MAKE TO INNOVATE

Mid-Term Review – Spring 2019

HABET

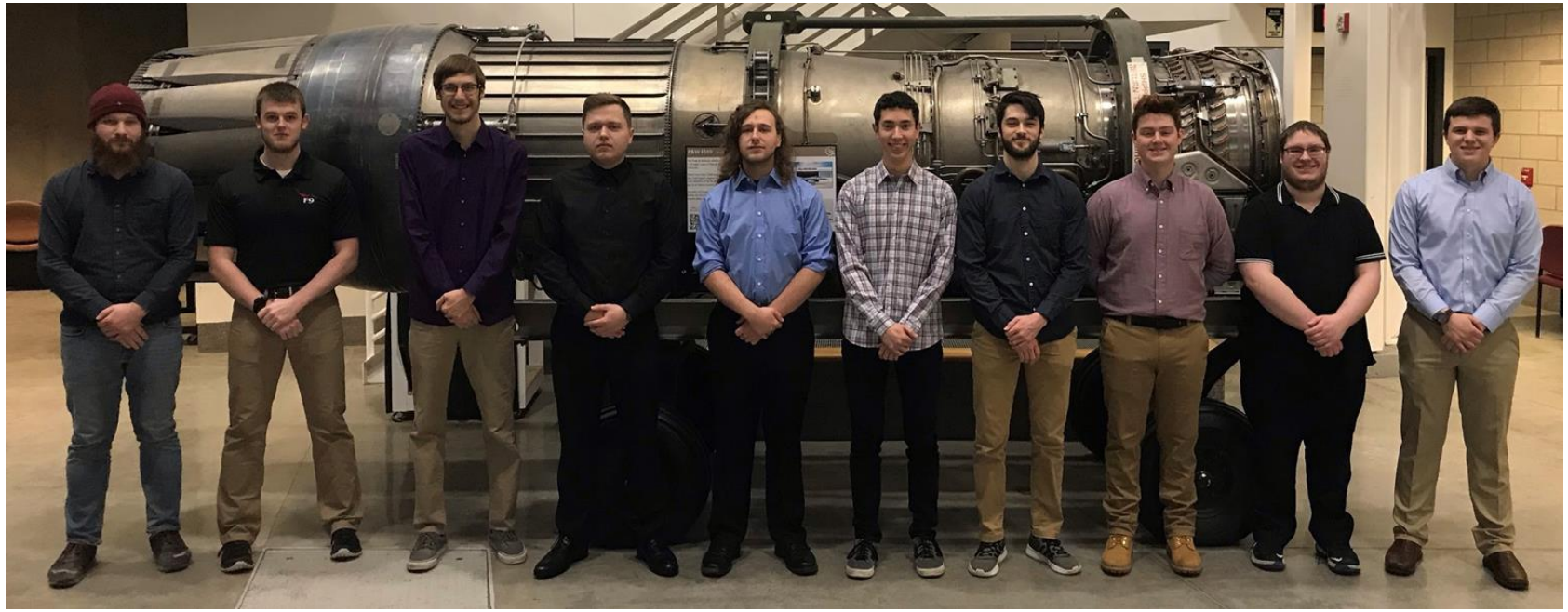
AGENDA

- Project Overview
- Activity Report
- Design Review
  - Design Constraints
  - Current Design
  - Proposed Changes
  - Design Risks
- Budget Status
- Conclusion

PROJECT OVERVIEW

Project Executive Summary

Project Photo

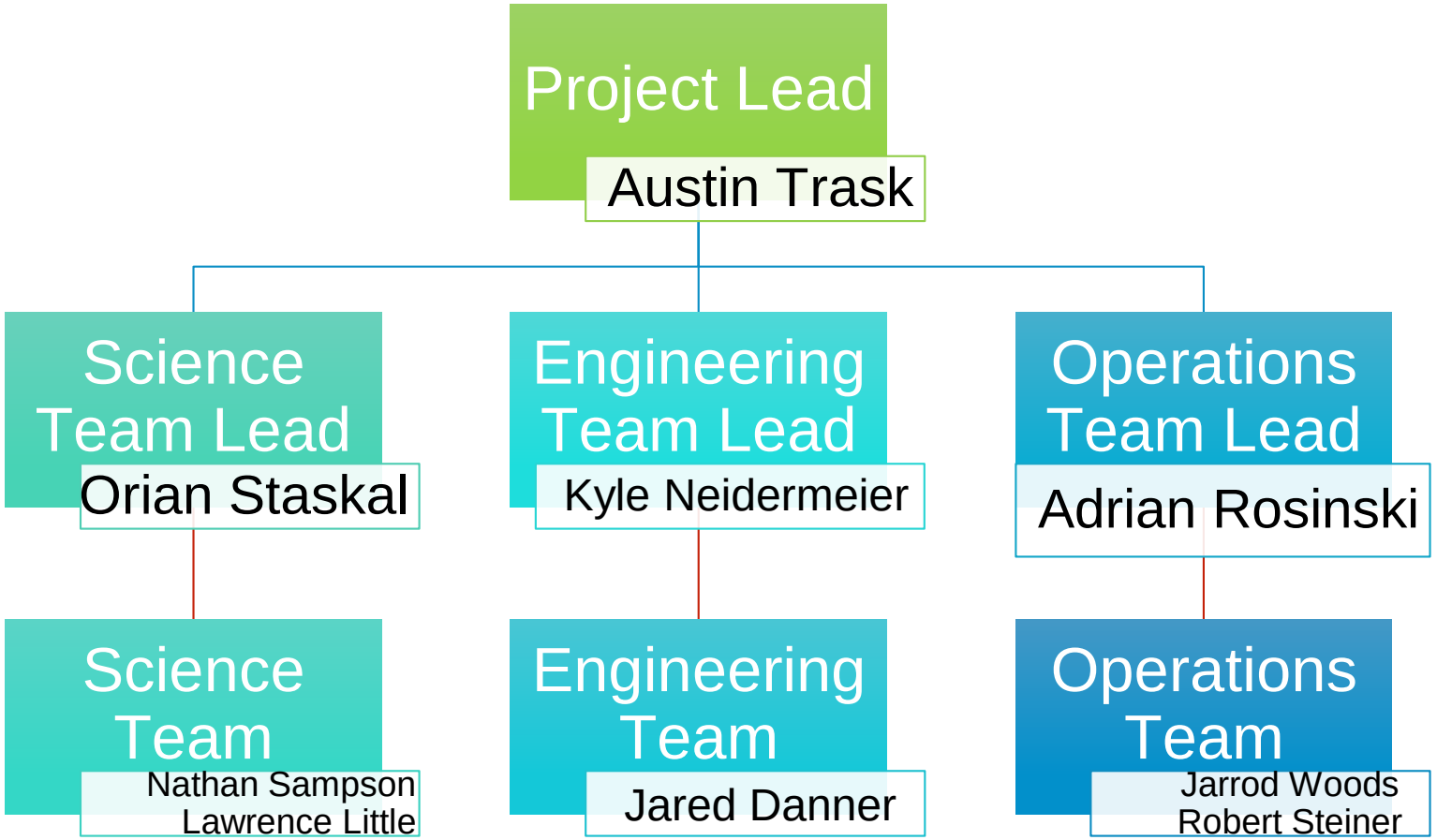


From Left to Right: Matthew Plewa, Jared Danner, Nathan Sampson, Adrian Rosinski, Kyle Neidermeier, Orion Staskal, Lawrence Little, Jarrod Woods, Robert Steiner, Austin Trask

PROJECT OVERVIEW

Project Faculty Adviser	Matthew Nelson - Iowa State University
Project Technical Advisers	Christine Nelson - Iowa State University Matthew Plewa - Undergraduate Advisor Dillyn Mumme - Undergraduate Advisor
Project Team Lead	Austin Trask
Project Stake Holders	Make to Innovate Iowa Space Grant Consortium University of Iowa

Project Organization Chart



Project Objectives

- Fly balloon payloads to support high-altitude research
  - Operate with well-documented and up-to-date procedures
  - Regularly and successfully launch and recover payloads
- Work with customers for the success of their research
  - Other M:2:I teams, ISU professors, and 3rd parties are eligible
  - Inform customers of their options when flying with HABET
- Conduct research of our own
  - Design and fly our own research missions

Semester Goals

- Return HABET to full flight operations
  - Gain experience running full flights
  - Have clear procedures and documentation
  - Be ready to train new members
- Fully implement the LoRa comms
  - LoRa system will integrate into eventual website
  - Less reliance on 3rd party software
- Begin work with University of Iowa
  - Prove our capabilities
  - Discuss their requirements for our eventual flight

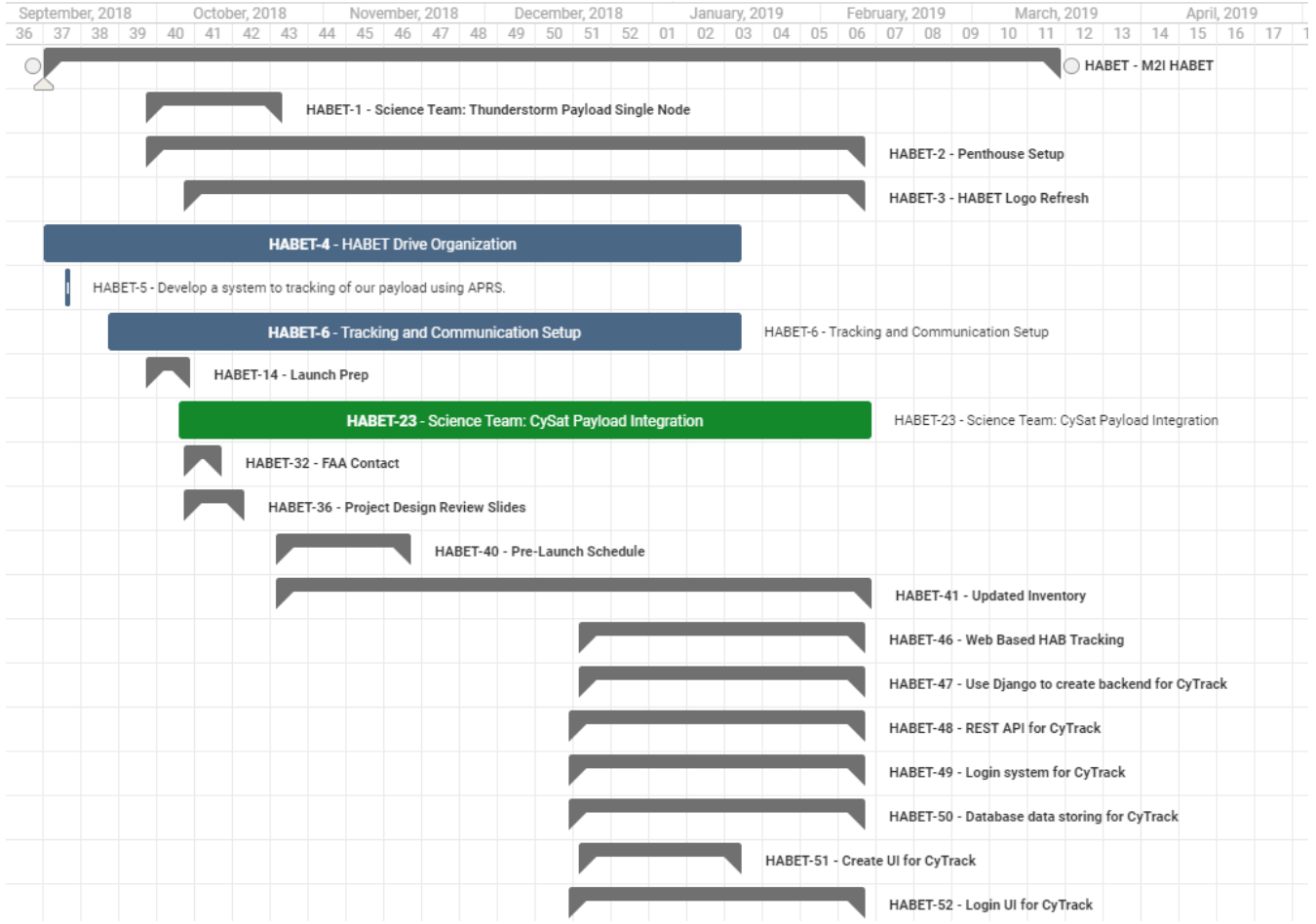
Semester Deliverables

- Successful flight of the LoRa
- Implementation of tracking and predictions through website
- New fill nozzle
- Proposal for research mission
- Updated documentation
- Implementation of checklists into the website

ACTIVITY REPORT

Milestones, Tasks, and Health Report

TASK BREAKDOWN



LX-150-A

- First launch of the semester
- LoRa failed before launch
- Provided needed experience for everyone on the team

ENGINEERING TEAM

Lead: Kyle Neidermeier
Member: Jared Danner

Engineering Overview

- Main objectives:
  - Hardware advancement
  - Software support
  - Tracking systems
  - New balloon release mechanism
  - New fill nozzle

Engineering Milestones

[HABET-141] Website Implementation **Created: 03/Mar/19 Updated: 03/Mar/19 Due: 23/Mar/19**	
Status:	In Progress
Project:	M2I HABET

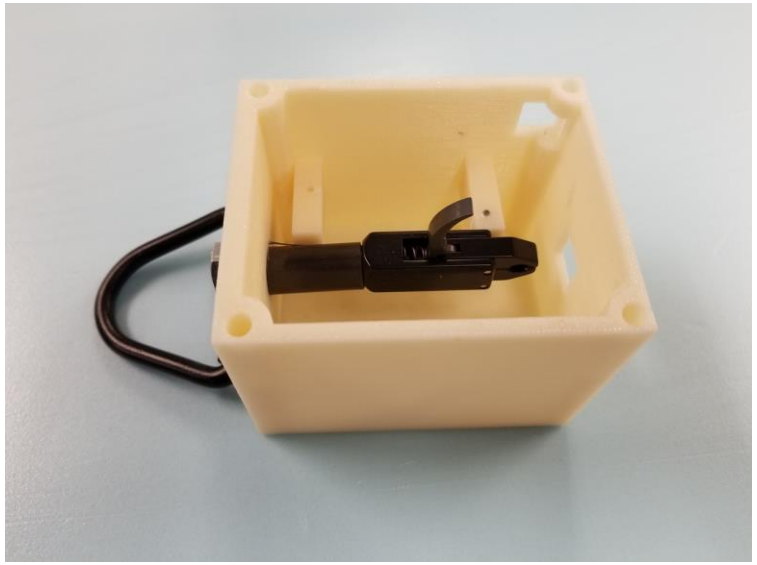
[HABET-140] LoRa Implementation **Created: 03/Mar/19 Updated: 03/Mar/19 Due: 30/Mar/19**	
Status:	In Progress
Project:	M2I HABET

[HABET-138] Create Fill Nozzle **Created: 03/Mar/19 Updated: 03/Mar/19 Due: 27/Mar/19**	
Status:	In Progress
Project:	M2I HABET

Balloon Auto-Launch Latch System

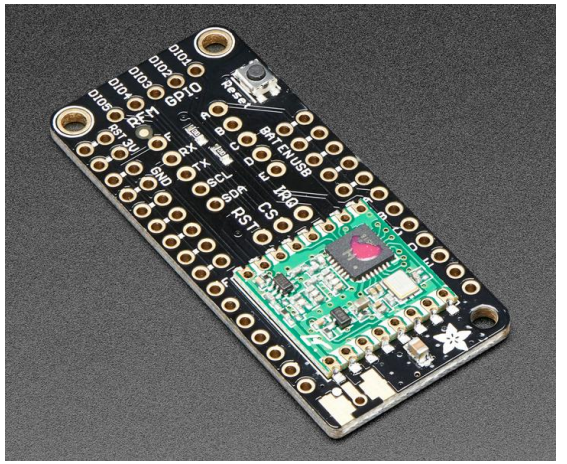
- Work In Progress
- Will be integrated into LoRa system.
- LoRa will use a servo to move the latch as shown.
- Manual trigger via button press of Mission Manager.

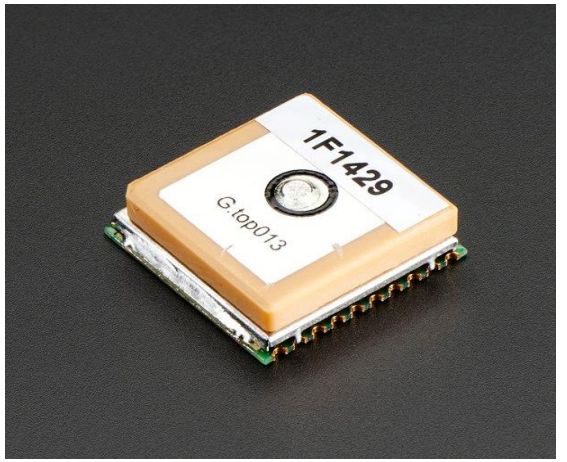
Similar System Used For Eagle Eye



LoRa Comms System

- Hardware
  - Adafruit LoRa Radio FeatherWing - RFM95W 433 MHz
  - FGPMMOPA6B GPS Module
- Software
  - Languages
    - C++ : firmware
    - Python : Tkinter GUI
  - Network
    - Decentralized nodes. (all are independant)
    - Pass around 1 packet.
    - Each node owns a section of the packet.
    - Uses millisecond timestamps for synchronization of variables within packet.





LoRa Network Packet

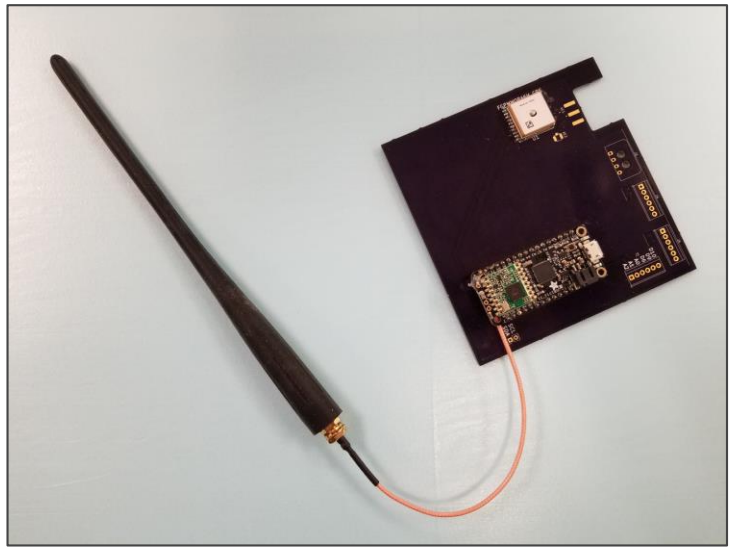
Checksum	Payload						Mission Control		Recovery				Network	Checksum
$	p_ts	p_alt	p_lat	p_lng	p_event	p_rs	mc_ts	mc_rs	r_ts	r_lat	r_lng	r_rs	node_id	$

ts : Time stamp (ms)

event : Error detection (GPS fix loss, burst detected, etc..)

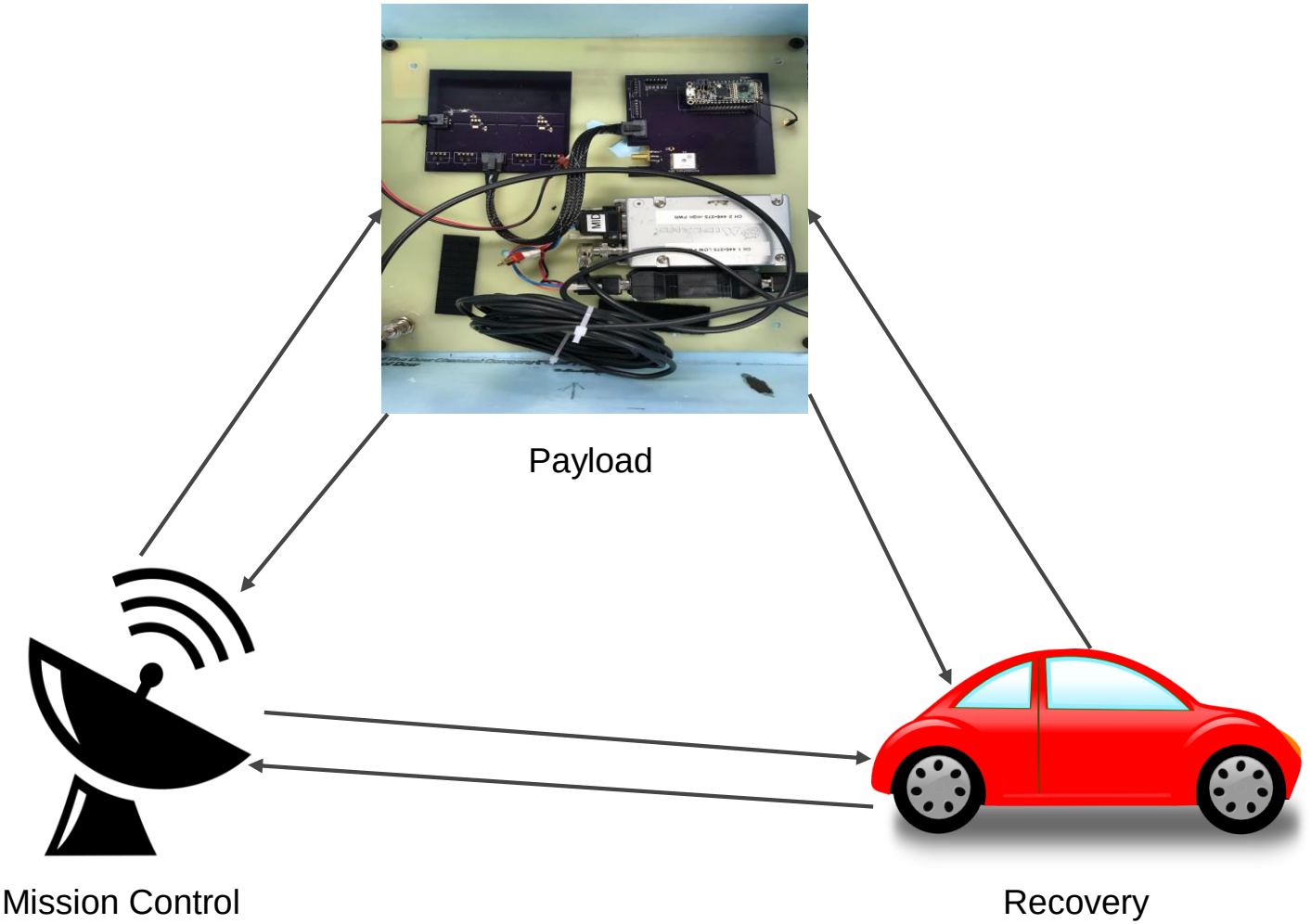
rs : Node reset

node_id : Node signature



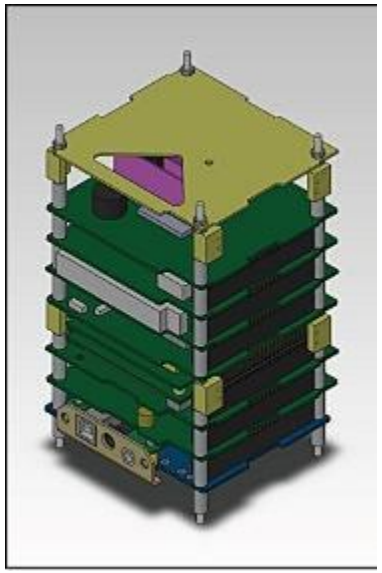
High-Level System Architecture

- Mission Control (Howe Hall)
  - Python GUI to view data
  - Send commands
- Payload
  - Sensory Data
  - Tracking Systems
- Recovery Vehicle
  - Tracking Systems



CyStack

- Completely new hardware stack
  - New tracking
  - New power distribution board
  - New onboard processing capabilities
  - Multi-team single CPU architecture
  - Vertical stacking (similar to CubeSats)



https://directory.eoportal.org/web/eoportal/satellite-missions/c-missions/cinema

Multi-Team Single CPU

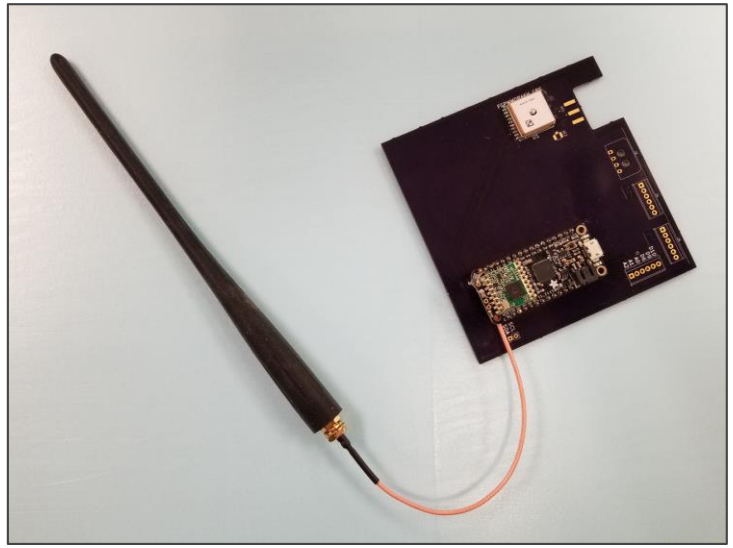
- Based off of raspberry pi CM3+
  - 48 gpio pins compared to 28
  - Peripherals not needed can be excluded
- Common busses can be wrapped
  - I2C multiplexer to prevent teams from interfering
  - Wrappers for com stacks will handle data transmit and receive functionality
- Pi hats can be connected to a 40 pin header just like standard Raspberry Pis

Wrapper Functionality

- GPIO pins will be broken into RJ45 ports with port IDs
  - Cables will be ribbon cables to reduce crosstalk
  - In python GPIO pins assigned based off of order declared in software
  - One line of code to change to switch ports
- I2C ports will be based off of multiplexer
  - Only need to know I2C port the wrapper will than know the address on the multiplexer
- Serial and Com wrapper
  - Utilize a prefix added to the data being sent to only supply data to correct team

CyStack Tracking Module

- Utilizing previously discussed LORA
- Switch to Cortex M0 processor
  - Built in DAC
- Split LORA radio off of Feather board
- Add VHF/UHF radio for NAPRS
  - DAC will allow us to do AFSK cleaner

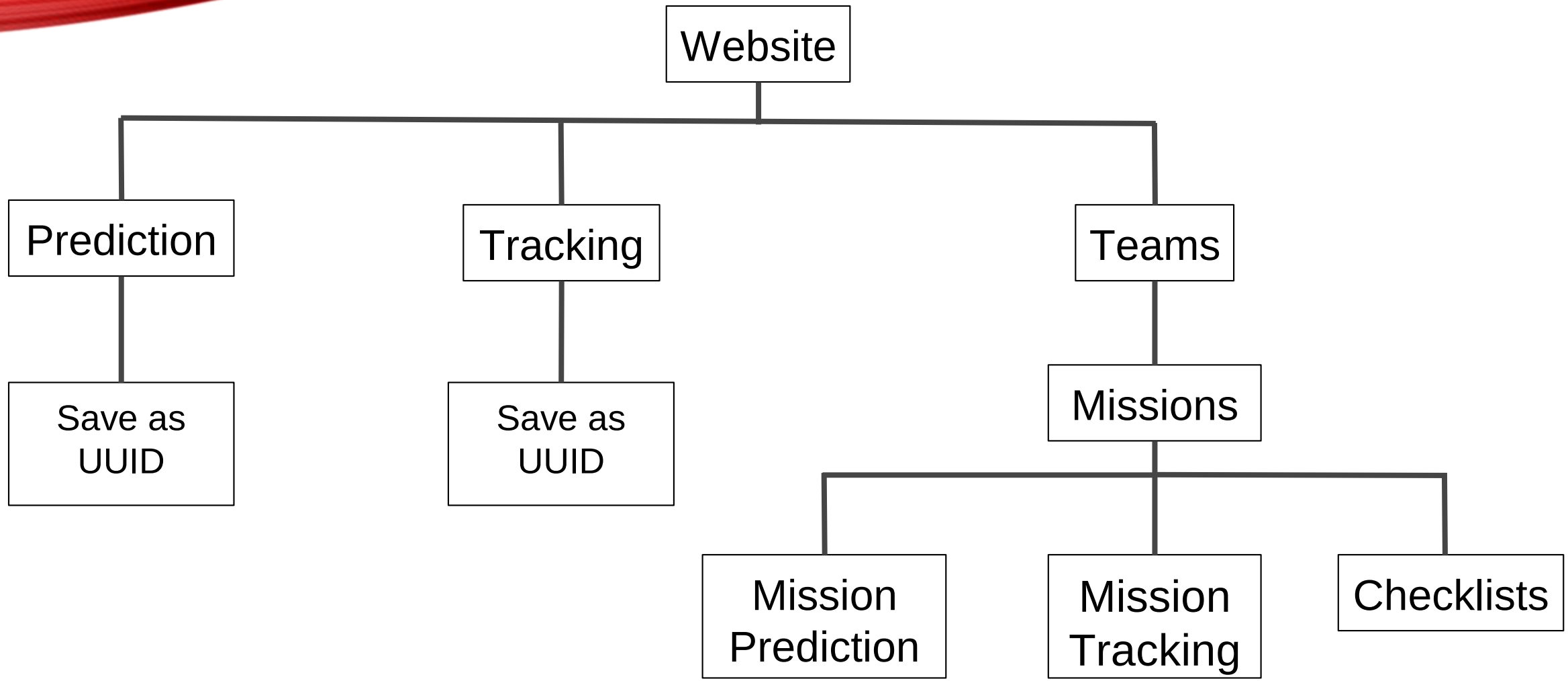


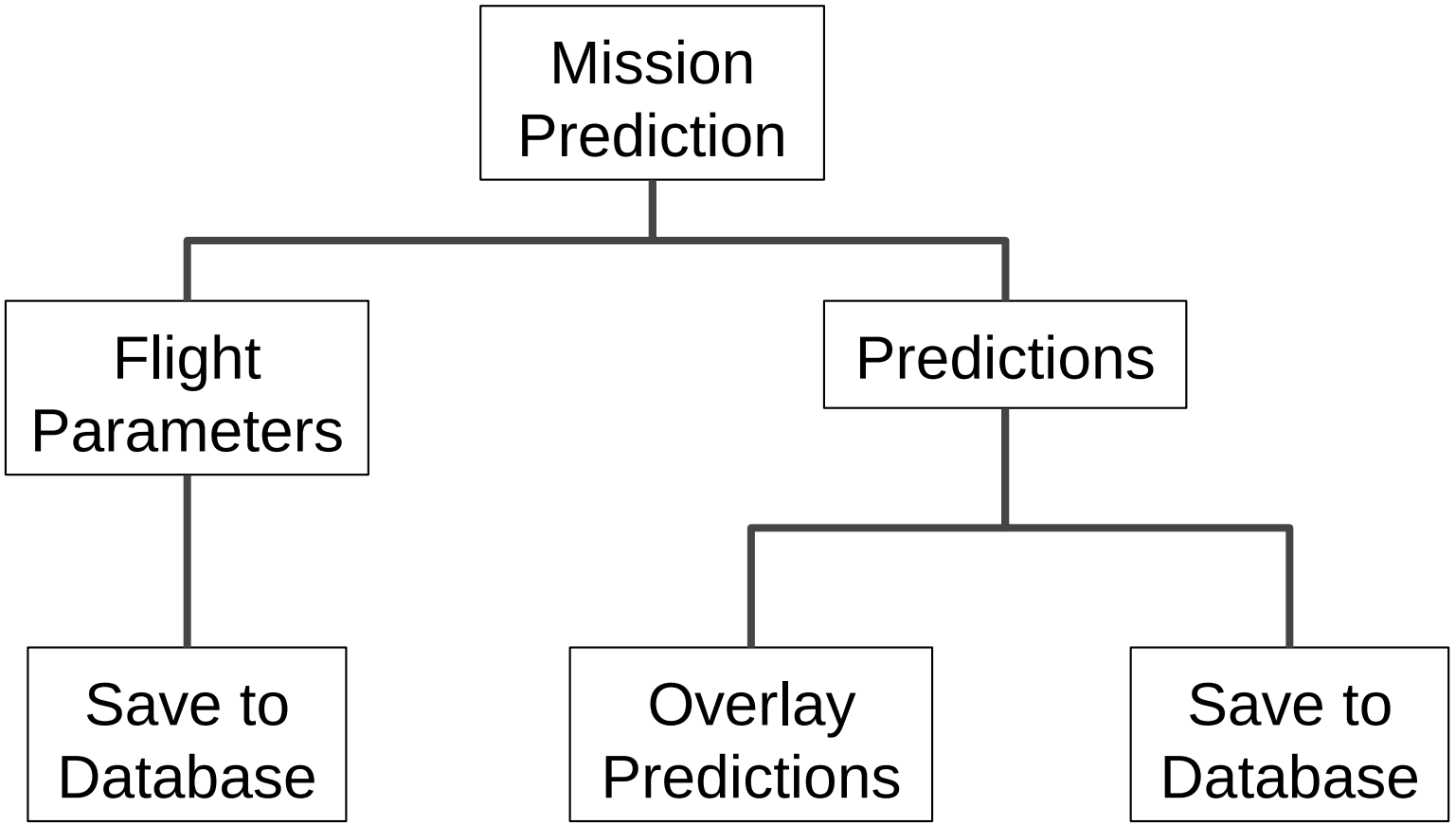
CyStack EPS

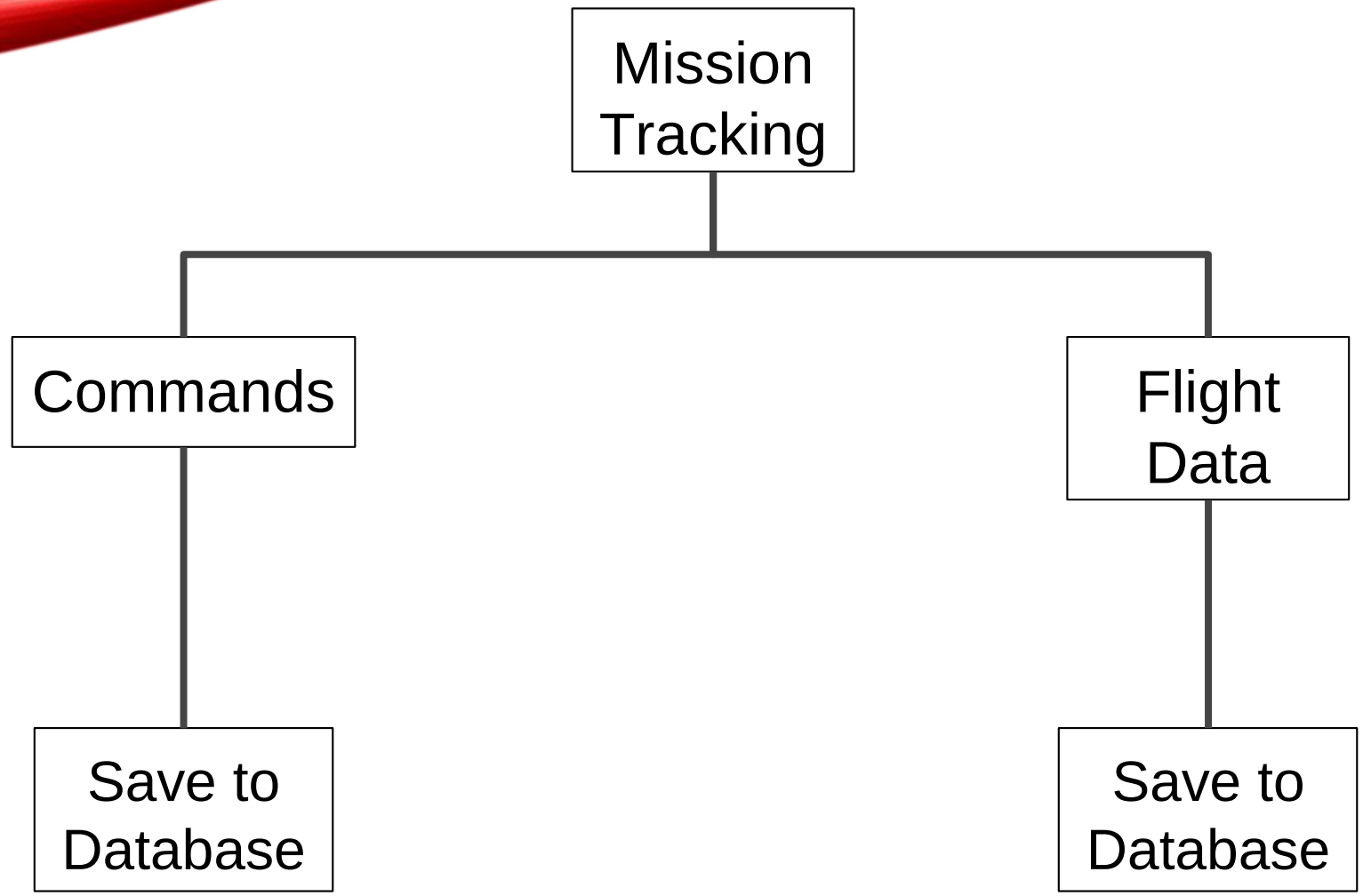
- Ultra low cost
  - Similar non-space rated boards run for over $800
- Power busses:
  - Unregulated (7v4 nominal)
  - 5V
  - 3v3
- External power
  - Ultra fast power switching with capacitor tie over
- Battery cell heaters
- I2C data and status
- Low voltage cell protection

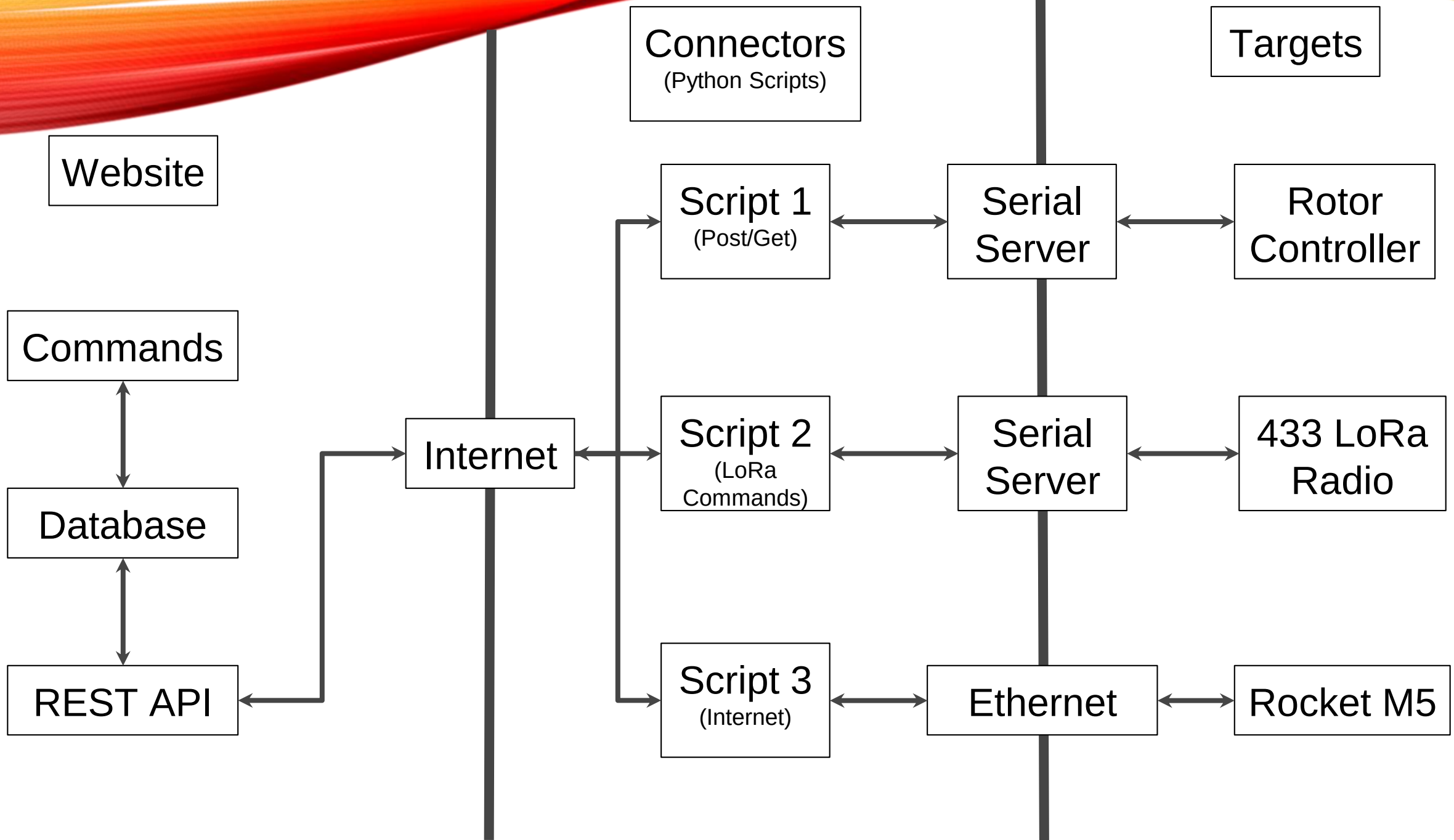
HABET Website

- Streamline all current software into one website
- Anything launch related will be on the website
- Main functions:
  - Predictions
  - Tracking
  - Controlling
  - Organization


Website
Prediction
Tracking
Teams
Save as UUID
Save as UUID
Missions
Mission Prediction
Mission Tracking
Checklists


Mission Prediction
Flight Parameters
Predictions
Save to Database
Overlay Predictions
Save to Database


Mission Tracking
Commands
Flight Data
Save to Database
Save to Database

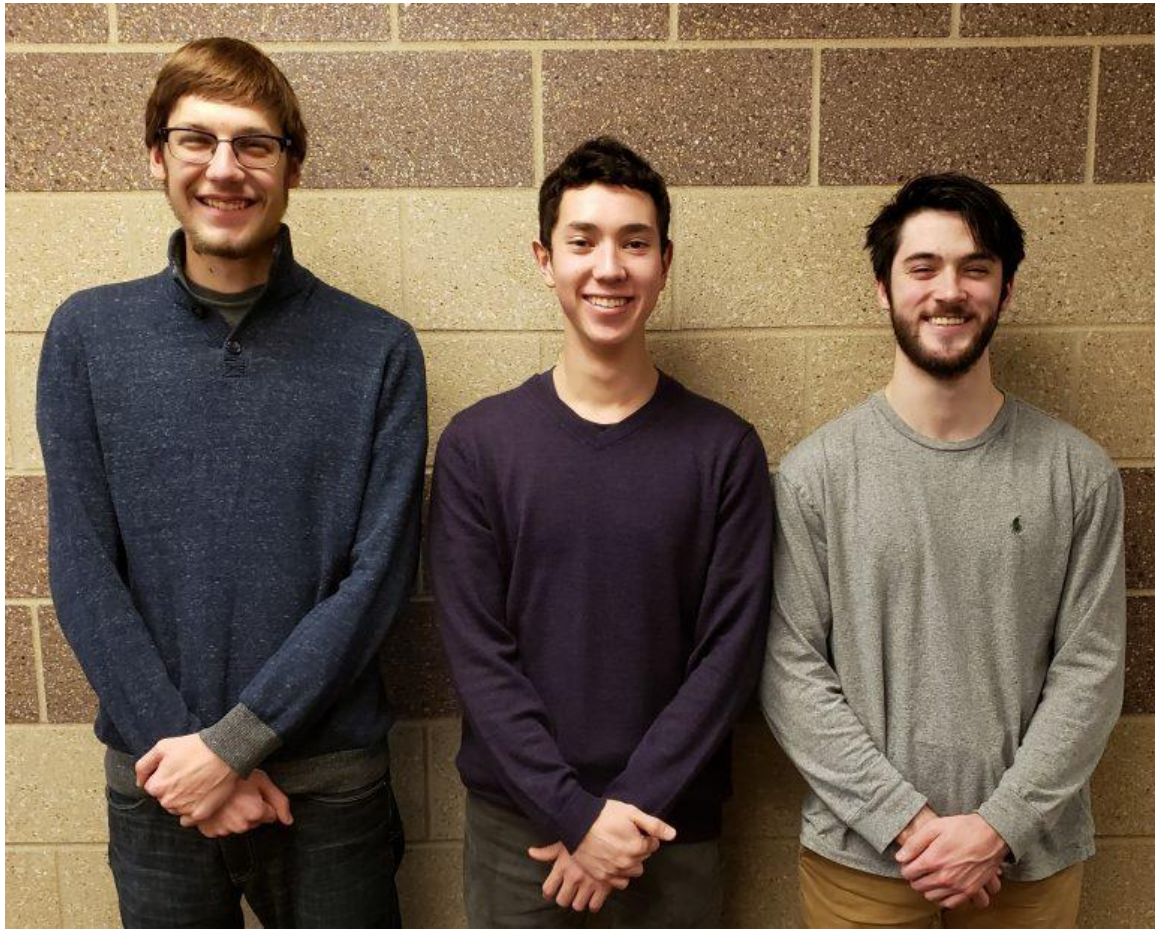

Website
Connectors
(Python Scripts)
Targets
Script 1
(Post/Get)
Serial
Server
Rotor
Controller
Commands
Database
REST API
Internet
Script 2
(LoRa
Commands)
Serial
Server
433 LoRa
Radio
Script 3
(Internet)
Ethernet
Rocket M5

SCIENCE TEAM

Team Lead: Orion Staskal
Members: Nathan Sampson, Lawrence Little

Science Overview

- Main objectives:
  - Payload Familiarization
  - Create new Fill Nozzle
  - Look at potential research missions
  - Work with potential third parties



MILESTONES

[HABET-139] Science Mission Proposal Created: 03/Mar/19 Updated: 03/Mar/19 Due: 26/Apr/19	
Status:	To Do
Project:	M2I HABET

[HABET-137] Create Fill Nozzle Created: 03/Mar/19 Updated: 05/Mar/19 Due: 27/Mar/19 Resolved: 05/Mar/19	
Status:	In Progress
Project:	M2I HABET

Fill Nozzle

- Old nozzle leaked gas
- Designed new fill nozzle
- Needs to be tested

Payload Familiarization

- Learn how the LoRa works
- Learn methods for collecting data
- Propose research mission

Future Endeavours

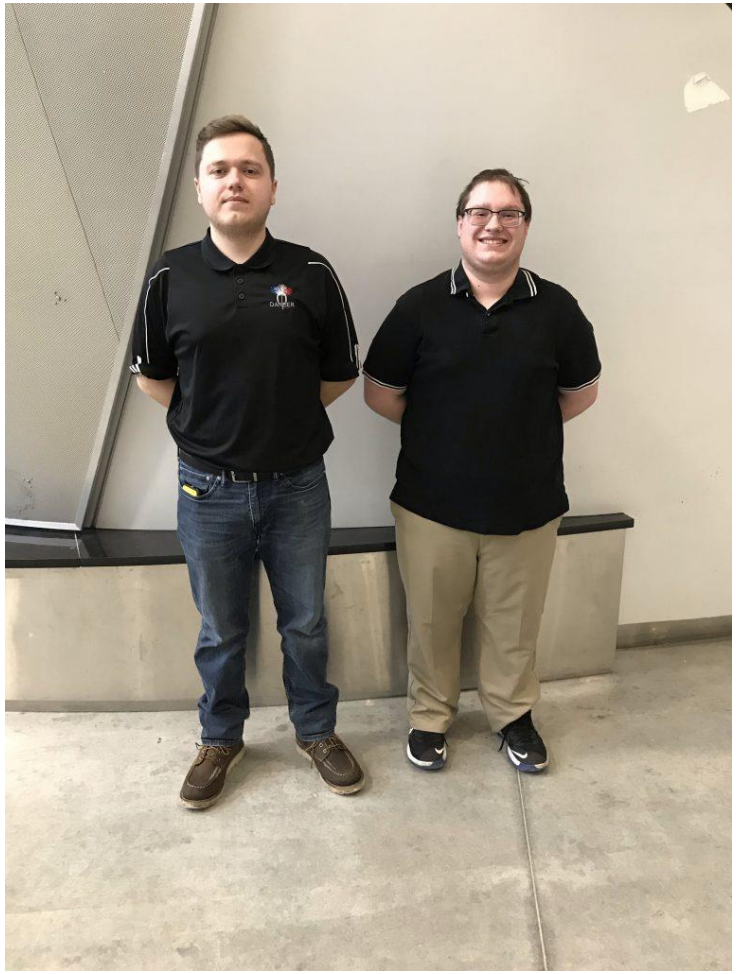
- Work with third parties on outside experiments
- Create experiments unique to HABET

OPERATIONS TEAM

Lead: Adrian Rosinski
Members: Robert Steiner, Jarrod Woods

OPERATIONS

- Main objectives:
  - Develop and maintain proper procedures during launch
  - Create documentation and checklists
  - Create cohesive information for third parties
  - Supervise and maintain launch day inventory
  - Launch, operate radios, and recover payload on launch day



Operation Milestones

[HABET-142] Documentation and Procedures Created: 30/Jan/19 Updated: 04/Mar/19 Due: 27/Apr/19	
Status:	In Progress
Project:	M2I HABET

[HABET-143] Trainings Created: 30/Jan/19 Updated: 04/Mar/19 Due: 27/Apr/19	
Status:	In Progress
Project:	M2I HABET

Operations Trainings

- Review lecture powerpoints
  - Extract vital information from lecture slides
- Develop new trainings for members to complete
- Allow members and third parties to access lecture powerpoints
- Give members an opportunity to gain background information on radio operations
  - Implement trainings to help aid in acquiring the technician license

Operations Documentation

- Keep checklists up to date
  - Readiness reviews
  - Inventory
  - Launch
  - Recovery
- Organize HABET documents and update as needed

Operations Procedures

- Contact the FAA as required by CFR Part 101
- Day of Launch
  - Set up balloon
  - Fill
  - Release
- Recovery
  - Receive data from payload
  - Retrieve payload

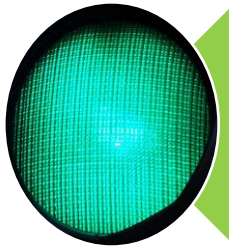
Operations Deliverables

- Formulate launch checklists and third party launch forms
  - Cohesive
  - Professional
  - Thorough
- Develop new launch procedures to ensure the smoothest possible launch
  - Checklists
  - Communication
  - Schedules

PROJECT HEALTH REPORT

University of Iowa meetings

N/A



LoRa
Website
Fill nozzle
Documentation
Science proposal

DESIGN REVIEW

Constraints

DESIGN CONSTRAINTS

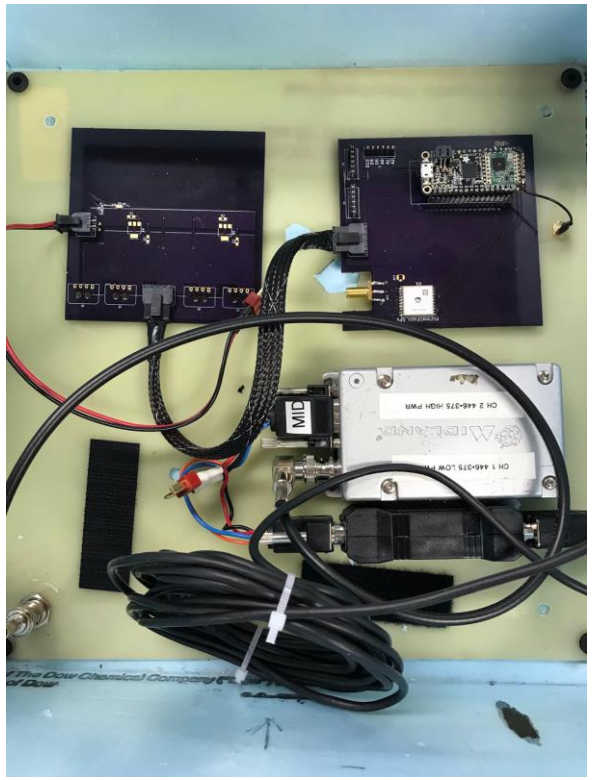
- FAA 14 CFR Part 101
  - Payload mass dictates if or how we are required to communicate with FAA
- Limit mass of main hardware
  - Lower standard payload mass allows research payloads to fly on smaller, cheaper balloons
- Weather
  - Affects integrity of payload
  - Potential to make launches unsafe

DESIGN REVIEW

Current Design

CURRENT DESIGN

- Primary tracking: Midland radio
- Secondary tracking: Big Red Bee
- Experimental tracking: LoRa
- Power: Two LiPo batteries and power distribution board



DESIGN REVIEW

Proposed Changes

PROPOSED ENGINEERING CHANGES

- New payload box
  - More airtight to insulate electronics
- Heating pads
  - Prevent thermal shutdown of LoRa
- LoRa becomes primary tracking
  - Create options for secondary and tertiary tracking

PROPOSED SCIENCE CHANGES

- Work with engineering
- Test the new fill nozzle
- Design new experiments based on new hardware

PROPOSED OPERATIONS CHANGES

- Implement trainings for members and third parties
- All documentation and procedure information to be available on the HABET Website
- Operations members will be given the task to take the amateur radio license exam

DESIGN REVIEW

Design Risks

DESIGN RISKS

- LoRa range
  - Range could be lower than anticipated
- Thermal issues with LoRa
  - Engineering changes intended to prevent this
- PCB errors
  - Getting new boards is a lengthy process
- Software issues
  - Having a plan to test software mitigates the risk of issues occurring during launch

BUDGET

Status and requests

BUDGET STATUS

- Requested: $7,860.00
- Approved: $6,600.00
- Spent: $1453.16
- We do not expect to exceed this budget

		Total Project Budget		**$7,860.00**	**$6,600.00**	**$0.00**	**$6,600.00**
☐		**Equipment**		**$5,050.00**	**$5,050.00**	**$0.00**	**$5,050.00**
☑		Thunderstorm Payload Electronics	modules required for the thunderstorm payload single and two node configurations	$250.00	$250.00		$250.00
☑		Trak Stak Components	any additional components needed for trak stak upgrades	$400.00	$400.00		$400.00
☑		Tower		$800.00	$800.00		$800.00
☑		HABET Electrical System V3	New PCBs and compatability with Cubesat	$2,500.00	$2,500.00		$2,500.00
☑		Ground Station Upgrades	New wiring and power supplies	$300.00	$300.00		$300.00
☑		Garmin VIRB Camera	New camera for videos	$800.00	$800.00		$800.00
☐					$0.00		$0.00
☐					$0.00		$0.00
☐					$0.00		$0.00
☐					$0.00		$0.00
☐					$0.00		$0.00
☐					$0.00		$0.00
☐					$0.00		$0.00
☐					$0.00		$0.00
☐		**Travel**		**$750**	**$750**	**$0.00**	**$750.00**
☑		Chase Vehicle Rental	5 flights	$750	$750.00		$750.00
☐					$0.00		$0.00
☐					$0.00		$0.00
☐							$0.00
☐		**Raw Supplies**		**$2,060.00**	**$800**	**$0.00**	**$800.00**
☑		Helium	8 canisters @ $100 each	$800	$800.00		$800.00
☑		3000 g balloon	2 @ $350	$700			
☑		1500 g balloon	1	$200			
☑		600 g balloon	6	$360			

CONCLUSION

Extra Slide

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☐					$0.00		$0.00
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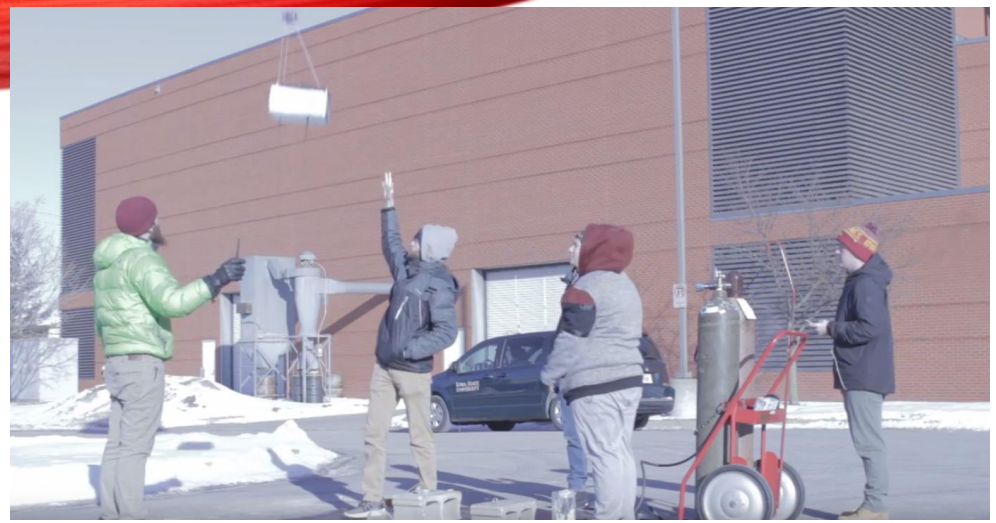
LX-150-A Gallery



Launch