NanoRacks CubeSat Deployer (NRCSD) History

- 186 Total CubeSats Deployed
  - 3 from ISS via JSSOD
  - 171 from ISS via NRCSD
  - 12 from Orbital-ATK Cygnus vehicle via External NRCSD (8 at altitude > ISS)

- CubeSat Deployment by Configuration
  - 12x 1Us
  - 29x 2Us
  - 139x 3Us
  - 2x 2Us
In general, CubeSats deployed from ISS unlikely to pose significant issues from an SSA and conjunction risk perspective for the following reasons:

- Limited lifetime for CubeSats deployed at ISS altitude (6 months to 1 year or so)
- Coordination and communication between ISS Program and 18th Space Control Squadron (JSpOC)
- Accurate and understood insertion parameters
• **Issues Encountered**
  - Individual CubeSat teams have not always registered with the 18th Space Control Squadron prior to deployment
  - Educational and amateur teams have had difficulty with initial acquisition due to uncertainty in TLEs and inexperience with orbital analysis
  - FCC has different standards than NASA for verifying mission viability from an orbital debris and reentry survivability perspective
  - CubeSat sub-deployables less than 1U in size have generated issues due to uncertainty in trackability
Examples of Actions Taken by ISS Program

- Flight rules for first NRCSD mission dictated 90 minutes between deployment events from ISS
  - Flight rules changed after first deployment mission from 90 minutes to 6 hours
  - Flight rule currently stands at 3 hours between deployments
• Several challenges encountered when first pursuing capability of deploying CubeSats from the Orbital-ATK Cygnus vehicle at an altitude higher than the ISS
  • ISS Program concerned about risk of having to complete additional Debris Avoidance Maneuvers (DAMs)
  • Risk assessment required sophisticated orbital analysis
    • Critical pre-launch coordination completed between NanoRacks and the Orbital Debris Program Office (ODPO) prior to demonstrating this capability for the first time
      • Analysis provided by NanoRacks (via SpaceNav) and presented to ODPO
      • ODPO completed equivalent analysis and the risk of increase in ISS DAMs was quantified
• **LEO Getting Crowded?**
  - Per TOPO, 500km orbit is getting ‘crowded’
    - First deploy above NRCSD mission deployed at ~500km
    - Second deploy above NRCSD mission deployed at ~480km due to ‘congestion’ in 500km orbit
  - No other launch vehicle will do this
    - Primary payloads will continue to dictate orbits and large scale constellations will not compromise on orbit unless required to do so
What more can we do?

- Most important thing is to ensure that customers (satellite owner/operators) are educated, in contact with the 18th Space Control Squadron (before launch), and understand what tools are available to them (and what is ‘expected’ of them)
  - Coordination between Launch Service Providers could potentially aide in establishing these ‘expectations’
  - Consider data sharing agreements with 18th Space Control Squadron to ensure exact insertion parameters are communicated
- What else?

Current and Potential Issues

- Squatters rights, turf wars, and regulatory influence
  - Pre-launch coordination critical to ensure viability of launch campaigns (Launch Service Providers and CubeSat owner/operators need to work together on this). At times this could require sophisticated orbital analysis to obtain regulatory approval that not all small satellite teams can support.
- Lack of consistent ‘requirements’ and incentive for cooperation
  - NASA small satellite launches (such as ISS and VV campaigns) have requirements that ensure pre-launch coordination is completed. What about everyone else? How does this become the ‘norm’?
- Lack of incentive for Launch Service Providers to enforce ‘expectations’ or ‘norms’
  - As there is no ability to enforce cooperation, the CubeSat owner / operators are ultimately responsible for volunteering data unless Launch Service Providers enforce requirements to do so (which is not likely to happen)