HASP Student Payload Application for 2008

Payload Title:
HawkHASP 2

Payload Class: (circle one)
[✓ Small] Large

Institution:
Hawk Institute for Space Sciences

Submit Date:
12/17/2007

Project Abstract:

The Hawk Institute for Space Sciences and the University of Maryland Eastern Shore are sponsoring a course in Spring 2008 called Gateway to Space. This course will include lab content to design, build and document the HawkHASP Small Payload. After the course, HISS and UMES will sponsor students to continue integration, test, flight and flight analysis. HawkHASP will include a variety of experiments.

1a) Comparing a space-rated solar cell and a terrestrial solar cell.
1b) Cells or photodiodes on each side for HASP orientation.
2) Digital camera for orientation, altitude, ground track, and algorithms applicable to processing photos taken from low earth orbit.
3) Triaxial accelerometer for recording flight events, and may be useful in further understanding the responses of Small Payloads on the HASP structure.
4) RF payload on amateur radio band. Inclusion of this payload requires volume exceedance. If not granted, then this payload will likely be removed. Coordination with LSU needed.
5a) External temperature sensor for comparison with Standard Atmosphere.
5b) Internal temperature sensor(s) for health monitoring and evaluation of insulation.

Team Name:

Team or Project Website:

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High Altitude Student Platform (HASP)

Payload Flight Application

HawkHASP 2008

Hawk Institute for Space Sciences / University of Maryland Eastern Shore

Submitted to LSU December 15, 2007

The HawkHASP Small Payload is part of a larger program at the Hawk Institute for Space Sciences and the University of Maryland Eastern Shore. The balloon payload will be used as an introduction to topics applicable to the HawkSat CubeSat (microsat) under development.

Payload Description

The first experiment is a continuation of the solar cell comparison which flew in September 2007. The comparison will again be between a space-qualified solar panel and a terrestrial panel. This experiment explores the features of a solar panel which are required for space flight, such as UV tolerance, wide temperature range, exposure to vacuum, and others. The 2007 flight had single-junction Gallium Arsenide (GaAs) spare space-rated cells and a terrestrial flexible silicon panel. The 2008 flight will include panels with triple-junction cells selected for use on the HawkSat cubesat (cube about 4” on a side) and terrestrial alternate cells. Additionally, a cell or photodiode will be placed on each of the four sides of the payload. This solar data will be analyzed post-flight to report the spin properties of the HASP ballooncraft flight. This process is also applicable to determining the orientation and tumble rate of the HawkSat cubesat once in orbit. The total flux can also be used to roughly determine altitude.

A second experiment is a digital camera. The camera will be triggered using a timing circuit to produce a specific interval. The photos will help us confirm the orientation data collected from the solar cells, the altitude based on the atmospheric characteristics, and position over the earth. Algorithms will also be explored to triangulate position of camera, using earth features. This is applicable to the processing of cubesat data.

The third experiment is a three-axis accelerometer logger. This experiment is in conjunction with our Code 548 partner at NASA Wallops Flight Facility. Flight shock and quasi-static loading will be logged and post-flight compared to the analysis requirements of 10 G vertical and 5 G lateral. The natural frequency of the support frame for the small payloads will also be determined. Some useful characteristics of the ground preparation, balloon release, ascent, free fall, parachute opening, and landing may be extracted from this data. The availability of this experiment is dependent on support from NASA WFF.

The fourth experiment is an RF payload in conjunction with our AMSAT partner and possibly a separate RF course. This RF payload may be a demonstrator unit of SuitSat 2, for future free-flight release from the International Space Station. The unit would include both the transmitter and possibly receiver, both operating on amateur radio frequencies. The transmitter power (on/off) will be toggled via HASP command of power on/off to the HawkHASP. The antenna may be omni-directional about 0.5 Watt around 146 MHz (2 meter “VHF” band). It is recognized that this payload has special characteristics that must be coordinated with the HASP team, including frequency coordinating, and antenna protrusion from the Small Payload volume allotment. This RF payload has the capability of additional serial data, but this feature may not be included in this flight. If included, there’s potential for additional sensors and/or real-time downlink of telemetry. This flight of this payload would be advertised to amateur radio operators within the ground track of the projected flight path. The payload may include packet, GPS and APRS components. The availability of this payload is dependent on delivery from AMSAT.

The fifth experiment is an external temperature sensor, and at least one internal temperature sensor. To help maintain the stability of internal temperatures, consideration will be given to using a thermostat. The external temperature sensor will be used later for correlation to the Standard Atmosphere. The internal temperature sensor(s) will be used to determine gradients experienced by flight electronics.

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 Ron Bettini in spring 2008. Students in this ½ lecture and ½ lab course will design and build components of the HASP payload. Assistance will be provided by two interns, both of whom participated in the 2007 HASP payload. Subject mentors will also available from UMES, HISS and NASA Wallops Flight Facility. Once again, mentors will be tapped to help students in design trades and peer reviews. The students will be separated into different groups to handle the various experiments.

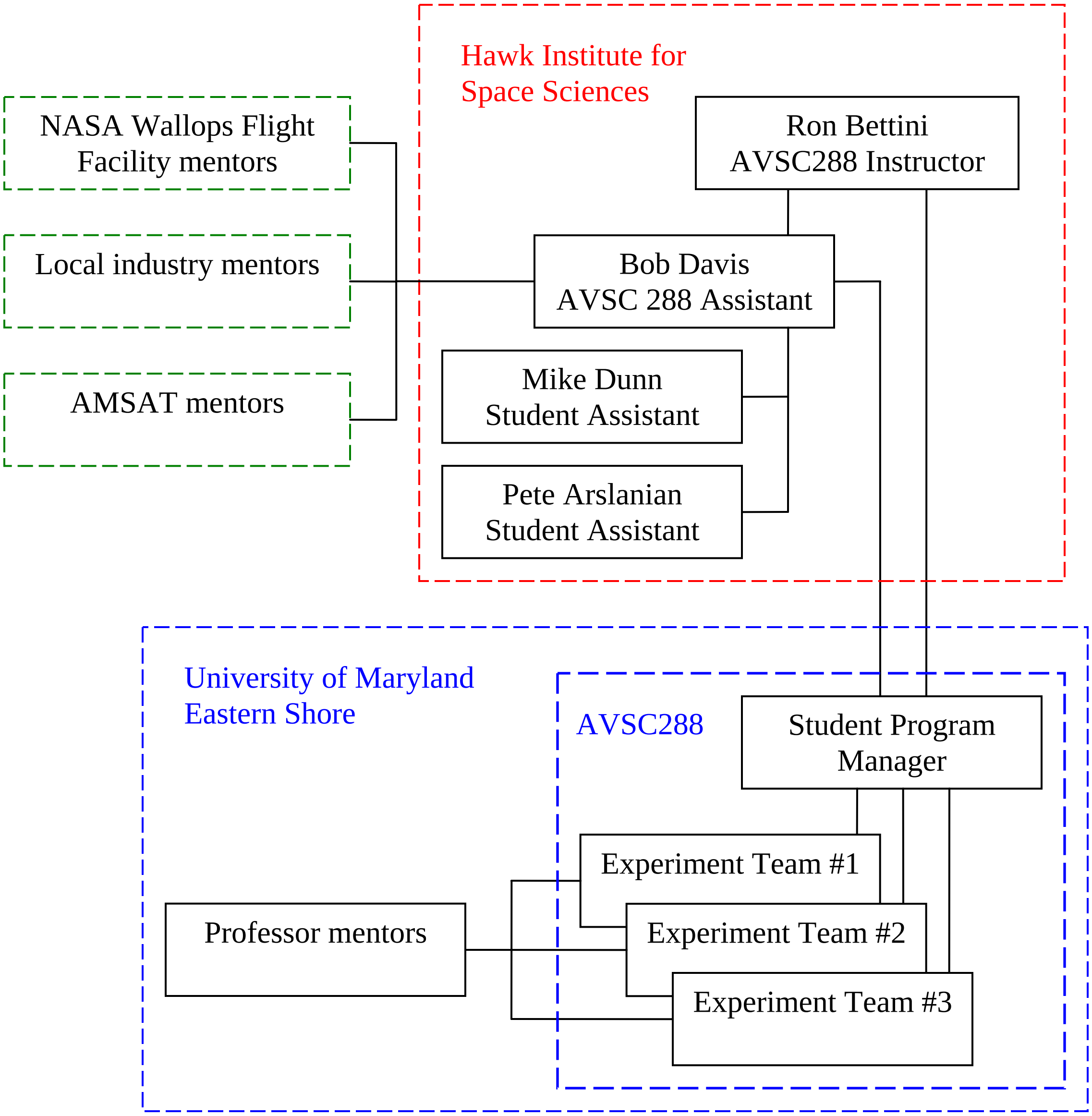

Figure 1 HawkHASP Organization Chart

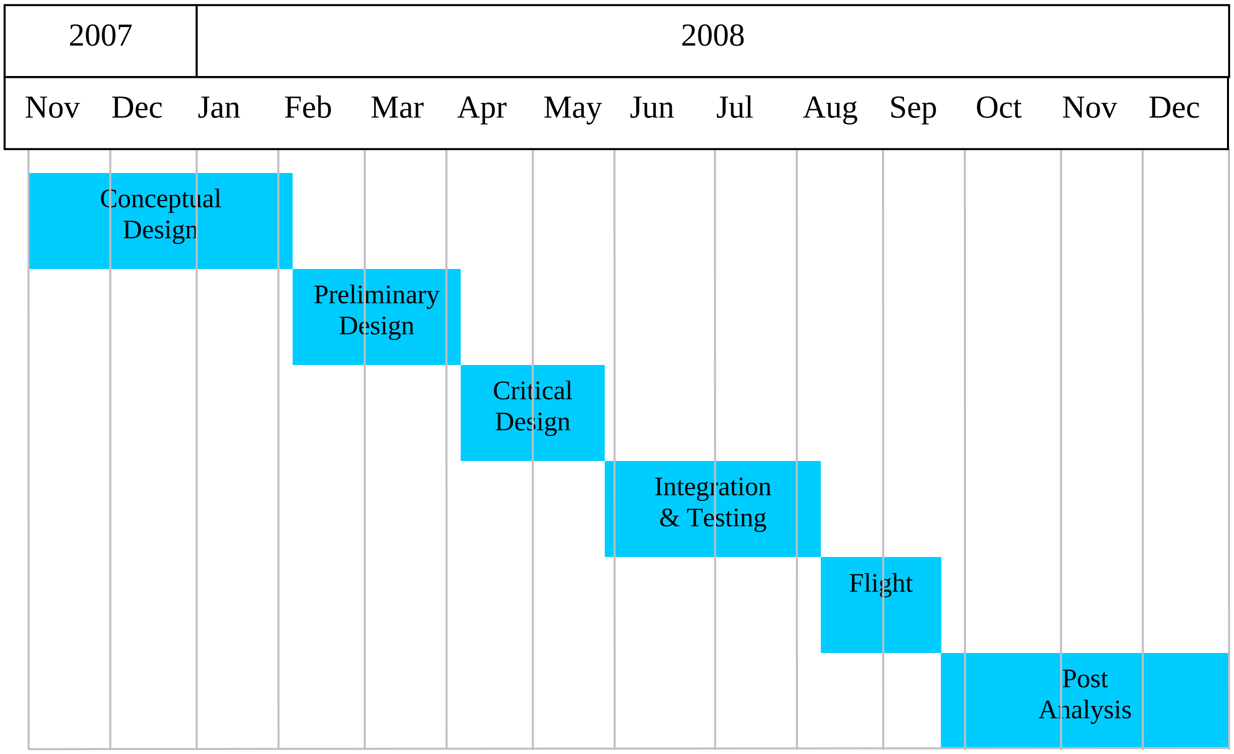

Figure 2 HawkHASP Schedule

The hardware purchases for HawkHASP Small Payload will be sponsored by UMES, with budget cap.
Student Assistants will be funded by HISS.
The travel expenses for integration to HASP in Texas, and the flight in New Mexico, will be sponsored by remaining funds already obtained from the Maryland Space Grant Consortium.

Payload Specifications

Power

The HawkHASP small payload will use the supplied 29-33 VDC, up to 0.5 amps (at 30VDC). Some small self-contained components, such as a portable logger or camera, may include small batteries. Any battery powered components may remain switched manually regardless of status of power provided by HASP. These would be “coin” style batteries that would not pose a risk to our payload or the HASP ballooncraft.

Mass

The HawkHASP small payload will be near the 3 kg weight limit.
If included, the RF payload will dominate the weight. If the RF payload is not included, then HawkHASP will likely delivery well below the 3kg weight limit.

Volume

The HawkHASP small payload may seek a volume exceedance to incorporate the RF payload. The potential exceedance would be two fold.

Above the Baseplate, the limit of 15cm x 15cm x 30cm (must be coordinated) may be exceeded to approximately 25cm x 25cm x 30cm. This exceedance is to accommodate the RF payload without requiring this payload to re-package. The exceedance would be spaced sufficiently above the Baseplate as to not change its interface, or cause interference with the standard connector positions or HASP structure.

Below the Baseplate, additional volume may be requested to a hanging whip antenna. This whip would be flexible (probably custom), and may not point straight down (which creates signal null directly under HASP for users on the ground). The antenna would attach through a hole in the Baseplate.

Baseplate

Regardless of approval status or magnitude of volume exceedance request, the Baseplate supplied by LSU will be used and the attachment footprint will not be exceeded. If the RF payload is included, then the whip would attach through a hole in the Baseplate, approximately centered. The HawkHASP Small Payload will likely attach to the Baseplate using four corner bolts.

Downlink serial telemetry

The HawkHASP Small Payload is unlikely to use the downlink serial telemetry.

Uplink discrete commands

The HawkHASP would have appreciated an additional uplink discrete pair, however these are not supplied to Small Payloads. Had this been available, it would have been used to toggle the proposed RF transmitter, without otherwise affecting operation of the remainder of the HawkHASP Small Payload.

Drawings

The following drawing is conceptual only. The students in the spring Gateway to Space Course at UMES will complete drawings as part of their design documentation. The correct drawings will be submitted in time for LSU to respond for formal request for volume exceedance.

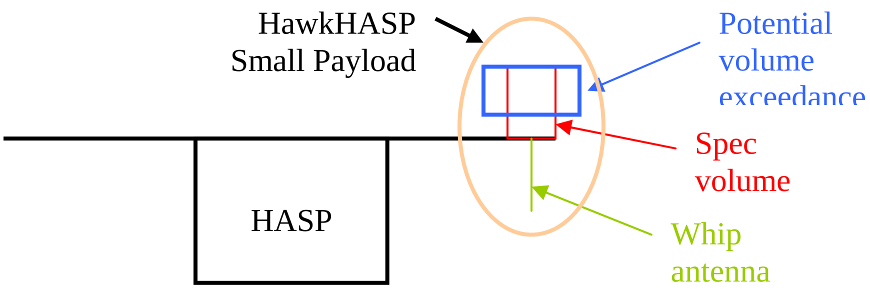

Figure 3 HawkHASP Side View

Lessons Learned from 2007 HawkHASP

Last year's 2007 flight opportunity was a learning experience for the course instructors, mentors and students. That experience will be applied to the 2008 flight opportunity.

Technical improvements will include:

1) Selection of terrestrial solar cell for greater likelihood of survival.
2) More comprehensive environmental testing program is needed for digital camera and associated power supply prior to integration to HawkHASP.
3) Accelerometer package inclusion in 2007 was too aggressive given student resources. In 2008, NASA Wallops Flight Facility mentoring has been pursued.
4) Pyranometer (pointing upward) may not provide data not otherwise collected by a solar cell.
5) Internal heater needs better control and/or placement.
6) Multiple internal temperature sensors may be useful (gradients or individual packages).
7) Foam exterior and optical properties require greater understanding of environment, and minimal testing prior to delivery.
8) Synchronization of data: HASP-recorded and HawkHASP recorded, and time-stamping photos.

Managerial improvements will include:

1) Scheduled duration of Preliminary and Critical Design phases will not be allowed to slip. This substantially reduced available schedule for testing.
2) Greater emphasis will be placed on maintaining documentation on schedule.
3) Non-performing experiment teams will be disbanded sooner.
4) More time will be invested in understanding weekly progress of experiment teams.
5) Scope of project will not be underestimated.