HASP Student Payload Application for 2008

Payload Title: University of Maryland Advanced Balloon Communications Experiment (UMD/ABC)

Payload Class: (circle one)	Institution:	Submit Date:
[✓ Small] Large	University of Maryland, College Park	12/18/07

Project Abstract:

Reliable communications are a key requirement for successful sounding balloon flights being operated by an ever increasing number of universities and Space Grants. GPS tracking beacons are now very common, but there are many projects and experiments that could benefit from telemetry similar to that provided by HASP's mini-SIP.

The University of Maryland and Maryland Space Grant have been developing a next generation system that provides a total downlink of 9.6-128 kbps. This system has been flown numerous times with great success. The same team that designed the new system is also responsible for launching balloon flights in Maryland and it has proven difficult to properly characterize the communications link and to analyze antenna performance while trying to track and recover the payloads.

A HASP flight opportunity would allow for the proper characterization of the equipment.

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	www.nearspace.net

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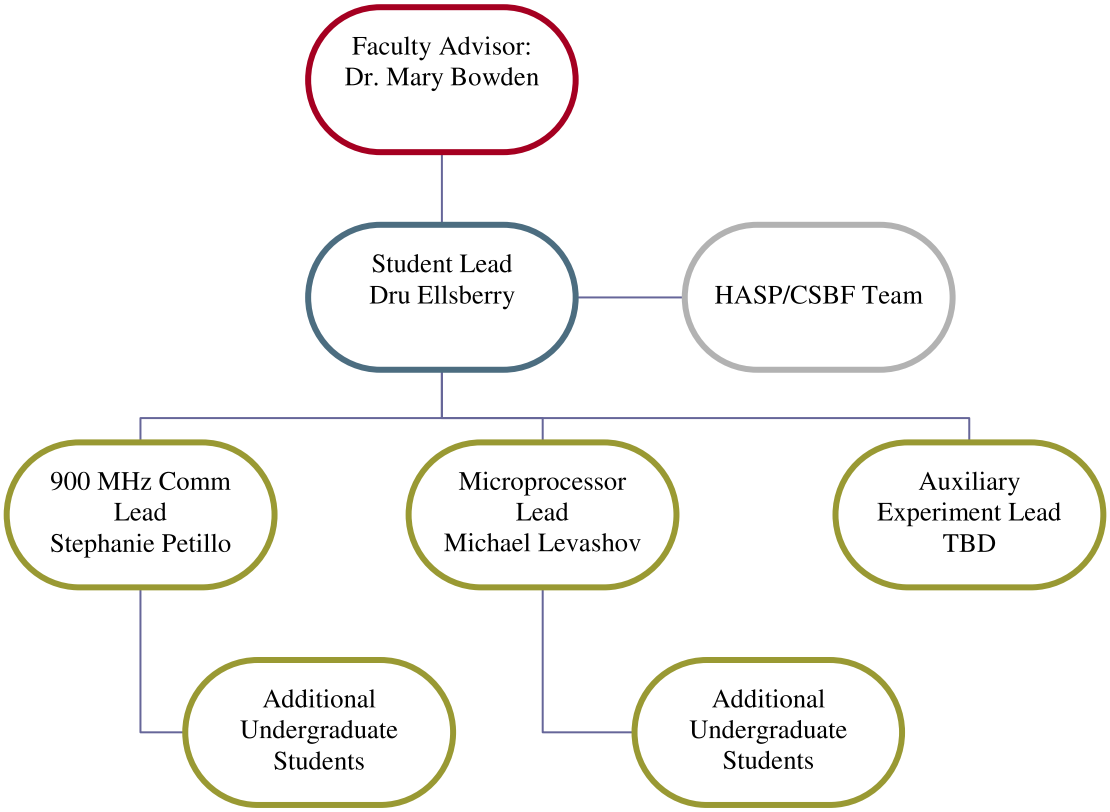

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Overview

The objective of this experiment is to characterize the performance of a new generation of radios for use on simple sounding balloon payload flights which are being flown by or for an ever increasing number of universities and space grants across the country. This new system, already designed and being tested by Maryland Space Grant's Balloon Payload Program, has 2 components, a short range 2.4 GHz network which communicates between multiple balloon payloads attached to a single payload string, and a 900 MHz downlink channel that communicates from the balloon to a ground station or recovery team. The two networks combine to form an affordable system for providing telemetry downlink, similar to that afforded (supplied?) by HASP, on any midsize sounding balloon flight, dozens of which carry student payloads every year.

The payload proposed here to fly on the 2008 HASP flight will test the 900 MHz radios and determine their maximum range at different baud rates and with different antennas. This data will allow the design team to determine the optimal flight configuration for different launches based on the predicted range of that flight and the required data rates of the manifested payloads.

Thermal Control

Past experience with this hardware has shown that the active components actually produce excessive heat if operated at significant duty cycles. Heat sinks will be attached to the radios and microprocessor and each component will have a temperature monitor. The payload will undergo significant testing in a thermal chamber, a thermal vacuum chamber, and on short sounding balloon flights to ~100,000 feet, but without the long stay at altitude. If it is determined that additional heating is needed for any component for the long duration HASP flight, a simple electro-resistive heating element running off of the 30v line and controlled by the processor will be added.

Structure

Most past payloads designed by the UMD team have been constructed out of various foam materials for ease of fabrication, thermal insulation, and to minimize potential damage on landing. For the HASP flight, the team will be doing some testing in a thermal vacuum chamber and outgassing concerns will prevent the team from using foam. For this reason, the payload will be fabricated from aluminum, with a frame to support the payload components and side panels covering each of the 5 exposed sides. The end result may appear similar to a "cube sat."

Power System

A DC-DC power converter will provide 5V power to most of the systems including the 900MHz radios, and GPS. The microcontroller will be powered by a 3.3V linear regulator (low drop out) attached to the 5V voltage line to minimize losses. Maximum current draw at 5V is about 2 Amps. With a converter efficiency of 80% (conservative), this will result in current draw at 30V of about 400 mA.

Microcontroller

The microcontroller will be a ColdFire (68K) preassembled core module. It will control all of the radios onboard along with collecting and recording data for later analysis. All data and both transmitted and received communications will be stored on a SD Flash Card. One of its serial ports will also be used to communicate with the HASP mini-SIP and through it be commandable from the ground through serial commands.

Radios Communications

The payload will contain 2 identical 900 MHz Radios. One will be connected to a simple omnidirectional "whip" antenna, while the other will utilize a high gain "patch" antenna pointed towards the ground. The radios will be controlled by the microcontroller and switched throughout the flight between 9.6 and 128 kbps operation.

Sensors

The payload will include a GPS unit and a digital compass. The GPS will provide the location of the balloon during the flight at 1Hz. A digital compass will provide information on the orientation of the payload that can be used to analyze the effects of antenna polarization and also the effects of possible interference from the gondola (including blocking the line of sight).

Auxiliary Experiment:

The primary purpose of our payload is to test radio communications which require the handling of large amounts of data. Much of the data, however, is not significant to the research and could be random noise. We are looking to take advantage of this and carry a small (< 500 gram) experiment that will interface simply with the microcontroller's A/D or a serial port. Potential users could include a UMD student doing his senior research thesis, one of UMD's partner institutions in MDSGC's Balloon Payload Program, or a different department at UMD wishing to test a sensor or the like. This auxiliary experiment will be simple and will not have a significant effect on HASP, but it can be removed if it would affect selection for a HASP opportunity. We are pursuing opportunities in this area in an attempt to provide the maximum utilization of a HASP flight opportunity.

Telemetry

The payload will communicate to the ground primarily over the serial connection with the gondola. Due to high volumes of data being exchanged (up to 128 kbps on one radio), we expect to saturate the 1200 baud communications link and are requesting a 4800 baud connection, but this will not prevent the payload from flying if not approved. The analog telemetry lines will be used to monitor the 5V power supply from the DC-DC converter (across a voltage divider) and from an analog temperature sensor. The discrete commands will be used to turn the payload on and off. This is important as it will allow us to shut the payload down if it is determined that it is causing unforeseen interference with other payloads on the mini-SIP.

Payload Characteristics Summary

Payload Mass	~2.5 kg
Power Draw @ 30v	400 mA
Payload Size	Small
Payload Dimensions	15 cm x 15 cm
Payload Height	15 cm*
Payload Orientation	Pointed Down (Toward Ground)
Serial Commands?	Yes
Serial Telemetry?	Yes
Analog Telemetry?	Yes
Discrete Commands?	Power On / Power Off

*Does not include detachable 900 MHZ whip antenna

Timetable:

- Mid January – Early March: Finish detailed design and complete fabrication.
- March – April: Testing & Modifications (includes thermal vacuum tests and sounding balloon flight)
- Early May: End of Semester & Finals (little work will be completed!)
- Late May – Early June: Final Packaging & Shipping to CSBF
- Late June: Payload integration at CSBF
- Late August – Early September: Support Launch of Payload

Payload Integration:

We expect to send 1-2 team members to CSBF in June to integrate the payload with HASP. This will consist of physical mounting, testing the electrical and digital connections, and testing with the radios to insure that they will not interfere with the mini-SIP on HASP.

Flight Operations:

We hope to send 3-4 team members to CSBF for the launch in August/September. This will allow for testing communications both from the launch site and also from a mobile “chase” vehicle (one driver and one operator). If funding is scarce or scheduling difficult, we may be forced to send only 1-2 team members and settle for testing communications from 1 ground station at the launch site. During the flight, team members will monitor the payload health and work with the HASP/CSBF team to send necessary commands to the payload. Additionally, there will be significant testing to determine receive range, reliability (packet loss), and signal strength from our 900 MHz radios with different ground radios. This will take place from the CSBF parking lot, unless a more appropriate location can be found that will help either the testing or communications with the HASP/CSBF team.

Special Requests:

We have two special requests for the HASP flight: a waiver to the height limit of 30 cm and an upgrade of the serial connection from 1200 baud to 4800 baud.

The height restriction will make it difficult to fly with the COTS omnidirectional (whip) antenna we whish to characterize as, depending on the final antenna mount point, the antenna may exceed the height envelope by up to 2 inches. The antenna is similar to those found on a common WiFi router. It can be rotated and articulates at the base in addition to being removable. Alternative mounting or antenna configurations are a possibility if the exception is not granted, but they will limit the fidelity of the experiment to characterize its "nominal" operation.

The second request is a serial connection at 4800 bps instead of the 1200 bps allocated to small payloads. This is based on the large amount of data being handled 128 kbps and what we anticipate sending to the ground. A 1200 bps link will not be a major detriment to our experiment, but we would appreciate the faster connection if it is a simple configuration adjustment.

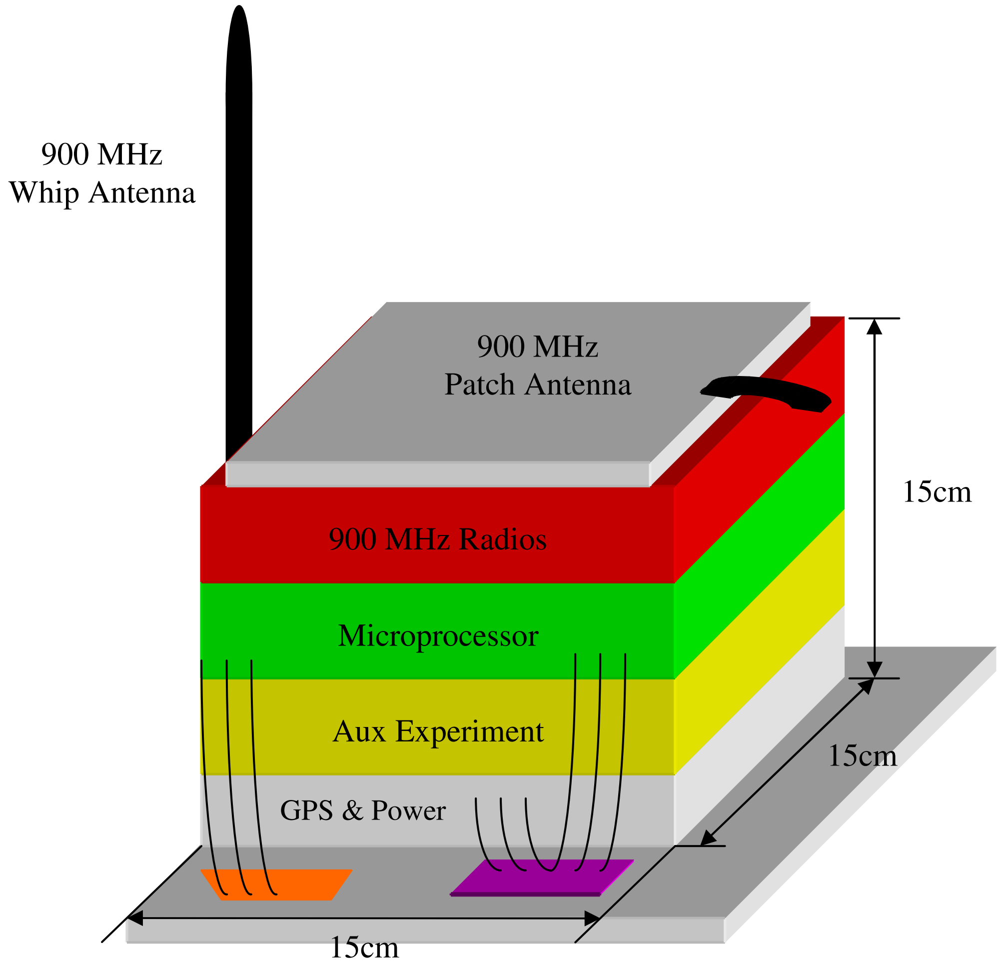

Figure 1: Payload Diagram (Note “Top” Faces Ground)

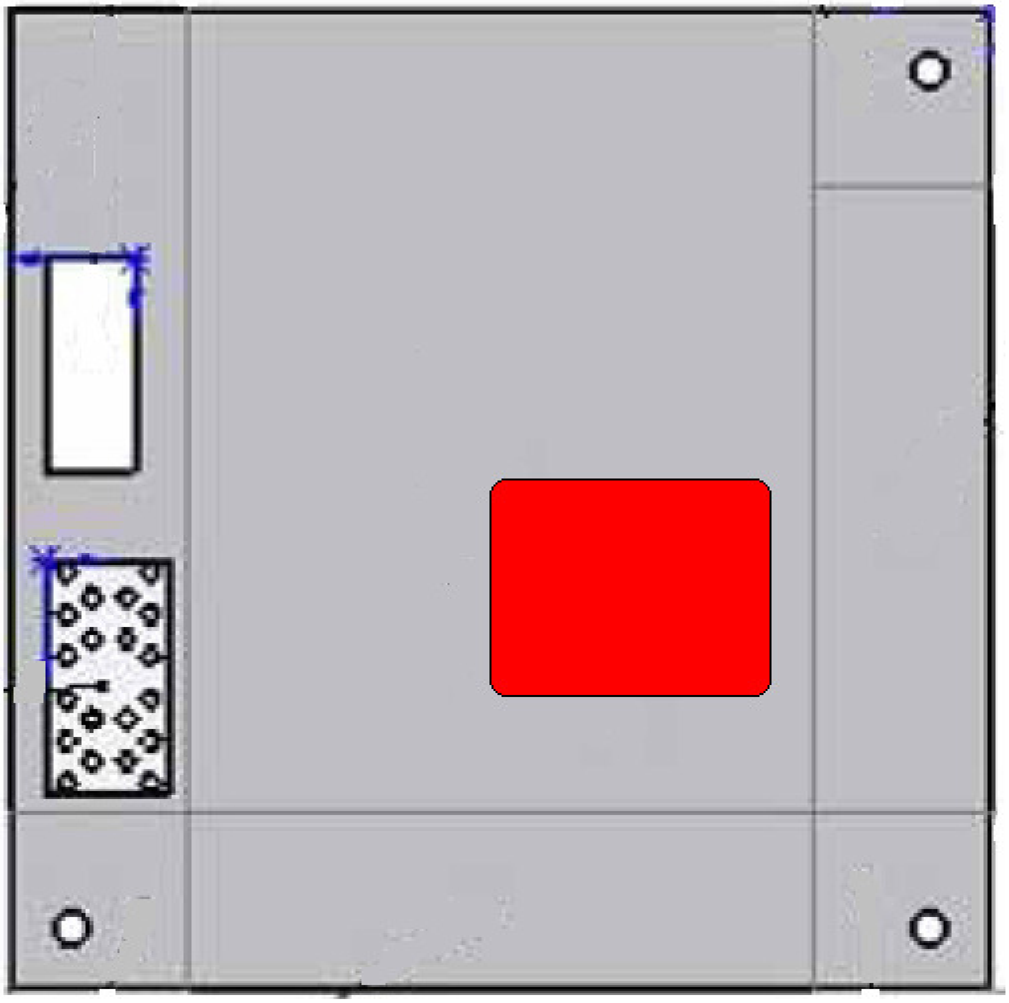

Figure 2: Location on Reverse of Mounting Panel for GPS Antenna

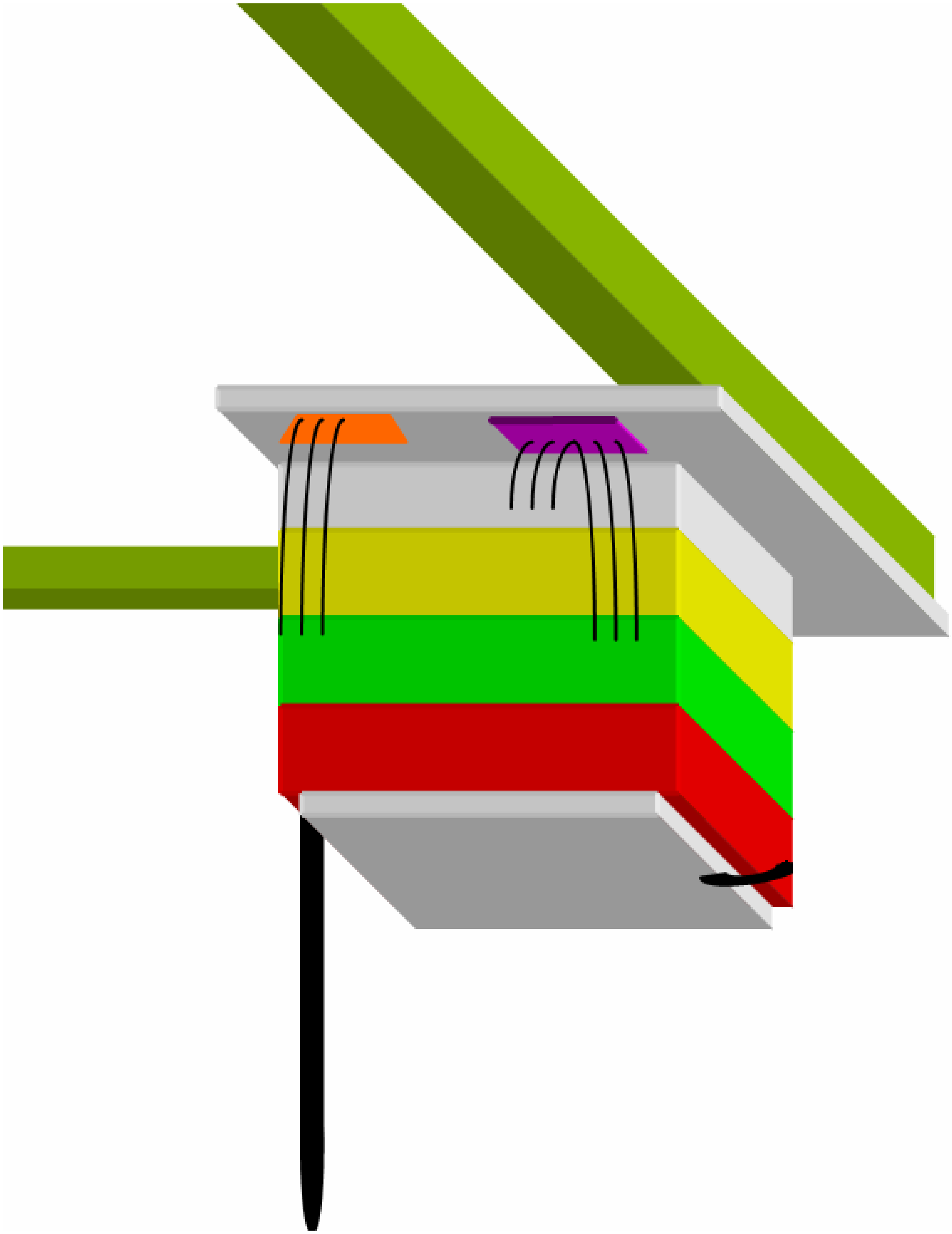

Figure 3: Small payload position, oriented pointing down