NASA's Dragonfly Program: Commercialized Robotics

Enabling a New Generation of Evolvable, Resilient Assets in Orbit

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What does in-space Assembly offer?

- **Resilience**
  - Reconfiguration and Refresh leads to:
  - Commercial
    - response to market and technology changes
      - 15 year business plan no longer viable
  - Government
    - response to changing threats,
      - disguised or stored capabilities
      - Present an uncertain target with uncertain capabilities

Current state of the art commercial GEO communications satellite is highly optimized for performance, but is inflexible

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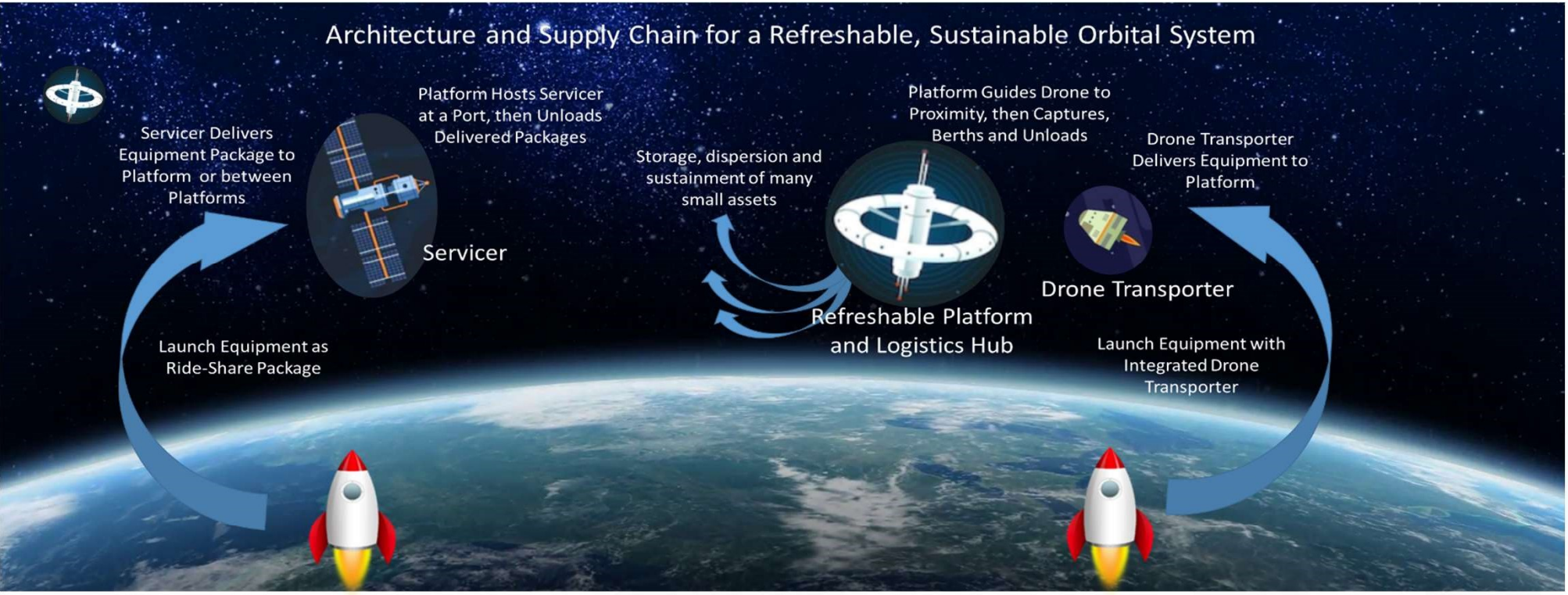
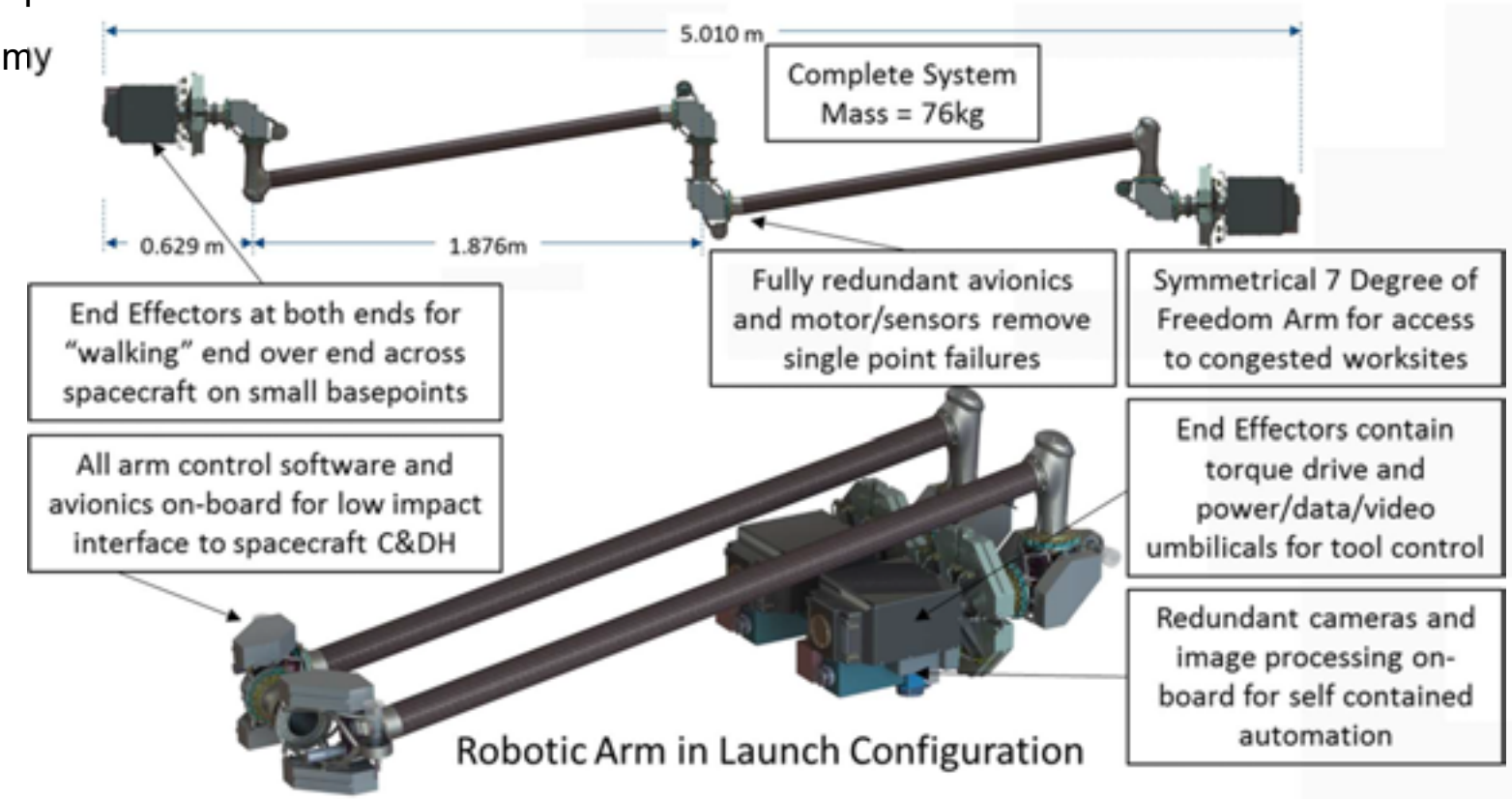
A Notional Orbiting Ecosystem



- **Ability to do things – Servicer, Platform**
- **Ability to accept things being done – modular platforms**
- **Supply Chain – ride-shares, Drones Transporters, Servicers**

The Robotic Building Block

- Inexpensive to integrate
- Inexpensive to operate
- Trusted autonomy



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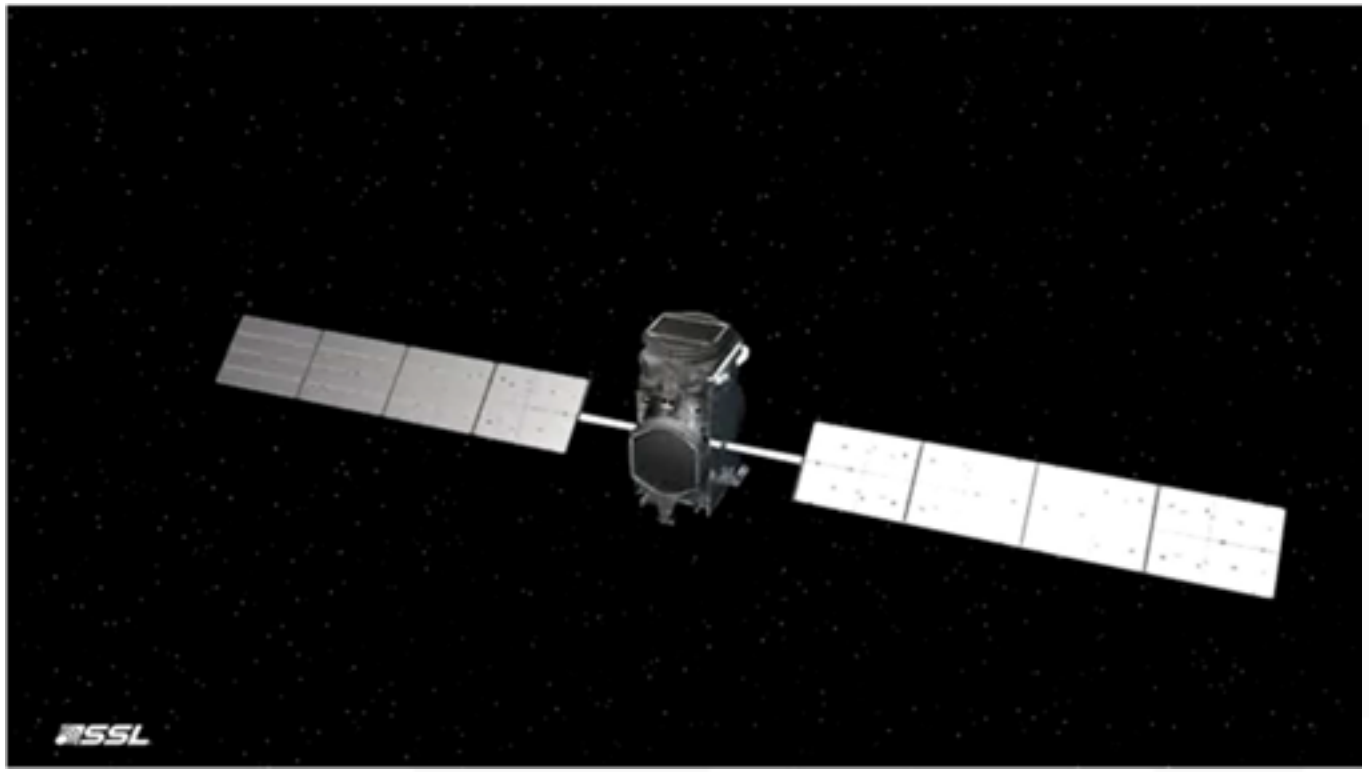
Near term applications – impact to the bottom line



- Dragonfly arm assembles large mm wave antennas to a small GEO satellite to increase aperture area by 2-4x over current state of the art. Aperture area is proportional to data throughput and revenue

Building on Operational Experience

Advanced arm control and force regulation software from ISS robotics

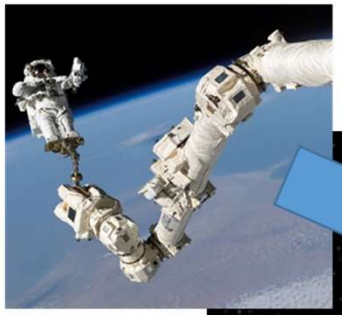
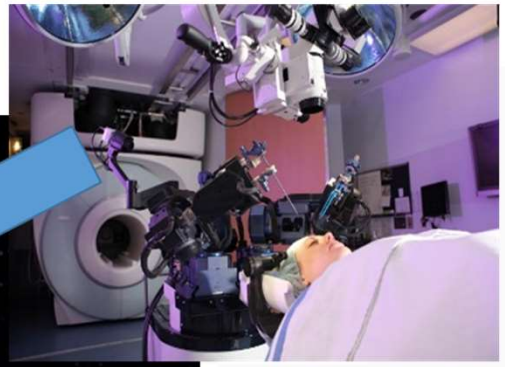
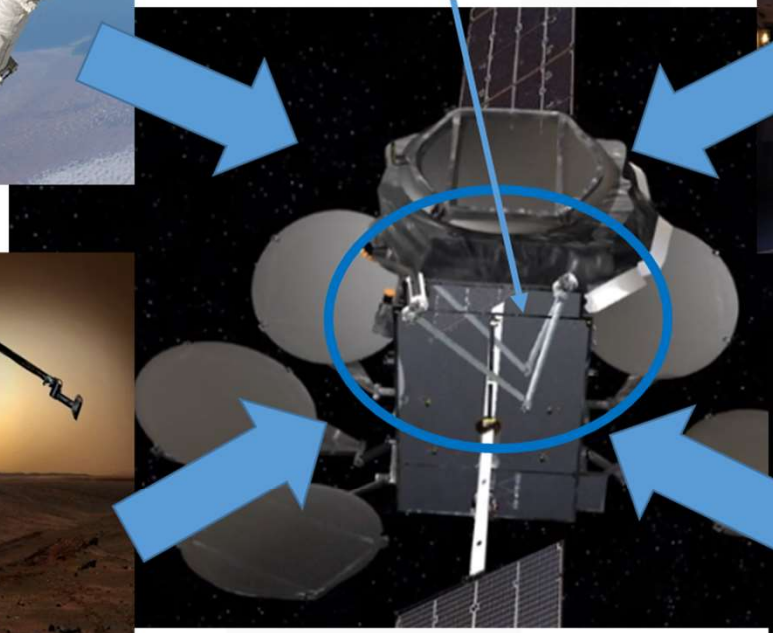
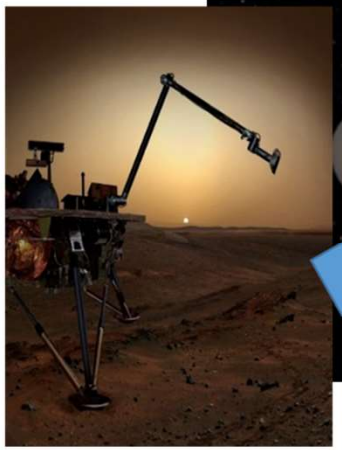


Image guidance and Supervised Autonomy from advanced neurosurgical robotics



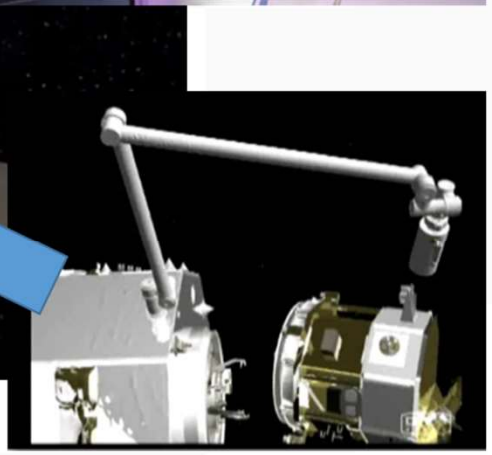
Dragonfly Robotic System assembling an antenna in GEO





Super-light Actuators, booms and cables from Mars Phoenix and MER IDD

Dragonfly: 5m, 7 DoF, double ended, fully redundant, on-arm avionics, control software and image/video processing, all-in mass of 76kg



3D graphics based planning, automatic script generation and end effector from Orbital Express Mission

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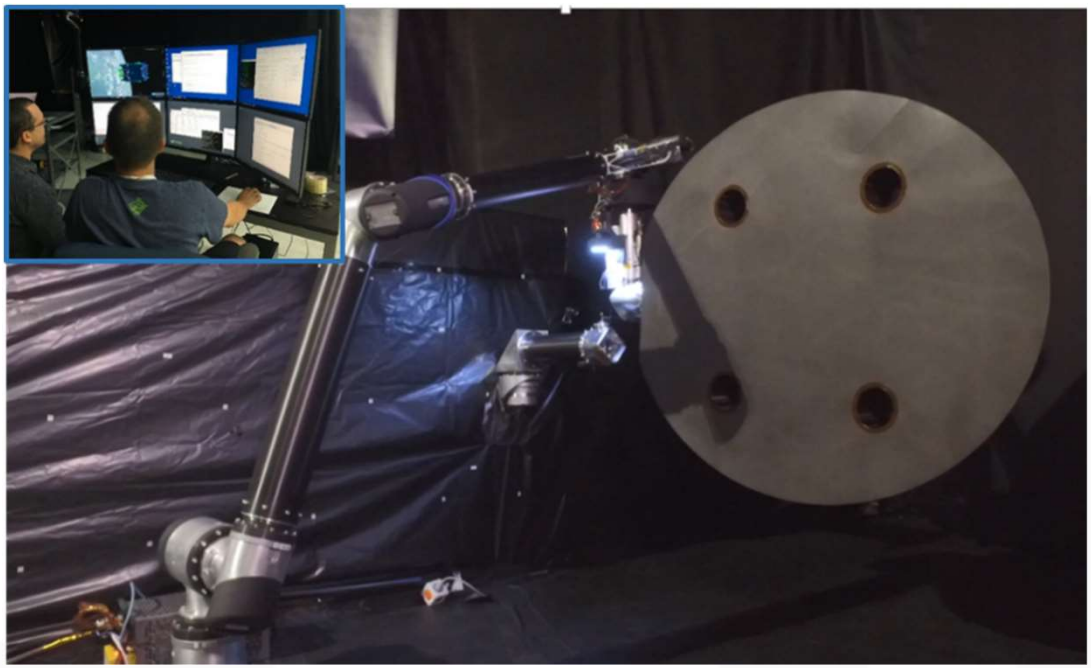
Supervised Autonomy Operations

- Graphical mission planning for rapid and low cost ops support
- Automated ops that use existing MCC, network and low rate TCR links
- Accommodate the real world with image guidance and force sensing/regulation in the robot



Dragonfly project demonstrates automated antenna assembly in Maxar's 1g robot lab in Pasadena in 2017

In-space Assembly is Ready

- Trusted hardware
- Trusted autonomy
- Low impact to existing communications infrastructure