The SBIR Commercialization Challenge

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Aurora Flight Sciences Overview

RESEARCH & DEVELOPMENT

Develop, integrate, and fly payloads for atmospheric and space missions

ADVANCED CONCEPTS

Studies & analysis, applied research, prototype development, and technology demonstrators

TACTICAL PRODUCTS

Develop and deploy products for small teams that increase situational awareness and mission effectiveness

AEROSTRUCTURES

Provide design-build and build-to-print services to prime contractors

Recent NASA SBIRS (selected)

- Thermally Stable Catalytic Combustors for Very High Altitude Airbreathing Propulsion
- SPHERES/Universal ISS Battery Charging Station
- Mars Orbiting Sample Return External Orbiting Capture
- Small Probes for Orbital Return of Experiments
- Aspirated Compressors for High Altitude Engines
- Titan Montgolfiere Buoyancy Modulation System
- Suit Simulator (S3) for Partial Gravity EVA Experimentation and Training
- Analysis and Development of UAV Operations in the NAS

Commercialization Options

- Develop a product or service that can be sold commercially or to other government agencies
- Craft a comprehensive program from a series of SBIRs that can be used to leverage additional non-SBIR resources
- Use the SBIRs to develop skills, expertise, and other allow you to be a credible bidder for other non-SBIR programs

- Discuss each of these individually

Product or Service

- Hardest to achieve
  - NASA topics often have limited commercial applications
  - NASA topics often ask for comprehensive programs, not specific technologies
- Even when Phase II completed successfully, you still have the Valley of Death
  - SBIR resources not enough to get to commercial product
  - Firms that are good at SBIRs are often not good at raising capital
- SBIR time frame often too slow for fast paced technologies

Examples

- General Aviation Black Box
  - Designed to be a stand alone data and voice recorder. Inexpensive, survivable.
  - Presented to NTSB, conferences
  - Technology moved too fast
- Swelling Hemostat (US Army)
  - Internal tourniquet for trauma care
  - Licensed to start-up
- Smart Container
  - Keeps track of contents automatically with RFID and reports via wifi
  - Follow-on work as a technology to assist aging population

Crafting a Comprehensive Program: SPHERES

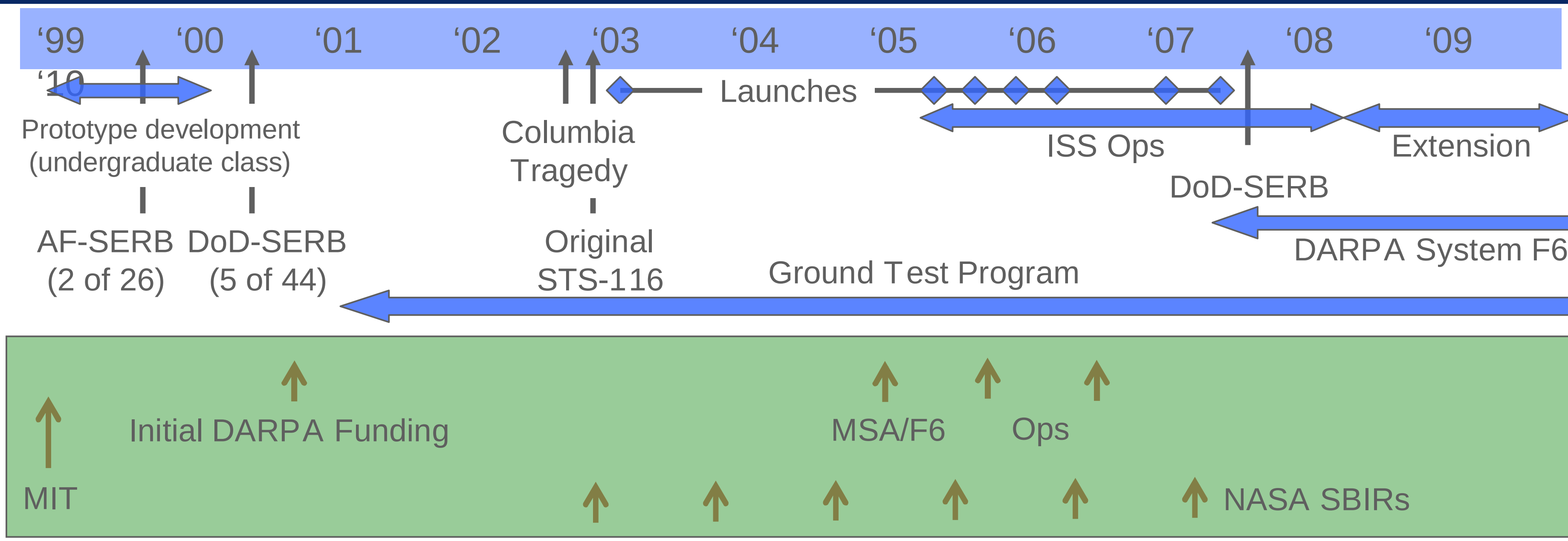
Objective: to develop a reconfigurable and risk-tolerant laboratory for maturing close-proximity satellite GN&C algorithms under micro-gravity conditions

- Long duration μ-g is essential
  - Full 6-DOF motion (incl. quaternion slews, tumbling, nutation)
  - Proper contact dynamics
  - Key element of space environment needed for reaching higher TRL's
- Reconfigurable
  - Permit spiral development through reconfigurable software
  - Enable mission specialization through mounted payloads
- Risk-tolerant
  - Push technology under both nominal and off-nominal conditions

- Three nano-satellites inside US Laboratory on ISS
  - Cold-gas propulsion, inertial and ISS-relative sensing, expansion port, RF-communication

ISS016E014220

Programmatic History



Funding Agencies:

- DARPA
  - Baseline- Hardware fabrication and flight operations
  - MSA/F6 - SPHERES hardware used to develop µEMFF
- NASA
  - 6 SBIR awards for ground testing and flight support
  - MARS program development of sample return capture mechanism
  - Other NASA - JPL TPF, GSFC SIFFT

Operations Team:

- Aurora Flight Sciences / Payload Systems
  - Hardware fabrication, integration, crew training, and operations
- MIT
  - Ground and space testing
  - Guest Investigator Program
- Space Test Program
  - integration and mission ops support

Develop Skills and Capabilities

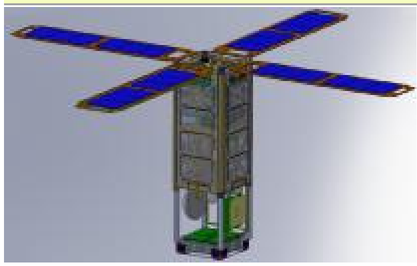
- Spaceflight has large barriers to entry, which reduces the number of credible participants
- SBIR Phase II’s not usually enough to get flight hardware, unless limited in scope
- But, parabolic flight, suborbital, and cubesat opportunities get you part of the way.

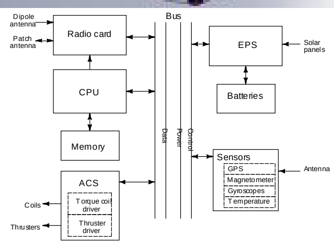
Mothercube for Cubesat-based Synthetic Aperture Radio Telescope

Expanding Cubesat capabilities through fractionation

Michael Price and Javier de Luis, Aurora Flight Sciences

The Mothercube satellite

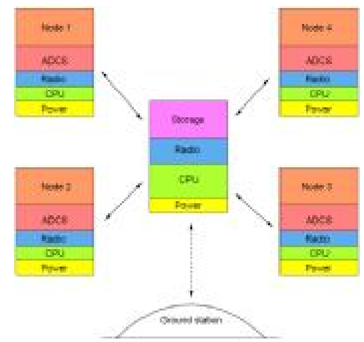




- Functions as the hub of a Cubesat cluster
- Combined attitude control and propulsion system
  - Electrospray thrusters
  - Torque coils
  - Allows formation flying with no moving parts
- Multi-level avionics architecture supporting FPGA and DSP
- Differential GPS positioning
- Redundant radio and antenna support

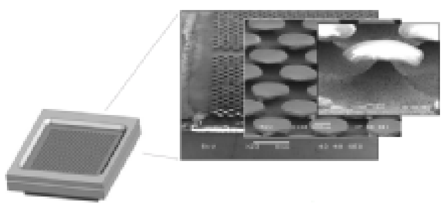
Fractionated architectures

→ Distributed sensing
Risk reduction / responsiveness
Capability split

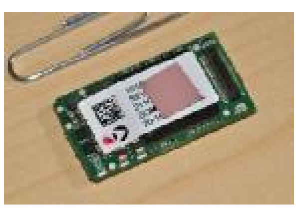


- This type of mission is impossible to accomplish with monolithic satellites
- Other supported architectures allow reduced requirements for payload cubes:
  - Ø Data storage
  - Ø Radio range
  - Ø Power consumption

Enabling technologies



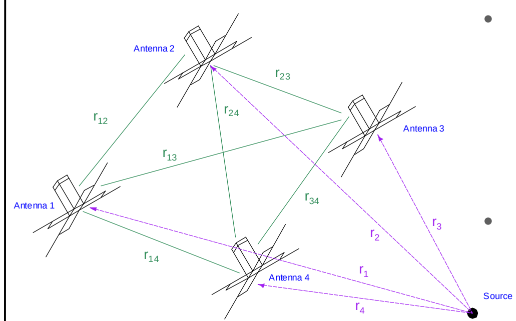
Arrayed electrospray thrusters
MIT Space Propulsion Laboratory
300 μm separation; 0.1 μN thrust per emitter at 1900 V, 1 μA; MEMS fabrication process
Precise attitude control, formation flying



DM3730 system-on-chip module
Texas Instruments, LogicPD
1 GHz CPU, 800 MHz DSP and many peripherals with power consumption near 1 W
Secondary avionics: tranjectory planning, payload data processing

Planned flight demonstration

RFSAS – Radio-frequency Sparse Array System



- Long-baseline radio interferometry
  - Ø Timing and positioning recovered from GPS
  - Ø Baseline correlation performed on FPGA on Mothercube
- Applications
  - Ø Space weather monitoring, including solar CME imaging
  - Ø Surveillance of ground-based radio sources

Goal: design and build first Mothercube in Phase II SBIR

Summary and Recommendations

- Allow contact with COTRs prior to proposal announcement period
  - Helps in determining what NASA wants – less wasted time
  - Allows crafting on comprehensive program
- Focus individual awards on specific technologies with spin out potential
- Include when possible operational testing (suborbital, parabolic, etc.) with the goal of providing experience to new players
- Not all topics can do all these things. A good mix is desirable.