HASP Student Payload Application for 2009

Payload Title: Cajun Probe I		
Payload Class: (circle one) (Small) Large	Institution: University of Louisiana-Lafayette	Submit Date: 11/23/2008

Project Abstract

The Cajun Probe I team seeks to build a compact payload with various sensors and detectors that in the near future will be implemented into a probe. The payload will include sensors such as temperature, humidity, pressure, a accelerometer, an altimeter, a GPS device, and other detectors such as a Geiger Counter. HASP provides an excellent platform to test the payload and gain benchmark data that will be used in the future for comparison. The objective of Cajun Probe I is to design and build a probe(s) to be ejected from a Rocket that is traveling over a hurricane. This project will provide a way to better understand Hurricanes and predict their nature and path in hopes to better inform the area affected.

Team Name: Cajun Probe	Team or Project Website:

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Project Summary

University of Louisiana at Lafayette (UL Lafayette) Cajun Probe team would like to participate in HASP 2009. Since 2004 we have been participating in high altitude balloon flights through LaAces and HASP. Also in June 2008, we were the only Louisiana team to participate in the RockOn 2008 Workshop where we built a payload that flew on a sounding rocket. For HASP 2009, we plan to build a compact payload that will contain a multitude of sensors which will eventually be integrated into a probe. The sensors will include a Geiger Counter, temperature sensor, barometric pressure sensor, humidity sensor, altimeter, accelerometer, and a GPS device; all of which will be recorded on flash memory and sent back to Earth. The construction and testing of this payload is part of Mark's Master's thesis.

The occurrences of natural disasters have and will always plague the world throughout time. Unfortunately it is beyond anyone's ability to control these phenomena; however, it is within our ability to understand and predict this phenomenon. In this particular case, we are looking to better understand and model the workings of hurricanes/thunderstorms.

As some may currently know, radar planes already fly through a hurricane at a particular altitude and collect data. This process is repeated at different altitudes such that the radar plane gathers horizontal slices of the storm. These horizontal slices are then interpolated to form a 3D model of the hurricane. As one can imagine, this is a rather dangerous job.

While hurricanes can be as large as 50,000 feet high, Hurricane Hunters are only interested in the part of the hurricane that has an effect on land. Thus they fly at an altitude of 10,000 feet or less (The Lockheed-Martin WC-130J aircraft has a maximum altitude of 30,000 feet). However, to better fully understand and model the storm for a more accurate prediction, the entire system must be considered. This is obviously beyond the limitations of the Hurricane Hunters, hence the necessity for this very proposal.

Phase Two of Mark's thesis is to launch a sounding rocket over a hurricane and drop probes through it at various spots yielding vertical slices of data which Mark can interpolate into a complete 3D model of the storm. This could potentially allow for a more accurate hurricane model capable of more accurate predictions.

Project Narrative

Introduction

Thus the objectives of the Cajun Probe I project are as follows:

1. Develop a payload that will be integrated into a probe
2. Testing of payload under space conditions
3. Obtain data to form a baseline for comparison of future testing and launches

These objectives will be carried out by developing a payload which the exact specifications have yet to be determined; however, the payload will fit within the size and weight restrictions for a small payload. Separating the payload into these specific subsystems shown in Figure 1 makes the construction, programming, and integration much easier. Keeping all power components separated from the rest of the components will help reduce any interference produced by the DC/DC converters.

The power board will be a similar design to the design and implementation Mark used for his work on the UL Lafayette's Pico Satellite. However, instead of using a system of solar cells and lithium ion batteries to charge and power both the Pico Satellite and the batteries, the power will just be received from the bus supplied by HASP.

Because all subsystems are fed by one DC/DC converter, DC/DC converters are a common failure point in the system. A simple solution that will be implemented is having redundant DC/DC converts with a MOSFET as shown in Figure 2. Using an N-type MOSFET with the gate attached to the output pin on the origin DC/DC converter is one solution. If the DC/DC output signal reads zero; the MOSFET will start the redundant DC/DC converter with the same output voltage. The redundant DC/DC converter will remain unused if nothing fails.

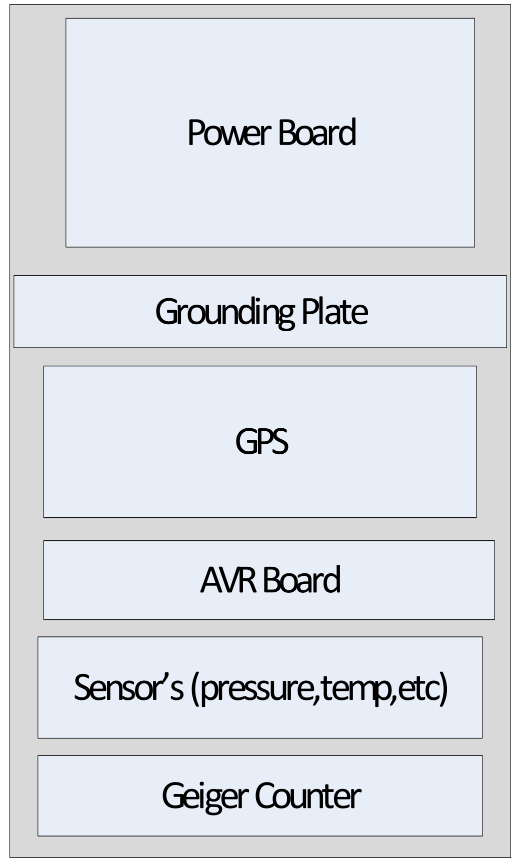


Figure 1. Preliminary layout of what the payload

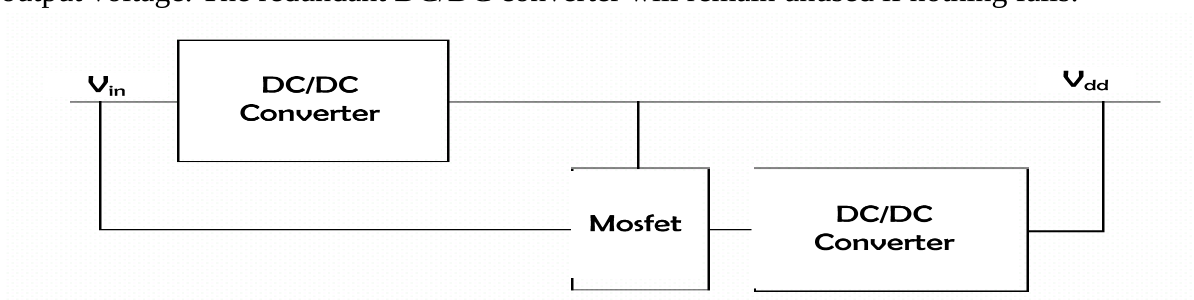


Figure 1 Diagram of the **r**edundant DC/DC converter with a MOSFET switch..

Objectives

The objectives of this experiment are as follows:

1. Design of robust, compact payload to latter be integrated into a probe.
2. Design of platform to mount payload onto.
3. Testing of payload's durability and performance under space conditions.
4. Obtain data for a baseline of future experiments.
5. Analyze data for use of future experiments on sounding rockets.

Sensors

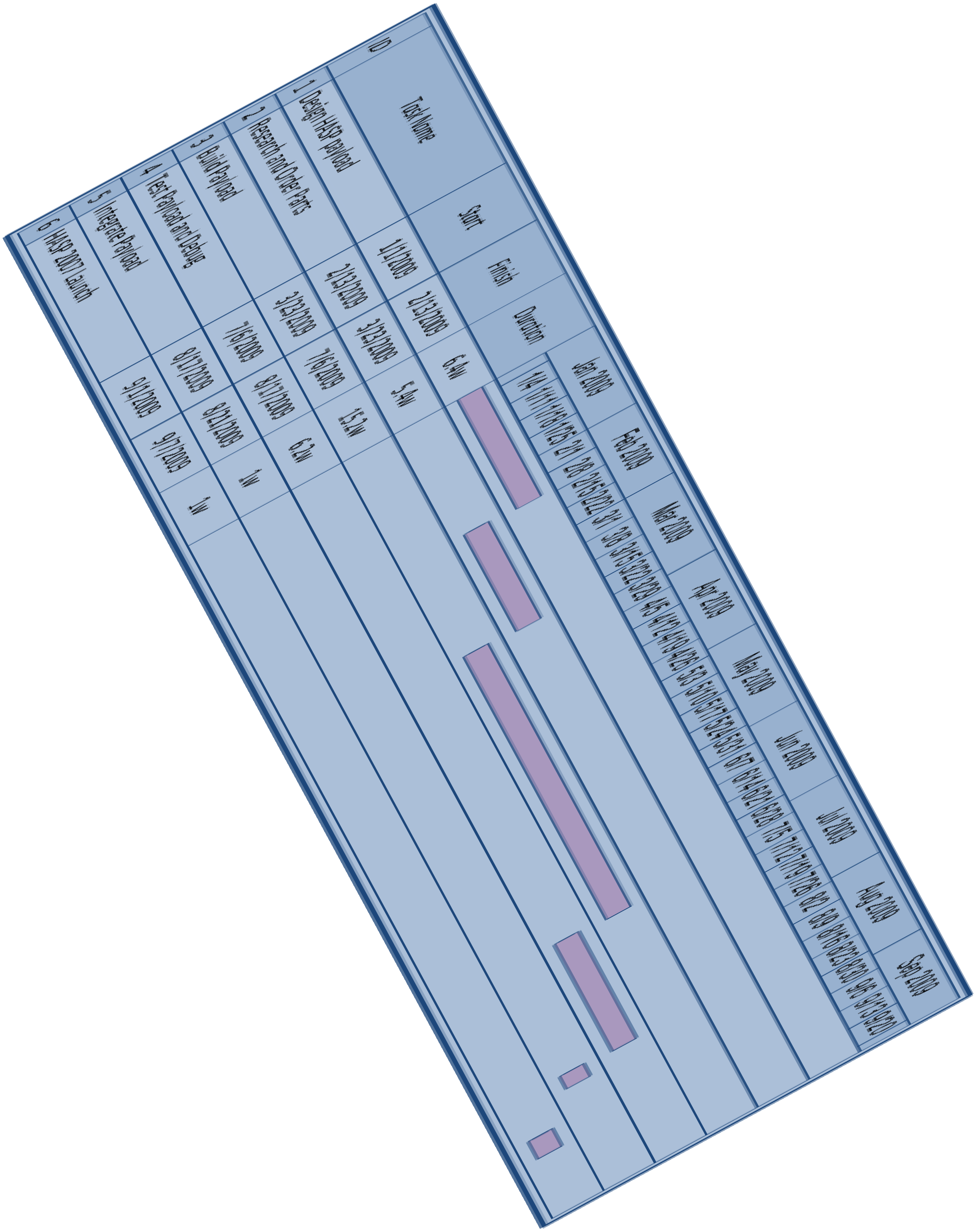
The following sensors will be included in the payload package.

- Temperature Sensor
- Humidity Sensor
- Pressure Sensor
- Altimeter
- Accelerometer
- Geiger Counter
- GPS Device

Timetable

Cajun Probe I will be supervised by Andy Hollerman, Ph.D. Mark Roberts will be the graduate student in charge. He will also be designing the system to run and record the sensors, installing sensors, testing the sensors, and writing the code to run the system. The undergraduate students will be primarily responsible for designing and testing the Geiger counter experiment as well as helping Mark with his research. There will be weekly meetings to discuss progress and fix problems with designs or testing. We hope to have this payload finished by early May and integrated into HASP in early July. Once the payload is flown, we will spend the rest of the year analyzing the data, writing the final paper, and creating presentations for conferences, talks, or poster presentations.

The major milestones will first be to get the Cajun Probe I platform built. We anticipate this to be done by mid February. Next we must build and test the controlling systems. This should be complete by late March. By mid Julyl we will have the all the sensors completed and working. Then the rest of July will be spent debugging and testing. Once this is complete we will run day long tests to simulate a long balloon flight. All of this is summarized in the CajunSat time table that is shown in the following figure.



ID	Task Name	Start	Finish	Duration
1	Design HASP payload	1/1/2009	2/13/2009	6.4w
2	Research and Order Parts	2/13/2009	3/23/2009	5.4w
3	Build Payload	3/23/2009	7/6/2009	15.2w
4	Test Payload and Debug	7/6/2009	8/17/2009	6.2w
5	Integrate Payload	8/17/2009	8/21/2009	1w
6	HASP 2007 Launch	9/1/2009	9/7/2009	1w

Team Structure

Andy Hollerman: Principle Investigator and Supervisor

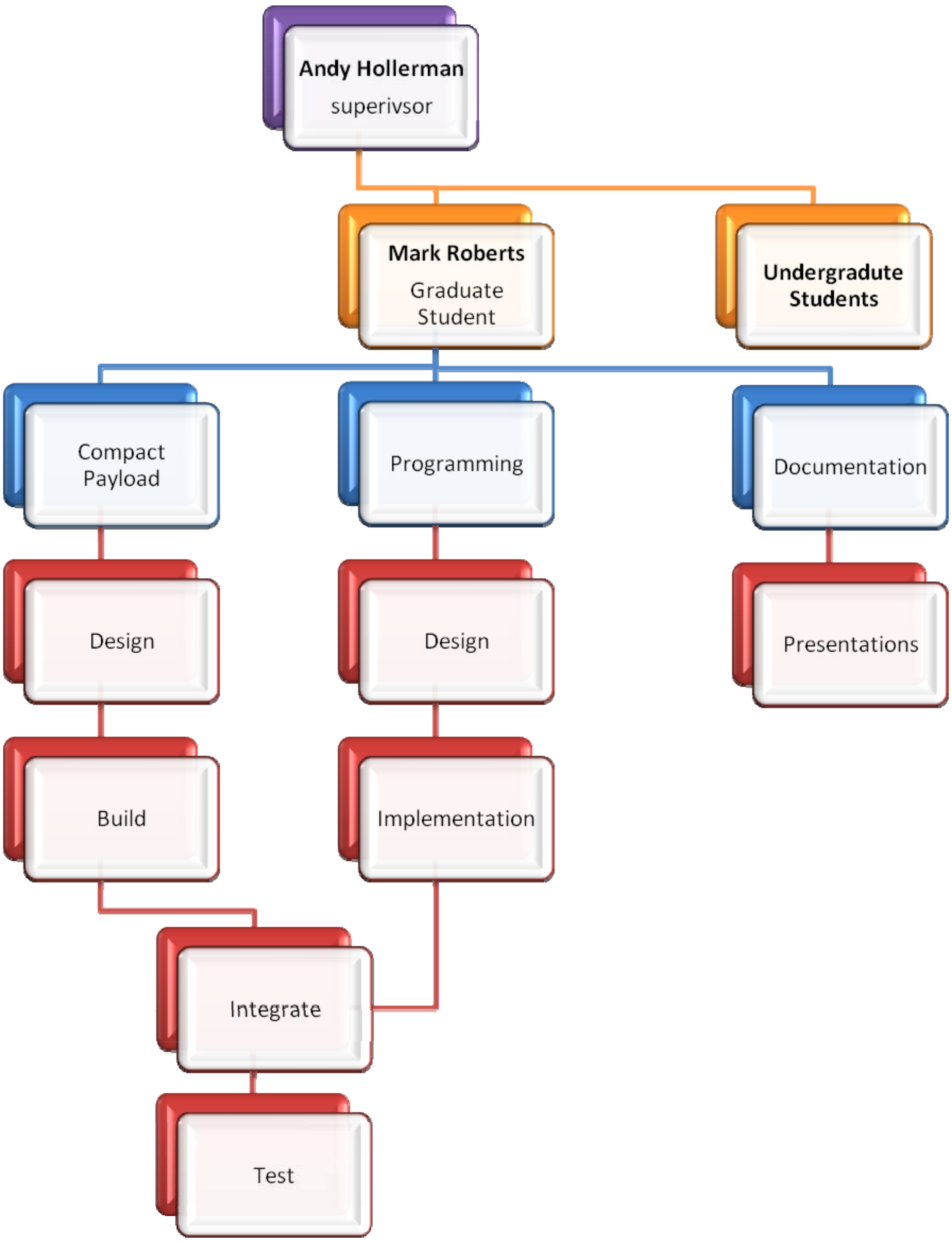
Andy Hollerman an Associate Professor of Physics at the University of Louisiana at Lafayette. He has done research dealing in the following:

- Phosphor Materials and Fluorescence
  - Triboluminescence
  - Thermometry
- Space Physics
  - Radiation Effects and Environments
  - Hypervelocity Impacts
- Environmental Physics
  - Trace Element Analysis
  - Pollution Remediation Analysis
- Accelerator Physics and Engineering
  - Operations
  - Materials Analysis
- Hazardous Materials and Environments
  - Engineering and Remediation
  - Analysis

Andy Hollerman has supervised CajunSat I, CajunSat II, and CajunSat III. He also has worked at various NASA facilities and at Oakridge National Laboratory.

Mark Roberts: Graduate student in charge of Cajun Probe I

- Designed and implemented the power system and monitoring system for UL Lafayette’s Pico Satellite, which is currently orbiting Earth. This includes using solar cells to charge both a Lithium-Ion battery (engineered by myself) and running the satellite systems and sub-systems. The satellite is powered by the battery, if there is not sufficient amount of current supplied from the Solar Cells.
- Built the payload for the RockOn Workshop which consisted of a Geiger counter, temperature sensor, Altimeter, Accelerometer, pressure sensor, and an AVR controller.
- Proficient with computers and C++ programming.



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Payload Specifications

The Cajun Probe I team will require the following from HASP.

Number of Positions need:	1 Small Student Payload
Approximate weight:	3 kg
Approximate dimensions:	12 cm x 12 cm
Approximate height:	10”
Voltage needed:	28 V
Approximate Amps needed:	0.5 Amps
Serial Downlink:	Yes
Serial uplink:	Yes
Serial interface:	Yes
Analog downlink:	Yes
Discrete command:	2 commands

We expect all the sensors and mounting boards to have a mass of about 2.5 kg. This leaves us with about 1 pound (0.5 kg) extra for the sun shield and glue as well as extra weight in case our approximation is off. Using DC/DC converters we will convert the 29 V into the voltage needed to run the sensors and controller board. We do not expect to go over the 0.5 A requirement and actually expect our amperage to be much less than this. As of now, we do expect to send the data down using the HASP telemetry. However, as a backup, we will have a flash storage device storing the data just in case something happens to the telemetry.

We expect to integrate into HASP in early August. The integration procedures will be to mount our payload to the HASP structure and then run tests to see if our payload will work on HASP. The orientation or HASP position will not matter.

The flight line operations will be to make sure that the payload is receiving power and that there are no errors. Once HASP is recovered all that will be required is for us to get the data off of the flash drive and then start analyzing the data. Once this is complete we will write the final report and then prepare any sort of presentations or posters that will be needed.