NATIONAL RECONNAISSANCE OFFICE

(U) A Path Forward for Small Satellite Ground Architecture

LtCol Joseph Gueck: gueckjos@nro.mil

MAJ Benjamin Seth Bowden: bowdenbe@msd.nro.mil

Mr. David C. Williamson: willdavi@msd.nro.mil

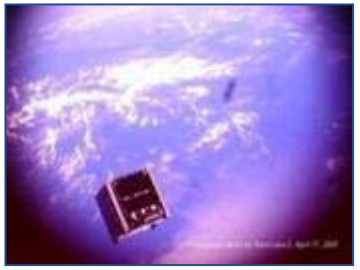
2013 Ground Systems Architecture Workshop

SUPRA ET ULTRA

(U) What are CubeSats?

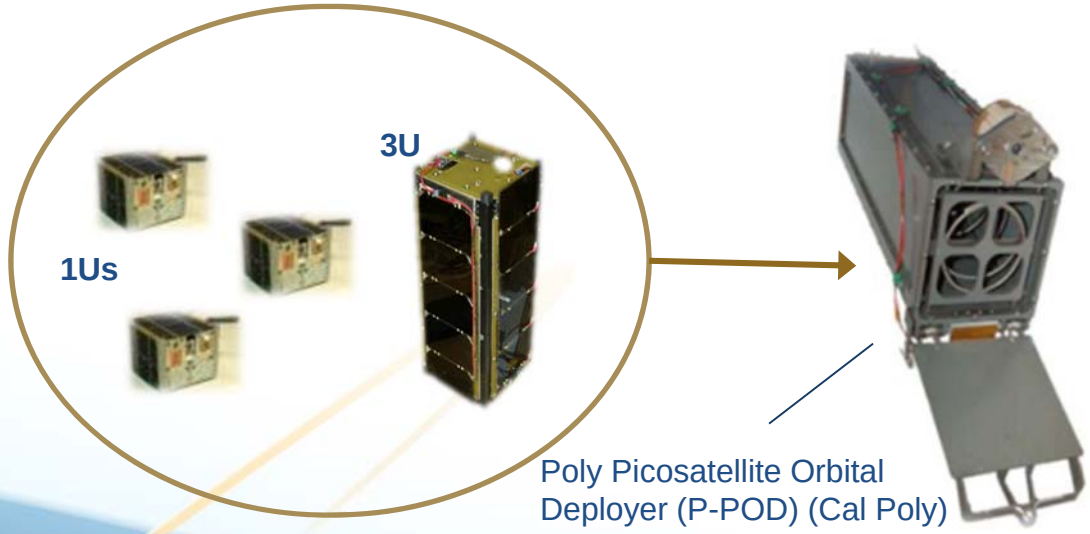
- **(U) <u>CubeSat are containerized Nanosatellites:</u>**
  - (U) 1U = ~10 cm/side; multiple "U" cubes (e.g., 3U, 6U, etc…); Masses range approx 1 kg – 12+ kg
  - (U) Controlled standard mechanical interface requirements
  - (U) Standard deployers developed and flown (P-POD, ISI-POD, etc…)
  - (U) > 98 CubeSats launched to date from various launch vehicles (including several from host spacecraft)
- **(U) <u>Increasingly broad acceptance, large active developer list:</u>**
  - (U) 70+ U.S. companies; 50+ U.S. universities; 17+ U.S. Government
  - (U) 41+ foreign universities on six continents
  - (U) 37% of papers at '08 SmallSat Conference were CubeSat related
    - 48% of papers at '09; 62% of papers at '10; 70% of papers at '11

CUTE 1.7 + APD (Tokyo Tech. University)



CP4 (CalPoly) as seen from AeroCube-2 (Aerospace)

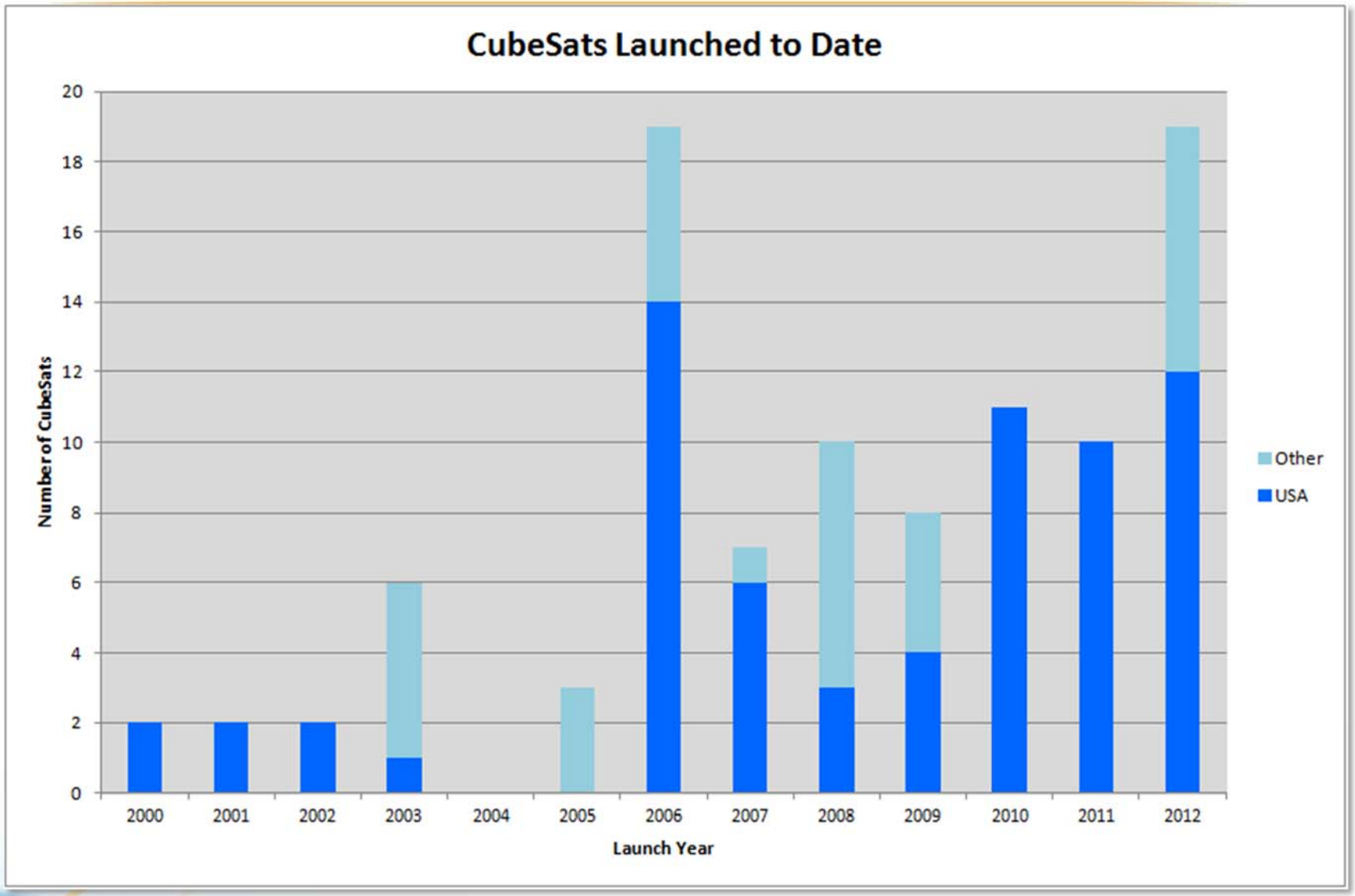
QuakeSat-1
(Stanford University and QuakeFinder, LLC)



Poly Picosatellite Orbital Deployer (P-POD) (Cal Poly)

Figures are UNCLASSIFIED

(U) CubeSats Launched To-Date



(U) NRO CubeSat Program

(U) PROGRAM OBJECTIVES

- **(U) Apply the utility of Containerized Nanosatellites to the ISR architecture for:**
  - (U) Workforce Development
  - (U) Assessing the viability of novel architectures
  - (U) Enabling rapid pathfinder implementation
    - High levels of accepted risk
  - (U) Technology Maturation:
    - Accelerate fielding of new technologies
    - Reduce tech insertion risk for NRO SPOs

Figures are UNCLASSIFIED

(U) ADDITIONAL THRUSTS

- **(U) Develop and distribute general purpose Bus (Colony Series):**
  - (U) Provide state-of-the-art exemplar for customers with a payload or operational need
- **(U) Establish a fixed and "mobile" ground station infrastructure:**
  - (U) Provide end-to-end systems operations outreach
- **(U) Enable on-orbit operations capability through launch outreach**

(U) State of Access

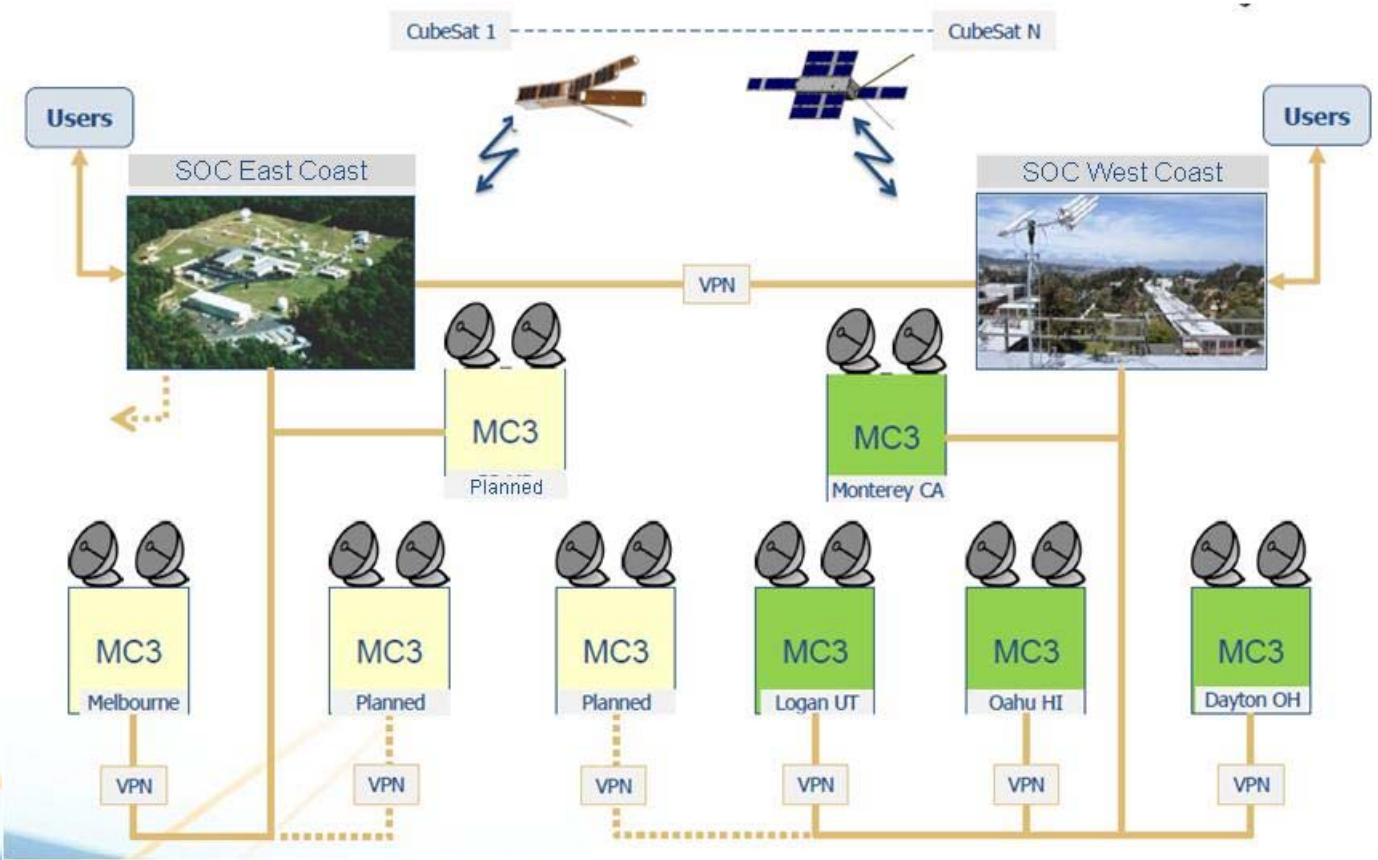
- **(U) Worldwide - > 95 CubeSats have been launched since CY2000**
  - Until 2007-8 most have been affiliated with Academia as learning tools
- **(U) In 2007, the NRO and US Government Partners recognized the utility of CubeSats**
  - Actively engaged Universities, Service Academies, Service Labs, DOE Labs and Industry to advance the state of practice
- **(U) Within the US, CubeSat secondary payloads have been integrated and launched from multiple launch vehicles including:**
  - Minotaur I/IV, Falcon 1/9, Delta II, Taurus XL, Atlas-V, Space Shuttle, ISS
  - and planned for Antares, Athena, and Delta IV
  - Launch capabilities in development include: Super-Strypi, SWORDS, ALASA
- **(U) Currently, CubeSats are operated primarily via <u>independent</u> ground systems established at universities or leverage <u>disparate</u> government/civil network(s)**

(U) Current MC3 Operations Architecture

(U) CubeSat program is fielding the Mobile CubeSat Command and Control (MC3) system

(U) Enables users to communicate with Colony I / II buses on orbit

(U) Aligned to provide multi-mission C2 across the community



(U) Impacting the Future

- **(U) Leverage Efficiencies**
  - Synchronize / Share Resources

- **(U) New Tool in the Toolbox for:**
  - Maturing Technologies
  - Growing Future Workforce

Centaur Upper Stage as Seen From AeroCube 4.5

NATIONAL RECONNAISSANCE OFFICE

SUPRA ET ULTRA