Bishop: The NanoRacks Airlock Module

Your Commercial Gateway to Space

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HOW NANORACKS OPERATES & WHERE WE COME FROM

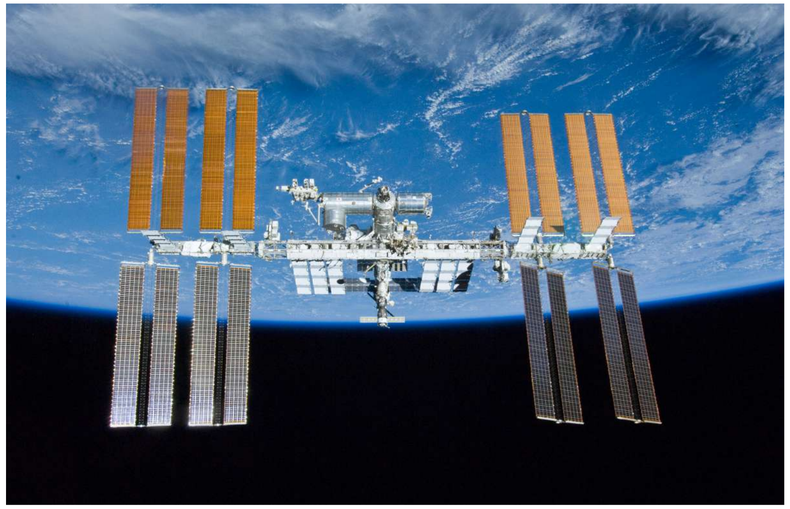
WHO WE ARE:

- Started self-financed in storage facility space in 2009 by Jeffrey Manber
- In eight years we have disrupted the market for low-earth orbit services; developed first US commercial CubeSat deployment program, first commercial successful biomedical program and proved LEO market
- Pioneered US/international commercial participation on the Space Station
- Developed Unique Operational Expertise in Commercial Relations with NASA and other ISS space agencies

HOW WE OPERATE:

- NanoRacks operates principally under a Space Act Agreement
- This allows us to:
  - Directly access ISS manifest
  - Access NASA Crew Time
  - Manage Payload Integration
  - Independently own hardware
  - Negotiate new agreements
- We currently enjoy multiple Space Act Agreements

OUR REAL ESTATE IN SPACE



INTERNATIONAL SPACE STATION

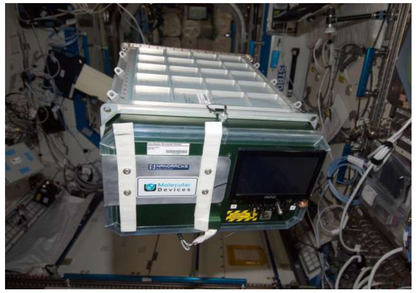
BLUE ORIGIN'S *NEW SHEPARD*

INDIA'S PSLV - POLAR ORBIT ROCKET

OUR ACTIVITIES IN SPACE

NanoLabs - Basic Research

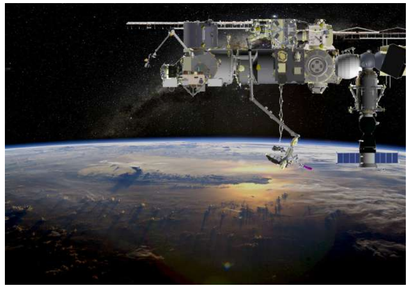
Space Environmental Exposure



Biomedical Research

CubeSat Deployment (NRCSD)

Launch Vehicle Satellite Deployments



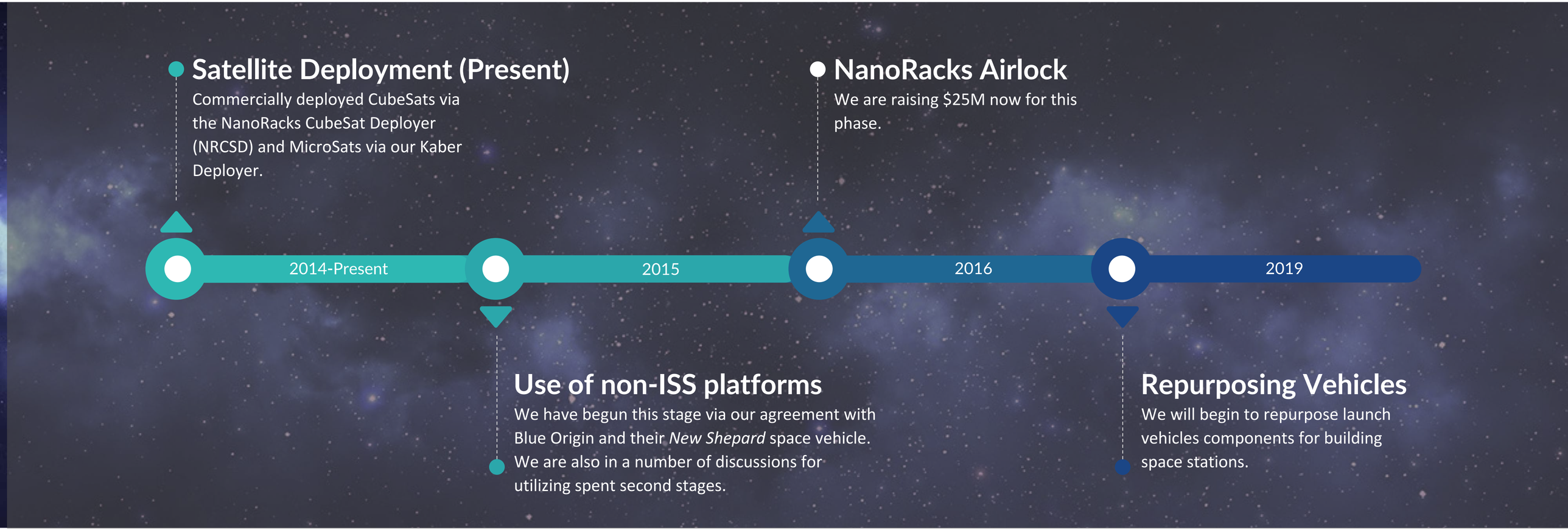
Small Satellite Deployments

RESEARCH PLATFORMS

SATELLITE DEPLOYMENT SERVICES

THE NANORACKS PATH TO BUILDING SPACE STATIONS

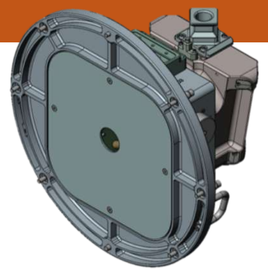
Stepping stones to orbit.



EVOLUTION OF NANORACKS HARDWARE AND CUSTOMER BASE

COMMERCIAL RESEARCH PLATFORM

CUBESAT DEPLOYMENT



MICROSAT DEPLOYMENT

Domestic and Foreign Industry

EXTERNAL PLATFORM

EARTH OBSERVATION

MICROPLATE READER & BIOPHARMA

Commercial researchers

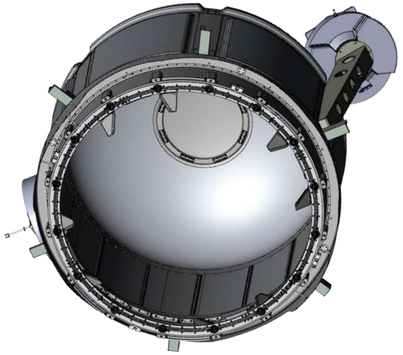
MIXSTIX

Privately owned microgravity research equipment

NANOLAB

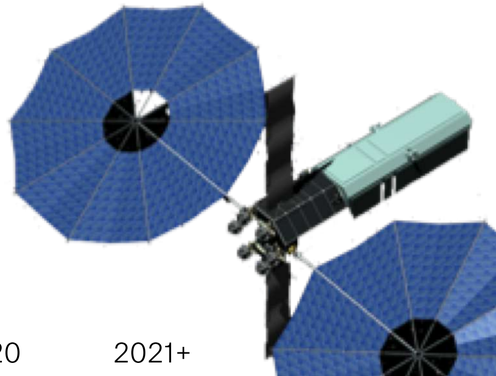
Commercial and government organizations worldwide

COMMERCIAL AIRLOCK



Space Station Operation System, Free Flyers, Commercial Modules, Commercial Space Stations

COMMERCIAL PLATFORMS AND STATIONS



2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021+

NANORACKS IS THE WORLD'S ONLY COMMERCIAL SPACE STATION COMPANY WITH CUSTOMERS

EUROPEAN UNION

Multimillion Contracts For Satellite and CubeSat Programs

NASA

$32 Million Open IDIQ

BOEING

Investment in NanoRacks Airlock Module

spire

esa

PLANET LABS

مدينة الملك عبدالعزيز للعلوم والتقنية KACST

MILLENNIUM SPACE SYSTEMS

PLANETARY RESOURCES

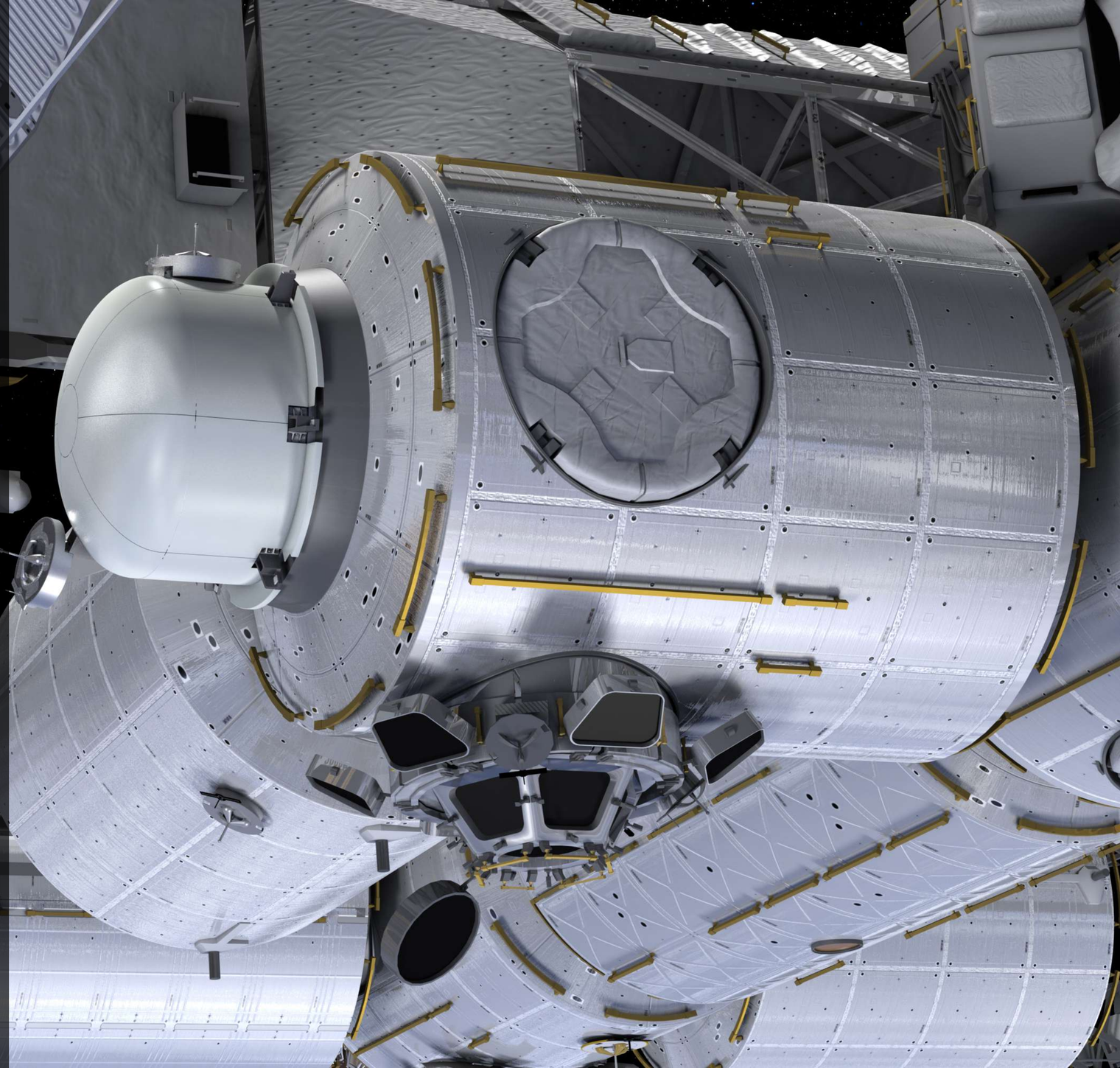
CATAPULT Satellite Applications

Virgin GALACTIC

National Center for Earth and Space Science Education

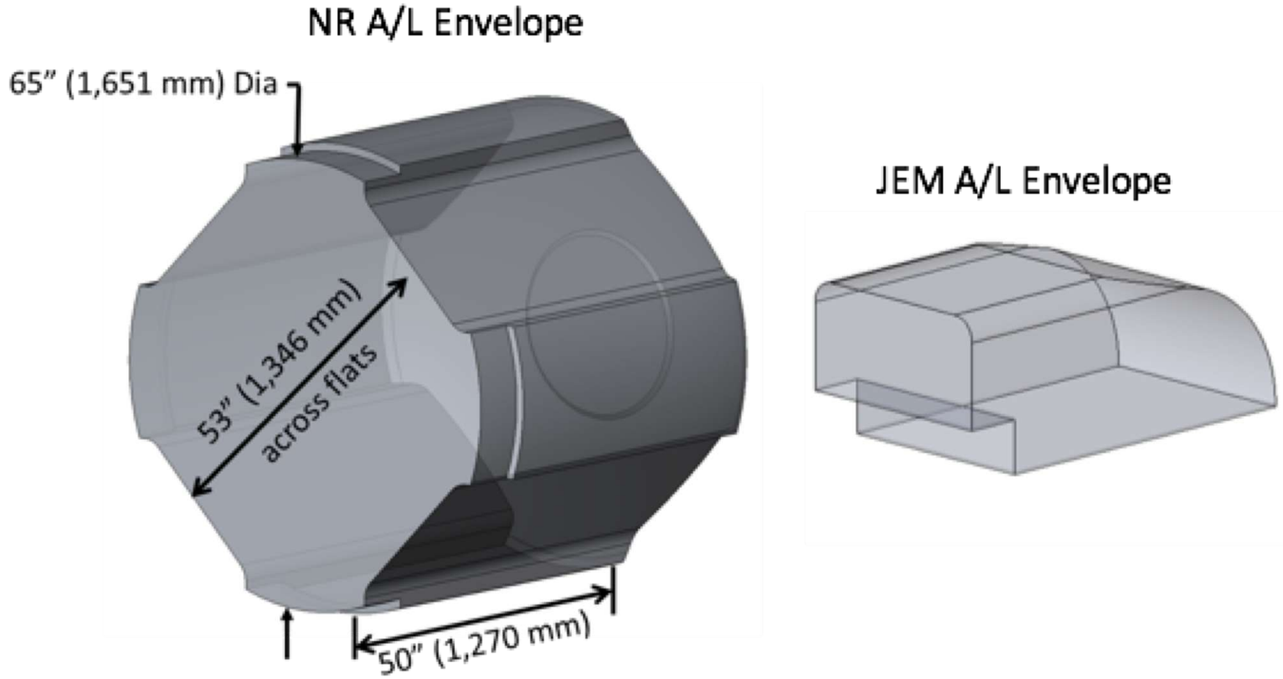
About Bishop

- The NanoRacks Airlock Module is our next generation ISS payload facility and it builds upon NanoRacks successful NanoLab Modules, NanoRacks CubeSat Deployers, External Platform and Kaber Deployer
- An enabling system to provide additional capability for future utilization of ISS - both commercial and government use
- Provides additional airlock capacity for deployment satellites from ISS, housing experiments, and the ability to move equipment inside to outside ISS



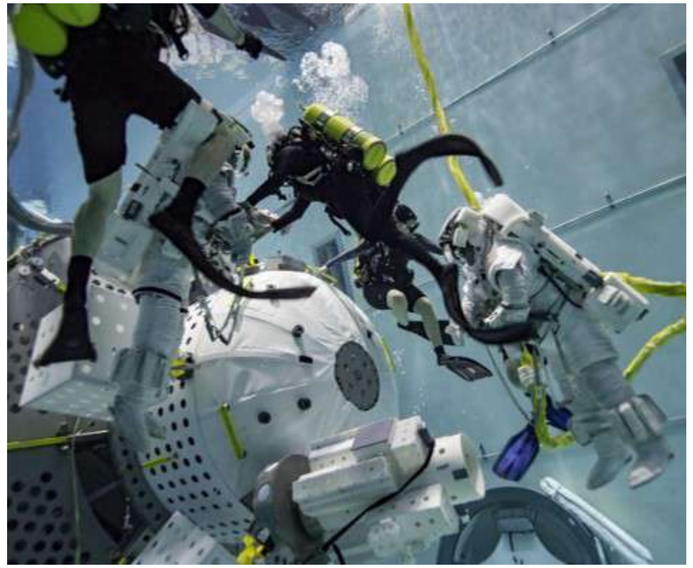
Building a Bigger Gateway to Space

- Current bottleneck at the JEM Airlock
  - Limited size (~25 ft^3, (0.70 m^3))
  - Only ~10 openings per year with the restrictions on who uses these openings
- NanoRacks Airlock will expand those capabilities
  - Over 5X the volume (~141 ft^3, (3.99 m^3))
  - Number of openings driven by commercial market and ISS availability (4-8 times per year expected)



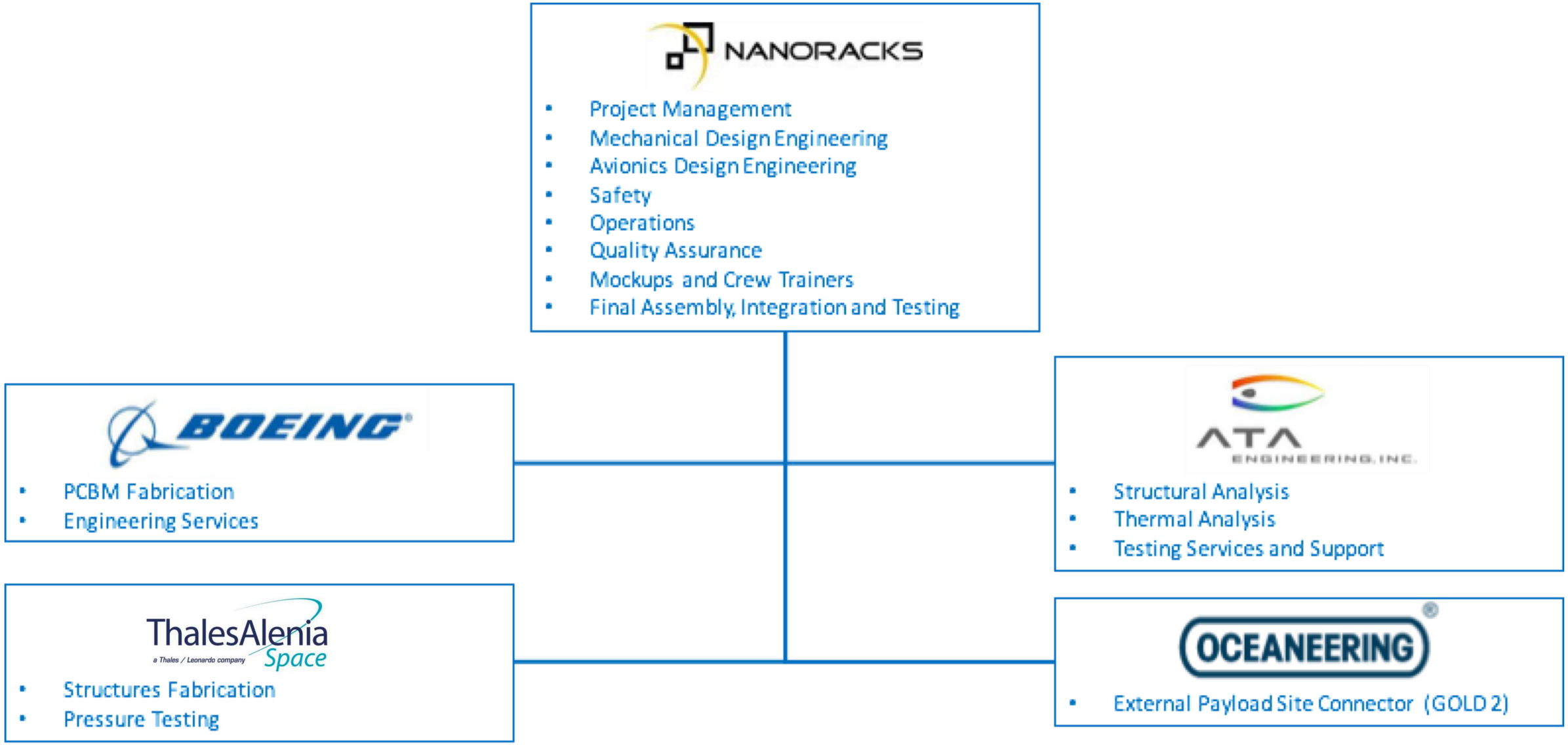
More About Our Program

- Commercial development
- NanoRacks is the leading technical team to execute this project
- Internal funds, customer down payments, and investor contribution is financing the project
- NanoRacks will own the facility for it’s lifetime
- Non-Reimbursable Space Act Agreement (OZ-16-047) with NASA to develop the Airlock
- Change Request 15277 approved by the SSPCB to integrate the Airlock to the ISS
- Manifested SpaceX-19, scheduled for October 2019



Photos from the NASA JSC mockup of the NanoRacks Airlock Module at the Neutral Buoyancy Lab where astronauts train for EVAs

THE AIRLOCK TEAM

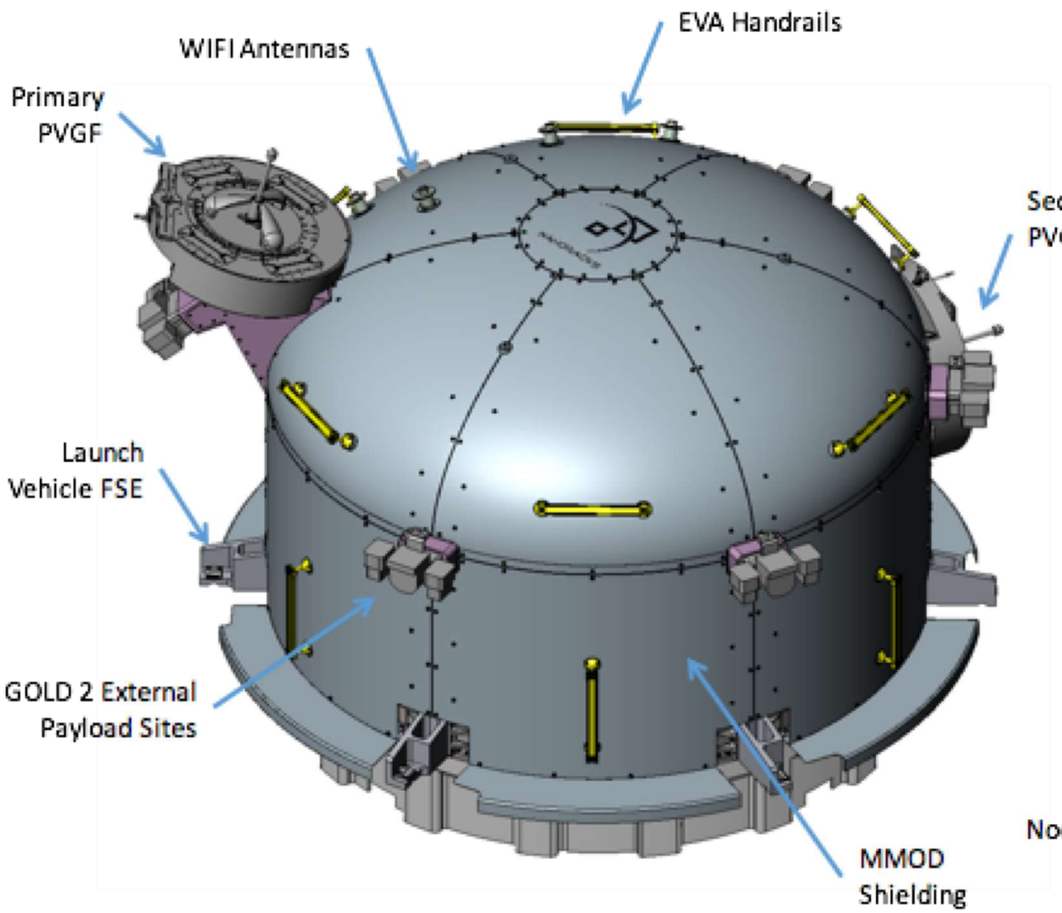


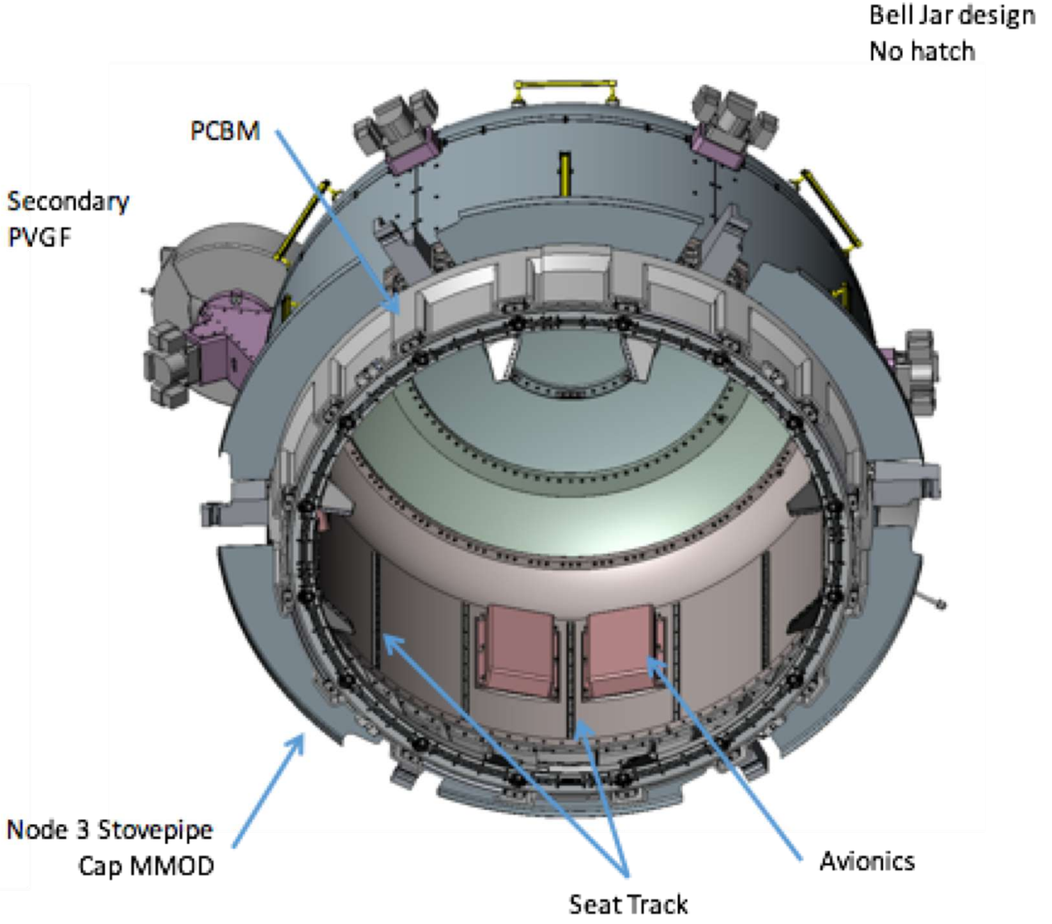
Airlock Milestones

Schedule Through 2019

1. **Space Act Agreement Signed**
   May 17, 2016
2. **ISS Change Requests Directive Signed**
   July 28, 2016
3. **Systems Requirements Review**
   August 30, 2016
4. **Phase 0 Safety Technical Interchange Meeting**
   September 7, 2016
5. **Preliminary Design Review**
   February 2017
6. **Phase 1 Safety Review**
   April 2017
7. **Critical Design Review**
   March 2018
8. **Phase 2 Safety Review**
   May 2018
9. **Start of Integrated Assembly**
   January 2019
10. **Phase 3 Safety Review**
    May 2019
11. **Integrated Testing Complete**
    May 2019
12. **Ship To Launch Site**
    June 2019
13. **Ready To Launch**
    October 2019

Airlock Technical Overview





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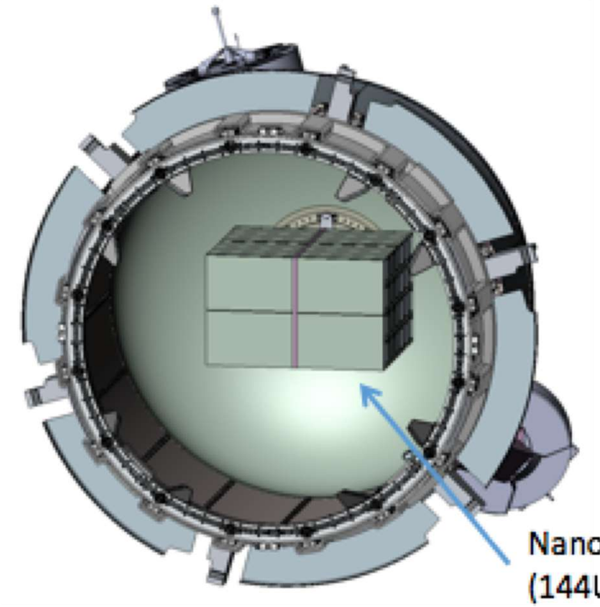
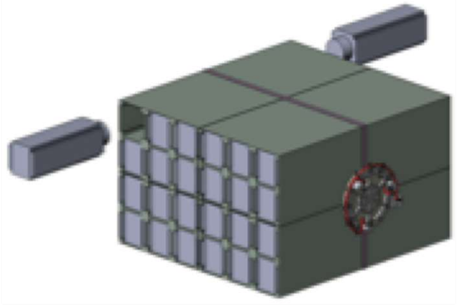
Satellite Deployment from the NanoRacks Airlock Module

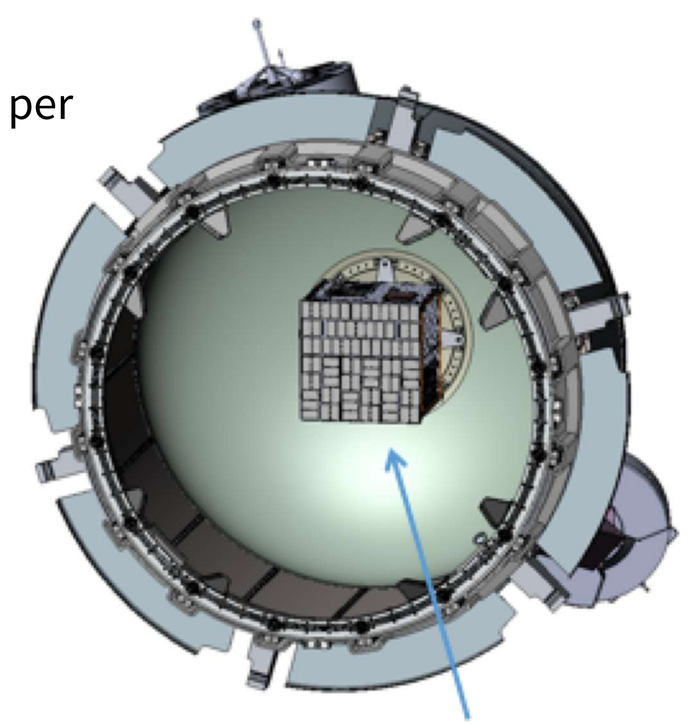
- The Nanoracks Airlock Module will be able to deploy much larger satellites that currently available through the JEM Airlock
- Our Airlock will be able to increase throughput by deploying up to 4 small satellites per Airlock sortie (opening) versus just one at a time through the JEM Airlock





"HayBale" is deployed from NanoRacks Airlock in similar fashion to ESPA/Kaber type satellites, using NRSS or Lightband. NanoRacks Airlock is then re-berthed to ISS. Once adequately separated from ISS, the orbiting "HayBale" deploys pairs of cubesats over time until deployments are complete. Empty "HayBale" orbit degrades and "HayBale" is destroyed upon re-entry.

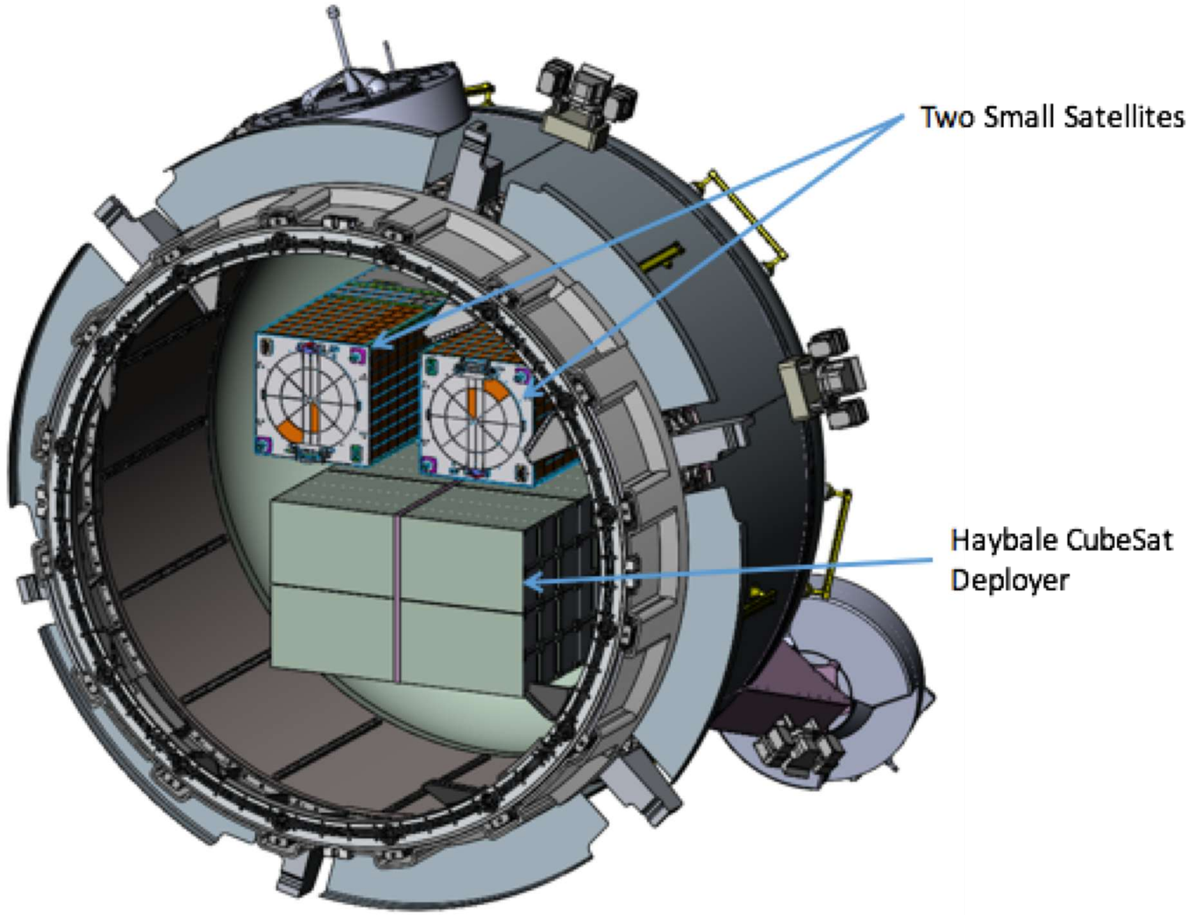
NanoRacks "HayBale" Deployable Cubesat Dispenser (144U capability in configuration shown)



Representative Small satellite shown. Typical size that can go through JEM Airlock now. Could fit up to four of these satellites in at one time

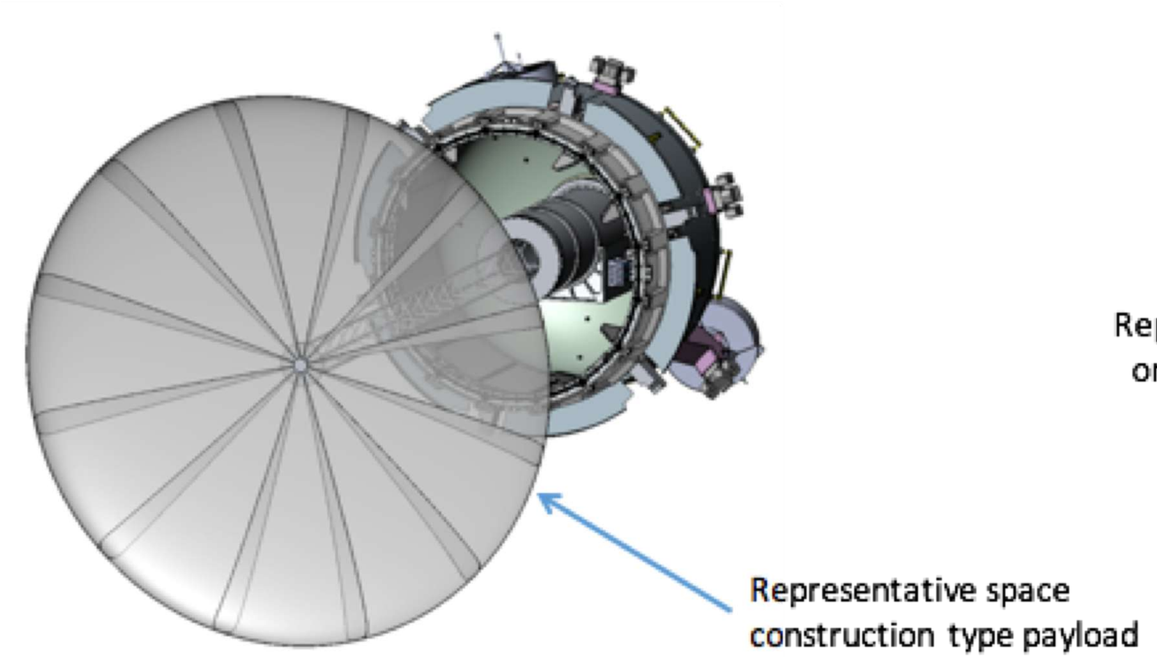
Combination Payload Deployer

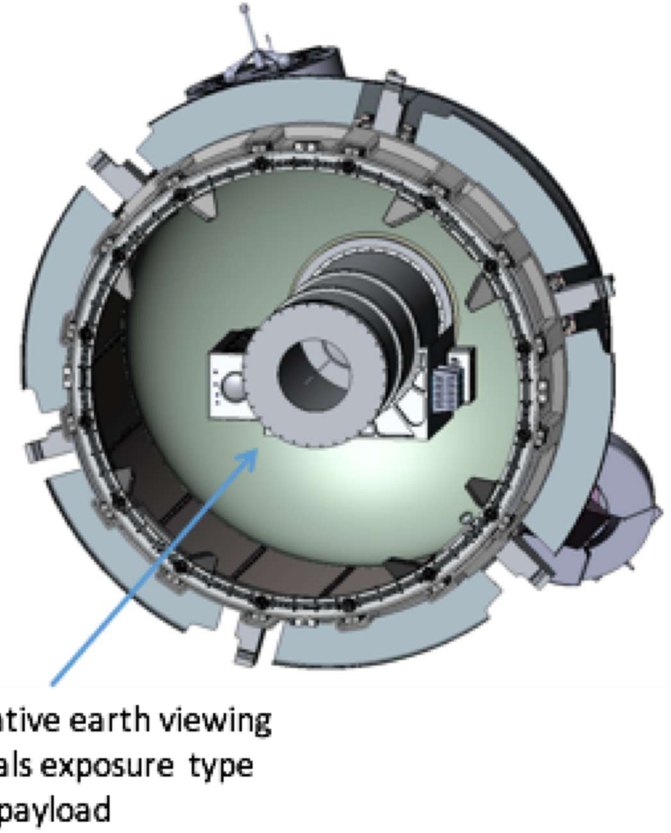
- Combine payloads on one Airlock sortie
- Various payload sizes
- Various payload customers (government, commercial, etc)



Tech Demo with the Airlock

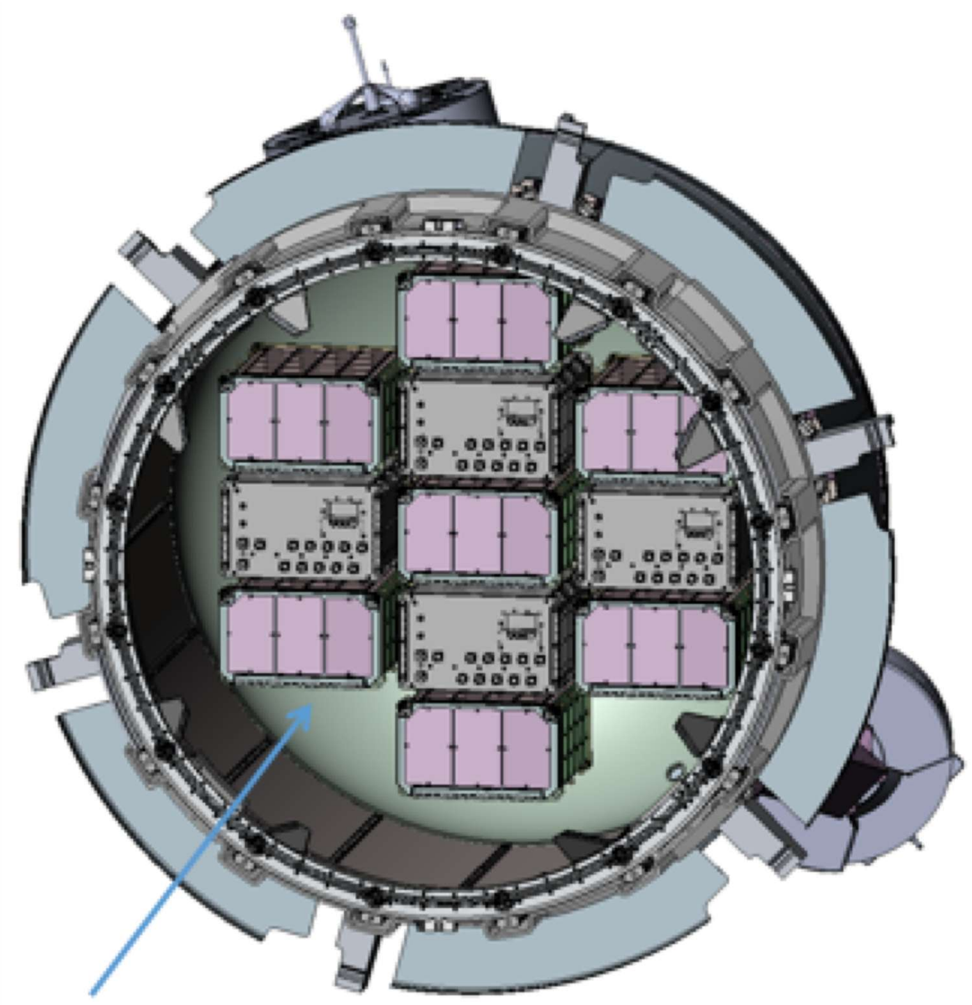
- Payload exposure to space environment for short duration (~1-2 weeks)
- Infinite pointing options while on the SSRMS (e.g. Ram, Wake, Zenith, Nadir)
- Examples: Earth viewing cameras, materials exposure, space construction, sensor validation





Internal Payloads in the Airlock

- Typical internal ISS Rack/Locker type payload
  - Power: 120 VDC, 700 Watts (4 sites internal)
- Similar electrical interfaces as ISS Racks
- Can operate in ISS environment (Node 3 hatch open) or in various pressure conditions down to vacuum (Node 3 hatch closed)
- Examples: Locker payloads, glove box payloads, NR Frame payloads, custom size internal payloads



Representative mid-deck locker type payloads

Payload Interfaces

- **Deployable payloads**
  - Mechanical: Clamp Band Opening Devices (CBOD) - NanoRacks Separation System or similar commercial variant
  - Maximum size: 3.6x3.6x4.1 ft; 710 lbs (1.12x1.12x1.27m; 322 kg)
    - Based on max rectangular volume and max ballistic number required by NASA for deployable payloads to minimize risk of recontact
- **Internal Payloads**
  - Mechanical: Interface to Airlock seat track (or NanoRacks develops)
  - Power: 120 VDC (4 sites internal)
  - Data: Ethernet to Airlock avionics
    - Airlock communicates to ISS JSL
    - Store and forward capability with Airlock Network Attached Storage

External Payloads

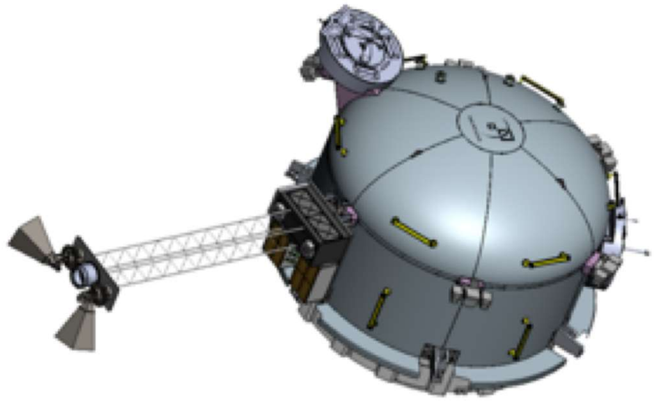
- **6 external payload sites available**
  - Oceaneering GOLD 2 connector provides electrical, mechanical, and robotic interface
  - Nominal Payload Envelope
    - •24” x 24” x 28” (0.6m x 0.6m x 0.7m)
    - •500 lbs (227 kg)
    - •Exceedances may be considered on a case by case basis

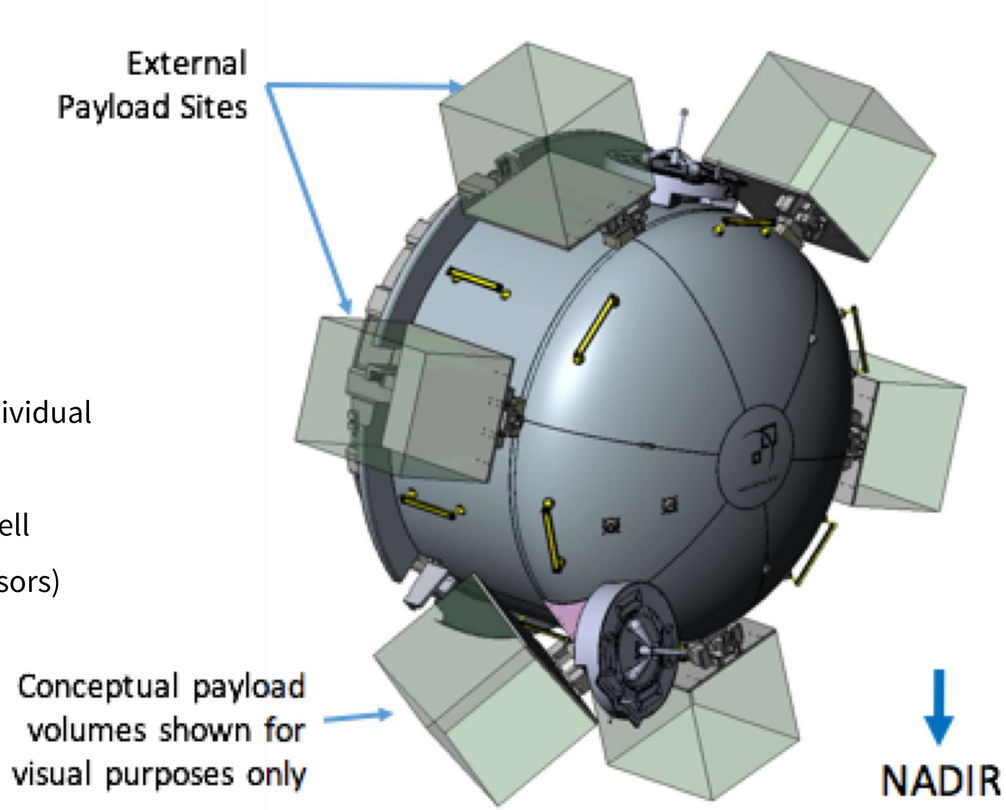
•Redundant power and data interfaces:

- •120 VDC; 700 watts max
- •Ethernet data
- •Data storage capability within Airlock avionics
  - •Note: Power is a shared service with ISS and thus overall Airlock power draw may limit individual payload usage depending on payload complement

•Scarring for redundant fiber optics and coaxial connections and terminated inside of Airlock pressure shell

•Payloads could utilize a combination of internal volume (e.g. for avionics) and external sites (e.g. for sensors)





NANORACKS

The NanoRacks Airlock Module: Your Commercial Gateway

Thanks!

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