



# Space Technology Mission Directorate

## NASA's Role in Small Spacecraft Technologies: Today and in the Future

Presented by:  
Jim Reuter

Deputy Associate Administrator  
for Programs

April 27, 2017

# Space Technology...

# ... an Investment for the Future



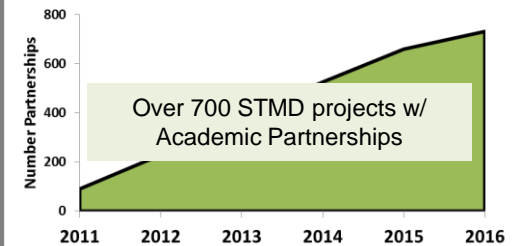
- Enables a **new class of NASA missions** beyond low Earth Orbit.
- **Delivers innovative solutions** that dramatically improve technological capabilities for NASA and the Nation.
- Develops technologies and capabilities that make NASA's missions **more affordable and more reliable**.
- Invests in the economy by **creating markets and spurring innovation** for traditional and emerging aerospace business.
- **Engages the brightest minds** from academia and small businesses in solving NASA's tough technological challenges.

## Addresses National Needs

A generation of studies and reports (40+ since 1980) document the need for regular investment in new, transformative space technologies.

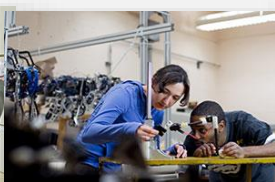
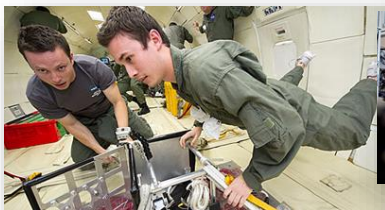


Cumulative University Partnerships in Early Stage



## Value to NASA

## Value to the Nation



## Benefits from STMD:

The NASA Workforce  
Academia  
Small Businesses  
The Broader Aerospace  
Enterprise



# Space Technology Pipeline



## Early Stage

- NASA Innovative Advanced Concepts
- Space Tech Research Grants
- Center Innovation Fund

## Commercial Partnerships

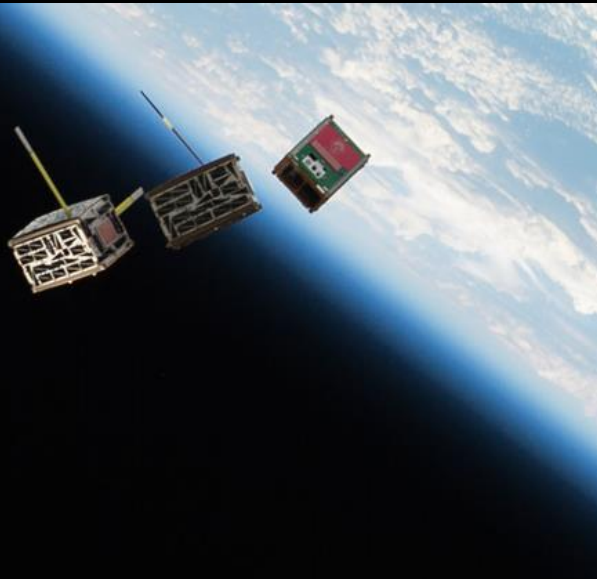
- SBIR/STTR
- Technology Transfer Program
- Flight Opportunities
- Centennial Challenges
- Regional Economic Development



TECHNOLOGY PIPELINE



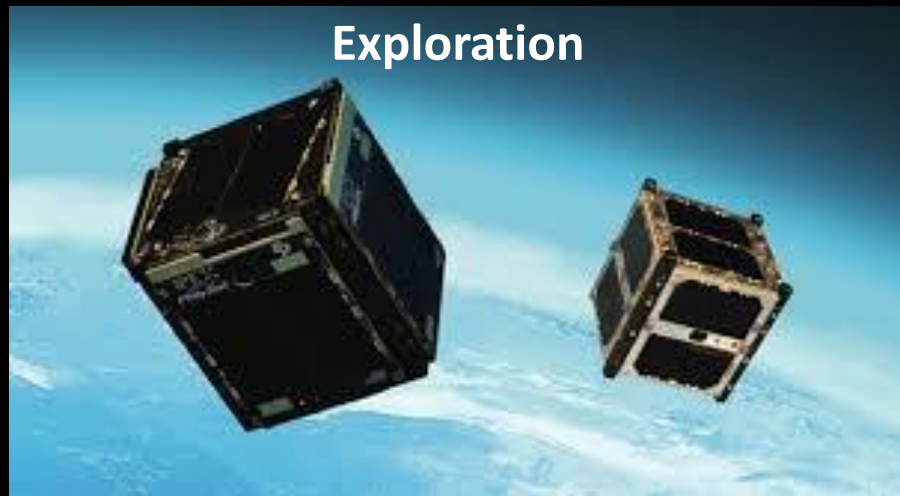
# NASA Small Spacecraft Activities



Space Technology

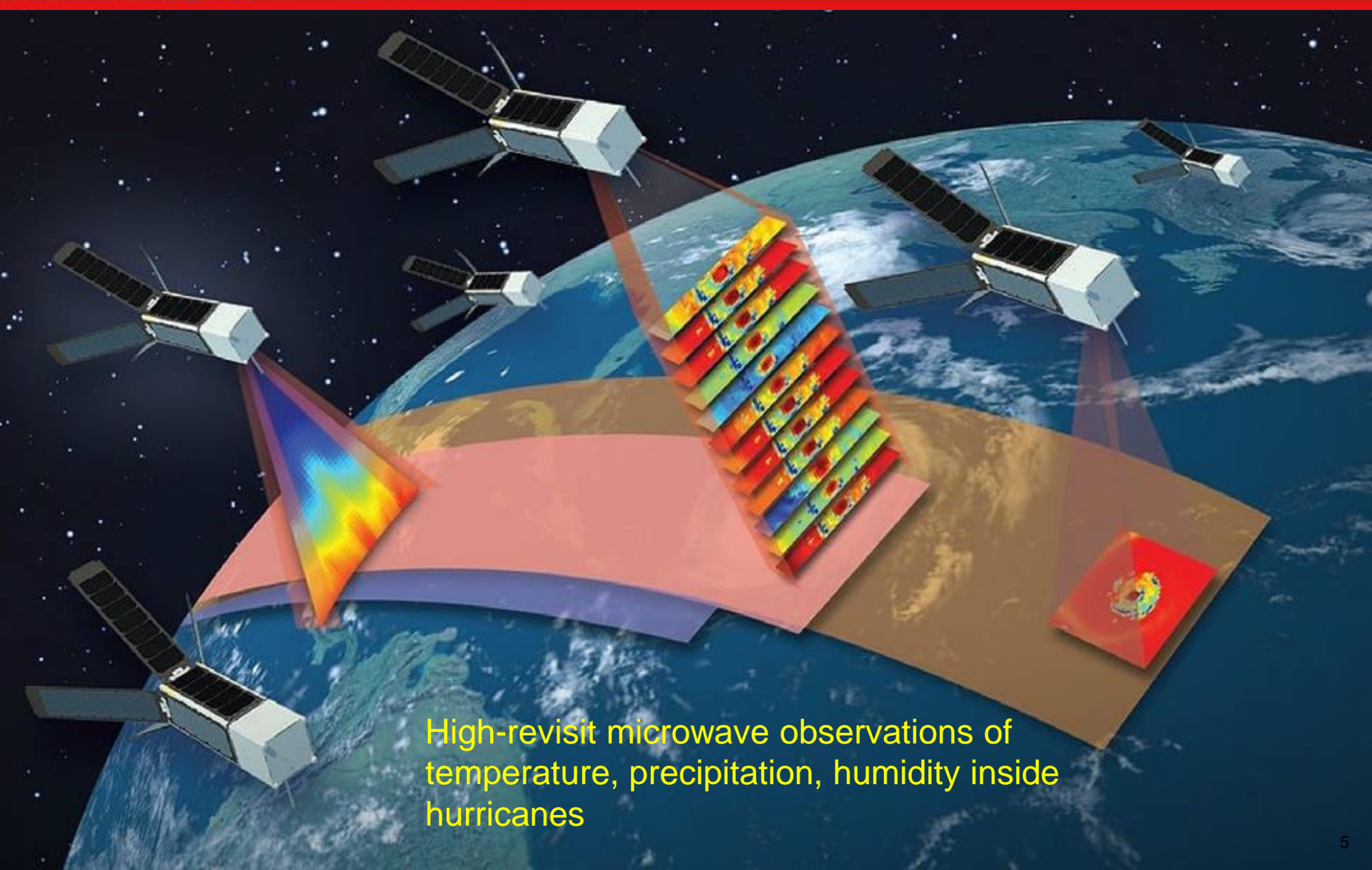


Science



Exploration

# TROPICS



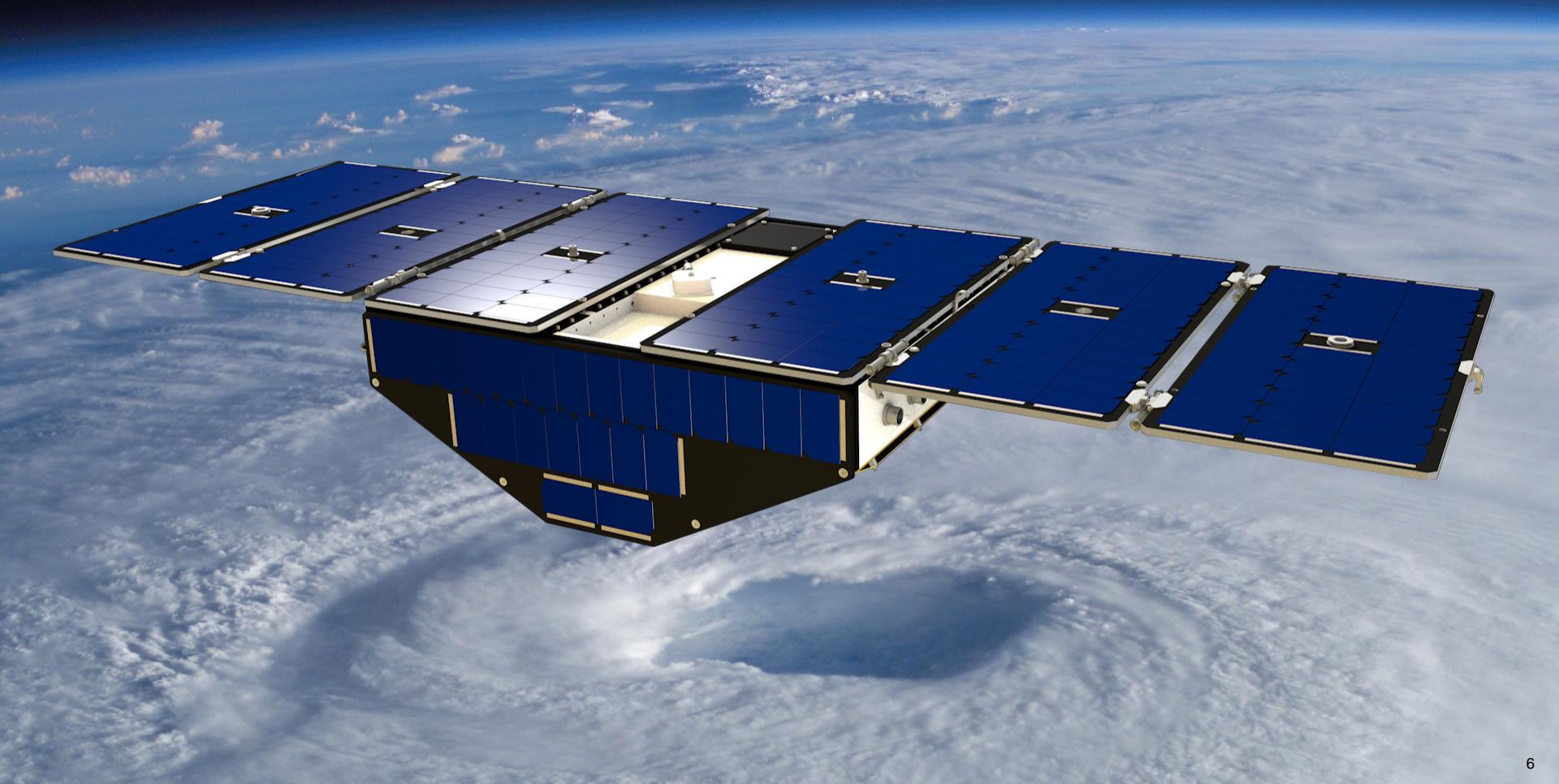
High-revisit microwave observations of temperature, precipitation, humidity inside hurricanes



# CYGNSS



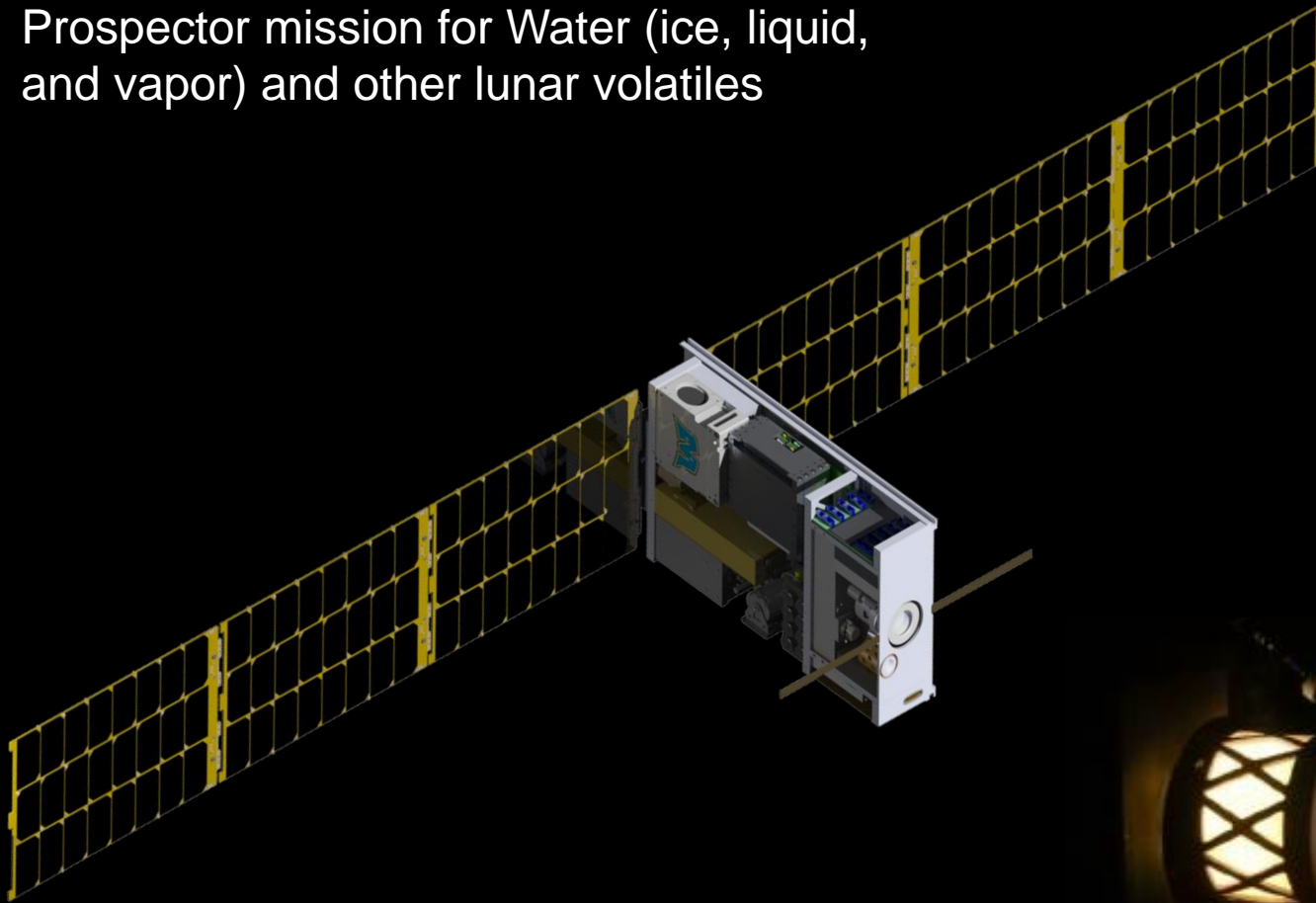
New measurement technique and mission architecture enabling frequent and accurate measurement of ocean surface winds to improve hurricane forecasting via GPS reflectometry



# Lunar IceCube



Prospector mission for Water (ice, liquid, and vapor) and other lunar volatiles



BIT-3 RF ion engine with iodine

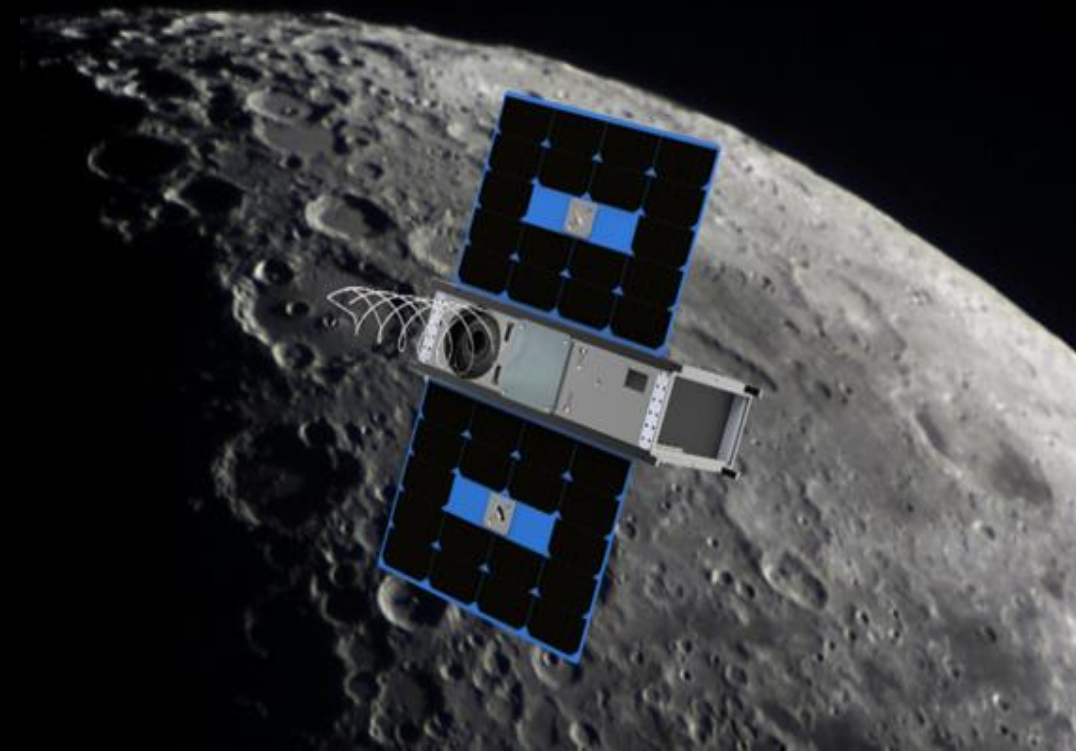




# SkyFire



Visible and mid-infrared lunar surface mapping mission to collect data on the thermal environment and as a precursor to a low size, weight and power common sensor suite for relative navigation



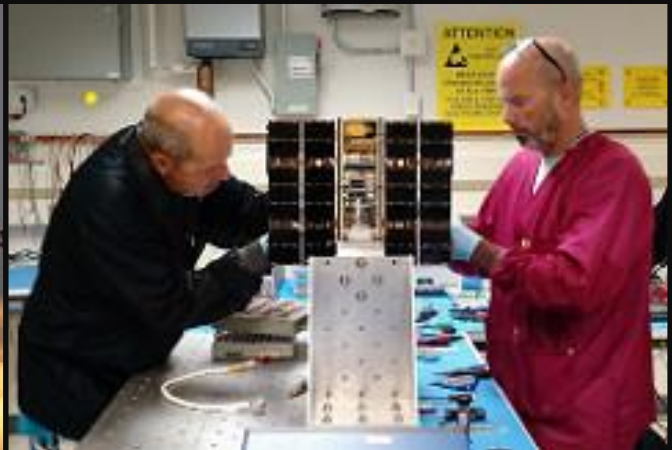




# CubeSat Launch Initiative



Provides launch opportunities to educational institutions, non-profit organizations and NASA Centers



# Select Overview of Small Spacecraft Activities in Space Technology



## Small Spacecraft Technology Program

- Small Spacecraft Technology Development
- Small Spacecraft Capability Demonstration Missions

## Flight Opportunities Program

- Suborbital Flight Testing and Capability Development
- Small Launch Vehicle Technology Development

## Centennial Challenges

- CubeQuest Challenge

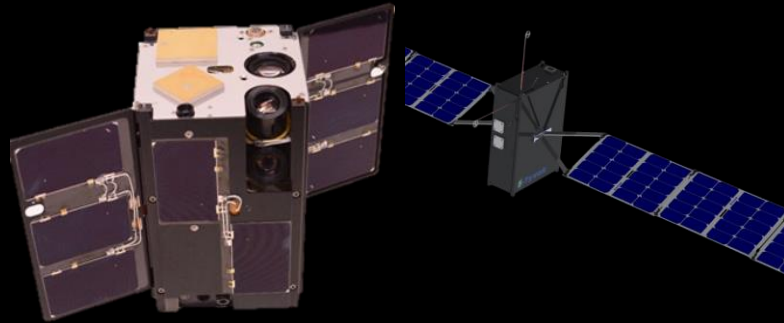
## Small Business Innovation Research

- Small Spacecraft Technology Development Subtopics

# Upcoming Small Spacecraft Technology Demonstration Missions

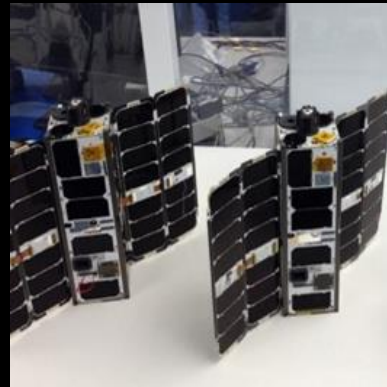


Optical  
Communications



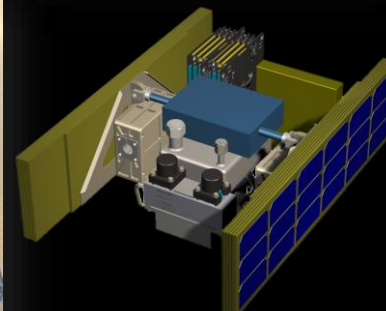
Pathfinder

Proximity  
Operations



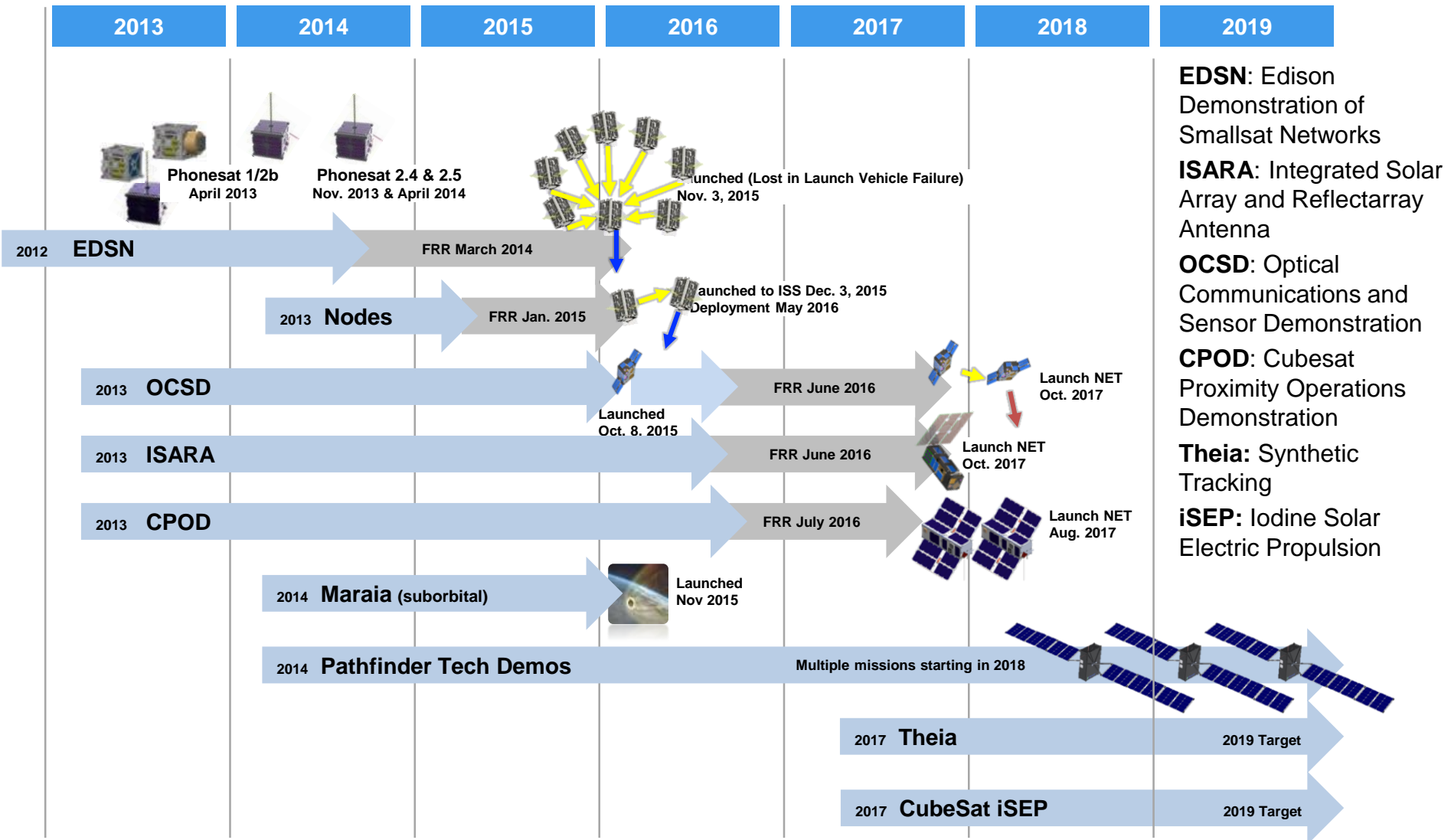
Synthetic Tracking  
Trans Astra

Reflectarray  
Antenna



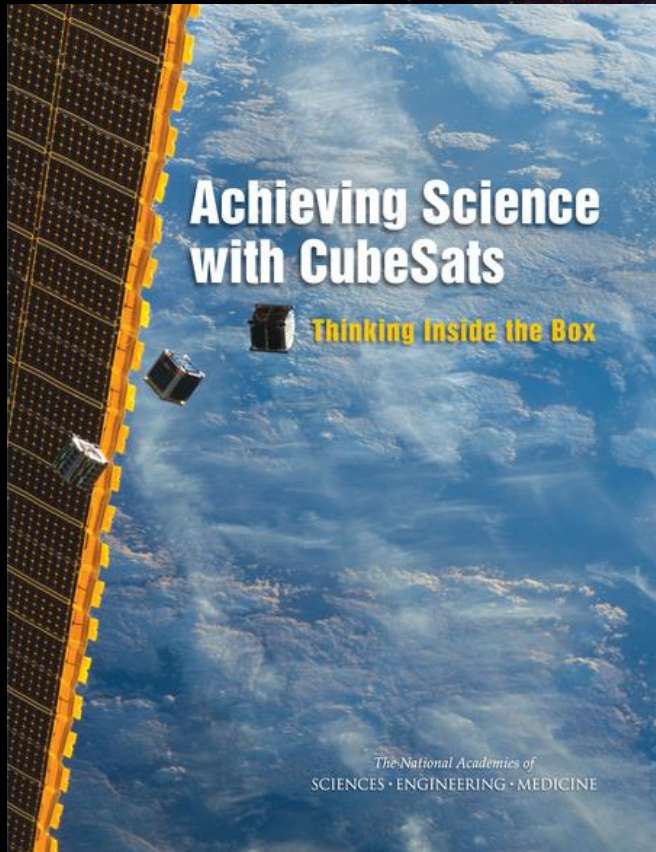
Solar Electric  
Propulsion  
ExoTerra

# Small Spacecraft Technology Flight Demonstration Missions



**EDSN:** Edison Demonstration of Smallsat Networks  
**ISARA:** Integrated Solar Array and Reflectarray Antenna  
**OCSD:** Optical Communications and Sensor Demonstration  
**CPOD:** Cubesat Proximity Operations Demonstration  
**Theia:** Synthetic Tracking  
**iSEP:** Iodine Solar Electric Propulsion

# Future Mission Needs



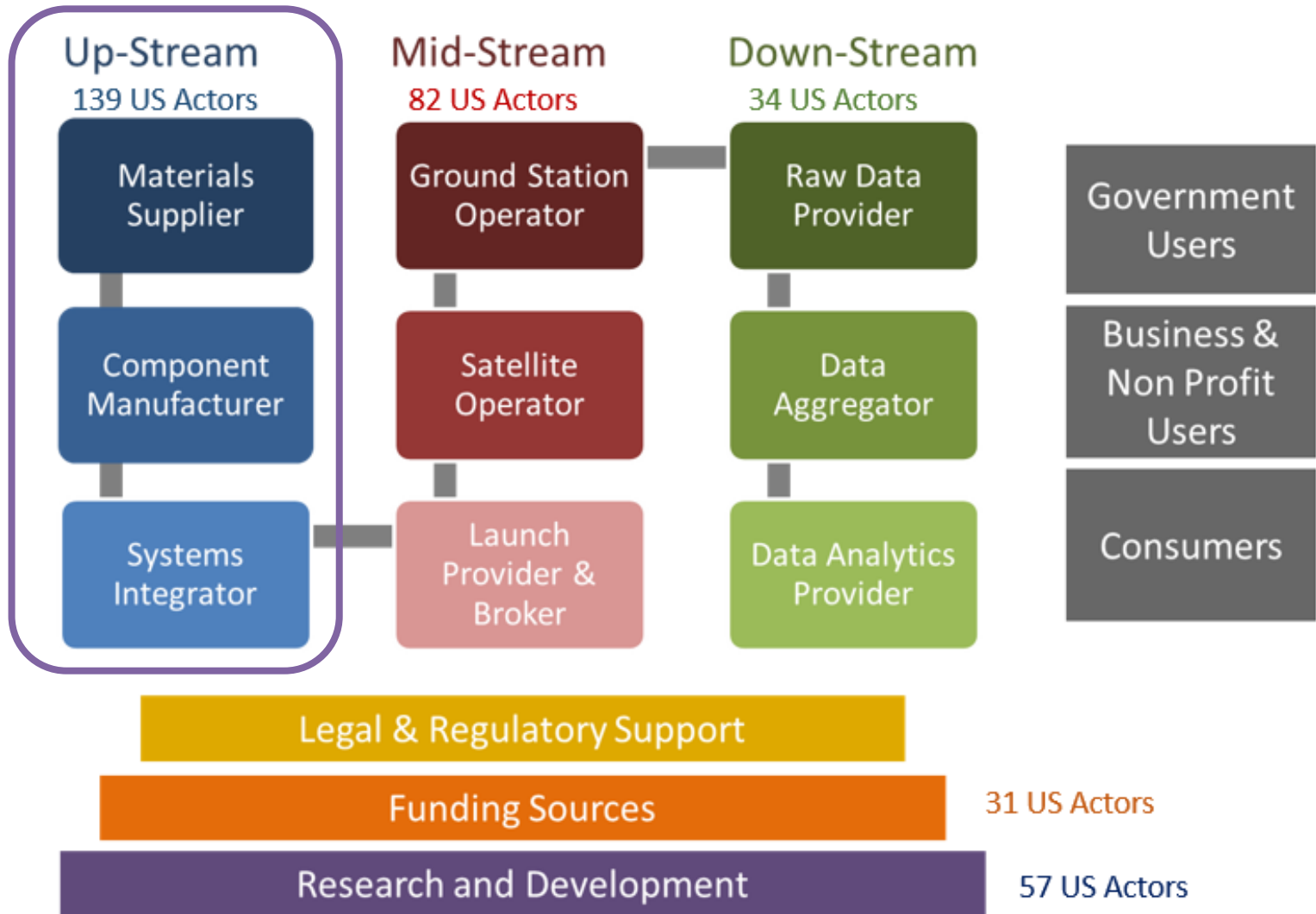
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- National Academies Report Achieving Science with CubeSats: Thinking Inside the Box
- IDA / Space and Technology Policy Institute Study: Trends in Small Satellite Technology and the Role of the NASA Small Spacecraft Technology Program
- Planetary Science Deep Space SmallSat Studies (PSDS3)

# Space Technology Supports Upstream Activity in the Small Spacecraft Ecosystem



Primarily supported by Space Tech.



# Public-Private Partnerships



## Industry Partnerships (Tipping Point and ACO)

- Small Spacecraft Subsystem Technologies
- Small Spacecraft Capability Demonstration Missions
- Small Launch Vehicle Technologies

## University Partnerships (STP)

- Small Spacecraft Subsystem Technologies and Scientific Instruments
- Small Spacecraft Mission Concepts

[www.nasa.gov/smallsat-institute/nasa-smallsat-opportunities](http://www.nasa.gov/smallsat-institute/nasa-smallsat-opportunities)

## Small Business Innovation Research

[sbir.nasa.gov/solicitations](http://sbir.nasa.gov/solicitations)

# Small Spacecraft Systems Virtual Institute



Promoting innovation and exploration of new concepts by establishing effective conduits for the exchange of information.



## Engage

Small Spacecraft Body of Knowledge



## Share

Small Spacecraft State of the Art & Technical Databases

## Small Spacecraft Systems Virtual Institute



## Collaborate

Working Groups, Partnership Opportunities



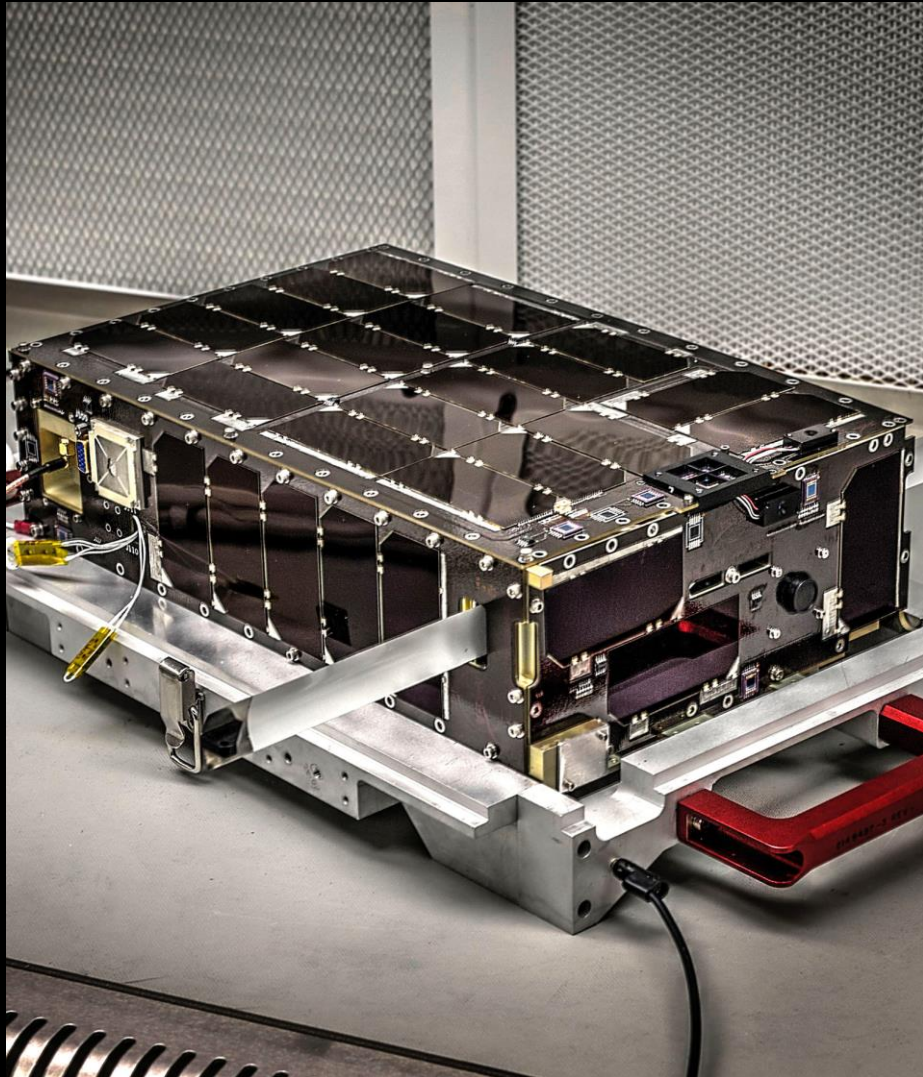
## Launch

Launch Portal

Jointly Sponsored by the Space Technology Mission Directorate and the Science Mission Directorate



# Common Barriers



- High efficiency, high  $\Delta V$  propulsion that is secondary payload compatible
- Affordable techniques for increasing radiation tolerance
- Low size, weight and power instrumentation
- High bandwidth communications for deep space / data intensive swarms
- High performance onboard processing and navigation for deep space / autonomy
- Formation flight for distributed systems / interferometry / coordinated multipoint measurements

# Confronting the Barriers

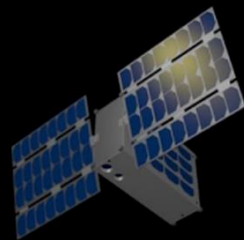
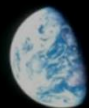


Work with our partners in academia and industry to...

- Science – Close instrument technology gaps to achieve decadal survey goals using lower cost small spacecraft.
- Exploration – Use small spacecraft to close strategic knowledge gaps for future missions.
- Space Technology – Close platform technology gaps to enable missions for Science and Exploration

Further support the community through...

- CubeSat Launch Initiative
- Small Spacecraft Virtual Institute





# CPOD



## Cubesat Proximity Operations Demonstration





## Optical Communications and Sensor Demonstration





**Technology Drives Innovation**

**[www.nasa.gov/spacetech](http://www.nasa.gov/spacetech)**