CanSat 2024
Preliminary Design Review (PDR) Outline
Version 1.1

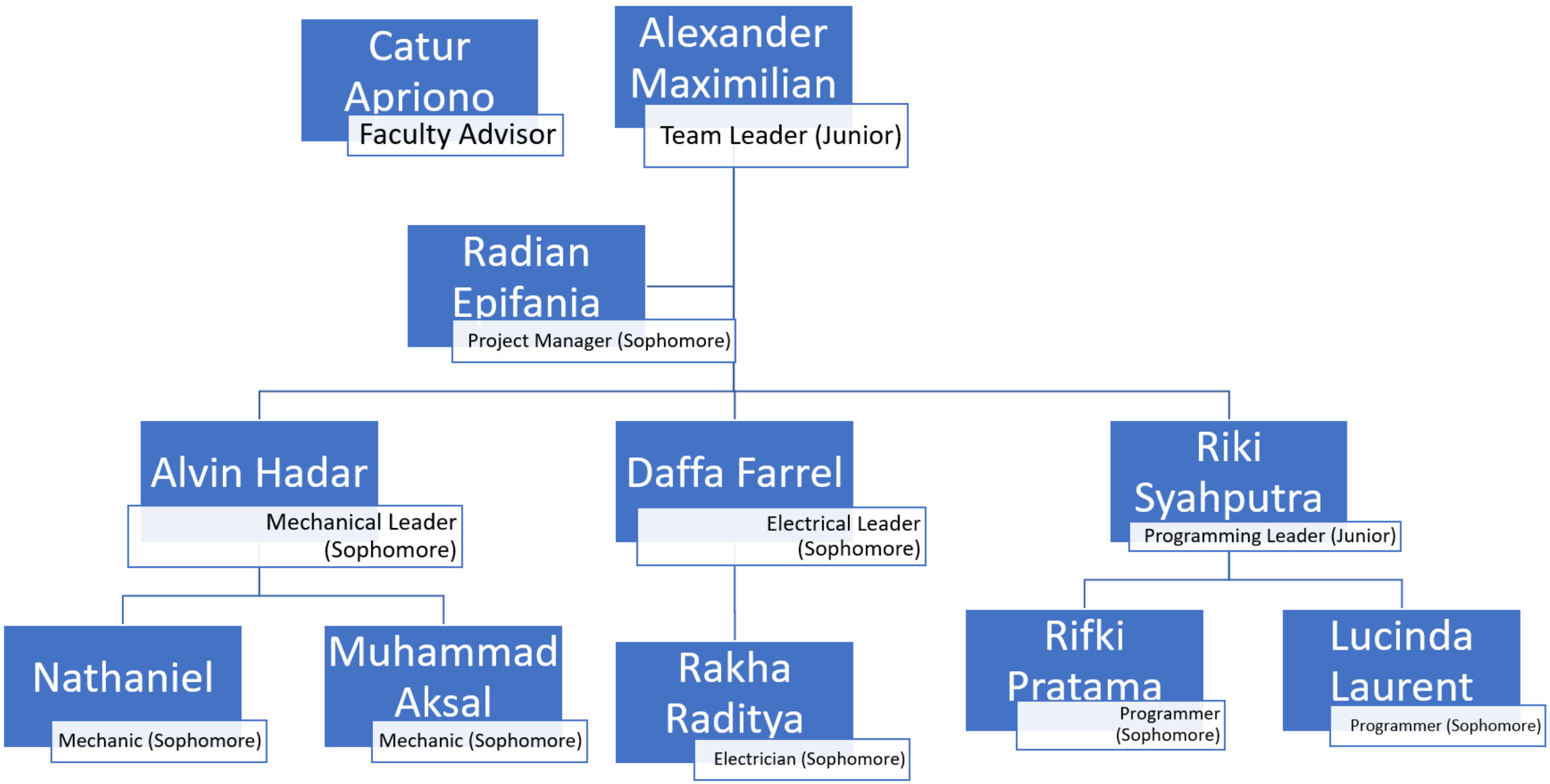
#2070

Makara Aerospace and Avionics Team

Presentation Outline

Section	Presenter
Systems Overview	Alexander Maximilian
Sensor Subsystem Design	Rakha Raditya
Descent Control Design	Nathaniel
Mechanical Subsystem Design	Alvin Hadar
Communication and Data Handling ( ) Subsystem Design	Riki Syahputra
Electrical Power Subsystem (EPS) Design	Daffa Farrel
Flight Software (FSW) Design	Rifki Pratama
Ground Control System (GCS) Design	Lucinda Laurent
CanSat Integration and Test	Muhammad Aksal
Mission Operations and Analysis	Daffa Farrell
Requirements Compliance	Radian Epifania
Management	Radian Epifania

Team Organization



Acronyms

A	Analysis
CDH	Communication and Data Handling
CDR	Critical Design Review
CONOPS	Concept of Operations
D	Demonstration
DCS	Descent Control System
EPS	Electrical Power Subsystem
FSW	Flight Software
G	Ground
GCS	Ground Control Station
GUI	Graphical User Interface
I	Inspection
I2C	Inter-Integrated Circuit

I/O	Input-Output
XCTU	XBee Configuration and Test Utility
T	Test
WPF	Windows Presentation Foundation
EEPROM	Electrically Erasable Programmable Read-Only Memory

The purpose of this section is to introduce the reviewer to the overall requirements and configuration of the CanSat. This provides a basis for the details presented in the subsystem sections.

Systems Overview

Alexander Maximilian

Mission Summary (1/2)

Main Objectives

Design a Cansat that shall carry a single large hen's egg and operate as a nose cone during ascent.

- Design a CanSat that shall take the place and function of the nose cone during ascent.
- CanSat is launched to a maximum 725 meters above the launch site, and being deployed when the rocket parachute ejection charge fires.
- CanSat shall descend utilizing an aero breaking heat shield at a rate of 10 to 30 meters per second.
- At 100 meters, the CanSat shall detach the aero-breaking heat shield, and simultaneously deploy a parachute to reduce the descent rate to less than 5 meters per second.
- The Cansat shall land with the egg intact.
- The Cansat shall include sensors for tracking altitude using air pressure, internal temperature, battery voltage, GPS position and a tilt sensor for stability verification during descent. A pitot tube shall be included to measure the ascent speed and descent speed

Mission Summary (2/2)

- A video recording camera shall be included to captue the horizontal view during ascent and landing. During descent, the camera shall point and maintain in determined direction.

Bonus Objectives

In this year competition, we planned to not include the bonus objective the pointing aft camera, since we are more prioritizing the system to maintain the direction of mandatory camera capture. Also, in the purpose to give more space for our egg containment design. The bonus objective is not being attempted due to low possibility of success.

External Objective

- Qualified until the final stage in Cansat 2024 competition for the first time
- Gain experience and portfolio in engineering project
- Improve skills and knowledge in aerospace engineering
- Efficiently realize functional, high-performing Cansat

System Requirement Summary (1/9)

Req #	Description	Subsystem	Verification A	I	T	D
C1	The Cansat shall function as a nose cone during the rocket ascent portion of the flight.	MECH	X	X	X	X
C2	The Cansat shall be deployed from the rocket when the rocket motor ejection charge fires.	FSW	X	X		X
C3	After deployment from the rocket, the Cansat shall deploy its heat shield/aerobraking mechanism.	MECH, FSW	X	X		X
C4	A silver or gold mylar streamer of 50 mm width and 1.5 meters length shall be connected to the Cansat and released at deployment. This will be used to locate and identify the Cansat.	MECH		X		
C5	At 100 meters, the Cansat shall deploy a parachute and release the heat shield.	MECH, FSW		X	X	X
C6	Upon landing, the Cansat shall stop transmitting data.	CDH				X
C7	Upon landing, the Cansat shall activate an audio beacon	FSW				X
C8	The Cansat shall carry a provided large hens egg with a mass range of 51 to 65 grams	MECH		X	X	
C9	0 altitude reference shall be at the launch pad	FSW		X	X	

System Requirement Summary (2/9)

Req #	Description	Subsystem	Verification A	I	T	D
C10	During descent with the heat shield deployed, the descent rate shall be between 10 to 30 m/s.	MECH	X		X	
C11	At 100 meters, the Cansat shall have a descent rate of less than 5 m/s.	MECH	X		X	
C12	Cost of the Cansat shall be under $1000. Ground support and analysis tools are not included in the cost of the Cansat. Equipment from previous years shall be included in this cost, based on current market value.	MANAGEMENT		X		
S1	The Cansat mass shall be 900 grams +/- 10 grams without the egg being installed.	MECH	X	X	X	
S2	Nose cone shall be symmetrical along the thrust axis.	MECH	X	X		
S3	Nose cone radius shall be exactly 71 mm	MECH		X		
S4	Nose cone shoulder radius shall be exactly 68 mm	MECH		X		
S5	Nose cone shoulder length shall be a minimum of 50 mm	MECH		X		
S6	Cansat structure must survive 15 Gs vibration	MECH		X	X	
S7	Cansat shall survive 30 G shock.	MECH		X	X	

System Requirement Summary (3/9)

Req #	Description	Subsystem	Verification A	Verification I	Verification T	Verification D
S8	The Cansat shall perform the function of the nose cone during rocket ascent.	MECH	X	X	X	X
S9	The rocket airframe can be used to restrain any deployable parts of the Cansat but shall allow the Cansat to slide out of the payload section freely.	MECH		X		X
S10	The rocket airframe can be used as part of the Cansat operations.	MECH	X	X		
S11	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	MECH, EPS		X		
M1	No pyrotechnical or chemical actuators are allowed.	MECH		X		
M2	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting the vegetation on fire.	MECH		X	X	
M3	All mechanisms shall be capable of maintaining their configuration or states under all forces.	MECH		X	X	
M4	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	MECH, EPS		X		

System Requirement Summary (4/9)

Req #	Description	Subsystem	Verification A	I	T	D
M5	The Cansat shall deploy a heat shield after deploying from the rocket	MECH, FSW				X
M6	The heat shield shall be used as an aerobrake and limit the descent rate to 10 to 30 m/s.	MECH	X		X	
M7	At 100 meters, the Cansat shall release a parachute to reduce the descent rate to less than 5 m/s.	MECH	X		X	
M8	The Cansat shall protect a hens egg from damage during all portions of the flight.	MECH		X	X	
M9	If the nose cone is to be considered as part of the heat shield, the documentation shall identify the configuration.	MECH, FSW	X			X
M10	After the Cansat has separated from the rocket and if the nose cone portion of the Cansatis to be separated from the rest of the Cansat, the nose cone portion shall descend at less than 10 meters/second using any type of descent control device.	MECH, FSW, EPS	X	X	X	
E1	Lithium polymer batteries are not allowed.	EPS		X		
E2	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	EPS		X		

System Requirement Summary (5/9)

Req #	Description	Subsystem	Verification A	Verification I	Verification T	Verification D
E3	Easily accessible power switch is required	EPS, MECH		X		
E4	Power indicator is required	EPS		X		
E5	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	EPS	X	X	X	
X1	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	CDH		X		
X2	XBEE radios shall have their NETID/PANID set to their team number.	CDH		X		
X3	XBEE radios shall not use broadcast mode.	CDH		X		
X4	The Cansat shall transmit telemetry once per second.	CDH			X	
X5	The Cansat telemetry shall include altitude, air pressure, temperature, battery voltage, Cansat tilt angles, air speed, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	CDH, FSW		X	X	

System Requirement Summary (6/9)

Req #	Description	Subsystem	Verification A	Verification I	Verification T	Verification D
SN1	Cansat shall measure its speed with a pitot tube during ascent and descent.	FSW			X	X
SN2	Cansat shall measure its altitude using air pressure.	FSW			X	X
SN3	Cansat shall measure its internal temperature.	FSW			X	X
SN4	Cansat shall measure its angle stability with the aerobraking mechanism deployed.	FSW			X	X
SN5	Cansat shall measure its rotation rate during descent.	FSW			X	X
SN6	Cansat shall measure its battery voltage.	FSW, EPS			X	X
SN7	The Cansat shall include a video camera pointing horizontally.	FSW			X	X
SN8	The video camera shall record the flight of the Cansat from launch to landing.	FSW			X	X
SN9	The video camera shall record video in color and with a minimum resolution of 640x480.	FSW		X		

System Requirement Summary (7/9)

Req #	Description	Subsystem	Verification A	Verification I	Verification T	Verification D
G1	The ground station shall command the Cansat to calibrate the altitude to zero when the Cansat is on the launch pad prior to launch.	GCS,FSW			X	X
G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	GCS		X		X
G3	Telemetry shall include mission time with 1 second or better resolution.	GCS		X	X	
G4	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	GCS		X		
G5	Each team shall develop their own ground station.	GCS	X	X	X	X
G6	All telemetry shall be displayed in real time during descent on the ground station.	GCS		X	X	
G7	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.) and the units shall be indicated on the displays	GCS		X		
G8	Teams shall plot each telemetry data field in real time during flight	GCS		X	X	X
G9	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and an antenna.	GCS		X	X	

System Requirement Summary (8/9)

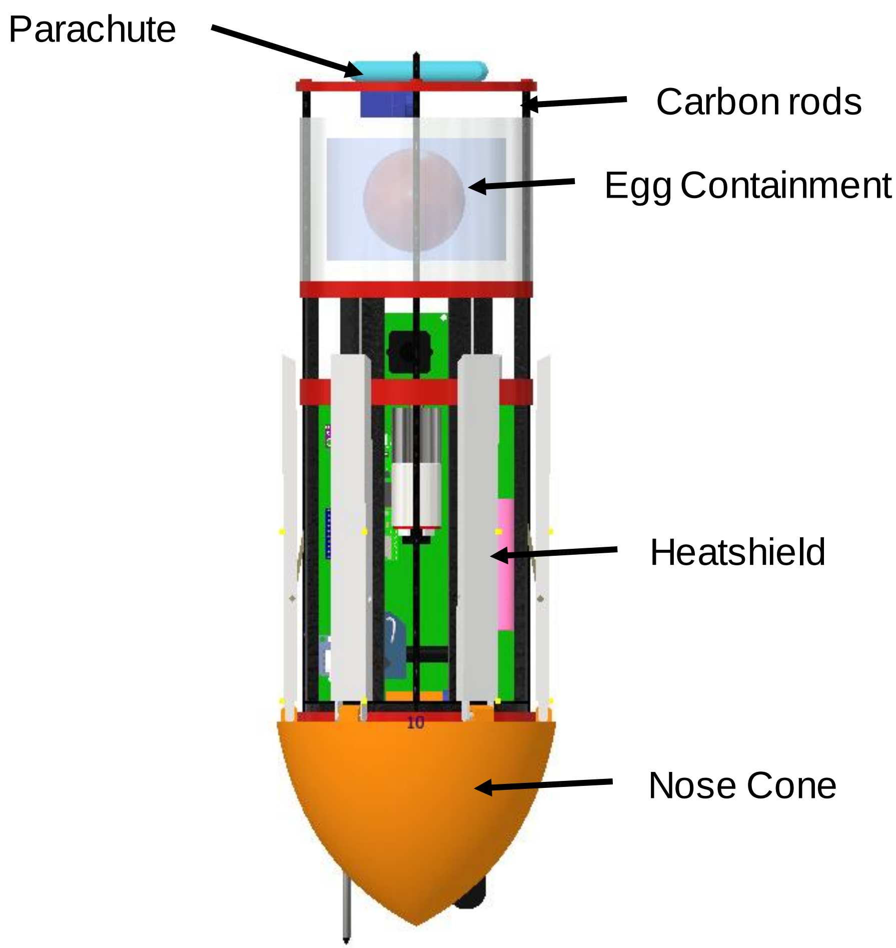
Req #	Description	Subsystem	Verification			
			A	I	T	D
G10	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	GCS	X	X		
G11	The ground station software shall be able to command the payload to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	GSC, FSW		X		X
G12	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the Cansat.	GCS		X	X	
G13	The ground station shall use a table top or handheld antenna.	GCS	X	X		
G14	Because the ground station must be viewed in bright sunlight, the displays shall be designed with that in mind, including using larger fonts (14 point minimum), bold plot traces and axes, and a dark text on light background theme.	GCS		X		
G15	The ground system shall count the number of received packets. Note that this number is not equivalent to the transmitted packet counter, but it is the count of packets successfully received at the ground station for the duration of the flight.	GCS		X	X	X

System Requirement Summary (9/9)

Req #	Description	Subsystem	Verification A	I	T	D
F1	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	FSW, CDH		X	X	X
F2	The Cansat shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	FSH, EPS	X		X	
F3	The Cansat shall have its time set to within one second UTC time prior to launch.	FSW		X	X	
F4	The flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.	FSW, CDH, GCS				X
F5	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the payload altitude.	FSW, CDH		X		X
F6	The payload flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	FSW		X		X

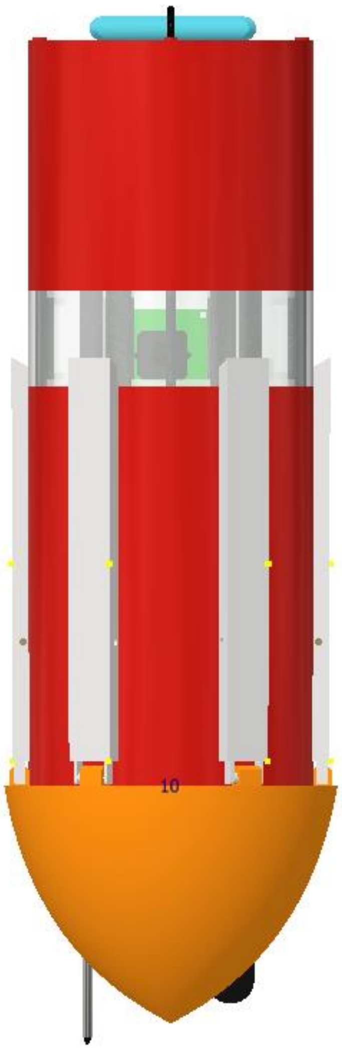
System Level CanSat Configuration Trade & Selection

Design A :



GENERAL DESCRIPTION
1 Phase Parachute
The heat shield is integrated with the nose cone
The nose cone is connected to the payload via a locking mechanism at the bottom of the payload,
Nose cone and heatshield will be deployed after reaching a certain height
The egg containment is directly integrated into the payload, featuring a dual-layer design aimed at ensuring the safety of the egg

System Level CanSat Configuration Trade & Selection



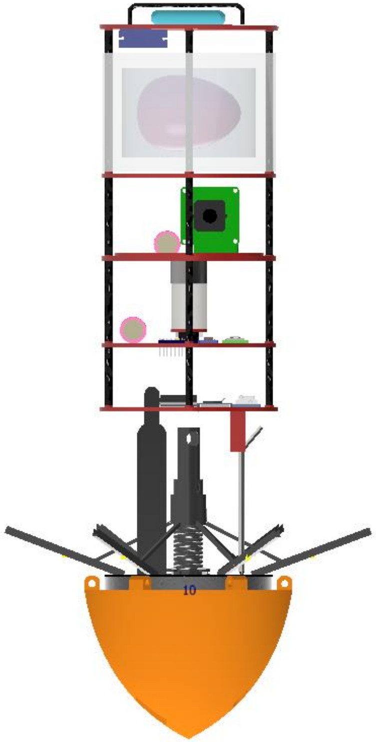
Pros

- Increased stability post-launch
- Amplified latitude for alterations and integration
- Convenient alterations to the Printed Circuit Board or electrical components
- A simplified release mechanism for both the nose cone and heat shield

Cons

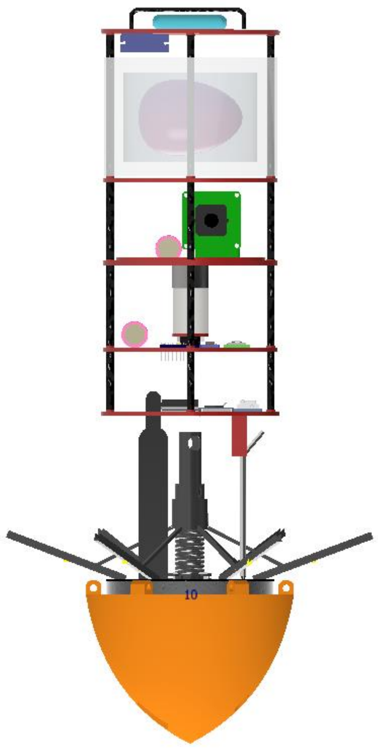
- Manufacturing Complexity
- Exposed components emerge upon the detachment of both the nose cone and heat shield.

Design B :



GENERAL DESCRIPTION
1 Phase Parachute
1 Phase Heat shield
Nose cone and heatshield will be deployed after reaching a certain height
The egg container is securely connected to the payload to ensure the preservation of egg integrity.

System Level CanSat Configuration Trade & Selection



Pros

- Decreased utilization of arms
- Reduced weight

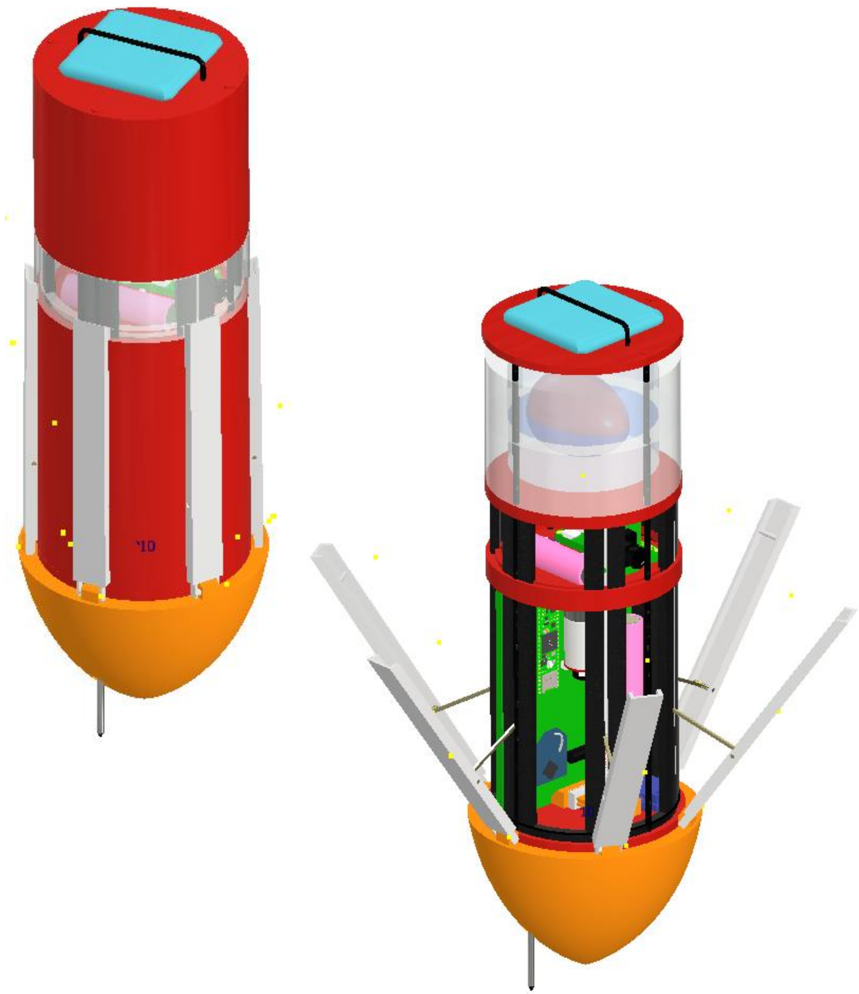
Cons

- Increased reliance on Printed Circuit Board
- Assembly complexity
- Inequitable weight distribution within the Cansat receptacle
- The electronic components become visible when the nose cone dna heat shield is detached.

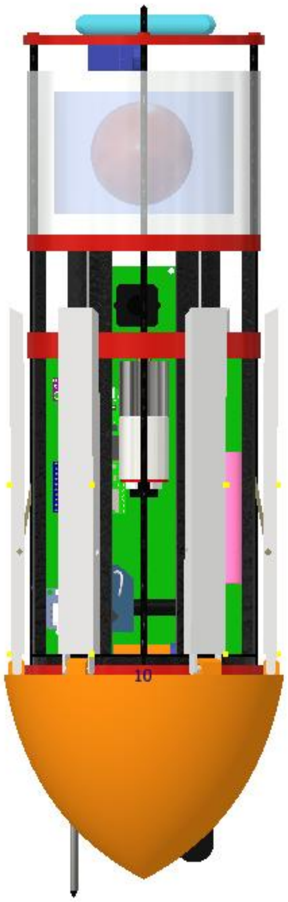
System Level Configuration Selection

SELECTION **:** ***Design A***

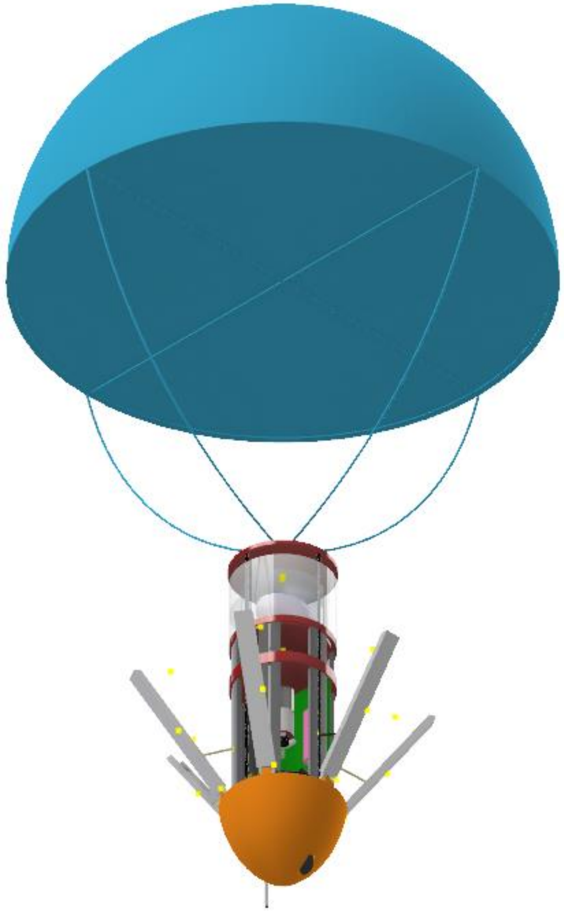
Design A was ultimately selected as our final option due to its superior ease of assembly, cost-effectiveness, and operational efficiency. Additionally, the placement of electrical components is more advantageous, offering ample space for electronics, and the weight distribution in Design A is significantly improved. With Design A, the likelihood of failures during parachute, nose cone and heat shield deployment is substantially reduced



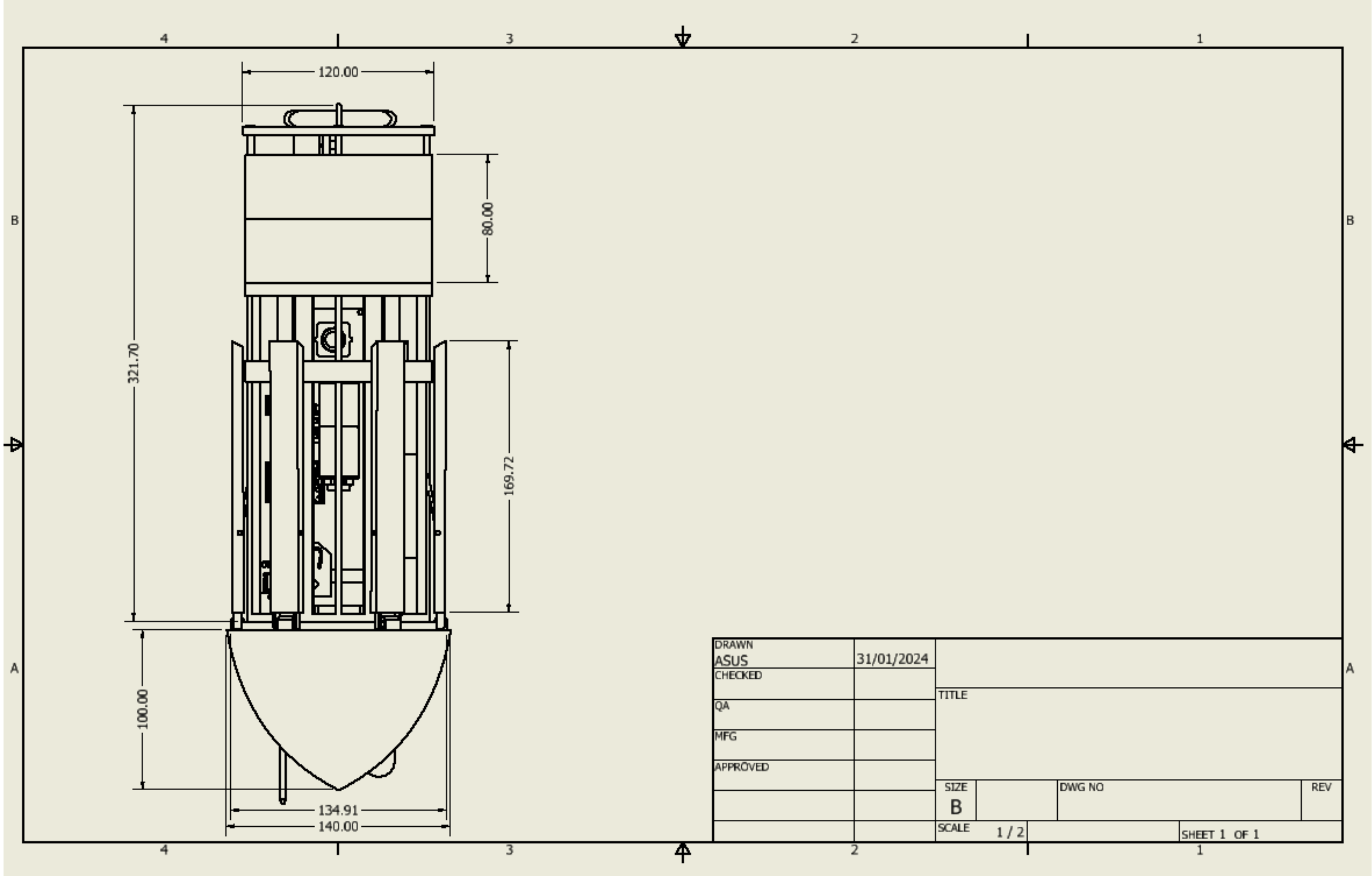
Launch Configuration:



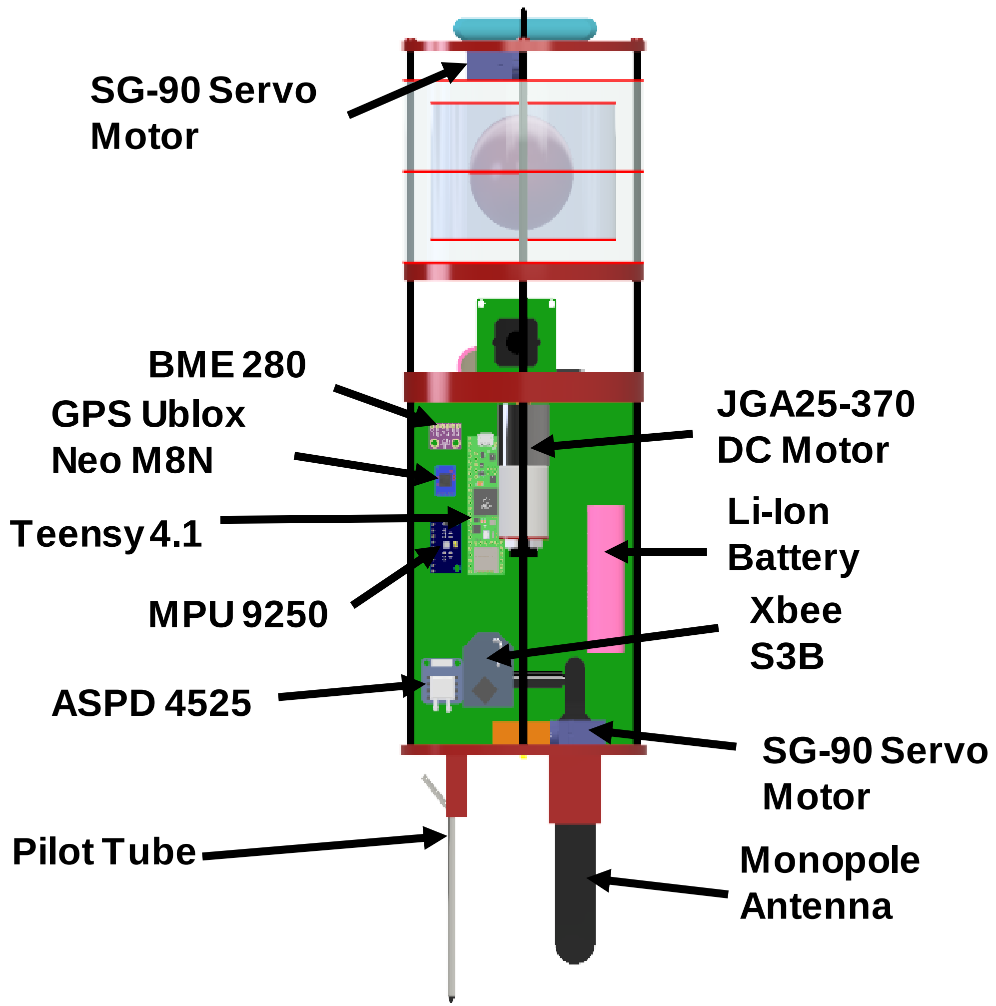
Deployment Configuration:



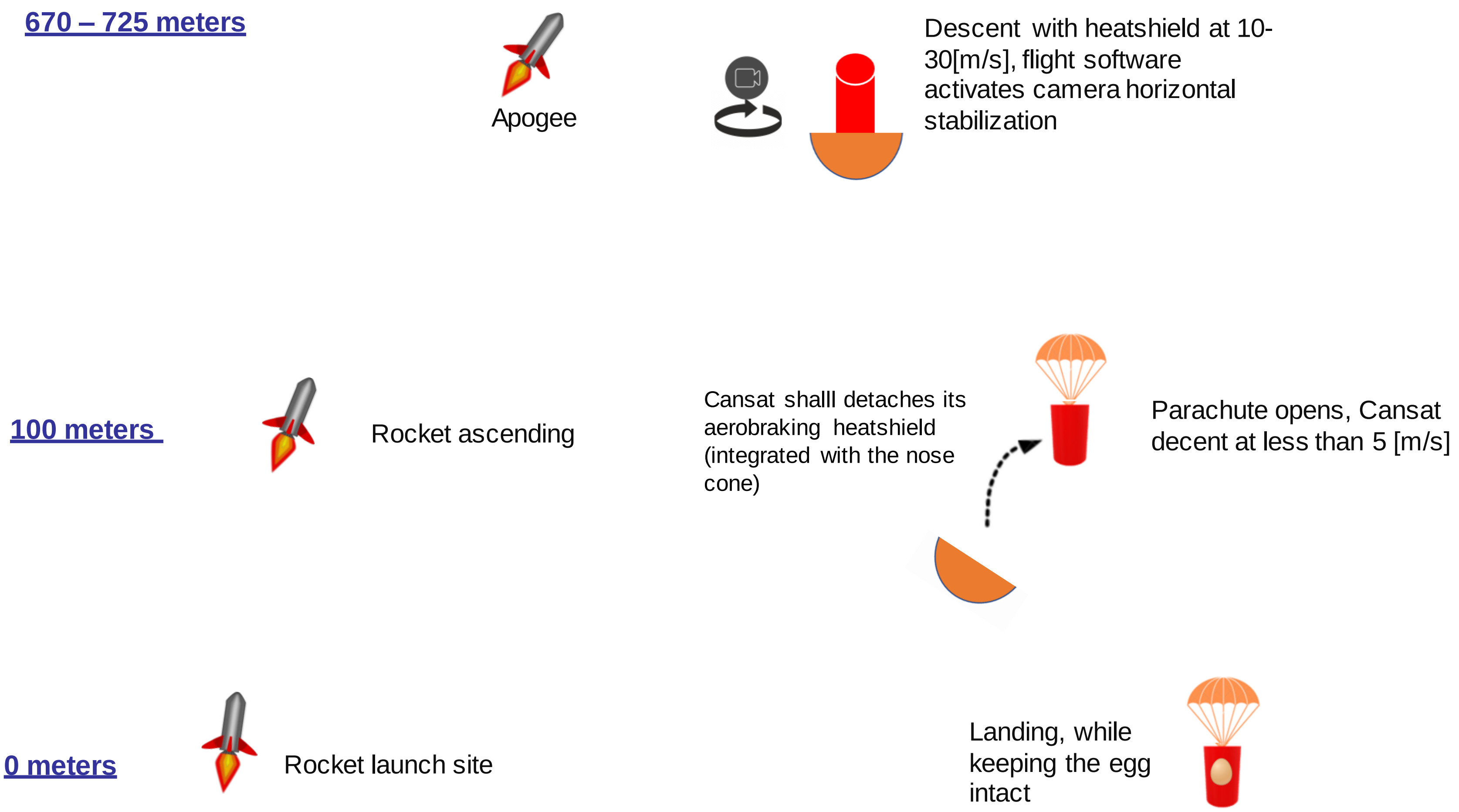
Physical Layout (2 of 3)



Payload Mechanics:



System Concept of Operations (1/2)



System Concept of Operations (2/2)

Pre-Launch

- Team briefing
- Turn on all power switches
- Communication check
- Final verification of CanSat
- Cansat inserted into rocket

Launch

- Rocket launch initiation
- Data transmission activated
- Apex reached
- Detach Cansat from rocket (max 750m)
- Activate camera stabilization functionality for decent capturing
- Deployment of aerobreaking heatshield, descent with velocity of 10-30 m/s.
- At 100m, detach the heat shield which integrated to the nose cone, while releasing the parachute to reduce decent rate below 5 m/s
- Terminate telemetry transmission

Post-Launch

- Retrieve Cansat
- Assess the state of Cansat
- Assess the post-flight condition of the egg
- Analyze data
- Prepare for PFR
- Presentation of PFR

Launch Vehicle Compatibility (1/2)

- **Include a dimensioned drawing that shows *clearances* with the payload section**
  - Focus on launch configuration
  - Include all descent control apparatus (no sharp protrusions)
  - At PDR this may be allocated dimensions (if this is the case, these should be requirements at the system and subsystem levels)
  - What is the clearance? (Leave margin to allow *easy* deployment!)

Launch Vehicle Compatibility (2/2)

Mission Guide Rocket Payload Dimensions:
- Diameter – 136 mm
- Height – 350 mm

Cansat Dimensions:
- Diameter – 140 mm
- Height – 428,2 mm

Payload Dimensions:
- Diameter – 120 mm
- Height – 326,742 mm

Payload Parachute Dimensions
- Diameter – 1000 mm
- Height – 300 mm

Heatshield Dimensions
- Diameter – 320 mm
- Height – 200 mm

Nose Cone Dimensions
- Diameter – 140 mm
- Height – 100 mm

Sensor Subsystem Design

Rakha Raditya

Sensor Subsystem Overview

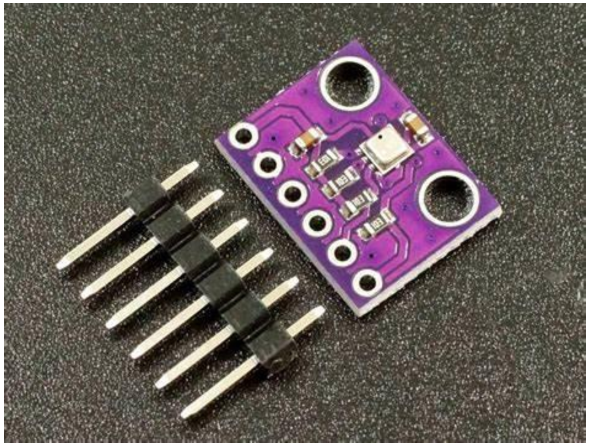
Component	Type	Function
BME 280	Pressure and temperature sensor	Gets atmospheric pressure and air temperature
Voltage Divider	Voltage sensor	Gets battery voltage measurement
ASPD-4525	Speed sensor	Measure the speed of an object
MPU9250	Tilt and rotation sensor	Gets angles or slope of an object, as a compass
Ublox NEO-M8N	GPS	Gets latitude and longitude
Raspberry Pi Camera v1.3	Video Camera	Records the videos needed

Payload Air Pressure Sensor Trade & Selection

Sensor	Dimensions (mm)	interface	Mass (g)	Operating Voltage (V)	Operating Current (uA)	Max. update rate (Hz)	Range (hPa)	Cost (USD)
BME 280	**19 x 16 x 3**	**I2C, SPI**	**1**	**5**	**3.6**	**250**	**300 - 1100**	**$3.90**
BMP 390	20 x 15 x 3	I2C, SPI	1	3.3	3.2	200	300 - 1250	$10.95
DPS 310	25.5 x 17.7 x 4.6	I2C, SPI	1	1.7 - 3.6	1.7	200	300 - 1200	$6.95

Selected Tilt Sensor: **BME 280**

- More readily accessible in our region.
- Optimal cost-to-performance ratio.
- Sleek and light
- Accuracy can be increased by connecting external sensors

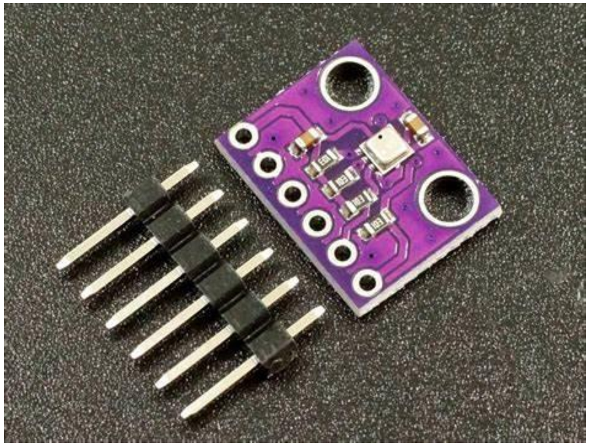


Payload Air Temperature Sensor Trade & Selection

Sensor	Dimensions (mm)	interface	Mass (g)	Operating Voltage (V)	Operating Current (uA)	Max. update rate (Hz)	Temperature Range (°C)	Cost (USD)
BME 280	**19 x 16 x 3**	**I2C, SPI**	**1**	**5**	**3.6**	**250**	**-40 - +85**	**$3.90**
BMP 388	21.6 x 16.6 x 3	I2C, SPI	0.1	1.71 - 3.6	3.4	200	-40 - +85	$9.95
MPL 115A2	25.5 x 17.7 x 4.6	I2C	0.61	2.375 - 5.5	6	200	-40 - +85	$9.95

Selected Tilt Sensor: **BME 280**

- More readily accessible in our region.
- Sleek and lightweight.
- Can be used in multiple measurements

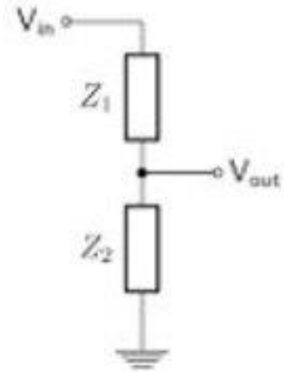


Payload Battery Voltage Sensor Trade & Selection

Sensor	Weight (g)	Error rate	Voltage Range (V)	Interface	Cost (USD)
Teensy 4.1 Analog Pin	**0**	**< 1 %**	**Any**	**Analog**	**$0**
BMP 390	>0	< 1 %	0 - 36	I2C	$9.95

Selected Tilt Sensor: **Analog Pin**
Combines accelerometer and gyroscope

- Uncomplicated yet precise
- Avoids the requirement for additional component

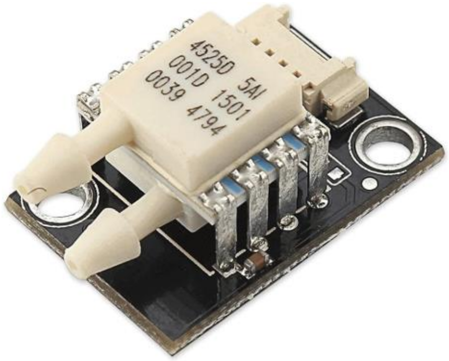


Payload Speed Sensor Trade & Selection

Sensor	Supply voltage (V)	Weight (g)	Dimension (mm)	Interface	Pressure range (psi)	Speed range (km/h)	Cost (USD)
ASPD-4525	**4 - 6**	**3.5**	**20 x 20 x 14**	**I2C**	**1**	**360**	**$62.07**
ASPD-7002	4.8 - 5.2	4	20 x 20 x 14	I2C	0.3	200	$45.98
DLVR-L10D	4-6	4	22 x 22 x 12.5	I2C, CAN	0.36	250	$89.91

Selected Speed Sensor: **ASPD-4525**

- Optimal cost-to-performance speed range.
- Lightweight
- Wide measurement range for air pressure.

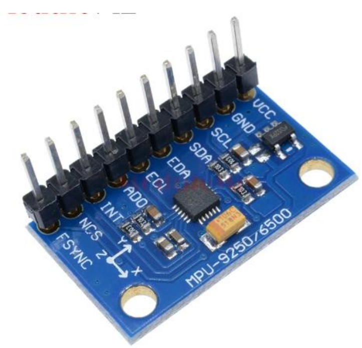


Payload Tilt Sensor Trade & Selection

Sensor	Dimensions (mm)	interface	Mass (g)	Operating Voltage (V)	Operating Current (mA)	Gyroscope Full-Scale Range	Resolutin (bits)	Cost (USD)
BNO055	3.8 x 5.2 x 1.13	HID-I2C, I^2C, UART	3	3.3	12.3	±250, ±500, ±1000, and ±2000°/sec	14	$25.57
MPU9250	**3 x 3 x 1**	**I2C, SPI**	**3**	**2.4 – 3.6**	**0.4**	**±250, ±500, ±1000, and ±2000°/sec**	**16**	**$5.01**
MPU6050	14 x 12 x 2	I2C	3	2.9 – 3.6	0.4	±250, ±500, ±1000, and ±2000°/sec	12	$1.85

Selected Tilt Sensor: **MPU9250**

- Combines accelerometer, gyroscope, and magnetometer
- Has lower noise
- High accuracy
- Optimal cost-to-performance ratio



Rotation Sensor Trade & Selection

Sensor	Dimensions (mm)	interface	Mass (g)	Operating Voltage (V)	Operating Current (mA)	Gyroscope Full-Scale Range	Resolutin (bits)	Cost (USD)
BNO055	3.8 x 5.2 x 1.13	HID-I2C, I^2C, UART	3	3.3	12.3	±250, ±500, ±1000, and ±2000°/sec	14	$25.57
MPU9250	**3 x 3 x 1**	**I2C, SPI**	**3**	**2.4 – 3.6**	**0.4**	**±250, ±500, ±1000, and ±2000°/sec**	**16**	**$5.01**
MPU6050	14 x 12 x 2	I2C	3	2.9 – 3.6	0.4	±250, ±500, ±1000, and ±2000°/sec	12	$1.85

Selected Tilt Sensor: **MPU9250**

- Combines accelerometer, gyroscope, and magnetometer
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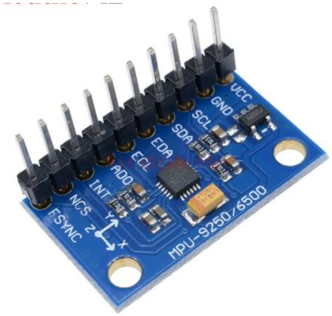
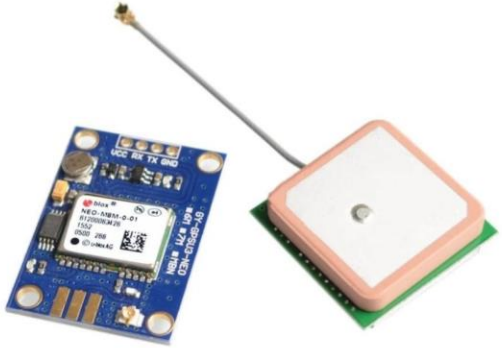


Payload GPS Sensor Trade & Selection

Sensor	Supply voltage (V)	Current (mA)	Interface	Sensitivity (dBm)	Position accuracy (m)	Max. update rate (Hz)	No. of channel	Cost (USD)
Adafruit Ultimate GPS	3.0 - 5.5	20	UART	-165	1.8	10	66	39,92
Ublox NEO-M8N	**2.7 V - 3.6 V**	**10**	**UART, I2C**	**-166**	**2.5**	**10**	**72**	**11.89**
Ublox NEO-6M	-0.5 - 3.6	10	I2C, UART, SPI	-161	2.5	5	50	9.59

Selected GPS Sensor: **Ublox NEO-M8N**

- High positional accuracy
- High refresh rate
- More readily accessible in our region
- Fast locking time due to # of channels

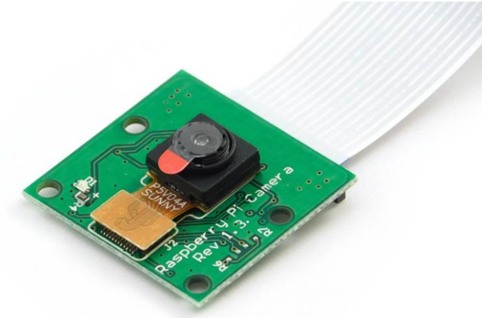


Payload Camera Trade & Selection

Sensor	Supply voltage (V)	Current (mA)	Size (mm) L x W x H	Weight (g)	Video File Type	Resolution (px)	Interface	Cost (USD)
Raspberry Pi Camera Module v1.3	**3.0 - 5.5**	**20**	**25 x 24 x 9**	**3**	**MJPEG**	**640 x 480**	**CSI**	**6.2**
OV7670 Camera	3.3 - 5	20	30.5 x 30.5 x 3	20	RAW RGB	640 x 480	SCCB, SPI	$4.83
Quelima SQ11	5	200	23 x 23 x 23	5.2	AVI	1280 X 780	Digital	$3.26

Selected GPS Sensor: **Raspberry Pi Camera v1.3**

- Interoperable with our SBC, offering a user-friendly interface.
- Sleek and lightweight.
- Low power usage.
- High image quality.



Bonus Camera Trade and Selection

As stated previously in Mission Summary, we decided to not include the Bonus Camera to the Cansat in this year competition.

Descent Control Design

Nathaniel

Descent Control Overview

670 – 725 meters

Apogee

Descent with heatshield at 10-30[m/s], flight software activates camera horizontal stabilization

100 meters

Rocket ascending

Cansat shalll detaches its aerobraking heatshield (integrated with the nose cone)

Parachute opens, Cansat decent at less than 5 [m/s]

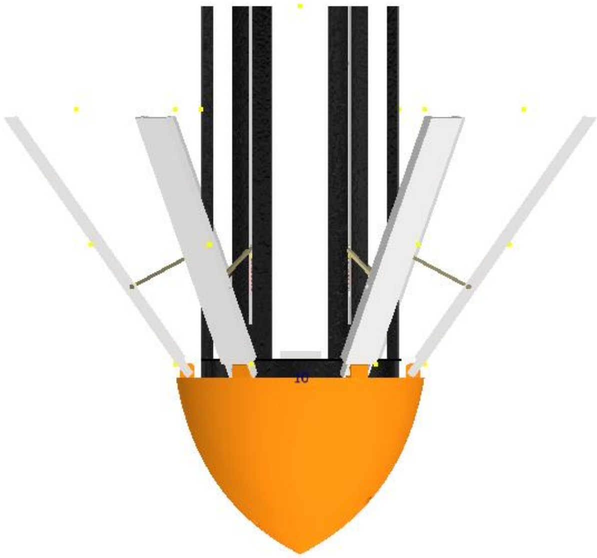
0 meters

Rocket launch site

Landing, while keeping the egg intact

Payload Aerobraking Descent Control Strategy Selection and Trade (1/3)

Design A :
Design A heat shield is composed of six arms, each of which is attached to six poles through a joint. This arm will serve to broaden the heat shield diameter, facilitating the descent of the payload to a targeted velocity of less than 20 m/s. The poles, arms, and base of the heat shield will be covered with cloth/fabric, rendering it ideal as an aerodynamic braking device.



Pros:
- Increased surface area, allowing for easier reduction of payload descent rate
- Highly compact
- Adaptable to future configurations

Cons:
- Challenging to manufacture

Design B :

Design B heat shield is comprised of six rods. The rods and the extensive circular base of the heat shield will be enshrouded in cloth/fabric, rendering it a suitable aerodynamic braking device.

Pros:

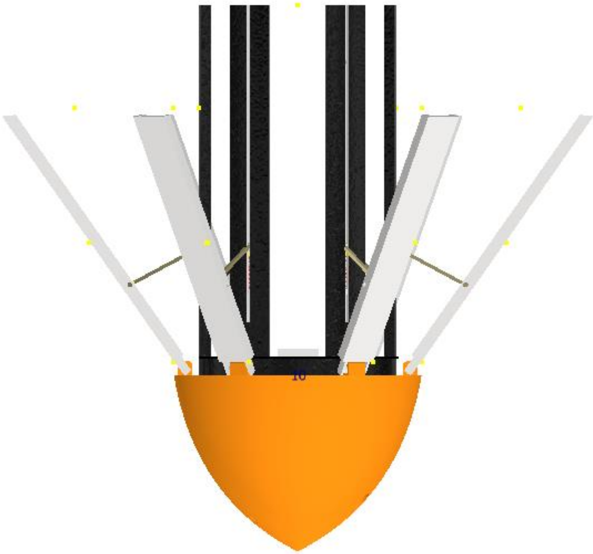
- Facile to fabricate

Cons:

- Inferior compactness
- Exorbitant unused space
- The ample base of the heat shield may bear an undue burden
- Inflexible to future modifications

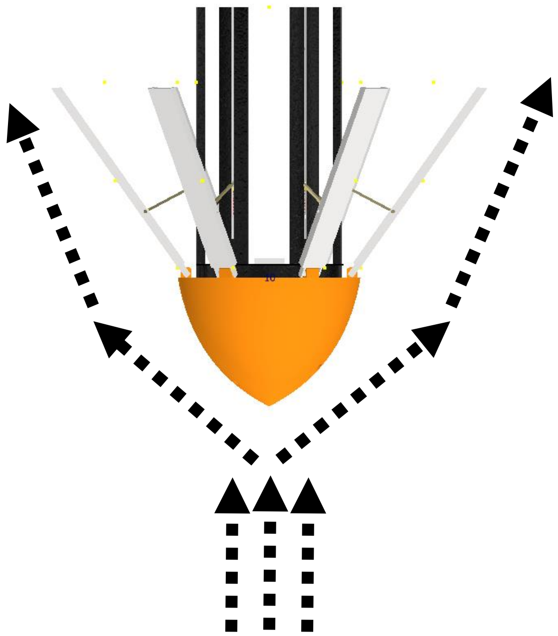
We selected: Design A

Design A encompasses a more expansive realm, thereby facilitating a more efficient deceleration of the payload's rate of descent. It is remarkably compact and adaptable to future configurations



Design A :

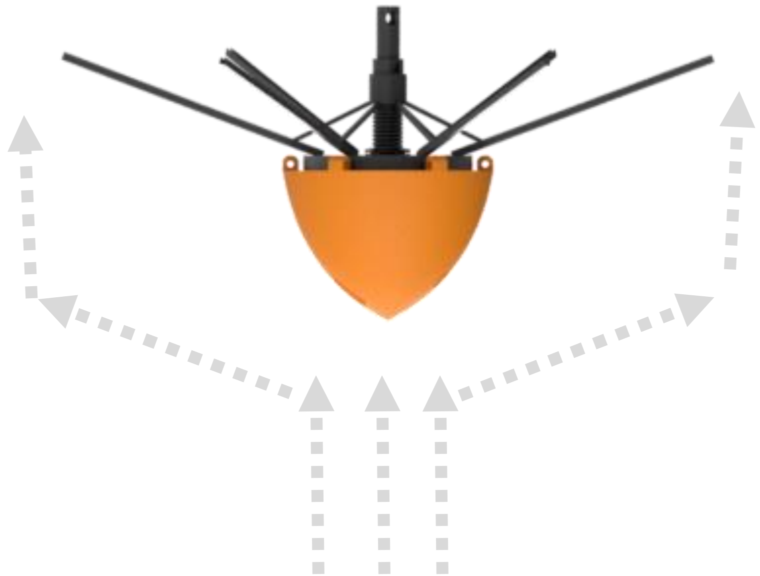
Design A's heat shield relies upon atmospheric currents to attain descent stability, conceived to be aerodynamic and thereby enable the flow of air to mitigate the velocity of the payload's descent, all the while ensuring a smooth and stable plummet of the payload



Payload Aerobraking Descent Stability Control Strategy Selection and Trade (2/3)

Design B :

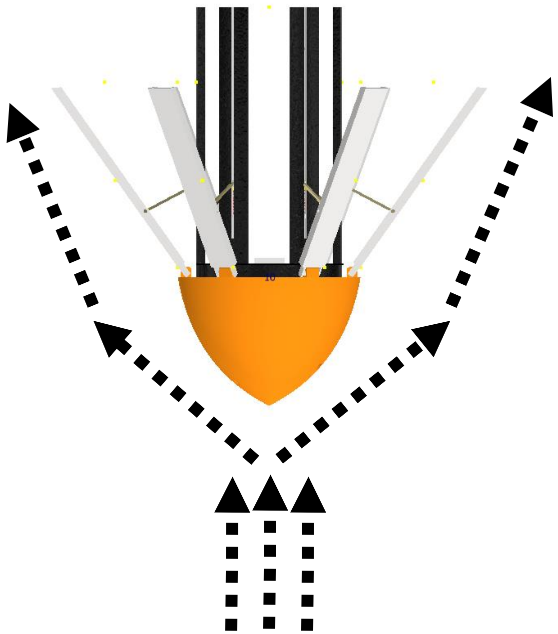
Design B's heat shield also avails itself of atmospheric currents for stability during descent, though while the rods are arranged in an aerodynamic manner, the broad and flat circular foundation plate was not engineered to be aerodynamic, potentially leading to an unsteady plummet



Payload Aerobraking Descent Stability Control Strategy Selection and Trade (3/3)

We selected: Design A

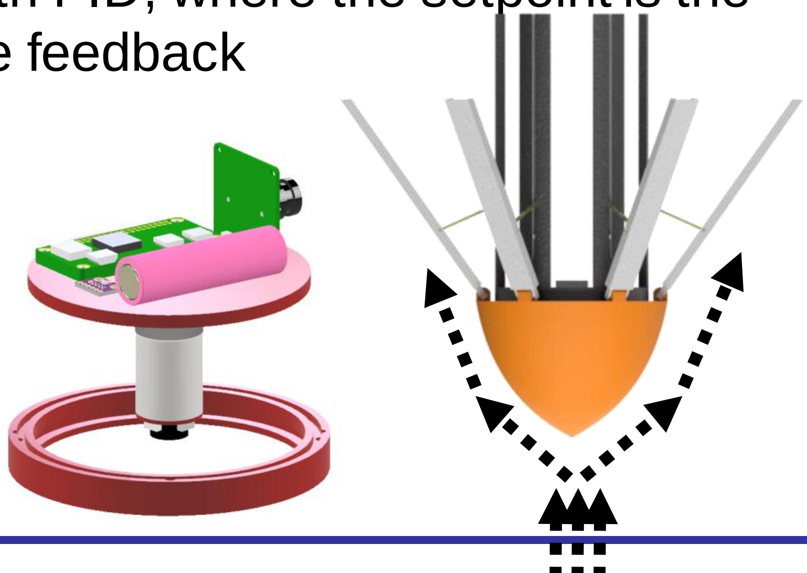
The aerodynamic design of Design A portends a more stable descent trajectory



Design A :

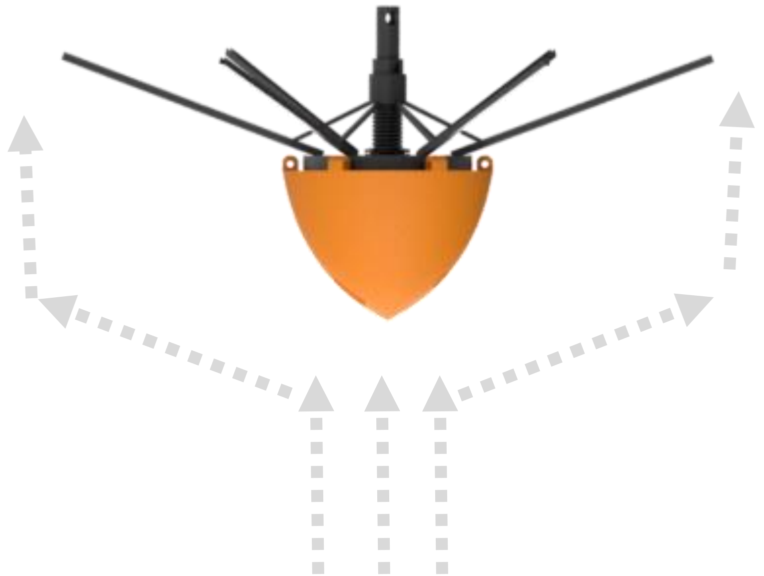
Design A's heatshield is intended to be not excessively aerodynamic to prevent unstable rolling movement, yet the nose cone don't have any additional fins or patterns. Also the dome-like form which is relatively wide in angle helps to reduce incoming rotation.

Primarily, to compensate rotation in video capturing with camera (as required in the guidebook), it is also prepared camera active rotation feedback control using DC motor with PID, where the setpoint is the azimuth and degree deviation as the feedback



Design B :

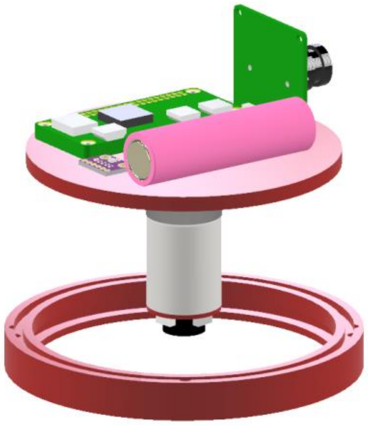
Design B's physical system also rely on the shorter form of heatshield, and but without any active control for camera capturing. Less in total weight of the Cansat since there is no rotating actuator which typically way heavier than other supporting components.

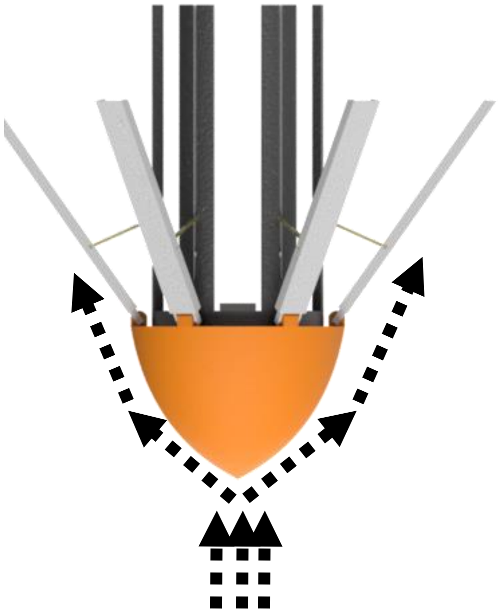


Payload Rotation Control Strategy Selection and Trade (3/3)

We selected: Design A

Way more reliable for the camera to capture video in one determined direction, regardless of any unwanted disturbances.





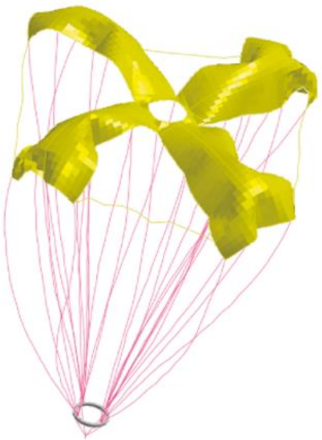
• Payload Parachute Descent Strategy

Type 1 Configuration: Dome Type

- Effortless production
- Spill holes enhance stability
- Requires minimal space when compressed
- Significantly increased drag coefficient

Type 2 Configuration: X Type

- Enhanced stability
- Decreased drag coefficient
- Reduced weight
- Facilitates stacking.



Descent Rate Estimation Overview

- **The terminal velocity during each phase of descent shall be quantified through a variety of parameters**
- **The utilization of a parachute will serve as a means to regulate the rate of descent of the probe.**

- **Apogee to 100m**
  - **Parameter used :** CanSat's round *heatshield* diameter ***28cm***

    Desired rate : parachute diameter ***28cm***

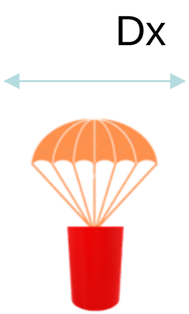
    Decent rate of 12.5 +/- 5 m/s

From 100m to 0m

- **Parameter used :** CanSat's round *parachute* diameter ***1m***

  Desired* rate** : parachute diameter ***1m

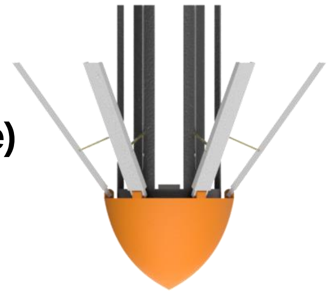
  Decent Rate of 5m/s +/- 3.5m/s



- **Descent with Heatshield (Apogee to 100m)**
- **Using variabel to calculate the descent with heatshield**

$$v = \sqrt{\frac{2 \times m \times g}{\rho \times A \times Cd}}$$

» **M = Mass (Heatshield + Cansat) = +/- 0,9kg**
» **g = 9.8 m/s (gravitation)**
» **P = 1.225 kg/m^3 (Air Density In Texas)**
» **A = Area Used Heatshield (Circular area of half sphere)**
» **Cd = Drag Coefficient Half Sphere = 0,42**



$$v = \sqrt{\frac{2 \times 0.9kg \times 9.8m/s}{1.225kg/m^3 \times (\pi \times 0.16 \times 0.16) \times 0.42}}$$ **= 20.6 m/s**

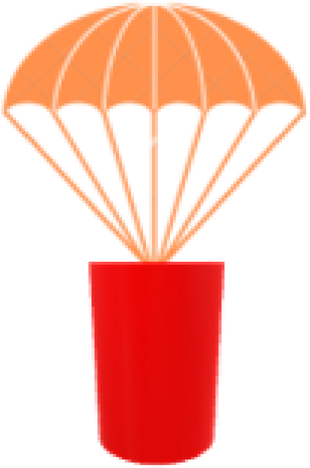
- **By utilizing the Equation and Parameters utilized for calculating the descent rate of the payload utilizing the heat shield from an altitude of apogee to 100m, it was determined to be approximately 20.6 m/s, thereby adhering to the competition's requirement of a descent rate between 10m/s to 30m/s. The Parameter utilized in this calculation was the circular area of a hemispherical shape, calculated to be approximately 804 cm^2, and the drag coefficient of a hemispherical shape, determined to be 0.42**

Descent Rate Estimates (3/3)

- **Descent with Parachute (100m to 0m)**
- **Using variabel to calculate the descent with parachute**

$$v = \sqrt{\frac{2 \times m \times g}{\rho \times A \times Cd}}$$

» **M = Mass (Cansat) = +/- 0.6kg**
» **g = 9.8 m/s (gravitation)**
» **P = 1.225 kg/m^3 (Air Density In Texas)**
» **A = Area Used (parachute r = 50 cm)**
» **Cd = Drag Coefficient Dome Type (1,5)**



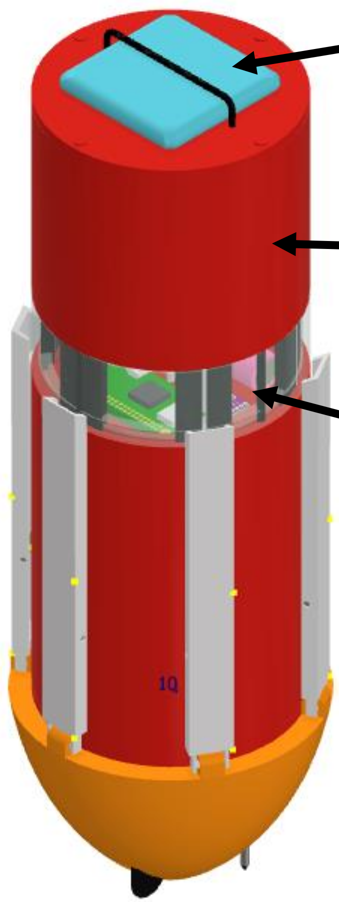
$$v = \sqrt{\frac{2 \times 0.6kg \times 9.8m/s}{1.225kg/m^3 \times (\pi \times 0.5 \times 0.5) \times 1.5}}$$ **= 2.8 m/s**

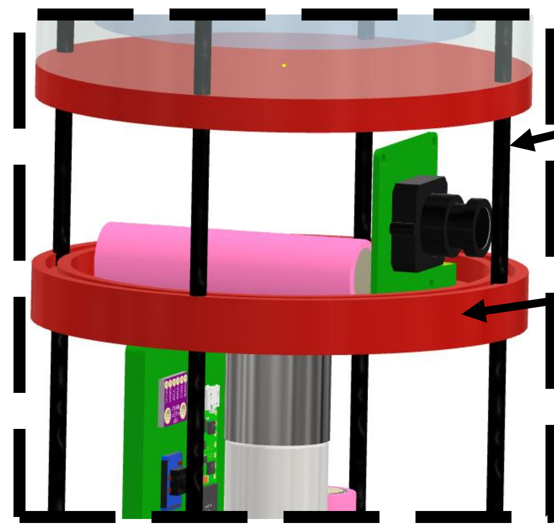
- **The descent velocity of the cansat from 100m to the ground will be calculated by applying a specific set of parameters to an equation. Utilization of a dome-shaped parachute is envisioned to regulate the rate of descent. The calculated descent velocity of 2.8 m/s, as derived from the equation, was deemed suitable in the competition's requirement of a velocity below 5 m/s, given the utilization of a 50 cm radius (100 cm diameter) dome-shaped parachute.**

Mechanical Subsystem Design

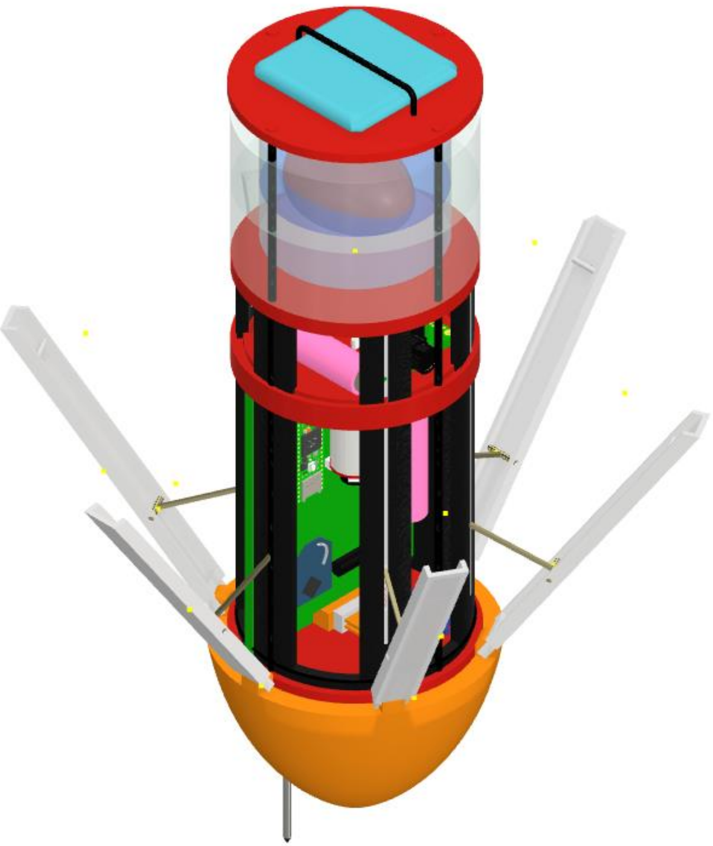
Alvin Hadar

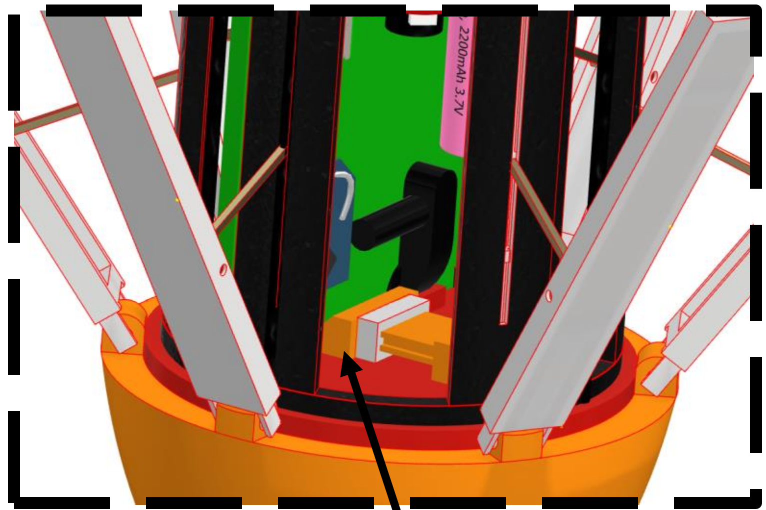
Mechanical Subsystem Overview (1/4)





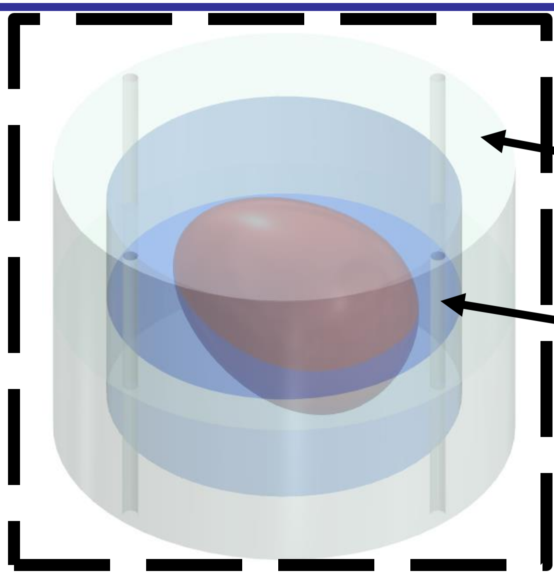
Mechanical Subsystem Overview (2/4)





Heat Shield
Attachment Lock
System
Material: Filamen

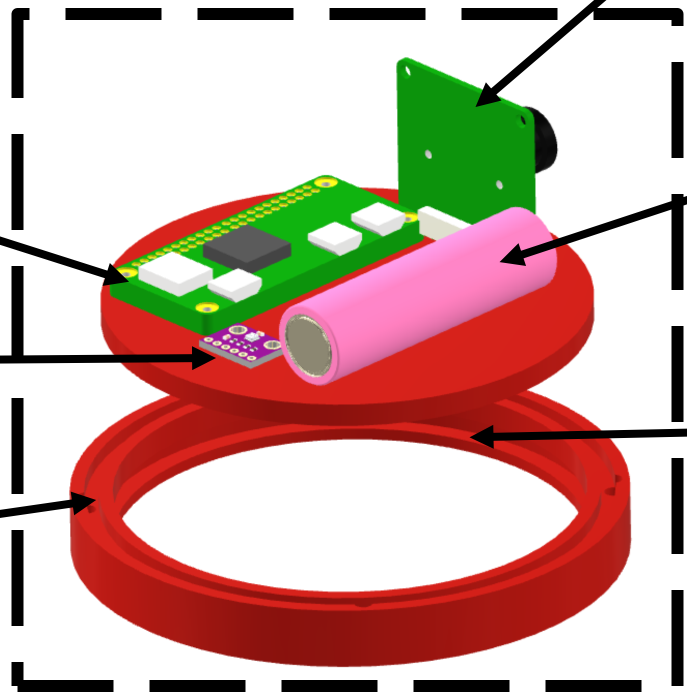
Mechanical Subsystem Overview (3/4)



Egg Containment First Layer
Material: Styrofoam

Egg Containment Second Layer
Material: Cushion

Rasphberry Pi Camera



Rasphberry Pi Zero

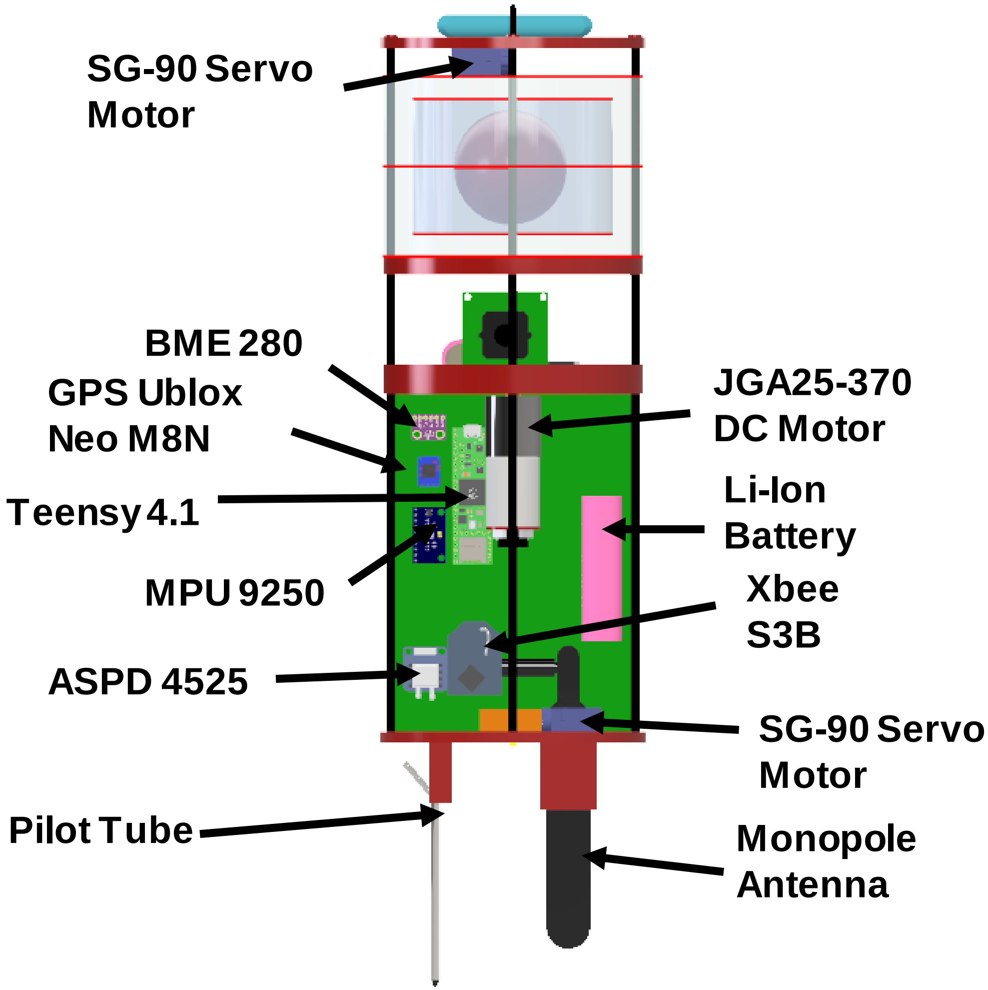
Li-Ion Battery

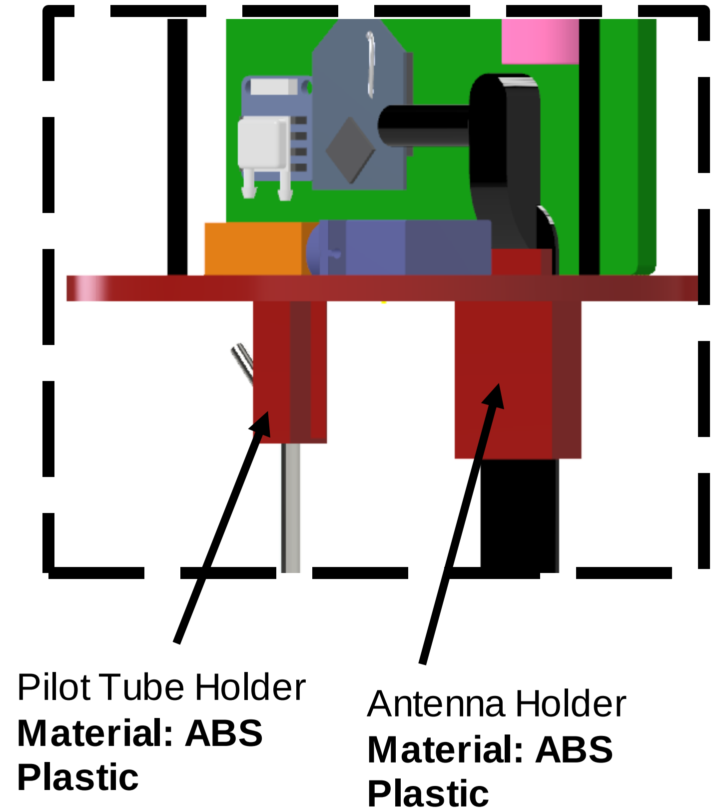
BME 280

Rotating Segment For Horizontal Stabilization
Material: ABS Plastic

Transparent Acrylic Compartmen/Slot
Material: ABS Plastic

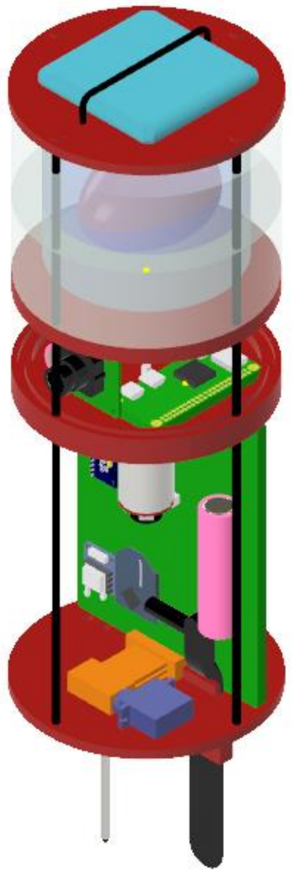
Mechanical Subsystem Overview (4/4)





Payload Mechanical Layout of Components Trade & Selection (1/2)

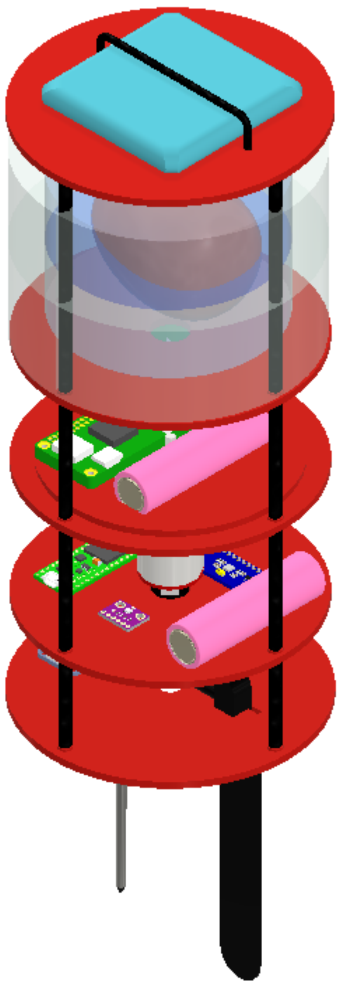
DESIGN A :



GENERAL DESCRIPTION (Chosen Design A)
Simpler release parachute mechanism
Larger space for Electric Component
Even weight distribution
More Compact, more spacing in the chassis
Combined material : ABS and Polyfoam
Have sharp edges

Payload Mechanical Layout of Components Trade & Selection (2/2)

DESIGN B :

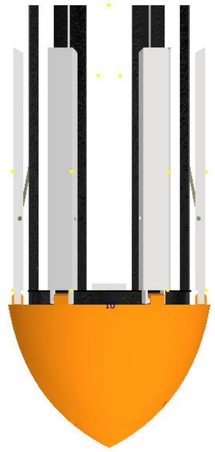


GENERAL DESCRIPTION
Simpler release parachute mechanism
Less space for Electric Component
Have a lighter weight.
More unstable because centre of mass is spred out.
More Fragile
Combined material : ABS and Polyfoam
Doesn't have sharp edges

DESIGN A :

The aerobraking heatshield utilizes is designed to surround the wall of the payload, which connected to centralized servo mechanism to keep the structure remained closed until the Cansat's sensory system (tilt sensor and altimeter) detected significant pitch movement, meaning it's deployed from the rocket.

By default, the closing angle of aerobraking structure isn't perfectly 90 degrees. Instead, it is given a margin to help our Cansat hold on to the wall of payload section of the rocket more rigidly, supported by spring's suspension of the heatshield.



DESIGN B :

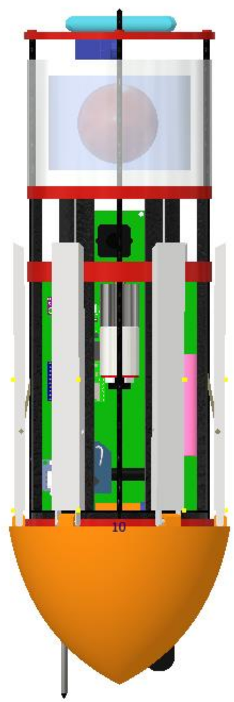
The heat shield's slider is connected to its rods at the center below the payload section, and the movement of the former regulates the extension of the latter, as seen in the figure.

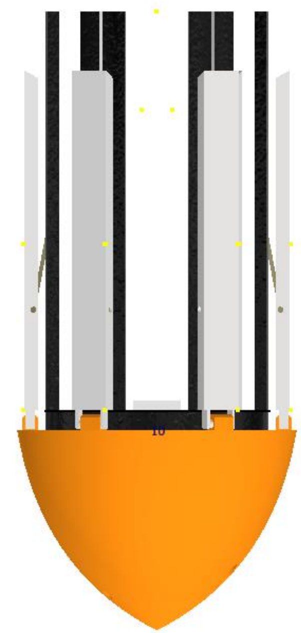
The slider is attached to a tensioned spring, which keeps the heat shield compactly stowed inside the Cansat. To keep the slider in this position and prevent the spring from slackening, a solenoid actuator is used, piercing the slider pole of the heat shield and retaining it until deployment.

Payload Aerobraking Pre Deployment Configuration Trade & Selection (3/3)

We selected: Design A

Design A will be able to stow the payload more securely until the time of deployment, while only consume much lesser space

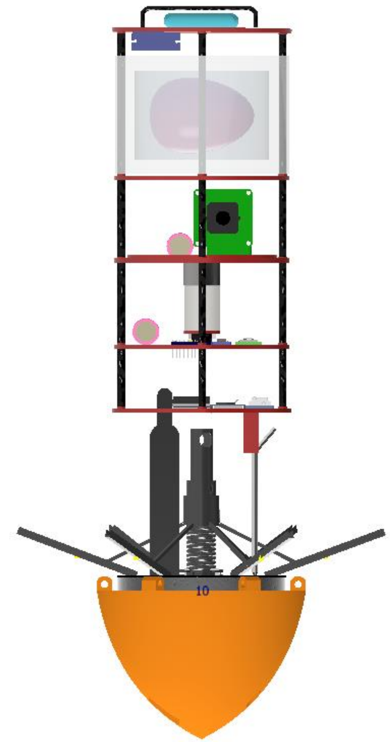




Payload Aerobraking Deployment Configuration Trade & Selection (1/3)

DESIGN B:

The cansat is safeguarded inside the rocket and, upon reaching an altitude of 725 meters above the Earth's surface, it will initiate a descent, rotating to position the nose towards the Earth owing to its center of gravity. Within moments, the heatshield will be activated, shielding the payload from heat and decelerating the rate of descent.



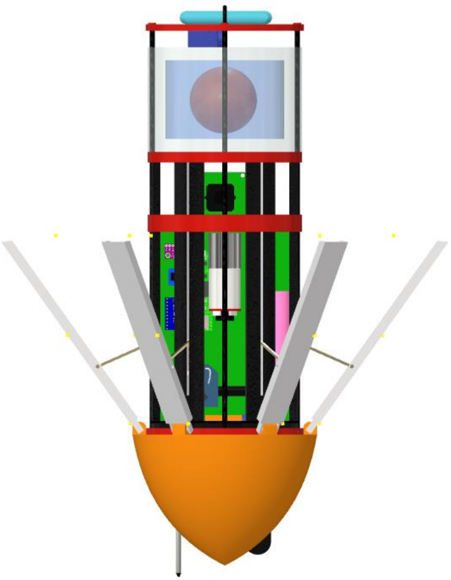
Simultaneously, the actuator will receive an activation signal, inducing it to retract and relinquish the slider. This action will relieve the spring's tension and facilitate the slider's descent, deploying the heat shield in the process

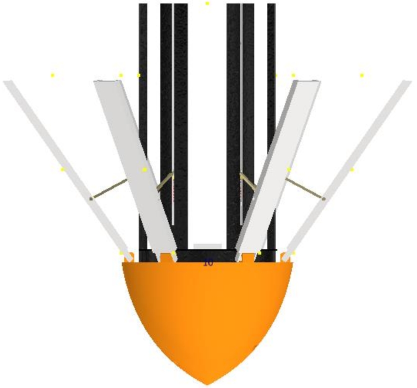
Payload Aerobraking Deployment Configuration Trade & Selection (2/3)

DESIGN A :

The payload is secured within the confines of the rocket and upon reaching the altitude of 725 meters above the earth's surface, will start to fall while rotating to the nose facing the earth due to its center of gravity. In a matter of seconds, the heatshield will deploy and protecting the payload from the heat while slowing down the descent rate.

When the altitude of 100 meters, heatshield and nose cone will be released from the payload and at the same time, parachute will be deployed and slows even more the cansat until it touches the ground.

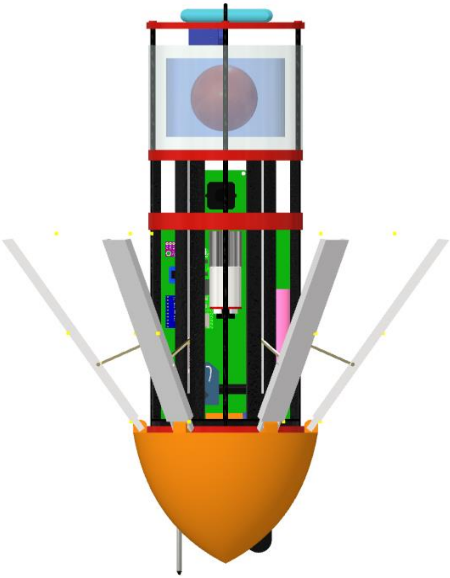


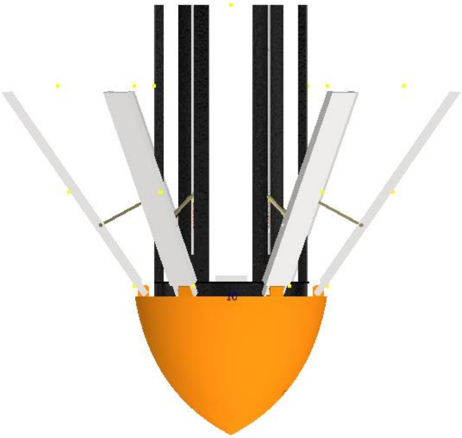


Payload Aerobraking Deployment Configuration Trade & Selection (3/3)

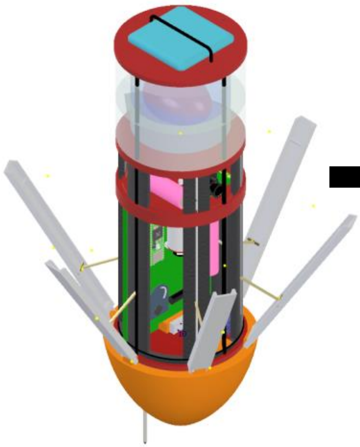
We selected: Design A

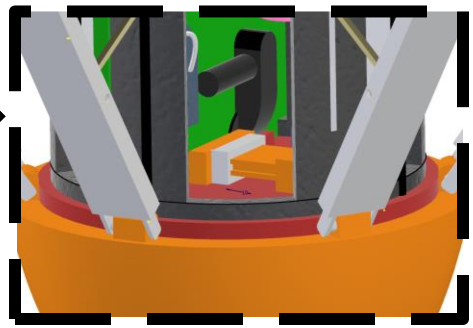
Design A will mitigate potential deployment anomalies by utilizing a more meticulously structured and regulated deployment mechanism also efficent in use of space due to the integration of payload and the heatshield.



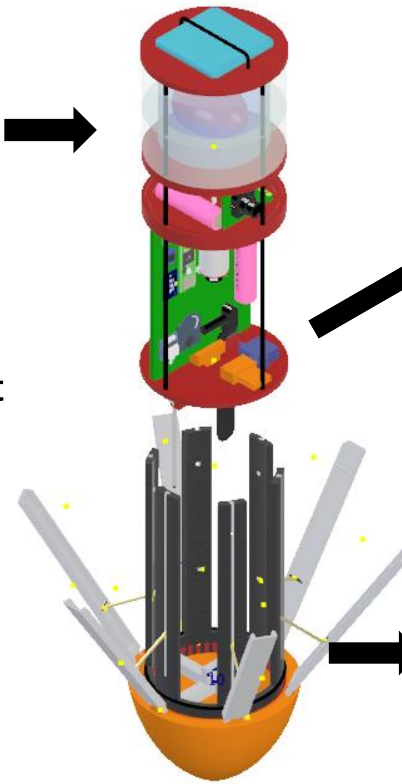


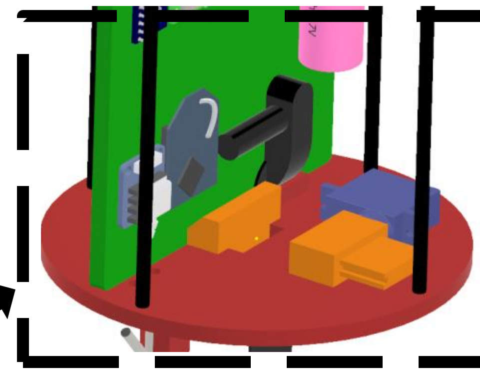
Payload Aerobraking Release Trade & Selection





Nose Cone Pre deployment



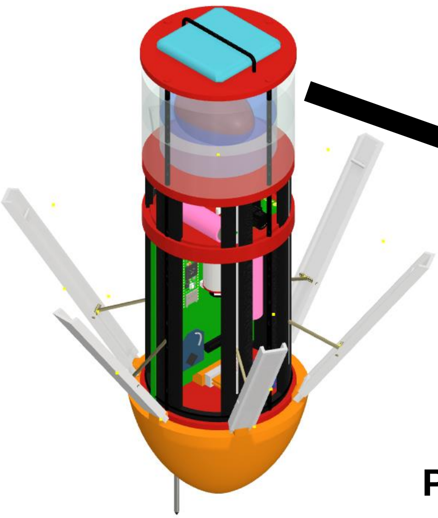


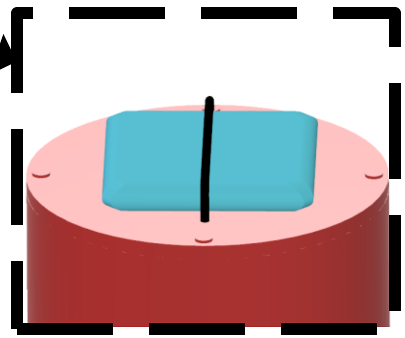
Nose Cone Post Deployment

Aerobraking Release Step By Step

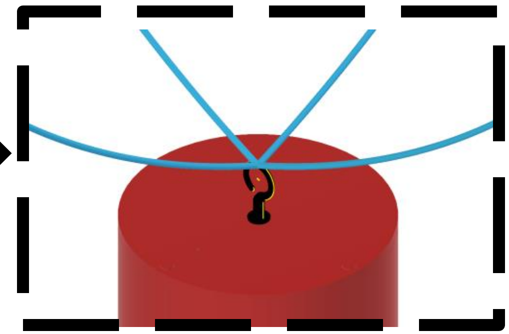
1. The nose cone is connected to the payload using a locking mechanism that secures the supports from the nose cone.
2. The system will engage the lock by sliding the locking bar.
3. Upon sliding, the nose cone will disengage and cause the heat shield to be realeased.

Payload Parachute Deployment Configuration Trade & Selection

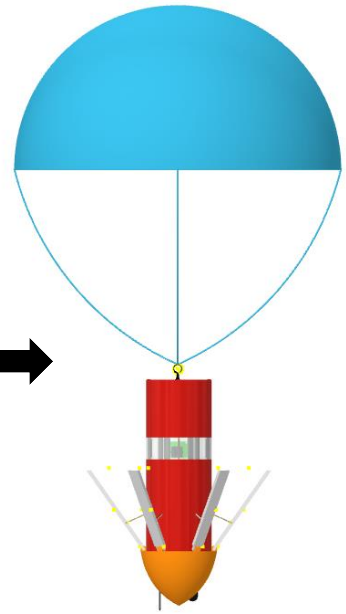




Parachute Pre deployment



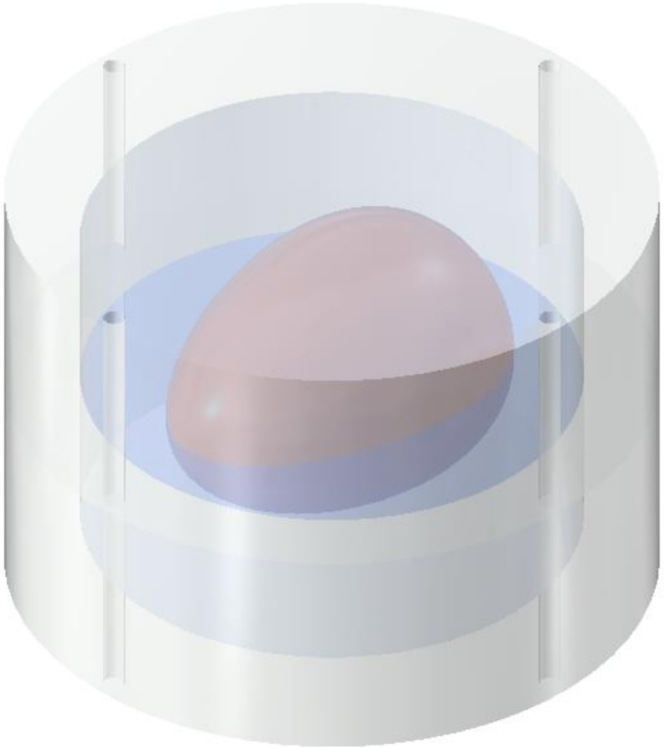
Parachute Post Deployment



Parachute Deployment Step By Step

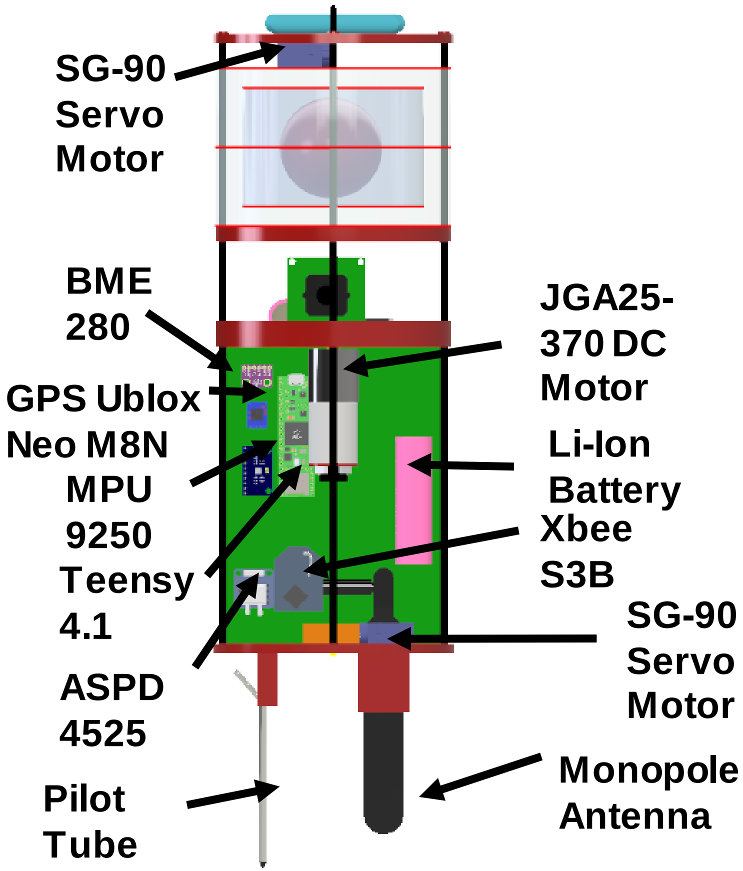
1. The parachute is carefully folded and tethered to the top of the payload
2. At a specified altitude, a servo located at its base activates, pulling the rubber band and releasing the parachute tether
3. The chute spontaneously unfurls to its full extent.
4. The parachute reduces the velocity of the payload until it reaches the ground.

Payload Egg Containment Configuration Trade & Selection



- The egg container consists of two sections, each comprising two layers. The eggs will be placed inside the container, which is directly attached to the payload, by opening the top part of the container.
- The primary layer employs cushioning material aimed at diminishing interstices to minimize egg displacement within the container, therefore there is still some margin to hold on the ununiform size of egg (51 to 65 gr). The second layer is fabricated from styrofoam to enhance structural integrity while ensuring lightweight properties of the receptacle.

Electronics Structural Integrity



- The payload components, including the Teensy 4.1, Xbee S3B, Battery, BME 280, MPU 9250, and GPS Ublox Neo, ASPD 4525 and JGA25-370 DC Motord are affixed to the payload utilizing standoff screws.
- The battery is secured within the payload via mounting fixtures.
- The pilot tube is affixed to its holder located at the underside of the payload, whereas the antenna is interconnected with the XBee S3B module and also a dedicated holder within the payload structure to accommodate the antenna securely.

Mass Budget (1/4)

Component Name	Mass (g)	Obtain Method	Margins (g)
XBEE	6,5	D	-
Monopole Antenna	5,00	E	+/- 0,50
MPU 9250	2,00	D	-
BME 280	1,00	D	-
Raspberry Pi v 1.3 Camera Module	3	D	-
Panasonic NCR18650	95,00	D	-
Holder 18650 2 slot	6,00	E	+/- 0,50
LED	2,00	E	+/- 0,50
Teensy 4.1	10,00	D	
GPS Ublox NEO-M8N	16,00	Website	
Buzzer	5,00	Website	

Mass Budget (2/4)

Electronics Mass Chart

Component Name	Mass (g)	Obtain Method	Margins (g)
Sandisk Micro-SD 8GB	1,00	E	+/- 0,50
ASPD-4525 + Pitot tube	33,00	Website	-
SG-90 Microservo	9,00	E	-
MT3608	1,00	D	+/- 0,50
Switch	2,00	E	+/- 0,50
Mosfet	4,00	E	+/- 0,50
DRV8833 Motor Driver	4,00	E	+/- 0,50
JGA25-370 + enconder	85,00	Website	-
Cable + header	20,00	E	+/- 0,50
PCB	30,00	E	+/- 0,50
Total Electronics	340.5		+/- 5

Mass Budget (3/4)

Structural Mass Chart

Component Name		Mass (g)	Obtain Method	Margins (g)
Parachute		6	E,M	+/- 0,50
Nose Cone		140	E,M	+/- 0,50
Aerobreaking Syte m		270	D	
Structure Body		55	D	-
Casing		12	D	-
Bent Acyrlic		15	E	+/- 0,5
Bottom and Top Cover		2	D	+/- 0,5
Micro spring		5	10	+/- 0,5
DC Motor Bracket		2	M	
Screws, bolts, nuts, etc		30	E	+/- 0,5
Egg Containement		20	E,M	+/- 0,50
Total Container		557		+/- 3,5

Mass Budget (4/4)

Total Mass Chart

Component Name	Mass (g)	Obtain Method	Margins (g)
Electronics	340,5		+/-5
Structural	557	E	+/-3
Total Mass Payload	897,5	E	+/- 8
Margin	897,5 - 900 = -2,5g	Uncertainties	+/- 8

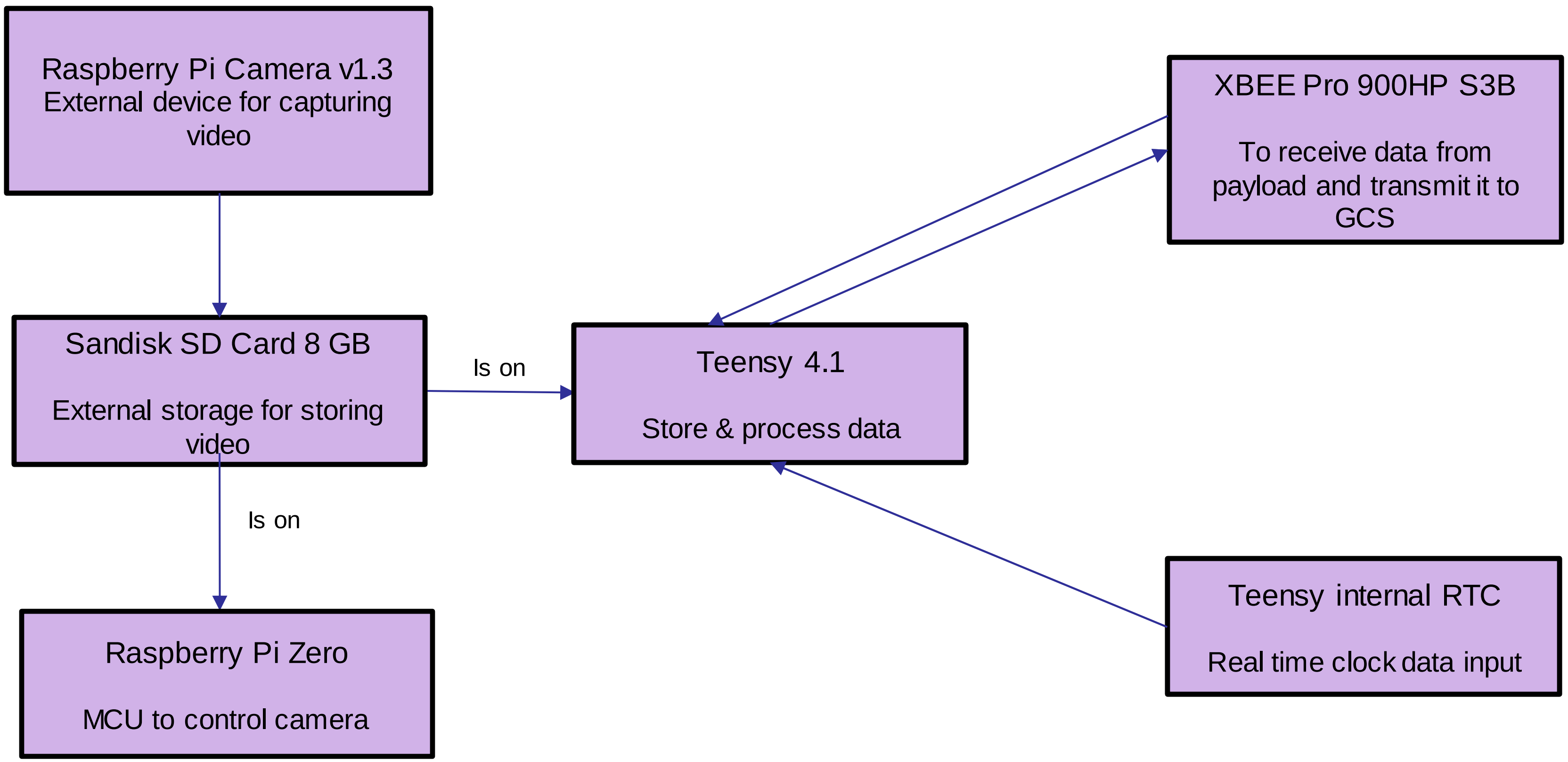
Legends:
E = Estimate
D = Data Sheet
M = Measured

If too heavy: Change in one of the battery, research on alternative for heatshield structural material, heashield, nose cone, rods, etc.
If too light: Include additional sand-filled or metal body concentrated close to the center of mass of the Cansat

Communication and Data Handling (CDH) Subsystem Design

Riki Syahputra

Payload Command Data Handler (CDH) Overview

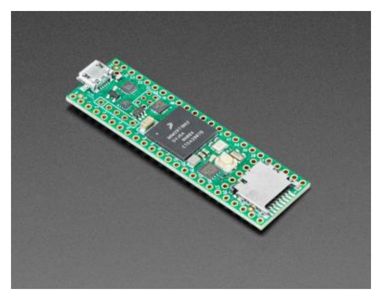


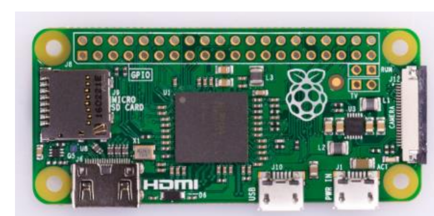
Payload Processor & Memory Trade & Selection (1/2)

Component	Supply voltage (V)	Process or speed (MHz)	Boot time (ms)	I/O Pins	Interfaces	Memory	Size (mm) L x W x H	Weight	Cost (USD)
Teensy 4. 1	**5**	**600**	**5**	**55 GPIO 35 PWM**	**3 I2C 3 SPI 8 UART**	**Flash (79 36K) RAM (10 24K) EEPROM (4K)**	**60.96 x 17.78 x 1.57**	**10**	**31.5**
Raspberry Pi Zero W	**5**	**1000**	**14.4**	**27 GPIO 4 PWM**	**2 I2C 2 SPI 1 UART**	**RAM (512 MB)**	**65 x 30 x 5**	**9**	**35.00**
Raspbeery Pi Pico	5	133	18.76	28 GPIO 16 PWM	2 I2C 2 SPI 2 UART	Flash (1984 KB) SRAM (264KB)	51 x 21 x 1	3	23.00

Selected: **Teensy 4.1 & Raspberry Pi Zero W**

- Lightweight
- Good performance with fast boot time and processing speed
- Has many pins for each interface
- Has ADC pins
- Support and easy to interface with our selected camera
- Had the experience to work with





Payload Processor & Memory Trade & Selection (2 of 2)

Component	Storage (GB)	Interface	Transfer rate	Cost (USD)
SanDisk Ultra 8 GB Class 10/UHS-I microSDHC	**8**	**Directly mounted**	**Read: Up to 100MB/s Write: Up to 65MB/s**	**2,09**
V-Gen Micro SD Card	8	Directly mounted	Read: Up to 100MB/s Write: Up to 48MB/s	5.00

Selected: **SanDisk Ultra 8 GB Class 10/UHS-I microSDHC**

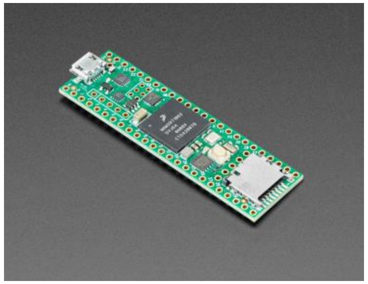
- Higher transfer rate
- Cheaper

Payload Real-Time Clock

Component	Independent Power Source	Interface	Built-in Temperature Compensated Crystal	Cost (USD)
Teensy 4.1 internal RTC	**Yes (CR2032)**	**Internal**	**No**	**0 (included)**
DS3231	Yes (CR2032)	I2C	Yes	2,40
DS1307	Yes (CR2032)	I2C	No	0.84

Selected: **Teensy 4.1 internal RTC**

- Fast time retrieval
- No need to introduce another component



Payload Antenna Trade & Selection

Component	Frequency Range	Gain	Pattern	Connection	Cost ($)
Modem Router GSM Antenna	**700-2700 Mhz**	**8dBi**	**Omnidirectional**	**RP - SMA**	**$1.94**
WiFi Antenna	433-2700 Mhz	6dBi	Omnidirectional	SMA	$2.58

Selected Tilt Sensor: **Modem Router GSM Antenna**

- Higher in gain and narrower bandwidth.
- Low price.
- Be able to connect in RP-SMA connection.

Payload Radio Configuration

Component	Frequency Band (MHz)	Transmitting Power	Receiver Sensitivity	Cost (USD)
XBEE Pro S3B	**902 – 908**	**Up to 24 dBm**	**-101 dBm**	**51.02**
XBEE Pro S2C	2.400 - 2.483	Up to 15.9 dBm	-100 dBM	41.42

RADIO CONFIGURATION

NETID: 2070
Configuration Mode: Unicast
Transmission Control: 1Hz data transmission to Ground Station

The data transmission will be stopped if Ground Station commands the telemetry to be off.

Payload Telemetry Format (1/3)

INDEX	DATA	DATA SAMPLES	DESCRIPTION
1	TEAM_ID	2070	Team ID number
2	MISSION_TIME	1:23:40	Time elapsed since startup
3	PACKET_COUNT	1	Counter of transmitted packets
4	MODE	F	'F' for flight mode and 'S' for simulation mode
5	STATE	A	Using letters, A, B, C, D, E, F to represent current state of LAUNCH_WAIT, ASCENT, ROCKET_SEPARATION, DESCENT, HS_RELEASE, LANDED respectively
6	ALTITUDE	35.2	Current altitude measured in meters above sea level, 1 decimal point accuracy
7	AIR_SPEED	12.3	The air speed in meters per second measured with the pitot tube during both ascent and descent
8	HS_DEPLOYED	P	P indicates the heatshield is deployed, N otherwise.
9	PC_DEPLOYED	C	'C' indicates the Probe parachute is deployed (at 100 m), 'N' otherwise.
10	TEMPERATURE	25.6	The temperature in degrees Celsius with a resolution of 0.1 degrees.

Payload Telemetry Format (2/3)

INDEX	DATA	DATA SAMPLES	DESCRIPTION
11	VOLTAGE	3.3	The battery voltage in volts with a resolution of 0.1 volts.
12	PRESSURE	1013.2	The air pressure of the sensor used.
13	GPS_TIME	65	Time generated by the GPS measured in seconds
14	GPS_ALTITUDE	124.5	altitude from the GPS receiver in meters above mean sea level with a resolution of 0.1 meters
15	GPS_LATITUDE	0.0001	Lattitude coordinate generated by the GPS.
16	GPS_LONGITUDE	0.0003	Longitude coordinate generated by the GPS.
17	GPS_SATS	8	Number of GPS being tracked by the receiver
18	TILT_X, TILT_Y	34,40	angles of the CanSat X and Y axes in degrees
19	ROT_Z	45.6	The rotation angle in the z-axis in units of degrees.
20	CMD_ECHO	"CXON"	the text of the last command received and processed by the CanSat, Either CXON or SP101325

Payload Telemetry Format (3/3)

- **The payload data format is sent at a frequency of 1 Hz**

- **Data Format**

  The data transmitted will follow the format below

  TEAM_ID, MISSION_TIME, PACKET_COUNT, MODE, STATE, ALTITUDE, AIR_SPEED, HS_DEPLOYED, PC_DEPLOYED, TEMPERATURE, VOLTAGE, PRESSURE, GPS_TIME, GPS_ALTITUDE, GPS_LATITUDE, GPS_LONGITUDE, GPS_SATS, TILT_X, TILT_Y, ROT_Z, CMD_ECHO

  Example data packet

  1092,01:23:4Q,1,F,A,35.2,12.3,P,C,25.6,3.3,1Q13.2,65,124.5,Q.QQQ1,Q.QQ03,8,34.4Q ,45.6,CXON

  The presented format match the Competition Guide requirements

Payload Command Format

- **Type & Command Format**
  - CX: CMD,<TEAM_ID>,CX,<ON_OFF>
  - ST: CMD,<TEAM_ID>, ST,<UTC_TIME>|GPS
  - SIM: CMD,<TEAM_ID>,SIM,<MODE>
  - SIMP: CMD,<TEAM ID>,SIMP,<PRESSURE>
  - CAL: CMD,<TEAM ID>,CAL
  - BCN: CMD,<TEAM ID>,BCN,ON|OFF

- **Example Data**
  - CX: "CMD,2070,CX,ON"
  - ST: "CMD,2070,ST,17:25:20"
  - SIM: "CMD,2070,SIM,ENABLE"
  - SIMP: "CMD,2070,SIMP,100000"
  - CAL: "CMD,2070,CAL"
  - BCN: “CMD,2070,BCN,ON”

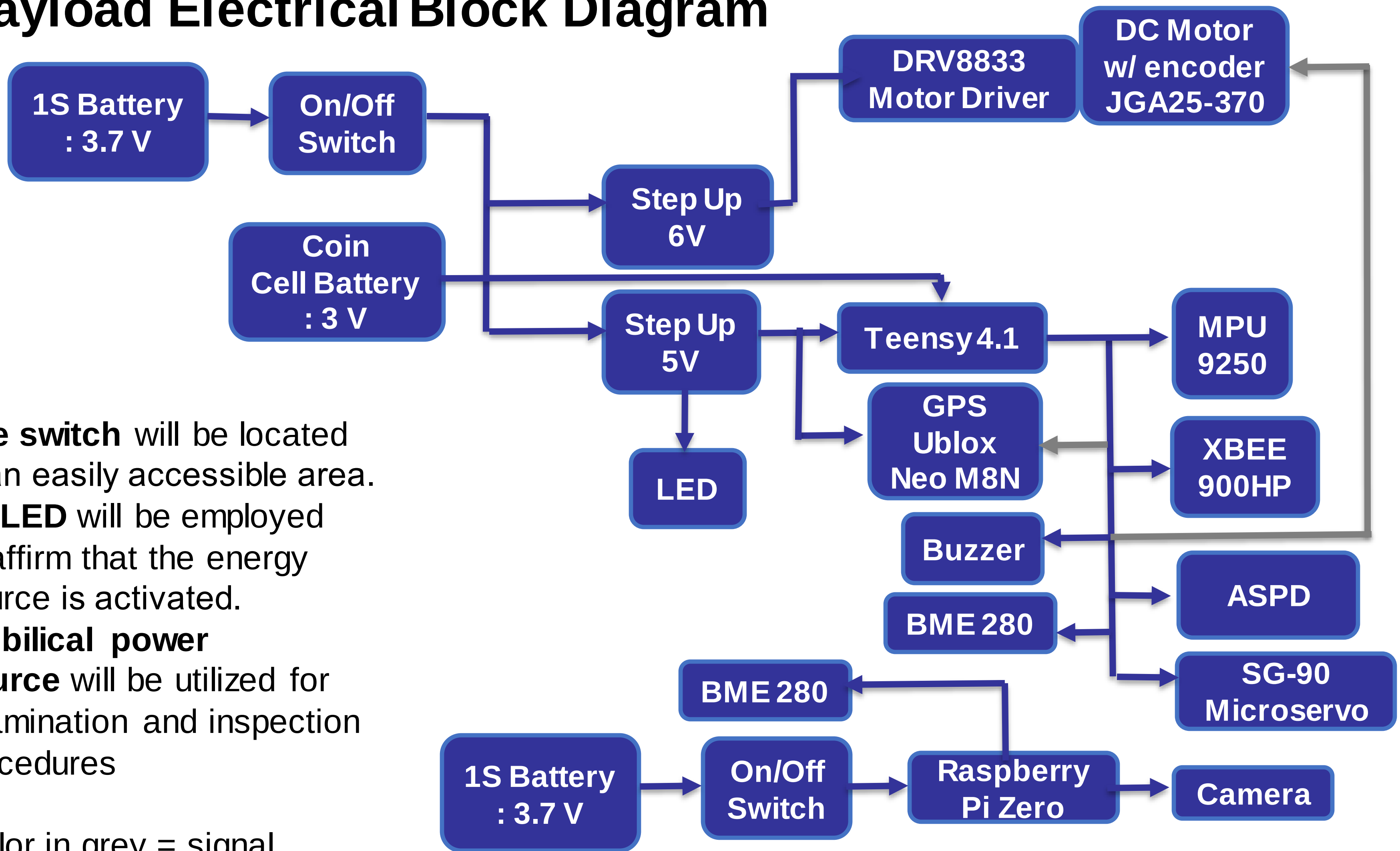
Electrical Power Subsystem (EPS) Design

Daffa Farrell

EPS Overview

Component Type	Purpose
Battery	Supplies power to the components, 3.6V nominal voltage
Switch / Mosfet	Connects and disconnects power
Voltage Regulator	Adjusts the voltage to the appropriate level that the sensors and processor need
Sensor	Provides environment measurement
Microcontroller	Receive and process data obtained from sensor and to control the actuator
Actuator	To control the heatshield

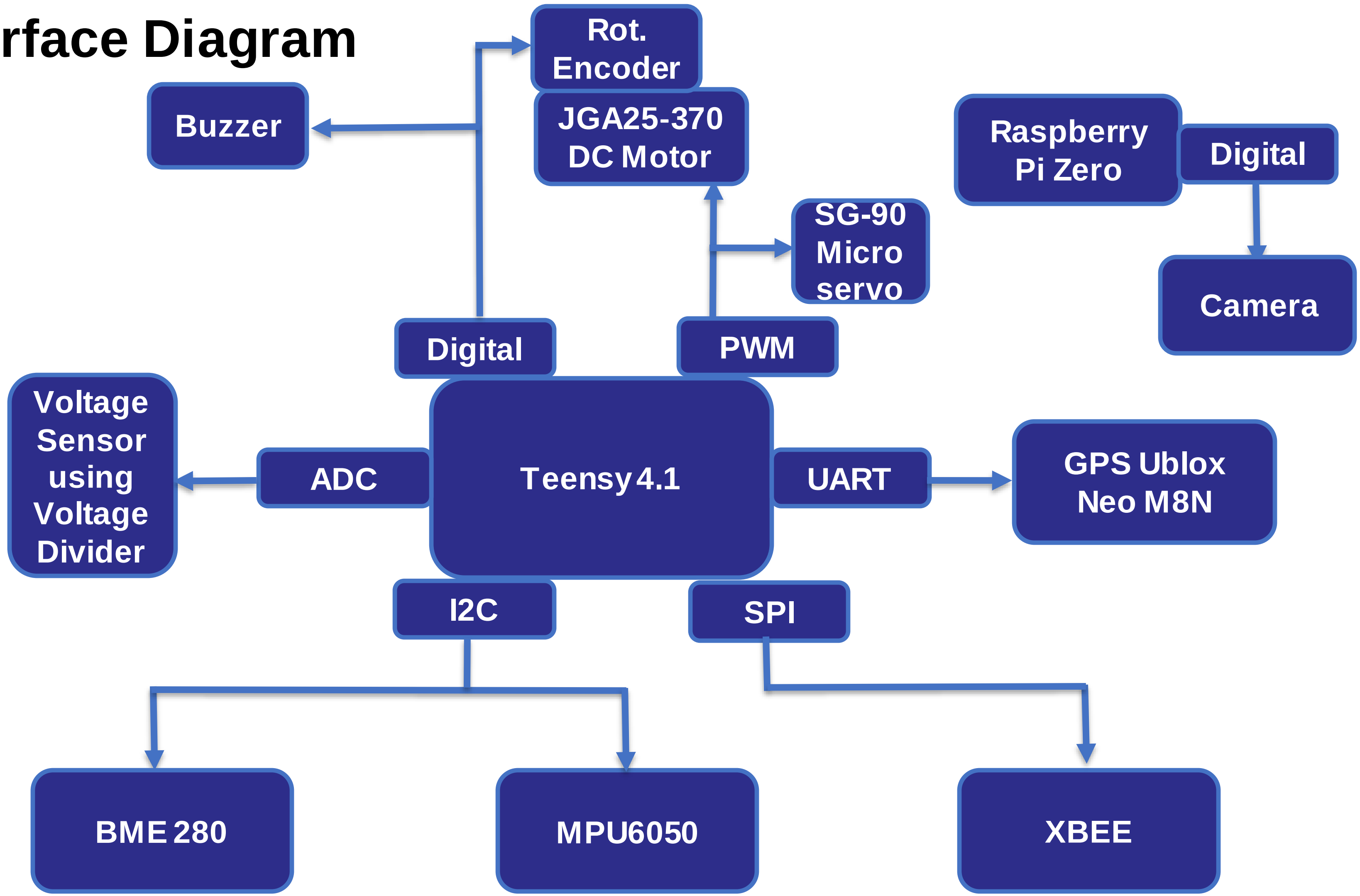
Playload Electrical Block Diagram



The switch will be located in an easily accessible area. An **LED** will be employed to affirm that the energy source is activated. **Umbilical power source** will be utilized for examination and inspection procedures

*color in grey = signal

Interface Diagram



Payload Power Trade & Selection

No.	Model Name	Type	Voltage (V)	Capacity (mAh)	Weight (g)	Max continuous discharge (A)	Size (mm)	Cost ($)	Quantity
1.	**Panasonic NCR18650B**	**Lithium Ion**	**3.7**	**3400**	**48**	**4.875**	**65 x 18**	**$2**	**1**
2.	LG HG2	Lithium Ion	3.6	3000	50	20	65 x 18	$3.75	1
3.	Vapcell N40 18650	Lithium Ion	3.6	4000	48	10	18.3 ± 0.2 * 65.0 ± 0.3	$7.68	1
4.	**CR2302**	**Lithium Cell**	**3**	**230**	**3**		**23 x 2**		

Selected Battery: **Panasonic NCR18650B & CR2302**

- Very high capacity
- High current capacity
- Lighter weight
- Suitable to our design

Li-Ion Battery Configuration :
2 singular cell arranged in separately to each system affixed to a switch, furnishing the necessary energy to the payload.
CR2302 is used to maintain the RTC clock whilst if there is momentary power less

Payload Power Budget (1/5)

- **Payload Power Budget (Main)**

No.	Component	Voltage (V)	Current (A)	Duty Cycle (%)	Qty	Power (W)	Power Consumption (Wh)	Source
1.	Teensy 4.1	5	0.1	100	1	0.5	1.0	Estimate-Datasheet
2.	BME 280	3.3	2.8u	100	1	0.00000924	0.00001848	Estimate-Datasheet
3.	XBEE 900 HP	3.3	0.23	100	1	0.759	1.518	Estimate-Datasheet
4.	ASPD-4525	3.3	0.005	100	1	0.017	0.034	Estimate-Datasheet
5.	Ublox Neo M8N	5	0.025	100	1	0.125	0.25	Estimate-Datasheet

Payload Power Budget (2/5)

No.	Component	Voltage (V)	Current (A)	Duty Cycle (%)	Qty	Power (W)	Power Consumption (Wh)	Source
6.	MPU 9250	3.3	0.1	100	1	0.33	0.66	Estimate-Datasheet
8.	LED	5	0.02	100	1	0.1	0.2	Estimate
9.	JGA25-370 DC Motor w/ enc	6	0.5	50	1	3	3	Estimate-Datasheet
10.	DDRV8833 Motor Driver	6	3m	100	1	0.018	0.036	Estimate-Datasheet
11.	SG-90 Micro servo	5	0.25	5	5	6.25	0.625	Estimate

Payload Power Budget (3/5)

Total Final Power is power consumed by all of the boost converter with approximately 85% efficiency

Total Power Consumed (Wh)	Total Final Power (W)
7.323	11.099

- **Payload Power Budget**

Available Total Power (Wh)	Total Final Power Consumption (Wh) 2 hours
3.7 V x 3.4 Ah = 12.58	7.323
Power Consumption Margin	
(12.58 – 7.323) / 12.58 x 100% = **41.79%**	
Our power source is sufficient to power the Payload (main) for 2 hours 50 minutes	

Payload Power Budget (4/5)

- **Payload Power Budget (Camera)**

No.	Component	Voltage (V)	Current (A)	Duty Cycle (%)	Power (W)	Power Consumption (Wh)	Source
1.	Raspberry Pi Zero W	3.3	0.3	100	0.99	1.98	Estimate-Datasheet
2.	BME 280	3.3	2.8u	100	0.00000924	0.00001848	Estimate-Datasheet
3.	Raspberry Pi Camera Module Re v 1.3	3.3	0.02	100	0.066	0.132	Estimate-Datasheet

- **Total Final Power is power consumed by all of the boost converter with approximately 85% efficiency**

Total Power Consumed (Wh)	Total Final Power (W)
2.11	1.056

Payload Power Budget (5/5)

- **Payload Power Budget (Camera)**

Available Total Power (Wh)	Total Final Power Consumption (Wh) 2 hours
3.7 V x 3.4 Ah = 12.58	2.11
Power Consumption Margin	
(12.58 – 2.11) / 12.58 x 100% = 83.23 **%**	
Our power source is sufficient to power the Payload (camera) for 3 hours 33 minutes	

Flight Software (FSW) Design

Rifki Pratama

FSW Overview (1/2)

Programming Languages:

- C/C++

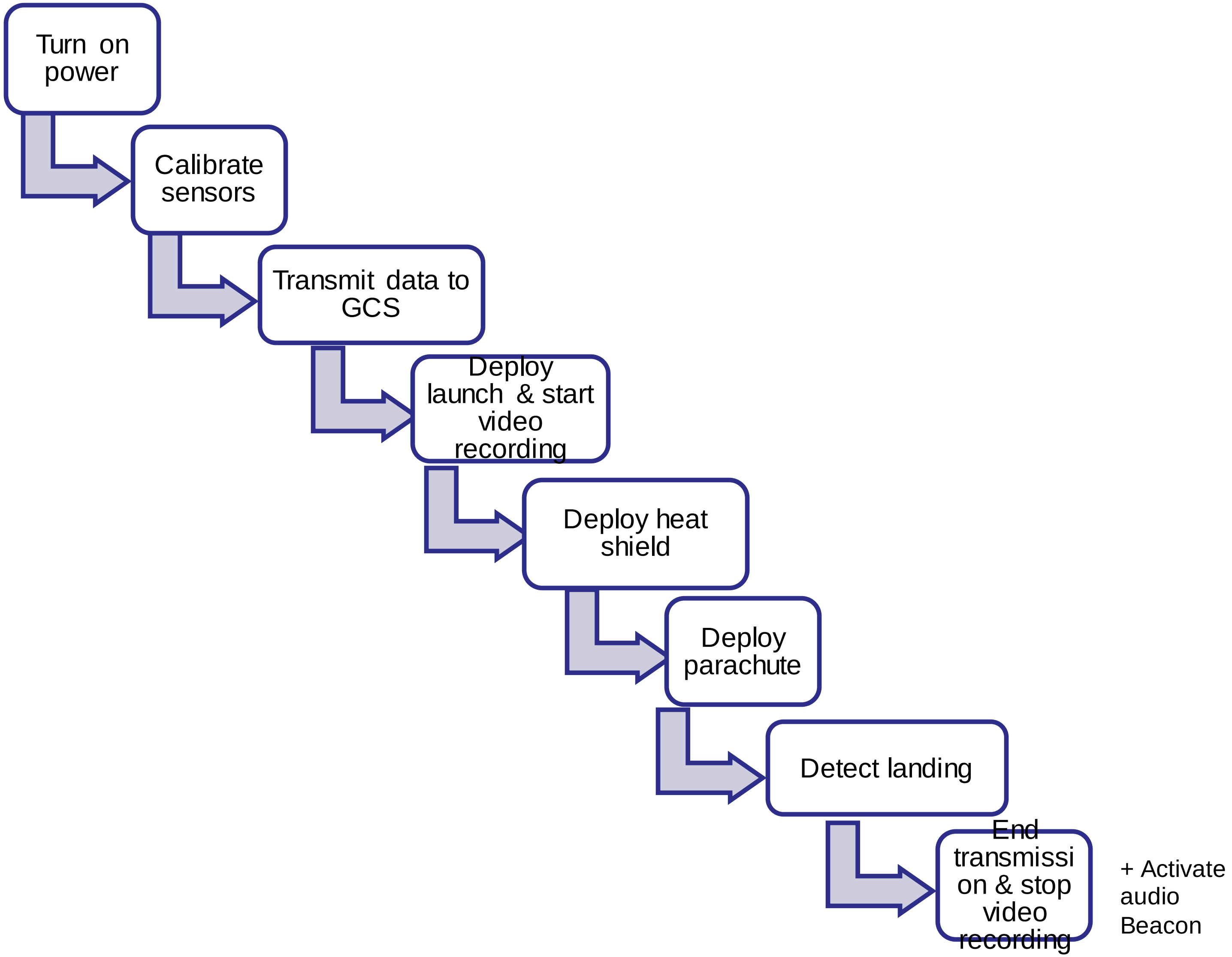
Development Environment:

- Arduino IDE

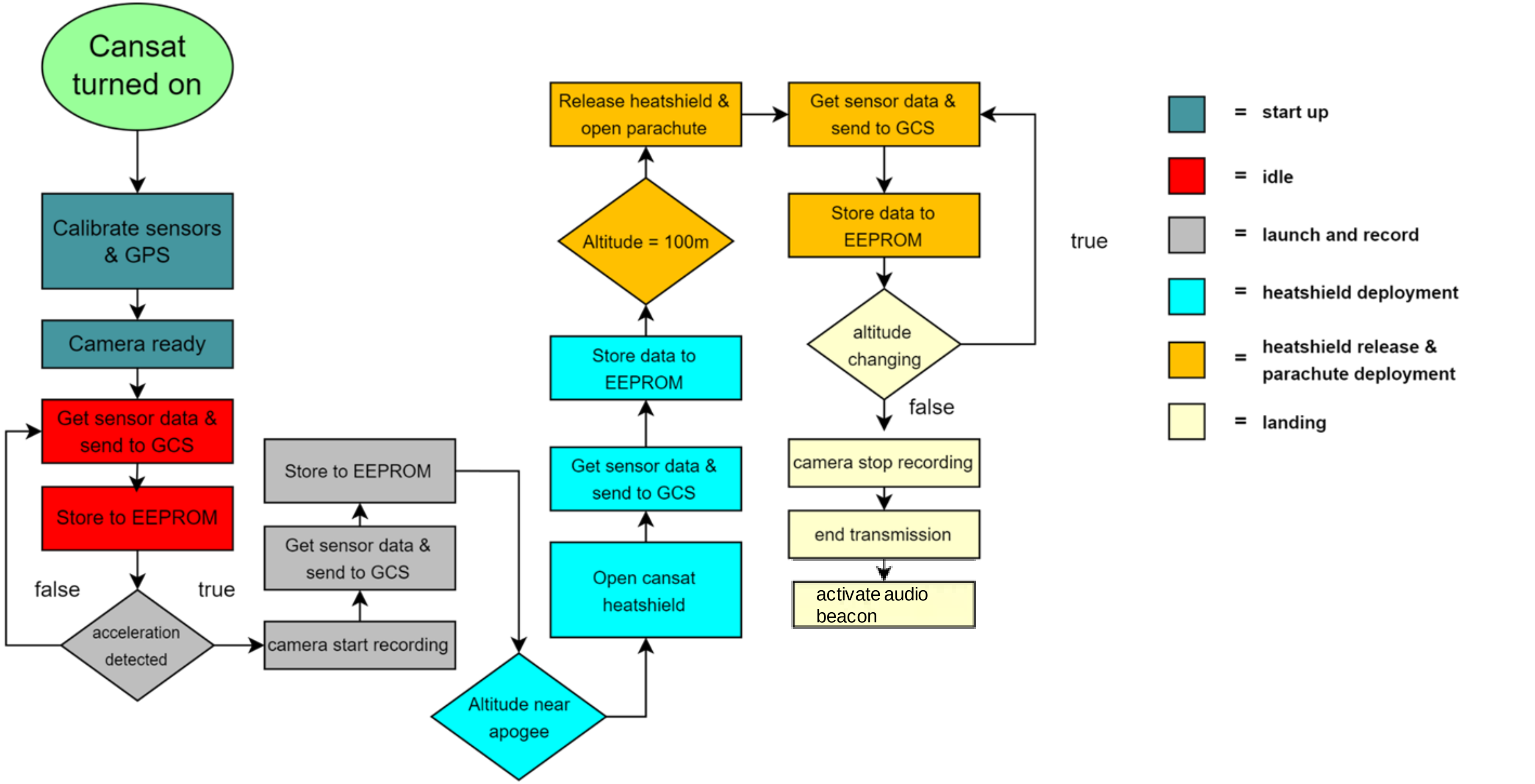
FSW Payload Tasks:

- Obtain sensor readings and transmit them to the Ground Control Station in congruence with the CanSat specifications.
- Undertake the calibration of the sensors.
- Perform data processing.
- Preserve the system's information in the EEPROM for recovery contingencies.

FSW Overview (2/2)



Payload FSW State Diagram (1/2)



Payload FSW State Diagram (2/2)

FSW Data Recovery for Payload:

- Processor reset events may occur due to temporary power outages or software malfunctions. In such cases, previously recorded sensor measurement data will be retrieved from the EEPROM.
- Recoverable data includes mission time, packet count, and software state.
- Data recovery will occur at a rate of 1 Hz.

Simulation Mode Software

The flight software of the Cansat will only transition to simulation mode upon receipt of the "SIM ENABLE" or "SIM ACTIVATE command from the Ground Control Station (GCS)

The GCS will transmit simulated barometric pressure readings, which will be monitored by flight software as SIMP commands, at a rate of 1 Hz to the payload, effectively replacing the readings from the actual pressure sensor in altitude calculations and for use by the flight software algorithms.

Simulation Mode Commands:

SIM - Control Command:

CMD,<TEAM ID>,SIM,<MODE>

MODE: ENABLE to enable simulation mode, ACTIVATE to activate simulation mode, and DISABLE to both disable and deactivate simulation mode

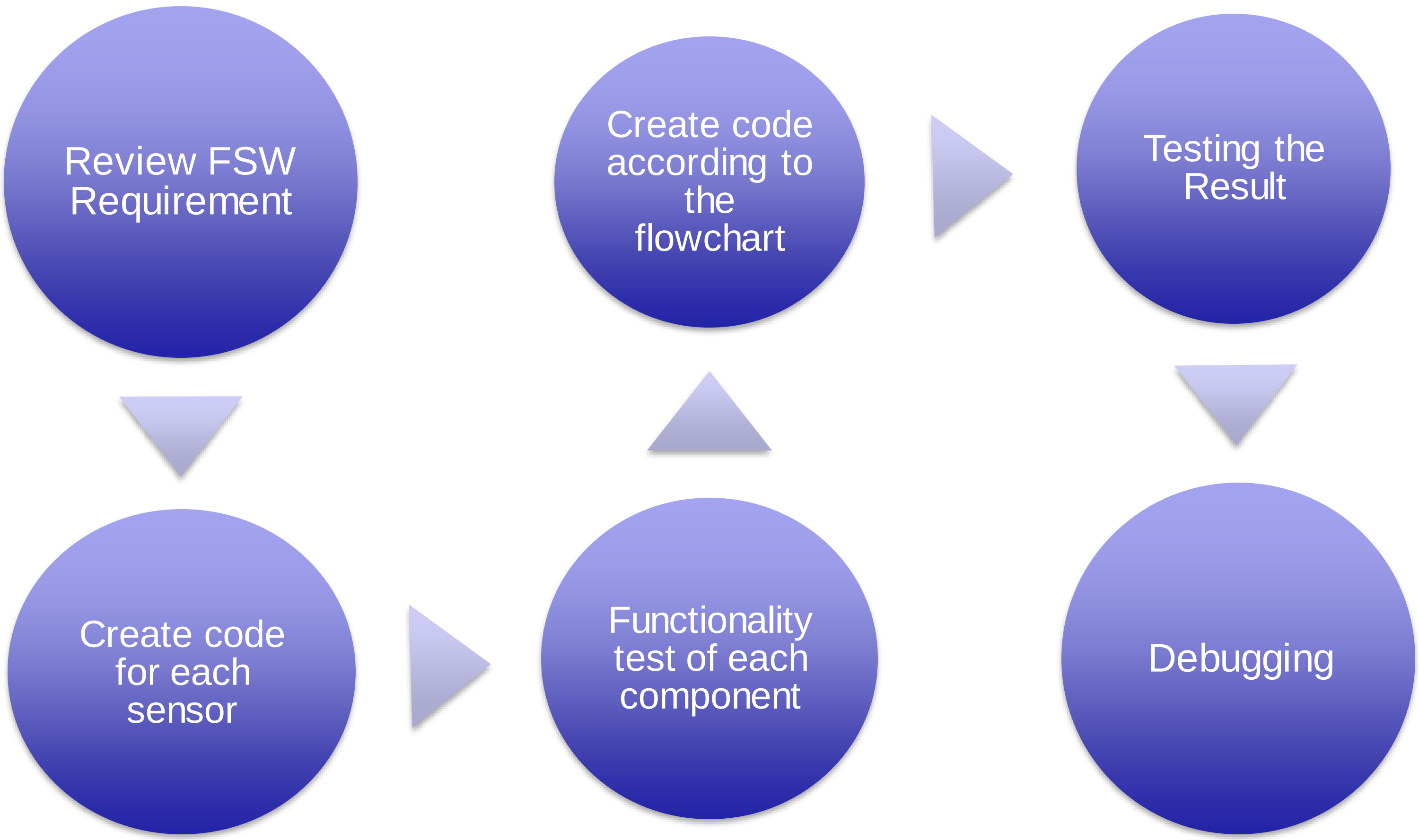
SIMP – Simulated Pressure Data

CMD,<TEAM ID>,SIMP,<PRESSURE>

PRESSURE unit in Pascal

Software Development Plan (1/3)

Software Development Sequence Plan



Software Development Plan (2/3)

Prototype and Testing Approach:

- Each component is individually evaluated using a breadboard setup
- Evaluation results are monitored via the Arduino Serial Monitor

Verification Procedure:

- The planned CanSat sensors will be subjected to testing
- The algorithms for deployment of the secondary parachute and probe release will be evaluated
- The mechanism for data recovery will be thoroughly assessed.

Development Team

- Riki Awal Syahputra
- Rifki Pratama
- Lucinda Laurent

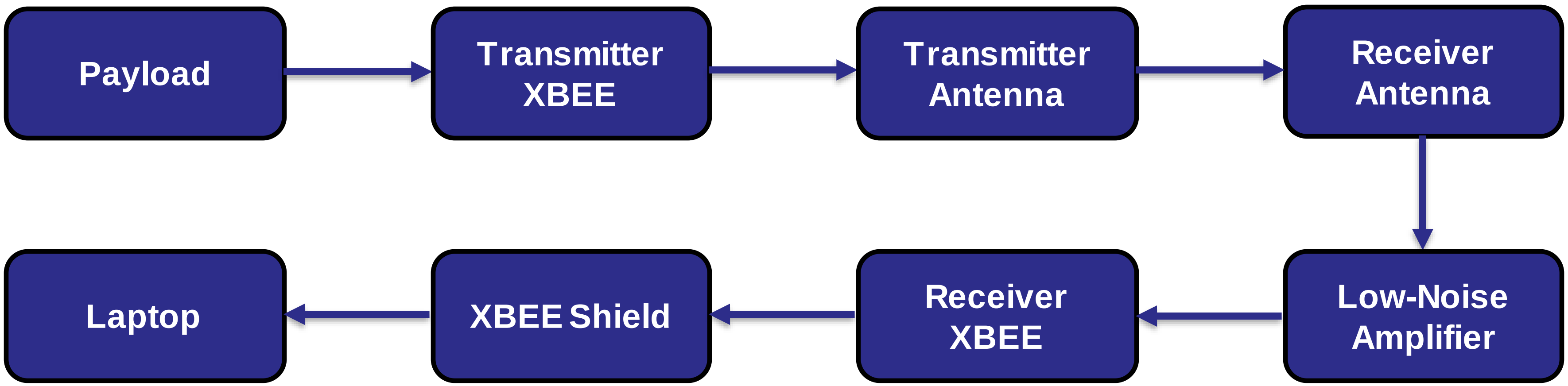
Software Development Plan (3/3)

Subsystem	Development Sequence
Sensors	1. Selecting the most suitable sensors. 2. Functionality test program each sensor with Teensy 4.1 (C/C++) 3. Integrate all sensors code
Xbee Radio	1. Configure and test communication 2. Integrate sensors with Xbee and ensure the data can be transmitted at 1Hz (Payload)
Flight Control	Program closed feedback control system
Probe Release Mechanisms	Program release a probe that shall open a heat shield with a descent rate of 10 to 30 meters/seconds.
Software State	Program change the state of the software using the altitude sensor as data
Audio Beacon	Audio beacon for make it easier to search Cansat
Integrate All	Integrate the software subsystem and ensure that the data can be transmitted at 1 Hz from payload to GCS

Ground Control System (GCS) Design

Lucinda Laurent

GCS Overview



GCS Design

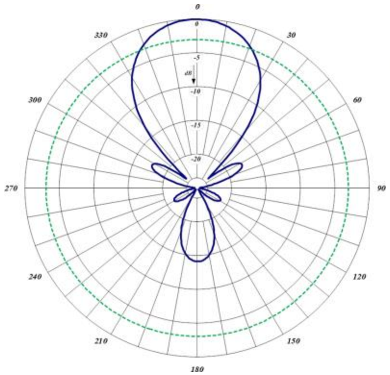
Specification	
Ground station battery life	Approximately 2.5 hours
Overheating mitigation	Cooling fan and umbrella to keep the ground station away from direct sunlight
Operating system auto-update mitigation	Disable the Windows Update feature

GCS Antenna Trade & Selection

Component	Frequency Range	Gain	Pattern	Range (KM)	Cost ($)
Antenna Yagi TXR185	**700-2700 Mhz**	**25dBi**	**Directional**	**~ 30**	**$17.841**
BetaFPV Antenna Moxon	2400 Mhz	5.4dBi	Directional	~ 11	$8.772
Antenna Grid	2400-2483 Mhz	19dBi	Directional	-	$12.865

Selected: **Antenna Yagi TXR185**

- The gain is greater than the others
- The distance coverage is very large
- Adequate frequency range
- Had some past experiences with it

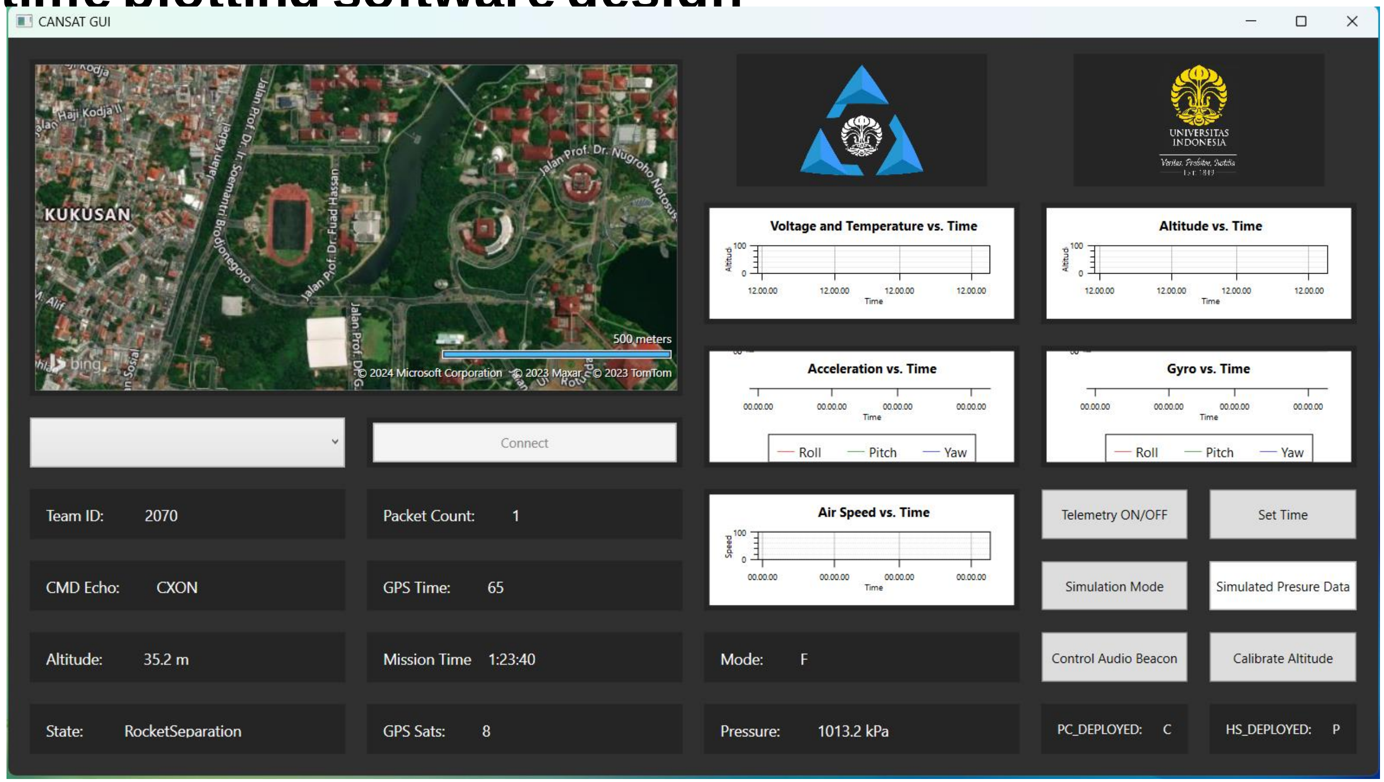


How will Telemetry be displayed in real time and how will it be recorded?

- Telemetry Data will be displayed live in the user interface on the next slide
- In addition, all the data will be recorded to a CSV file named Flight_2070.csv
- The software can also send Simulation mode command to the payload

GCS Software (2/3)

- **Commercial off the shelf (COTS) software packages used**
  - WPF (Windows Presentation Foundation)
  - XCTU (Xbee Program Software)
- **Real-time plotting software design**



GCS Software (3/3)

- **Command software and interface**
  - Telemetry ON/OFF
  - Simulation Mode
  - Set Time
  - Simulated pressure Data
  - Calibrate Altitude to Zero
  - Control Audio Beacon
- **Simulation mode**
  - The initiation of the mode shall commence through the transmission of a command signal from the Ground Control Station (GCS) to the Payload
  - Upon receipt of the signal, the Payload shall then emit dummy or simulated data to the GCS
  - The GCS software shall depict the data received via its designated port

CanSat Integration and Test

Muhammad Aksal

CanSat Integration and Test Overview (1/2)

Descent Control Tests

- Parachute Testing
- Payload Descent Stability Testing

Mechanical Subsystem Tests

- Payload Heatshield and Parachute Deployment and Release Testing
- Payload Egg Containment Testing

Sensor Subsystem Tests

- Operational test
- Integration test

CDH Tests

- Communication test
- Data storage test

EPS Subsystem Tests

- Battery capacity test
- Current draw test

FSW Subsystem Tests

- Payload release mechanism test
- Camera stabilization test
- Reset Recovery (EEPROM) test

GCS Tests

- Communication Tests
- Laptop Battery durability tests

CanSat Integration and Test Overview (2/2)

Test Plans	
Subsystem level test	Every subsystem test mentioned earlier will be carried out.
Integrated level functional test	Integration of the subsystems will be inspected. Any necessary adjustments and corrections will be applied.
Environmental test	Testing the readiness of CanSat on various environmental condition
Simulation test	Simulating the mission on CanSat.

Subsystem Level Testing Plan (1/2)

Sensors

- The accuracy and validity of the output measurements will be confirmed by a comprehensive evaluation of the sensors' performance.
- The sensors will be integrated with the SBC and other subsystems, and then reexamined to ensure optimal performance in a range of situations.

CDH

- It will be verified whether the CDH components are operating proficiently, including the data transmission quality.
- Writing operation will be used to assess the SD card recording data permanently.

EPS

- The batteries will be tested to determine whether they can run at least two hours under the necessary load.
- To ensure that every part is operating as needed, the current draw will be measured.

Radio communications

- Range test and transmission quality will be carried out.

Subsystem Level Testing Plan (2/2)

FSW

- After a thorough examination of the sensors accuracy and output reliability, it will be integrated with the SBC and other subsystems and retested to ensure optimal performance in a range of conditions.
- A rotating device will be utilized to mimic possible disturbance causing rolling action toward the Cansat, while monitoring the actual positional value versus the set point result plot

Mechanical

- It will be verified that the heatshield release mechanism works as intended.
- Both the deployment mechanism supported by the servo/stepper motor and the heat shield's capacity to work as intended will be functionally assessed.

Descent Control

- CanSat's stability will be examined at different elevations.
- Drop tests will be carried out at various altitudes to verify that the heatshield and parachute are effective in slowing the payload's descent.

Integrated Level Functional Test Plan

Descent test

- Using an unmanned aerial vehicle, a drop test will be conducted to evaluate the accelerometer and parachute's functioning. The electrical components will be removed before the CanSat is dropped from different heights.

Communication test

- In order to account for any possible wind drift or changes in horizontal or vertical distance during the flight, the transmitter (on the CanSat) and receiver (on the ground) will be separated by 1000 meters to test the radio's transmission and receiving capabilities.

Mechanism test

- Experimenti under various settings, including activating the heat shield to evaluate its mechanism, to functionally test the servo/stepper motor mechanism and heat shield.

Deployment test

- In order to test the payload deployment system and ensure that the payload is securely released from the container, the payload will be deployed utilizing a servo/stepper motor mechanism.

Environmental Test Plan (1/5)

Drop Test

The purpose of this experiment is to determine whether the parachute and the point where it connects to the container can survive the turbulent separation from the rocket payload. A 61-cm non-stretch cord, with one end attached to a static point and the other to the parachute, will be used to simulate the drop test described in the CanSat Competition Guidebook. The CanSat's structure must not show any signs of fracturing or deformation because it will be dropped. Making sure the CanSat can withstand a shock of 30 Gs to its system is the aim of this test. The steps in the methodology are as follows:

I. Turn on the CanSat.
II. Verify the status of the telemetry transmission.
III. With the cord attached, raise the CanSat until the eye bolt and parachute are in line with the cord's attachment points.
IV. Release the CanSat.
V. Verify that there was no power outage for the CanSat.
VI. Look for any indications of damage or perhaps loose parts.
VII. Verify telemetry is still being received

Environmental Test Plan (2/5)

Thermal Test

This test is meant to find out how well the CanSat and its container perform in a hot environment. The manual states that the Cansat can get up to 30 degree Celcius. The purpose of this test is to determine whether temperature variations will cause any materials to deform, weaken, change in properties, or malfunction. A temperature chamber will be set up and heated using a heat gun in order to achieve this. The steps are as follows:

I. Place the CanSat within the chamber that is heated.
II. Activate the CanSat.
III. Shut down and lock the heat chamber.
IV. Turn on the heating element.
V. When the interior temperature hits 60 degrees Celsius, pay attention to the temperature and turn off the heat source. When the temperature falls to 55 degrees Celsius, turn it back on.
VI. For two hours, keep the test circumstances in place.
VII. To ensure that the CanSat has survived the heat exposure and is operating as intended, turn off the heat source and perform functional tests as well as a visual inspection.
VIII. Test all mechanisms and structures to make sure their integrity hasn't been compromised while the CanSat is still hot. To avoid getting hurt, use caution.
IX. Verify that the strength of the composite materials and epoxy joints has not diminished.

Environmental Test Plan (3/5)

Vibration Test

In this test, a random orbital sander is used. Instead of spinning, this portable power tool works in an erratic rhythm. Random orbital sanders operate at set orbits per minute (opm) of between 200 and 233 Hz, or 12,000 and 14,000 opm. The test makes use of the sander's power-up and power-down cycles. The sander takes a moment to reach its maximum speed of 14,000 opm. It does not do it quickly. The CanSat may experience some resonances during this transitional phase. The following are the steps in the procedure:

I. Turn the CanSat on.
II. Check to make sure accelerometer data is being gathered.
III. Turn on the sander.
IV. Wait five seconds after the sander has reached its maximum speed.
V. Reduce the sander's power to a complete stop.
VI. Steps iii to v should be repeated four times.
VII. Examine the CanSat for wear and tear and for functionality.
VIII. Verify that data from accelerometers is still being gathered.
IX. Turn off the CanSat.

Environmental Test Plan (4/5)

Fit Check

This check includes some dimension measurement tools to ensure our Cansat fit properly in side the open space payload section. Rulers, measurement tape measurement bow, and caliper, etc will be utilized to verify the accuracy of our design. Additionally, similar size container is prepared to pre-verify the before in-competition check. The steps in the procedure are as follows:

I. Measuring Nose Cone and its shoulder diameter/radius
II. Measuring Nose Cone length
III. Verifying symmetry of the Nose Cone, with slope degree in some points as the parameter
IV. Confirm the dimension of payload in length and diameter below the maximum, as well as the angle deviation
V. Prepare and self-test in our container prototype, to verify proper fit.

Environmental Test Plan (5/5)

Vacuum Test

The purpose of this test is to confirm the payload(s)' deployment operation. A bucket or pail that holds five gallons (18+ liters) can be used to easily construct a vacuum chamber. You can cover the bucket with a polycarbonate sheet that is ¼ inch or 6 mm thick, or you can use a lid. Acrylic should not be used since it can break. To pull a vacuum, using a shop vacuum or vacuum cleaner:

I. Place the CanSat, fully charged and configured, in the vacuum chamber and suspend it.
II. To begin drawing a vacuum, turn on the vacuum.
III. Once the max height has been attained, stop the vacuum and keep an eye on the telemetry.
IV. As the air gradually enters the vacuum chamber, keep an eye on the CanSat's performance.
V. Gather and store telemetry data.
VI. Saved telemetry data access opened for judges to review

Simulation Test Plan

Simulation Test

With the use of a drone, we will conduct a drop test to mimic the mission's circumstances. In an attempt to duplicate the mission, we will attempt to drop the CanSat at different altitudes. This test will be performed to ensure that every system is functional and able to withstand the real-world conditions. We'll ensure that all ensuing mechanisms function correctly and that telemetry data collection is timely. The pressure used in this test will come from the CSV data that is sent by the ground station rather than the pressure sensor in order to comply with the requirements.

Mission Operations & Analysis

Daffa Farrell

Overview of Mission Sequence of Events (1/4)

Arrival	Pre-Launch	Launch Preparation
Team’s arrival at Launch site	GCS on site deployment	Assembly of CanSat major components
Inspection of the CanSat's condition	Replacement and adjustment of the electronics (if necessary)	Mechanic inspection
Verification of the CanSat's weight and dimensions	Remediation of any damages sustained by the CanSat (if applicable)	Ensure payload is securely packed.
Preparing and examining the GCS and antennas	Peruse the field score sheet and checklist.	Ensure CanSat structural integrity
	Communicational inspection and labeling of the receptacle and payload with the team's contact information (including the email address)	Final examination before launch.

Overview of Mission Sequence of Events (2/4)

Mission	Recovery	Analysis
Initiating the Launch	Recovery initiation	Data analysis and acquisition
Monitoring the ascent and descent of the CanSat	Using the buzzer and GPS to locate the CanSat	Transmitting the telemetry data file to the line judges for evaluation
Preparation of the retrieval crew		Evaluating the performance of the launch day team
Recovery crew preparation		Evaluation of the mission
Observing the landing area		Preparation for the development of the Post Flight Review
Ensuring the security of the data received from the probe		

Team member roles and responsibilities

Roles	Member name
Mission Control Officer	Radian Epifania
CanSat Crew	Alexander Maximilian
	Daffa Farrell
	Rakha Raditya
Ground Station Crew	Riki Ardiansyah
	Lucinda Laurent
	Rakha Raditya
CanSat Recovery Crew	Alvin Hadar
	Nathaniel
	Muhammad Aksal

Overview of Mission Sequence of Events (4/4)

Antenna Construction and Ground System Setup
1. Prepare the Ground Control Station's equipment. 2. Connect the XBEE Pro s3b to the laptop via an XBEE adapter, then use an RP-SMA cable to connect the antenna to the XBEE. 3. To ensure that all information is received, do a communicational evaluation.

CanSat Assembly	CanSat Test
1. Assembly of the key components of the CanSat. 2. Fix each constituent in place. 3. A technical inspection of the mechanisms. 4. Verify the structural integrity of the CanSat. 5. Conduct a last examination prior to launch.	1. Verification of the compatibility and mass of the CanSat. 2. Communicational examination 3. Calibration of sensors. 4. Inspection of electrical components 5. A thorough investigation of the CanSat.

Mission Operations Manual Development Plan

Mission Operation Manual Outline:

- **Configuration of Ground Control Station**

  The arrangement and examination of communication systems, and testing of aerial communications.
- **Assemblage of CanSat**

  The amalgamation of the CanSat's primary elements, and a comprehensive assessment of its apparatus.
- **CanSat Integration with Rocket**

  A thorough clearance inspection of the CanSat, and a final examination prior to launch.
- **Launch Procedure**

  To be executed by the event coordinator.
- **Extraction Procedure**

  Retrieval and data procurement.
- **Overall Objectives of Missionary Operations Manual**

  To guarantee that every team member comprehends the competition regulations and procedures during the competition, to ensure the team is capable of conducting the competition safely.

Container and Payload Recovery
Container will be red colored to aid recovery search
A sonorous signal of a high-pitched buzzer shall serve as an aid to the retrieval search
The final recorded position of the GPS shall facilitate the retrieval search
The abode and the point of contact of the team's delegate shall be inscribed on the outer structure of the component

The purpose of this section is to summarize and cross reference the compliance to the CanSat Competition Mission Guide requirements.

Requirements Compliance

Radian Epifania

Requirements Compliance Overview

The majority of the CanSat's payload and container designs are complete. What remains to be progressed on is the realization and testing.

Color Explanation

- Green = The majority of the work has been completed.
- Yellow = Requirements that must be met before the CanSat may be built and tested. We estimated that we may finish in the upcoming weeks. After fabricating and inspecting the structure's orderly parts, we'll proceed with further testing and modeling.
- Red = Serious issue, as of the present moment, there is none.

Requirements Compliance (1/9)

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
C1	The Cansat shall function as a nose cone during the rocket ascent portion of the flight.	Comply	17, 18, 19, 20, 21	
C2	The Cansat shall be deployed from the rocket when the rocket motor ejection charge fires.	Partial	41	In design yes, but we haven't created a prototype
C3	After deployment from the rocket, the Cansat shall deploy its heat shield/aerobraking mechanism.	Comply	62, 65	
C4	A silver or gold mylar streamer of 50 mm width and 1.5 meters length shall be connected to the Cansat and released at deployment. This will be used to locate and identify the Cansat.	No Comply	-	We haven't included in our design
C5	At 100 meters, the Cansat shall deploy a parachute and release the heat shield.	Comply	68	
C6	Upon landing, the Cansat shall stop transmitting data.	Comply	98, 99	
C7	Upon landing, the Cansat shall activate an audio beacon.	Comply	98, 99	
C8	The Cansat shall carry a provided large hens egg with a mass range of 51 to 65 grams	Comply	70	
C9	0 altitude reference shall be at the launch pad.	Comply	98, 112	

Requirements Compliance (2/9)

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
C10	During descent with the heat shield deployed, the descent rate shall be between 10 to 30 m/s.	Partial	51	In design yes, but we haven't created a prototype
C11	At 100 meters, the Cansat shall have a descent rate of less than 5 m/s.	Partial	52	In design yes, but we haven't created a prototype
C12	Cost of the Cansat shall be under $1000. Ground support and analysis tools are not included in the cost of the Cansat. Equipment from previous years shall be included in this cost, based on current market value.	Comply	150	
S1	The Cansat mass shall be 900 grams +/- 10 grams without the egg being installed.	Comply	75	
S2	Nose cone shall be symmetrical along the thrust axis.	Comply	23	
S3	Nose cone radius shall be exactly 71 mm	Partial	23	Tiny margin is intended, add layering later to fit the size is preferred
S4	Nose cone shoulder radius shall be exactly 68 mm	Partial	23	Tiny margin is intended, add layering later to fit the size is preferred
S5	Nose cone shoulder length shall be a minimum of 50 mm	Comply	23	
S6	Cansat structure must survive 15 Gs vibration	Partial	56	In design yes, but we haven't created a prototype

Requirements Compliance (3/9)

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
S7	Cansat shall survive 30 G shock.	Partial	58	In design yes, but we haven't created a prototype
S8	The Cansat shall perform the function of the nose cone during rocket ascent.	Comply	17	
S9	The rocket airframe can be used to restrain any deployable parts of the Cansat but shall allow the Cansat to slide out of the payload section freely.	Partial	17, 18, 62	In design yes, but we haven't created a prototype
S10	The rocket airframe can be used as part of the Cansat operations.	Comply	17	
S11	All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	71	
M1	No pyrotechnical or chemical actuators are allowed.	Comply	-	We don't use any
M2	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting the vegetation on fire.	Comply	-	We don't use any
M3	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Partial	56	In design yes, but we haven't created a prototype
M4	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	71	

Requirements Compliance (4/9)

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
M5	The Cansat shall deploy a heat shield after deploying from the rocket.	Comply	66	
M6	The heat shield shall be used as an aerobrake and limit the descent rate to 10 to 30 m/s.	Partial	51	In design yes, but we haven't created a prototype
M7	At 100 meters, the Cansat shall release a parachute to reduce the descent rate to less than 5 m/s.	Partial	52	In design yes, but we haven't created a prototype
M8	The Cansat shall protect a hens egg from damage during all portions of the flight.	Partial	69	In design yes, but we haven't created a prototype
M9	If the nose cone is to be considered as part of the heat shield, the documentation shall identify the configuration.	Comply	42	
M10	After the Cansat has separated from the rocket and if the nose cone portion of the Cansatis to be separated from the rest of the Cansat, the nose cone portion shall descend at less than 10 meters/second using any type of descent control device.	Comply	-	We don't use this method
E1	Lithium polymer batteries are not allowed.	Comply	91	
E2	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	Comply	91	
E3	Easily accessible power switch is required	Comply	89	

Requirements Compliance (5/9)

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
E4	Power indicator is required.	Comply	89	
E5	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	Comply	94, 96	
X1	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	Comply	82	
X2	XBEE radios shall have their NETID/PANID set to their team number	Comply	82	
X3	XBEE radios shall not use broadcast mode.	Comply	82	
X4	The Cansat shall transmit telemetry once per second.	Partial	82	In design yes, but we haven't created a prototype
X5	The Cansat telemetry shall include altitude, air pressure, temperature, battery voltage, Cansat tilt angles, air speed, command echo, and GPS coordinates that include latitude, longitude, altitude and number of satellites tracked.	Comply	83, 84, 85	
SN1	Cansat shall measure its speed with a pitot tube during ascent and descent.	Comply	34	

Requirements Compliance (6/9)

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
SN2	Cansat shall measure its altitude using air pressure.	Comply	31	
SN3	Cansat shall measure its internal temperature.	Comply	32	
SN4	Cansat shall measure its angle stability with the aerobraking mechanism deployed.	Comply	35	
SN5	Cansat shall measure its rotation rate during descent. .	Comply	36	
SN6	Cansat shall measure its battery voltage.	Comply	33	
SN7	The Cansat shall include a video camera pointing horizontally.	Comply	17, 38	
SN8	The video camera shall record the flight of the Cansat from launch to landing.	Comply	99, 100	
SN9	The video camera shall record video in color and with a minimum resolution of 640x480.	Comply	38	
G1	The ground station shall command the Cansat to calibrate the altitude to zero when the Cansat is on the launch pad prior to launch.	Comply	99, 100, 112	

Requirements Compliance (7/9)

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
G2	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Comply	110	
G3	Telemetry shall include mission time with 1 second or better resolution	Partial	85	In design yes, but we haven't created a prototype
G4	Configuration states such as zero altitude calibration shall be maintained in the event of a processor reset during launch and mission.	Comply	98	
G5	Each team shall develop their own ground station.	Comply	108, 109	
G6	All telemetry shall be displayed in real time during descent on the ground station.	Comply	110, 111	
G7	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.) and the units shall be indicated on the displays.	Comply	111	
G8	Teams shall plot each telemetry data field in real time during flight.	Comply	110	
G9	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and an antenna.	Comply	108	
G10	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Comply	108	

Requirements Compliance (8/9)

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
G11	The ground station software shall be able to command the payload to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	Comply	102	
G12	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the Cansat.	Comply	102	
G13	The ground station shall use a table top or handheld antenna	Comply	108	
G14	Because the ground station must be viewed in bright sunlight, the displays shall be designed with that in mind, including using larger fonts (14 point minimum), bold plot traces and axes, and a dark text on light background theme.	Comply	111	
G15	The ground system shall count the number of received packets. Note that this number is not equivalent to the transmitted packet counter, but it is the count of packets successfully received at the ground station for the duration of the flight.	Comply	85	
F1	The flight software shall maintain a count of packets transmitted which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Comply	85	
F2	The Cansat shall maintain mission time throughout the whole mission even with processor resets or momentary power loss.	Comply	101	
F3	The Cansat shall have its time set to within one second UTC time prior to launch.	Comply	112	

Requirements Compliance (9/9)

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
F4	The flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.	Comply	102	
F5	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the payload altitude.	Comply	102	
F6	The payload flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Comply	102	

Management

Radian Epifania

CanSat Budget – Hardware (1/4)

Electronic Components

Part Name	Qty	Unit Cost ($)	Total Cost ($)	Status	Consideration
XBEE	1	51,58	51,58	Re-Use	Actual
GPS Ublox Neo M8N	1	11,89	11,89	New	Actual
BME 280	2	3,90	7,80	New	Actual
MPU 9250	1	1,90	1,90	New	Actual
Teensy 4.1	1	54,87	54,87	New	Actual
Raspberry Pi Camera Module	1	5,46	5,46	New	Actual
ASPD-4525	1	62,07	62,07	New	Actual
Monopole Antenna	1	1,90	1,90	New	Actual
Step Up MT3608	3	0,33	0,99	New	Actual

CanSat Budget – Hardware (2/4)

Electronic Components

Part Name	Qty	Unit Cost ($)	Total Cost ($)	Status	Consideration
IRFZ44N	2	1,00	2,00	New	Actual
Panasonic NCR18650B	2	6,32	12,64	New	Actual
Micro-SD 8GB	1	2,60	2,60	New	Actual
DRV8833	1	0,57	0,57	New	Actual
JGA25-370 w/enc	1	9,62	9,62	New	Actual
SG-90	2	0,82	1,64	New	Actual
Raspberry Pi Zero W	1	22,17	22,17	Re-Use	Actual
		Total	249,7		
		Margin	24,97		

CanSat Budget – Hardware (3/4)

Mechanical Components

Part Name	Qty	Unit Cost ($)	Total Cost ($)	Status	Consideration
Heatshield	1	9.5	9.5	New	Estimation
Payload and Nosecone	1	24	24	New	Estimation
Parachute	1	4.7	4.7	New	Actual
		Total	38.2		
		Margin	3.8		

Ground Control System

Part Name	Qty	Unit Cost ($)	Total Cost ($)	Status	Consideration
XBEE USB Shield	1	4,52	4,52	Re-Use	Estimation
XBEE Pro 900HP	1	51,58	51,58	Re-Use	Estimation
Yagi Antenna TXR185	1	17,48	17,48	New	Estimation
		Total	73,58		
		Margin	7,36		

CanSat Budget – Other Costs (1/3)

Income

Source	Amount($)
Last Year income	0
University	400
Sponsors	0
Total	400

CanSat Budget – Other Costs (2/3)

Other Cost	Quantity	Unit Cost	Total Cost	Consideration
Test Facilites & Equipment	Provided by University	Provided by University	Provided by University	Provided by University
Airfare	10	1000	10000	Estimated
Hotel & Expenses	10	550	5500	Estimated
Food	10	50	500.00	Estimated
Visa	10	160	1600.00	Actual
Competition Entry Fee	1	200.00	200.00	Actual
		Total	17800	
		Margin	1780	

CanSat Budget – Other Costs (3/3)

Categories	Cost($)
Mechanical & Electrical	287.9
Ground Control Station	73.58
Other Costs	17800
Total	18161.48
Margin	1816.148
Income	400

Procurement of sponsors shall be expeditiously accomplished. In the event that sponsors remain elusive, each consortium member shall resort to utilizing their private funds to defray the expenses.

Program Schedule Overview

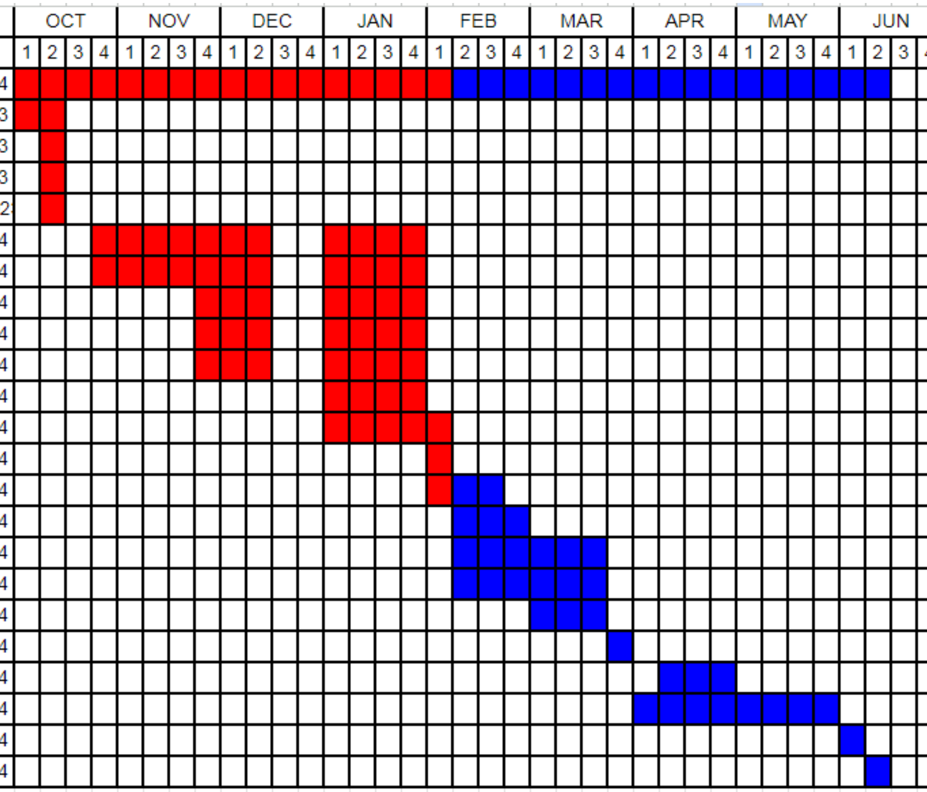
Summary				Oct				Nov				Dec				Jan				Feb				Mar				Apr				May				Jun			
Activity	Day	Start	End	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Cansat Competition	252	10/1/2023	6/8/2024																																				
Team Member Recruitment	8	10/1/2023	10/8/2023																																				
PDR Preparation	115	10/9/2023	1/31/2024																																				
Cansat Registration	1	11/2/2023	11/2/2023																																				
Midterm Exam	5	11/16/2023	11/20/2023																																				
Finalterm Exam	5	12/18/2023	12/22/2023																																				
New Year Holiday	375	12/23/2023	12/31/2024																																				
PDR Submission	1	2/2/2024	2/2/2024																																				
PDR Presentation	19	2/5/2024	2/23/2024																																				
Finding Sponsors	147	1/3/2024	5/28/2024																																				
Integration, Testing, Maintenance	116	2/3/2024	5/28/2024																																				
2nd Midterms Exam	6	3/25/2024	3/30/2024																																				
CDR Preparation	54	1/31/2024	3/24/2024																																				
CDR Submission	1	3/29/2024	3/29/2024																																				
FDR Preparation	89	3/1/2024	5/28/2024																																				
2nd Finalterm Exam	6	6/3/2024	6/8/2024																																				

Red = Done

Blue = On Progress

Detailed Program Schedule (1/4)

Mechanic				
Activity	Assignee	Days	Start	End
Cansat Competition	All Team	252	10/1/2023	6/8/2024
Team Member Recruitment	All Team	8	10/1/2023	10/8/2023
Analyzing Guidebook	All Team	1	10/8/2023	10/8/2023
Researching from previous PDR	All Team	1	10/8/2023	10/8/2023
Researching the mission	All Team	7	10/8/2023	10/14/202
Designing the parachute system	Nathaniel, Alvin	96	10/28/202	1/31/2024
Designing the aerobraking shield	Nathaniel	96	10/28/202	1/31/2024
Designing the egg containement	Aksal	65	11/28/202	1/31/2024
Designing the payload	Alvin	65	11/28/202	1/31/2024
Designing rotation control	Mechanic	65	11/28/202	1/31/2024
Material Trade and Mass Budget Estimate Mechanic	Mechanic	29	1/3/2024	1/31/2024
Finishing PDR	All Team	31	1/3/2024	2/2/2024
PDR Submission	All Team	1	2/2/2024	2/2/2024
PDR Presentation	All Team	19	2/5/2024	2/23/2024
Ordering for materials	All Team	22	2/7/2024	2/28/2024
Implementing the payload	Mechanic	47	2/8/2024	3/25/2024
Testing the prototype	All Team	47	2/8/2024	3/25/2024
Finishing Mechanic Part of CDR	Mechanic	25	3/1/2024	3/25/2024
CDR Submission	All Team	1	3/29/2024	3/29/2024
CDR Presentation	All Team	19	4/8/2024	4/26/2024
FDR Preparation	All Team	89	3/1/2024	5/28/2024
2nd Final Term Exam	All Team	5	6/3/2024	6/7/2024
Cansat Competition Main Event	All Team	2	6/8/2024	6/9/2024



Red = Done

Blue = On Progress

Detailed Program Schedule (2/4)

Electric					OCT				NOV				DEC				JAN				FEB				MAR				APR				MAY				JUN			
Activity	Assignee	Days	Start	End	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Cansat Competition	All Team	252	10/1/2023	6/8/2024																																			
Team Member Recruitment	All Team	8	10/1/2023	10/8/2023																																			
Analyzing Guidebook	All Team	21	10/8/2023	10/28/2023																																			
Researching from previous PDR	All Team	21	10/8/2023	10/28/2023																																			
Researching the mission	All Team	7	10/8/2023	10/14/2023																																			
Researching on sensors and cameras	Electric	11	10/28/2023	11/7/2023																																			
Researching on actuators	Daffa	11	10/28/2023	11/7/2023																																			
Researching on microcontrollers	Rakha	11	10/28/2023	11/7/2023																																			
Researching on battery	Daffa	11	10/28/2023	11/7/2023																																			
Researching on Antennas	Daffa, Rakha	14	11/8/2023	11/21/2023																																			
Understanding the mission to be adapted to electronics	Electric	14	11/8/2023	11/21/2023																																			
Designing a PCB design for the payload	Electric, Mechanic	11	11/28/2023	12/8/2023																																			
Designing a GCS electrical components	Electric	33	12/8/2023	1/9/2024																																			
Designing the antenna	Electric	33	12/8/2023	1/9/2024																																			
Finishing PDR	All Team	30	1/3/2024	2/1/2024																																			
PDR Submission	All Team	1	2/2/2024	2/2/2024																																			
PDR Presentation	All Team	19	2/5/2024	2/23/2024																																			
Ordering for parts	All Team	26	1/3/2024	1/28/2024																																			
Printing PCB	Daffa	21	2/8/2024	2/28/2024																																			
Collaborate with Programming to integrate FSW	All Team	23	2/28/2024	3/21/2024																																			
Testing prototype Finishing electrical part of CDR	All Team	44	2/8/2024	3/22/2024																																			
CDR Submission	All Team	1	3/29/2024	3/29/2024																																			
CDR Presentation	All Team	19	4/8/2024	4/26/2024																																			
FDR Preparation	All Team	89	3/1/2024	5/28/2024																																			
2nd Final Term Exam	All Team	5	6/3/2024	6/7/2024																																			
Cansat Competition Main Event	All Team	2	6/8/2024	6/9/2024																																			

Red = Done
Blue = On Progress

Detailed Program Schedule (3/4)

Programming				
Activity	Assignee	Days	Start	End
Cansat Competition	All Team	252	10/1/2023	6/8/2024
Team Member Recruitment	All Team	8	10/1/2023	10/8/2023
Analyzing Guidebook	All Team	1	10/8/2023	10/8/2023
Researching from previous PDR	All Team	1	10/8/2023	10/8/2023
Researching the mission	All Team	7	10/8/2023	10/14/202
Dividing workload between GUI and Payload	Lucinda	7	10/8/2023	10/14/202
Designing the UI	Lucinda	79	10/28/202	1/14/2024
Analyzing what need to be put on the UI	Riki	10	10/28/202	11/6/2023
Serial Port coding	Lucinda	15	11/21/202	12/5/2023
UI coding	Lucinda	71	11/21/202	1/30/2024
Binding Data with UI	Lucinda	61	12/1/2023	1/30/2024
Individual Sensor coding	Rifki	61	12/1/2023	1/30/2024
Finishing PDR	Riki	30	1/3/2024	2/1/2024
PDR Submission	All Team	1	2/2/2024	2/2/2024
PDR Presentation	All Team	19	2/5/2024	2/23/2024
Integrate Programming with electrical parts	Rifki	30	2/28/2024	3/28/2024
Prototype Testing	All Team	30	2/28/2024	3/28/2024
Finishing Programming part of CDR	Riki	30	2/28/2024	3/28/2024
CDR Submission	All Team	1	3/29/2024	3/29/2024
CDR Presentation	All Team	19	4/8/2024	4/26/2024
FDR Preparation	All Team	89	3/1/2024	5/28/2024
2nd Final Term Exam	All Team	5	6/3/2024	6/7/2024
Cansat Competition Main Event	All Team	2	6/8/2024	6/9/2024

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Blue = On Progress

Detailed Program Schedule (4/4)

Managerial					OCT				NOV				DEC				JAN				FEB				MAR				APR				MAY				JUN			
Activity	Assignee	Days	Start	End	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Cansat Competition	All Team	252	10/1/2023	6/8/2024																																				
Team Member Recruitment	All Team	8	10/1/2023	10/8/2023																																				
Analyzing Guidebook	All Team	1	10/8/2023	10/8/2023																																				
Researching from previous PDR	All Team	1	10/8/2023	10/8/2023																																				
Researching the mission	All Team	7	10/8/2023	10/14/202																																				
Looking for internal funding & sponsors	All Team	160	11/22/202	4/29/2024																																				
Making Proposal	All Team	22	11/1/2023	11/22/202																																				
Making an Estimate of Budget Needed	All Team	52	1/3/2024	2/23/2024																																				
Sending Proposal	Alex	12	6/1/2024	6/12/2024																																				
Administration of Cansat	Radian	32	10/1/2023	11/1/2023																																				
Finishing PDR	All Team	30	1/3/2024	2/1/2024																																				
PDR Submission	All Team	1	2/2/2024	2/2/2024																																				
PDR Presentation	All Team	19	2/5/2024	2/23/2024																																				
Ordering for materials	Alex	26	1/3/2024	1/28/2024																																				
Finishing Managerial Part of CDR	Radian	50	2/1/2024	3/21/2024																																				
CDR Submission	All Team	1	3/29/2024	3/29/2024																																				
CDR Presentation	All Team	19	4/8/2024	4/26/2024																																				
FDR Preparation	All Team	89	3/1/2024	5/28/2024																																				
2nd Final Term Exam	All Team	5	6/3/2024	6/7/2024																																				
Cansat Competition Main Event	All Team	2	6/8/2024	6/9/2024																																				

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Conclusions (1/2)

Administration and Finance	
Major Accomplishment	Major Unfinished Work
Application for reimbursement has been written and ready to be sent to the university.	Lack of sponsorship from external entities.
Electronics and Programming	
Major Accomplishment	Major Unfinished Work
The system(s) have adhered to the specifications in a satisfactory manner.	The integration and verification procedure has not yet been applied to the system or systems.
Mechanics	
Major Accomplishment	Major Unfinished Work
The blueprint have been created for the processes of implementation and inspection.	The lack of a prototype prevents us from implementing enhancements to the CanSat design depending on the outcomes of the evaluative experiments.

Conclusions (2/2)

Why we are ready for the next stage:

- Our involvement in contests related to aerospatial pursuits has provided us with significant insights and skills.
- Our agenda has been mostly completed within the timeframe specified, leaving us with only the obligation to implement monitoring, starting with the manufacturing and evaluation processes.