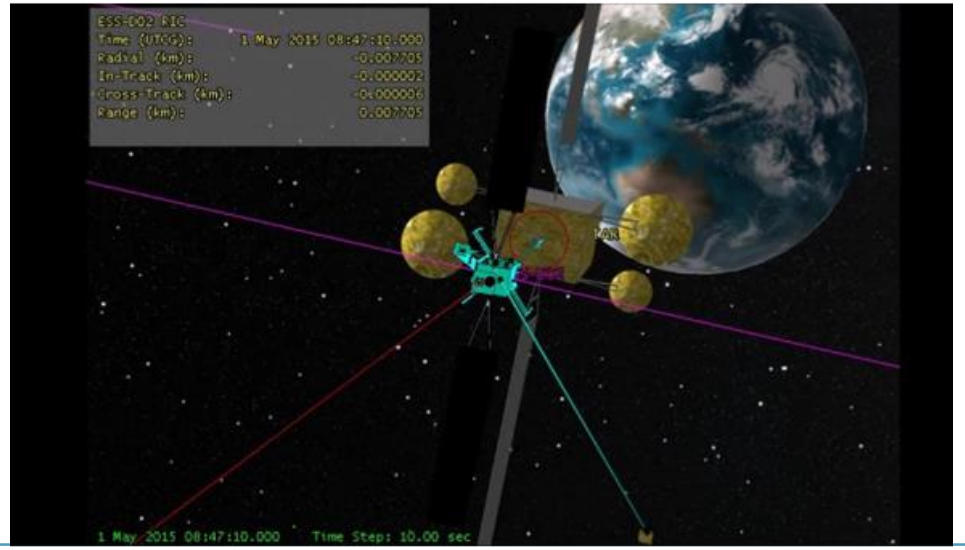
Rendezvous and Docking Process



Rendezvous and Docking Validation &Verification

- 2D verification on air table ☺
- Rendezvous algorithms analysis and simulation ☺
- SPACE DRONE™ spacecraft image processing verified at in-house visual lab ☺
- Docking test campaigns in end of 2017, in 6 DOF robotic lab
- Continuing Test Campaigns: (2018)
  - End-to-end Rendezvous and docking verification in 6DOF robotic lab,
  - Algorithm and payload integration
- End to End Simulator tests for overall mission scenarios





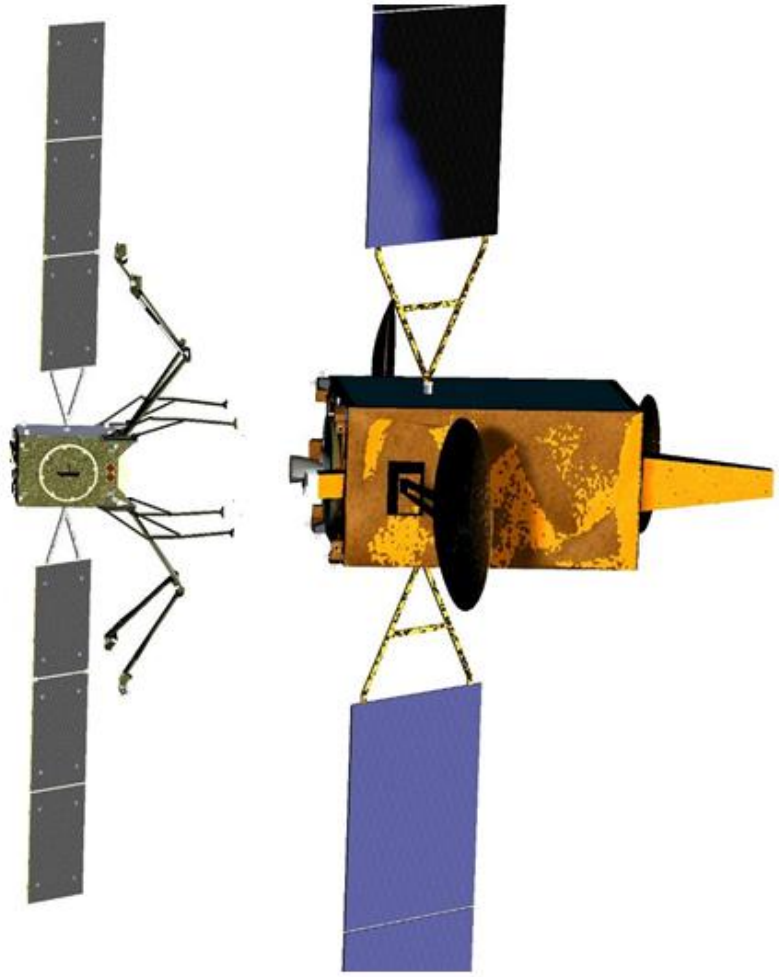
SPACE DRONE™ SPACECRAFT PROPULSION SYSTEM

- **THE CHALLENGE:** High efficiency electric propulsion accommodated into the compact allowable mass and volume of the SPACE DRONE™ spacecraft
- **THE SOLUTION:** 4 electric propulsion thrusters, redundant and reliable PPU design, low mass
- **THE PERFORMANCE:** Very high I_{sp} (> 3000 seconds)
- LEO , MEO and GEO compatibility with extended life and radiation hardening

SPACE DRONE™ for Active Debris Removal & LEO servicing

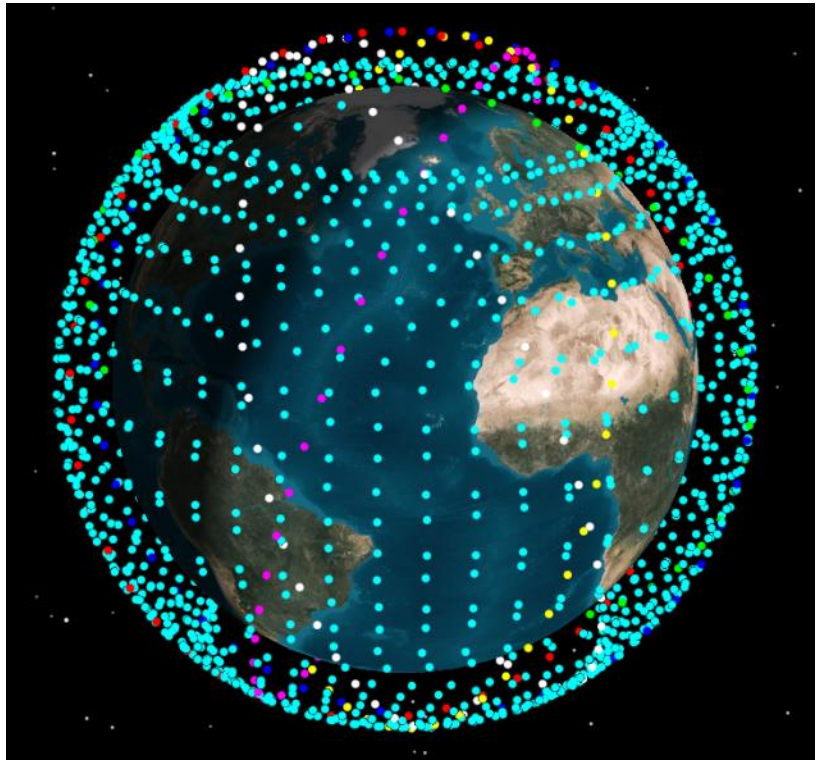
SPACE DRONE™ spacecraft is ideally suited for ADR and LEO servicing:

- Heritage technologies from GEO servicing platform
- Re-use of rendezvous and docking technologies
- High efficiency electric propulsion & high propellant mass allocation
- Low mass spacecraft platform



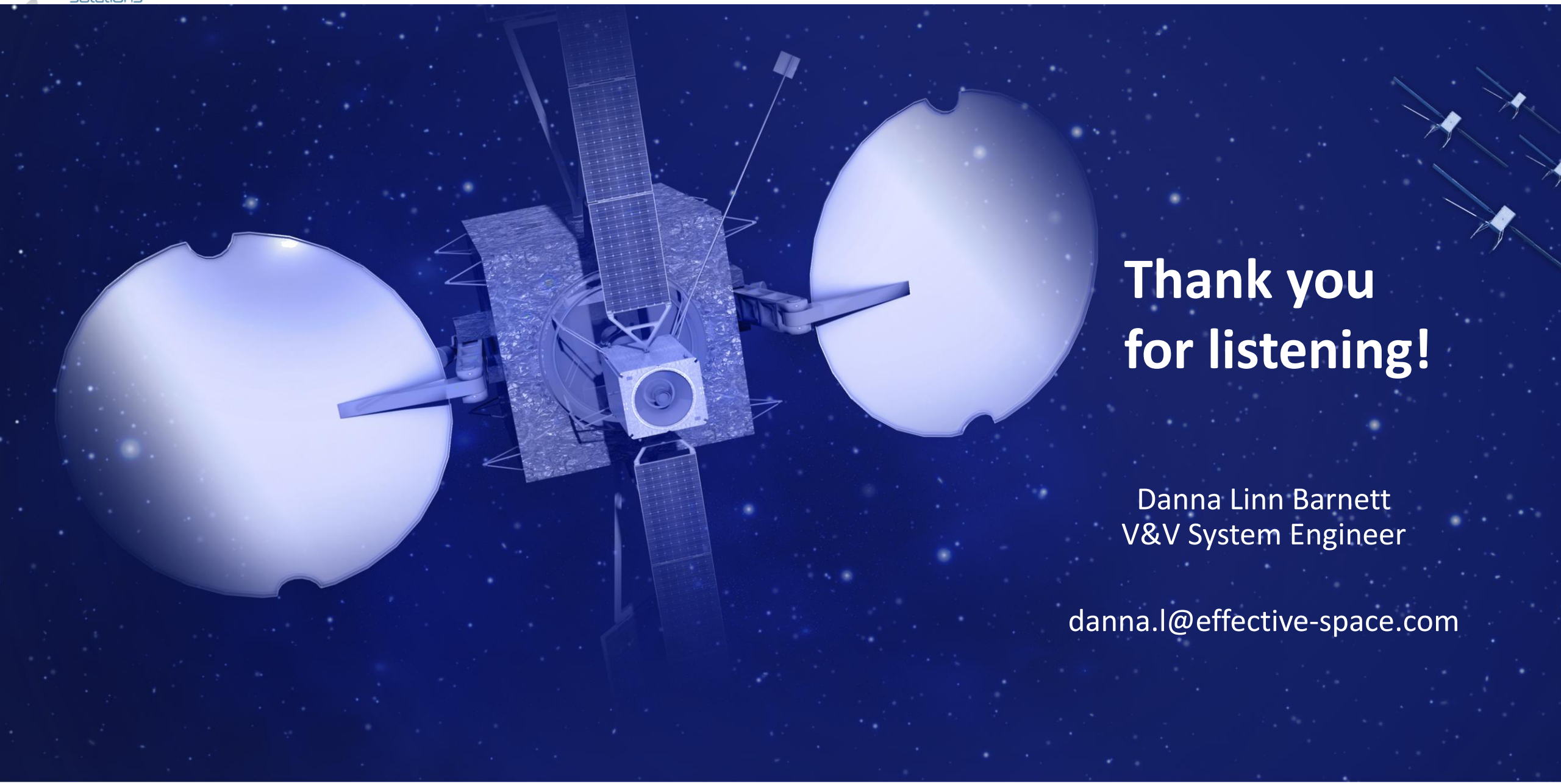
TEST CASE: SPACE DRONE™ in LEO

- Solution for mega-constellation deorbit management
  - Average mass of removed objects is 200kg
  - More than 20 deorbit runs per SPACE DRONE™ spacecraft
- Suitable of post mission disposal handling up to 10ton of debris in LEO
- Provides the most cost effective solution for large-scale deorbiting of constellation satellites



Summary

- SPACE DRONE™ spacecraft is a semi autonomous satellite, capable of multiple docking and servicing of GEO satellites
- Development and validation in advanced stages
- SPACE DRONE™ spacecraft platform suited for LEO active debris removal and post mission disposal
- Provides the most cost effective solution for large-scale deorbiting of constellation satellites



Thank you for listening!

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