CubeSat Launchers, ESPA-rings, and Education at the Naval Postgraduate School

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• NPS – Monterey, CA (120 miles / 200 km south of San Francisco)
  – ~1700 students
  – Mid-career military officers and government employees
  – ~30 to 50 different countries send students to NPS
  – predominately MA degrees, increasing number of PhD degrees

  – Space Systems Academic Group
    • Space Systems Operations
    • Space Systems Engineering
PANSAT

- NPS – payloads and satellites as part of space education
  - Shuttle mid-deck experiments
  - PANSAT (deployed on STS-95 Oct 1998 – the “John Glenn flight”)
PANSAT
NPSAT1 Update

- Education

- Research and technology demonstrations
NPSAT1 Update

- Flight-qualified structure
- Working processor board & CFTP experiment
- Flight batteries built
- Flight ACS components on-hand
  - Magnetometer
  - GPS receiver
  - Torquer coils
  - Momentum wheel
  - MEMS rate sensor flight-build in progress
- Solar panel flight-build in-progress
- Ground station antenna build in-progress
- 19 Master’s theses to date
- ~5+ Students actively participating during any given academic quarter

- Target completion: Jan. 2009
Genesis of a CubeSat Launcher (NPSCuL)

- STP-1 Mission launched March 2007
  - One empty slot
  - NPSAT1 Mass Simulator
As NPSAT1 nears completion, NPS will evolve to the use of CubeSats in its educational program.

There “should” be ESPA carrier missions in the future.

There already exists a strong university CubeSat development community.

There appears to be a scarcity of U.S. launch opportunities for CubeSats.

It appears that an ESPA-compatible CubeSat Launcher could be of value:
- NPS will need to launch NPS CubeSats in the future:
  - NPS is forming collaborations with other USG organizations and universities interested in flying CubeSats.
  - This is also an educational outreach opportunity for NPS.
- A CubeSat launcher could ensure utilization of ESPA slots:
  - Seek STP dedicated slot for the CubeSat Launcher for NPS CubeSats.
  - Be mass and cg reconfigurable and ready to “fill in” for a payload not ready to launch due to development schedule issues or late problems in test or integration.
Concept

• Utilize existing standards and processes
  – ESPA carrier interface
  – Cal Poly Cubesat organization
    • Broker for university satellites
    • Standards for Poly-Picosatellite Orbital Dispenser (P-POD)
  – STP launch process
Requirements

- Programmatic Requirements
  - Cal Poly as broker for university CubeSats
  - NPS liaison to STP
  - Completion of survey form
    - Mission: description, objectives, schedule, etc.
    - Technical: mechanical, electrical, orbital, safety, etc.
  - ESPA-compatible payload flight request to STP
  - Earliest launch target: FY09 – FY10
University CubeSat Flight Experiments

Cal Poly Cubesat Program

CubeSats from NPS and other USG partners

Space Test Program

CubeSat Launcher
- Integration
- Test
- Payload Processing

Integration & Launch
Requirements

• Technical Requirements
  – Integrate multiple P-PODs
  – Maximize CubeSat volume
  – Be ESPA-compatible (mechanical / electrical)
  – Reconfigurable mass & distribution (functional mass simulator)
  – Meet all safety requirements
  – Ease of manufacturability
  – Implement certification & verification program
  – Allow experimenter access up to final P-POD assembly

Notional concept of launcher (8 P-PODs) within ESPA payload envelope
Objectives fulfilled

- Provide a launcher capability to meet objectives of:
  - NPS Space Systems Education
    - Hands-on satellite development and operations
    - Shorter development cycle
  - Technology innovations for DOD
    - Encourage creative minds in higher education
    - Advance S&T for spacecraft technology (flight demonstrations)
  - Encouraging students to join the aerospace work force
    - Provide exposure to DOD / USG aerospace professionals by working on projects of mutual interest
NPS CubeSat Missions

Current NPS CubeSat projects:
• Solar cell measurement system
• 3-axis stabilized imager

Potential NPS CubeSat projects:
• Ship tracking
• Formation flying / docking
• Max. power tracking circuit
• Configurable, fault-tolerant processors (CFTP)
• Technology demonstrations
  – Attitude control
  – Energy storage devices