



NASA Space Technology Mission Directorate
Small Spacecraft Technology

John Allmen
Program Manager – NASA Ames Research Center

Andrew Petro
Program Executive – NASA Headquarters

Cubesat Workshop – Logan, UT
August 3, 2014

Small Spacecraft Technology Program



Program Executive: Andrew Petro (HQ)

Level 2 Program Office at Ames Research Center

Program Manager: John Allmen

Objectives:

- Identify and develop new subsystem technologies to enhance or expand the capabilities of small spacecraft.

TRL 3 to 5

- Demonstrate new technologies, capabilities, and applications for small spacecraft.

TRL 5 to 7

- Use small spacecraft as low-cost platforms for testing technologies and capabilities with applications for spacecraft and systems of any size.

- Promote the small spacecraft approach as a paradigm shift for NASA and the larger space community.



Small Spacecraft Technology Program



Small, Affordable, Rapid, & Transformative

Focused Technology Development Projects in:

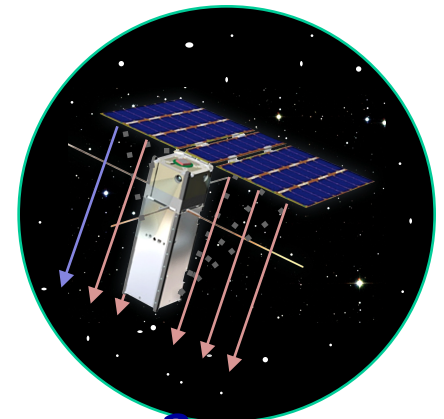
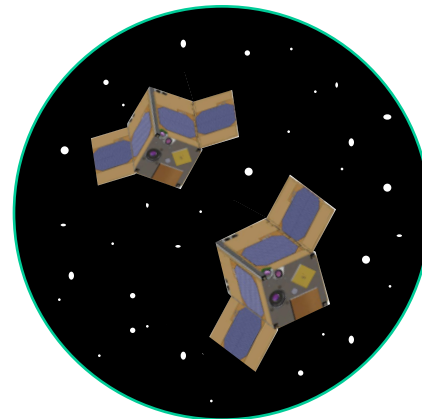
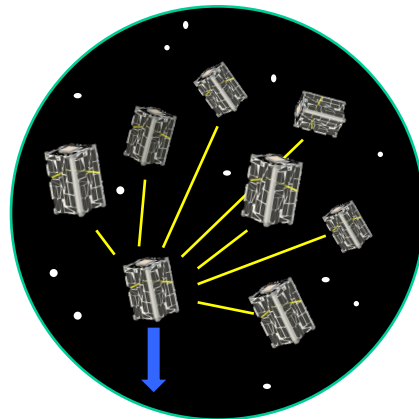
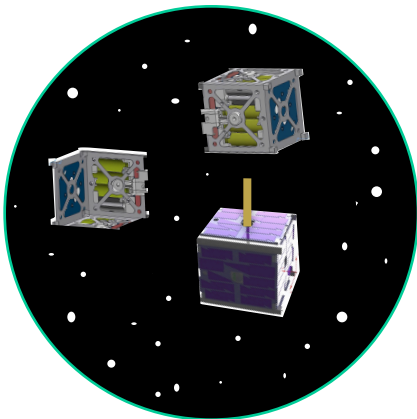
- Communications
- Avionics
- Propulsion
- Power
- Instruments
- Manufacturing
- Small Earth Return Vehicle

Flight Demonstration Projects in:

- Radio and Laser Communications
- Formation Flight and Docking
- Low cost satellite buses
- Smallsat swarms for space science missions

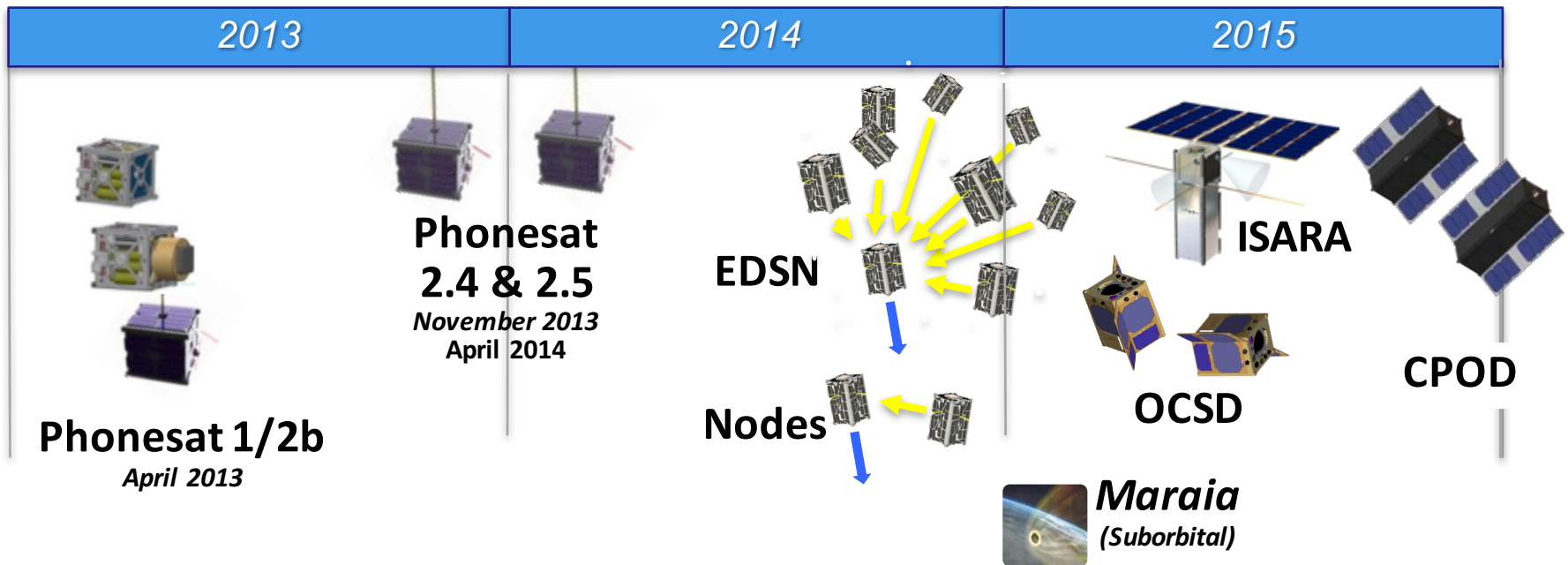
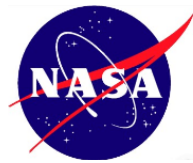
Implemented through:

- Directed NASA projects
- Contracts with private industry
- University-NASA partnerships
- Collaboration with SBIR and other programs



Small Spacecraft Technology Program

Projects: 2013-2015



Smallsat Technology Partnerships
13 projects with NASA-University collaboration

5 Propulsion Technology Projects

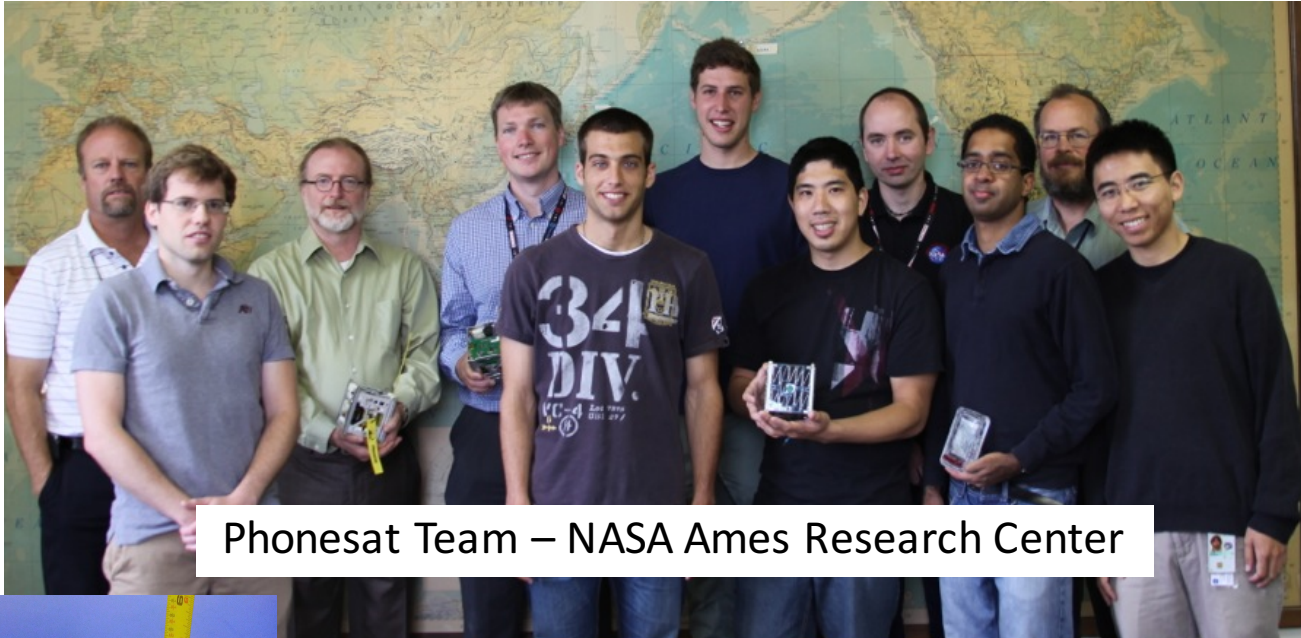
SBIR - Deep Space Cubesats

EDSN: Edison Demonstration of Smallsat Networks
ISARA: Integrated Solar Array and Reflectarray Antenna
OCSD: Optical Communications and Sensor Demonstration
CPOD: Cubesat Proximity Operations Demonstration

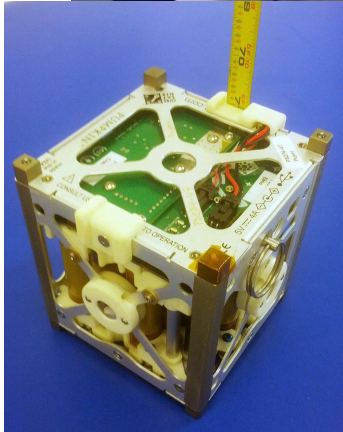
Phonesat



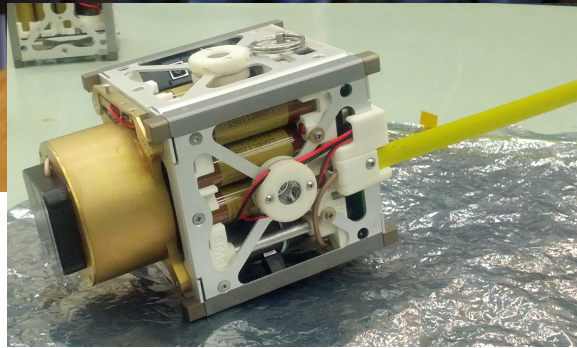
Five satellites
flown in one year



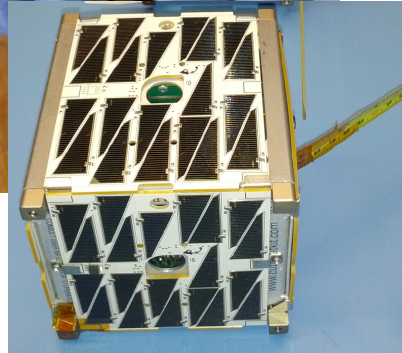
Phonesat Team – NASA Ames Research Center



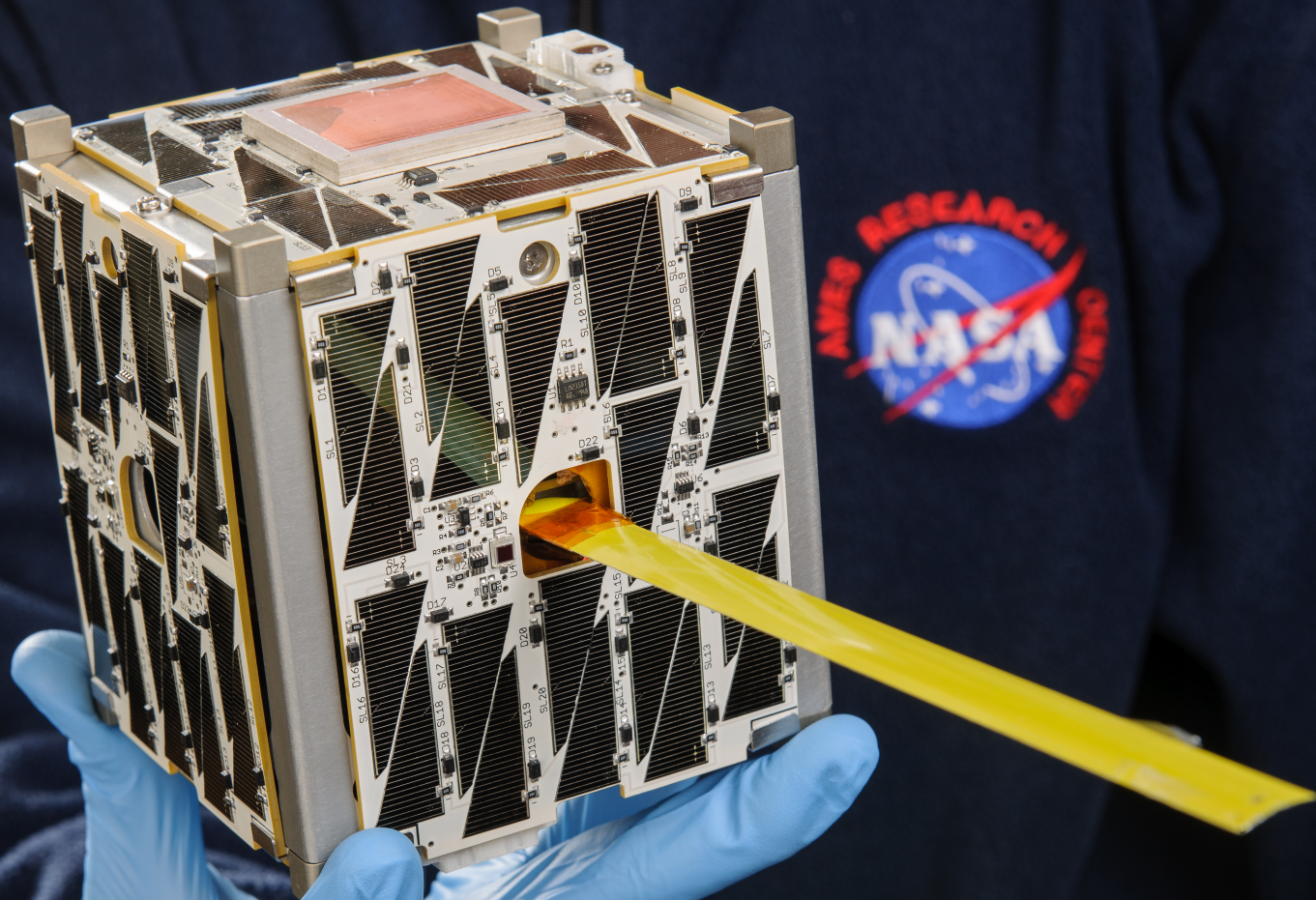
"Graham"
Phonesat 1.0



"Bell"
Phonesat 1.0
with Iridium experiment



"Alexander"
Phonesat 2.0b



Phonesat 2.5

Launched April 18, 2014

EDSN

Edison Demonstration of Smallsat Networks

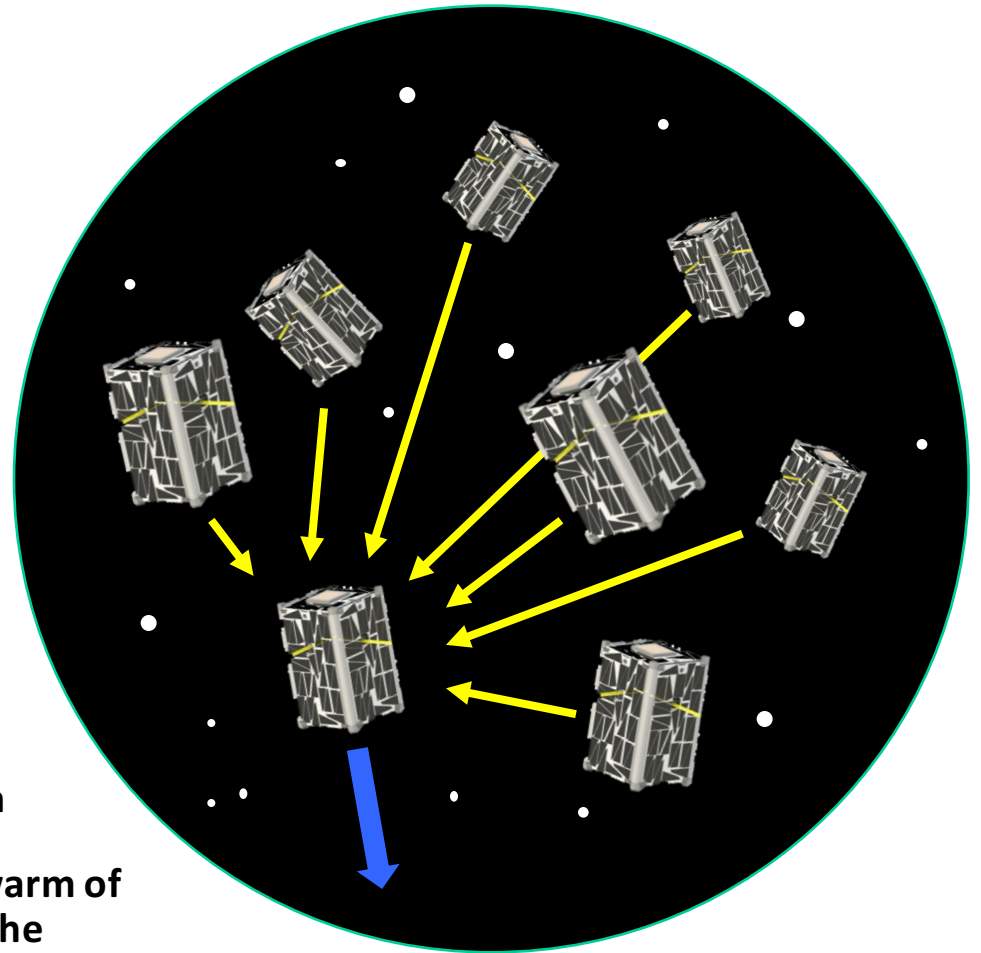
Ames Engineering Directorate,
with support from MSFC

Partners:

Montana State University – Payload
Santa Clara University – Ground Station

Objective: The EDSN Mission will launch a swarm of 8 low-cost small satellites and demonstrate the operation of an intra-swarm communication link and multi-point sensing measurement.

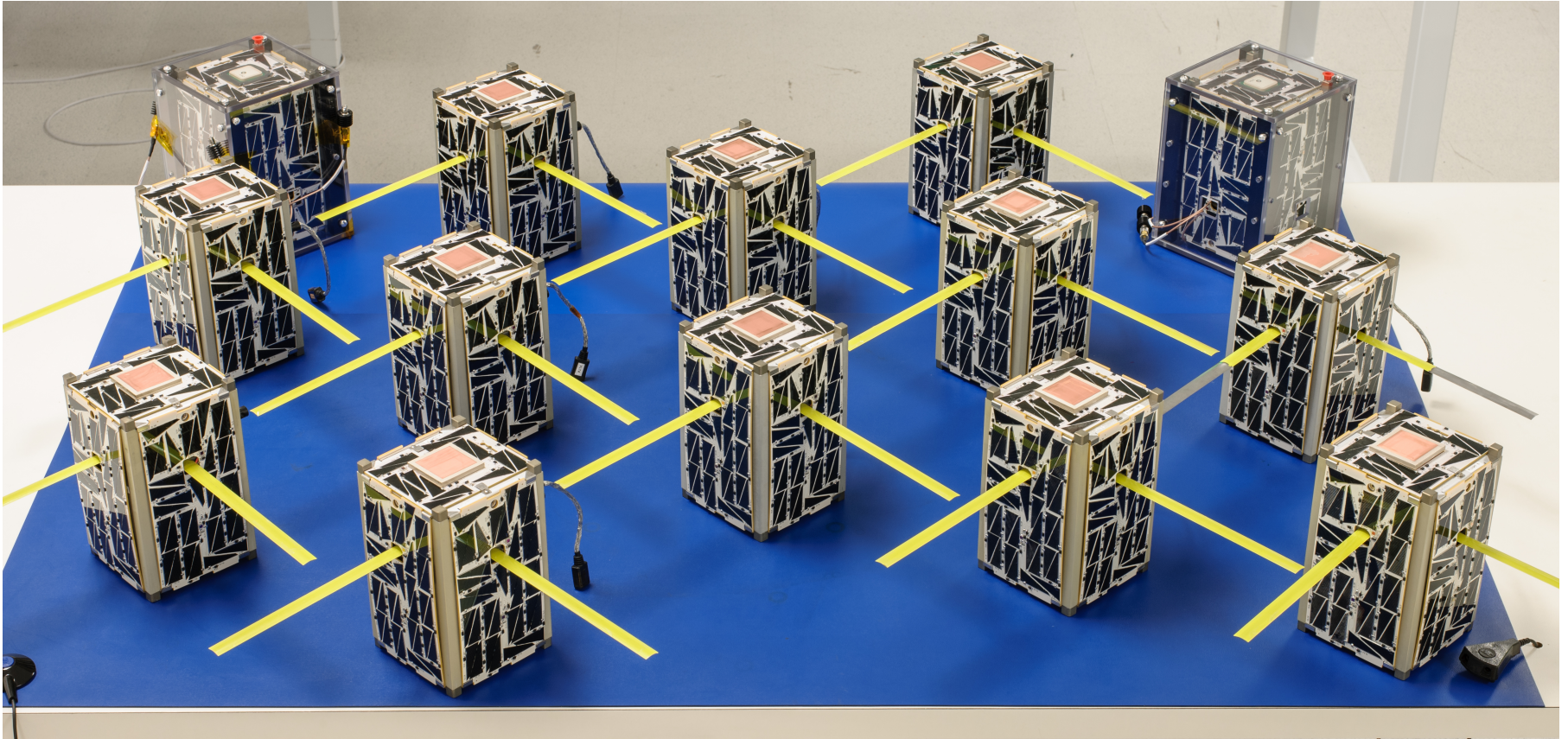
Satellite bus based on Phonesat heritage.





EDSN Spacecraft

8 Flight Units, 2 Spares, 4 Engineering Development Units



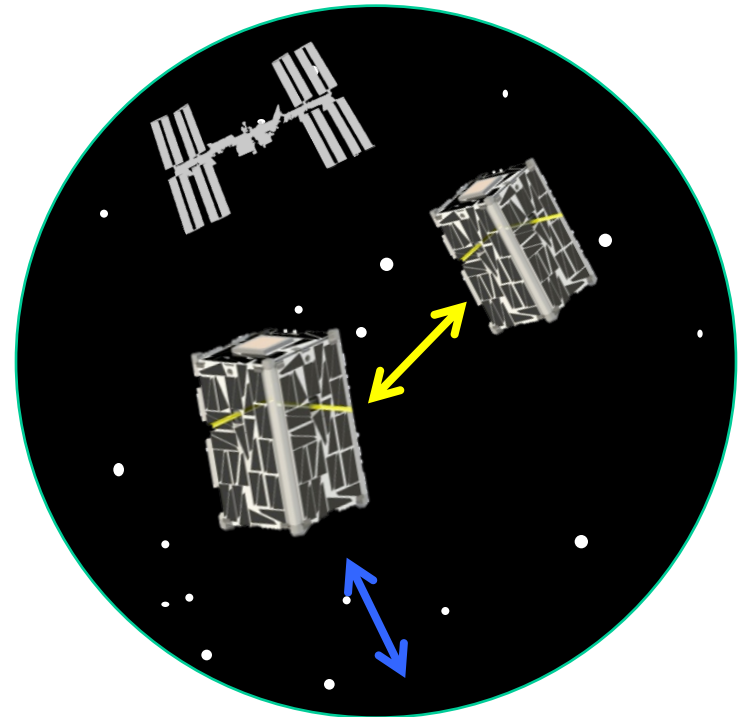
Nodes

Companion mission to EDSN, using the same satellite design with additional new software capabilities

Led by: NASA Ames Research Center
Partners: Montana State University
Santa Clara University

Objective:

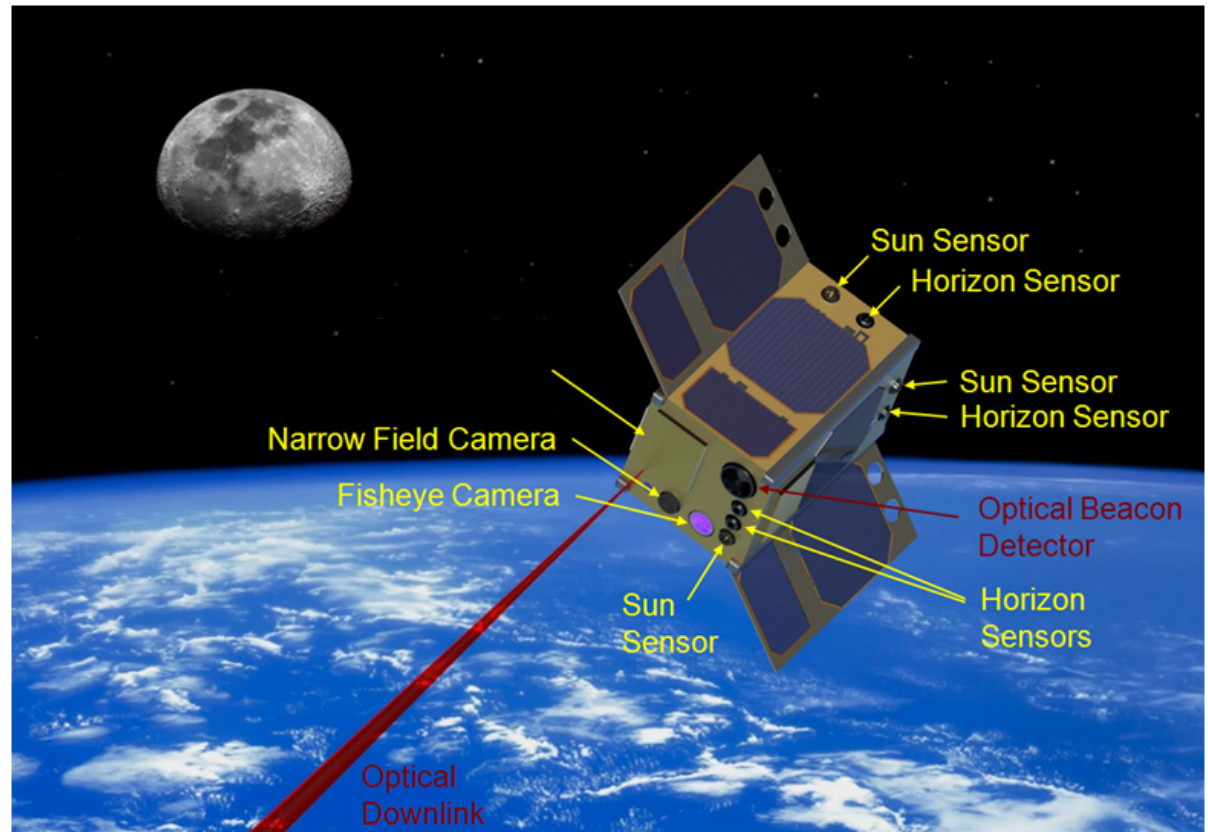
- Each 1.5U cubesat can collect and relay data to the other
- Downlink role is negotiated between the satellites
- Two-way communication for commands and updates from the ground
- Deployed into orbit from ISS



OCSD Optical Communication and Sensor Demonstration

The Aerospace Corporation

Objective: Demonstrate ranging, optical downlink, cold gas propulsion, and cross-track motion sensing technologies on a cubesat proximity operations mission with two 1.5 U cubesats.



ISARA

Integrated Solar Array and Reflectarray Antenna

Jet Propulsion Laboratory

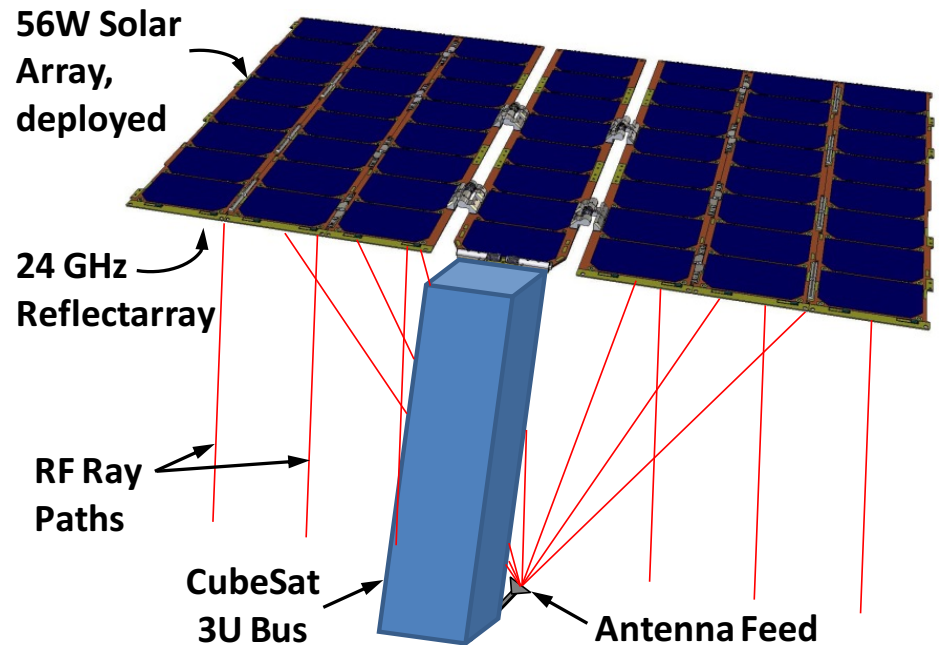
Partners:

Aerospace Corporation

- Cubesat bus and operations

Pumpkin, Inc. - Solar Panel

Objective: ISARA will demonstrate a high gain antenna (HGA) integrated into a commercially available solar array that enables 100 Mbps Ka-band cubesat communications capability at very low cost and minimal payload mass and volume impact.



CPOD

Cubesat Proximity Operations Demonstration

Tyvak Nano-Satellite Systems LLC

Partners:

406 Aerospace

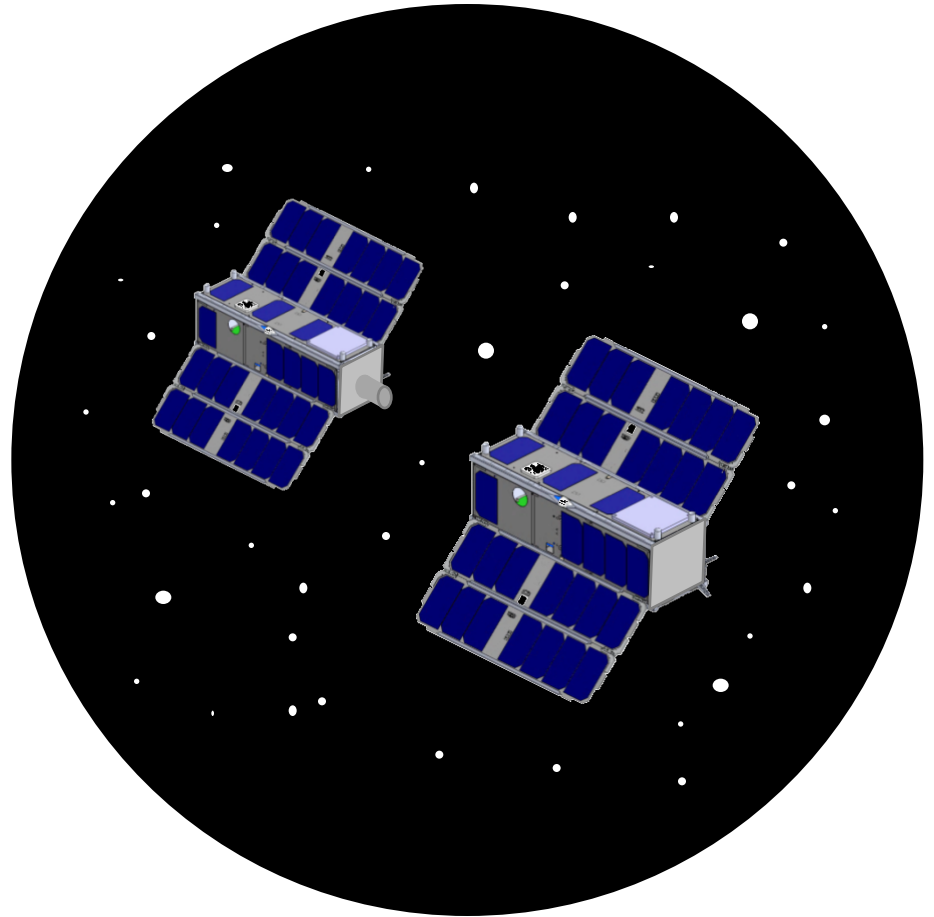
Applied Defense Solutions

Analytical Graphics Inc.

California Polytechnic State University

Government Partner: AFRL

Objective: Demonstrate close proximity operations and docking of two 3U cubesat spacecraft in LEO.





Smallsat Technology Partnerships

Cooperative agreements with US colleges and universities to develop and/or demonstrate new technologies and capabilities for small spacecraft in collaboration with NASA.

One to two year projects

Up to \$100,000 per year, per university (up to \$150,000 if more than one university)

Up to 1.0 FTE in NASA labor per year, per project

13 Projects selected on August 8, 2013

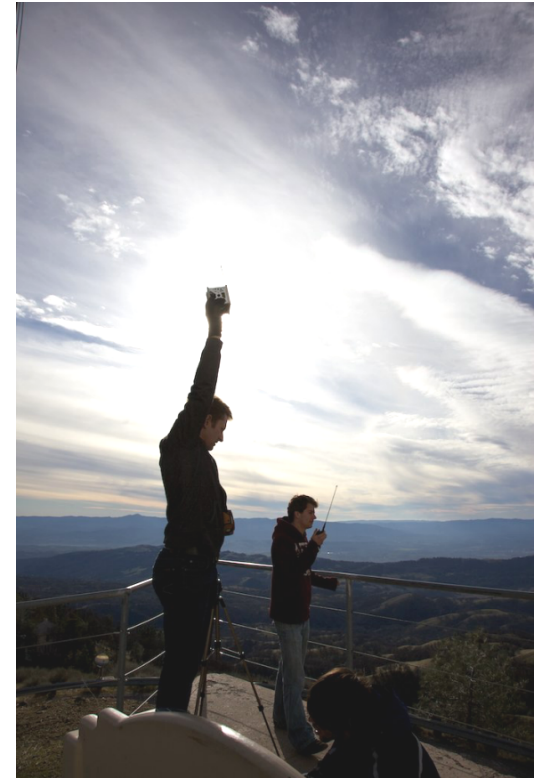
17 universities

7 NASA Center partners

Plan solicitations in two-year cycles

Next solicitation expected in early 2015

for 2016-17 projects



Smallsat Technology Partnerships

2013 Awards



COMMUNICATIONS

High Rate Cubesat X-band/S-band Communication System

University Of Colorado - Goddard Space Flight Center, Marshall Space Flight Center

Space Optical Communications Using Laser Beam Amplification

University Of Rochester - Ames Research Center

Development of Novel Integrated Antennas for Cubesats

University Of Houston - Johnson Space Center

GUIDANCE, NAVIGATION & CONTROL

Smallsat Precision Navigation With Low-Cost MEMS IMU Swarms

West Virginia University & Marquette University - Johnson Space Center

Cubesat Autonomous Rendezvous & Docking Software

University Of Texas - Johnson Space Center

Radiation Tolerant, FPGA-based Smallsat Computer System

Montana State University - Goddard Space Flight Center, Marshall Space Flight Center

An Integrated Precision Attitude Determination and Control System

University Of Florida - Langley Research Center

PROPULSION

Propulsion System and Orbit Maneuver Integration in Cubesats

Western Michigan University - Jet Propulsion Lab

Film-Evaporation MEMS Tunable Array for Picosat Propulsion and Thermal Control

Purdue University - Goddard Space Flight Center

POWER

Smallsat Low Mass, Extreme Low Temperature Energy Storage

California State University - Northridge - Jet Propulsion Lab

SCIENCE INSTRUMENT CAPABILITIES

Compressive Sensing for Advanced Imaging and Navigation

Texas A&M University - Langley Research Center

Mini Fourier-Transform Spectrometer for Cubesat-Based Remote Sensing

Appalachian State University & University of Maryland - Baltimore County - Goddard Space Flight Center

ADVANCED MANUFACTURING

Printing the Complete Cubesat

University Of New Mexico, University of Texas - El Paso, & Drake State Technical College - Glenn Research Center

Technology Development Projects

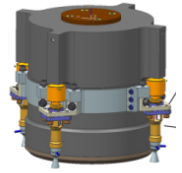
2013 NRA Awards



SMALL SPACECRAFT PROPULSION

MPS-120 Cubesat High-impulse Adaptable Modular Propulsion System

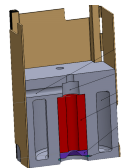
PI: Christian Carpenter, Aerojet General Corporation, Redmond, WA



Advanced Hybrid Rocket Motor for Cubesats

PI: John DeSain, The Aerospace Corporation, El Segundo, CA

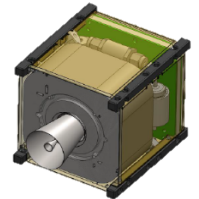
Partner: Pennsylvania State University, University Park, PA



1U Cubesat Green Propulsion System with Post-Launch Pressurization

PI: Michael Tsay, Busek Company. Inc., Natick, MA

Partner: NASA Goddard Space Flight Center



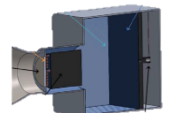
Iodine RF Ion Thruster Development

PI: Kurt Hohman, Busek Company. Inc., Natick, MA



Inductively Coupled Electromagnetic Thruster System Development for Small Spacecraft Propulsion

PI: John Slough, MSNW LLC, Redmond, WA



Technology Development Projects

2013 NRA Awards

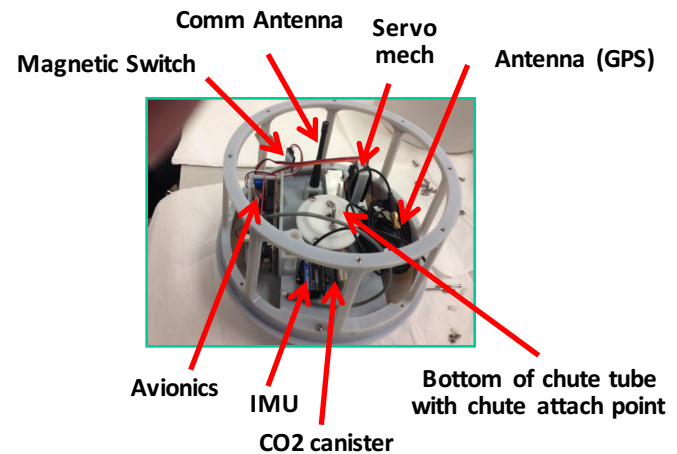
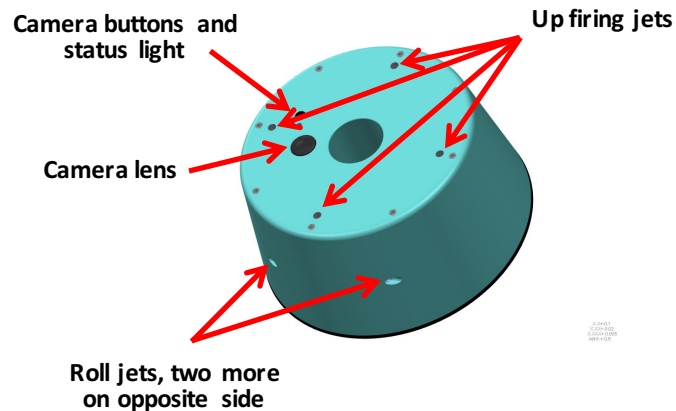


SMALL EARTH RETURN VEHICLES

Technology Development for the Maraia Earth Return Capsule

PI: Alan Strahan, NASA Johnson Space Center

Partners: NASA KSC, Up Aerospace



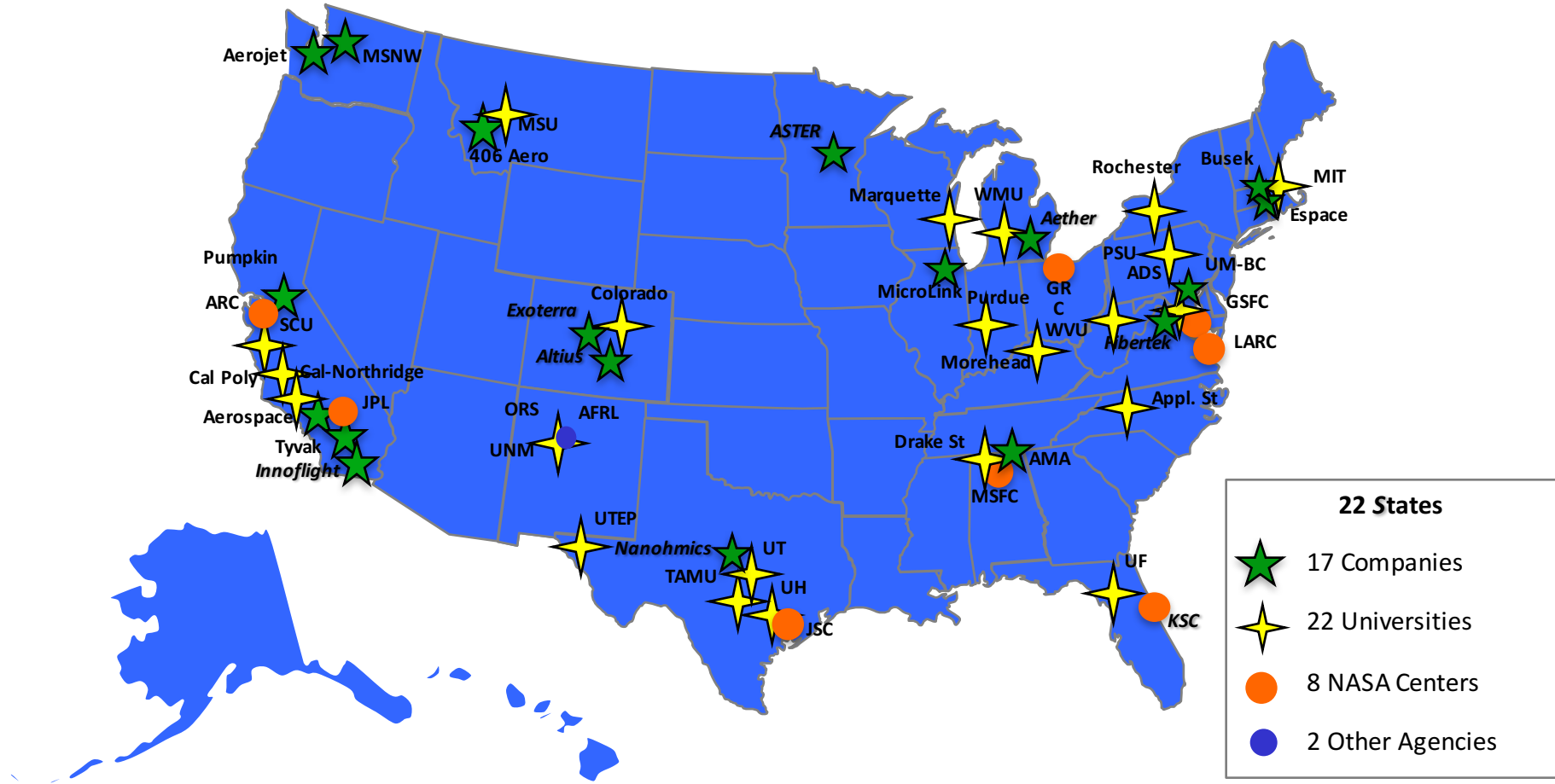
Up Aerospace Launch Facility at Spaceport America, New Mexico



Small Spacecraft Technology Program



Nationwide Participants and Partners



www.nasa.gov/smallsats

Small Spacecraft Technology



Small Spacecraft Technology - State of the Art Report

- Compiled for the SST Program by Ames Engineering with inputs from the larger community
- Completed in October 2013
- Annual update intended, broad participation desired
- Link to report on STMD/SSTP website:
www.nasa.gov/smallsats

SBIR Select Topic – Deep Space Cubesat Technology

- New topic in current solicitation
- Large Phase I proposal response from small businesses

Anticipate future SBIR topics related to Small Spacecraft

SBIR – Deep Space Cubesat Technology

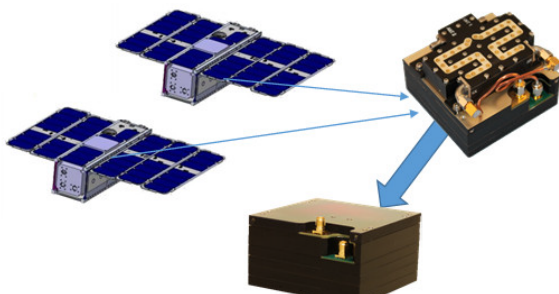
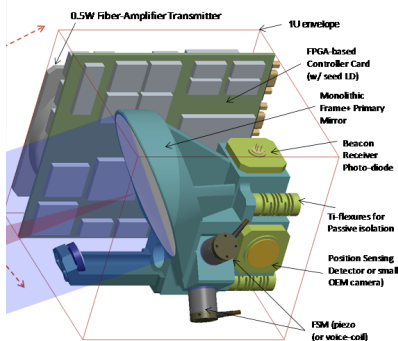
2014 Phase 1 Projects



COMMUNICATIONS AND NAVIGATION

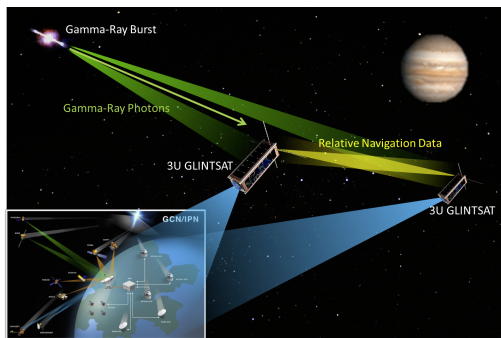
1U Cubesat Lasercom Terminal for Deep Space Communication

Fibertek, Inc. - Herndon, VA



Deep Space Cubesat Regenerative Ranging Transponder

Innoflight, Inc. - San Diego, CA



Deep Space Cubesat Gamma-ray Navigation Technology Demonstration

ASTER Labs, Inc. - Shoreview, MN

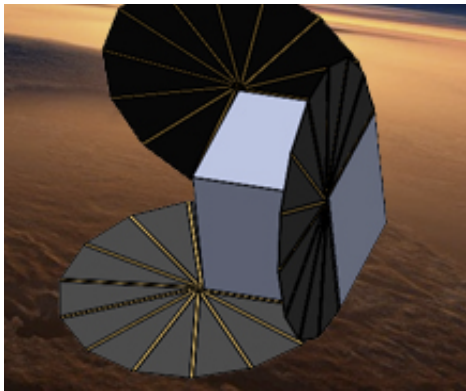
SBIR – Deep Space Cubesat Technology 2014 Phase 1 Projects



POWER GENERATION



High Power Betavoltaic Technology
MicroLink Devices, Inc. - Niles, IL



**Deployable Solar Energy Generators for Deep
Space Cubesats**
Nanohmics, Inc. - Austin, TX

SBIR – Deep Space Cubesat Technology 2014 Phase 1 Projects

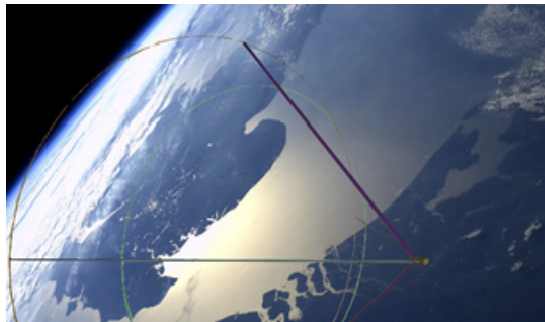


PROPULSION



Cubesat Ambipolar Thruster for LEO and Deep Space Missions

Aether Industries, LLC - Ann Arbor, MI



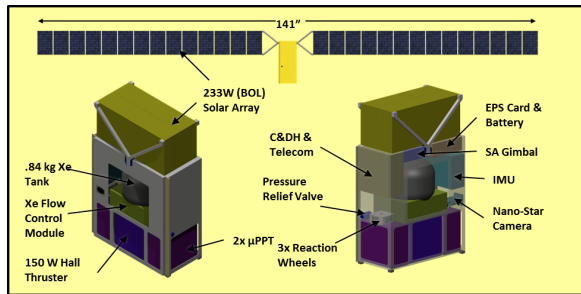
Multi-Purpose Interplanetary Deployable Aerocapture System

Altius Space Machines, Inc. - Louisville, CO

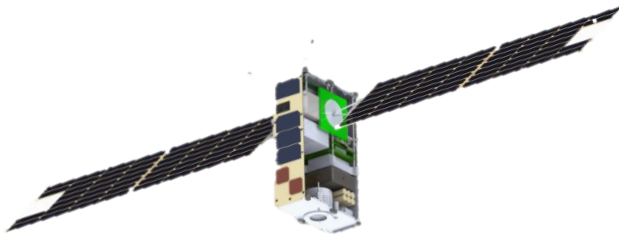
SBIR – Deep Space Cubesat Technology 2014 Phase 1 Projects



DEEP SPACE BUS



**Solar Electric Propulsion Cubesat Bus for
Deep Space Missions**
ExoTerra Resource LLC - Lone Tree, CO



LunarCube for Deep Space Missions
Busek Company Inc. - Natick, MA

Small Spacecraft Technology



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- Talk with SST Program Staff*
- Visit our website*

