NANORACKS
ISS CUBESAT DEPLOYMENT

NanoRacks is the proven leader of CubeSat deployment from the International Space Station, having deployed over 90 CubeSats to date, with a full pipeline intact. Now displaying new capabilities on the Cygnus spacecraft, NanoRacks is continuing to grow as the customer-choice for LEO CubeSat deployment.

CubeSat Developers Workshop
San Luis Obispo, 2016

Henry Martin: hmartin@nanoracks.com
EVOLUTION OF NANORACKS HARDWARE AND CUSTOMER BASE

- **NANOLAB**
  - Privately owned microgravity research equipment

- **MIXSTIX**
  - Commercial researchers

- **MICROPLATE READER & BIOPHARMA**
  - Commercial researchers

- **CUBESAT DEPLOYMENT**
  - Domestic and Foreign Industry

- **MICROSAT DEPLOYMENT**
  - Commercial and government organizations worldwide

- **EXTERNAL PLATFORM**
  - Commercially operated space facilities in microgravity

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

- **COMMERCIAL PLATFORMS AND STATIONS**
  - Commercial researchers

Timeline:
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021+
ISS OPPORTUNITIES

SMALLSAT DEPLOYMENT SERVICES

OUR CURRENT SERVICES INCLUDE satellite deployment, biopharma services, test platforms for advanced earth observation sensors, materials and educational research platforms—wherever there is a need for space goods or services, NanoRacks is part of the commercial solution.

NANORACKS CUBESAT DEPLOYER (NRCSD)

- Low-cost deployment system using Japanese module on ISS
- Deployed more satellites in the last 2 years than any other launch service provider
- Each NRCSD can deploy up to 6U of CubeSats
- 8 NRCSD’s per airlock cycle, for a total of 48U deployment capability
- Flight heritage with wide variety of COTS CubeSat components:
  - Clyde Space
  - GomSpace
  - Pumpkin
  - ISIS

KABER SMALL SATELLITE DEPLOYER

- New Kaber deployer to deploy medium 50 kg to 82 kg satellites
- Size favored by NASA, Air Force, and other high-value customers
- NanoRacks Separation System
- Launched via pressurized cargo resupply vehicle to the International Space Station

- 51.6 degree inclination, 385-415 KM
- Orbit lifetime 6-12 months
- Deployment typically 1-3 months after berthing
- Soft stowage internal ride several times per year
EXTERNAL CYGNUS DEPLOYMENT

- Launched on OA-6 in March 2016
- Payloads on the exterior of the Cygnus vehicle
- Cygnus will deploy CubeSats after departing ISS
- Inclination of 51.6 degrees
- NanoRacks CubeSat Deployer
  - Panel 5 of Cygnus Service Module
  - 2x3 array of 6U deployers (36U total)
- Planned missions on OA-5, OA-7, OA-8
EXTERNAL CYGNUS, CONT.

NANORACKS CUBESAT DEPLOYMENT

EXTERNAL DEPLOYMENT

• Identical mechanical interface as the NanoRacks CubeSat Deployer that operates via the JEM airlock on Station
• Two fault tolerant release mechanism
• Installed post-fueling of Cygnus Service Module
  • Occurs around L-20 to 40 days
THE DOUBLEWIDE DEPLOYER
GROW YOUR CUBESAT

BUILDING ON EXISTING PLATFORMS

- NanoRacks developing deployer capable of accommodating traditional 6U form factor, optimized for use on ISS
- Design compatible with JEM airlock slide table and existing NRCSDs
- Target launch Q2 2017
**NANORACKS EXTERNAL PLATFORM**

**NREP**

**ALTERNATIVE TO FREE FLYERS**

- Platform placed on the exterior of the ISS to provide convenient access to space environment
- First mission deployment in August 2016
- Serves technology developers, aerospace companies, and government entities for in-space technology validation and commercial endeavors such as space situational awareness

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<tr>
<th>Standard payload provisions</th>
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<tbody>
<tr>
<td><strong>Voltage</strong></td>
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<tr>
<td><strong>Total power</strong></td>
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<td><strong>Maximum current</strong></td>
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<td><strong>USB 2.0 bus</strong></td>
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<td><strong>Total payload data rate</strong></td>
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LAUNCHED TO ISS ON HTV-5- AUGUST 2015
**NANORACKS AIRLOCK**

**IMPLEMENTATION**

NANORACKS’ COMMERCIAL AIRLOCK, will supercharge the satellite deployment business and open up new, lucrative business lines. Built as a pressurized teapot dome attached to the side of the ISS, The Airlock will be able to deploy large numbers of satellite, small and large, at a pace and schedule un-hindered by the many restrictions on NanoRacks’ current deployer systems.

THE IMPORTANCE OF THE AIRLOCK IS:

- Maximum operational flexibility, more control over deployments
- Greater capacity - multi-satellite deployments and Large satellite deployments
- Stepping stone to use of platforms outside of ISS
- Additional capacity for External Platform customers
- Station equipment repair
WHAT ARE OUR CUSTOMERS UP TO?

THEY'RE ALL AROUND THE WORLD

Our customers include everyone from high schools to government space agencies, all who pay for our services on a commercial basis. The client base includes commercial companies, VKI, ESA, NASA, NRO, DoD, and dozens of high schools and universities. Our customer base is thoroughly international, with companies and organizations from Romania to Israel, from Peru to Saudi Arabia, as well as a full range of government and private customers from the United States.

- NanoRacks is accommodating customers from both the private and public sectors who are looking to expand their commercial business ventures as well as demonstrate future technologies.
- Highlights include:
  - CubeSat tracking
  - Deployment of 100 nanosatellites
  - Propulsion systems
  - Formation flying
  - Reentry experiments
  - QB50
The QB50 mission will demonstrate the possibility of launching a network of 50 CubeSats built by Universities Teams all over the world as a primary payload on a low-cost launch vehicle to perform first-class science in the largely unexplored lower thermosphere.

One of the main purposes of the QB50 project is to achieve a sustained and affordable access to space for small scale research space missions and planetary exploration.

QB50 will make use of three different launch campaigns to complete the orbital injection of all the CubeSats. NanoRacks was selected as the deployment provider for the ISS launch scenario, utilizing the NRCSD.

- 6 CubeSats launched on a “Dnepr Science Flight”, QB50-DS
- 40 CubeSats deployed from the ISS, QB50-ISS
- 2 IOD CubeSats launched on a second Dnepr, the “Dnepr IOD Flight”, QB50-DIOD
## Deploying in 2016

### Nanoracks Customers

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<tr>
<th>CUBESATS</th>
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<tr>
<td><strong>CADRE</strong>: University of Michigan</td>
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<td><strong>MinXSS</strong>: University of Colorado</td>
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<td><strong>STMSat</strong>: St. Thomas More Cathedral School</td>
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<tr>
<td><strong>KickSat-2</strong>: Cornell University</td>
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<td><strong>NODeS</strong>: NASA Ames</td>
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<td><strong>TechEdSat-5</strong>: NASA Ames</td>
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<td><strong>SGSat</strong>: University of Kentucky</td>
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<td><strong>Doves</strong>: Planet Labs</td>
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<td><strong>ALTAIR-1</strong>: Millennium Space Systems</td>
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<tr>
<td><strong>Gumstix</strong>: Yosemite Space</td>
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<tr>
<td><strong>NanoTube Solar Cells</strong>: Georgia Tech</td>
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<tr>
<td><strong>DM</strong>: Honeywell Aerospace and Morehead State University</td>
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<tr>
<td><strong>CID</strong>: Florida Institute of Technology</td>
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<td><strong>A-76</strong>: A-76 Technologies</td>
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THANKS!
ANY QUESTIONS?

Conor Brown, Senior External Payloads Coordinator: cbrown@nanoracks.com

Henry Martin, External Payloads Coordinator: hmartin@nanoracks.com

Ajeeth Ibrahim, Account Manager: aibrahim@nanoracks.com