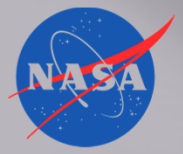

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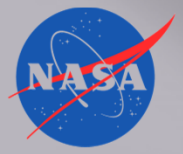
EMERGING RIDESHARE ACTIVITIES

A Report Back to the Small Payload Rideshare Community

Linda Herrell
Jet Propulsion Laboratory
California Institute of Technology



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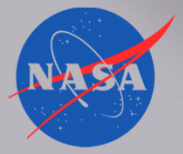
Background

- In 2008, I initiated a session at the IEEE Aerospace Conference.
- "Access to Space and Emerging Mission Capabilities" was meant to provide a "cross-fertilization" of information gained at this Rideshare conference (launch experts) with the experts at IEEE Aerospace (payloaders)
- Sam Sims of Aerospace Corp. and the Air Force STP Program joined me shortly thereafter to Co-Chair

Here is a window into how rideshares are being used.



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THE FOLLOWING CHARTS ARE EXCERPTED FROM THE 2011 IEEE SESSION 2.04, "ACCESS TO SPACE AND EMERGING MISSION CAPABILITIES"

Kentucky Space Missions




New NanoRacks/CubeLab Standard on the ISS, July 2010


First Student Built Satellites to be Launched by NASA (ELaNa/Glory) March 4, 2011


First CubeSats Ejected into Sub-Orbital Space, March 2010

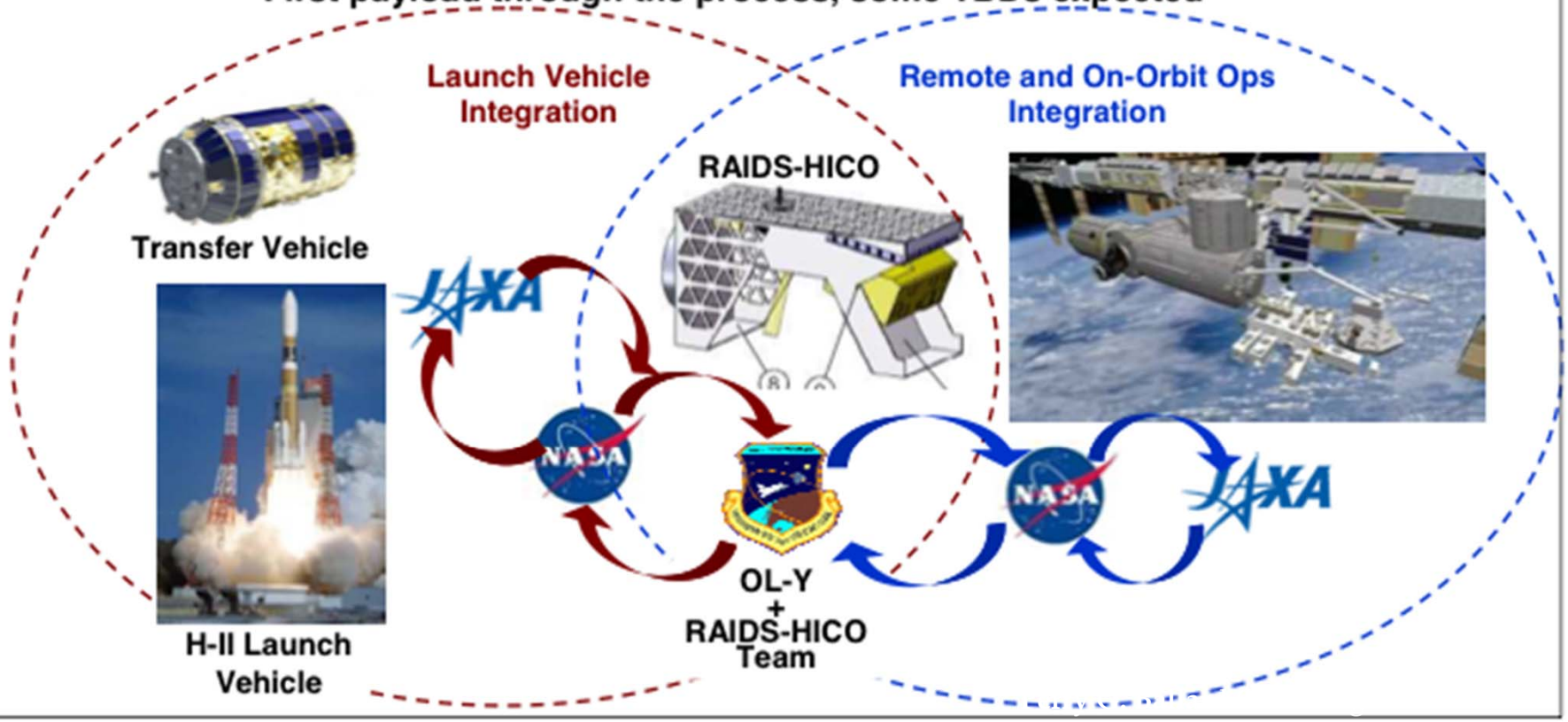
Balloon-1, July 2008 (Background Image)

Garvey P-12A

First Flight, Composite Super Loki, December 2007

Overview of the Process

- The Process…like most of our payloads, two integrations for each mission
  - Launch Vehicle integration to HTV
  - ISS integration for on-orbit and remote operations
  - Trailblazing the path for NASA to use both HTV and JEM-EF
    - First payload through the process, some TBDs expected



Challenges of Space Weather Resarch

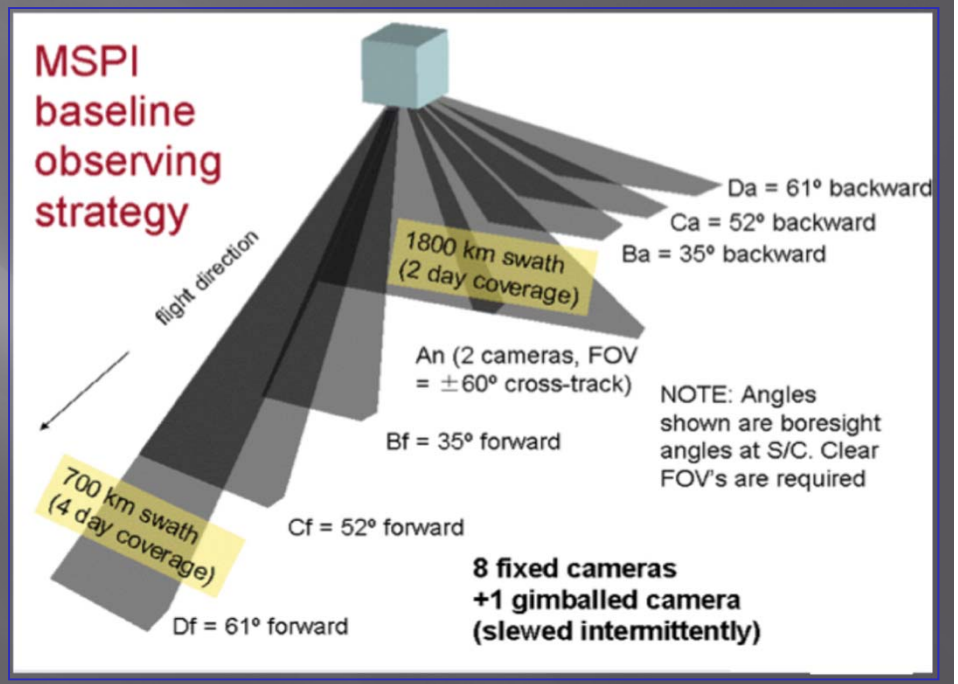
- Multipoint observations needed (Space Weather research is where terrestrial meteorology was 100 years ago, with a sparse measurement grid, and lacking important models and measurements to achieve true predictive capability)
- New types of sensors are often needed - often at TRL 4. How to get to TRL 7?

One solution: Secondary rides of small instruments on launches with excess capacity

- Inexpensive launches, platforms, and instruments (total mission cost $5-30M) are in a “sweet spot” for technology demonstration - you get enough capability to do exciting and new things, without breaking the bank. Success rates below 100% also acceptable.
- Rapid turnaround for iterative instrument development “learn by flying” is a necessary supplement to on the ground instrument modeling, calibration, and test (some aspects of system performance cannot be accurately tested or simulated on the ground)
- Frequent launches can solve the “sparse measurement” problem as well, by putting up lots of small simple sensors to better characterize the space environment - wide range of temporal and spatial scales matter!
- DOD and other providers often have excess launch capacity, and are developing standardized interfaces to utilize this without adding risk to main payloads (ESPA, PPOD, etc.)

MSPI OBP Overview

- AIST[1] task (3 years), funded by ESTO[2]
- Targeting the Decadal Survey Aerosol-Cloud-Ecosystem (ACE) mission
- Multiangle SpectroPolarimetric Imager (MSPI) instrument
- A single (1 of 9) MSPI camera must process 95 MB/s of raw video data; data reduction to 0.45 MB/s is required
- On-board processing (OBP) is done via a least-squares fitting algorithm
- **Implemented on the Virtex-5FXT FPGA**
- Year 3 technology validation on AirMSPI camera via ER-2 flight demo
- *Paper to be presented on this task in Session 6.01 on Thursday AM*



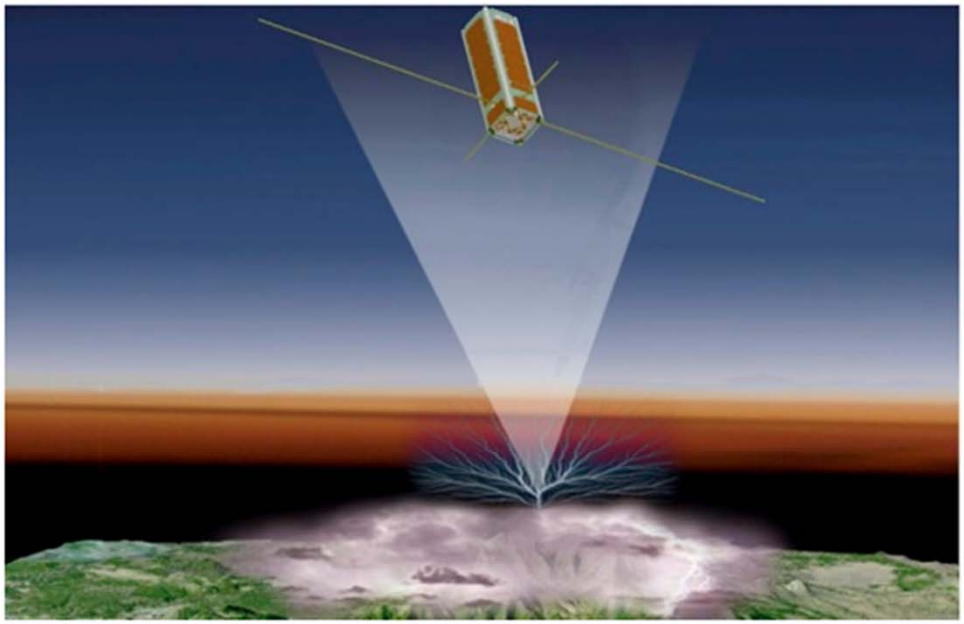
1 Advanced Information System Technology (AIST)
2 Earth Science Technology Office (ESTO)

The NSF Firefly CubeSat Mission: Rideshare Mission to Study Energetic Electrons Produced by Lightning

D.E. Rowland, J. Hill, P. Uribe, J.H. Klenzing, F. Hunsaker, M. Fowle, T. Cameron, K. Simms, H. Hancock, M. Saulino, D. Guzman, S. Kholdebarin, L. Ramsey, A. Willingham / **NASA Goddard Space Flight Center**

A.T. Weatherwax, J. Kujawski, M. McColgan, R. Carroll, J. Williams, J. DeMatteo, K. Melsert / **Siena College**

O. Ganel, L. Lutz, C. Dailey, C. Naegeli / **Hawk Institute for Space Science**



Studying Terrestrial Gamma Ray Flashes (TGFs): Earth's most powerful natural particle accelerator

2011 IEEE Aerospace Conference Big Sky, MT

Session 2.04 / Paper 1405

March 8, 2011

Firefly Instruments

Gamma Ray Detector (GRD) measures:

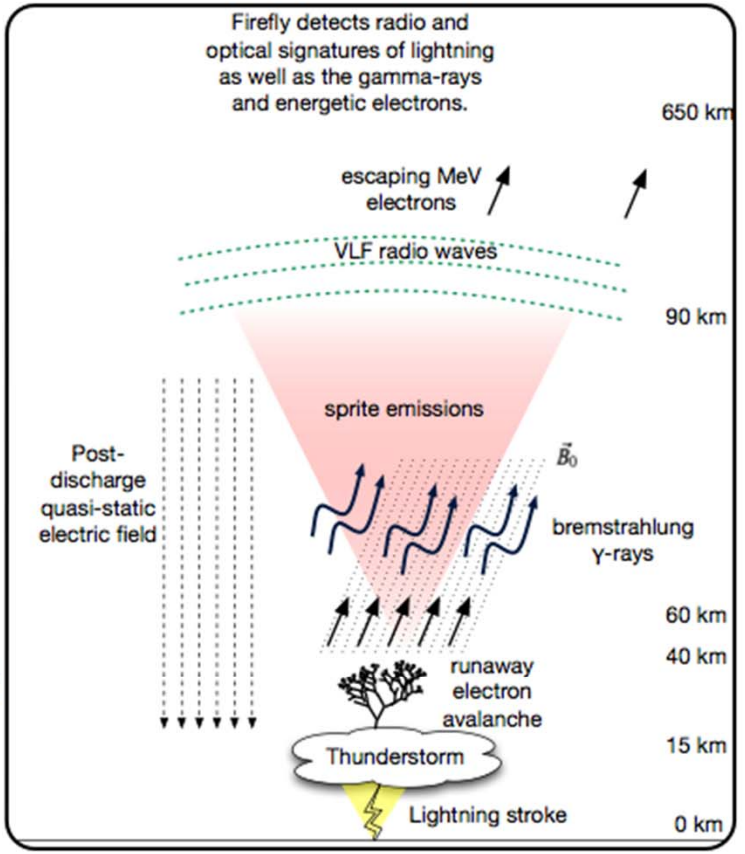
photons from 100 keV to 10 MeV, at count rates up to 1 MHz
electrons from 2 MeV to 8 MeV, at count rates up to 1 MHz
"counts" up to 2 MHz
snapshots, spectra, and count rate histograms
64 cm^2 physical detector area

VLF wave receiver (VLF) measures:

single-axis electric fields 100 Hz to 16 kHz, up to +/- 20 mV/m
uses 3 m long monopole antenna

Optical photodiode (OPD) measures:

four FOV light levels 100 Hz to 50 kHz, saturates above 98 %ile lightning
near-IR filter (777.5 nm) sensitive to 80% of all lightning
VIS filter (300-700 nm) sensitive to 92% of all lightning
provides localization of lightning to one of twelve regions (overlap of FOVs)
can see lightning within about 400 km horizontal distance
designed to work day and night
one narrowband filter allows current moment measurement and TLE identification



Firefly summary

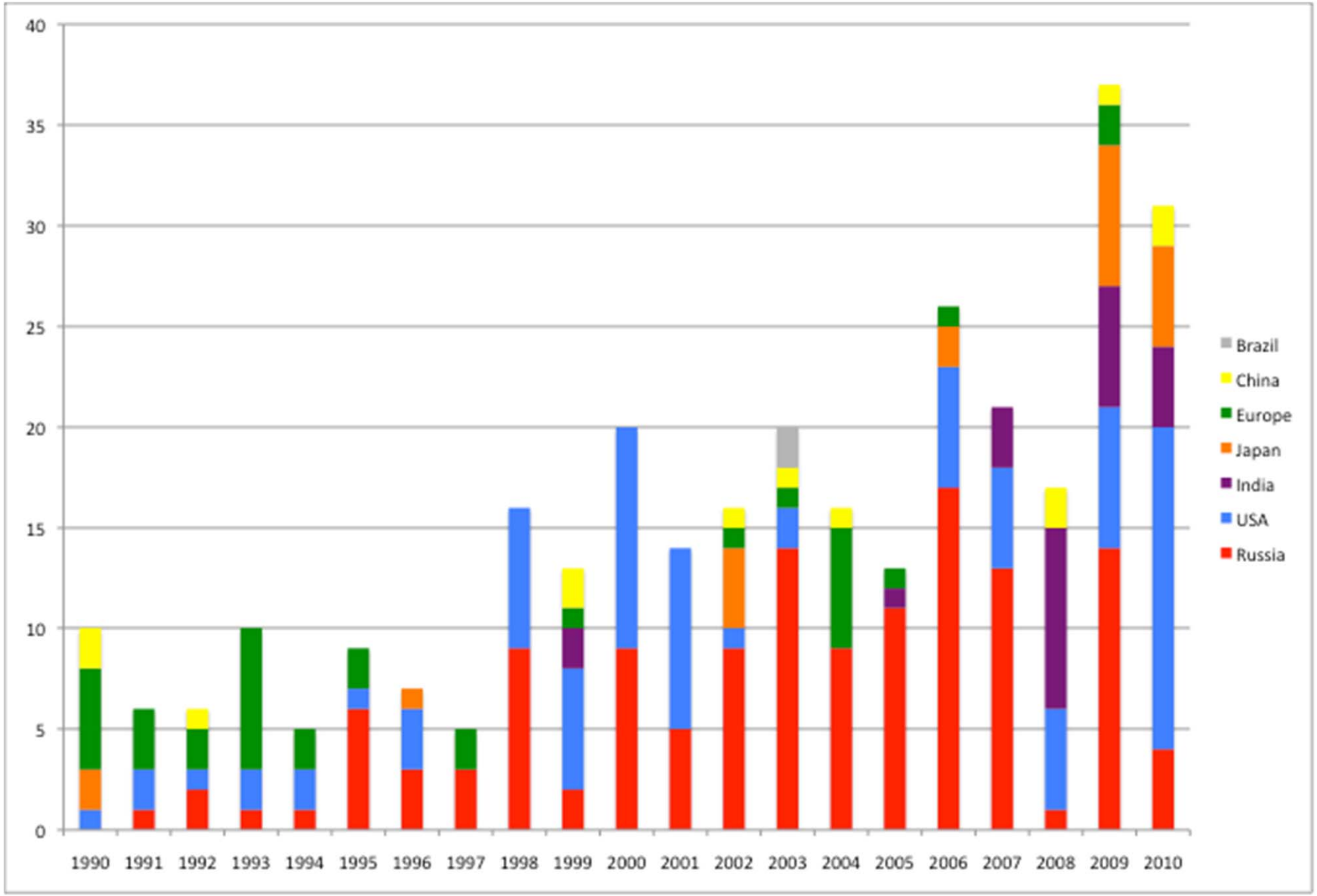
Parameter	Value	Notes
ACS	gravity gradient stabilized plus air core torque coils: nadir pointing within 15 degrees	GGB 3m 40 g tip mass
Comm	TX: 400.15-401 MHz space research band RX: 450 MHz federal user band	2W transmit power AstroDev Colony 2 radio
Power	>= 3W orbit avg	experiment + GPS uses 2W transmitter uses 6W during contacts
Mass	4.0 kg	
Size	3U (10x10x34 cm)	
GPS	SSTL SGR-05U receiver	Civ L1 Patch antenna
Flight Computer	MSP430 F2618	Pumpkin FMB
EPS	Clyde Space 3U	2 daughter battery boards
orbit	500 km circ x 45 deg (TBD)	launch 2012 (OUTSat backup) (TBD)
ground station	Wallops UHF radar	18.3 m dish
Data rate	38.4 kbps downlink	15 Mbits per day (173 bps orbit-averaged)

CSA Engineering
A Moog Company

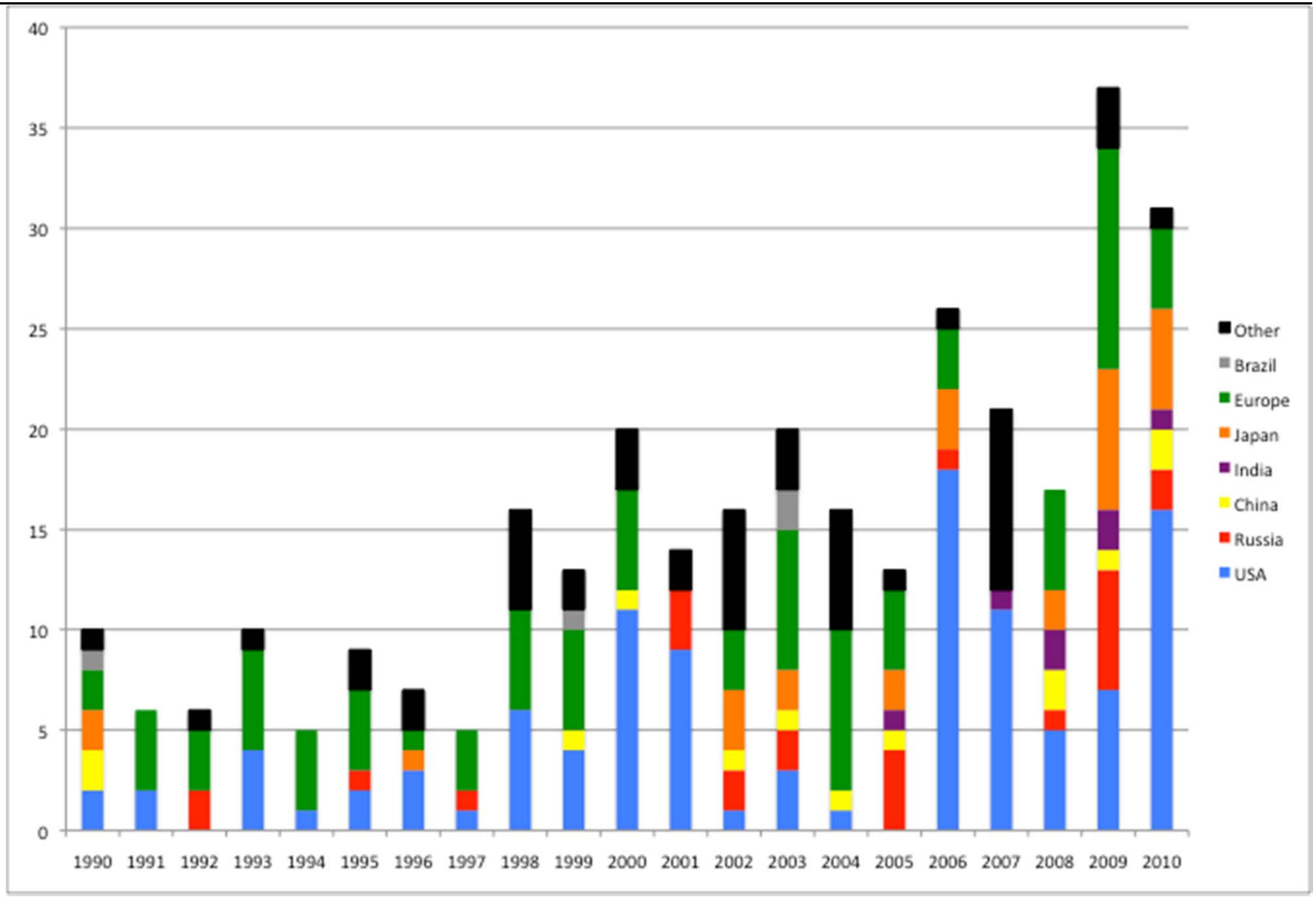
Outline

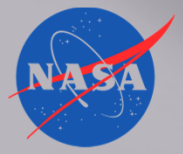
- Small Payload Rideshare and Multi-Payload Adapters
- ESPA: EELV Secondary Payload Adapter
  - Development
  - Flight Heritage
- ESPA Grande
- Small Launch ESPA
- CubeSats on ESPA
- Summary

Rideshare Providers



Rideshare Customers





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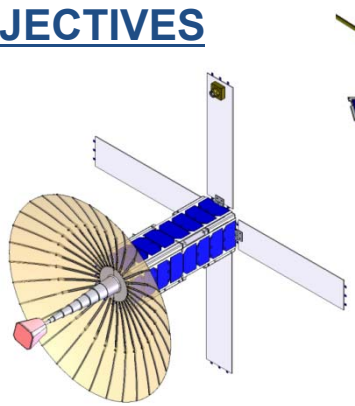
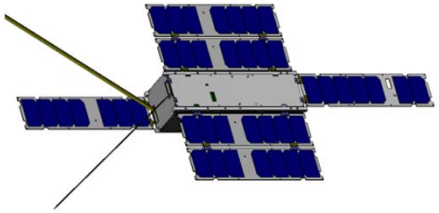
PANEL 2.14
ACCESS TO SPACE AND EMERGING MISSION CAPABILITIES

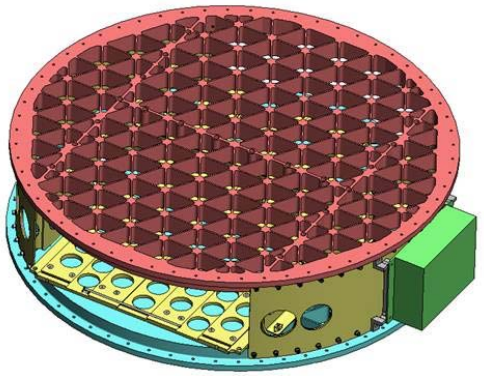
CubeSat Program

PROGRAM OBJECTIVES

- **Addresses multiple R&D priorities:**
  - **Outreach:**
    - Supports University Outreach
  - **Workforce Development:**
    - Service Academy Outreach
  - **Technology Maturation:**
    - Accelerate fielding of new technologies
    - Reduce tech insertion risk for NRO programs
    - Reduce Cost; Improve Manufacturability

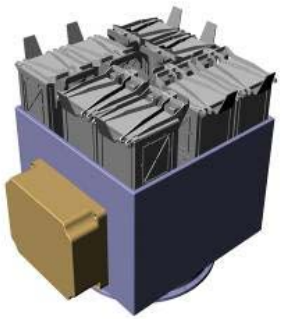




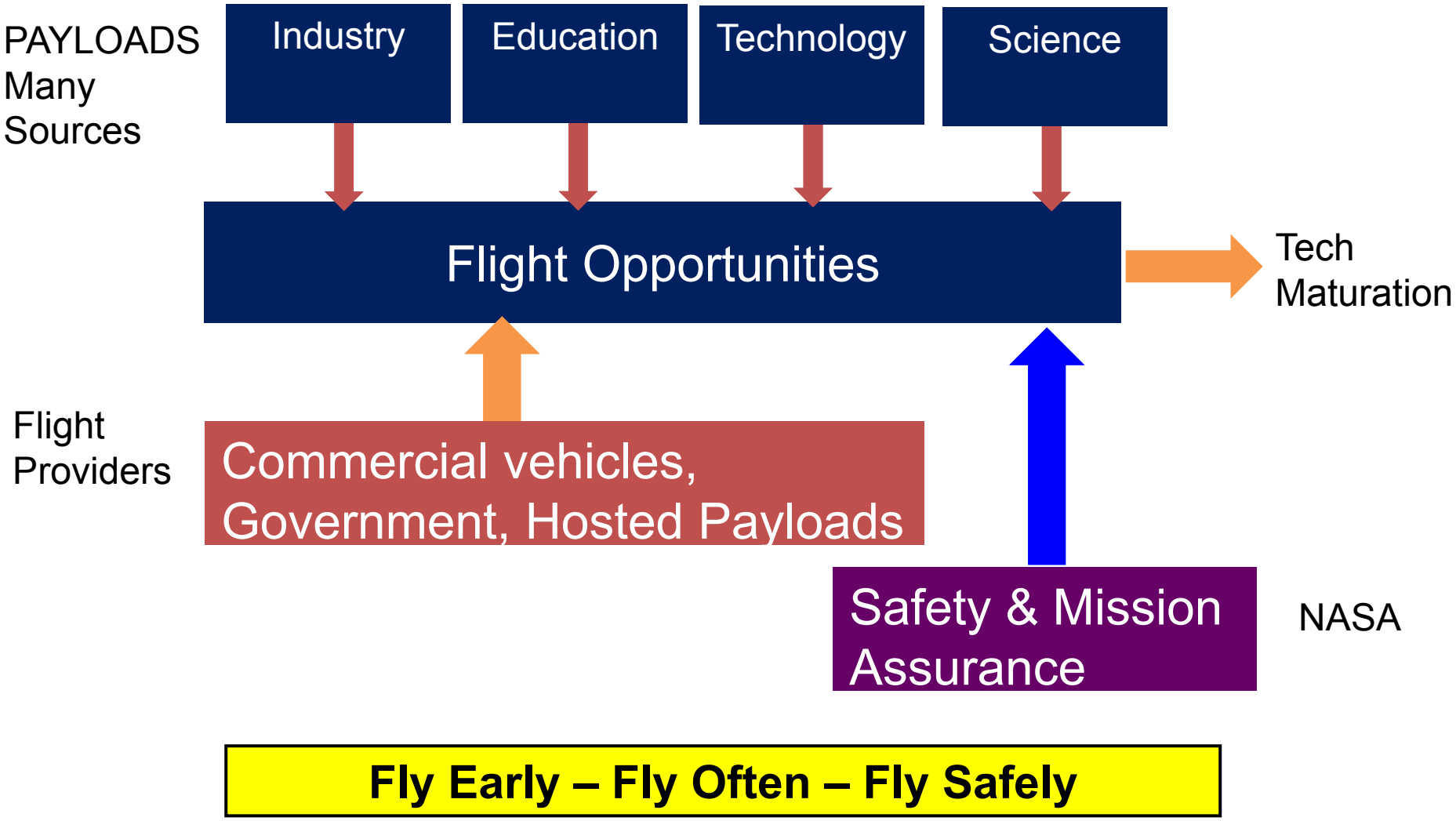


KEY THRUSTS

- **Colony Bus:**
  - Provide template for customers with a payload or demonstration need
- **Space Experiments:**
  - Enable on-orbit demonstration capability through launch outreach
    - Accelerate new “Sources and Methods”; Demonstrate new foundational technologies
  - Provide end-to-end systems operations outreach
    - Common (distributed) Ground Architecture



Flight Opportunities Program



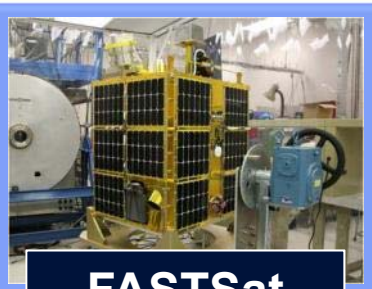
Fly Early – Fly Often – Fly Safely

Dr. Laguduva "LK" Kubendran
Program Executive, Flight Opportunities

STP Areas of Expertise: Access To Multiple Space Vehicles

Small Satellites

SIV



FASTSat

Academy/ University

CubeSats

Medium to Large SC

Custom Spacecraft

Access To Multiple Contract Vehicles

STP has experience with all sizes and complexity of space missions

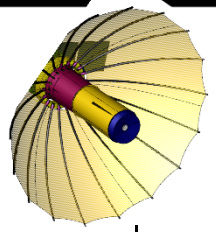
ORS Tier 2 Bus and Payload Families

Assured Space Power Focused on Timely Satisfaction of Joint Force Commanders' Needs

RF Electronics

Processing Electronics

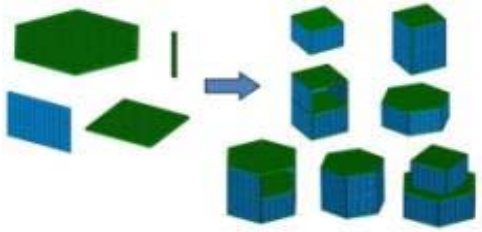
RF Feeds



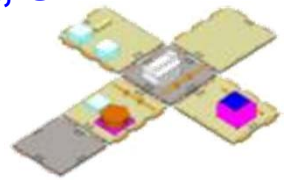
Multi-Band Reflector

Bus - PL Interface Standard

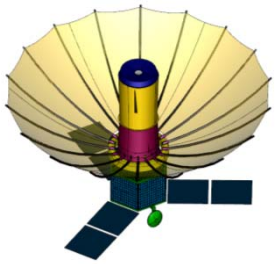
RF : Communications, Tactical Electronic Support, SAR



Reconfigurable Bus Structure



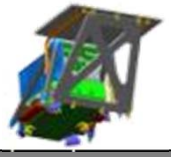
Pre-Fabricated Bus Structure/SPA Backplane



Modular Propulsion

EO/ IR : Imaging, Spectral Sensing

Modular Electronics



Modular Filter Assembly

Modular Focal Plane Assembly

Multi-Function Telescope

Modular bus and payload subsystems enable a reconfigurable architecture

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Please consider joining us next year.

Abstracts due
July 1, 2011

Paper due for review
Nov 3, 2011

Final paper due
Jan 4, 2011