NSGSSP: Addressing US Space Program Priorities

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Mike Drake, Arizona SG
Chris Koehler, Colorado SG
Alec Gallimore, Michigan SG
Luke Flynn, Hawaii SG
Outline of Talk

- Status of US Space and Satellite Program
- Increasing Interest in Small Satellites
- New NASA Mission Directorate – OCT
- Where does NSGSSP fit in?
- Summary and Issues
State of the Spacecraft & Rocket Industry

How is Responsive Space Doing?
State of U.S. Space Industry

+ U.S. does not drive the satellite market
  - > 40 Countries w/ Space Programs

+ Commercial only statistics are worse
  
  U.S. SHARE OF THE WORLD SATELLITE MARKET WENT FROM 68% IN 1998 TO 29% IN 2008 WHILE OVERALL SATELLITE DEMAND REMAINED STEADY
UNCLASSIFIED

State of U.S. Space Industry

- U.S. does not command launch market
  - > 7 Countries / consortiums w/ launch systems

Launches by Country/Consortium Builder

- Few commercial satellites are launched using U.S. rockets

U.S. SHARE OF LAUNCHES WENT FROM 40% IN 1998 TO 23% IN 2008 WHILE TOTAL LAUNCH NUMBERS REMAINED STEADY

Launch Opportunities

- Reduced costs will increase launch opportunities
  - Current cost range for U.S. launch to LEO: $4.5K – $11K per pound

- Expand market for small launchers
  - Space X, Minotaur, Pegasus, etc

Impact of Decreasing Launch Prices on Commercial Market Forecast Year 2001 - 2021

Source: Futron Corp. ASCENT Study April 2003
Interest in “Rapid, Low-Cost” Space

- Small Sats are Cheaper!!
  - Current satellite and launch cost for “big” satellite = $1B
  - Current small satellite and launch cost ~ $140M
  - Low-cost satellites and launch vehicles needed.

- Space Technology Development Interest
  - National Reconnaissance Office – Investing in 4-5 “generations” of 3-u CubeSats
    - Boeing building ~ 50 satellites (Space News)
    - 9-month development cycles per generation
  - Air Force interest in CubeSats
  - Operationally Responsive Space Office “Chili Works” dedicated to small satellite development.
  - NASA spins up Office of Chief Technologist
    - Interest in TRL advancement for critical technologies
    - Willing to accept experimental missions for iterative technology development.
    - Returning to 60’s mentality when failure was part of the learning process.

- Rapid Response – Simple to assemble, inexpensive LV in terms of parts and “pad maintenance”.
  - Disaster management, on-orbit asset replacement
NASA’s “New Mission Directorate”

- OCT will be the equivalent of a new NASA Mission Directorate
- Office of the Chief Technologist
  - Deputy Director laid out OCT goals at the August NASA EPSCoR meeting in Washington DC
  - OCT is willing to accept Class D missions to promote rapid development of new space technology.
  - “Space technology” means the traditional instrument development but also subsystem and small sat development.
  - NASA Ames will receive significant development responsibilities in small satellites (technology and missions).
  - Focus on providing support for technology to orbit.
- RFP’s and AO’s prepared and ready for release with FY 11 funding to NASA.
National Space Grant Survey

- Survey Results
  - 44 SG’s with small sat programs

- Working Together
  - Common CubeSat components
  - Custom NanoSat components
  - Time zones, schedules
  - Real-time networking and communications
  - Educational Focus – Grad, undergrad?
  - Build Schedule – 1 year, 2 years??

- Working with NASA Center(s)
  - NASA’s Posture
    - Risk averse
    - Paper intensive
  - SAA Legal Challenges
Pipeline: UH Forays to “Near Space”

- **UH/CoE CubeSat Team**
  - Builds small sats of various sizes based on 10cm³ box.
  - Larger CubeSats have increased capability
  - Relatively low component cost makes them useful for university projects.
  - Failed launch on Russian Dnepr rocket - July 26, 2006.

- **Community Colleges and UHM Build CanSats**
  - Windward CC, Honolulu CC, Kapiolani CC, and UH-Manoa have all participated in CanSat competitions
  - “Soda can” satellite launched to 10K ft. and recovered.
  - Kapiolani CC placed 5th in 2009 competition.
  - Kauai CC launched a CanSat from Kauai in August.

- **Windward CC Rocketry Program**
  - Students build and launch rockets in national competitions.
  - Help to sponsor Kauai CC rocketry program.

- **HawaiiSat-1 in progress – 80 kg small sat**
Kit Development for Multi-Unit CubeSats

- Next Step: Shared development of 3-u, 6-u, and 12-u CubeSats for technology demonstrations, instrumentation development and rapidly executed science missions.
- Collaborative COTS subsystem development
- Favorable IP restrictions – Government (Space Grant?) ownership of IP that would allow use by any affiliated Space Grant institution.

Shared Support Elements

- Ground station coordination following North Dakota shared observatory model.
- Concurrent engineering design, I&T facilities
  - Example: U Texas online Systems Engineering materials
Comprehensive Open-architecture Space Mission Operations System (COSMOS)

Features of COSMOS:
- Set of software and hardware tools to support spacecraft mission operations
  - Mission Planning & Scheduling Tool (MPST)
  - Mission Operations Support Tool (MOST)
  - Ground Network Control Tool
  - Data Management Tool
  - Analysis Tools
  - Test Bed Control Tool
- Open architecture to enable modifications and adaption to new missions and MOCs
- User-friendly interfaces and short learning curves for users and software integrators
- COSMOS editor
- Uses Limited Qt – helps ITAR
- Sockets for COTS/GOTS

COMOS is especially designed to be easily adaptable to operate multiple small satellites and to be easily transferable to new MOCs. COSMOS is being developed as a collaboration between HSFL, NASA Ames Research Center, and Santa Clara University. Participation by other universities is welcome.
Rideshare Payload Configurations

- Large fairing capacity for multiple small sats
- NASA Ames Payload Adapter and Deployer (PAD)
  - PAD can carry 24 1-u Cubesats or a combination of 1-u, 3-u, 6-u, and 12-u Cubesats
## Small Sat Performance and Costs

<table>
<thead>
<tr>
<th>Spacecraft Size</th>
<th>Mass (kg)</th>
<th>S/C Volume (cm³)</th>
<th>Power (W)</th>
<th>Bus Cost ($K)</th>
<th>Launch Cost ($K)</th>
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</thead>
<tbody>
<tr>
<td>1-u</td>
<td>1-2</td>
<td>10 x 10 x 10</td>
<td>2</td>
<td>20-30</td>
<td>40-60</td>
</tr>
<tr>
<td>3-u</td>
<td>5-6</td>
<td>10 x 10 x 30</td>
<td>4-5</td>
<td>100-200</td>
<td>250-300</td>
</tr>
<tr>
<td>6-u*</td>
<td>12-15</td>
<td>10 x 20 x 30</td>
<td>12-15</td>
<td>400-500</td>
<td>750</td>
</tr>
<tr>
<td>12-u*</td>
<td>30-40</td>
<td>20 x 20 x 30</td>
<td>40</td>
<td>1000</td>
<td>1500</td>
</tr>
<tr>
<td>HawaiiSat</td>
<td>60-80</td>
<td>60 x 60 x 70</td>
<td>100</td>
<td>2000</td>
<td>4500</td>
</tr>
<tr>
<td>Other</td>
<td>&gt;80</td>
<td>larger</td>
<td>??</td>
<td>??</td>
<td>Up to 12000</td>
</tr>
</tbody>
</table>

- Goal: Future 3-u CubeSat could be built and launched within the budget of a NASA EPSCoR Research Award.

- * 6-u and 12-u CubeSats have not flown in orbit.
Summary and Issues

- Space Grant and OCT can play a pivotal leadership role in small spacecraft development and technology maturation projects.
  - Create 3-u, 6-u, and 12-u CubeSat kits for new technology and mission developments.

- Facilities and Workforce Training Support
  - Developing the new workforce for Class D missions.
  - UHF/VHF and S-band ground stations for mission support.
  - Other shared facilities – Mission design centers, I&T facilities, etc.

- Hurdles – Questions posed to OCT
  - Who owns IP?
    - Kits should be made from readily available COTS parts – derived from already-published research.
    - All 52 Space Grant consortia should have access to CubeSat designs
  - NASA has to streamline reporting requirements for Class D
  - Communication and networking – NASA-led MIMIC model??