A Survey of the Space Access Value Chain for CubeSats and the Future Outlook

CubeSat Developers Workshop 2021
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TEAM INTRODUCTION

Who are we?

Kishen Raghunath  
Co-Founder & CEO  
• 8+ years aerospace and defense experience  
• Venture capital investor and strategy advisor for startups  
• Early stage fintech startup experience  
• BS Aerospace Engineering at Georgia Institute of Technology  
• MS Aerospace Engineering at Georgia Institute of Technology  
• MBA University of Chicago Booth School of Business

Dr. Jin Kang  
Co-Founder & CTO  
• Director of US Naval Academy Small Satellite Program  
• 15 years teaching and building aerospace engineering and building small satellites  
• BS Aerospace Engineering at University of Michigan  
• MS & DE Aerospace Engineering at Stanford  
• PhD Aerospace Engineering at Korea Aerospace University

Why Listen to Us?

• Discuss the current space access value chain  
• Understand how the different solutions on the market compare  
• Learn about how new technologies are impacting the space access value chain
GETTING CUBESATS TO ORBIT IS COMPLICATED

Although engineering is an integral part of building a CubeSat, there is so much more...

CubeSat manufacturing and operations is technically complex and involves multiple organizations

Capital Intensive and Time Consuming
SOLUTIONS TODAY

Do-It-Yourself

Turnkey
DO-IT-YOURSELF APPROACH

Pros
- Low cost
- Highly customizable
- Learning opportunity for students and academics

Cons
- Long development timeline
- Reliability not guaranteed
- Complicated integration
- Coordination between many different entities

Although low cost, the DIY approach is inefficient, long, and does not guarantee reliability.
**Pros**

- Extremely hands-off
- Heritage configurations reduce technical risk
- Schedule is predictable
- Operations can be done by the customer or the service provider
- Don’t need to have facilities to build a satellite

**Cons**

- Higher cost than DIY
- Can be not as flexible as building your own
- Customization comes with a cost

Although higher cost, turnkey services provide significant value and simplify getting payloads into orbit and operating.
### TRADE-OFFS BETWEEN SOLUTIONS

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
<th>Schedule</th>
<th>Available Payload Volume</th>
<th>Resources</th>
<th>Notes</th>
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<tbody>
<tr>
<td><strong>DIY</strong></td>
<td>Starting at ~$250k</td>
<td>3 – 4 years</td>
<td>Restricted volume, bus takes up to 50% of the volume</td>
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<td>- Lower reliability</td>
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<td>Starting at ~$0.8M</td>
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There isn’t one best solution on the market, but different options based on constraints of the mission.
TECHNOLOGIES ENABLING NEW OPTIONS

Rendezvous, Proximity Operations, and Docking (RPOD)

Altius Space CubeSat Connectors

NASA 3U RPOD Demonstration

ESA 6U RPOD Demonstration
Recent successful docking of Northrop Grumman’s Mission Extension Vehicle has proven that this technology is at a mature state for satellite operations.

On-orbit servicing and manufacturing (OSAM), enabled by RPOD, has come to light as a key capability of interest by governments and commercial organizations to enable:

- Modularity
- In-orbit satellite servicing and de-orbiting
- In-orbit refueling
- Large space structures
- Persistent platforms

RPOD technologies will enable persistent in-space infrastructure that will help reduce costs and increase efficiencies of spacecraft operations.
**THE REAL ESTATE MODEL IN SPACE IS ENABLED BY REUSABILITY**

**PLUTONICS OFFERS...**

- **Turnkey service.** Customers provide their payloads, and we handle the rest. Customers access their payloads through an encrypted web platform for tasking and access their data.

- **Ready to go when you are.** Scheduled launches and on-orbit assets ensure customers start their missions as soon as they are ready instead of waiting for long-lead satellite components.

- **Mass Savings.** In space, mass is money, our solution saves up to 50% of a traditional satellite bus.

- **Pay-per-use model.** Customers only pay for mission time and resources they use, not an entire satellite mission.
Launch. Rocket carries the Payload Integration Pallet (PIP) as a secondary payload to LEO.

Docking. The RSB finds and docks to the PIP that was recently launched.

Mission Operations. Mission operations begin and customers access and task their payloads and pay for what they use.

Deorbit Burn. The RSB thrusts into a decaying orbit in preparation of jettisoning the PIP.

PIP Deorbit. The RSB jettisons the PIP in a decaying orbit, the PIP uses drag device to deorbit.

Reuse! The RSB is now ready to receive a new PIP and start the cycle over.

Reusability enables Speed, Affordability, and High Performance
# Trade-Offs Between Solutions with RPOD Technology

## Cost

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<td><strong>Reusable Bus RPOD Technology</strong></td>
<td>Lowered cost</td>
<td>Bus is ready on demand</td>
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## Resources

**Available Payload Volume**
- **Restricted volume, bus takes up to 50% of the volume**
- **Up to 50% of the bus volume can be used for payload**
- **Limited by CubeSat size 15 – 120W**
- **Based on base spacecraft Up to 1kW**

## Notes
- Lower reliability
- High customization
- Dependent on main customer payload destination
- Simple operations
- Customization comes at a cost
- Simple operations
- Customized orbits and placements
- Simple operations

RPOD technology can enable new architectures that can bring about the best of the solutions on the market.
CONCLUSION

Space is at the cusp of explosive growth, yet the infrastructure to support its growth isn't developed...

- **Current solutions are inefficient.** The current solutions still require either a high tolerance for risk or significant capital resources to reduce technical risk.

- **RPOD technology as driver of cost and schedule savings.** Renewed interest in docking technologies along with successful commercial demonstrations offer options for new architectures such as reusable infrastructure to come to market.

- **The Plutonics Approach.** Just as rockets enabled lower costs through reusability, Plutonics is developing reusable satellite buses to reduce development costs and the time it takes to get to orbit in an affordable way with our pay-as-you-go pricing model.

Plutonics hosts customer payloads as a turnkey service in LEO, enabled by reusable space infrastructure
Let’s talk about your space mission!

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