Enabling Low Cost Planetary Missions Through Rideshare Opportunities

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June 20, 2013
A Low Cost Approach for Exploration

CubeSats have revolutionized Earth science mission by providing regular, low-cost access to space through standardization.

Regular access to space provides various ways to lower-cost:

1. Higher Risk Approaches
2. Increased community for operating missions
3. Innovative uses of technology
4. More Focused Science Investigations

What approach could be used to reduce cost for Planetary Science missions?
Deep Space Travel is Not Easy!

Stand-alone Planetary CubeSat missions must overcome significant technological hurdles to succeed.

Long distance communication requires increased power or antenna area.

Propulsion systems require increased potential energy or power.

The result is a significant increase in complexity in order to force the Deep Space functionality to fit within the current CubeSat standard.

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June 20, 2012

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CubeSats As Daughter Craft

The reduced number of planetary launches results in less opportunities for Cubesats in the Mother-daughter architecture

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Relies on a much more expensive mission (higher quality assurance)

Reduced number of launch opportunities (requires higher reliability)

The reduction of opportunity forces more consideration for mission reliability and quality assurance, increasing the cost and complexity of the systems
A New Approach

*Increased access to the inner solar system could be enabled by combining the ESPA ring launch flexibility with lunar gravity assists*

**ESPA Ring**
- The EELV Secondary Payload Adapter (ESPA) provides a standard launch interface for spacecraft <180kg per slot

**Lunar Gravity Assists**
- Lunar gravity assists can be used to customize the departure energy and direction to any potential target of interest including NEOs, Venus and Mars
Potential Platform for Planetary Exploration

The ‘Micro Surveyor’ spacecraft concept combines the launch flexibility of a CubeSat with the performance of a Deep Space spacecraft.

- Single string spacecraft with a launch mass of <75kg
- Easily fits within the defined volume for the ESPA ring (24”x28”x35.5”)
- Two 1.5m² deployable solar arrays provides ~750W of power
- Capable of delivering up to 15kg of science payload
- Rad hard cubeSat based avionics and attitude determination provides sufficient computing and pointing control
- COTS low-power EP system provides up to 5.4 km/s of ΔV for flight to Mars, Venus or NEOs
- JPL developed X-band telecommunication system provides navigation and communication

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Potential Targets of Interest

From GTO, Planetary Science mission could potentially be conducted at Venus, Mars and NEOs

- **Example Mars Trajectory**
  - Launch date: December 2017
  - Time to Earth Departure: 6 months
  - Transfer flight time: ~3 years
  - Mars Arrival Time: March 2021
  - Total Delta V to Mars: 2.35 km/s

- **Venus and NEO Trajectories**
  - **NEOs**
    - Launch in late 2019
    - Flight time of ~21 months
  - **Venus**
    - Launch in late 2018
    - Flight time of ~16 months to Venus
Summary

• A new standard needs to be developed to provide the launch regularity that enables interplanetary low-cost flight.

• An extension of the CubeSat Launch Initiative using the ESPA ring would increase the opportunity for planetary science by providing rideshare opportunities on GTO, Lunar or Low C3 launches.

• ‘Micro Surveyor’ is an example of a spacecraft concept that leverages CubeSat technologies and provides the required capability to access deep space targets from Mars to Venus using regularly available GTO launch opportunities.