NanoRacks/Quad-M Rideshare Overview
Rideshare Overview

• Why NanoRacks/Quad-M Team?
• NRCSD
• Kaber
• Cygnus External Deployer
• NREP
• NR Airlock
• Dragon Trunk Deployer
• Centaur Aft Bulkhead Deployer
• Centaur MegaDeployer
Why NanoRacks/Quad-M Team?

- NanoRacks is a leader in providing commercial space access solutions
  - Over 375 payloads delivered to the ISS
    - Most successful CubeSat program with 139 deployed to date
- Quad-M built and NanoRacks operates rideshare hardware on the ISS
- Multiple ISS flight opportunities per year
- NanoRacks/Quad-M has a signed MOU with ULA to develop a rideshare deployer system that can support over 1 metric ton to different orbits
Trusted Relationship with the ISS Program

• Dedicated NASA personnel that work with us (including some based in NanoRacks’ headquarters)

• NanoRacks directly interfaces with the ISS program on behalf of the customer

• Access to on orbit resources and all ISS Visiting Vehicle flights (SpaceX/Orbital/SNV/HTV/Progress/Soyuz) via a NASA Space Act Agreement

• Recently signed a new Space Act Agreement to build and deploy a commercial airlock on the ISS that will provide flexibility and enhanced satellite launch capabilities (ESPA class)
NanoRacks CubeSat Deployer (NRCSD)

1. NRCSDs transported in CTBs
2. Launched by ISS visiting vehicle
3. NRCSDs installed by ISS Crew
4. JEM Air Lock depress & slide table extension
5. Grapple by JRMS
6. NRCSDs positioned by JRMS
7. Deploy
8. JRMS return to slide table; Slide table retracts into JEM air lock
9. ISS Crew un-install first 8 NRCSDs; repeat install/deploy for second set of NRCSDs
NRCSD Capabilities

- 51.6 degree inclination, 385-400 KM
- Orbit lifetime 6-12 months
- Deployment typically 1-3 months after berthing
- Soft stowage internal ride several times per year
- Each NRCSD can deploy up to 6U of CubeSats
- 8 NRCSD’s per airlock cycle, for a total of 48U deployment capability
- ~2 Air Lock cycles per mission
- Concept to flight hardware- 92 days

Scheduling (L-/+ months)
L-9 Initial data call
L-3 Safety Review
L-1.5 Customer delivery
L-1 NanoRacks deliver to NASA
L+1.5 Deployment (typical)

NanoRacks Requirements
- Battery flight acceptance test
- Electrical: 3 inhibits minimum
- Customer responsible for spectrum & remote sensing licensing
- Fault-tolerance for deployables
- Non/low toxicity materials
- Secondary locking features
Kaber

1. SmallSats transported in CTBs
2. Launched by ISS visiting vehicle
3. Sats installed on Kaber by ISS Crew
4. JEM Air Lock depress & slide table extension
5. Grapple by SPDM
6. Kaber positioned by SPDM/Deployed
7. SPDM return to slide table; Slide table retracts into JEM air lock
8. Kaber returned inside
Kaber Capabilities

- NanoRacks Kaber Microsatellite Deployment Service
  - Kaber Generation 2 Service, up to 100Kg
  - Payload Envelope Easily Accommodates > 24U Form Factor
  - Kaber is currently on-orbit
  - ISS SPDM Interface and Deployment Commanding

- NanoRacks Separation System (NRSS)
  - Designed and Built by NanoRacks/Quad-M
  - Cost Effective Alternative to Motorized Lightband Separation System
  - Compatible with LightBand Satellite Bolt Pattern (8", 11.47", 13", 15")
  - Compatible with Lightband electrical interface
  - Provides satellite with tunable separation velocity
  - Built to Customer Specifications for each mission
  - 3 point, ultra low-shock separation system
  - Variable number of separation springs for fine thruster vector tuning
  - Unitary release mechanism
  - Release actuated by a Hold Down Release Mechanism (HDRM) by Sierra Nevada
  - COTS, high reliability, flight heritage
  - Tip-Off target performance < 2deg/sec
Cygnus External Deployer

1. SmallSats loaded into Deployer
2. Launched by Cygnus on Atlas V/Antares
3. Cygnus Docks to ISS
4. Cygnus Departs from ISS/Orbit Raise to 450 km
5. Deploy
6. Cygnus destructive reentry
Cygnus External Deployer Capabilities

- Standard 6U deep
- 2 x 3 Deployers
- 36 U Total
- ISI-POD Format
- Compatible with P-POD Format
NanoRacks External Platform (NREP)

1. NREP Payloads transported in CTBs
   Five Powered 4 x 1 U
   Four Unpowered 4 x 1 U

2. Launched by ISS visiting vehicle

3. NREP configured by ISS Crew

4. JEM Air Lock depress & slide table extension

5. Grapple by JRMS

6. NREP installed by JRMS

7. 6 Month Dwell

8. JRMS return to slide table; Slide table retracts into JEM air lock

9. ISS Crew reconfigured NREP for next sortie
NREP Capabilities

NREP Payloads Capability
• Five Powered 4 x 1 U
• Up to 150 W total @ 28VDC Standard Service
• Up to 3 kW @ 120 VDC possible
• WiFi Data (~8 Mbps)
• Four Unpowered 4 x 1 U
• Typical 6 month exposure
• -VV/Nadir Facing
• Payload return possible via Dragon/Soyuz/Dream Chaser

Future NREP Expansion Capability
NanoRacks Airlock

- 5 Times the Volume of JEM Airlock
- Up to 1 MT Deployment Capability
- 2m diameter x 1.5 m possible
- Can Berth on POA
- 6 External Payload Locations (~ 5 kW/T100 available)
- On-orbit late 2018

Massive CubeSat Deployment Capacity

4 JEM Slide Tables in NR Airlock
Berth Dragon at ISS

Launch in Trunk

Return Deployer to Earth

Remove Deployer from Trunk

Return Deployer to ISS

Deploy Satellite

Temp Stow on NREP (if required)
Dragon Trunk Deployer Capabilities

- Satellite Separation System (Lightband Like)
- Deployer Base
- SPDM Robotic Interface
- NREP Attach Mechanism
- JEM Slide Table Interface
- Satellite Volume
- SPDM Operating Volume
- Dragon Holdown Separation Nuts

Specifications:
- 160 kg
- 1m x 1m x 1.66m

Dragon Trunk Deployer Capabilities:
- Toxic Propellants OK
- Large Batteries OK
- Flammable Materials OK
Centaur Aft Bulkhead Deployer

- Toxic Propellants OK
- Large Batteries OK
- Flammable Materials OK
- Based on Cygnus External
- 27U Capability
- Meets “Do No Harm”
Centaur MegaDeployer

- Toxic Propellants OK
- Large Batteries OK
- Flammable Materials OK
- Based on Cygnus External
- 54U x 8 = 432U Capability
- Up to 8 150 kg Small Sats
- Meets “Do No Harm”