NASA Launch Initiative (Sensor Package)

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Payload Name: G.A.M.B.L.S

CPE495-01 Computer Engineering Design I

Electrical and Computer Engineering
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The Team

- Jason G Renner - Project Manager
- Patrick R Williamson - Software development
- Michael A Bizanis - Hardware Development
- Tin T Tran - Test Master

Project Summary

This project's goal is to develop a rocket payload for the MAE team's USLI rocket. Data from sensors including accelerometers, gyroscopes, magnetometers, and atmospheric pressure sensors will be recorded at approximately 1 kHz rate on-board. This data will be transmitted from the rocket to a ground station during flight and will also be stored on board. All data will be available post-recovery for download. The sensors will include a pitot-static system incorporated into the rocket nosecone to measure velocity. This payload will begin collecting data at launch and continue gathering data until reaching apogee at 5280 feet. A ground-based system capable of in-flight processing of transmitted data and post-flight processing of high-fidelity information will also be developed.

The Need

- Describe the need or opportunity
  - We need the hardware to gather data from all sensors including an accelerometer, magnetometer, gyrometer, and pitot probe.
  - The data sampling rate shall be 1000Hz
  - The payload shall fit into a 3.5”x4.5” space and weigh less than 1kg
- Who is affected and who will benefit?
  - The MAE Department will benefit from the high fidelity information for future rocket designs.

Marketing Requirements

This payload has the following requirements:

- Shall operate under the under the rigors of flight
- Shall operate effectively for multiple launches
- Shall be able to idle on the launch pad for up to forty-five minutes and still be able to operate during flight
- Shall store data on the rocket and transmit data to a ground station
- Shall take data from an accelerometer, gyrometer, magnetometer, and atmospheric pressure sensor and have the capability to add more sensors

Engineering Requirements

The payload must contain the following instruments:

- 3-axis accelerometer (3 channels)
- 3-axis gyrometer (3 channels)
- 3-axis magnetometer (3 channels)
- One pressure sensor for ambient pressure (up to 15 psia)
- Develop a way to synchronize data between multiple copies of this payload in order to compare events between payloads.
- Five additional channels of data which may be used for sensors chosen by the USLI team

Engineering Requirements cont.

The payload must also meet the following requirements:

- Minimum 500 Hz sampling rate
- Sensors and five additional channels must have a 12-bit minimum resolution
- Capable of making 5 voltage measurements (0 - 5 V) at up to four feet from the payload. These are the five additional channels.
- Noise tolerant digital or differential analog signaling required for the five additional channels and any other signals traveling more than five inches.
- System shall provide a minimum of 1W power to sensors and associated support components (e.g. ADCs, bus transceivers) for remote sensors

Engineering Requirements cont.

- Capable of operating under a 50g acceleration loading
- Capable of operating under vibration experienced during a rocket flight.
- Have a means of confirming operational state when the rocket is on the launch pad
- Have a means of powering on and off via an external switch when the payload is in the assembled rocket
- Must be capable of being integrated with the rest of the rocket, powered up, and operational within 45 minutes
- Must be ready for re-flight (new batteries installed, data transferred to ground station, and empty memory) within 45 minutes
- Capable of operating for up to one hour in the powered up (standby) state on the rocket pad
- Capable of fitting inside of a 3.5-inch cylinder with a 4 inch height
- Weigh under 1 kg
- Contain an independent power source (i.e. not require power from other systems in the rocket)

Survey: Market & Competition

Market

- Current sensor boards are generally large, heavy, and expensive
- Data rates too low for detailed analysis
- All-in-one solutions contain unnecessary features

Proposed Approach

- Create our own solution from a combination of sensor boards available on the market
- Reuse the working software and hardware from previous projects
- Coordinate with MAE team to evaluate sensor payloads during the test launches

System Design Description

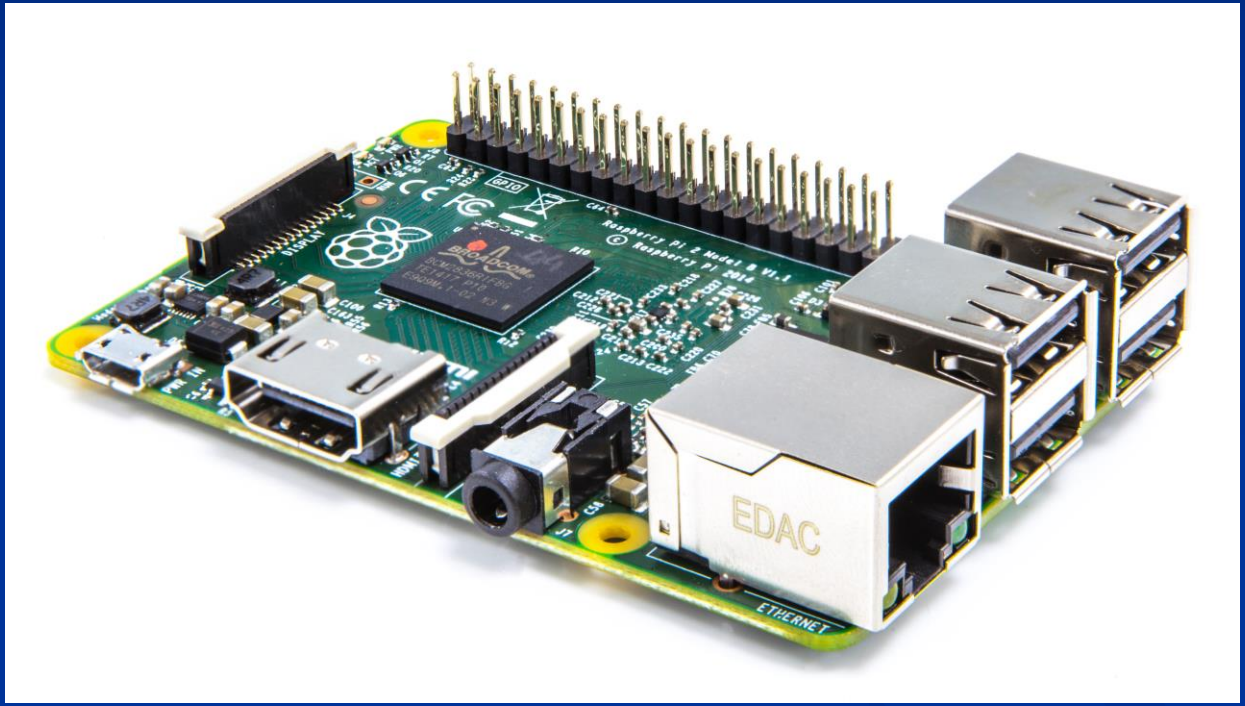
- Preliminary Design
  - We will use a Raspberry Pi to communicate and store data between all the sensors
  - We will connect breakout boards to the Raspberry Pi with each sensor installed on them
  - We will be able to use the pitot probe board from last year
  - We will use the xbee pro from last year to transmit data to ground

Alternative Approaches

- Could also build our own circuit boards instead of ordering breakout boards
  - This approach would cost too much time learning how to create our own boards
- Another alternative is using Arduino instead of Raspberry Pi
  - Arduino does not meet the memory storage requirements we have
  - We will plug a 64GB micro SD card into the Raspberry Pi

Raspberry Pi 2

- A 900MHz quad-core ARM Cortex-A7 CPU
- 1GB RAM
- Micro SD card slot
- 40 GPIO pins



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Survey: Existing Projects

- Previous years, UAH students have built several systems by using Arduino, but have had issues with power supply because the system was out of battery while waiting for launch.
- Other projects took too long to create operational hardware and software

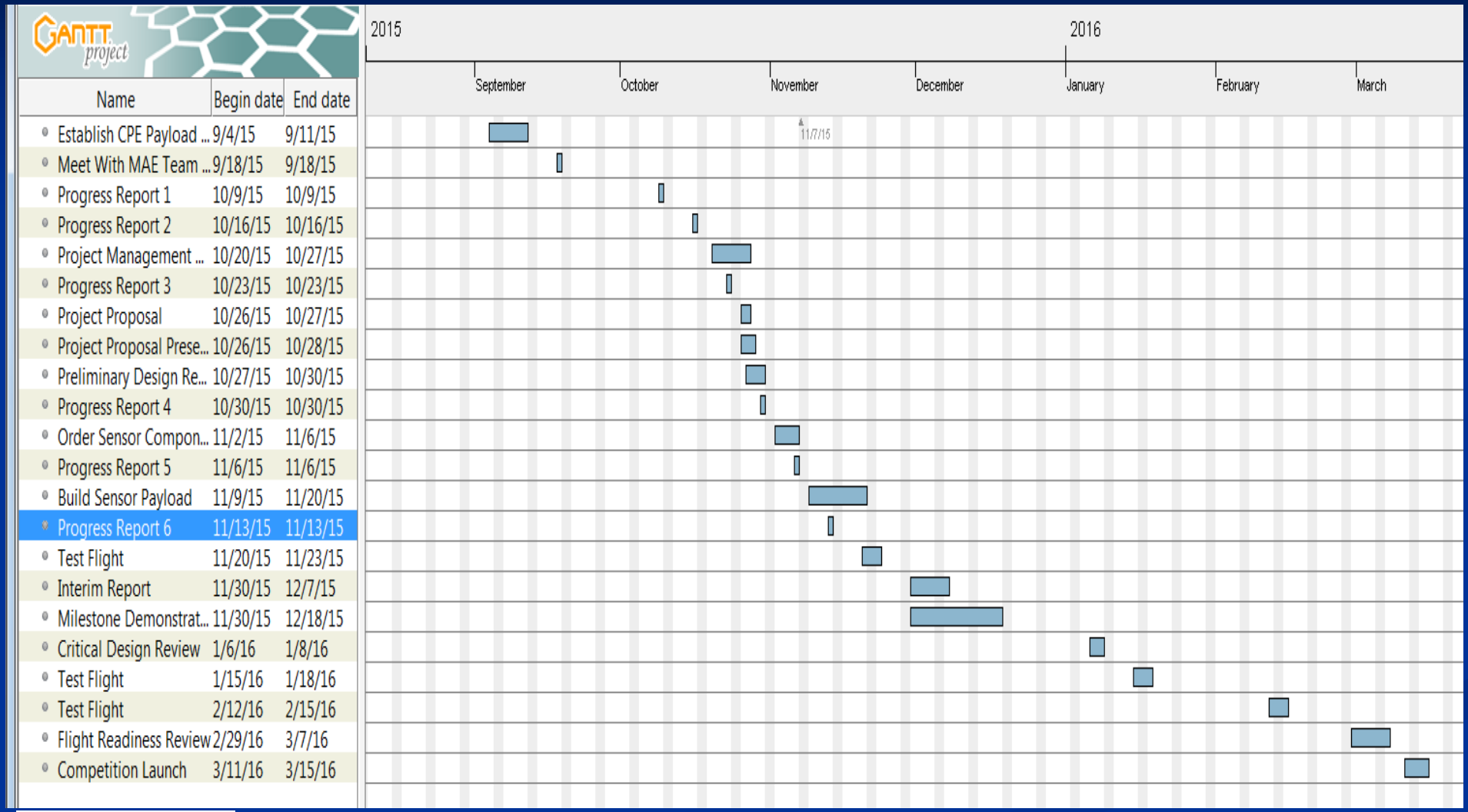
CPE 495 Go/No Go Milestone

- By the end of the Fall Semester, we will be able to sample and store data from the accelerometer, gyrometer, magnetometer, and pitot probe.

Testing Plan

- Unit Tests
  - Verify software for each sensor outputs data correctly
  - Verify wireless communication between ground and rocket
  - Verify flight data stored to micro SD card after landing
- Acceptance Tests
  - Demonstrate data acquisition to MAE team
- Hardware
  - We can test the payload at each rocket launch
  - We can test components individually in the lab

The Project Timeline



Name	Begin date	End date
Establish CPE Payload ...	9/4/15	9/11/15
Meet With MAE Team ...	9/18/15	9/18/15
Progress Report 1	10/9/15	10/9/15
Progress Report 2	10/16/15	10/16/15
Project Management ...	10/20/15	10/27/15
Progress Report 3	10/23/15	10/23/15
Project Proposal	10/26/15	10/27/15
Project Proposal Prese...	10/26/15	10/28/15
Preliminary Design Re...	10/27/15	10/30/15
Progress Report 4	10/30/15	10/30/15
Order Sensor Compon...	11/2/15	11/6/15
Progress Report 5	11/6/15	11/6/15
Build Sensor Payload	11/9/15	11/20/15
Progress Report 6	11/13/15	11/13/15
Test Flight	11/20/15	11/23/15
Interim Report	11/30/15	12/7/15
Milestone Demonstrat...	11/30/15	12/18/15
Critical Design Review	1/6/16	1/8/16
Test Flight	1/15/16	1/18/16
Test Flight	2/12/16	2/15/16
Flight Readiness Review	2/29/16	3/7/16
Competition Launch	3/11/16	3/15/16

Cost Estimation

Mounting Board	$35.00
1 Raspberry Pi 2 Model B	$40.00
Each Sensor (3 total)	$15.00
64GB Micro SD Card	$30.00
LiPo Battery	$40.00
Total:	$160.00

Updated CPE 495/496 Deliverables

- Hardware
  - Sensor payload
  - Ground station receiver
- Software
  - Sensor payload software
  - Ground station software
- USLI Reports

Team Responsibilities

- Jason – Create project work timeline and communicate with MAE team
- Patrick – Researching software libraries for components of the payload
- Michael – Testing the functionality of hardware systems
- Tin – Maintain a checklist of working or nonworking parts and software

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Questions

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