Modular Rapidly Manufactured SmallSat: Using Advanced Manufacturing Processes for CubeSats

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Overview

- Introduction
- Digital Materials
- Goals and Objectives
- Current Designs
- Accomplishments to Date
- Schedule
- Conclusion
Team

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San Jose State University
Introduction

Complex, labor/time intensive  Simple, modular, rapid
Digital Materials

1.0 PROJECT OBJECTIVES

(Cheung ETAL 2013, MIT CBA)  (Ward ETAL 2011, MIT CBA)  

(McNutt ETAL 2009, nano-SPA, AFRL)  (White ETAL 2011, RAMPART)  (Lopes ETAL 2012, COSMIAC, AFRL)
Integration

Assembly

Launch

Jettison

Fabrication of kit
Objective is to bring down the cost, integration and time from start to finish.

Using slide-fit card technology for spacecraft subsystems and components to maximize payload

Looking at low-cost microcontrollers and advanced manufacturing

RJ45 connectors to connect side panels

Looking at advanced communications
TechEdSat Document Tree/ Process

TechEdSat Project ARC

- Project Plan
- Requirements
- SEMP
- Ground Ops/Safety
- Flight Ops
- Test Plan/Procedures
- TM Summary
- ODAR
- SpaceCap Data Form
- FCC Submittal; Approval
- SBD Letter of Awareness (Orbcomm and Iridium)
- ICD
- PDR (JSC Kickoff)
- CDR
- FRR

ISS Safety (JSC)

- Standard/Reference Safety Document
  - ICD Verification
- PSRP Documentation
  - HR/UHR (Hazard Reports)
    - Standard Hazards
    - Sharp edges, Shatterable Materials, Outgassing, Flammable Materials, Touch Temperature
  - Unique Hazards (4)
    - Battery, Structural Failures, Antenna Deployment, EMI

Note: This process will be used for MRMSS since we are deploying from ISS
FY14 Accomplishments:

Possible prototypes of designs are being built
Talked to JSC for possible material and design selections
Destructive testing for connections addressing Human Factors
Established conversation with Launch Vehicle Service Provider
Established collaboration with TechEdSat team for Communication system
  - PM/IP are being successful in deploying cubesat from ISS using different communication Systems

Technology Firsts

Will demonstrate the rapidly fabricated, modular and integrated small satellite systems in the International Space Station using the advanced manufacturing technologies, techniques and materials
<table>
<thead>
<tr>
<th>Element</th>
<th>Milestone</th>
<th>Date</th>
<th>Description</th>
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<tbody>
<tr>
<td>FY14</td>
<td>Project Kickoff</td>
<td>November 15, 2013</td>
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<td></td>
<td>Status Review 1</td>
<td>April 4, 2014</td>
<td>Review of project development</td>
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<td>Status Review 2</td>
<td>July 18, 2014</td>
<td>Project design review and development</td>
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<td>Close-out / Transition Review</td>
<td>September 30, 2014</td>
<td>The Final review of the research project development and transition to SSTP</td>
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<td>FY15</td>
<td>Technical Interchange Meeting (TIM) meeting with ISS PSRP</td>
<td>Nov-14</td>
<td>Presentation to Safety Panel at JSC</td>
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<td>PSRP 0/I</td>
<td>Jan-15</td>
<td>Review of project and safety by the safety panel</td>
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<td>PSRP II</td>
<td>Mar-15</td>
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<td>PSRP III</td>
<td>May-15</td>
<td>Review of project and safety by the safety panel</td>
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<tr>
<td></td>
<td>On Dock date</td>
<td>Jun-15</td>
<td>Product deliver to NanoRacks or JAXA for intergartion to softstow bag</td>
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<td></td>
<td>Launch to ISS</td>
<td>Jul-15</td>
<td>On launch Vehicle</td>
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<td>Assemble in ISS</td>
<td>Aug-15</td>
<td>Astronauts assemble cubesat in ISS</td>
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<td>jettison from ISS</td>
<td>Sep-14</td>
<td>Cubesat get integrate on Deployer and jettison from ISS</td>
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<td>Operation in space</td>
<td>~ 300 day after deployment</td>
<td>Functional and operational cubesat on space</td>
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Summary

• MRMSS will utilize Modular “Digital Material” technology for spacecraft subsystems and components to maximize payload volume
• Adding assembly capability to the ISS for cubesats
• Numerous Technologies Advanced
  • Manufacturing
  • Fabrication
  • Assembly
• Future Work leads to Developing advanced manufacturing technologies that enable the development of more capable and lower-cost space missions and launch vehicles.