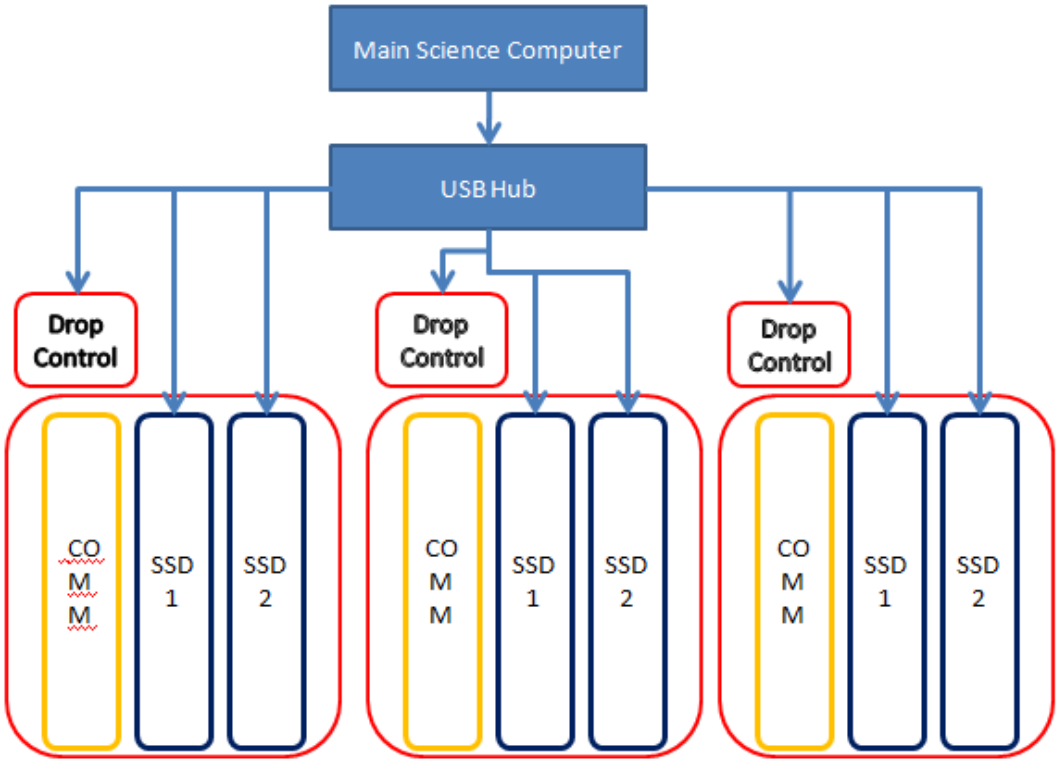
University of Maryland
January 2012 Status Update

HASP 2012: StratoPigeon III

1. Activities of Team Members

The UMD team has made a lot of progress in refining payload design. Contributing to this was the opportunity to talk with the CREAM (Cosmic Ray Energetics and Mass) scientific payload design team here at UMD about integration with their payload. The CREAM platform has had six successful flights on a NASA long-duration balloon flight in Antarctica. The UMD team lead was able to speak with the Principal Investigation, Dr. Eun-Suk Seo, and her graduate students about re-design of StratoPigeon for a more easily integrated capsule with the main CREAM architecture. Overall, the response was very favorable and a flight with the CREAM platform is possible as early as next year. However, some changes were made to the StratoPigeon payload architecture in order to facilitate this integration.

The biggest change to the payload is that the main computer has been removed from the dropped payload and made a static element remaining on the main HASP gondola. This allows for a "hub" architecture, i.e. with a single main computer and USB hub on board the main gondola, many drop capsules can be added to a single flight. In addition to this, the interface to the drives has been modified to be a USB interface. As well as being the sensor interface for CREAM, it is a common bus architecture and allows the drop capsule to be plugged into an already existing main computer on the scientific research payload with very minor software updates. In addition to reducing the required software changes for the main science payload, there are volume, weight, and power advantages in taking the main computer out of the dropped payload and installing it on the HASP platform instead. The dropped payload now contains only 2 Solid State Drives (SSD's), the communications Printed Circuit Board (PCB), and a much smaller battery. This is a lighter and smaller payload. An overall architecture diagram is pictured below:



With an industrial USB hub, many drop payloads can be attached and controlled and software changes are limited to adding a storage drive name into the flight software of the research payload. For HASP, there will still be only 1 dropped payload but the principles of the above architecture will be tested. This architecture will actually result in a much simpler electronics design as well. To that end, the electronics team is currently working on first revision to the PCB design. PCB design and power distribution schematics will be provided prior to the next status update. There will be no changes to the HASP interface provided in the payload proposal.

A simpler mechanical detachment was also discussed in conjunction with the revision of the capsule to a smaller payload. A new attachment has been developed which is an enhanced version of the previously used method with some improvements. The mechanical team is currently developing drawings and beginning the fabrication process. The modified detachment mechanism centers around a stepper motor actuation instead of a servo controlled detach. The principle is the same; the stepper motor will rotate and drive the the payload off by rotating two screws. Long alignment pins will be mounted with the electronic connectors on the payload to prevent pin bending and to keep the payload itself from rotation during insertion and extraction. This screw method also has the benefit of pushing the payload down in addition to having a gravity driven release. Drawings are currently

being developed and will be provided along with the electrical schematics. The position of the payload relative to the HASP gondola is unchanged from the proposed design, only how the payload is attached to the underside of the HASP plate.

2. Issues Encountered During Design

   With a stepper motor controlled release mechanism, the motor control circuit increases in complexity. The electronics team is currently working on the design and will be testing with the mechanical team within the month. With this new type of detach mechanism, thermal testing, drop testing on the ground, and flight drop testing are required. These tests add a significant amount of time into the design process. However, some tests can be performed with Arduino shields prior to the first revision of the custom electronics. These tests are also beneficial for the electronics team to see the status of the smaller payload and components during thermal and flight testing.

3. Milestones Achieved in January

   a. Design revised as per Antarctic science payload needs
   b. Detach mechanism improved
   c. PCB design started

   February Target Milestones

   d. First revision of custom PCBs ordered
   e. Bench test drop with stepper motor configuration

   Revised Integration Plan

   Two team members will be sent to integrate the payload in Texas. Integration will include:

   - Attachment of the payload to the HASP gondola
     - Testing both mechanical compatibility with HASP and the insertion method for the StratoPigeon capsule into the payload plate
   - Test of serial communications with HASP
     - Data downlink: Data strings including status of relays, temperatures, status of heaters, and status of detach
     - Command uplink: In normal operation, only 2 commands will be necessary; arm payload and release payload. All other payload functions will be automated and monitored by the integration team. In the case of malfunction during automated operation, the team can switch

the payload into a manual mode, where the following commands can be given:
    - Internal heater 1 % on
    - Internal heater 2 % on
    - Internal heater 3 % on
    - Motor heater 4 % on
    - Stop data transfers
    - Start data transfers
    - Arm for detach (Communications active)
    - Detach
- Test of payload radio communications
    - Will utilize hand held radio to test reception of tracking beacon
    - Repeater function on board main gondola will not be tested due to close proximity of payload to gondola and integration team
- Test of payload detach
    - Test for successful separation at cold/hot temperatures

Flight Plan

Three or four team members will be sent to Ft Sumner for the HASP flight. One team member will arrive several days prior to the others in order to set up communications equipment for the flight, the details of which will be worked out with CSBF personnel. (In the past we have set up communications equipment for an identical radio. It is our hope that we can propose the same set up. A detailed plan will be sent out in the coming months.)

Prior to the flight, upper wind data will be obtained for flight path prediction and payload descent trajectory prediction. A landing zone will be selected for the StratoPigeon payload 1-2 days prior to flight. Payload will be integrated with the gondola and a drop test for the payload will occur during the hang test prior to the HASP flight.

During flight, 2 away team members will track the payload via the HASP website and stay in contact with 2 team members remaining at base. Because the communications inside the payload will not be active until the payload is released, the HASP data will be essential for the tracking team prior to release. The 2 team members at the base will be monitoring payload data and making sure the data remains within designated limits. If the data is within limits, the base team should only need to issue arm, detach, and activate repeater commands. If the data is outside limits, a full manual mode will be used in which the ground team must issue all

commands for the payload including heater regulation, data transfers, and detach commands.

CSBF will be notified by the base team members approximately1 hr prior to predicted drop. 15 minutes prior to release, the arm command will be given and communications checked with the ground station and tracking team. The repeater on command will be given a few minutes prior to detach. Once the signal and GPS lock is confirmed, the detach command will be given. The tracking team and base station team will track the progress of the payload as it descends, giving altitude updates to CSBF as desired. Once the landing location is found, the tracking team will retrieve the payload.

4. Current Team Members and Leaders

The StrotoPigeon III payload is being designed, built, tested, and integrated by a long standing team called the Balloon Payload Team in the Space Systems Lab of the University of Maryland - Aerospace Engineering Department. Our Balloon Payload Program started in the Fall of 2003 after the Faculty Advisor, Dr. Mary Bowden, attended a "BalloonSat Workshop' in Colorado. The program has developed a balloon launch capability in Maryland that regularly launches freshmen payloads in the fall and payloads from other schools in the spring. We have now flown 33 tracked flights, most all with successful recovery of payloads. This team will be developing and testing StratoPigeon III, including at least one balloon flight in Maryland to test the new drop mechanism concept.

Team Members who will be actively participating in our HASP Payload development are as follows:

Dr. Mary Bowden – Faculty Advisor
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Connie Ciarleglio – Student Lead/Electronics Lead
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Chris Carlsen – Mechanical Systems Lead
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Our organizational chart (shown below) also includes some additional undergraduate students recruited from among the 28 freshmen payload designers who participated in our program last semester.