CubeSat Initial Objectives

• Started in 1999: Stanford-Cal Poly Team
• Facilitate Access to Space:
  ◦ Rapid Development Time (1-2 years, Student Career)
  ◦ Low-Cost
  ◦ Launch Vehicle Flexibility
• Use Standards
• University Projects
• Industry Testbed
Successful Satellite Standard

- 28 CubeSats in LEO (44 Launched)
- Over 100 Developers Worldwide
- Dedicated Workshops/Meetings
- CubeSat Industrial Suppliers
Lessons Learned / Results

- Multiple manifest: distribute launch costs over many customers
- Repetition minimizes design, analysis, and testing for subsequent missions
- Spacecraft Development Without Firm Launch
  - Standard Independent of Launch Vehicle
  - Fast Response to Launch Opportunities
- LV Manifest without Firm Spacecraft
- Transfer spacecraft between LV
- P-POD Protects LV/Primary & CubeSat
Surprise Result

Cal Poly-SRI Team view CubeSat as an Experiment in Secondary Payload Logistics
Following Traditional Secondary Launch Model

Launch Opportunity

Lost Opportunity: Late Notification

Spacecraft Developer

Launch Opportunity

Spacecraft Developer

Launch Opportunity

Spacecraft Developer

Launch Opportunity

Spacecraft Developer
Following Traditional Secondary Launch Model

- Launch Opportunity
- Lost Opportunity: Late Notification
- Lost Opportunity: Incompatible Reqs.
Following Traditional Secondary Launch Model

Launch Opportunity

Lost Opportunity: Late Notification

Spacecraft Developer

Launch Opportunity

Spacecraft Developer

Launch Opportunity

Lost Opportunity: Incompatible Reqs.

Spacecraft Developer

Launch Opportunity

Wasted Spot: Secondary not Ready

Spacecraft Developer
The Vision: Flexible Secondary Launches

- Launch Opportunity
- Launch Opportunity
- Launch Opportunity
- Launch Opportunity

- Standard Launch Interface / Services

- Spacecraft Developer
- Spacecraft Developer
- Spacecraft Developer
- Spacecraft Developer
VISION

• Full Launch Margin Utilization
• Predictable and Regular Launch Access
• Primary/Secondary Schedule Decoupling
• Just in Time Delivery
  ♦ Launch Soon After Sat is Ready
• Guaranteed Access for High Priority Missions
Enabling Activities

- Standarized Test/Integration Flows
  - Launch Vehicle Independent
- CubeSat Accommodations Pre-Qualified on all LV
- Secondary Manifest Independent of Payload
- Continuity of CubeSat Standard
- Streamlined Frequency Allocation and Other Licensing
- Debris Mitigation Plans
Benefits of Flexible Secondary Launches

- Increase in Launch Opportunities
- Decoupling of LV/Primary and Secondary Development Schedule
- Change in Risk Posture
- Accelerated Technology Injection
- Development of New Markets/Missions
- Improved Work Force Development
- Lower Secondary Launch Cost
Additional Effects

- Learning Opportunities that can be applied to Larger systems:
  - Satellite Standards
  - Launch vehicle independent Sat development
  - Responsive launch operations
  - Large launch numbers
Conclusions

• CubeSat is Ideal Platform for Launch and Operations Experimentation
  ♦ Not only satellite experiments

• Need New Model to Enable Launches of Large #’s of Spacecraft (100s)
  ♦ CubeSat Community Working on It

• Low Initial Investment to Pre-Qualify Systems and Develop Logistics Required