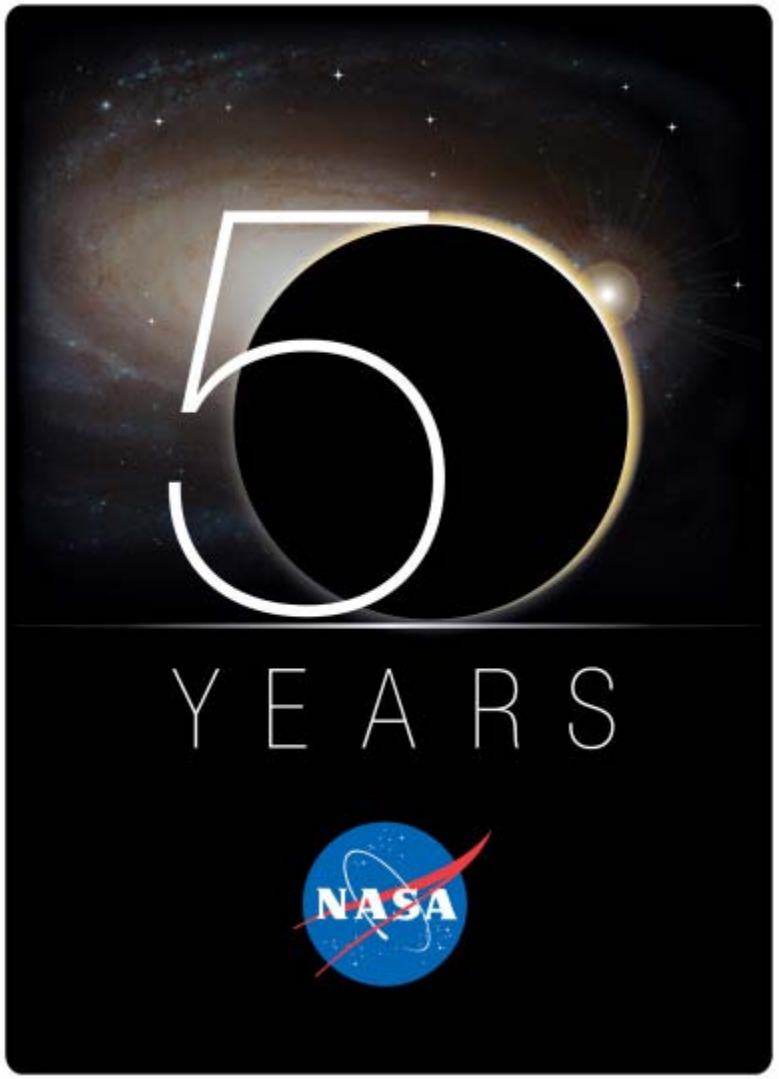
National Space Grant Student Satellite Program



NSGSSP: Addressing US Space Program Priorities

15 October 2010

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

NATIONAL RECONNAISSANCE OFFICE

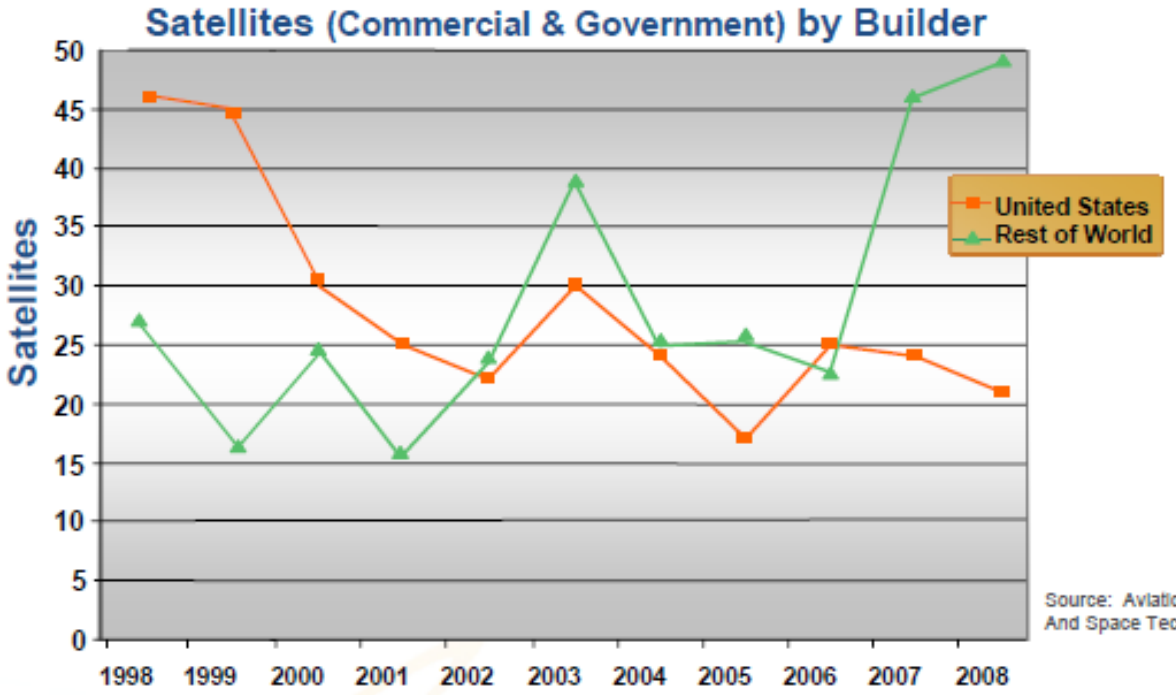
State of the Spacecraft & Rocket Industry

How is Responsive Space Doing?

VIGILANCE FROM ABOVE

State of U. S. Space Industry

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



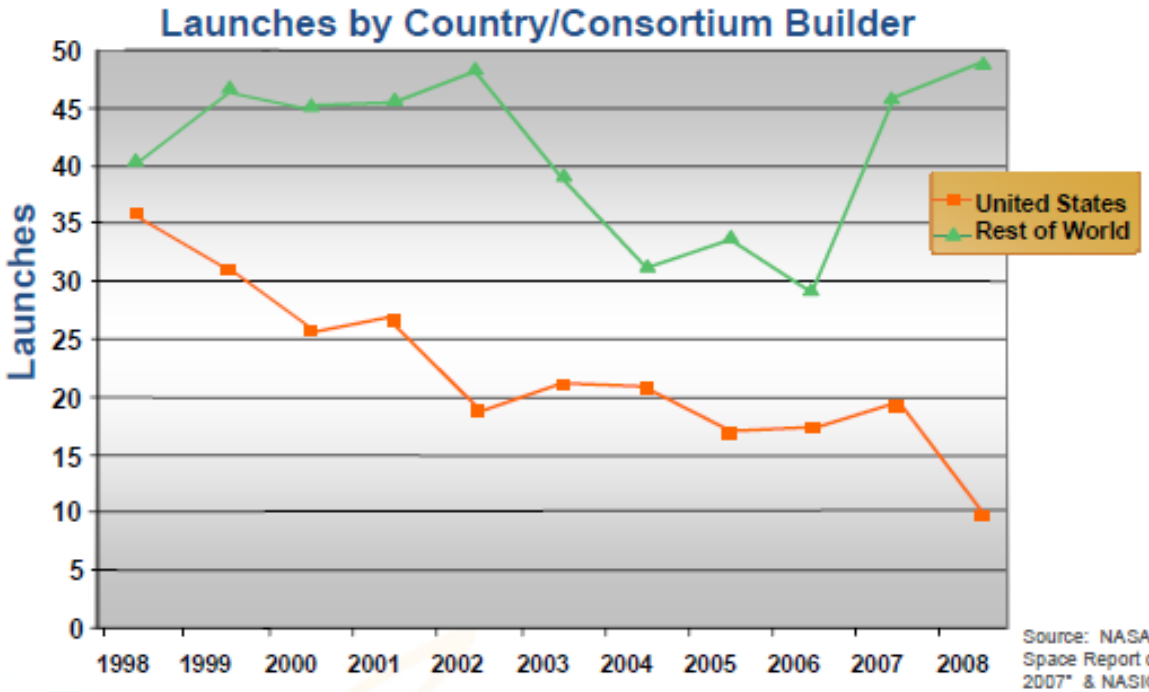
Source: Aviation Week And Space Technology

- **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

State of U. S. Space Industry

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



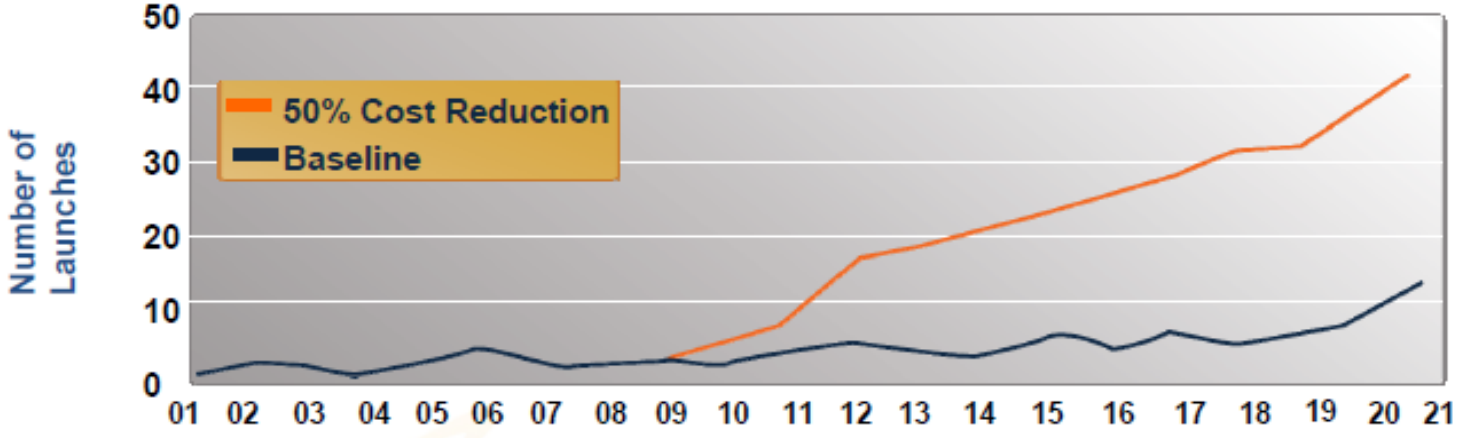
Source: NASA "Aeronautics & Space Report of the President 2007" & NASIC Space Flight Log

- **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



Source Futron Corp
ASCENT Study April 2003

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

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 Reconnaisance 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"

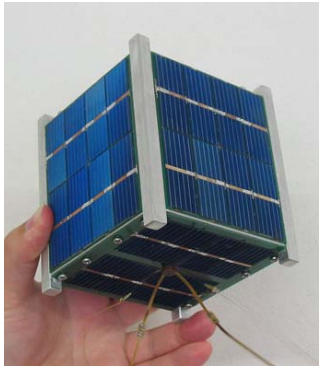
- OCT will be the equivalent of a new NASA Mission Directorate
- Office of the Chief Technologist
  - Deputy Director laid out OCT goals at the August NASA EPSCoR meeting in Washington DC
    - OCT is willing to accept Class D missions to promote rapid development of new space technology.
    - "Space 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

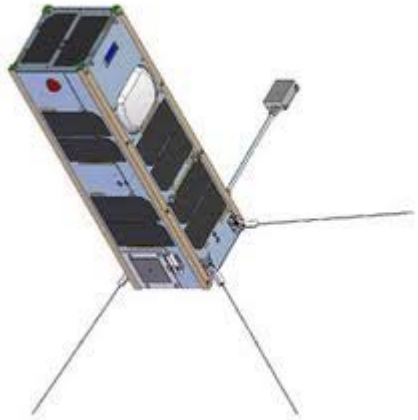
- Survey Results
  - 44 SG's with small sat programs
- Working Together
  - Common CubeSat components
  - Custom NanoSat components
  - Time zones, schedules
  - Real-time networking and communications
  - Educational Focus – Grad, undergrad?
  - Build Schedule – 1 year, 2 years??
- Working with NASA 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 10cm^3 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.

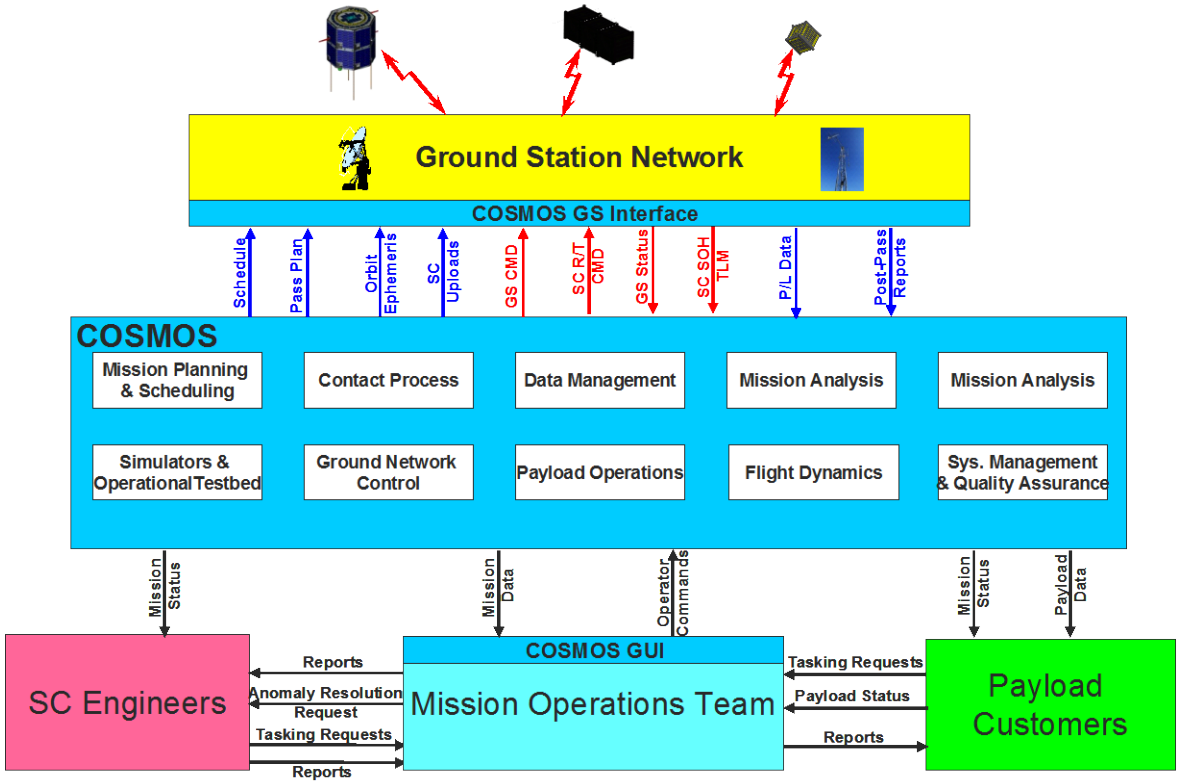


- Windward CC Rocketry Program
  - Students build and launch rockets in national competitions.
  - Help to sponsor Kauai CC rocketry program.
- HawaiiSat-1 in progress – 80 kg small sat

Space Grant Role?

- 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)

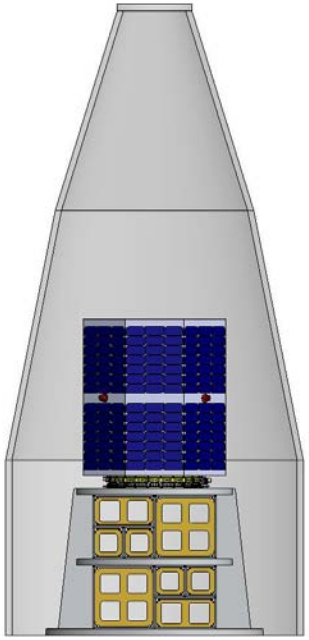


COMOS is especially designed to be easily adaptable to operate multiple small satellites and to be easily transferable to new MOCs. COSMOS is being developed as a collaboration between HSFL, NASA Ames Research Center, and Santa Clara University. Participation by other universities is welcome.

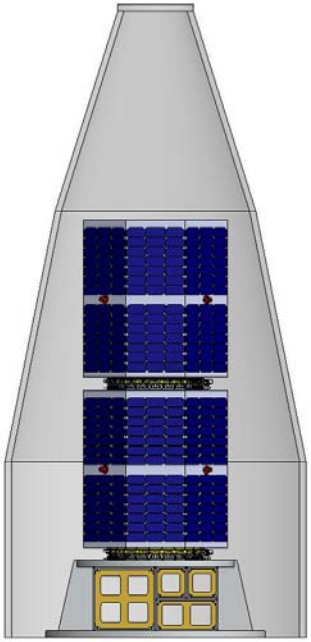
Features of COSMOS:

- 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

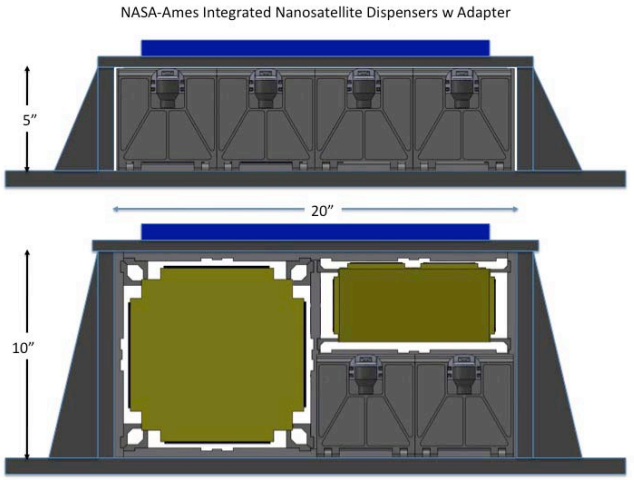
Rideshare Payload Configurations



1 small satellite, 2 PADs



2 small satellites, 1 PAD



- 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

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

- 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??