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
Satellite Deployment (Present)
Commercially deployed CubeSats via the NanoRacks CubeSat Deployer (NRCSD) and MicroSats via our Kaber Deployer.

NanoRacks Airlock
We are raising $25M now for this phase.

Use of non-ISS platforms
We have begun this stage via our agreement with Blue Origin and their New Shepard space vehicle. We are also in a number of discussions for utilizing spent second stages.

Repurposing Vehicles
We will begin to repurpose launch vehicles components for building space stations.

Stepping stones to orbit.
Evolution of Nanoracks Hardware and Customer Base

- **Nanolab**
  - Privately owned microgravity research equipment

- **Mixstix**
  - Commercial researchers

- **Microplate Reader & Biopharma**
  - Commercial researchers

- **Commercial Deployment**

- **Cubesat Deployment**
  - Domestic and Foreign Industry

- **Microsat Deployment**

- **External Platform**
  - Commercial and government organizations worldwide

- **Earth Observation**

- **Commercial Airlock**
  - Space Station Operation System, Free Flyers, Commercial Modules, Commercial Space Stations

- **Commercial Platforms and Stations**

Timeline:
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021+
NANORACKS IS THE WORLD’S ONLY COMMERCIAL SPACE STATION COMPANY WITH CUSTOMERS

- Multimillion Contracts For Satellite and CubeSat Programs
- $32 Million Open IDIQ
- Investment in NanoRacks Airlock Module

Brands and logos from various companies and organizations, including NASA, Boeing, ESA, Spire, Planet Labs, Millennium Space Systems, and others.
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.

About Bishop
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 its 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

NANORACKS

- Project Management
- Mechanical Design Engineering
- Avionics Design Engineering
- Safety
- Operations
- Quality Assurance
- Mockups and Crew Trainers
- Final Assembly, Integration and Testing

BOEING

- PCB Fabrication
- Engineering Services

Thales Alenia Space

- Structures Fabrication
- Pressure Testing

ATA Engineering, Inc.

- Structural Analysis
- Thermal Analysis
- Testing Services and Support

OCEANEERING

- External Payload Site Connector (GOLD 2)
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

The technical information contained within this presentation is considered EAR99 for export classification purposes.
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

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Combination Payload Deployer

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

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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

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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

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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

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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)
The NanoRacks Airlock Module: Your Commercial Gateway

Thanks!

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