HASP Student Payload Application for 2007

Payload Title: Hawk Helping Accrue Space Practice		
Payload Class: (circle one) (Small) Large	Institution: Hawk Institute for Space Sciences	Submit Date: December 13, 2006

Project Abstract

The Hawk HASP small payload is centered around the UMES *Gateway to Space* course in spring 2007. Several payloads are included in this project development including: an accelerometer package, a camera, an experimental power system with solar cells, a sun exposure experiment, a wind experiment, a radiation experiment, and possibly an RF data transfer experiment. These experiments include high-volume data applications and low- to no- volume data applications. Onboard storage will be considered by the student designers. Using mentors from UMES, HISS, NASA Wallops and local industry, the students in this course will be graded on their ability to manage, plan, design, build, and test their HASP payload.

This small payload has its origins in a CubeSat concept. A CubeSat kit (4” cube-shaped microsatellite) will provide the structure to mount PCBs and experiments. This package will then interface mechanically and electrically to the HASP platform using a small adapter.

Funding for the spring 2007 course has already been secured by UMES and HISS. External funding for the summer integration & flight support is currently being pursued.

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High Altitude Student Platform (HASP)

Payload Flight Application

Hawk Helping Accrue Space Practice (Hawk HASP)

Hawk Institute for Space Sciences / University of Maryland Eastern Shore 2007
Submitted to LSU December 13, 2006

Payload Description

The HISS/UMES 2007 HASP small payload is a first-step in broader new program at UMES. This project is a stepping stone to a sustained microsat program, which uses balloon experiments as an integral learning aid. This HISS/UMES HASP small payload consists of several small experiments.

The first payload is an accelerometer package. This consists of several accelerometers, one inside the small HASP payload and possibly several others positioned at various locations on the HASP structure. Preferably one of these would be placed near the payload CG, to be coordinated with LSU HASP team. This payload will generate large quantities of data, digitally recorded onboard after monitored levels exceed a trigger level. This data will then be analyzed post-flight to characterize loads and vibrations introduced into the payload system, and how the frame which holds the small payloads reacts to these loads. Expected triggers include release from ground, unusual wind gusts, flight termination and ground impact. Note that these specific triggers assume the UMES small payload is powered during all of these flight events. A commanded or timed period during float at altitude will also be recorded to capture typical flight characteristics not associated with major load events.

Several other payloads are manifested, with direct applicability to future flights and the university's microsat program. These include a camera, a power system experiment, a sun exposure experiment, a wind shear experiment, and possibly a radiation exposure experiment and an RF receiver experiment. All of these experiments are fully contained within the requirements of the small HASP payload.

The camera will take pictures at specific intervals, thanks to a simple timer circuit. The pictures obtained will be used post-flight as practice for the students to analyze visual data to determine position over the earth, altitude achieved and pointing orientation. All of these skills are also transferable to the microsat endeavors.

The power system experiment consists of at least two solar cells sample, independently connected to two shunt resistors. In this configuration, the solar cell acts on an independent load which allows the true performance of the solar cell to be characterized. The solar cell will be instrumented with a temperature sensor. The cell's voltage and current will be recorded and can later be compared to predictions using sun angle information provided by coarse sun sensors (photodiodes).

The sun exposure experiment will also compare the coarse sun sensor (photodiode) data with pre- and post- flight optical properties of some materials, including paints. Real exposure times can be derived using the coarse sun sensor data, as the exposure area may occasionally be shadowed or not visible to the sun. Although the solar exposure duration at altitude is relatively short, this is proposed to be compensated by varying material thicknesses. The results of this experiment will be applied to material selection decisions on future balloon and microsat projects.

The wind exposure experiment will attempt to detect the shear winds, despite the balloon following local winds, and assuming constant altitude float. Although not designed to derive direction of the shear wind, this data will provide some useful information about the consistency of the wind shear, or presence of shear gusts, when cross referenced with the accelerometers data.

A radiation exposure experiment may also be manifested. This payload could be a passive dosimeter called RADiation Field Effect Transistor (RADFET), which would yield some

information on the total radiation dose to which the device has been exposed throughout the flight. Another opportunity is to fly a mini-UV absorption ozonesonde instrument in order to support an ongoing study about stratospheric ozone depletion.
An RF data transfer experiment is also planned, but not defined yet. This system would be independent of the commanding and data RF paths offered by LSU on HASP, and it would be implemented only if we will be able to prove that it would cause no interference with pre-existing communication systems. This experiment may consist of a ground and flight segment and it will utilize a custom receiver or transmitter and recorded data. One possibility for the testing is to validate a new transmitter design, of possible use on the future microsat, or detect very small Doppler changes, to be applied to future ground station studies.

It is possible that in order to run all these experiments and to record the data, the payload will have a simple, but reliable, circuit board and, eventually, a microcontroller.

These payloads will be integrated into a HASP small payload package. This package will consist of two major components: a CubeSat structure and components, and an interface plate. Some experiments will be mounted to the exterior of the CubeSat standard volume, but all except additional accelerometers will be contained within the volume defined by LSU for the HASP small payload. See attached drawings for further packaging details.
The thermal plan is to implement a passive design to the greatest extent possible. The use of specific thermal coatings, materials and practices is expected to minimize the need for survival film heaters. If needed, these heaters will be attached to components as required and controlled using an automated system, to prevent real-time monitoring and commanding requirements.

Team Structure and Management

The team is centered around the AVSC 288 *Gateway to Space* course offered at the University of Maryland Eastern Shore by Dr. Marco Villa in spring 2007. Students in this ½ lecture and ½ lab course will design and build components of the HASP payload. With the assistance of subject mentors from UMES, HISS and NASA Wallops Flight Facility, the class students will provide the majority of the project and payload management, design, and implementation. These students may also be tapped for summer flight activities and later for post-flight data analysis. For the spring semester, the students in this class will be graded on their ability to manage, plan, design, build, and test their HASP payload. Subject mentors will also conduct peer reviews, which are an excellent learning experience for students. The multi-experiment approach has been adopted to allow the students to deal with one small problem at a time, while having to consider the entire system. This approach will allow the team to have a flight unit, even if one or more single experiments will not be ready on time.

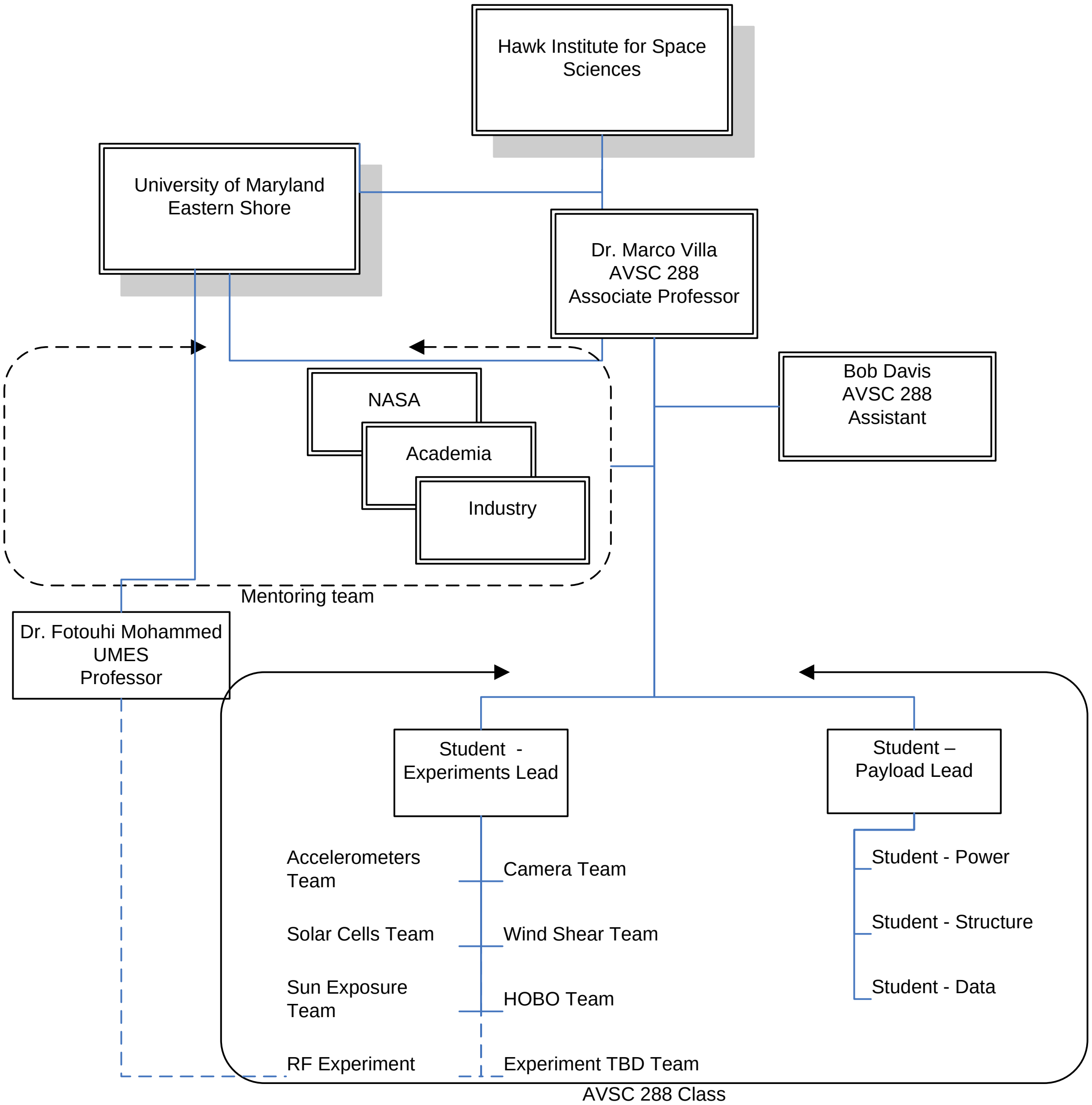


Figure 1 Hawk HASP Organization Chart

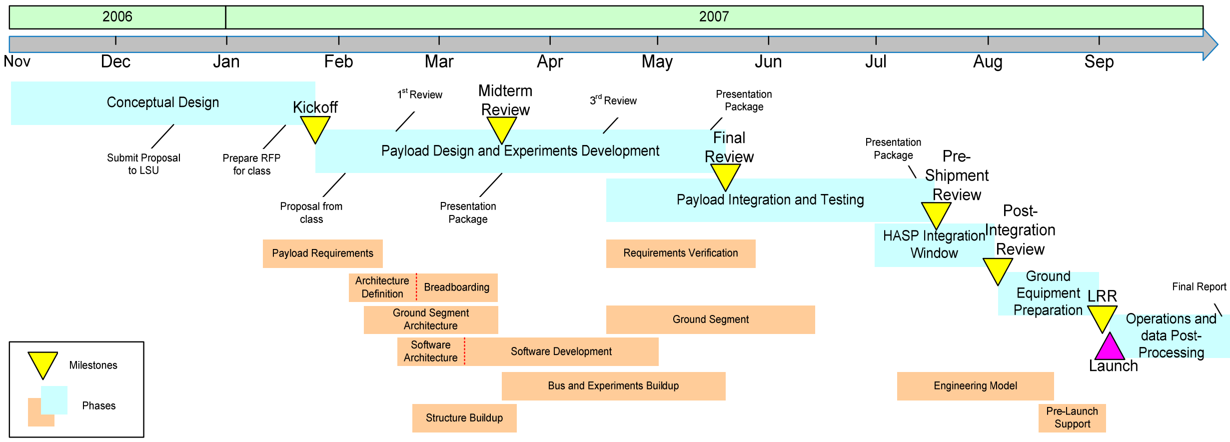


Figure 2 2007 Hawk HASP schedule

Payload Specifications

Because the payload will be developed as a class project during the spring semester, detailed information about budgets are not yet available. However, we are able to provide initial thoughts and mitigation plan to meet the constraints presented for the 1 kilogram payload.

<u>Mass Budget</u>

It is estimated that roughly 1/3 of the total mass available will be dedicated to the structure and the adapter plate. The next component with significant mass will be the camera, approx 160grams, and the HOBO, approx 30grams.

With the assumptions made above, we will have roughly 500 grams available for experiments and support items (batteries, wiring, etc…), which should suffice. In case the team will be ready with all the experiments, a trade will be done between altering the structure with a lighter version (trade the aluminum CubeSat kit for a custom "pink foam" approach) or split the experiment in two separate structures. With the second choice, we will then evaluate the possibility to fly both payloads on the same HASP flight in 2007, or have one on the 2007 flight and one available for future flights.

<u>Power Budget</u>

Since for the most part the experiments carried are passive, it is not envisioned a power need higher than the 0.5A @ 28V available through HASP. Also, to maintain independence between experiments, the team will pursue using independent batteries contained inside the structure.

<u>Downlink serial telemetry</u>

The use of the downlink telemetry is still unknown. The team is aware of the 1200 bps limit, and will respect it.

<u>Uplink serial command</u>

The use of the uplink is still unknown and as a design philosophy the team will try not to rely on any upload capability.

Additional data information

One of the experiments could involve an RF test in collaboration with another class offered at UMES. In the eventuality the payload will carry such experiment, the team will plan to limit any possibility to create interference with the HASP communication system, possibly opting for a receiver onboard, rather than a transmitter. In addition the team will present the design to HASP personnel for a review and approval.

Mechanical interface information

The Hawk HASP small payload has a number of sun experiments, and would want to be mounted upward facing and on the same side as the sun, if possible. This will allow for direct sun contact while minimizing shadowing from other neighboring payloads.
The Hawk HASP modifications to the small payload mounting plate tentatively only add 4x mounting holes. Positions to be confirmed during Spring semester. 4x bolt heads will protrude below mounting plate for securing the Hawk HASP Adapter Plate.
The optional remotely located accelerometers can be glued to a short length of kapton tape, allowing for easy removal post-flight. The exact positions of these will be coordinated with LSU.

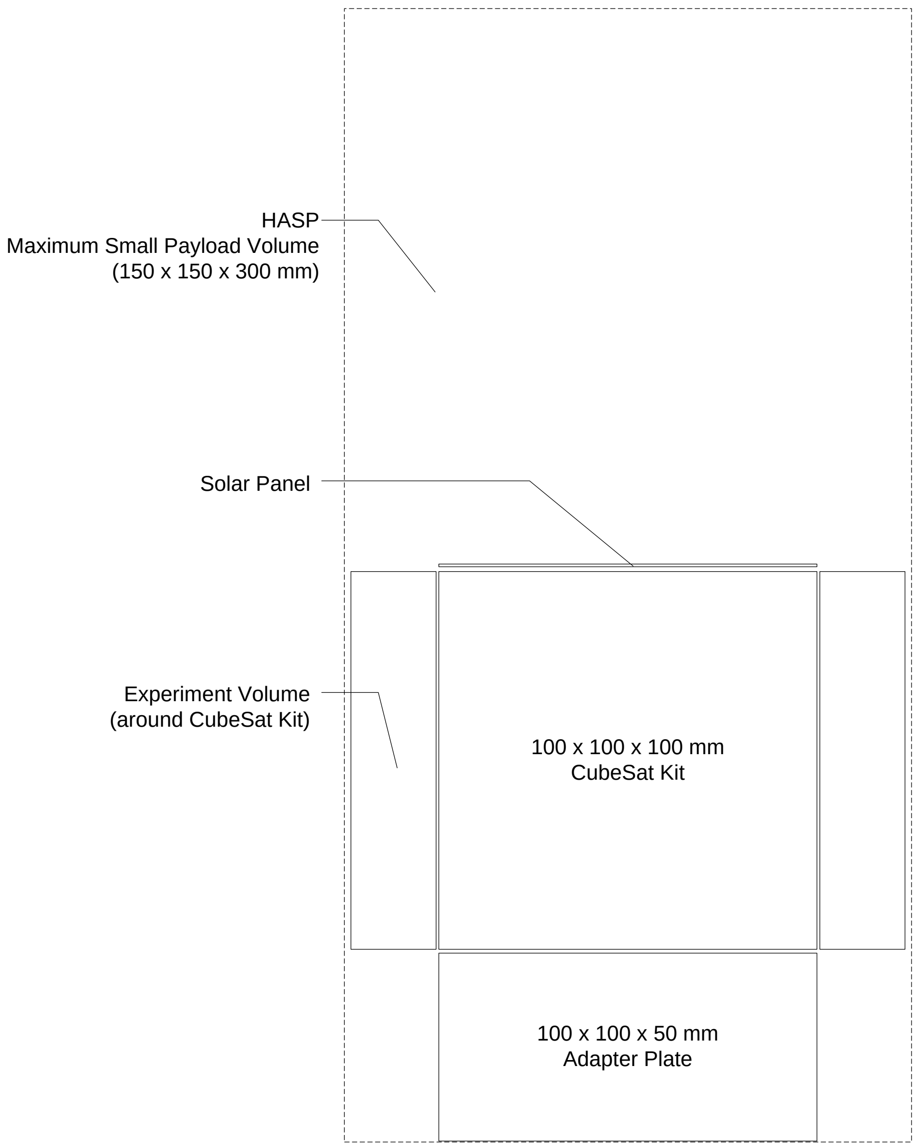
Integration and operations procedures

Starting from the integration and test of every single experiment, the students are requested to have a simple, but comprehensive, procedure to follow. The same approach will be used for the payload integration and "system" testing.
For HASP integration the team will have a procedure that will be followed to interface mechanically and electrically with the platform. The procedures will be coordinated with the LSU team and will be rehearsed prior to final use.
If needed, the UMES operations team will use drawings and procedure for the setup of any ground support equipment. When available the team will submit the documents to the HASP team for review and approval.

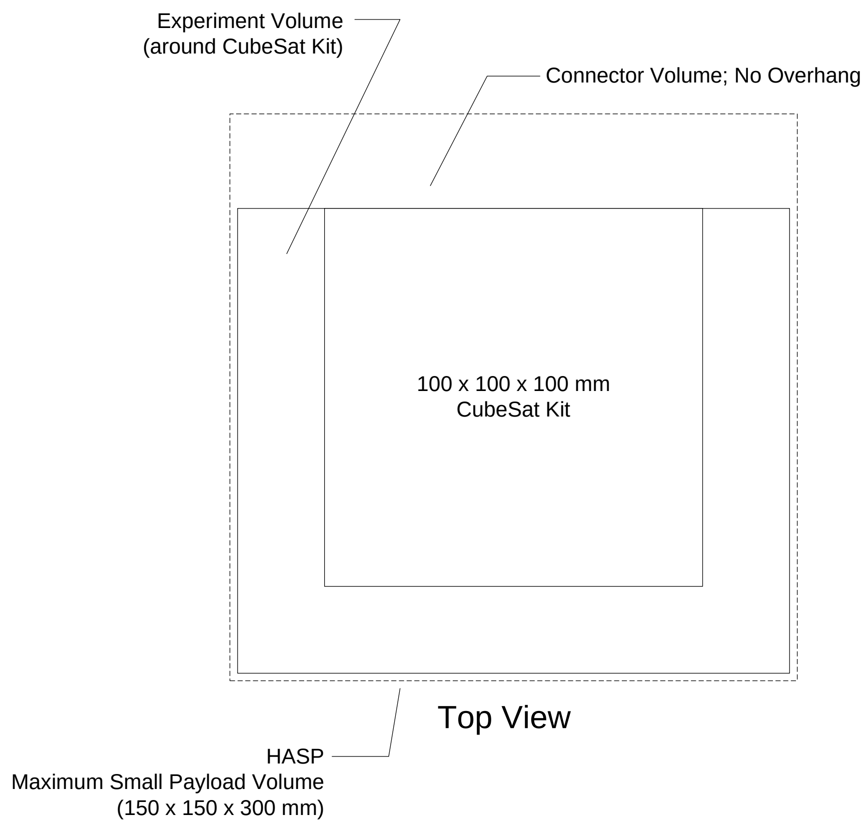
Drawing Attachments

HASP Volumes (and Identification of Major Components) Drawing

Mounting Plate Drawing



Side View



Top View

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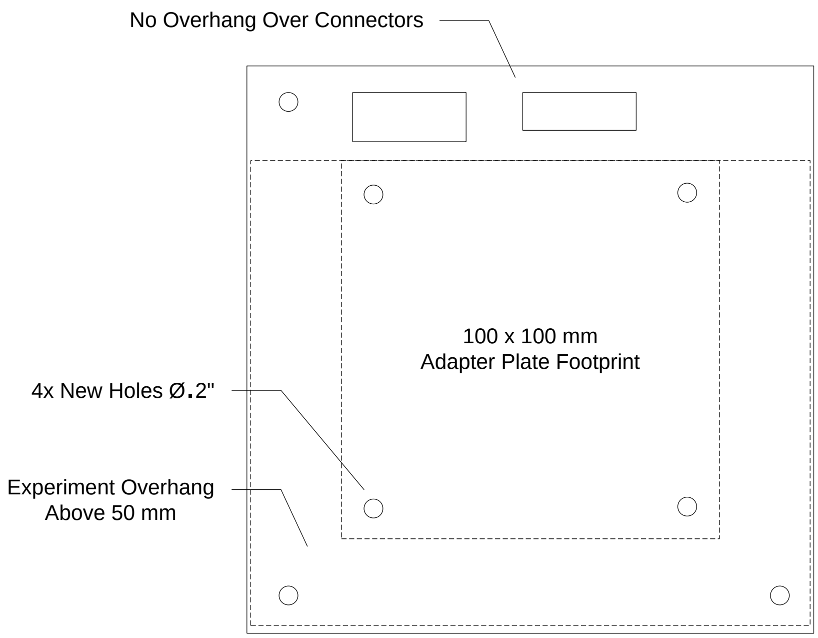

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