October 15, 2014
Grand Hyatt Washington
Washington D.C.

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NanoRacks External Payload Platform
Introduction

- NanoRacks has developed a hosted payload service, NanoRacks External Payload Platform (NREP)
- NREP will be installed on the JEM EF
- Hosted payloads will utilize the JEM airlock, slide table, and the JRMS for installation
- Status
  - IOC, Orbital Sciences CRS-4 (1Q2014)
  - Flight acceptance testing in progress
NREP ISS Location – IOC 2015

ISS velocity vector

64cm
80cm
40cm
Payload Configurations

- NREP payloads can be attached in various configurations to NREP baseplate
- Baseplate accommodates up to 5 powered 4U payloads, up to 4 unpowered 3U payloads
Standard Payload Configurations
Non-standard Payload Configurations

- 27cm
- 40cm
- 10cm
- 50cm

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Large Non-standard Payload

61cm
48cm
Service Level

• NanoRacks
  – Hosted Payload Platform (Space Environment, Power, CD&H)
  – Transport to/from ISS
  – Mission CD&H
  – ISS Flight Certification

• Payload Developer
  – Payload Experiment
  – Payload Enclosure, (physical and power connects)
  – Payload S/W CD&H Interfaces
  – ISS Required Flight Acceptance Testing
Service Model Overview

- Classes of payloads; form factor and passive/active
  - Passive/Active – use power and data services
  - Form factor – standard, non-standard or Large

- Nominal Mission Duration
  - Standard payload - 15 Weeks
  - Non-standard payloads - negotiable

- Additional Services
  - Mission Extension beyond nominal 15 weeks
  - Return to Earth, 1 to 4U Payload Enclosures
  - Payload Experiment Integration
Flight Safety Requirements

- NanoRacks represents the customer at NASA Payload Safety Reviews
- Payload Safety Reviews- Phase 1, 2 and 3
- NanoRacks provides consolidated safety data call template and procedures for required tests
- Flight Acceptance Testing (if required)
  - Random Vibration
  - Battery Testing
  - EMI
- Hazardous Materials Review- Bill of Materials analysis
- Payload enclosure briefly exposed to ISS crew- human rating for external surfaces (sharp edges, etc.)
- RF systems evaluated for human exposure and ISS communications interference
- Captive fasteners (either mechanical or locking compound)
**Payload Interfaces**

- **Physical**
  - Standard payload enclosures (1-4U) < 4Kg
  - Non-standard payloads < 35Kg
  - Large Non-standard Payloads, established in Mission Specific Interface Control Agreement
- **Electrical (Active)**
  - MS 27468 Umbilical, Switchable 50W @ 28 VDC
  - USB 2.0, 5 VDC/500mA
- **CD&H, 2 modes**
  - Store & Forward
  - Near Real-time via NREP Shared T&M Stream
- **Software**
  - Client (Payload)- Server (NREP Data Handling System),
  - RS-232 Serial protocol for Store & Forward mode
  - IP networking over USB for Near Real-time mode
- **Thermal**
  - Generally enveloped by worst-case on-orbit LEO excursions
CD&H: Store & Forward

RS-232 serial protocol
CD&H: Near Real-Time

Requires IP networking over USB
## Payload Developer Timeline

<table>
<thead>
<tr>
<th>Milestone/Activity</th>
<th>Launch minus Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authority to Proceed</td>
<td>L – 12</td>
</tr>
<tr>
<td>*Payload Data Submission</td>
<td>L – 11</td>
</tr>
<tr>
<td>Phase 1 Payload Safety Review</td>
<td>L – 7 to 6</td>
</tr>
<tr>
<td>Phase 2 Payload Safety Review</td>
<td>L – 4 to 5</td>
</tr>
<tr>
<td>*Flight Acceptance Testing</td>
<td>L – 4 to 5</td>
</tr>
<tr>
<td>Customer Delivery to NanoRacks</td>
<td>L – 3 to 4</td>
</tr>
<tr>
<td>Phase 3 Payload Safety Review</td>
<td>L – 1 to 2</td>
</tr>
<tr>
<td>NanoRacks Delivery to NASA</td>
<td>L – 1</td>
</tr>
<tr>
<td>Launch</td>
<td>0</td>
</tr>
<tr>
<td>Payload Mission Operations</td>
<td>L + 4 to L + Customer Need</td>
</tr>
<tr>
<td>Payload return to Earth</td>
<td>Availability of Down Mass</td>
</tr>
</tbody>
</table>
# Manifest & Flight Opportunities

## Current Manifest

<table>
<thead>
<tr>
<th>Payload</th>
<th>ISS Cargo Mission</th>
</tr>
</thead>
<tbody>
<tr>
<td>NREP EXT1 4U</td>
<td>OSC, CRS-4 Apr 1, 2015</td>
</tr>
<tr>
<td>NREP EXT2 2U</td>
<td>OSC, CRS-5 Oct 12, 2015</td>
</tr>
<tr>
<td>NREP EXT3 2U</td>
<td>OSC, CRS-5 Oct 12, 2015</td>
</tr>
<tr>
<td>NREP EXT4 2U</td>
<td>TBD</td>
</tr>
<tr>
<td>NREP EXT5</td>
<td>TBD</td>
</tr>
</tbody>
</table>

## Flight Opportunities

<table>
<thead>
<tr>
<th>ISS Cargo Mission</th>
<th>Launch</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpaceX-7</td>
<td>Jun 13, 2015</td>
</tr>
<tr>
<td>SpaceX-8</td>
<td>Sep 2, 2015</td>
</tr>
<tr>
<td>OSC-5</td>
<td>Oct 12, 2015</td>
</tr>
<tr>
<td>SpaceX-9</td>
<td>Dec 5, 2015</td>
</tr>
<tr>
<td>SpaceX-10</td>
<td>Feb 9, 2016</td>
</tr>
<tr>
<td>OSC-6</td>
<td>Apr 1, 2016</td>
</tr>
<tr>
<td>OSC-7</td>
<td>Jun 5, 2016</td>
</tr>
<tr>
<td>SpaceX-11</td>
<td>Jul 13, 2016</td>
</tr>
<tr>
<td>Orb-8</td>
<td>Aug 19, 2016</td>
</tr>
<tr>
<td>SpaceX-12</td>
<td>Oct 8, 2016</td>
</tr>
</tbody>
</table>
Questions?
Backup Data
NREP Install Overview

1. JRMS translates NREP to EFU #4 on the Exposed Facility
2. JRMS grapple NREP FRGF
3. JRMS remove NREP from airlock
4. NREP installed to EFU #4

Exposed Facility
JEM
JEM RMS
JEM Airlock

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NanoRacks Functional Overview

- FRGF
- Forward
- Inboard
- Outboard
- PIU
- Aft
- Top

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Complete specifications available for developers to fabricate their payload enclosures.