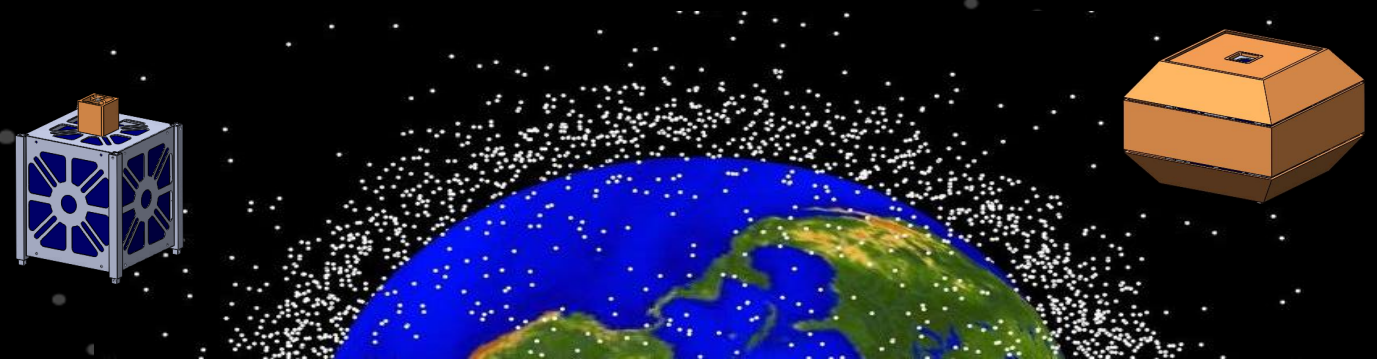
SPACE ENCASE

Space Debris Mitigation

Rawan Aljaber (G96)
Sukriti Kushwaha (G109)
Nuha Akhtar (G71)
Aditya Desai (G91)



LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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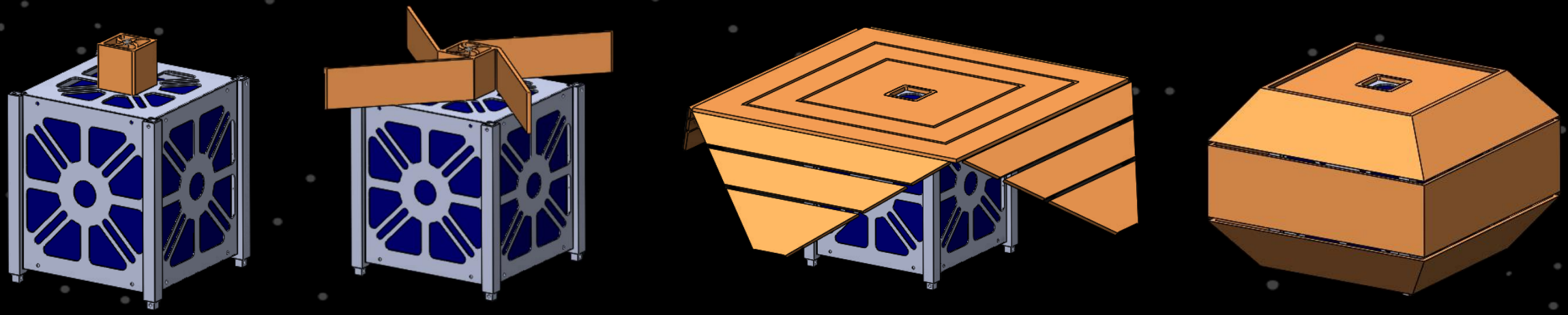
Introducing… SPACE ENCASE



Stowable satellite encapsulation device deployed at end of life to mitigate space debris and promote “good neighbor” space policy

Motivation

- *Focus*
  - Mitigate creation of small, untrackable MMOD (Micrometeoroid & Orbital Debris)
  - Contain, NOT SHIELD, spacecraft breakup

MMOD damage to ISS robotic arm

- *Incentive*
  - Maintain safe human spaceflight missions
  - Promote sustainable space policy, "good neighbor"
  - Qualification for streamlined FCC launch licensing

Project Progression

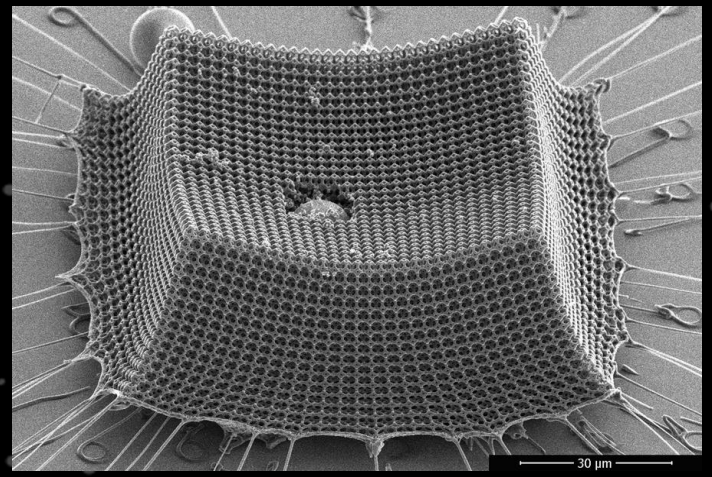
Material Identification

Material Testing

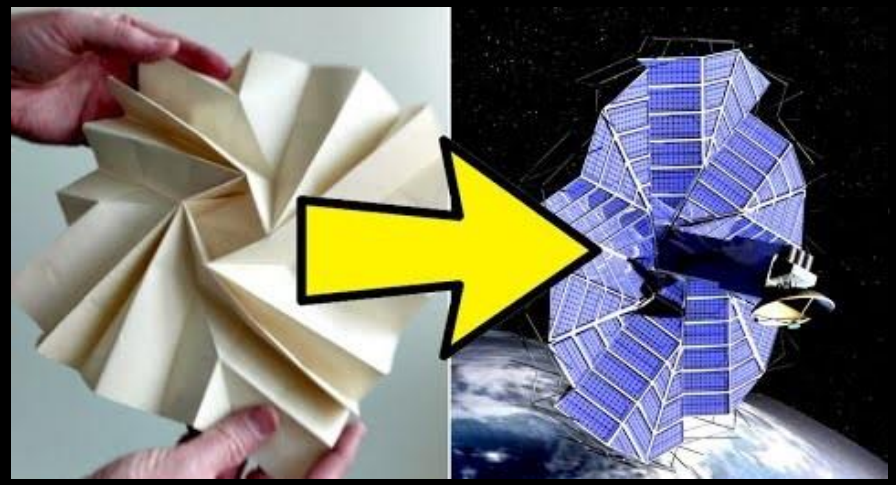
Material + Deployment Integration

Deployment Strategy

System Integration



Nanostructured carbon material (Dr. Portela-MIT)



Origami inspired deployment mechanism

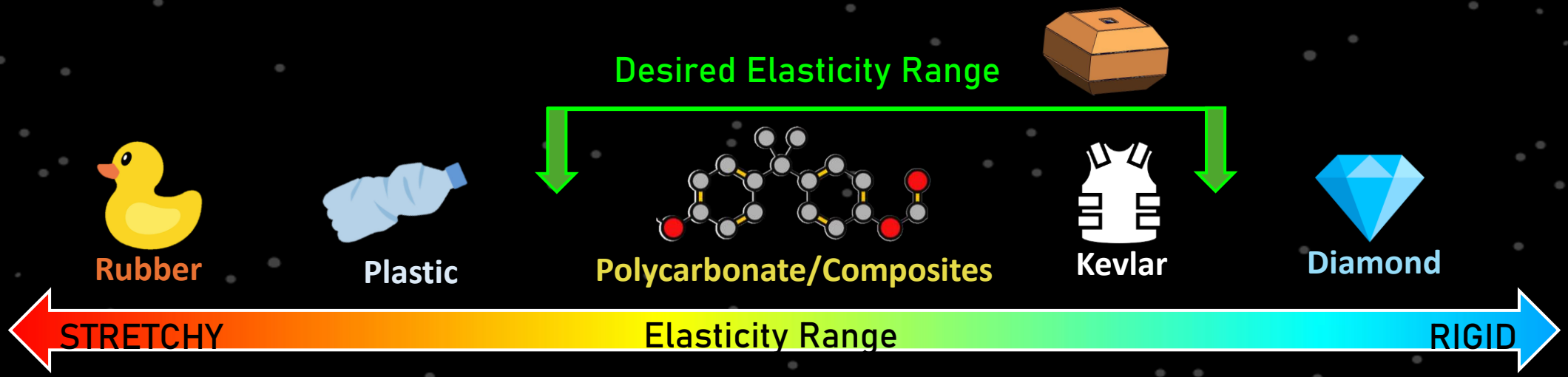
Materials

Necessary Characteristics

- Abrasion resistance
- Impact/debris absorption
- Light weight, foldable
- Elastic properties

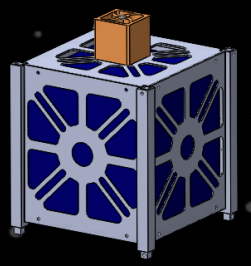
Possible Solutions

- Kevlar/Aluminum Composite Fiber
  - Woven and layered structures
  - Laminated
  - Polycarbonates
  - Composites



Deployment

- Current research exists on deployable structures (Pellegrino - Caltech)
- Compact, ultra-light stowable system
- Eventual development to smart shape sensing guidance



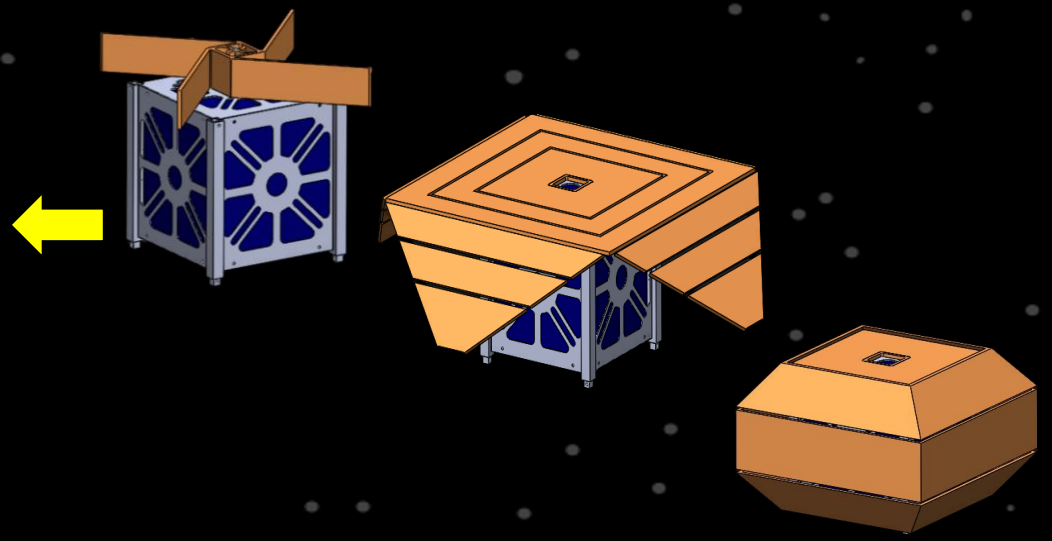
Space Encase + Spacecraft Integration

PRODUCTION: Attached to customer spacecraft

LAUNCH/MISSION: Encasement stays stowed

END OF LIFE: *DEPLOYMENT OF SPACE ENCASE*

DISPOSAL: Retrieval by future ADR* technology

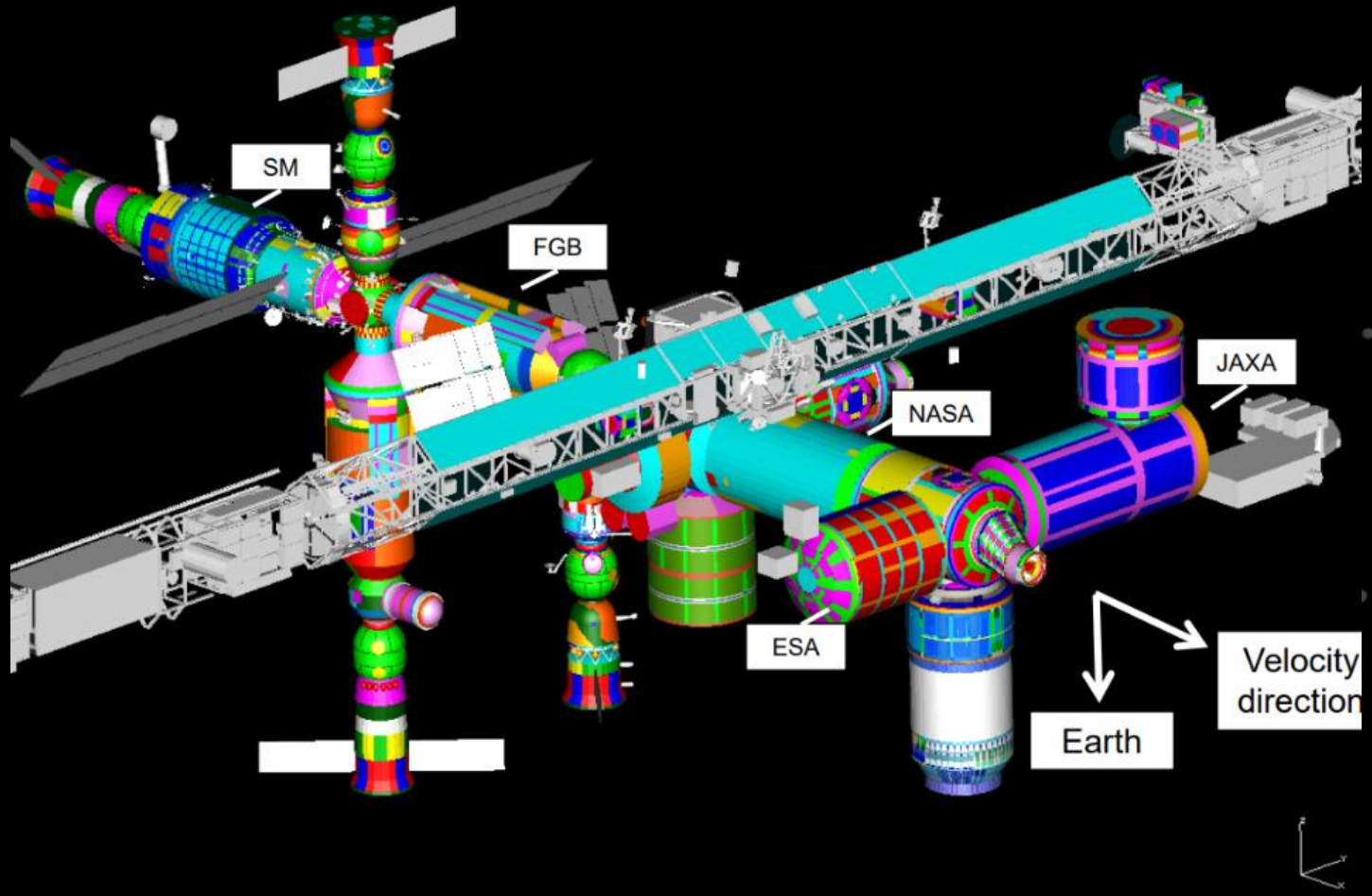


*Active Debris Removal

Thank you!

Questions?

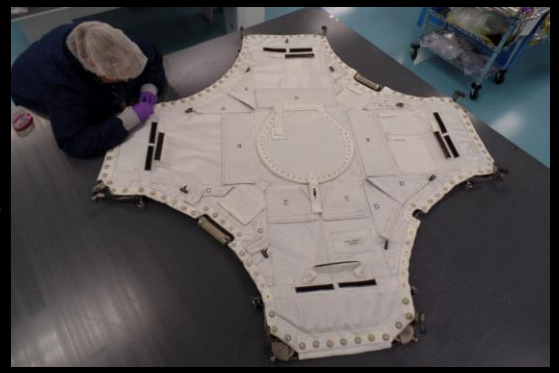
NASA ISS MMOD Shielding

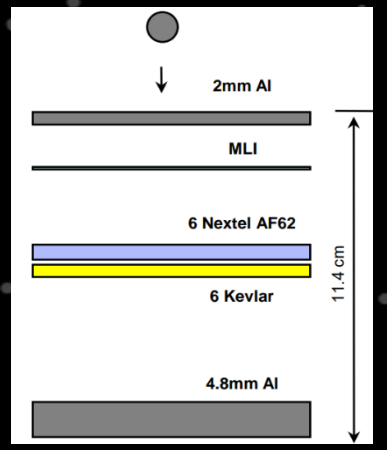


Each color represents a different MMOD shield configuration

Existing MMOD Work: Aerospace Fabrication

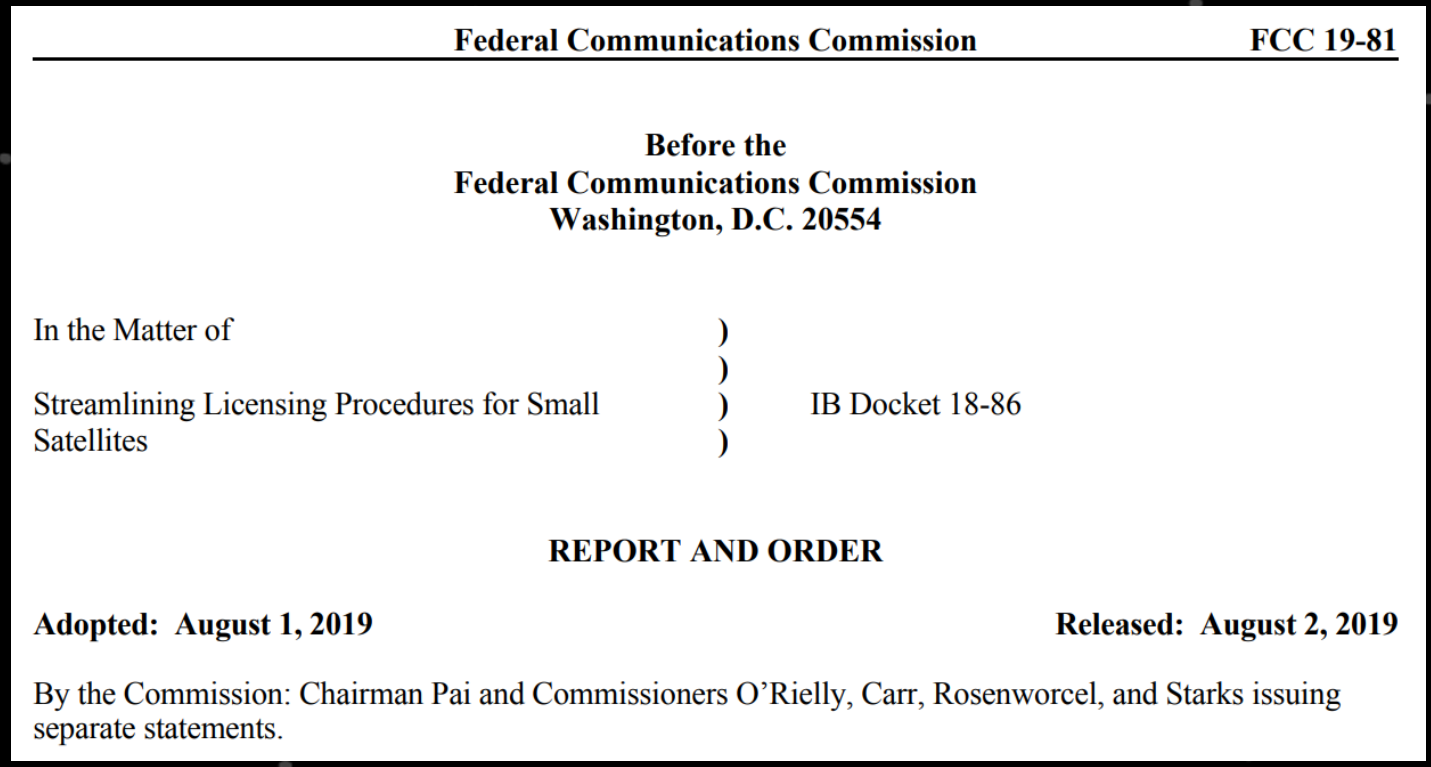
- Aerospace Fabrication MMOD Shield
  - Custom-designed armor blankets
  - Safeguard vulnerable surfaces
  - Offer passive thermal control
- NASA Whipple Shield
  - Multi-layer hypervelocity shield
  - effective for 1.3cm diameter debris impacting at typical impact conditions





FCC Streamlined Launch License

- Part 25 streamlined satellite license process
  - Granted earlier launch
  - Cuts down on cost
- For small satellites with orbital debris mitigation capability
- For commercial or non-commercial applications



Federal Communications Commission FCC 19-81

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Streamlining Licensing Procedures for Small Satellites	)	IB Docket 18-86
	)	

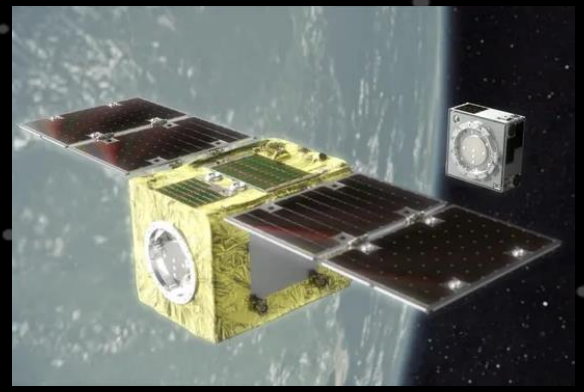
REPORT AND ORDER

Adopted: August 1, 2019 Released: August 2, 2019

By the Commission: Chairman Pai and Commissioners O'Rielly, Carr, Rosenworcel, and Starks issuing separate statements.

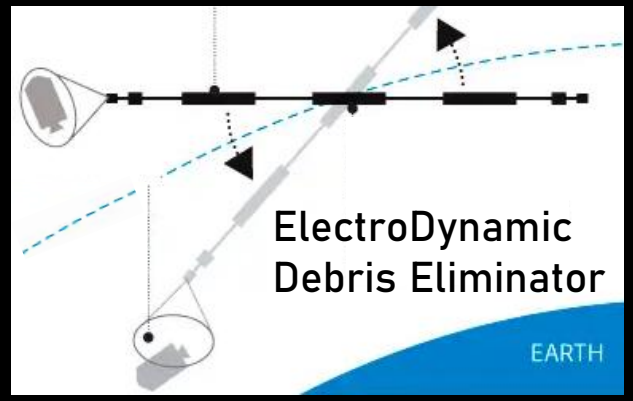
Future Active Debris Removal Technology

Astroscale



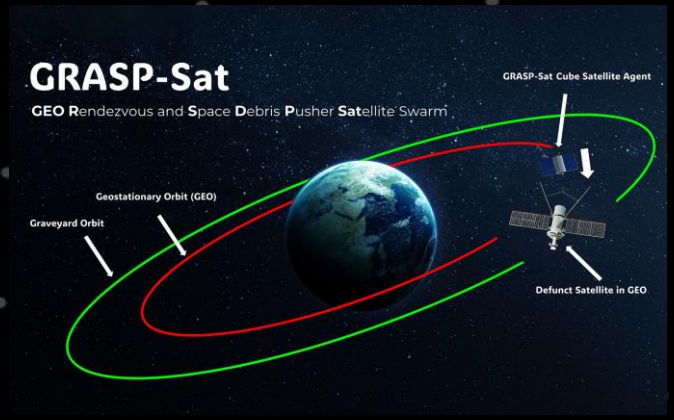
- Magnetic retrieval ADR
- $80 Million
- Currently testing

EDDE



- Tether pushing system
- $18 Million
- Conceptual

GRASP-Sat



- GEO pusher
- $ TBD
- Conceptual

Areas of Focus

Altitude

GEO (~3 km/s)				
MEO (4-7 km/s)				
LEO (~7 km/s)				
	Flecks/Dust (10^{-3})	Chips (10-1	Chunks (10^{0})	Satellites (10^{2})
	130,000	1,000	36	~10

Debris size (m)

Quantity (Thousands)

- Lower altitudes: faster orbital decay (drag)
- Larger debris: too much energy (and lots of debris)

Space Encase would allow for debris mitigation across many different collision scenarios

Orbital Debris Impact Comparison

- At conjunction in LEO, 2 space objects have relative average velocities of 4 km/s, or ~5 times the speed of a rifle bullet

Debris Size		Kinetic Energy Equivalent	
1 cm	=		Falling Anvil (70 kJ)
5 cm	=		Hit by Bus (9 MJ)
10 cm	=		Large Bomb (70 MJ)

ISS Tweet: Space Debris Prevents Space Walk