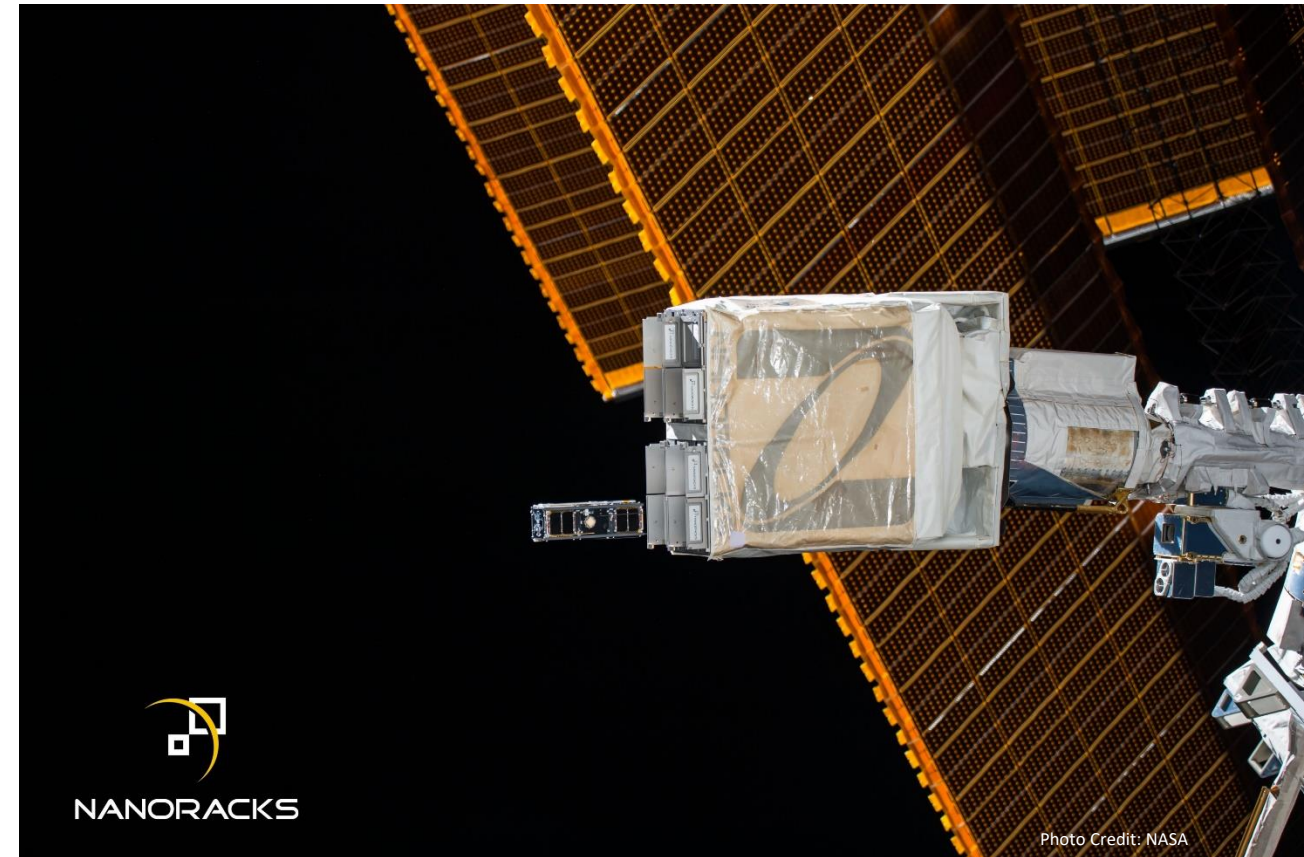# NANORACKS

SECURE WORLD FOUNDATION

CubeSat Launch and Deployment Best Practices

Lessons Learned Launching and Deploying CubeSats from the ISS and Visiting Vehicles

SmallSat Conference
Utah State University
August 7th, 2017
Eccles Conference Center – Room 305

Photo Credit: NASA

NANORACKS

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

Photo Credit: NASA

- **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

Photo Credit: NASA
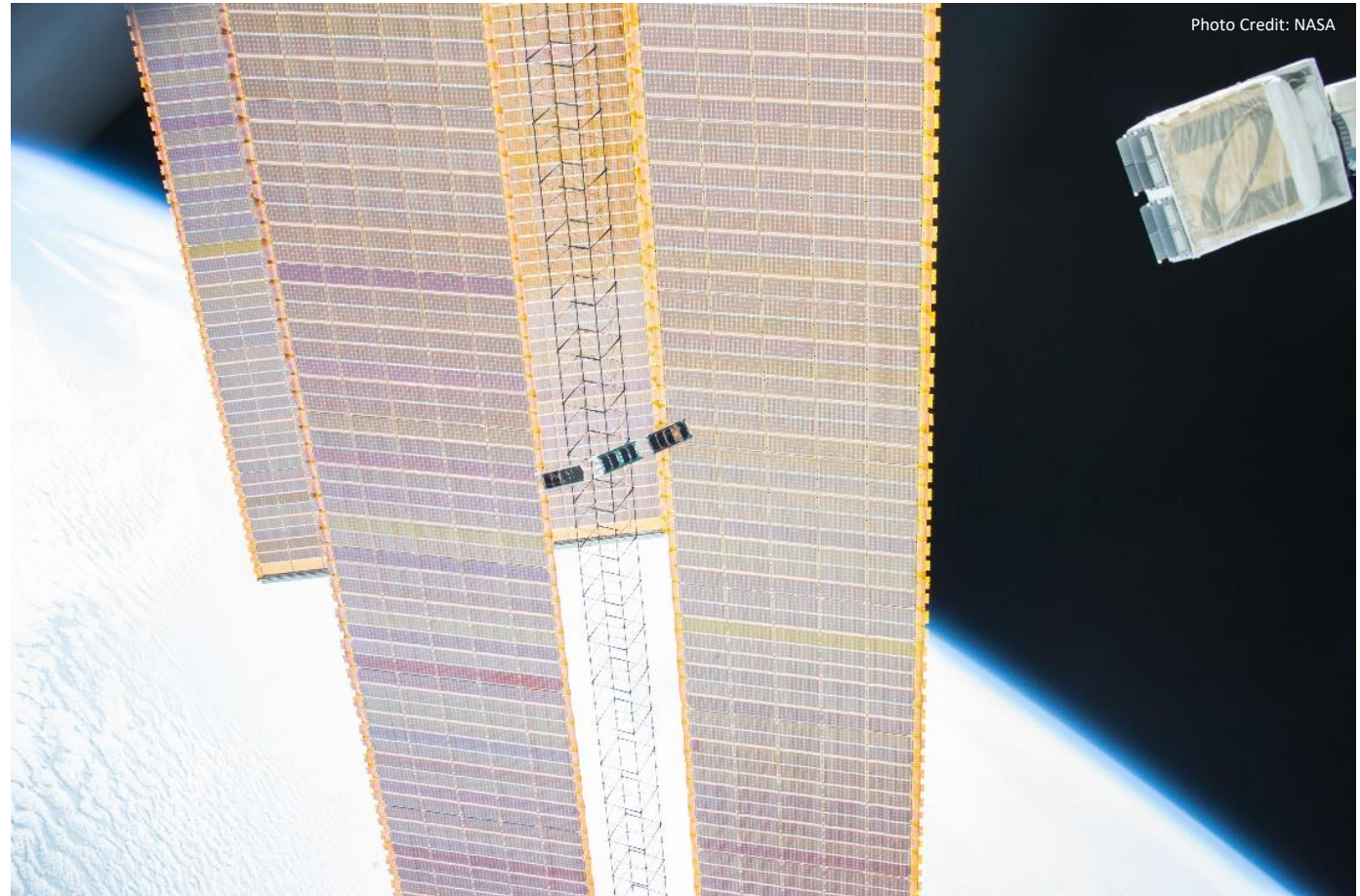
- **Issues Encountered**

  - 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
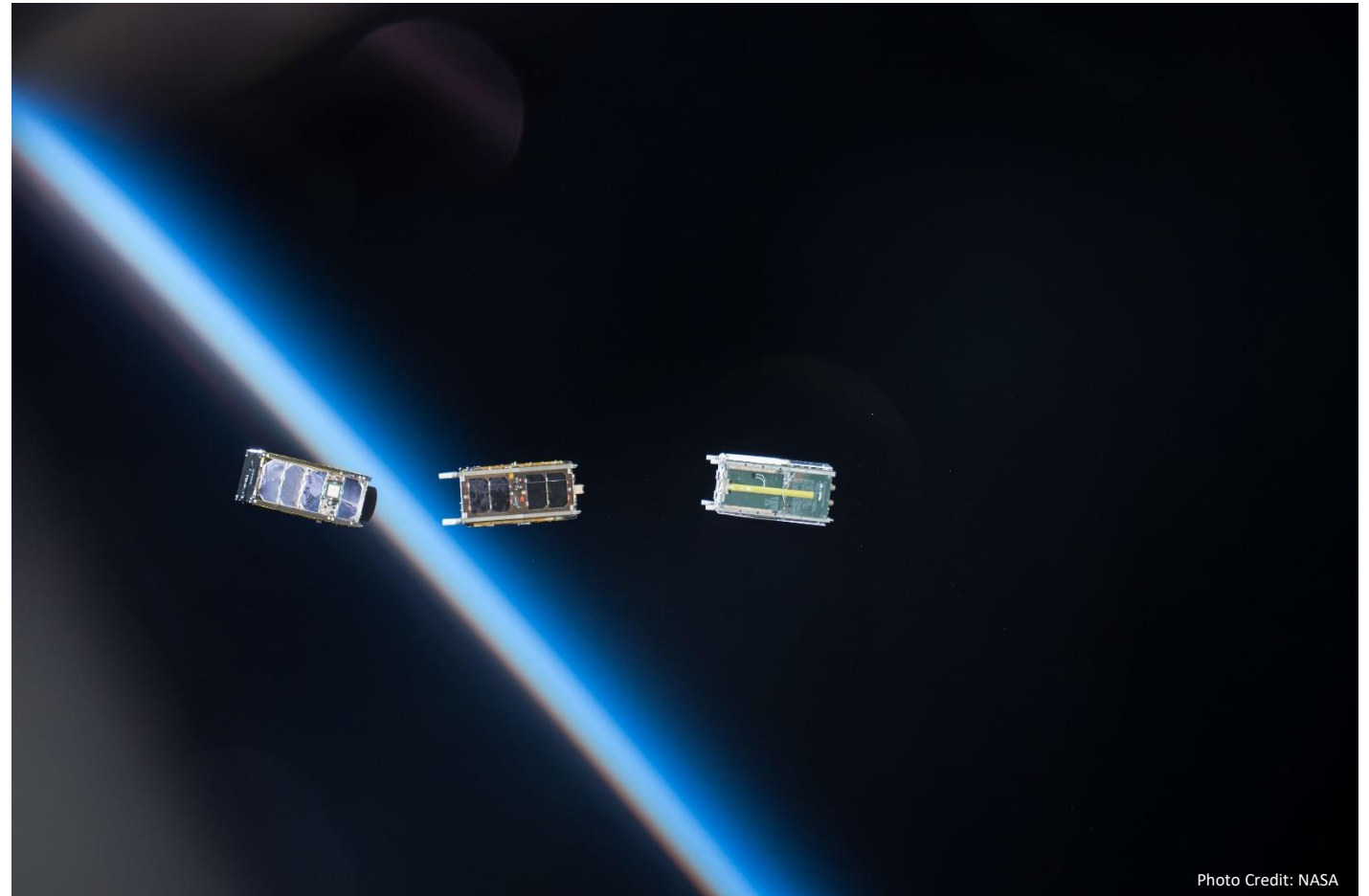

Photo Credit: NASA
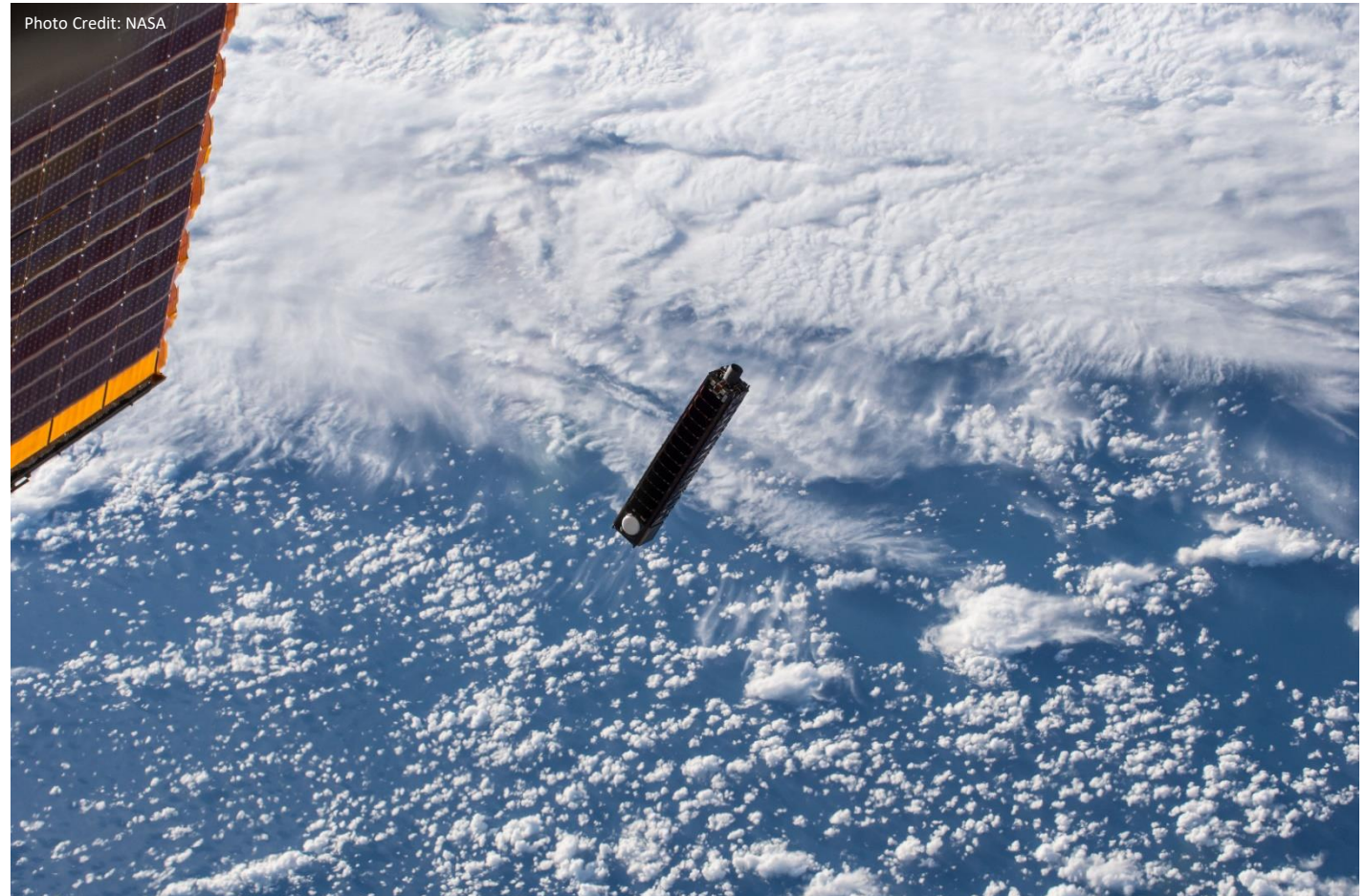
- **Examples of Actions Taken by ISS Program**
  - Flight rules for first NRCSD mission dictated 90 minutes between deployment events from ISS
    - Flight rules changed after first deployment mission from 90 minutes to 6 hours
    - Flight rule currently stands at 3 hours between deployments

Photo Credit: NASA

- **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


Photo Credit: NASA

- **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

Photo Credit: Orbital-ATK
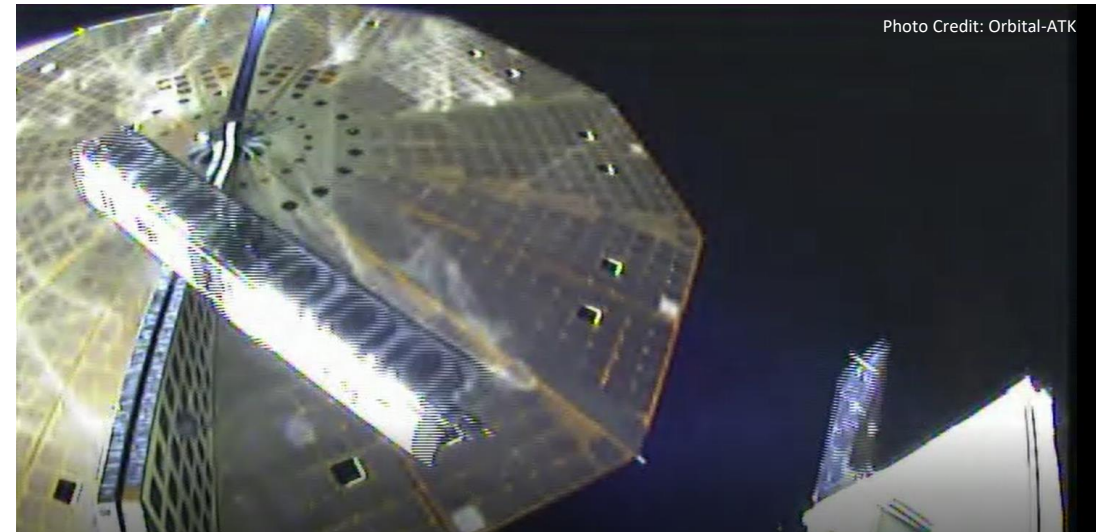
- **What more can we do?**
  - Most important thing is to ensure that customers (satellite owner/operators) are educated, in contact with the 18th Space Control Squadron (before launch), and understand what tools are available to them (and what is 'expected' of them)
    - Coordination between Launch 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)