



Three Corner Sat: Mission Overview and Lessons Learned

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Presentation Content

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3CS Overview

- 3 universities, 3 identical satellites - part of AFRL's University Nanosat 2 Program
 - New Mexico State University
 - Arizona State University
 - University of Colorado at Boulder
- Initially designed and integrated as a system of 3 s/c for shuttle, reconfigured and launched as 2 s/c aboard Delta 4 Heavy
- Each Satellite
 - Weight: ~45 lbs.
 - Size: 11 in. tall, 17 in. major diameter
 - 6061-T6 aluminum hexagonal isogrid structure



3CS Mission Objectives

- 3CS Mission Goals
 - Virtual Flying Formation
 - Inter-satellite Communication
 - Science Imaging
 - Micropropulsion
 - Autonomous Operations





From Shuttle to Delta 4 Heavy

- Given ATP for Delta 4 Heavy integration - Jan. '04
- Required Fully Tested Payload Delivery to Boeing in Mid-March
- Two major aspects of LV change requiring most attention and work
 - Fundamental Freq. Requirement
 - New orbit (GTO vs. Low LEO)





From Delivery to Launch

- Mate to DemoSat, May '04
- Ground station and mission ops preparation
- Mission ops training
- Launch! December 21, 2004.
- 8 seconds-premature engine shutdown of first stage
 - S/C De-orbited within 30 min of separation





Lessons Learned for the Universities

- Nano/Pico-satellites becoming popular, viable opportunity for universities to design, build, test, and operate their own spacecraft
- 3CS experienced/survived all aspects of a small satellite program, concept to launch.





Lessons Learned for the Universities

- Documentation/Configuration Management
 - Lacks hands-on appeal and is often neglected
 - Centralized location for documents
 - Photographic Documentation
 - Played crucial role during reconfiguration of s/c
- Sister Sat
 - Did not begin integration until flight units complete
 - Put on hold due to lack of launch opportunity and other projects
 - “Petey” became invaluable
 - Should be done in parallel with flight unit integration



Lessons Learned for the Universities

- Student Turnover and the Common Thread
 - Biggest problem for university programs
 - Another 6 months and 3CS would not have made it
 - Common Thread
 - University Staff Members, Lab Managers
 - Filled gap between PI and students.
 - Can effectively bring students up to speed

3CS Turnover Figures		
Total AFRL Program Managers		3
Total 3CS Program Managers		7
Total Subsystem Changes	Lead	26
Approximate Number of Students on 3CS at One Time		40
Total Students on 3CS Team		>200



Benefit for the Community

- Responsive Space

- DoD effort to decrease average time from mission call-up to launch and on-orbit operations

- Current average ~ **years**
- Goal is ~ **days!**

- Nanosat-2 was an ***inexpensive, “easy”*** pathfinder for responsive integration of a secondary payload onto an existing flight

→ ***Explored the responsiveness of existing systems and organizations***



Benefit for the Community

- Successful rapid reconfiguration of 3CS → a valuable baseline for development of responsive space tools, methods and architectures.
 - Modularity
 - COTS technology
 - Small teams → small responsive missions
 - Central trade of responsive space: Capability vs. Responsiveness
 - Payload reconfiguration complete before LV contracts in place!
- Students coming out of this program and entering the workforce have experience and training that is ***unique and unmatched.***



Conclusions

Even with launch failure, smallsat/university communities can take various things away from the program

1. Increased maturity among universities including launch ops and systems engineering
2. Taste of what responsive space looks like in practice
3. Highly qualified and experienced university graduates