COSMIC

THE POWER OF COLLABORATION

CONSORTIUM FOR SPACE MOBILITY AND ISAM CAPABILITIES

COSMIC Capstone Challenge (C3) Design Track Student On-Boarding

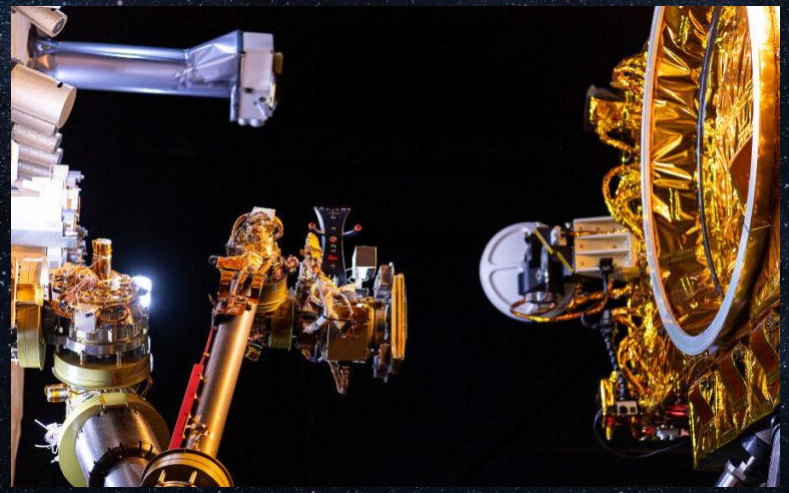
Andrew Kwas
C3 Champion for Track 3- Orbital Servicing

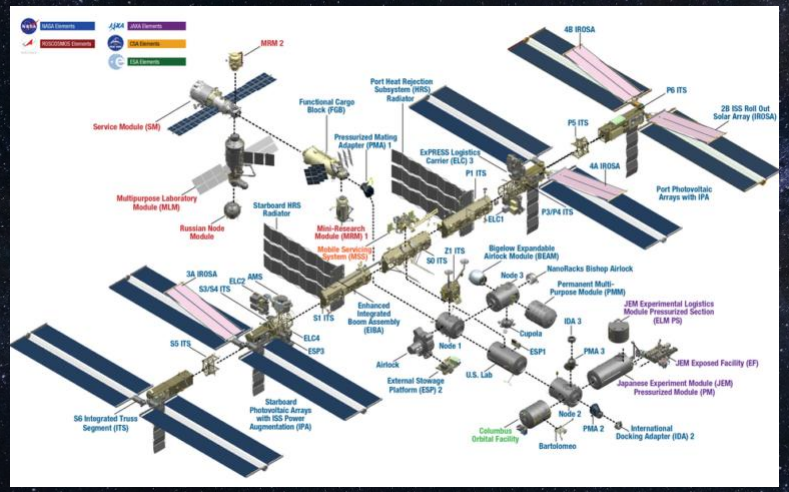
September 15, 2026

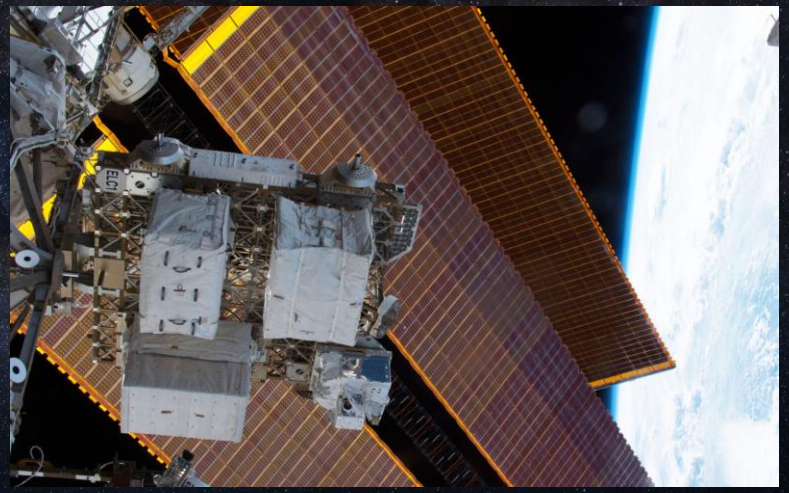
What is ISAM?

In-space Servicing, Assembly, and Manufacturing

- Design of modular, serviceable, upgradeable, and evolvable systems
- Assembly of simple to complex space systems
- Manufacturing in space using Earth- and locally-sourced materials







Orbital Servicing is the back bone of a successful on orbit program

Design Tracks for C3

- There are 6 design tracks that teams can participate in:
  - Track 1 Challenge: **Orbital Manufacturing and Assembly** (C3-Manufacturing)
    - Design a payload to be hosted aboard Arkisys's Bosuns Locker that would demonstrate a chain of 3 or more operations providing a capability important for orbital manufacturing or assembly.
  - Track 2 Challenge: **Lunar Operations** (C3-Lunar)
    - Design a payload to be delivered by Astrobotic's Griffin lander that can prepare the lunar surface for a Fission Surface Power reactor with humans residing within 1km. Prototype required.
  - Track 3 Challenge: **Orbital Servicing** (C3-Servicing)
    - Using Northrop Grumman's Mission Robotic Vehicle (MRV) and Mission Extension Pod (MEP) as a fixed servicer capability, design and analyze candidate on-orbit attachable components (OACs) that the MRV could use to alter a client spacecraft already on-orbit in geostationary orbit (GEO) or cislunar space.
  - Track 4 Challenge: **In-Space Construction** (C3-Construction)
    - Design orbital or surface infrastructure element(s) and outline the mission describing its construction using autonomous robotic assembly technologies. Teams should leverage previous work in modular building blocks and "builder robots" as referenced; teams may choose NASA's Project ARMADAS or other types of building blocks and robotic systems to address their mission needs.
  - Track 5 Challenge: **In-Space for Earth** (C3-Return)
    - Design a manufacturing payload hosted by Dispatch's Free Flyer 1 reentry vehicle to produce materials in space with properties that are impossible to achieve on Earth.
  - Track 6 Challenge: **Architecture of Autonomous Space Clusters** (C3-Cluster)
    - Develop an architecture and key elements that would enable a cluster of vehicles that would autonomously perform important functions in orbit or on the lunar surface (U.S. persons only).

Evolving In-Orbit Satellite Services

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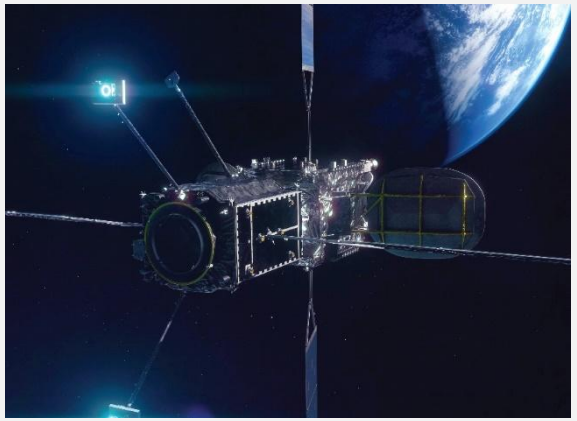
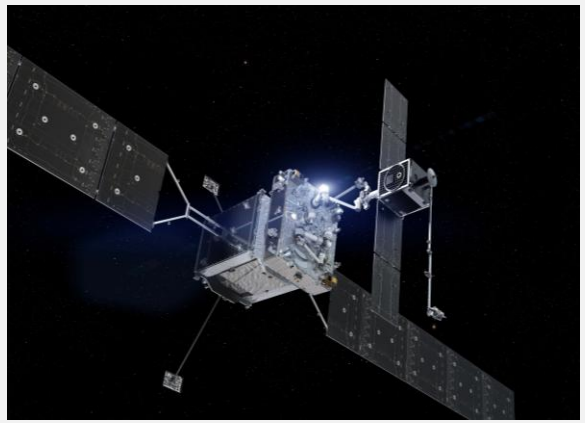
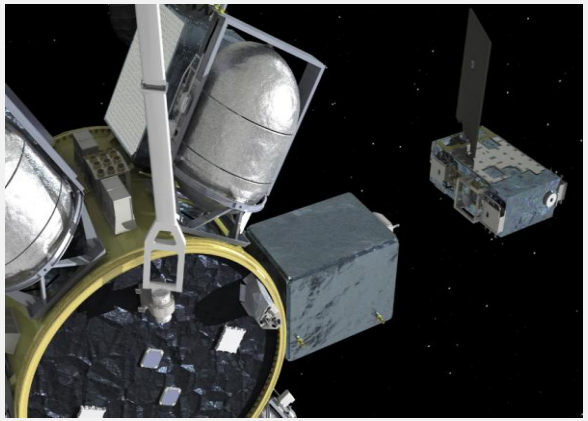
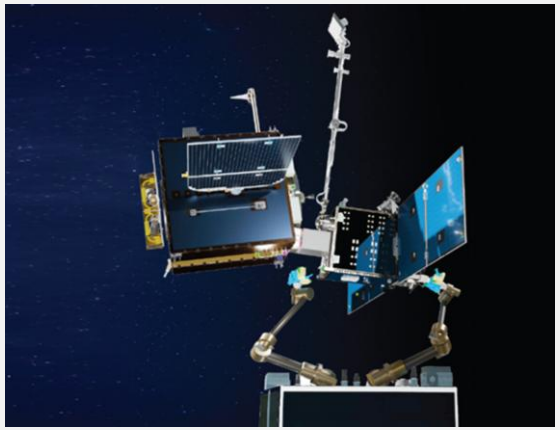
Epoch 1: Heritage Satellites (Unprepared)

Epoch 2: Future Satellites (prepared for servicing)









1st Gen (Today)

Mission Extension

2nd Gen

Mission and Resiliency Upgrade and Robotic Servicing

3rd Gen

Refueling and Upgrading

4th Gen (2030+)

In-Space Assembly and Manufacturing

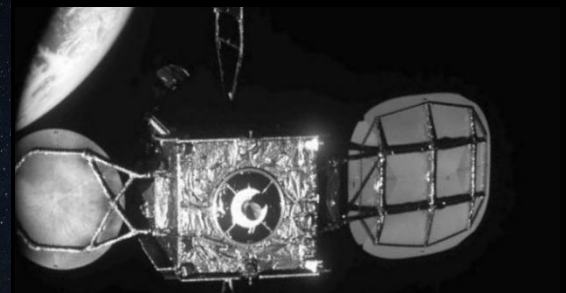
Extending Satellite Life, Enhancing Resiliency, And Reconfiguring On-orbit

Proven Experience in GEO

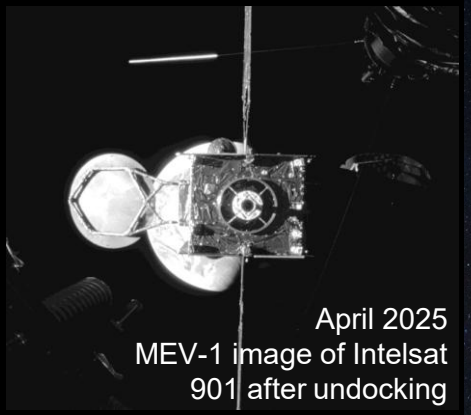
SpaceLogistics is the First Company with In-Space Servicing Missions

Two Mission Extension Vehicles (MEVs) on Orbit

The MEV is the industry's first operational satellite life-extension vehicle



February 25, 2020
MEV-1 image of Intelsat 901 prior to docking



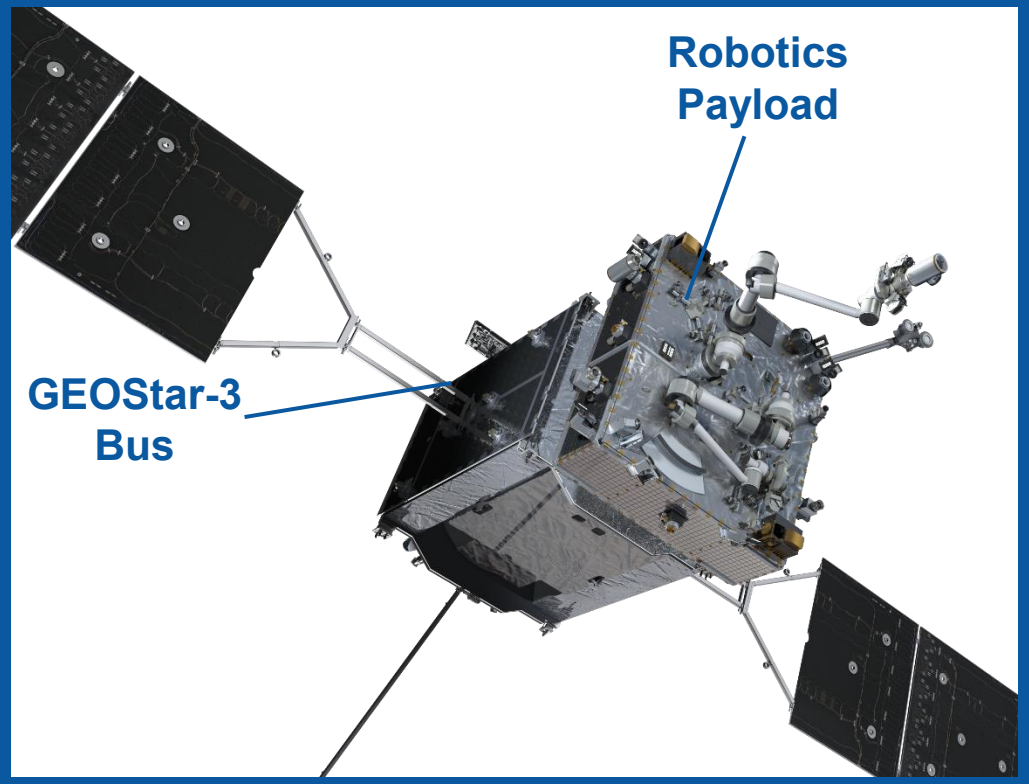
April 2025
MEV-1 image of Intelsat 901 after undocking

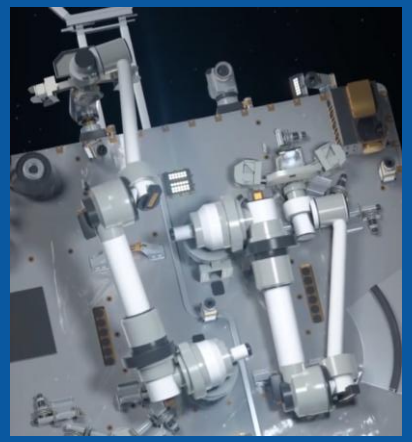
April 12, 2021
MEV-2 Image of Intelsat 1002 prior to docking

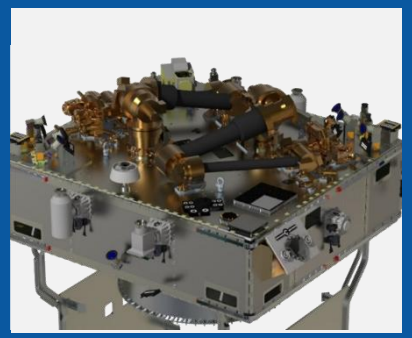
11 years of combined on-orbit servicing experience

Mission Robotic Vehicle (MRV)

Next-Generation Services and Products Cont'd







- **RPOD Sensor suite**
- **Robust Propulsion System with EP and CP**
- **Chemical propellant is refuellable via Passive Refueling Module (PRM)**
- **C-band & S-band (w/ classified encryption) Communications**

Two Robotic Arms

- 2-meter length class, testable in 1g
- High positional accuracy and repeatability
- Interchangeable end effectors

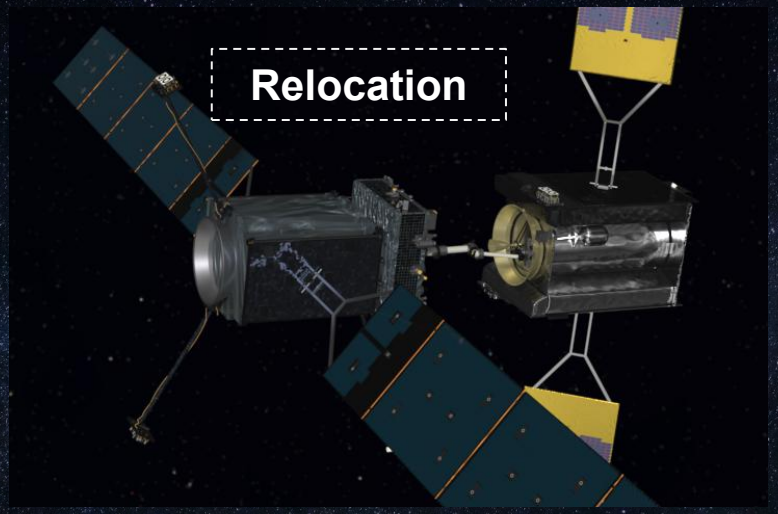
Interchangeable Tools

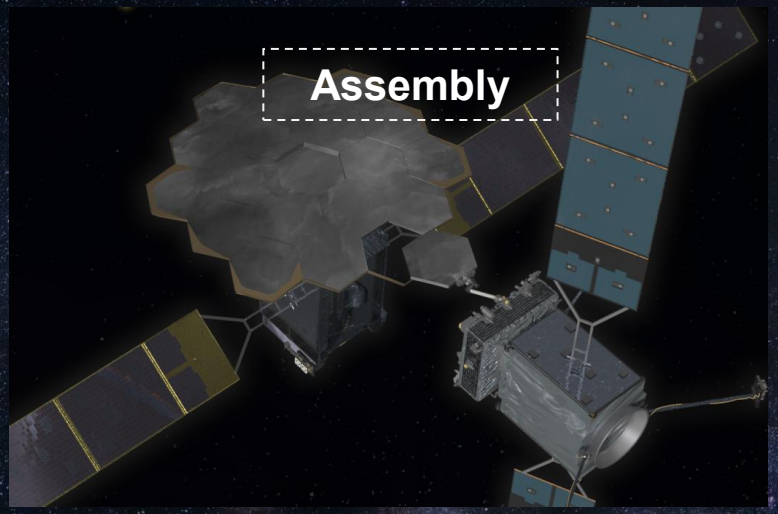
- MRT grapples unprepared client satellites via the launch interface ring
- POD Capture Tool captures free-flying objects prepared with grapple fixture (e.g., MEPs)
- 7 interface / tool storage ports – new tools can be delivered once on-orbit

Robotic Ops Sensors And Lights

- 4 visible End-of-Arm cameras & lights
- 1 color documentation camera
- 10 imaging cameras and lights
- 2 long range lights

Advanced MRV Applications





Upgrade of unprepared satellites

- Mission Extension, On Orbit Attachable Capabilities (OACs) such as Space Domain Awareness (SDA) payloads or other sensors/enhancements

Debris removal techniques

Manufacturing

- Welding
- Cutting
- Coating
- 3D printing

Assembly of large structures

- Apertures
- Power beaming
- Nuclear propulsion

Next Step & Questions

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Questions?

LinkedIn Group: https://www.linkedin.com/groups/14485139/

Future Refueling Architecture

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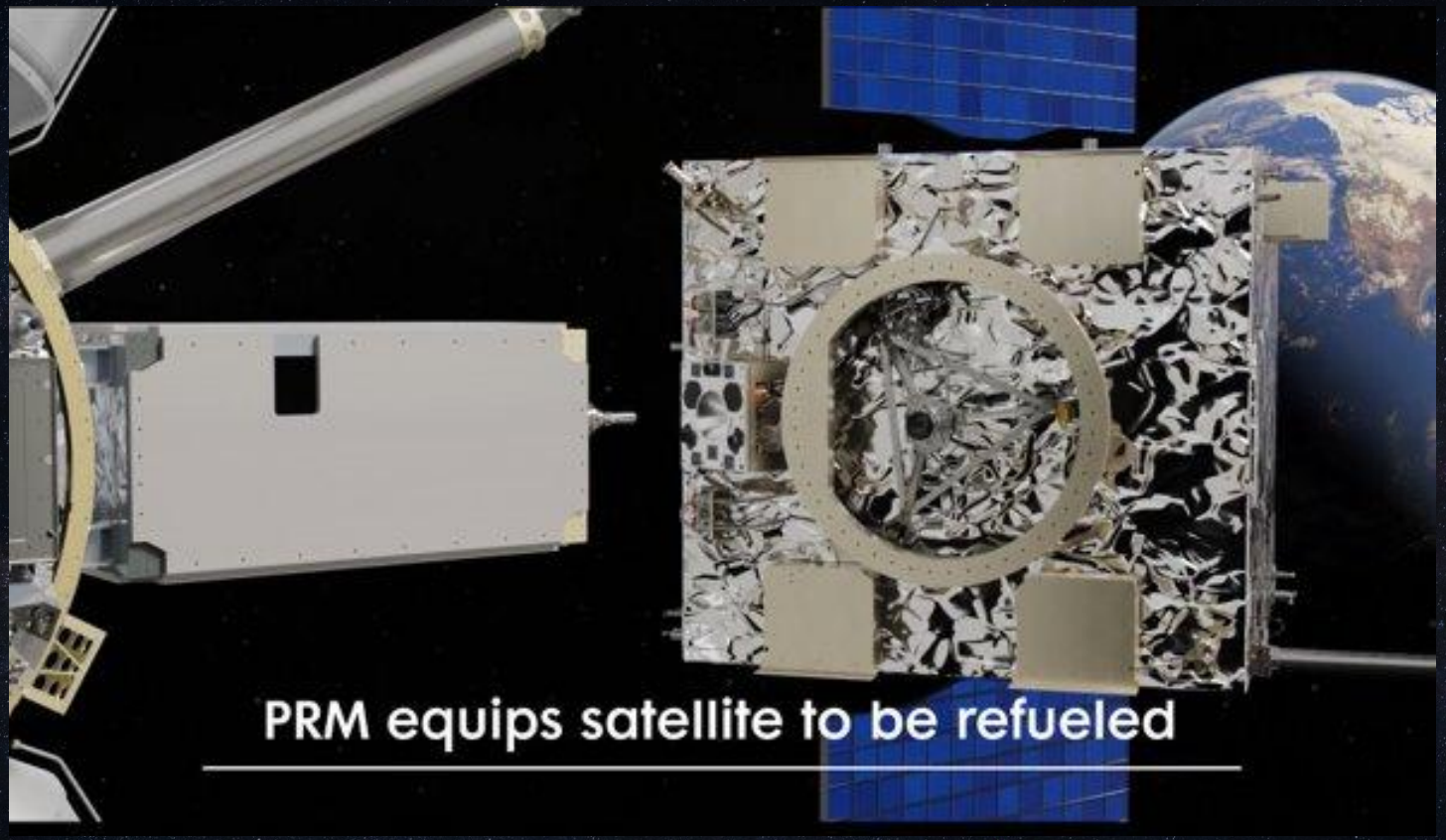
Northrop Grumman Passive Refueling Module (PRM) selected as a refueling solution interface standard for Space Systems Command (SSC)

- *Selected for maturity and technical viability of design*
- *Future satellites could be designed with an interface like the PRM to receive fuel. SSC contracted Northrop Grumman to fly the PRM on an operational mission.*
- These developments follow years of work across additional government contracts and internal investments to mature all elements of key refueling technology and mission architecture.
- Numerous successful design reviews and rigorous test campaigns have been accomplished.



In-space refueling supports spacecraft maneuvering sustain maneuver, avoid debris and extend operations.

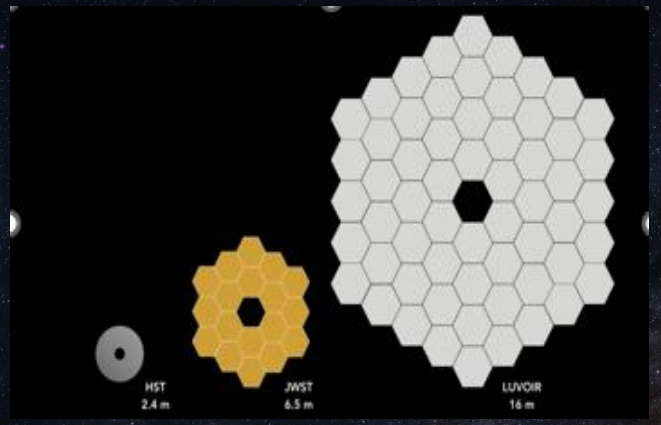
Tomorrow's In Space Assembly and Manufacturing

Beginning an era when we begin building large space structures. Relying on contortions and origami to pack space products under a shroud are waning

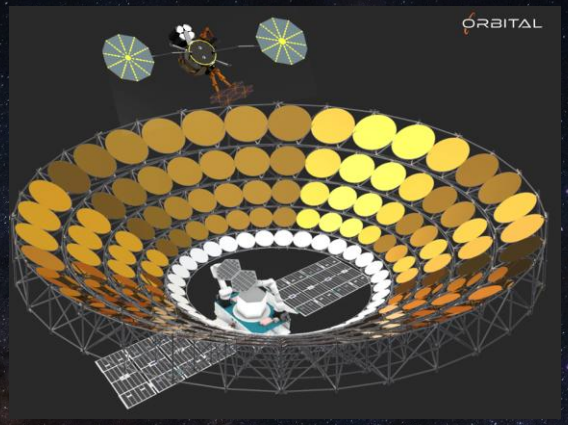
Systems like the next generation great telescopes (Habitable World Observatory), and space solar power systems will be built and/ or assembled in space

Where space environments are an unknown or a hinderance right now, they will eventually be embraced and seen as a benefit

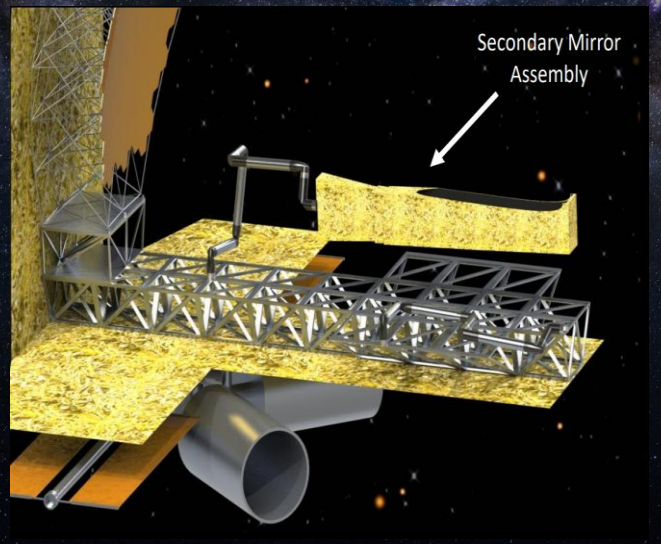
Autonomy, along with AI and Machine Learning will be the enabler to get space manufacturing accepted and exploited



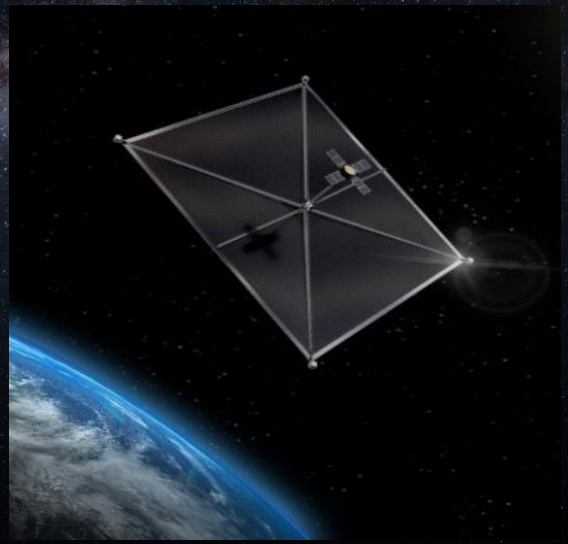
Size of Great Telescopes



Quantum Field Array- Orbital Composites



In-space assembly of telescopes - NASA



Space Solar Power- AFRL

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