ALL STAR KICK OFF MEETING

11/17/2009
Jessica (JB) Brown
Riley Pack
JB Around Space Grant
JB’s Interest in Space
When JB is Not in Space Grant...
Riley’s Societies and Internships
When Riley is Not in Space Grant...
Introduction to ALL STAR

- Agile Low-cost Laboratory for Space Technology
  Acceleration & Research

- Objectives:
  - Design a reproducible satellite bus
    - For Lockheed Martin’s use
  - Conform to the 3U CubeSat architecture
  - Maintain a low reproduction cost
    - $100,000
<table>
<thead>
<tr>
<th>Required Capabilities Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HERMES</strong></td>
</tr>
<tr>
<td>Physical Dimensions</td>
</tr>
<tr>
<td>Useable Payload Volume</td>
</tr>
<tr>
<td>Total Mass</td>
</tr>
<tr>
<td>Mass allotted for Payload</td>
</tr>
<tr>
<td>Power Output</td>
</tr>
<tr>
<td>Pointing Accuracy</td>
</tr>
<tr>
<td>Lifetime</td>
</tr>
<tr>
<td>Propulsion</td>
</tr>
<tr>
<td>Position Knowledge</td>
</tr>
<tr>
<td>Development time</td>
</tr>
<tr>
<td>Post Development Cost</td>
</tr>
</tbody>
</table>
## Required Capabilities Comparison

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Standard 1-U CubeSat</th>
<th>ALL STAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Dimensions</td>
<td>10 x 10 x 11.3 cm</td>
<td>10 x 10 x 34.0 cm</td>
</tr>
<tr>
<td>Useable Payload Volume</td>
<td>N/A</td>
<td>1450 cm³</td>
</tr>
<tr>
<td>Total Mass</td>
<td>1 kg</td>
<td>≤ 4.5 kg</td>
</tr>
<tr>
<td>Mass allotted for Payload</td>
<td>N/A</td>
<td>1.5 kg</td>
</tr>
<tr>
<td>Power Output</td>
<td>8 Watts</td>
<td>≥ 20 Watts</td>
</tr>
<tr>
<td>Pointing Accuracy</td>
<td>Passive ADCS (± 20°)</td>
<td>≤ ± 1°</td>
</tr>
<tr>
<td>Lifetime</td>
<td>1 year</td>
<td>≥ 1 year</td>
</tr>
<tr>
<td>Propulsion</td>
<td>None</td>
<td>desired</td>
</tr>
<tr>
<td>Position Knowledge</td>
<td>None</td>
<td>&lt; ± 10 km</td>
</tr>
<tr>
<td>Development time</td>
<td>2 years</td>
<td>2 years</td>
</tr>
<tr>
<td>Post Development Cost</td>
<td>$100,000</td>
<td></td>
</tr>
</tbody>
</table>
### Required Capabilities Comparison

<table>
<thead>
<tr>
<th></th>
<th>Pumpkin/Clyde Space</th>
<th>ALL STAR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Dimensions</strong></td>
<td>10 x 10 x 34.0 cm [3-U]</td>
<td>10 x 10 x 34.0 cm [3-U]</td>
</tr>
<tr>
<td><strong>Useable Payload Volume</strong></td>
<td>1500 cm³ [1.5-U]</td>
<td>1450 cm³ [≈1.5-U]</td>
</tr>
<tr>
<td><strong>Total Mass</strong></td>
<td>≤ 4.5 kg</td>
<td>≤ 4.5 kg</td>
</tr>
<tr>
<td><strong>Mass allotted for Payload</strong></td>
<td><em>varies</em></td>
<td>1.5 kg</td>
</tr>
<tr>
<td><strong>Power Output</strong></td>
<td>&lt; 7 Watts (peak)</td>
<td>≥ 20 Watts</td>
</tr>
<tr>
<td><strong>Pointing Accuracy</strong></td>
<td>± 1°</td>
<td>≤ ± 1°</td>
</tr>
<tr>
<td><strong>Lifetime</strong></td>
<td><em>Not Specified</em></td>
<td>≥ 1 year</td>
</tr>
<tr>
<td><strong>Propulsion</strong></td>
<td><em>None</em></td>
<td><em>desired</em></td>
</tr>
<tr>
<td><strong>Position Knowledge</strong></td>
<td><em>None</em></td>
<td>&lt; ± 10 km</td>
</tr>
<tr>
<td><strong>Development time</strong></td>
<td>2-3 years</td>
<td>2 years</td>
</tr>
<tr>
<td><strong>Post Development Cost</strong></td>
<td>≤ $95,000</td>
<td>$100,000</td>
</tr>
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</table>
## Required Capabilities Comparison

<table>
<thead>
<tr>
<th></th>
<th>Colony 1</th>
<th>ALL STAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Dimensions</td>
<td>10 x 10 x 34.0 cm [3-U]</td>
<td>10 x 10 x 34.0 cm [3-U]</td>
</tr>
<tr>
<td>Useable Payload Volume</td>
<td></td>
<td>1450 cm³ [1.5-U]</td>
</tr>
<tr>
<td>Total Mass</td>
<td>&lt; 4.5 kg</td>
<td>≤ 4.5 kg</td>
</tr>
<tr>
<td>Mass allotted for Payload</td>
<td>2 kg</td>
<td>1.5 kg</td>
</tr>
<tr>
<td>Power Output</td>
<td>15-20 Watts</td>
<td>≥ 20 Watts</td>
</tr>
<tr>
<td>Pointing Accuracy</td>
<td>± 1°</td>
<td>≤ ± 1°</td>
</tr>
<tr>
<td>Lifetime</td>
<td>1 year</td>
<td>≥ 1 year</td>
</tr>
<tr>
<td>Propulsion</td>
<td>none</td>
<td>desired</td>
</tr>
<tr>
<td>Position Knowledge</td>
<td>none</td>
<td>&lt; ± 10 km</td>
</tr>
<tr>
<td>Development time</td>
<td></td>
<td>2 years</td>
</tr>
<tr>
<td>Post Development Cost</td>
<td>$300,000</td>
<td>$100,000</td>
</tr>
</tbody>
</table>
### Required Capabilities Comparison

<table>
<thead>
<tr>
<th>Capability</th>
<th>Colony II</th>
<th>ALL STAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Dimensions</td>
<td>10 x 10 x 34.0 cm [3 U]</td>
<td>10 x 10 x 34.0 cm [3-U]</td>
</tr>
<tr>
<td>Useable Payload Volume</td>
<td>1425 cm³ [1.5 U]</td>
<td>1450 cm³ [1.5-U]</td>
</tr>
<tr>
<td>Total Mass</td>
<td>Unknown</td>
<td>≤ 4.5 kg</td>
</tr>
<tr>
<td>Mass allotted for Payload</td>
<td>1.83 kg</td>
<td>1.5 kg</td>
</tr>
<tr>
<td>Power Output</td>
<td>30-40 W (50% duty cycle)</td>
<td>≥ 20 Watts</td>
</tr>
<tr>
<td>Pointing Accuracy</td>
<td>± 0.5°</td>
<td>≤ ± 1°</td>
</tr>
<tr>
<td>Lifetime</td>
<td>1 year</td>
<td>≥ 1 year</td>
</tr>
<tr>
<td>Propulsion</td>
<td>≥ 10 m/s Δ V (desired)</td>
<td>desired</td>
</tr>
<tr>
<td>Position Knowledge</td>
<td>&lt; ± 10 km (desired)</td>
<td>&lt; ± 10 km</td>
</tr>
<tr>
<td>Development time</td>
<td>&lt; 1 year</td>
<td>2 years</td>
</tr>
<tr>
<td>Post Development Cost</td>
<td>TBD (Colony 1 cost $300 K)</td>
<td>$100,000</td>
</tr>
</tbody>
</table>

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Colorado Space Grant Consortium
ALL STAR
13
Key Capabilities

- Simple, Complete Interface with ALL-STAR Bus
- Flexibility of Payload and Bus Locations in Structure
- Auto-Configuration of CDH with Payload Hardware Allows for Easy Integration
Interface

- Two Major Possibilities Have Been Considered
  - Configurable Backplane PCB
    - Allows for easier integration and removes risk of wire fatigue
  - Wires/Cables from Bus to Payload
    - Simpler design with more flexibility in the signals that can be provided

- Both Will Give Access to Power, Subsystem Interface, Data Storage
Volume Division Options

- **Pros**
  - Continuous payload space
  - Continuous bus space
  - Payload has potential to be as far away from bus as possible
  - Allows for PCB “cards”
  - Easy integration

- **Cons**
  - No access to geometric center
Volume Division Options

- **Pros**
  - Continuous bus space
  - Allows for PCB “cards”
  - Payload access to two potential optical ports
  - Bus has access to geometric center & center of mass
  - Moderately easy integration

- **Cons**
  - Discontinuous payload space
Volume Division Options

- **Pros**
  - Continuous payload space
  - Allows for PCB “cards”
  - Payload access to geometric center & center of mass
  - Moderately easy integration
  - If we can design to this, we can design for previous two
    - Allows for multiple configuration options

- **Cons**
  - Discontinuous bus space
  - No payload access to the ends
Volume Division Options

- Payload Volume
- Bus Volume
Volume Division Options

- Payload Volume
- Bus Volume
Configuration

- CDH will support auto-configuration of payload needs
  - Determine number of sensors, size of each data packet, other payload capabilities
  - Modular CDH interface allows for custom "server" code to be integrated into core software
  - Provide all interface and configuration firmware to payload to ease development
Example Configuration

- **Master CDH Microcontroller**
  - File System Server
  - Core
  - Command Server
  - Power Control Server
  - Sensor Server
  - Other Interfaces

- **SD Card** SDIO connection
- **PnP Bus**
  - PnP Firmware
    - Comm Board
    - Other Device Software
  - PnP Firmware
    - Power Board
    - Other Device Software
  - PnP Firmware
    - Payload
    - Other Device Software

- **Other Sensor**
- **Other Interfaces**
Hard copies of Documentation
- Organized in binders
- Stored in a locked cabinet

Electronic copies of Documentation
- Stored in its own server
- Can be accessed by LMCO mentors and students
## Schedule

| Milestone                          | 2009 |  |  | 2010 |  |  |  | 2011 |  |  |  |  |
|-----------------------------------|------|--|--|--|----|--|--|--|---|--|--|--|--|
|                                   | Q3   | Q4|  | Q1 | Q2 | Q3 | Q4|  | Q1 | Q2 | Q3 | Q4|
| Start Date (10/09)               | ▲    |   |   |     |    |  |   |   |     |    |  |   |   |
| Program Plan (12/09)             |      | ▲|   |   |     |    |  |  |     |    |  |   |   |
| Requirements Def. (12/09)        |      | ▲|   |   |     |    |  |  |     |    |  |   |   |
| Systems Req. Review (03/10)      |      |   |   |     |    | ▲|   |   |     |    |  |   |   |
| Ops & Ground Design (05/10)      |      |   |   |     |    | ▲|   |   |     |    |  |   |   |
| PDR (07/10)                      |      |   |   |     |    |  | ▲|   |     |    |  |   |   |
| Payload Guide (07/10)            |      |   |   |     |    |  | ▲|   |     |    |  |   |   |
| CDR (11/10)                      |      |   |   |     |    |   |   | ▲|     |    |  |   |   |
| TRR (06/11)                      |      |   |   |     |    |   |   |   |     |    | ▲|   |   |
| LRR (11/11)                      |      |   |   |     |    |   |   |   |     |    |   | ▲|   |
| Final Report (12/11)             |      |   |   |     |    |   |   |   |     |    |   |   | ▲|
Spring 2010
Mentors

- Each subsystem works directly with a mentor

Mentor’s responsibilities:

- Attend major reviews
- Provide feedback on the design as the students develop it
- Help teams set milestones to meet
- Answer questions from the students as needed
- Accessible via phone or email when needed
Mentors

- **Mentor’s average time commitment:**
  - During the school year:
    - Teleconferences every other week to once a week
    - At least 2-3 face to face meetings per semester
  - During the summer:
    - Teleconferences once a week (1 hour each)
    - Face to face meetings at least once a month (4 times)
  - As the project progresses
    - The first two semesters, containing mostly design, will likely require the most time commitment
Mentors

- **Student’s responsibilities:**
  - Contact their mentor and set up regular meetings
  - Provide their mentor with updates at every meeting
  - Show improvements based on mentors’ suggestions
  - Contact mentor with reasonable questions
  - Host a BBQ for mentor upon completion of project
Discussions
Back Up Slides

Additional Volume Division Options
Volume Division Options

- **Pros**
  - Continuous payload space
  - Continuous bus space
  - More control over CG
  - Moderately easy integration
  - Allows for a longer/flat payload

- **Cons**
  - Height of components would be restricted
  - Would have to use long PCB boards
Volume Division Options

- **Pros**
  - Continuous payload space
  - Continuous bus space
  - Payload access to geometric center & end for optical port
  - Allows for a few boards to be longer

- **Cons**
  - Difficult integration
  - Non-uniform shapes for boards
Volume Division Options

- **Pros**
  - Continuous payload space
  - Allows for a back plane through the payload space
  - Allows for PCB “cards”
  - Easy integration

- **Cons**
  - Less continuous bus space
Volume Division Options

- **Pros**
  - Continuous payload space
  - Continuous bus space
  - Allows for payload to have different angles
  - Allows for cards longer than 34 cm

- **Cons**
  - Difficult integration & interfaces
  - Loss of useable volume due to angles
  - Cannot use uniform PCB’s