Faster, Smaller, Cheaper Exploiting the Imminent Low-cost Launch Era

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Overview

- Changing Economics of Launch
- Design Approach
- 50-kg Class: Concept and Capabilities
- 150-kg Class: Concept and Capabilities
- Conclusion



Changing Economics

- Current small launch vehicle examples
 - US: Pegasus, Minotaur (~\$20M)
 - Russian: Rockot, Kosmos (~\$15M)
 - Export control, transportation issues
 - Secondary: ESPA, ASAP (\$0-8M)
 - Availability, integration, schedule risks
- Future small launch vehicle examples
 - Falcon I (\$7M, 1st operational flight 3Q2007)
 - Microcosm Sprite (\$3.5M by 10th flight, TBD)
 - Super Strypi (\$7M recurring cost, TBD)
 - RASCAL goal (\$3M)



Technology Challenges

- "Valley of Death" TRL 5 to TRL 7
 - Breadboard to prototype in operational environment
 - \$40M \$50M and 2-3 years minimum for demo
- New technology risks
 - PMs unwilling to take risks on new technology
 - Multi-junction solar cells, HBTs, Li-ion batteries
- Need the means to quickly and inexpensively demonstrate components

TRL = Technology Readiness Level; HBT=Hetero-junction bipolar transistor 21st AIAA/USU Conference on Small Satellites



Reaping Benefits of Lower Launch Cost

- Reliability, optimization, and integration are driving factors for payload and bus costs
- Pareto's 80/20 Law (one of many!)
 - 80% of the resources are required to obtain the last 20% of the system performance
 - Driven by high launch costs
- IF launch costs can be
 dramatically reduced, less effort
 needs to be put into these areas





Design Approach

- Limited duration mission
 - Reliability, redundancy, radiation tolerance
- COTS hardware when suitable
 - As needed: COTS, high-reliability, space qualified
- Capability driven design
 - Exploit performance curves
 - Judicious use of advanced technology components
 - Simplicity and flexibility
- Simplified interfaces
 - Additional margin, overlapping functionality



50-kg Class Concept



- Gravity-gradient primary attitude control
- Reaction wheel/torque rods supplementary
- Deployed solar panels
- Li-ion battery
- No propulsion system

50-kg Class Capabilities

- Payload 15-kg, 3-W average power
- Attitude 5° control; 1° knowledge
- Power
 - Generation: 14-W average, 45-W peak
 - Storage: 28-V, 15-A-h Li-ion batteries
- Communication 256-kbps S-band
- Thermal Passive control
- Recurring cost < \$1M



150-kg Class Concept



- 3-axis stabilized using reaction wheels/torque rods
- Deployed solar panels
- Li-ion battery
- Cold-gas propulsion system (under consideration)



150-kg Class Capabilities

- Payload 35-kg, 20-W average power
- Attitude 0.1° control; 1' knowledge
- Power
 - Generation: 48-W average, 90-W peak
 - Storage: 28-V, 15-A-h Li-ion batteries
- Communication 10-Mbps S-band
- Thermal Passive control
- Recurring cost < \$3M



Conclusion

- Changing economics of launch opens new design space—lower cost, increased risk
- Will enable tech demos, reducing time to include advanced technology into programs
- Two classes of microsatellites defined
 - Significant capabilities
 - Much lower cost than traditional approach

