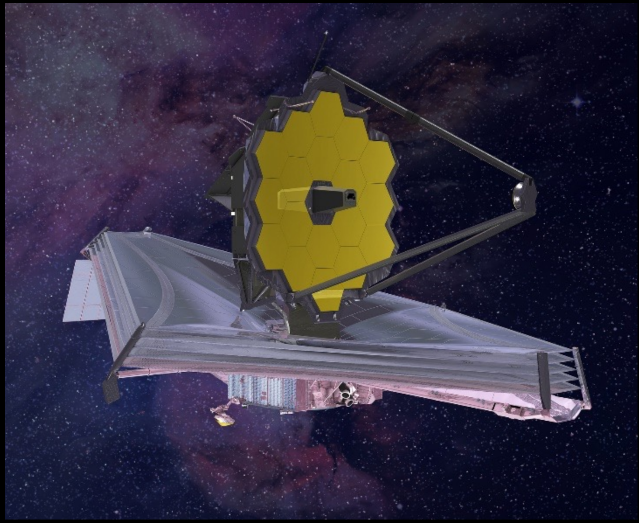

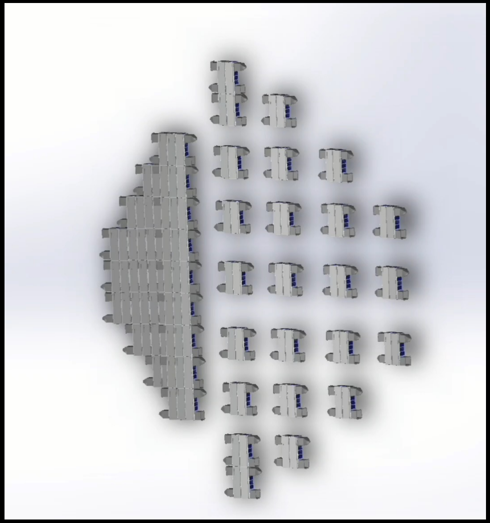

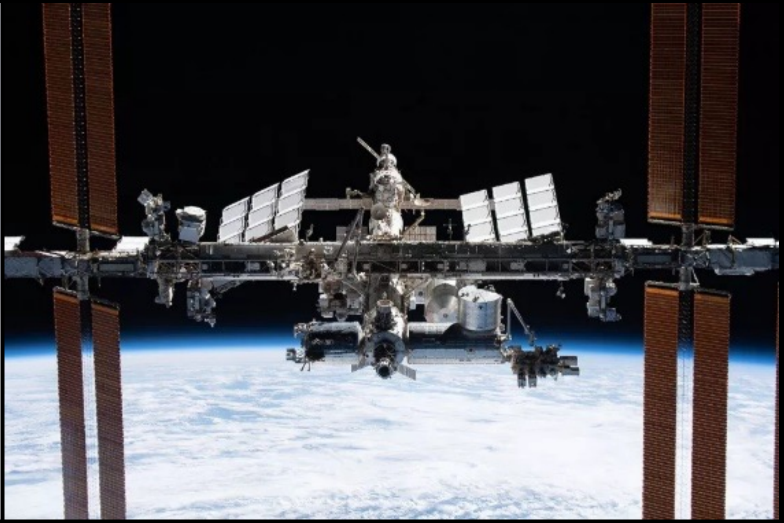

Extensible, Transformative Spacecraft Using CubeSats and Modular Building Blocks

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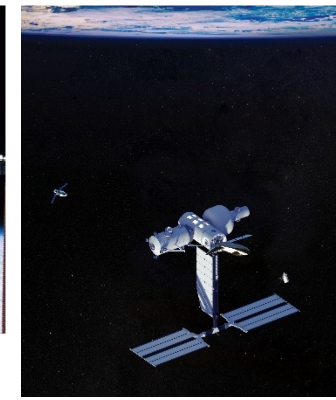
Outline

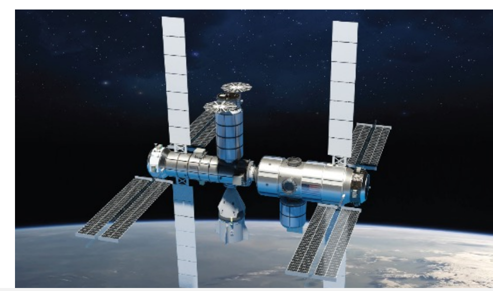
- Introduction and Motivation
- Inspiration
- Related Work
- Objectives
- Technical Methodology
  - Concept of Operations
  - System Architecture
  - System Design
  - Proposed Testing Methodology
- Conclusions and Future Work

Introduction and Motivation

- ISS Reaching End of Life
  - Currently plan to keep operational till 2024
  - Potential to remain operational till 2031 at the max
- Private Space Stations
  - $415.6 M awarded to 3 companies in 2021[1]

Figure: ISS

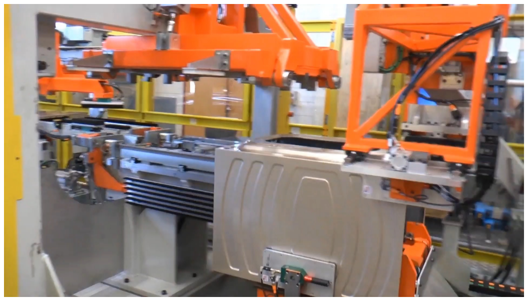




Great Potential for an autonomous robotic space station…

Space, and Lockheed Martin

Related Work



Video: Facteon Robotic Assembly Line for consumer appliances

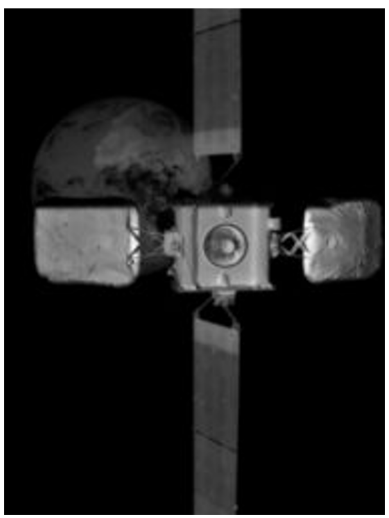


Figure: Intelsat 10-02 taken by MEV-2's infrared wide field of view camera at 15 meters away [2]

- Autonomous (and Manual) In-Space Assembly: ISS
- Autonomous Terrestrial Assembly: Commercial Products for Circuit Boards, IC Engines, and other appliances
- Autonomous Docking: Achieved with Large Satellites, CubeSats have not be Space Proven yet

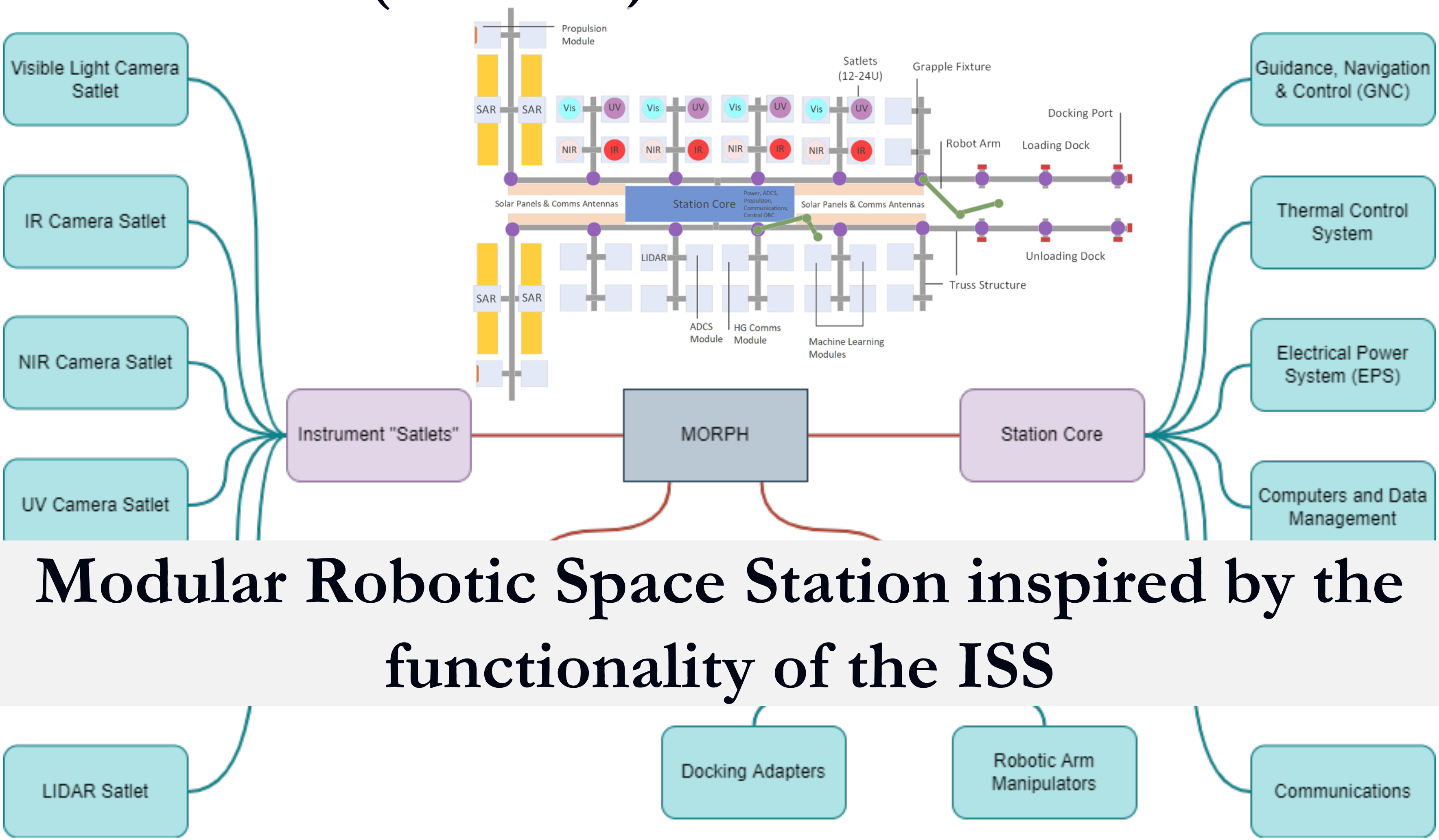
Video: ISS Assembly (NASA)

Figure: AAReST MirrorSats [3]

Objective

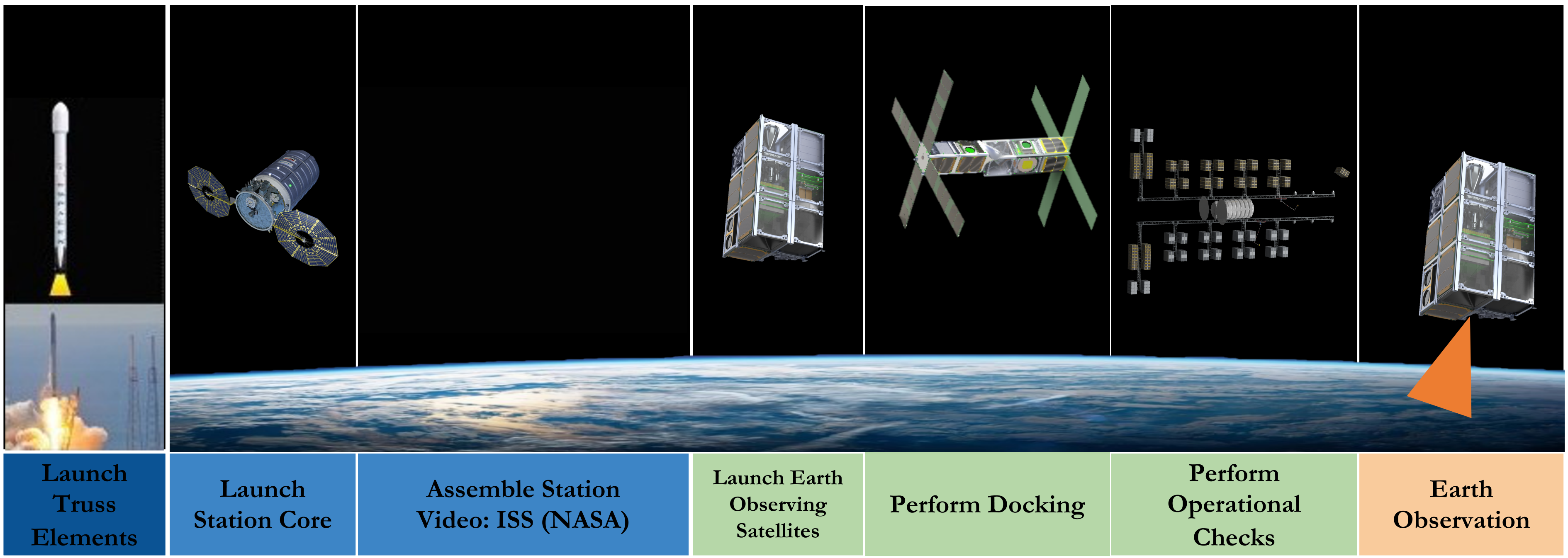
- Develop a design for a Space Station for LEO or Cis-Lunar Space
- Capable of autonomous operation
- Assembled in-space autonomously
- Modular with CubeSat building blocks

Functional Architecture: Modularly Oriented Robotic Platform Hub (MORPH)



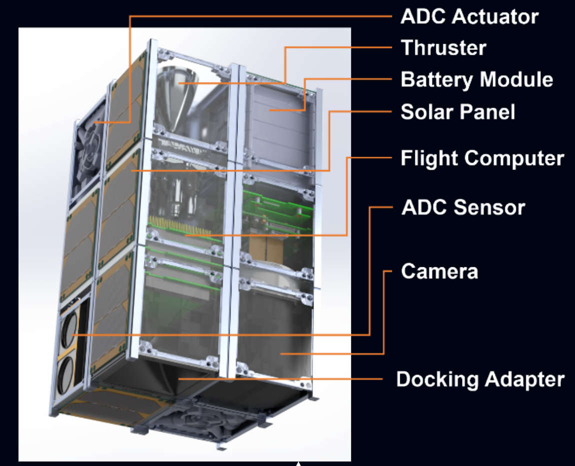
Modular Robotic Space Station inspired by the functionality of the ISS

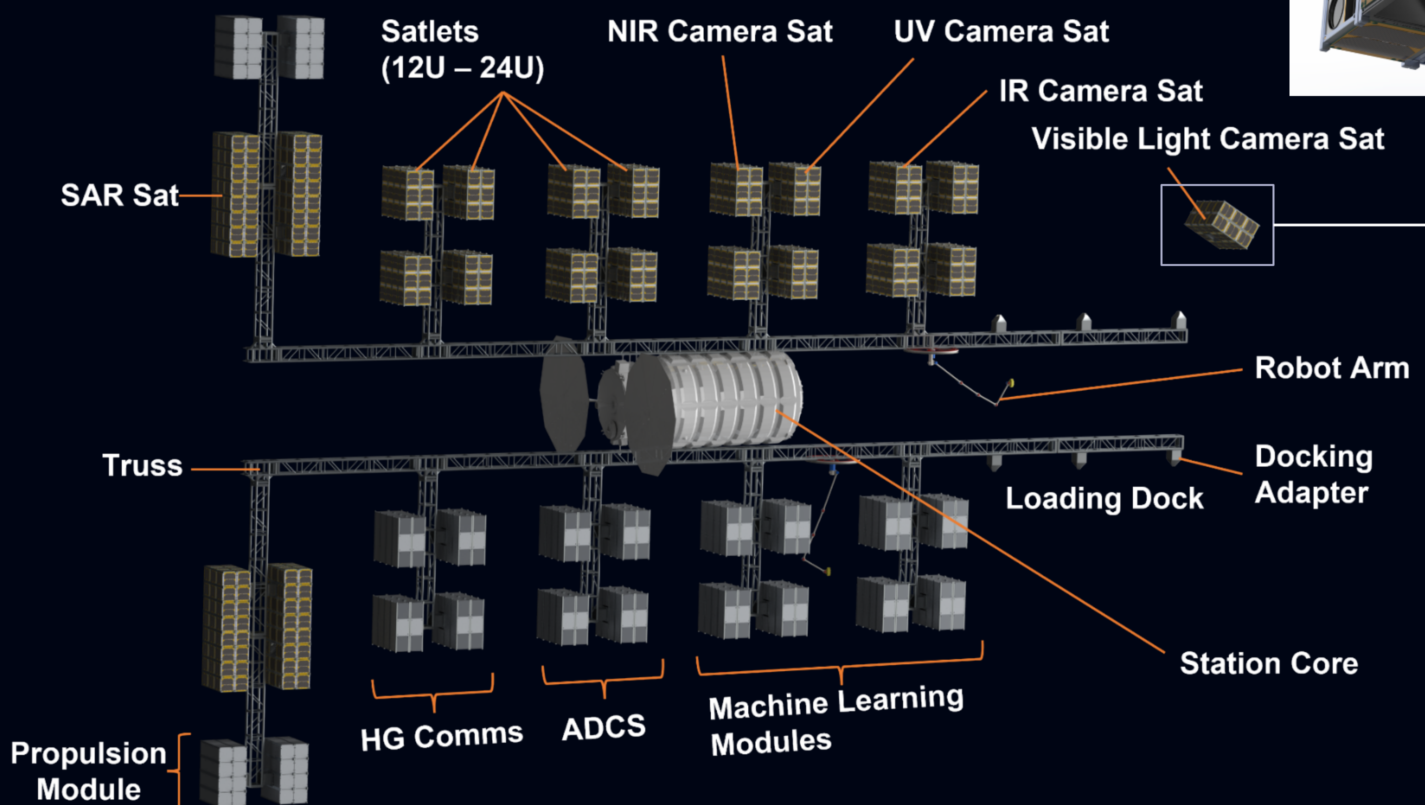
Concept of Operations



Vision for end-to-end autonomous robotic construction and assembly.

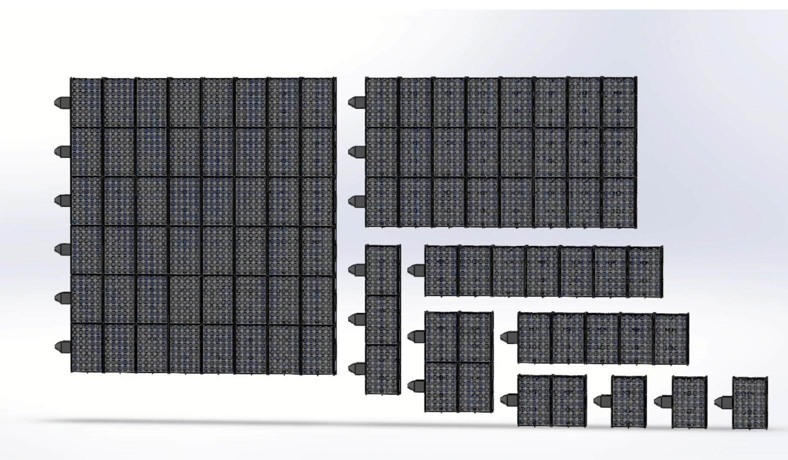
Proposed Station Layout: Earth Observation



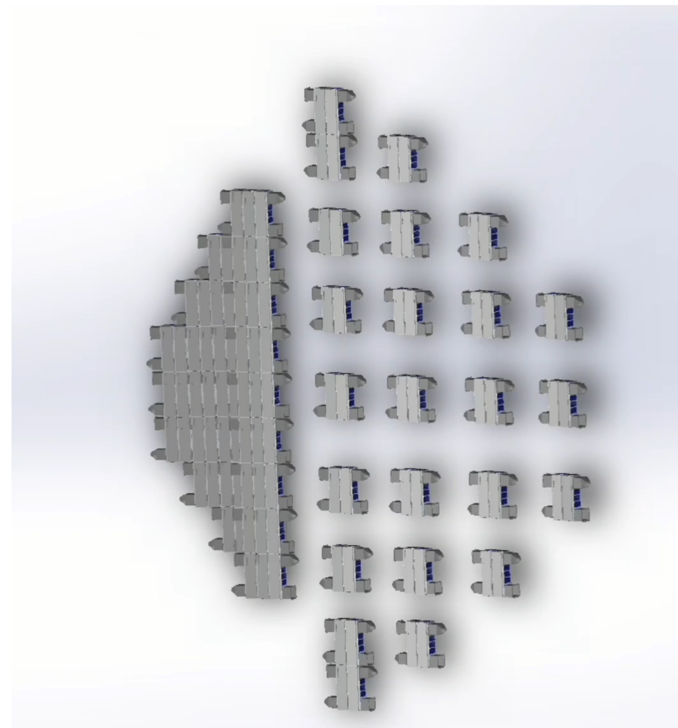


Alternative Configuration: Assembly of Complex Structures with CubeSat Building Blocks

- CubeSats with Docking capabilities to form modules of the Station Core itself



Video: Solar Panel Assembly using 12U Building Blocks



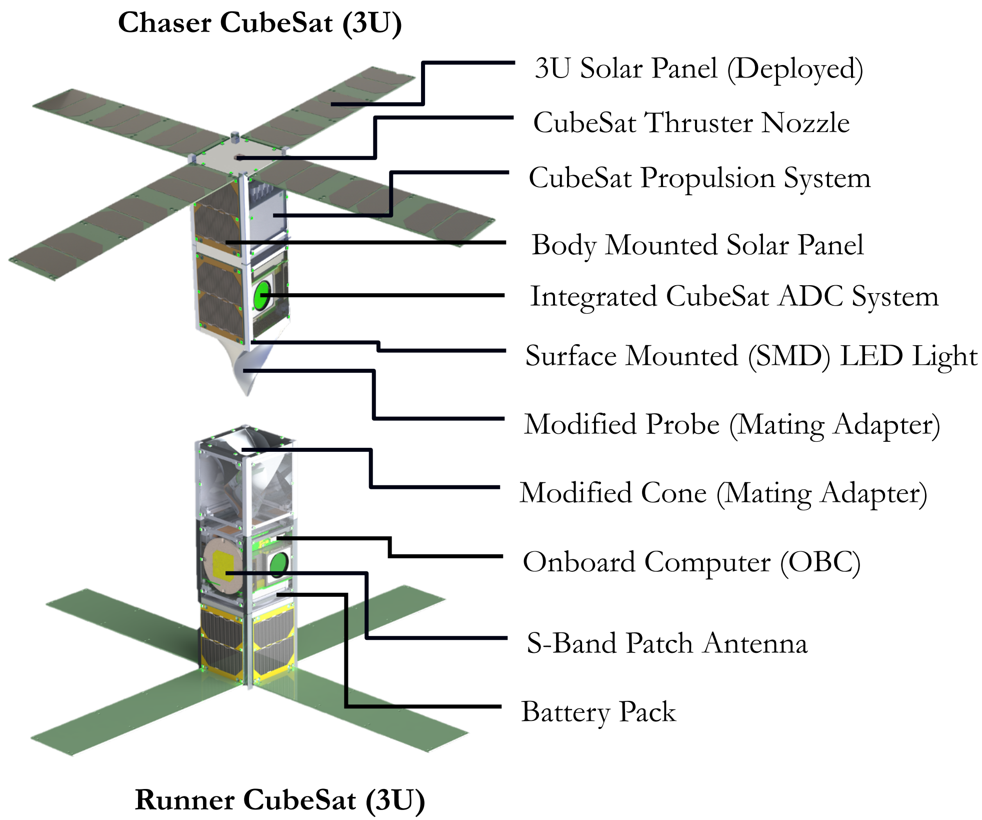
Video: Parabolic Dish/ Mirror Assembly using 12U Building Blocks

Potential Applications

- Earth Observation
- Space Telescope
- Ballistic Missile Defense/Detection
- Zero-G Experimentation Hub
- Communications Network (Military/Civilian)
- Spacecraft Refueling Center
- CubeSat Swarm Control Center
- Space Debris Collection and cleanup

Key Enabling Technologies

- Docking
  - IAC 2021, AASGNC 2022
- Inter-Satellite Communication and Coordination
  - AASGNC 2022, IAC 2022*



Conclusions and Future Work

- Analysis
  - Economic Viability
  - Longevity
  - Versatility
- Trajectory Design
- System and Subsystem Design

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SpaceTREx

LABORATORY

Space and Terrestrial Robotic Exploration (SpaceTREx) Laboratory

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CENTER

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SpaceTREx
Adventure Awaits

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[1] Margetta, R. (2021, December 14). NASA Selects Companies to Develop Commercial Destinations in Space. NASA. Retrieved April 30, 2022, from https://www.nasa.gov/press-release/nasa-selects-companies-to-develop-commercial-destinations-in-space/

[2] "Northrop Grumman and Intelsat Make History with Docking of Second Mission Extension Vehicle to Extend Life of Satellite", Northrop Grumman Newsroom, news.northropgrumman.com/news/releases/northrop-grumman-and-intelsat-make-history-with-docking-of-second-mission-extension-vehicle-to-extend-life-of-satellite. Accessed 21 Apr. 2021.

[3] S. Eckersley, C. Saunders, D. Lobb, G. Johnston, T. Baud, M. Sweeting, C. Underwood, C. Bridges, and R. Chen, "Future rendezvous and docking missions enabled by low-cost but safety compliant guidance navigation and control (gnc) architectures", in Proceedings of The 15th Reinventing Space Conference. British Interplanetary Society, 2017

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