CanSat 2023
Preliminary Design Review (PDR)

Team 1095

Team Aether

Presentation Outline

Systems Overview

Shreya Puri

Mission Summary (1/2)

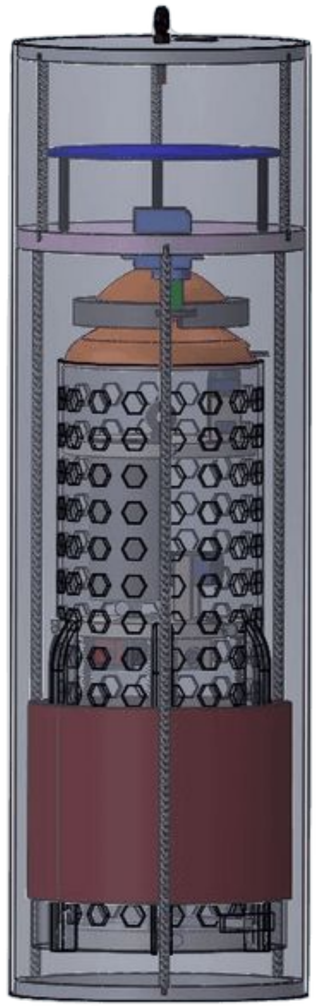
Mission Objectives
Design and build a **sturdy** CanSat structure including a **container** and and a **probe** for executing the probe lander mission
CanSat shall be deployed from the rocket compartment near the apogee between **670-725 m** and descend at **15 m/s** with a **parachute**.
The structure shall survive all forces incurred at launch and deployment. At **500m**, it shall **deploy a probe** that opens a **heat shield** working as an aerobraking shield with a descent rate of **20 m/s or less**.
When the probe reaches **200 m**, the probe shall deploy a **parachute** and slow the descent rate to **5 m/s**.
After landing, the probe shall attempt to **upright itself** and **raise a flag 500 mm above its base**
A **video camera** shall be included and **point toward the ground during descent** in color and with a minimum resolution of 640x480.
All telemetry shall be displayed and plotted on the **GUI** in real time during **descent** on the ground **(1 Hz)**
Setting up a **portable ground control station** for telemetry to and fro from the ground station to the probe and generate csv files for the received telemetry.

Mission Summary (2/2)

Bonus Objective
A **video camera** shall be integrated into the container and **point toward the probe**. The camera shall record the event when the probe is released from the container.
Video shall be in color with a minimum resolution of **640x480 pixels** and a minimum of **30 fps.** The video shall be **recorded and retrieved** when the container is retrieved.
This bonus objective has been selected due to **high feasibility** and to help us analyse the **moment of separation** during flight. It additionally provides us with more experience working on incorporating more components into the system.

External Objectives
Obtain the Institute's **approval** for participation and **secure funding** for as many phases of the competition as possible, and **attain sponsorships**
Achieve a commendable rank for our **first attempt** at the competition
Design and assemble **customised PCBs** for the electronics used
Starting a tradition of participating in the competition, fostering a healthy work environment in the team
Since the participating team is a part of a student club aiming to launch a **student satellite**, we want to gain experience on all phases of the mission on a smaller scale through the competition.

System Level CanSat Configuration Trade & Selection(1/5)

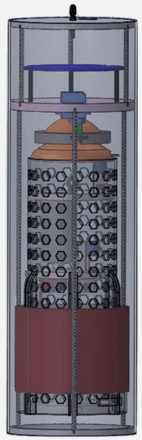


Configuration A	
1. The system is stabilised by passive control. 2. The system components are mounted using standoffs and screws. 3. Parachute is controlled using lid deployment by servo motor. 4. Probe is released using CAM mechanism	

Pros	Cons
1. The CanSat is stable as it descends. 2. Electronics are reliably secured.	1. 3D printed material is considerable in volume, increases cost and mass.

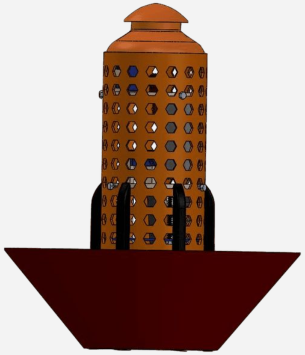
System Level CanSat Configuration Trade & Selection(2/5)

Stowed State



- A CAM mechanism is used to hold the probe.
- Probe is secured by circlip.
- Probe parachute is secured inside lid by means of a servo.
- Container parachute rests on top of the container.

Probe release and heat shield release

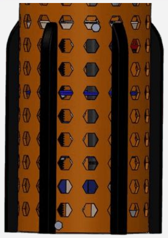


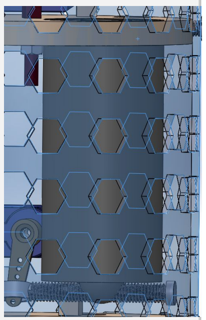
- The probe is released by rotating servo and expanding circlip.
- Heat shield is deployed by using a hotwire mechanism to snap an elastic material.

Probe Parachute deployment

- The parachute lid is held in place by a servo. This servo is rotated and the lid opens. The probe parachute deploys.
- Heat shield is released by rotating a servo pin through a certain degree.

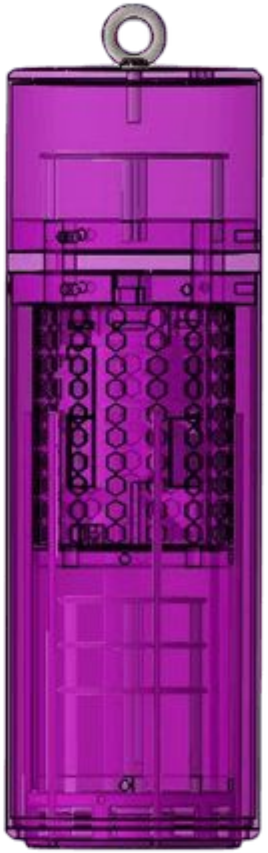
Uprighting and Flag rasing





- Spiderlegs are used to upright.
- The pin of the flag raising cylinder is connected by a thread to servo.
- When the servo rotates, the thread tugs on the pin, causing the flag to pop up

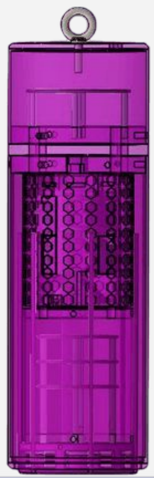
System Level CanSat Configuration Trade & Selection(3/5)



Configuration B	
1. The system will provide descent using only passive control. 2. All the electronic components will be enclosed inside the structure. 3. The payload is stowed using sheet of cardboard. 4. The base of the container is open to allow easier payload deployment. 5. Two servos and a spring will be used to deploy probe parachute. 6. The heat shield is deployed using burn wire mechanism	
Pros	**Cons**
1. Reduction in mechanism as heat shield is used for uprighting. 2. Mechanisms are simple.	1. Reduction in durability due to 3D printed components. 2. Chance of damage to the heat shield arms due to improper stowing and payload release.

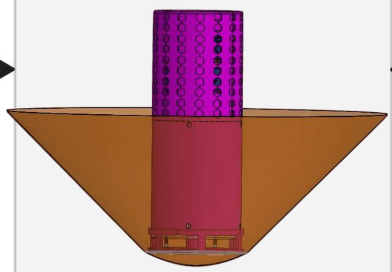
System Level CanSat Configuration Trade & Selection(4/5)

Stowed State



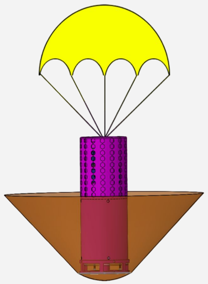
- The payload will be stowed using a cardboard sheet acting as the payload bay.

Probe release and heat shield release



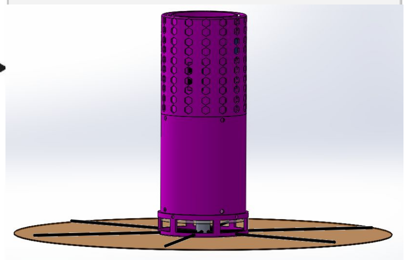
- The payload will be separated using a servo operated mechanism.
- The payload will be released and will deploy a heat shield using a burn wire mechanism.

Probe Parachute deployment



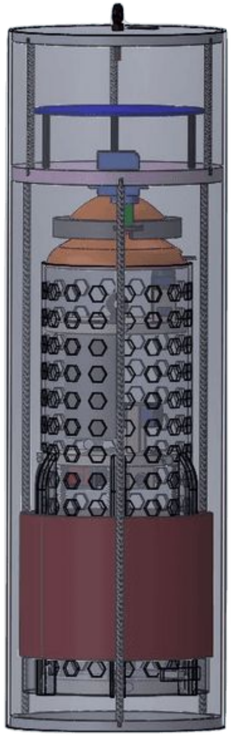
- At 200 m a parachute will be deployed using two servos and a spring.

Uprighting and Flag rasing



- After landing the payload will upright itself using the heat shield and raise a flag 500 mm above the base of the probe

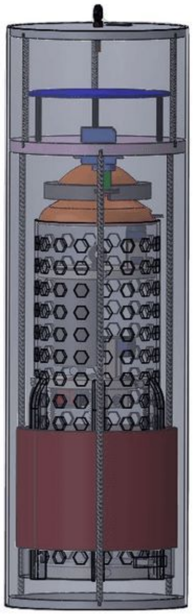
System Level CanSat Configuration Trade & Selection(5/5)



Criteria	Configuration A	Configuration B
Descent stability	Better stability	Chances of variable descent rate.
Durability	Durable structure	Fairly durable
Presence of failsafe	Mechanisms prevent failure due to error	No failsafes
Utilization of space	Better utilization of space	Wastage of space in probe

Selected Configuration	Reasons
Configuration A	**1. This configuration provides better descent stability and durability.** **2. Mechanisms are sound and reduce risk of failures.**

System Level Configuration Selection



Selected Configuration	Rationale
A	● Easier to stabilize and upright. ● More utilization of space ● Provides greater flexibility of other designs.

Physical Layout (1/3)

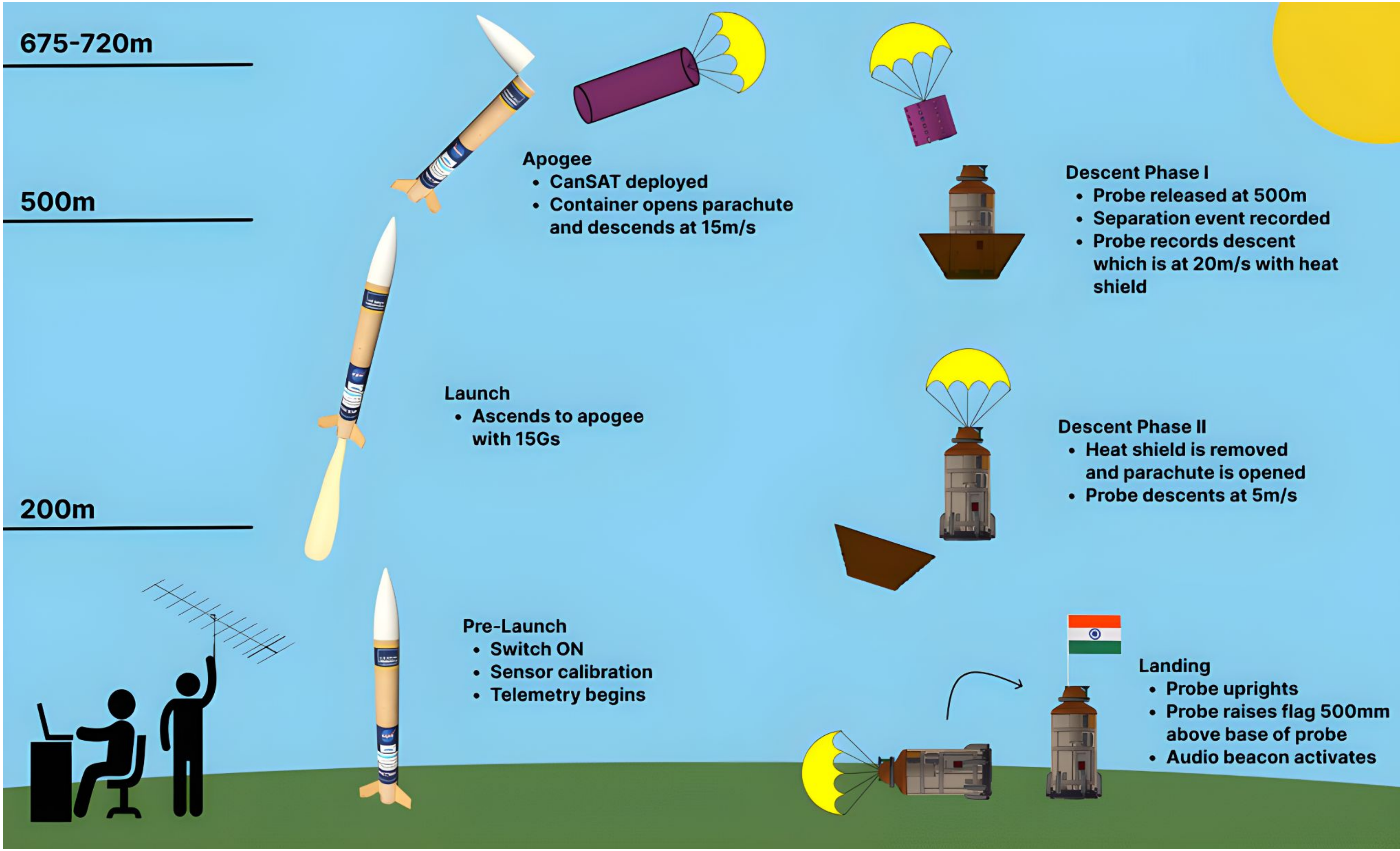
Physical Layout (2/3)

Physical Layout (3/3)

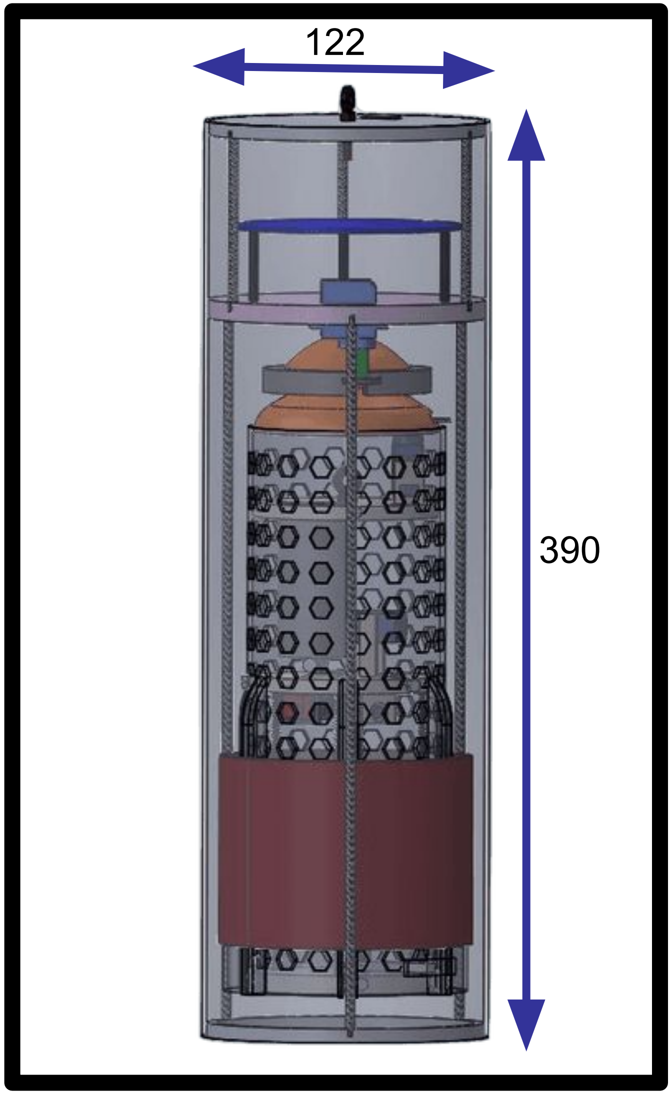
System Concept of Operations(1/2)

Pre-Launch	• Arrival at launch site and pre-launch configurations. • GCS setup and connection establishment with CanSat. • CanSat is switched on, sensors are calibrated and telemetry begins.
Launch	• CanSat submitted to launch site officials is placed in launch vehicle bay. • The launch vehicle is launched and ascends to apogee with 15Gs of acceleration.
Apogee	• Apogee is attained at 675-720m above launch site. • CanSat is deployed from launch vehicle under large shock forces. • Container immediately releases a parachute and descends at 15m/s.
Descent Phase - I	• The altitude of 500 m is sensed. • Container video camera starts recording separation event of probe. • Container releases a probe. • Probe immediately opens a heat shield and descends at 20m/s. • Probe camera starts recording descent while pointing towards ground.
Descent Phase - II	• At an altitude of 200m, probe deploys a parachute. • Immediately, the heat shield is detached. • Probe descends at a rate of 5m/s.
Landing	• After the probe lands, it uprights itself. • Post uprighting, probe raises flag 500mm above base of probe. • Telemetry is stopped and audio beacon activates.
Recovery	• Container and probe and recovered and switched off. • Flight data is recovered, analysed and PFR is made for submission.

System Concept of Operations(2/2)



Launch Vehicle Compatibility



Dimensions	Container	Payload
Length(mm)	390	156
Diameter(mm)	122	112

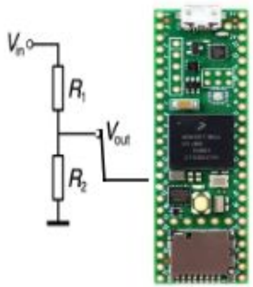
Particulars	Comments
Clearances	• The CanSat has a clearance of 1.5 mm on diametrically opposite sides. • Vertical clearance is 10mm
Sharp edges/protrusions	• There are no sharp edges anywhere and no chances of protrusion getting stuck.

Sensor Subsystem Design

Shreya Puri

Sensor Subsystem Overview

Air Pressure + temperature sensor



Battery voltage sensor

Tilt sensor

GPS

Camera

Bonus Camera

Sensor Type	Selected Model	Purpose
Air Pressure sensor	MS5611	Measures air pressure and altitude.
Temperature sensor	MS5611	Measures air temperature.
Battery voltage sensor	TeensyADC+ voltage divider	Measures the battery voltage.
Tilt sensor	Adafruit LSM6DS3TR-C	Determines the orientation of the payload.
GPS sensor	Neo-6M	Determines the position and no. of satellites.
Camera	SQ11	Records the video of the descent.
Bonus Camera	ESP-32 CAM	Records the release of the payload.

Payload Air Pressure Sensor Trade & Selection

Component	Power	Dimensions (mm)	Mass (g)	Pressure range (hPa)	Resolution (hPa)	Interface	Cost ($)
BMP280	3.3V x 0.0034mA	12 x 9 x 1.5	1	300 - 1100	0.01	I²C	0.63
BMP388	3.3V x 0.034mA	13.5 x10.5 x2	1.2	300 - 1250	0.0018	I²C,SPI	15
MS5611	3.3V x 0.015mA	19 x 13 x 2	1.5	10 - 1200	0.012	I²C	8.15

Selected Component	Rationale
 **MS5611**	• High Resolution. • Low power consumption. • Moderate cost. • Good pressure range.

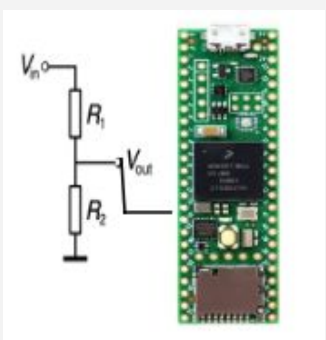
Payload Air Temperature Sensor Trade & Selection

Component	Power	Dimensions (mm)	Mass (g)	Range (℃)	Resolution (℃)	Accuracy (℃)	Interface	Cost ($)
BMP280	3.3V x 0.0034mA	12 x 9 x 1.5	1	-40~85	0.01	± 1.0	I²C	0.63
BMP388	3.3V x 0.034mA	13.5 x10.5 x2	1.2	-40~85	0.005	± 0.5	I²C,SPI	15
MS5611	3.3V x 0.015mA	19 x 13 x 2	1.5	-40~85	< 0.01	± 0.8	I²C	8.15

Selected Component	Rationale
 **MS5611**	• Better accuracy and resolution. • Low power consumption. • Moderate cost.

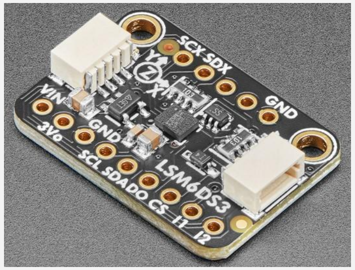
Payload Battery Voltage Sensor Trade & Selection

Model	Dimensions (mm)	Mass (gm)	Range (V)	Resolution (mV)	Interface	Cost ($)
Teensy ADC + voltage divider	Embedded	-	0 - 3.3	1.2	Analog	0
INA 219	26 x 22 x 6	3	0 - 26	1.2	I²C	3.14
Arduino voltage sensor	40 x 30 x 20	9	0 - 25	4.8	Analog	0.7

Selected Component	Rationale
 **Teensy ADC + voltage divider**	• Included ADC in Teensy. • Easy to implement voltage divider. • Good resolution.

Payload Tilt Sensor Trade & Selection

Component	Power	Dimensions (mm)	Mass (g)	Accelerometer range (g)	Gyrometer range (dps)	Interface	Cost($)
MPU 6050	3.3 V x 3.9 mA	20.7 x 15.5	2.1	± 2 ± 4 ± 8 ± 16 g	± 250, 500, 1000, 2000	I²C	2.12
Adafruit LSM6DS3TR-C	3.3 V x 0.9 mA	25.3 x 17.8	1.7	± 2 ± 4 ± 8 ± 16 g	± 250, 500, 1000, 2000	I²C	9.95
GY-87 10DOF	3.3 V x 4.1 mA	22 x17	5	± 2 ± 4 ± 8 ± 16 g	± 250, 500, 1000, 2000	I²C	12.24

Selected Component	Rationale
 **Adafruit LSM6DS3TR-C**	● Low current consumption. ● Moderate cost. ● On-board FIFO Management. We had encountered FIFO overflow error using MPU 6050.

Payload GPS Sensor Trade & Selection

Component	Power	Dimensions (mm)	Mass (g)	Resolution (m)	Update rate (Hz)	Interface	Cost($)
Neo 6M	3.3 V x 40 mA	22x30x4	12	±2.5	1-5	UART	4.91
Neo 8M	3.3 V x 22 mA	27x36x4	17	±2.5	1-10	UART	13.53
MTK3339	3.3 V x 25 mA	16x16x5	4	±1.8	1-10	UART	24.6

Selected Component	Rationale
 **Neo 6M**	● Moderate size. ● Affordable cost. ● Has the same tracking sensitivity as Neo-8M, but higher than MTK3339.

Payload Camera Trade & Selection

Component	Dimensions (mm)	Mass (gm)	Operating voltage(V)	Resolution	SD Card	Interface	Cost ($)
Adafruit 3202	28.5 x 17 x 4.2	2.8	5	640 x 480	Yes	CSI, GPIO	12.5
ESP-32 CAM	43 x 40 x 10	45	5	1600 x 1200	Yes	CSI	7.45
SQ11	23 x 23 x 23	20	5	1280 x 720	Yes	Digital	9.84

Selected Component	Rationale
 **SQ11**	• Small size. • Good resolution. • Has micro SD card slot. • In-built battery.

Descent Control Design

Ojas Taskar

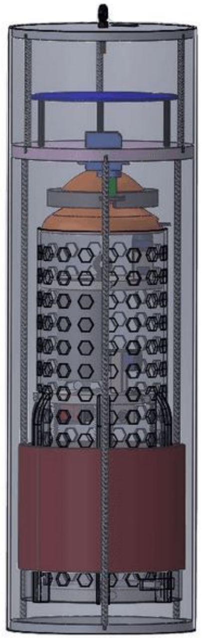
Descent Control Overview

The descent control strategy of the CanSat is as follows:

1. At an altitude of of **670-725 m**, the CanSat is deployed from the rocket. Immediately, the **first parachute** stowed inside the container deploys and reduces the entire CanSat descent rate to **15m/s.**

2.At an altitude of **500m**, the container releases the probe. The probe immediately opens a **dome shaped heat shield** with which probe descends at **20m/s.** A **passive mechanism** is used to stabilize the probe when the heat shield is open. Container with the first parachute descends at previous rate.

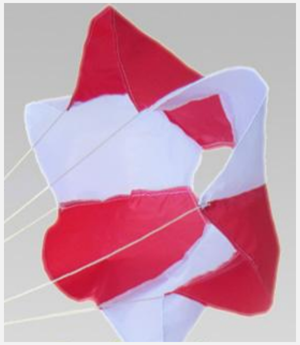
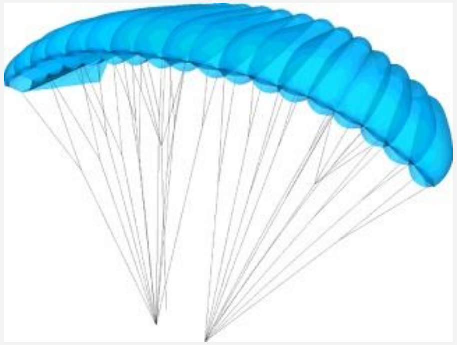
3.At a height of **200m**, probe releases the heat shield and immediately opens the **second round parachute** stowed inside it. This parachute reduces the probe descent rate to **5m/s.**



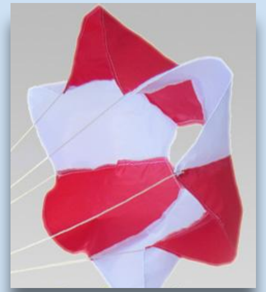
Altitude	Configuration	Components required
675-720m	**First round parachute**	Yellow ripstop nylon parachute attached by nylon strings.
500m	**Probe with heat shield and stabilization**	Servo-lever movable mechanism with hotwire for nylon heat shield deployment. () for stabilization of probe.
200m	**Probe parachute.**	Lid opening servo mechanism for stowed ripstop nylon parachute.

Container Descent Control Strategy Selection and Trade(1/7)

Container Parachute Design Trade (1/2)

Features	Round Parachute	X-form Parachute	Ram-air Parachute
Visual Description			
PROS	● Easy to fabricate ● More stability per unit area of parachute material ● Short opening time	● Reduces required area and material cost ● Less possibility of swaying ● Reduces horizontal drift	● Provide greater control over direction ● Spread stress evenly over area
CONS	❑ Possibility of greater stress on connecting points when deployed.	❑ Rope entanglement is likely. ❑ Harder to fabricate. ❑ Chances of stress.	❑ Descent rate may vary if control is not active. ❑ Complexity increases because of more number of threads

Container Parachute Design Trade (2/2)

Selected Parachute Type	Rationale
 Round Parachute with spill holes	• Spill holes improve stability • Easier to fabricate • Descent Rate can be easily verified • Experience of use on previous occasions

Container Descent Control Strategy Selection and Trade(3/7)

Container Parachute Material Trade (1/1)

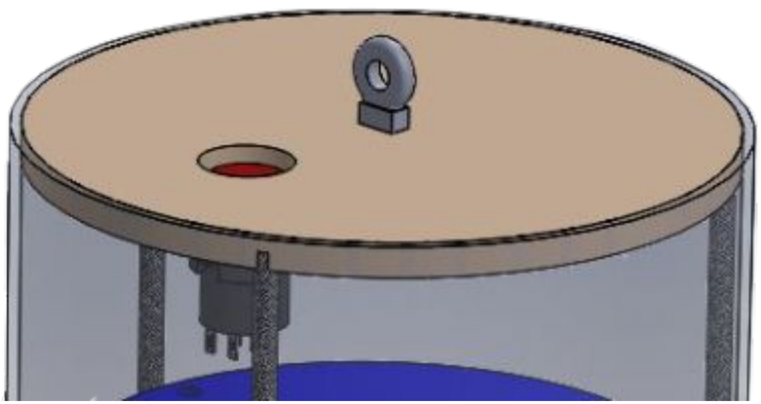
Features	Ripstop Nylon	Kevlar
Cost($) / meter	2.5	15
PROS	● Widely verified as a reliable option for making parachutes. ● Commercially available parachutes of this material.	● Strongest fabric commercially available. ● Light material per unit area.
CONS	❑ Heavier material per unit area. ❑ Can melt when exposed to high temperatures.	❑ Very Expensive. ❑ Not easily available in India.

Selected Material	Rationale
Ripstop Nylon	● Documentation is available online for designing own parachute of this material. ● Easy of supply in India. ● We have experience using this material previously. ● Reliable material at lesser cost.

Container Descent Control Strategy Selection and Trade(4/7)

Container Parachute Stowed Configuration Selection(1/3)

Configuration A



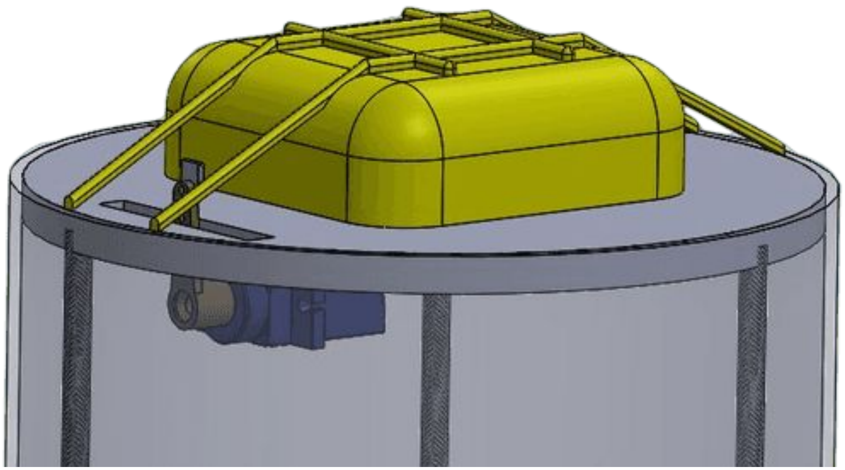
Description

- The parachute is attached to the attachment plate using nylon strings of 1 feet length.
- The nylon strings are attached to an eye-bolt made of metal which is attached to the plate by means of screws.
- The nylon strings are attached to metal welded holes in the parachute.
- The parachute rests loosely on top of the container.

Container Descent Control Strategy Selection and Trade(5/7)

Container Parachute Stowed Configuration Selection(2/3)

Configuration B



Description
● The parachute is tightly wound and kept on the topmost plate of the container. ● The parachute is kept secured by two threads running at 90° across its folded shape. ● The threads are attached to a point which is beside a servo motor with a sharp edge glued to it. ● The servo motor rotates, cuts the thread and the parachute is released due to airflow.

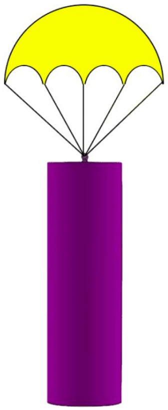
Container Parachute Stowed Configuration Selection(3/3)

Configuration	Advantages	Disadvantages
A	● Easy to design ● No complex mechanisms ● Recommended by mission guidelines	❑ Possibility that the parachute may get stuck when deploying.
B	● Complex ● Probability of late release of parachute/no release at all. ● Increases components and mass requirement.	❑ Parachute is kept compact ❑ Uniformly released parachute means there will be no unbalanced force from one side at the point of contact.

Selected Configuration	Rationale
Configuration A	➔ Saves power and mass. ➔ Complies to all mission requirements ➔ Easier to assemble and disassemble.

Container Descent Control Strategy Selection and Trade(7/7)

Container Descent Control Deployment Process

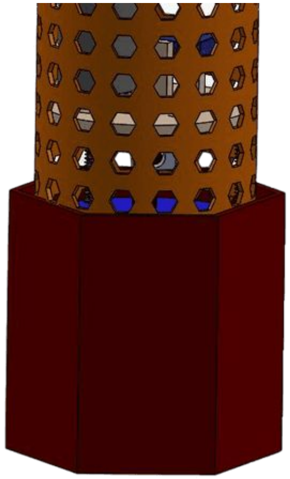


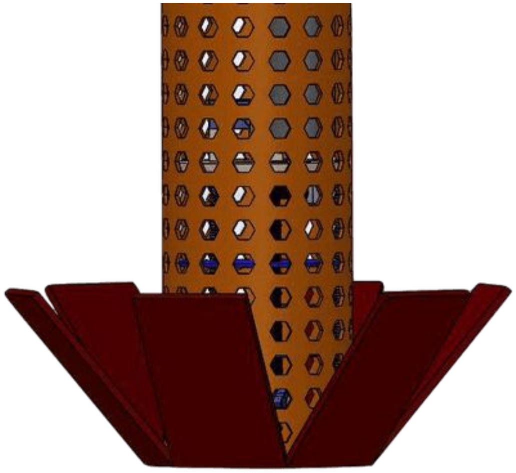
Just before release	Deployment	Post Deployment
• The CanSat rests on the parachute in the launch vehicle bay.	• As soon as the CanSat starts descending, the parachute opens naturally due to airflow. The eyebolt experiences shock force but stays in place as it is surrounded by a thin layer of rockwool.	• The container is stabilised against swaying by 1ft length of cord and **slightly thickened lower walls.** This keeps the mass concentrated at bottom and acts as a passive control mechanism.

Payload Aerobraking Descent Control Strategy Selection and Trade(1/5)

Payload Aerobraking Device Design Trade(1/3)

Configuration A - Hexagonal Heat Shield with interconnected panels





Stowed Configuration

- The two halves of the heat shield are connected by torsional springs.
- Shield folds inward forming a star-shape.
- Each panel of the shield is joined together by elastic cords.
- Entire shield is wound tight by a rubber connected to hotwire.

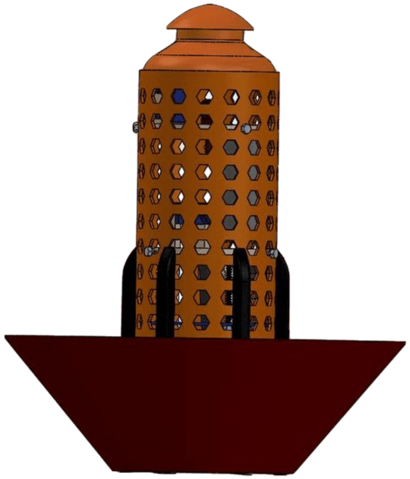
Deployed Configuration

- At 500m, the hotwire is given current from a MOSFET. The rubber band snaps open.
- The spring force pushes the panels outward and elastic cords force the panels to open up.

Payload Aerobraking Descent Control Strategy Selection and Trade(2/5)

Payload Aerobraking Device Design Trade(2/3)

Configuration B - Umbrella shape heat shield with metal links



Stowed Configuration

- Metal links are placed in holes on a ring held in place by servo latch mechanism.
- One end of the links is held by torsional spring. Heat shield material is held within links.
- Upper part of link has a through-hole for a rubber to pass through.

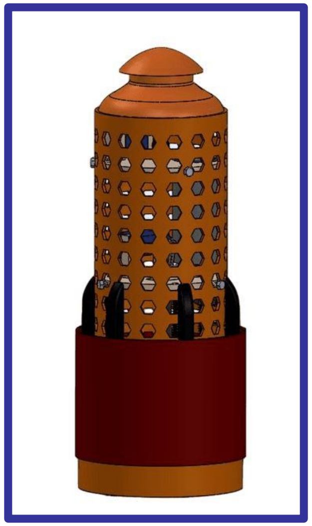
Deployed Configuration

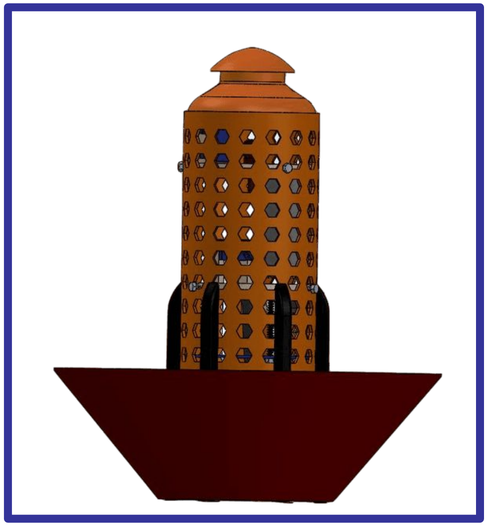
- To deploy, rubber is burnt using current.
- Torsional spring force pushes the links outward and heat shield opens.

Payload Aerobraking Descent Control Strategy Selection and Trade(3/5)

Payload Aerobraking Device Design Trade(3/3)

Configuration Selection





Selected Configuration	Rationale
Configuration B	● Eliminates possibility of uprighting mechanism and heat shield interfering. ● Descent rate can be easily calculated. ● Reliability is high and mechanism is relatively less complex. ● Easier to time for deployment

Payload Aerobraking Descent Control Strategy Selection and Trade(4/5)

Payload Aerobraking Device Material Trade(1/1)

Features	Ripstop Nylon	Silica Fabric	Carbon Fabric
PROS	● Less expensive. ● Has durability. ● Easily available..	● Highly thermal resistant (operating temperatures > 982℃) ● Tear proof.	● Heat and shock proof. ● Used as insulating and heat shield material by space agencies as well.
CONS	❑ Heavier material per unit area. ❑ Can melt when exposed to high temperatures.	❑ Very expensive. ❑ Not very easily available in India.	❑ High cost. ❑ Slight trace of carbon particles are left behind by it, may interfere with electronics.

Selected Material	Rationale
Silica Fabric	● Best material for price range. ● Prevents risk of 3D material melting due to heat when descending.

Payload Aerobraking Descent Control Strategy Selection and Trade(5/5)

Payload Aerobraking Device Deployment Description(1/1)

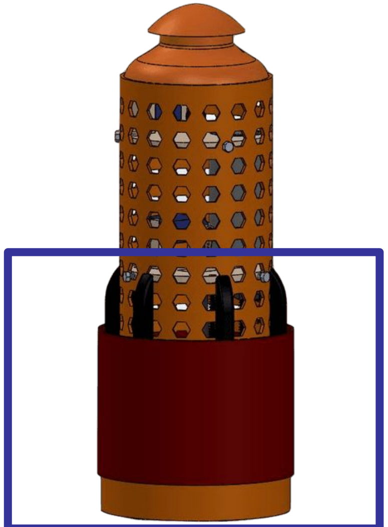
- ➔ Initially, the heat shield is held in place by the rubber, which resists the force of the torsional springs.
- ➔ At deployment point, the rubber is burnt by providing current through a MOSFET.
- ➔ The tension on the links is now provided by the torsional spring, which force it backward and heat shield opens.

- ★ At 200m, heat shield is needed to be released. To achieve this, the servo link is rotated and the heat shield ring is now free to move.
- ★ Due to airflow, the heat shield moves up and gets separated.
- ★ Slight delay is added between this release and parachute release to avoid entanglement.

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

Payload Aerobraking Stability Design Trade(1/3)

Configuration A - Passive Control

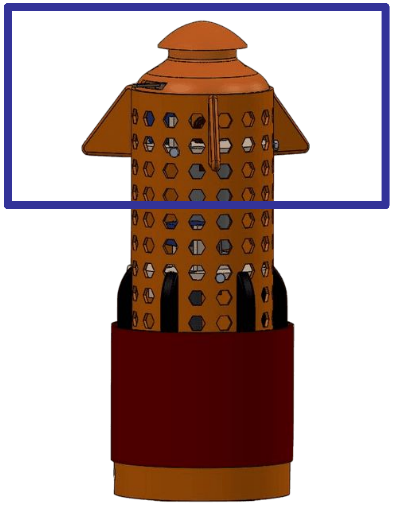


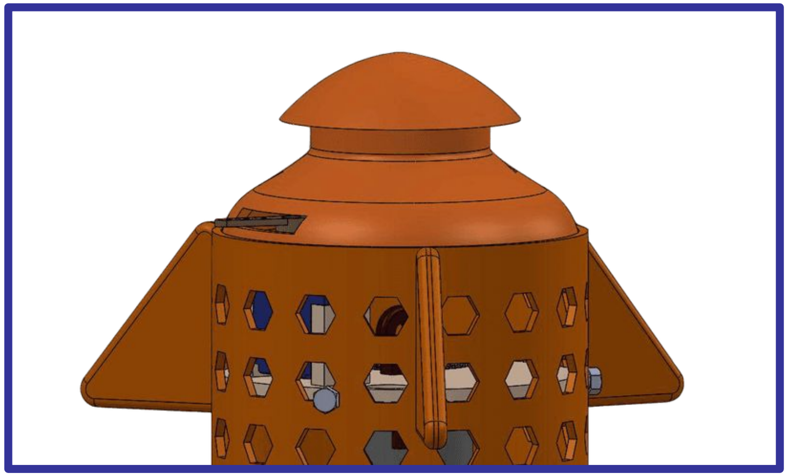
Strategy	Effect and Advantage
PCBs and electronics are placed at the bottom.	The mass is concentrated at the bottom and there is minimal swaying due to torque of airflow.
Heat Shield is attached as close as possible to COM.	The air flowing past the heat shield generates torque on the shield. In case of unstable air flow, the torque generated by that force will be very less **owing to a very small moment arm.**

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

Payload Aerobraking Stability Design Trade(2/3)

Configuration B - Active Control





Strategy	Effect and Advantage
4 servo controlled aerofoils are placed on the topmost plate.	It is possible to control the orientation of CanSat.
PID is used to determine position of aerofoil.	Using this, we can control the CanSat from twisting into the wind direction and becoming unstable due to windy conditions.

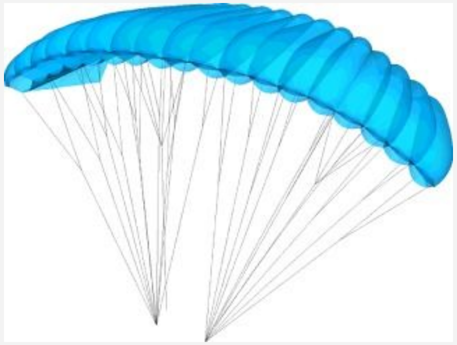
Payload Aerobraking Descent Stability Control Strategy Selection and Trade(3/3)

Payload Aerobraking Stability Design Trade(3/3)

Selected configuration	Rationale
Configuration A	• Eliminates the need for additional circuitry and additional mass. • Initial testing in windy conditions suggests this is a sufficient mechanism.

Payload Parachute Descent Control Strategy Selection and Trade(1/7)

Payload Parachute Trade (1/2)

Features	Round Parachute	Flat Circular Parachute	Ram-air Parachute
Visual Description			
PROS	● Easy to design ● Descent rate can be easily modified ● Less chance of error	● No complexity ● Opens very fast ● Uses less material	● Provide greater control over direction ● Spread stress evenly over area
CONS	❏ Possibility of greater stress on connecting points when deployed.	❏ May sway and control provided is very less	❏ Descent rate may vary if control is not active. ❏ Complexity increases because of more number of threads

Payload Parachute Descent Control Strategy Selection and Trade(2/7)

Payload Parachute Trade (2/2)

Selected Parachute Type	Rationale
 **Round Parachute**	• Spill holes reduce building of air pressure and hence, chance of tearing. • Can be easily woven by nylon strings to improve shock strength. • Familiarity of design.

Payload Parachute Descent Control Strategy Selection and Trade(3/7)

Payload Parachute Material Trade (1/1)

Features	Ripstop Nylon	Kevlar
Cost($) / meter	2.5	15
PROS	● Widely verified as a reliable option for making parachutes. ● Commercially available parachutes of this material.	● Strongest fabric commercially available. ● Light material per unit area.
CONS	❑ Heavier material per unit area. ❑ Can melt when exposed to high temperatures.	❑ Very Expensive. ❑ Not easily available in India.

Selected Material	Rationale
Ripstop Nylon	● Documentation is available online for designing own parachute of this material. ● Easy of supply in India. ● We have experience using this material previously. ● Reliable material at lesser cost.

Payload Parachute Descent Control Strategy Selection and Trade(4/7)

Payload Parachute Stowed Configuration Selection(1/3)

Configuration A

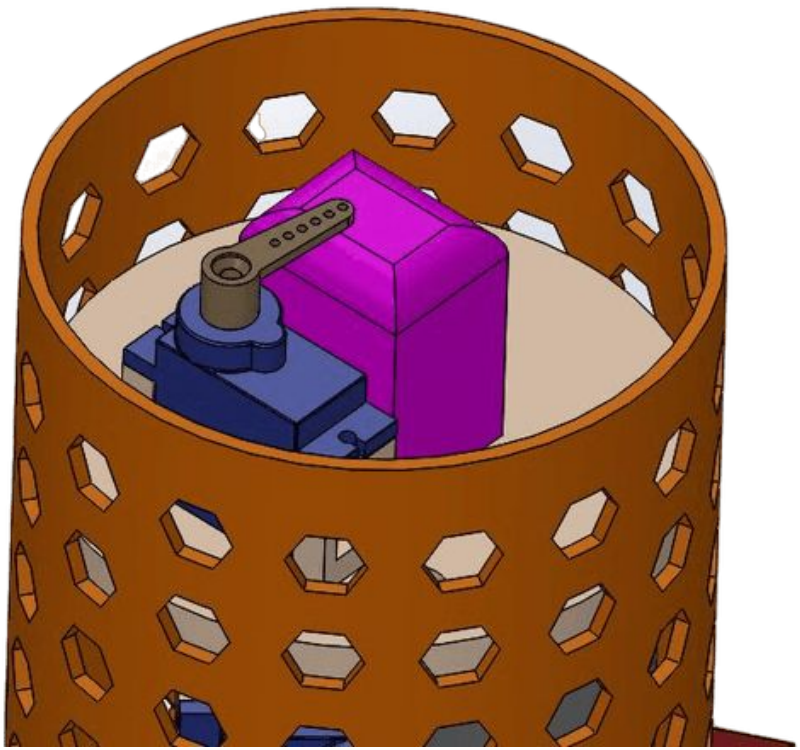
Description

- The parachute is stowed inside the upper section of the probe.
- The section is held in place by a lid controlled by a servo motor.
- To release the parachute, the servo motor rotates and the lid opens.
- Small holes provided at the side of the section provide airflow entry which forces the parachute to open.
- Parachute is attached to an eyebolt secured to a 3D printed PLA plate by nylon cords.

Payload Parachute Descent Control Strategy Selection and Trade(5/7)

Payload Parachute Stowed Configuration Selection(2/3)

Configuration B



Description

- The parachute is tightly wound into a small ‘pack’ by threads.
- This is placed over a rectangular slot on a small plate.
- This plate keeps a spring under compression. The entire mechanism is fit under the vertical length of a servo motor.
- To release, the servo motor rotates 90° and the parachute is thrown into the air and deploys.

Payload Parachute Descent Control Strategy Selection and Trade(6/7)

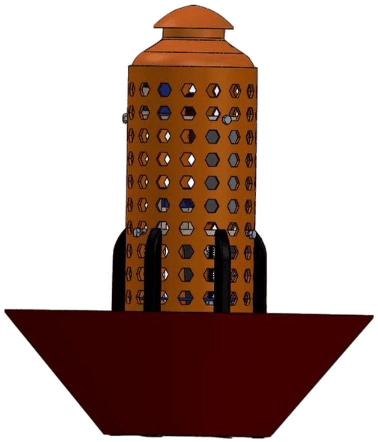
Payload Parachute Stowed Configuration Selection(3/3)

Configuration	Advantages	Disadvantages
A	● Easy to design ● Does not rely on high level circuitry. ● Can be controlled by a single digital pin	❑ Possibility that the parachute may not deploy due to airflow.
B	● Complex ● The launch forces may trigger the spring causing premature deplyoment. ● DIfficult to time exact deployment.	❑ Parachute is kept compact in shape. ❑ Uses up less space inside the probe.

Selected Configuration	Rationale
Configuration A	➔ Simple and highly reliable. ➔ Initial testing has suggested that these descent rates can be achieved with high accuracy.

Payload Parachute Descent Control Strategy Selection and Trade(7/7)

Payload Descent Control Deployment Process



Just before release

- The probe descends with the heat shield open at a rate of 20m/s.

Deployment

- At 200m, the heat shield is removed. At the same time, the servo mechanism releases the lid by rotating.
- To mitigate deployment risk, the parachute(nylon) and lid will be rubbed with a plastic before assembling CanSat. This ensures that the parachute is pulled out with lid

Post Deployment

- The probe descends to ground at the rate of 5 m/s.
- As mass of probe is contained at bottom, it is stabilised against swaying.
- Passive stabilising mechanism prevents shaking during descent.

Descent Rate Estimates(1/4)

Descent Rate for CanSat with Payload

$\frac{1}{2}mv^2 = mgh$ (Total Energy conservation)

$\therefore v = \sqrt{2gh}$

Now, h can be between 675 – 720 m

$h_{avg} = 697.5m$

$\therefore v = \sqrt{2gh_{avg}}$

$\therefore v = 116.92\ m/s$ of CanSat just after deployment.

Immediately, parachute will deploy,

$$\sqrt{\frac{8mg}{p(v_{max})^2\pi C_d}} \leq D_p \leq \sqrt{\frac{8mg}{p(v_{min})^2\pi C_d}}$$

$D_{spill} = 4\%\ of\ diameter$

$D_{side} = 2\%\ of\ diameter$

Part	Chosen Diameter(m)
First Parachute	0.193
Spill Hole	0.007
Side Hole	0.0035

Data
m = 0.62kg

Assumptions
$\rho = 1.225\ kg/m^3$
$g = 9.8\ m/s$
$\pi = 3.14$
$C_d = 1.5$

Descent Rate Estimates(2/4)

Descent Rate for Probe with Aerobraking Shield

To determine the required diameter for the heat shield, we calculate the diameter range using a maximum and minimum range of velocities.

Data
m = 0.45kg

Assumptions
$\rho = 1.225\ kg/m^3$
$g = 9.8\ m/s$
$\pi = 3.14$
$C_d = 1.5$

Part	Chosen Diameter(m)
Heat Shield	

Descent Rate for Probe with Parachute

$$\sqrt{\frac{8mg}{p(v_{max})^2\pi C_d}} \leq D_p \leq \sqrt{\frac{8mg}{p(v_{min})^2\pi C_d}}$$

Data

m =

Assumptions

$\rho = 1.225\ kg/m^3$

$g = 9.8\ m/s$

$\pi = 3.14$

$C_d = 1.5$

$$D_{spill} = 4\%\ of\ diameter$$

$$D_{side} = 2\%\ of\ diameter$$

Part	Chosen Diameter(m)
Second Parachute	0.483
Spill Hole	0.019
Side Hole	0.009

Descent Rate Estimates(4/4)

Final Result

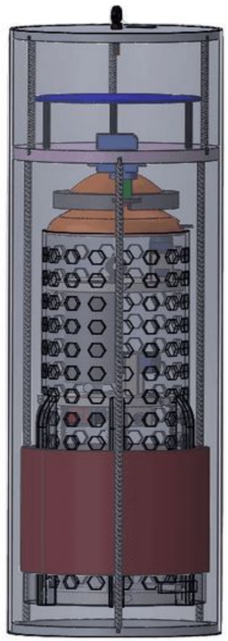
Summary	
Altitude range	**Description and Descent Rates**
From 675-720m to 500m	
500m - 200m	
200m - ground	

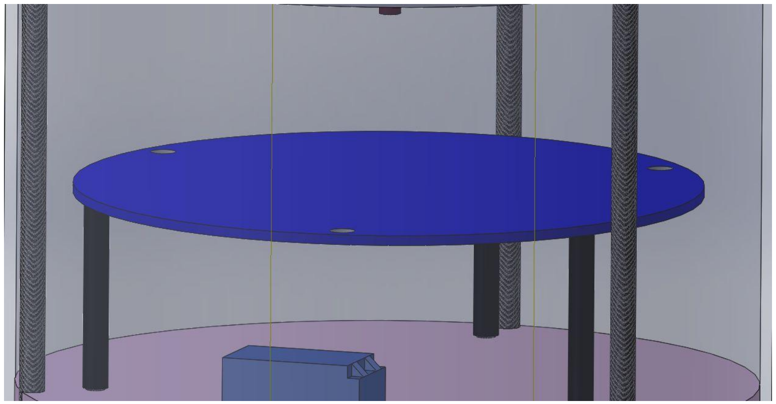
Section	Overview of entire descent journey
Container	
Probe	

Mechanical Subsystem Design

Hetal Vanel

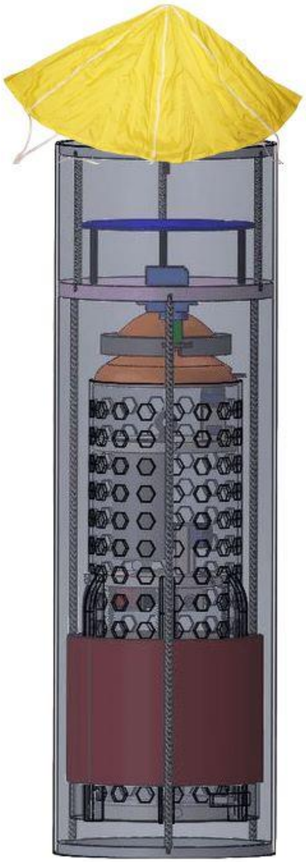
Mechanical Subsystem Overview

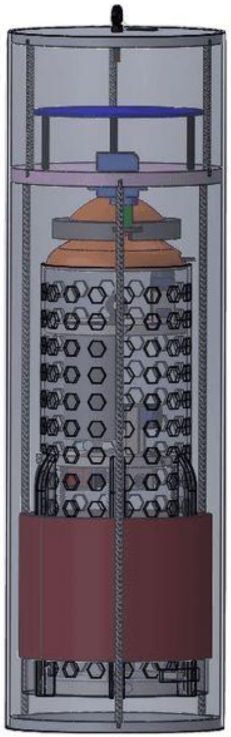


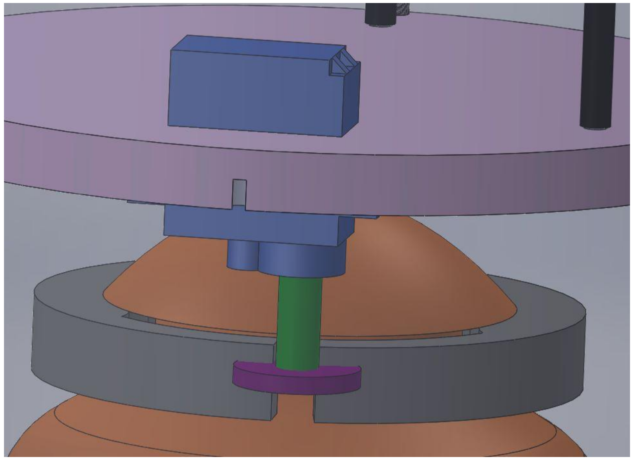


Section	Components required
Container structures(plates, rods)	PLA, Polypropylene, steel screws and nuts
Container Parachute plate	PLA and steel eyebolt
Probe structure	PLA, ABS plastic and carbon fibre
Electronics bays	Carbon fibre rods, FR-4, steel screws and nuts, epoxy glue

Container Mechanical Layout of Components Trade & Selection

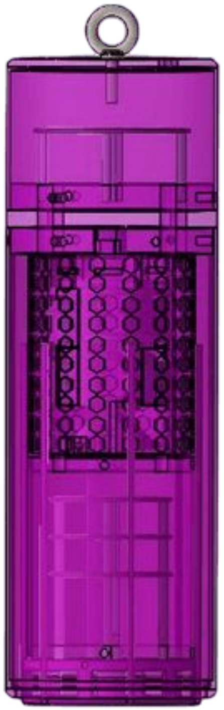






Container uses cam mechanism for probe deployment

Container Mechanical Layout of Components Trade & Selection (1/



Information
1. The container has 2 hinges and they are located at the bottom.

Container Mechanical Layout of Components Trade & Selection (1/

Selection
selected because the

Container Parachute Attachment Mechanism

(parachute bay w parachute)

(eyebolt and threads)

Upper part of container

- The parachute will be made of nylon. It will have small holes through which metal rings will be fixed.
- These metal rings will hold the connecting parachute threads.
- The threads are one feet in length.

- The nylon threads are attached to a steel eyebolt by a standard knot. The steel eyebolt is held tightly to the mounting plate by using screws inserted into plate.
- The plate is secured in place by carbon fibre rods.

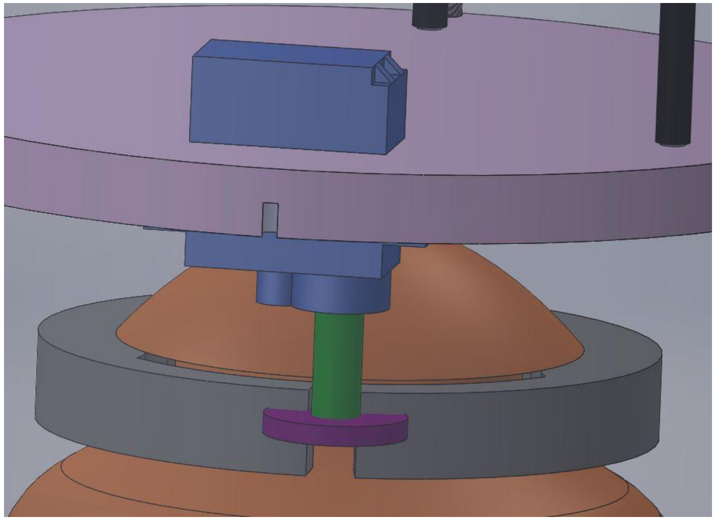
- Prior to deployment, the parachute is kept on top of the container. It rests on the top without any hindrance.
- The parachute strings are placed inside the parachute area to avoid entanglement

Payload Mechanical Layout of Components Trade & Selection

The Payload contains 3 mechanisms:

- Heat-shield deployment
- Uprighting the probe
- Flag erection

Payload Aerobraking Pre Deployment Configuration Trade & Selection



STOWED

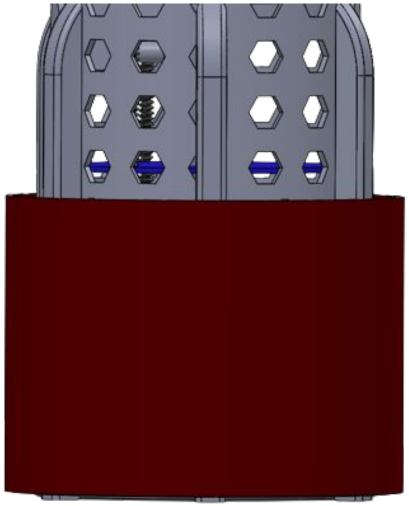
- The payload is secured into the container by means of a CAM mechanism.
- The configuration is kept locked by a circlip which is controlled by a servo motor.
- In locked configuration, the diameter of circlip is lesser than the upper ball part and hence there is no swaying of payload

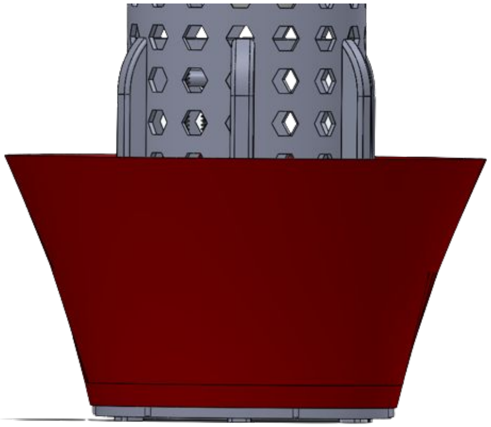
→

SECURING

- The CAM mechanism is held together by two rods coming down from the container.
- These rods connect to the ring surrounding the probe and ensure that the probe does not sway due to horizontal forces on it.

Payload Aerobraking Deployment Configuration Trade & Selection





TRANSITION

- The heat shield is held together by an elastic cord touching a metal wire.
- To deploy, the elastic cord is snapped by heating it.
- The links of the heat shield are connected to a torsional spring each. This spring force now pushes the shield outward.

DEPLOYED STATE

- The heat shield gets pushed out until the links reach their maximum length. The force exerted by the links is on the supporting ring which is made of steel for resistance.
- The heat shield stays open and provides aerobraking. To release it, a servo motor pin rotates through an angle of 14°, which leaves the ring free to slide and shield moves up.

Payload Parachute Deployment Configuration Trade & Selection

(parachute section)

(transition from stowed to deploying)

Deployed parachute

- The parachute is rolled tightly and stored in the uppermost part of the probe.
- The lid is controlled using a servo motor which moves to release the parachute.

- The lid opens and the parachute is pulled out due to airflow and the static electric charge on the parachute.
- The threads are connected to the eyebolt which is firmly secured to the plate.

- Parachute gets fully deployed and achieves a descent rate of 5m/s.
- The payload is passively stabilized due passive stability control.

Team Logo
Here
(If You Want)

Payload Uprighting Configuration Trade & Selection

INFORMATION
Spiderlegs are 3D printed using PLA material.
Used torsional spring for deployment.
Used for structural strength.

Mass Budget(1/

CONTAINER					
Structure					
Component	**Material / Part name**	**Quantity**	**Mass/unit (g)**	**Mass summary (g)**	**Source**
Container outer body	PLA	1	10.597	10.597	Calculated
Parachute Plate	PLA	1	78.54	78.54	Calculated
Container rods	Carbon fiber	3	3.77	11.31	Calculated

Summary Container Structure Mass	100.447 g

Mass Budget(2/

CONTAINER					
Mechanisms					
Component	**Material / Part name**	**Quantity**	**Mass/unit (g)**	**Mass summary (g)**	**Source**
Servo Motor	SG90 Servo	1	9	9	Datasheet
Cam Rods	PLA	2	2.493	4.986	Datasheet

Summary Container Mechanisms Mass	**13.986 g**

Mass Budget(3/

CONTAINER					
Electronics					
Component	**Material / Part name**	**Quantity**	**Mass/unit (g)**	**Mass summary (g)**	**Source**
Tilt Sensor	Adafruit LSM6DS3TR-C	1	1.7	1.7	Datasheet
Memory Card	SanDisk Ultra microSD 32GB	1	2.0	2.0	Datasheet
Buzzer	92 dB Buzzer	1	22.0	22.0	Estimate
LED	Green LED	1	0.3	0.3	Datasheet
ON/OFF Switch	Switch	1	4.2	4.2	Estimate
Bonus Camera	ESP32 CAM	1	10.0	10.0	Datasheet
Air Temperature and Pressure Sensor	MS5611	1	1.2	1.2	Datasheet
Battery	Orange ICR18650-20C	1	47.0	47.0	Estimate

Mass Budget(4/

CONTAINER					
Electronics					
Component	**Material / Part name**	**Quantity**	**Mass/unit (g)**	**Mass summary (g)**	**Source**
Custom PCBs	FR-4	1	25.62	25.62	Calculated

Summary Container Electronics Mass	114.02 g

Mass Budget(5/

PROBE					
Structure					
Component	**Material / Part name**	**Quantity**	**Mass/unit (g)**	**Mass summary (g)**	**Source**
Base Plate	PLA	1			
Central Plates	PLA	3			
Hinges for Servo	PLA	2	17.046	34.092	Calculated
Probe outer body	PLA	1	198.4	198.4	Calculated
Probe upper holder	PLA	1			
Probe rods	Carbon fiber	3	2.337	7.012	Calculated

Summary Probe Structures Mass	239.504 g

Mass Budget(6/

PROBE					
Mechanisms					
Component	**Material / Part name**	**Quantity**	**Mass/unit (g)**	**Mass summary (g)**	**Source**
Servo	SG90 Servo Motor	2	9	18	Datasheet
Spider legs	PLA	6	5.02	30.12	Calculated
Flag stick	Deployable Safety Stick	1	7.5	7.5	Datasheet
Heat Shield Cloth	Silica Fabric	1			
Heat Shield links	Metal rods	6	7	42	Estimate
Torsional Springs	Steel springs	12	3	36	Estimate

Summary Probe Mechanisms Mass	133.62 g

Mass Budget(7/

PROBE					
Electronics					
Component	**Material / Part name**	**Quantity**	**Mass/unit (g)**	**Mass summary (g)**	**Source**
Microcontroller	Teensy 4.1	1	10.0	10.0	Estimated
Air Pressure and Temperature Sensor	MS5611	1	1.2	1.2	Datasheet
Tilt Sensor	Adafruit LSM6DS3TR-C	1	1.7	1.7	Datasheet
GPS Sensor	UBLOX Neo 6M	1	12	12	Datasheet
Camera	SQ11 Mini Camera	1	18	18	Datasheet
Memory Card	Sandisk Ultra uSD 32GB	2	2	4	Datasheet
Coin Battery and holder	Duracell DL2032 3V	1	4.5 + 4.2	8.7	Estimate
92dB Buzzer	GoodLife 92Buzzer	1	5.35	5.35	Datasheet

Mass Budget(8/

PROBE					
Electronics					
Component	**Material / Part name**	**Quantity**	**Mass/unit (g)**	**Mass summary (g)**	**Source**
Battery Power Indicator	SMD 3 Colour LED module	1	1.2	1.2	Datasheet
LED	5mm LED	1	0.3	0.3	Datasheet
Radio	XBee Pro S2C	1	4	4	Datasheet
Antenna	Molex 214415-0011	1	7.7	7.7	Datasheet
SMA Cable	SMA-M to SMA-M	1	4.64	4.64	Estimate
Custom PCBs	Printed Circuit Board	2	27.32	27.32	Estimate
ON/OFF Switch	Switch	1	4.2	4.2	Estimate
Battery	Orange ICR 18650-20C	1	47	47	Datasheet

Mass Budget(9/

PROBE					
Electronics					
Component	**Material / Part name**	**Quantity**	**Mass/unit (g)**	**Mass summary (g)**	**Source**
Battery Holder	18650 SMD/SMT Holder	1	8	8	Datasheet

Summary Probe Electronics Mass	**165.310 g**

Mass Budget

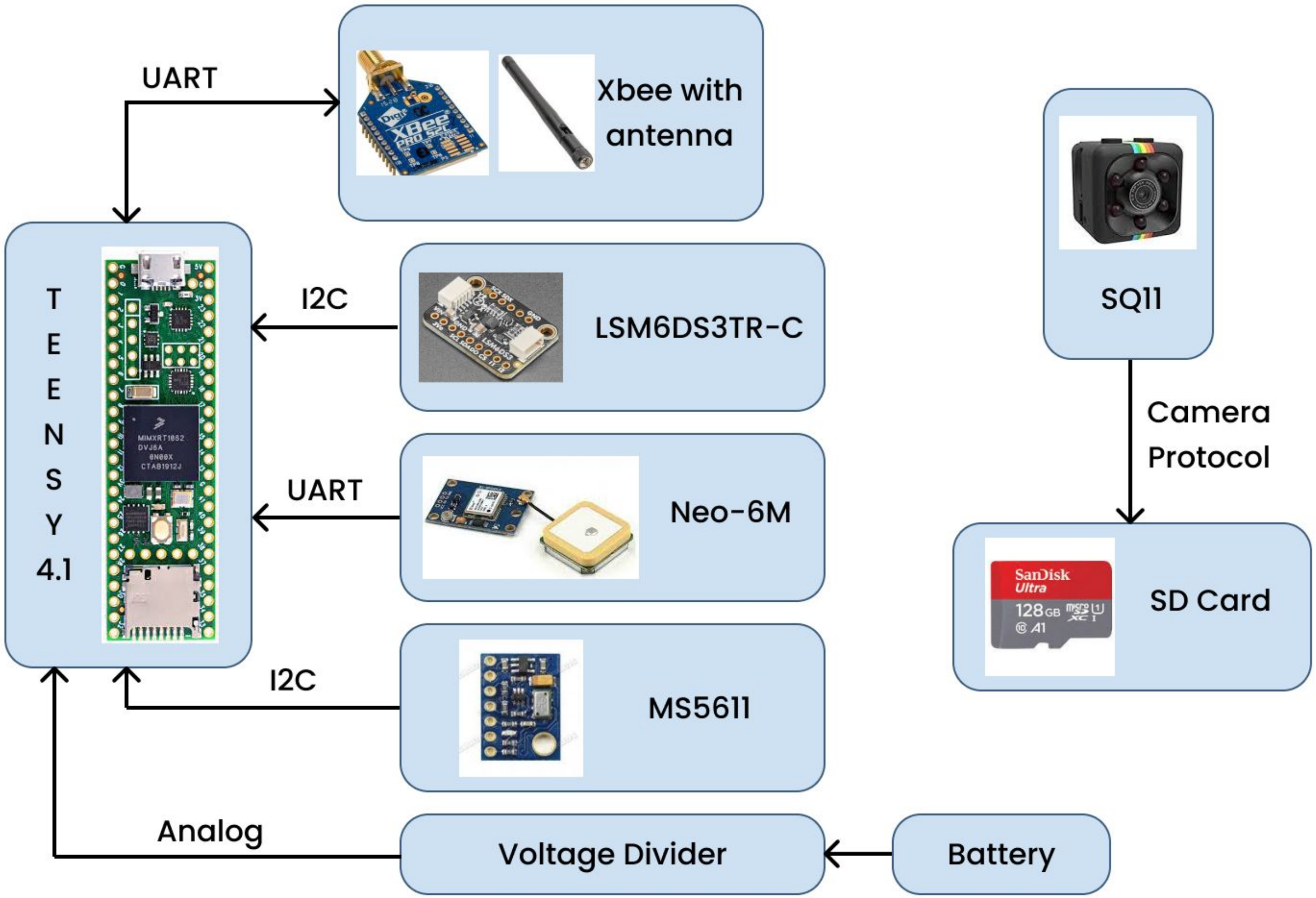
Communication and Data Handling (CDH) Subsystem Design

Ojas Taskar

Payload Command Data Handler (CDH) Overview (1/2)

Component	Selected Model	Purpose
Processor	**IMXRT1062DVJ6 on Teensy v4.1**	Collecting and processing data from the sensors, bidirectional communication with the ground station, control over CanSat mechanisms.
Storage	**Sandisk Ultra micro SD Card**	Stores backup telemetry data.
Radio Module	**XBee Pro S2C**	Transmitting to and receiving data from GCS.
Antenna Payload-GCS	**Molex 214415-0011**	Increases gain of XBee and amplifies the signal range.
Sensors	**Adafruit LSM6DS3TR-C, MS5611, Neo-6M**	Sending respective data fields.
RTC	**Built-in**	Measures mission time.
Camera	**SQ11 Mini Camera**	Records the video of descent in separate SD card.

Payload Command Data Handler (CDH) Overview (2/2)



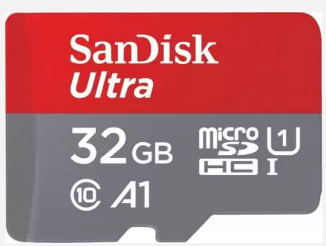
Payload Processor & Memory Trade & Selection (1/2)

Model	Size (mm)	Clock speed (MHz)	Boot time (ms)	Operating voltage (V)	Memory (kB)			Interface
					RAM	FLASH	EEPROM	
Teensy 4.1	61 x 18	600	5	3.3	1024	7936	4	UART(8), I^{2}C(3),SPI(3)
Teensy 4.0	36 x 18	600	5	3.3	1024	1984	1	UART(7), I^{2}C(3),SPI(3)
Raspberry-Pi Pico	51 x 21	133	>300	1.8 - 3.3	264	2000	0	UART(2), I^{2}C(2),SPI(2)

Selected Component	Rationale
 **Teensy 4.1**	• Very high clock speed. • Large flash memory compared to other boards. • In-built SD card slot and RTC. • More number of GPIO pins.

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

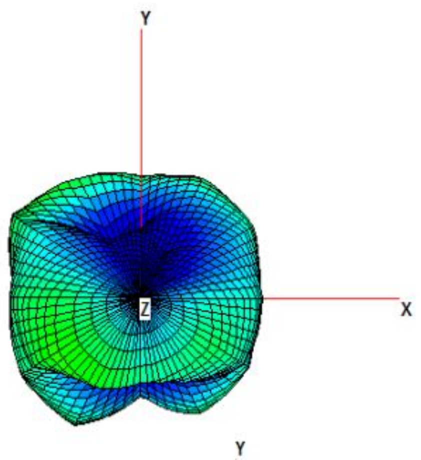
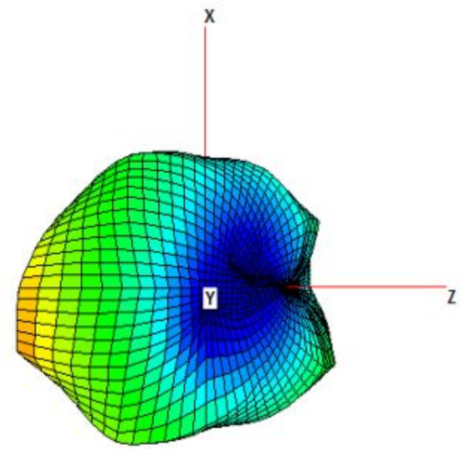
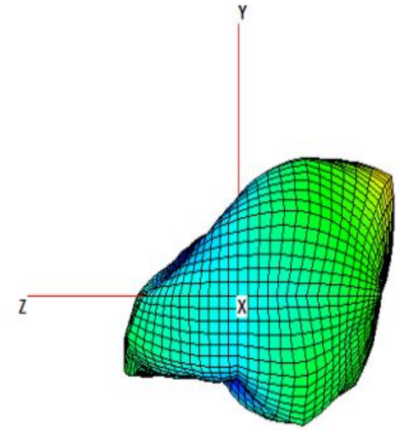
SD Card	Memory storage(GB)	Data Transfer Speed(MB/S)		Interface	Cost ($)
		Read	Write		
SanDisk Ultra	32	120	98	SPI, SD	4.38
HP microSD HC	32	80	30	SPI, SD	4.75
SAMSUNG Evo Plus	32	100	90	SPI, SD	5.63

Selected payload memory	Rationale
 **SanDisk Ultra**	• Sufficient memory storage. • Faster data transfer speed. • Moderate cost. • High availability.

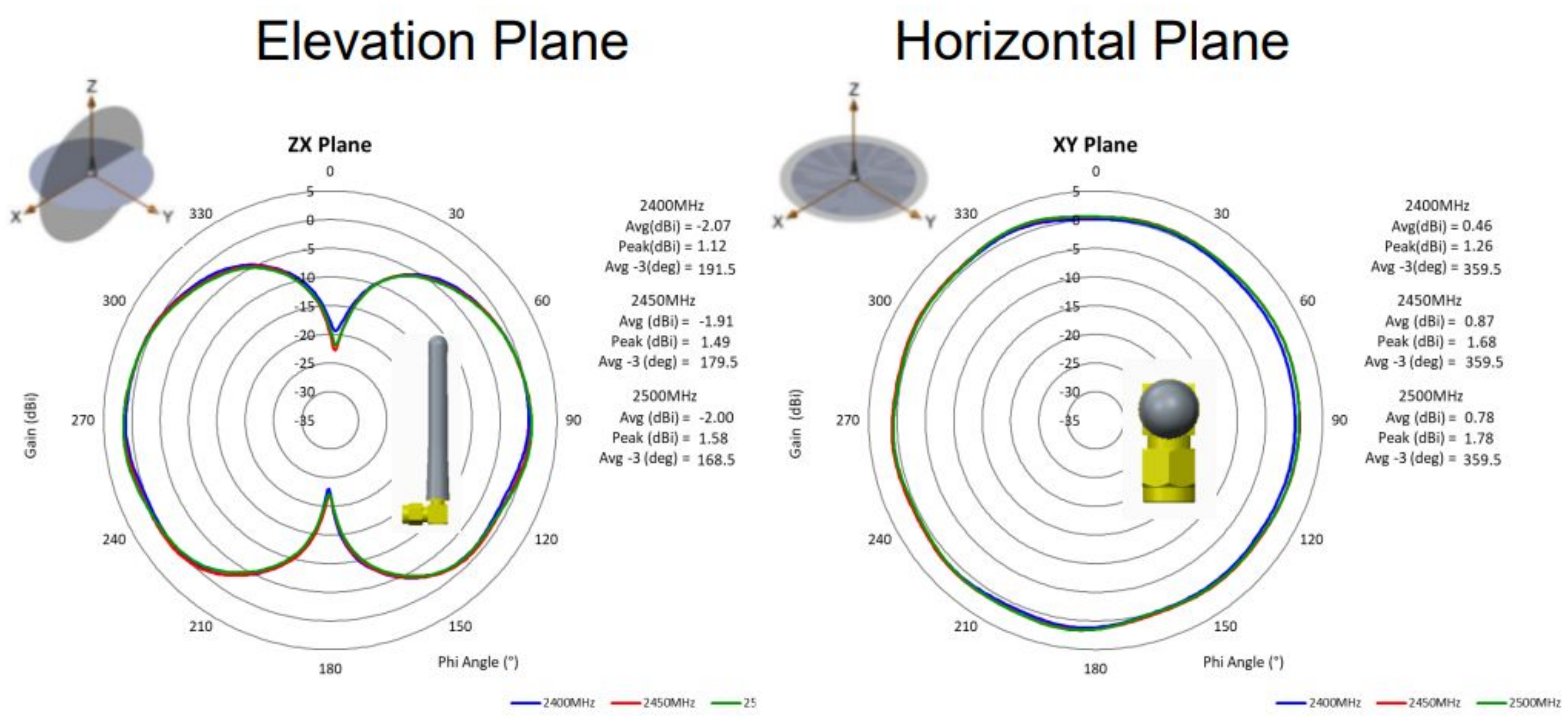
Payload Antenna Trade & Selection(1/6)

Model	Range(km)	Dimensions(cm)	Frequency(GHz)	Peak Gain(dBi)	Connection type	Weight(g)	Cost($)
Taoglas GW.20.A151	~ 12	8.95 x 0.95	2.4GHz, 5.8GHz	2	RP-SMA	7	5.46
Pulse Electronics W5029RPG	~ 8.3	7.6 x 0.79	2.4GHz, 5.15-7.125GHz	0.4	RP-SMA	7.82	5.52
Molex 214415-0011	~ 11	10.8 x 0.935	2.4GHz	5.3	RP-SMA	7.715	4.63

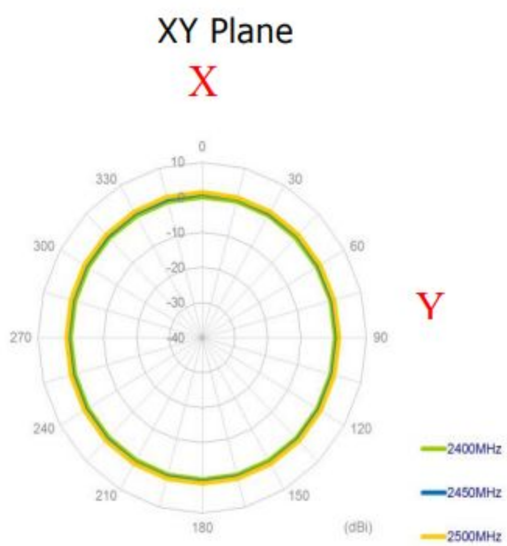
Radiation Patterns:

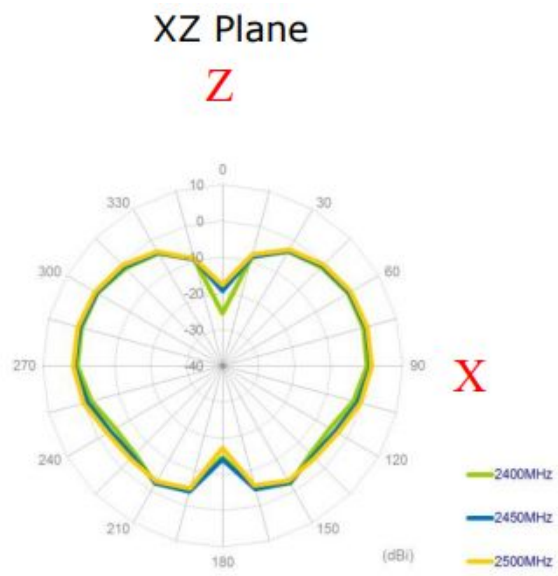
Radiation Pattern of Molex 214415-001115		
XY Plane	**XZ Plane**	**YZ Plane**
		

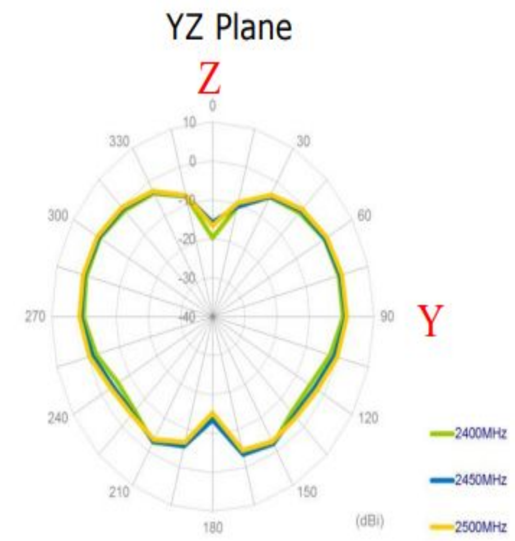
Pulse Electronics W5029RPG



Taoglas GW.20.A151



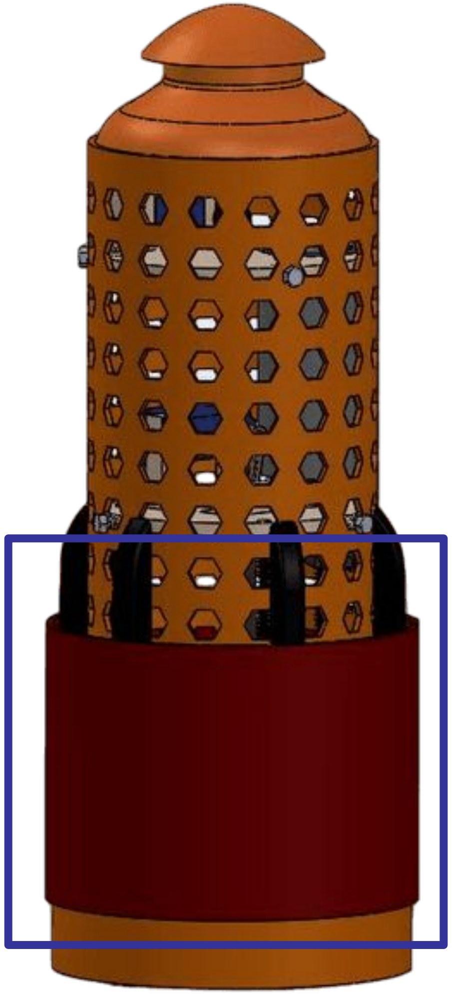


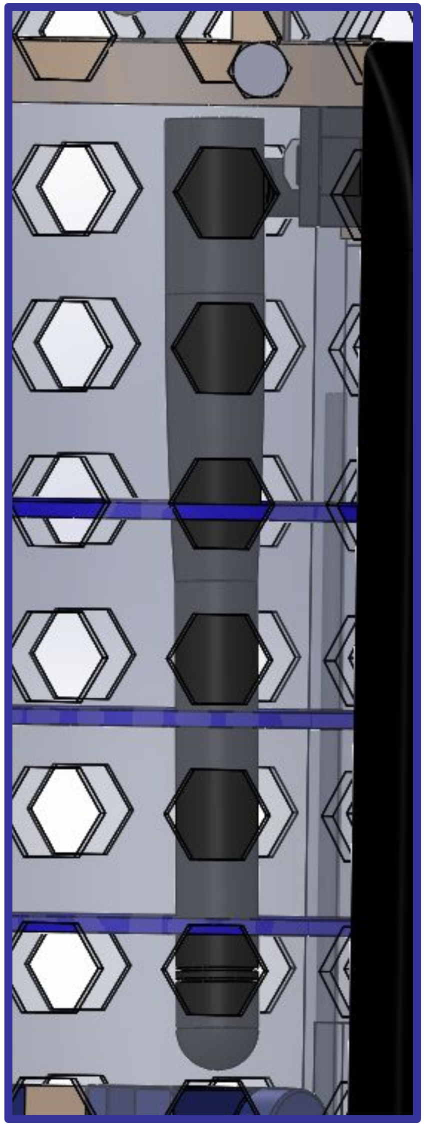


Payload Antenna Trade & Selection(5/6)

Selected Antenna	Reason
 **Molex 214415-0011**	● High gain at comparatively lesser price and medium weight. ● Single band-tuned antenna, less likely to face interference from other bands. ● Relatively uniform radiation pattern in all three planes. ● High efficiency over all frequency bands.

Payload Antenna Trade & Selection(6/6)





Payload Radio Configuration(1/5)

Payload to GCS XBee Selection

Model	Zigbee XBee Pro S2C 802.15.4	XBee S2C 2.4GHz	Digi XBee 3 Pro 2.4GHz
Frequency	2.4GHz	2.4GHz	2.4GHz
Range(km)	3.2km	1.2km	3.2km
Sensitivity(dBm)	-101	-100	-103
Supply voltage and currents	2.1-3.6V & 120mA(TX), 31mA(RX)	2.1-3.6V & 33mA(TX), 28mA(RX)	2.1-3.6V & 135mA(TX), 17mA(RX)
Connection type	RP-SMA	U.FL	RP-SMA
Dimensions	2.438 x 3.294 cm	2.438 x 2.761 cm	2.438 x 3.294 cm
Cost ($)	**28.90**	**22.90**	**42.87**

Payload Radio Configuration(2/5)

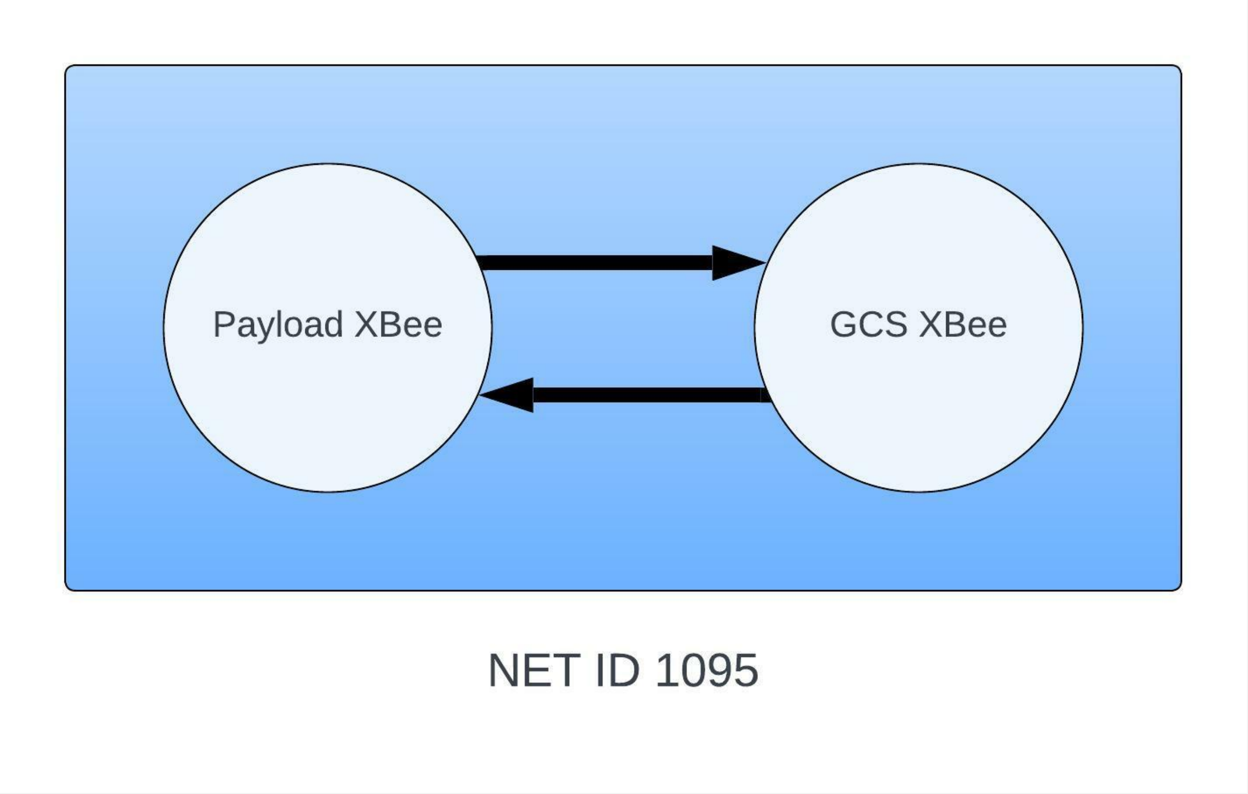
Selected Component	Rationale
 **Zigbee XBee Pro S2C 802.15.4**	● Best range and sensitivity for price. ● Omnidirectional antenna can be easily used with RP-SMA connector. ● Good transmit power to ensure safe communication.

We have already started prototyping and testing the above XBee radios in various configurations.

Payload Radio Configuration(3/5)

Description of transmission control

XBEE Radio Connection Architecture

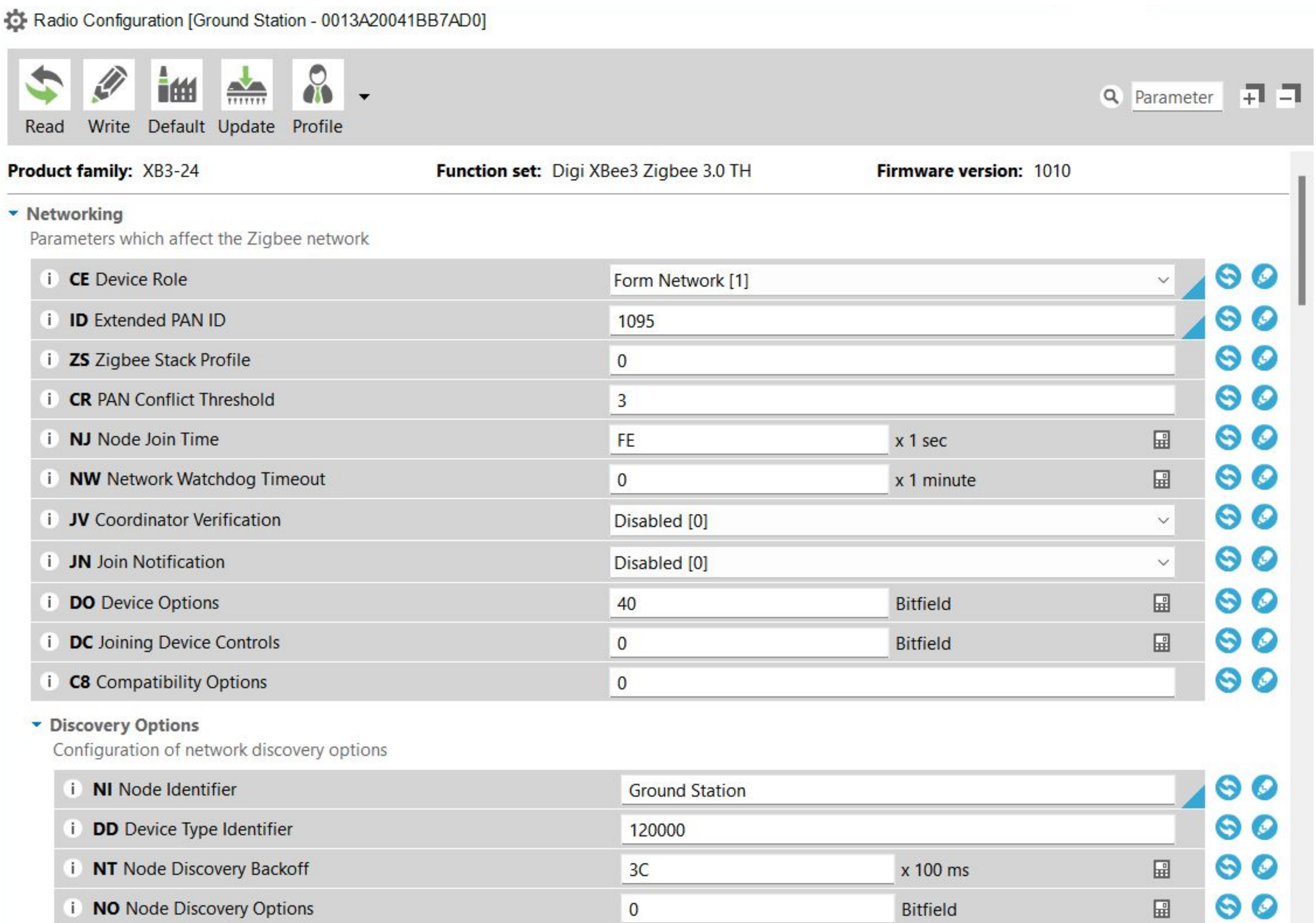


Payload Radio Configuration(4/5)

Communication Description	There are two XBee radios on the communications link. One XBee is present on the payload, the other on the ground control station. XBee radios operate in **AT(transparent)** mode on **Zigbee** protocol. The GCS XBee is configured as a **Coordinator** and the payload XBee as a **Router.** Data transmission between payload microcontroller and onboard XBee is done using **UART**.
Transmission Control	When the payload receives the **CMD,1095,CX,ON** command from ground station, it starts sending telemetry data. The payload collects the data and formats it into a packet. It sends the packet to the GCS. This process will be conducted once per sec, i.e 1 Hz. For avoidance of collision, a special character, '$' is added to the end of each packet. Once the payload flag is raised,, it will stop sending the telemetry.

Payload Radio Configuration(5/5)

NET ID - For XCTU Configuration



Payload Telemetry Format(1/4)

Data Field	Description	Resolution	Example
TEAM_ID	The assigned team ID.	N/A	1095
MISSION_TIME	UTC time in format hh:mm:ss.ss, where hh is hours, mm is minutes, and ss.ss is seconds (including 1/100th of a second).	hh:mm:ss:ss	03:12:57:35
PACKET_COUNT	The total count of transmitted packets, which is to be maintained through processor reset.	N/A	53
MODE	The ASCII character ‘F’ for flight (the default mode upon system start) and ‘S’ for Simulation mode.	‘F’ or ‘S’	F
STATE	This is the operating state of the software. Operating states are team defined.	Human readable description	DESCENT

Payload Telemetry Format(2/4)

Data Field	Description	Resolution	Example
ALTITUDE	The altitude in units of meters, relative to ground level.	0.1 m	283.5
HS_DEPLOYED	Indicates whether the probe with heat shield has been deployed, or not.	‘P’ or ‘N’	P
PC_DEPLOYED	Indicates whether the probe parachute is deployed, or not.	‘C’ or ‘N’	C
MAST_RAISED	Indicates whether the flag has been raised or not.	‘M’ or ‘N’	M
TEMPERATURE	The temperature in degrees Celsius.	0.1 ℃	29.1
VOLTAGE	The voltage of the CanSat power bus.	0.01 V	3.05
PRESSURE	Air pressure reading from the pressure sensor	0.1kPa	91.3
GPS_TIME	The time generated by the GPS receiver in UTC.	1 sec	07:33:09

Payload Telemetry Format(3/4)

Data Field	Description	Resolution	Example
GPS_ALTITUDE	The altitude generated by the GPS receiver in meters above mean sea level.	0.1 m	107.8
GPS_LATITUDE	The latitude generated by the GPS receiver in decimal degrees.	0.0001 North	19.0759
GPS_LONGITUDE	The longitude generated by the GPS receiver in decimal degrees.	0.0001 West	72.8776
GPS_SATS	The number of GPS satellites being tracked by the GPS receiver.	Integer	5
TILT_X, TILT_Y	The angles of the CanSat X and Y axes in degrees.	0.01 °	5.02, 78.09
CMD_ECHO	The fixed text command name and value field of the last received command with no commas.	N/A	CXON
[,,OPTIONAL_DATA]	If required, additional necessary data fields added by the team.	-	-

Payload Telemetry Format(4/4)

Packet Data Format	• The data field are separated by a comma and a space after the comma, i.e, “, “. • The entire packet format is given as: TEAM_ID, MISSION_TIME, PACKET_COUNT, MODE, STATE, ALTITUDE, HS_DEPLOYED, PC_DEPLOYED, MAST_RAISED, TEMPERATURE, VOLTAGE, PRESSURE, GPS_TIME, GPS_ALTITUDE, GPS_LATITUDE, GPS_LONGITUDE, GPS_SATS, TILT_X, TILT_Y, CMD_ECHO [,,OPTIONAL_DATA]
Example Packet	1095, 03:12:57:35, 53, F, ASCENT, 283.5, P, C, M, 29.1, 91.3, 3.05, 07:33:09, 107.8, 19.0759, 72.8776, 5, 5.02, 78.09, CXON$
Description	• The payload takes the values from the peripheral devices and formats them into the required packet format in the microcontroller. • The character ‘$’ is added at the end of frame for collision detection and resolving frames. • The formatted frame(packet) is sent to the GCS.

Payload Command Formats(1/2)

Command	Description	Example	Use
CX	Turning the payload telemetry ON/OFF.	CMD,1095,CX,OFF$	Can be used to turn on telemetry at the start of the mission.
ST	Sets mission time in UTC format to GPS time or any given time.	CMD,1095,ST,05:30:12$	Used to set mission time before take-off.
SIM	Activate the simulation mode.	CMD,1095,SIM,ENABLE$	Used to activate simulation command. It has 3 values: 'ENABLE', 'ACTIVATE' and 'DEACTIVATE'.
SIMP	In simulation mode, sends simulated pressure data.	CMD,1095,SIMP,101010$	Provides a simulated pressure reading to the container.
CAL	Calibrate altitude to zero.	CMD,1095,CAL$	Sets altitude to zero. Can be used as a processor reset command.

Payload Command Formats(2/2)

Field	Description
<TEAM_ID>	The assigned team identification number.
<ON_OFF>	ON turns on the payload telemetry, OFF turns it off.
<UTC_TIME>	UTC time in hh:mm::ss. It can be taken from GCS UTC time or GPS module
<MODE>	'ENABLE' and 'ACTIVATE' when sent one after the other, activate the simulation mode for the CanSat. 'DEACTIVATE' instructs the CanSat to exit simulation mode.
<PRESSURE>	The simulated atmospheric pressure data in units of pascals with a resolution of one Pascal.

- The commands are sent from the ground station to the CanSat.
- The character '$' is used for separation in case two commands collide.

The above format matches the Competition Guide requirements

Electrical Power Subsystem (EPS) Design

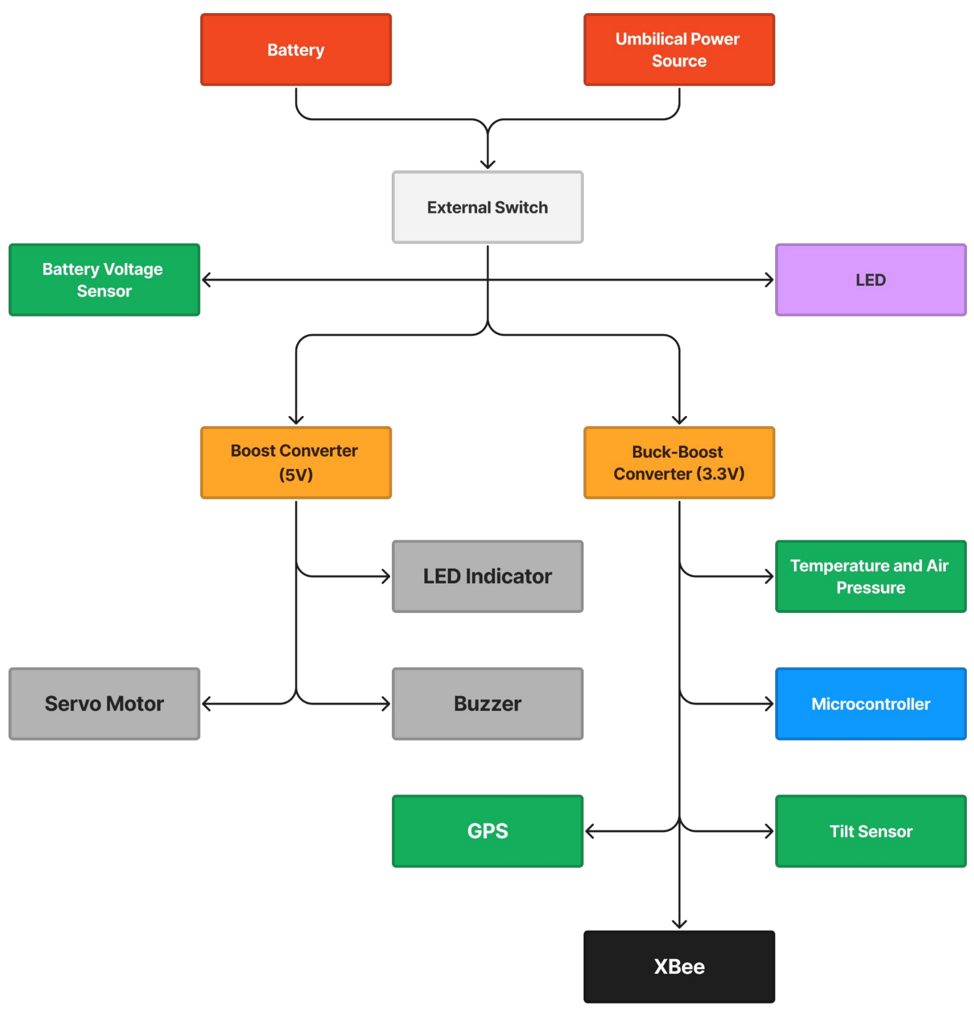
Kimaya Mutha

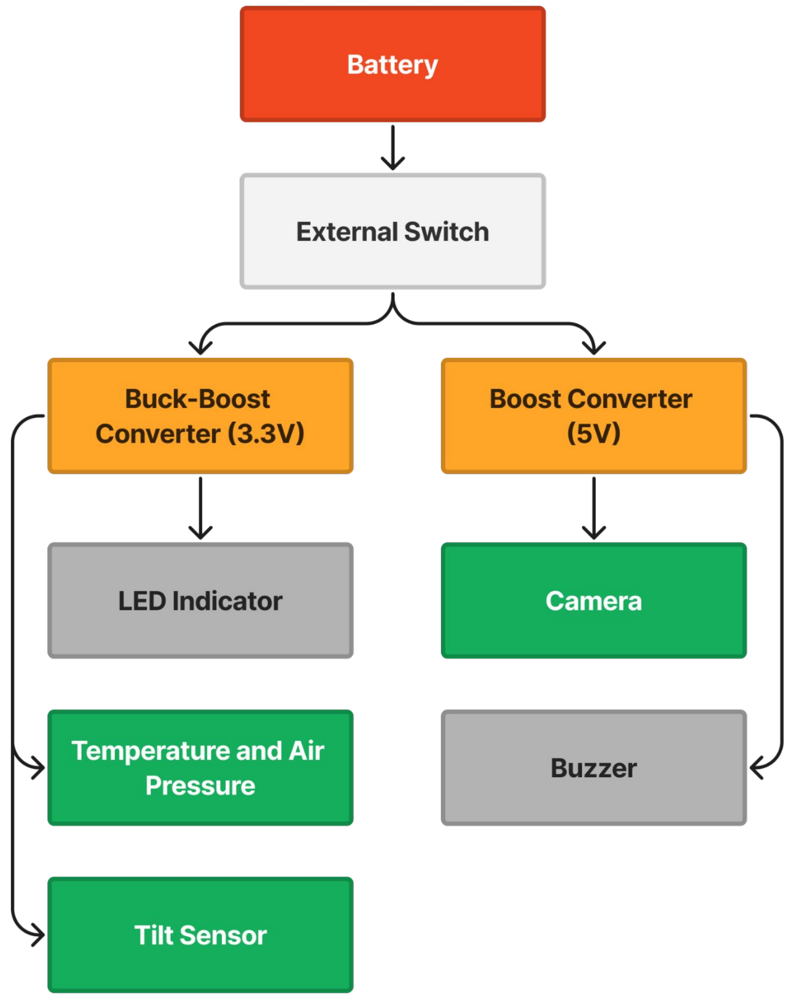
EPS Overview(1/2)

Component	Description
Orange ICR18650-20C	Main Power Source.
Voltage divider	To monitor battery voltage (Also the feed to the RGB indicator)
5V Boost Converter	Power supply for components which require 5V as input power.
3.3V Buck - Boost Converter	Power supply for components which require 3.3V as input power.
External switch	The switch which turns off the main power bus.
LED Indicator (SOC)	Power and battery SOC indicator.

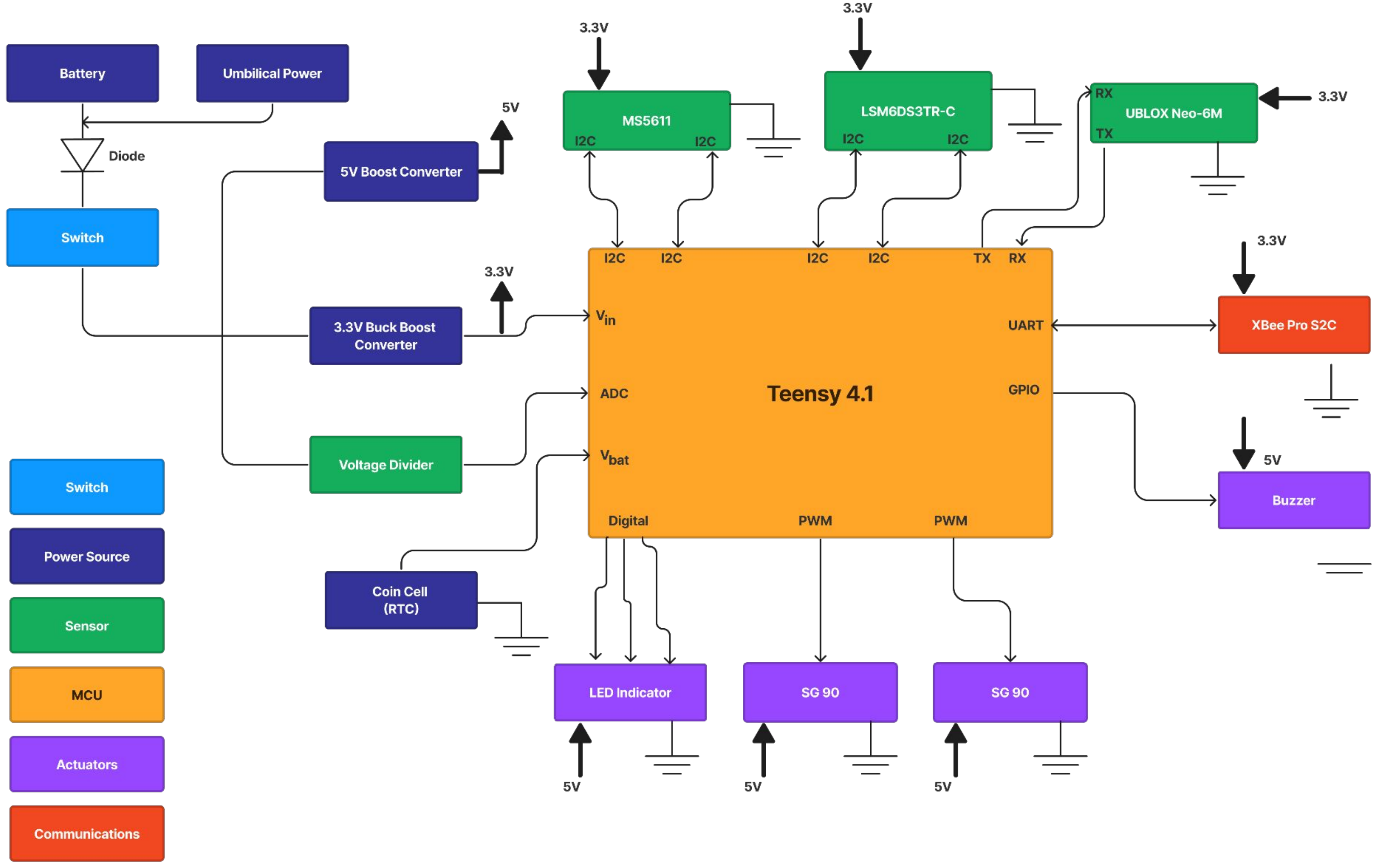
EPS Overview(2/2)

Probe Diagram	Container Diagram

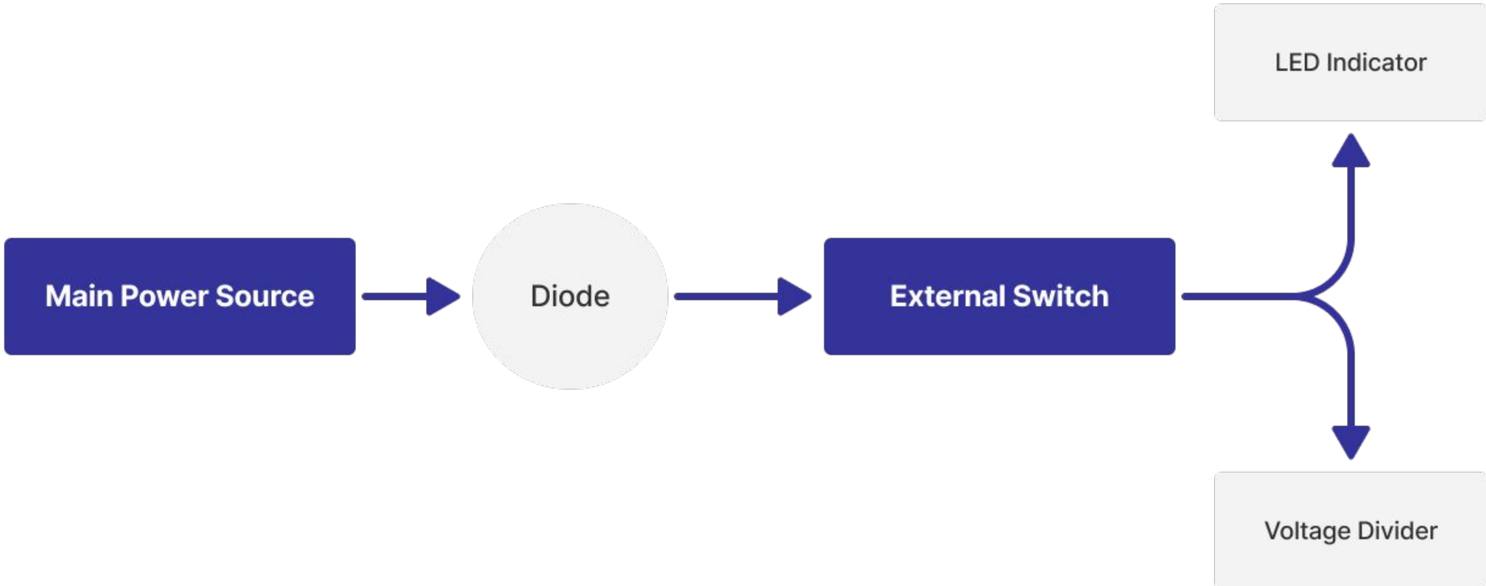




Payload Electrical Block Diagram(1/2)



Payload Electrical Block Diagram(2/2)



Features	Power Verification
• External switch is connected between the main power source and the rest of the circuitry. • The remaining circuitry is powered only if the switch is turned on.	• The LED indicator will glow only if the external switch is turned on. • In this way, presence of power can be verified by sight.

Payload Power Trade & Selection

Battery Model	Dimensions (mm)	Mass (g)	Voltage (V)	Charge(mAh)	Max current capacity(A)	Type	Cost($)
Panasonic NCR18650B	65 x ϕ18	45	3.7	3400	8	Li-ion	9.93
Orange ICR18650-20C	65 x ϕ18.2	50	3.7	2000	4	Li-ion	2.5

Selected Component

Rationale

- Satisfies requirement of providing power for at least two hours.
- Lesser max current capacity prevents chance of over-current damage.
- Sufficient energy available at less cost and mass.
- Higher number of charge cycle lifetimes and higher charge rate.

The battery is mounted in the holder shown, which is secured into a slot made on a PCB.

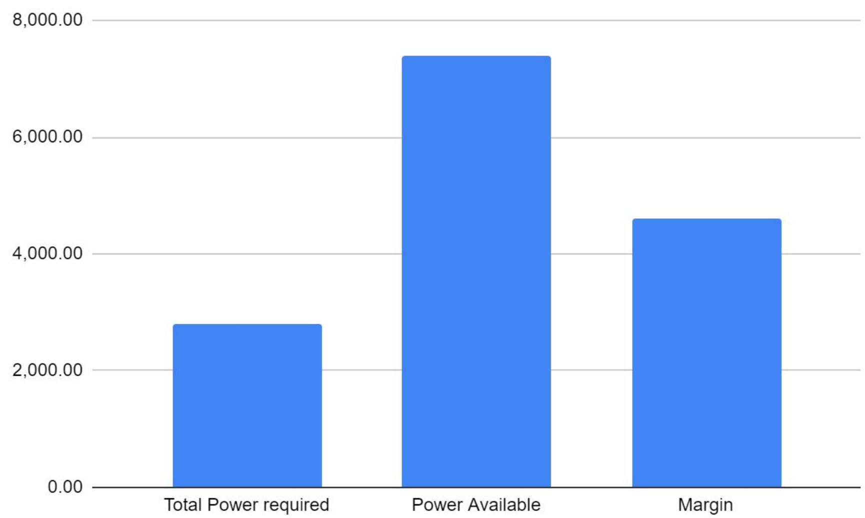
Payload Power Budget(1/2)

Component	Model	Voltage(V)	Current(mA)	Power(mW)	Duty Cycle(s)	Duty Cycle in %	Required Energy(mWh)	Source
Air Temperature and Pressure Sensor	MS5611	3.3	0.015	0.0495	7200	100	0.099	Datasheet
Tilt Sensor	Adafruit LSM6DS3TR-C	3.3	100	330	7200	100	660	Datasheet
GPS Module	UBLOX NEO- 6M	3.3	45	148.5	7200	100	297	Datasheet
Microcontroller + Memory	Teensy 4.1	3.3	100	330	7200	100	660	Datasheet
Radio	XBee Pro S2C	3.3	120	396	7200	100	792	Datasheet
Buzzer	92dB Buzzer	5	20	100	1200	16.67	33.34	Datasheet
Servo Motors	SG90	5	40	200	20	0.28	1.12	Datasheet
Camera	SQ11	5	310	1550	120	1.67	51.77	Datasheet
LED indicator	SMD RGB LED	5	30	150	7200	100.00	300.00	Datasheet
Total						**2795.329 mWh**		

Payload Power Budget(2/2)

Total Power required	**2795.329 mWh**
Total Power Available in Battery	**7400 mWh**
Margin	**7400 - 2795.329 = 4604 mWh**
Percent Margin	**(4604/7400)*100 = 62.21%**

Using the given battery, the CanSat can operate for approximately **5.29 hours** when integrated into the launch vehicle.



Flight Software (FSW) Design

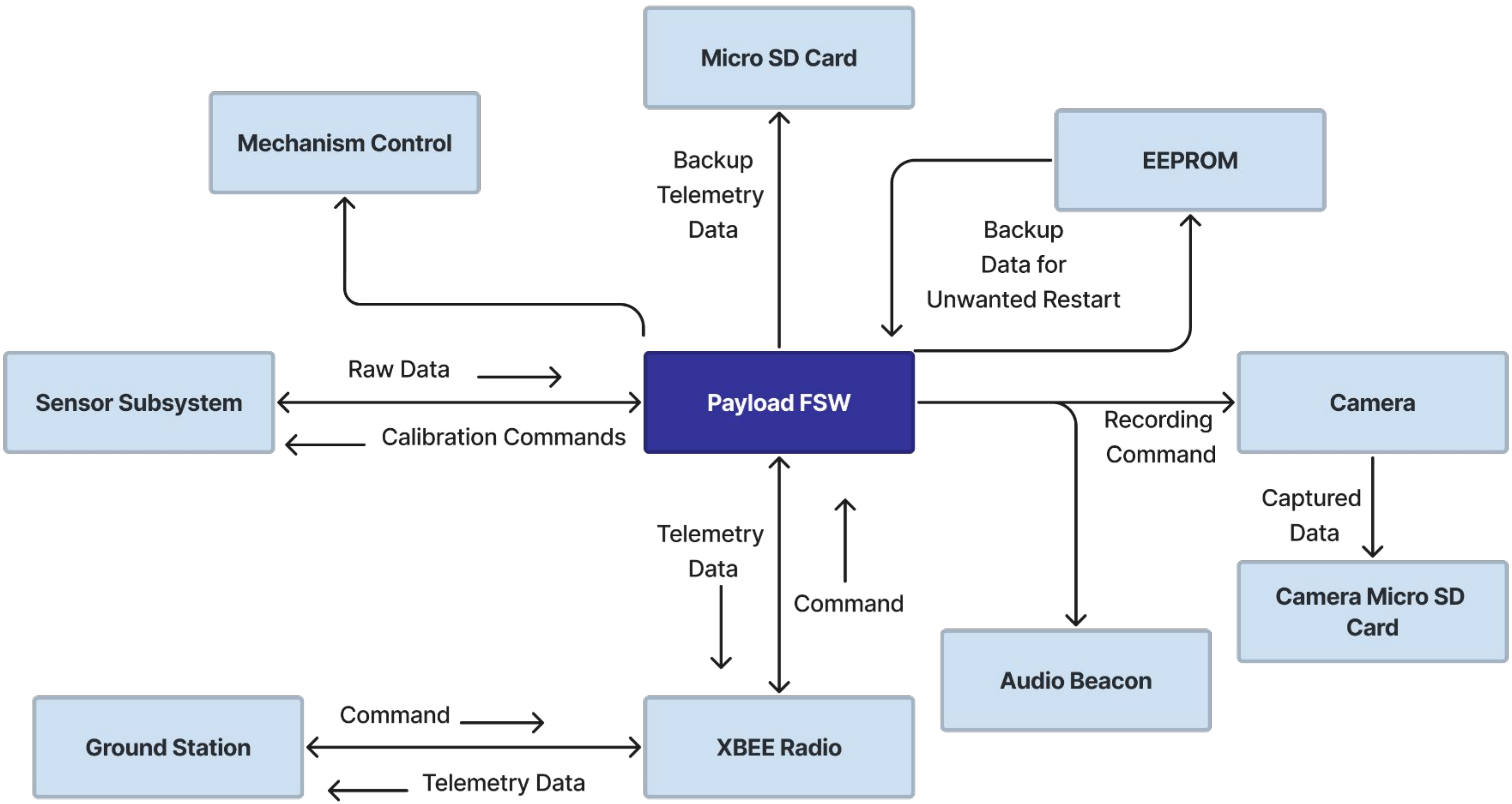
Shubham Salunkhe

FSW Overview(1/4)

Brief Summary of FSW Tasks
• **Probe FSW** will evaluate through different states based on data collected by the sensors. • These states are responsible for tasks such as data processing, telemetry packet creation and sending it to GCS via XBEE, performing the operations as per commands received from GCS, and deployment & uprighting mechanisms. • It is also responsible for recording the probe's descent using the camera at the bottom of the probe. • **Container FSW** is responsible for carrying out the bonus mission objective to record the probe's deployment.

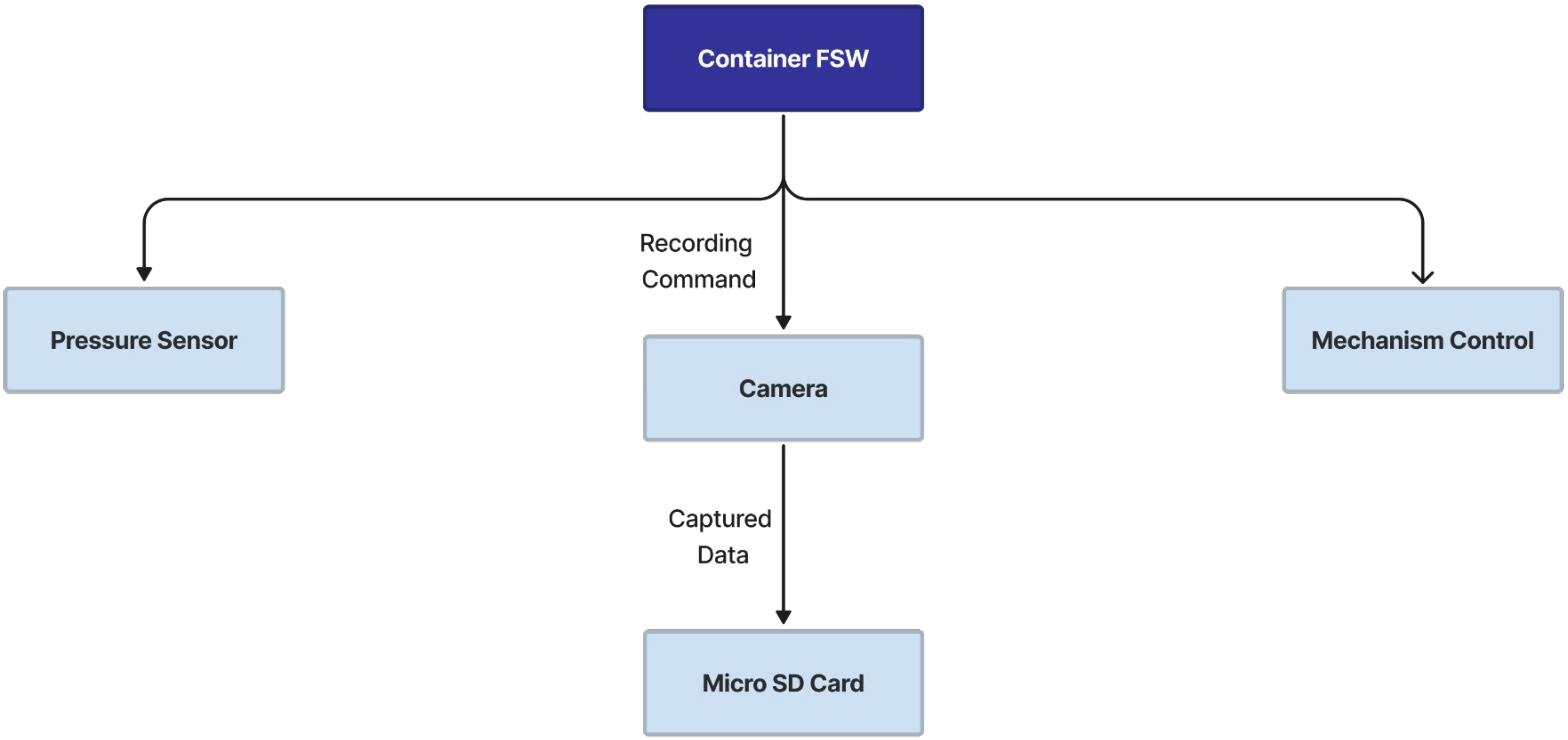
Development Environments	Programming Languages
• Arduino IDE • Visual Studio Code	• C/C++

Probe FSW Architecture



FSW Overview(3/4)

Container FSW Architecture



FSW Overview(4/4)

Summary of FSW Tasks

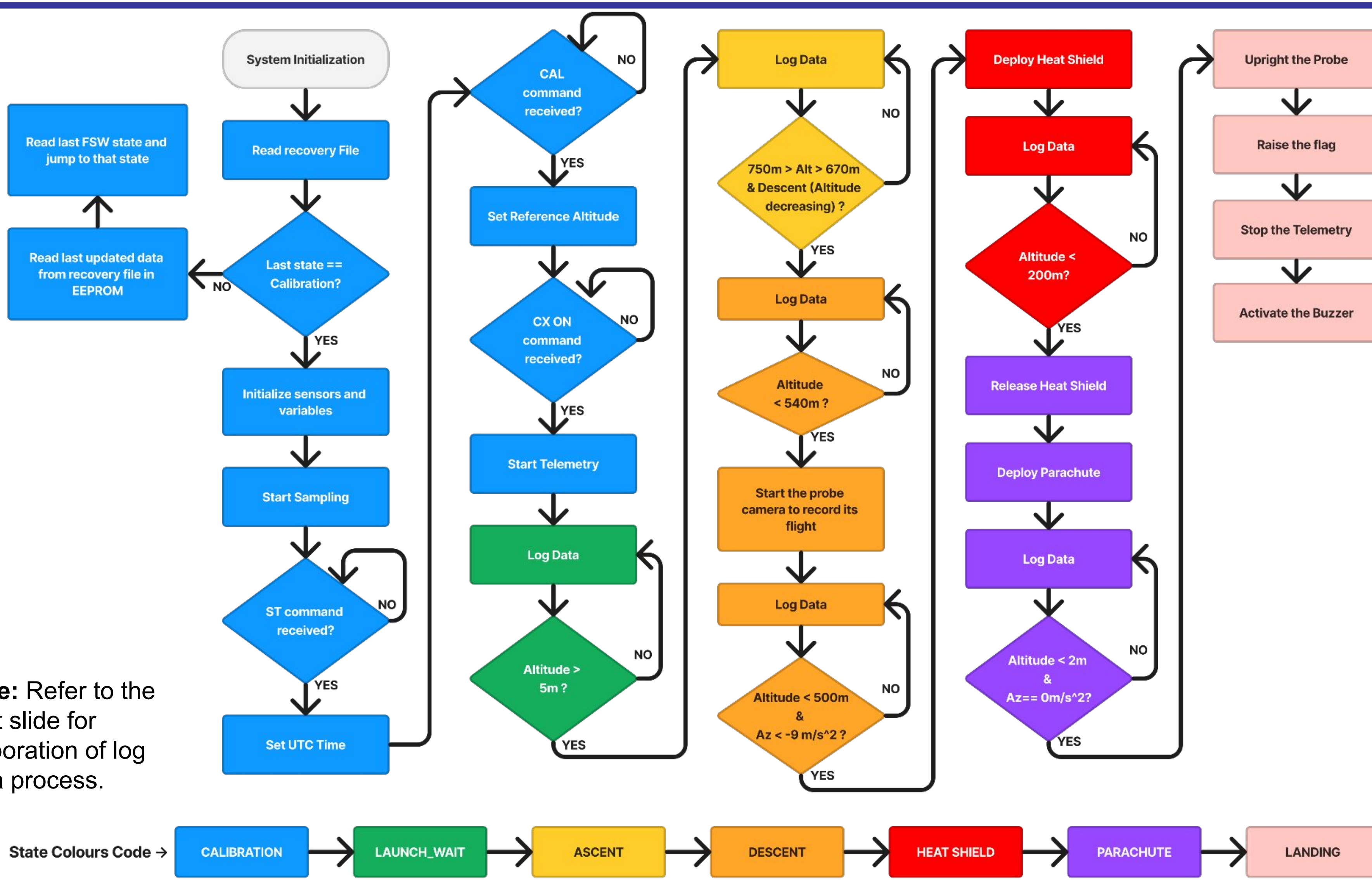
Container FSW

- Electronics system will be activated via a switch which will be indicated by blinking of LED.
- Initialize and calibrate pressure sensor.
- Start the camera to record the deployment of the probe.
- Release the probe at 500m altitude.
- Activate the audio beacon on landing.

Probe FSW

- Electronics system will be activated via a switch which will be indicated by blinking of LED.
- Initialize sensors and calibrate system when ST command to Set Time and CAL command to calibrate altitude is received.
- Activate telemetry when CXON command is received.
- Create the telemetry packet according to the given format.
- Save sensor data to SD card and send it to GCS via XBee.
- Keep on updating recovery data in EEPROM.
- Start the probe camera to record it's descent.
- Deploy the heat shield as soon as the probe is released.
- Release the probe parachute at 200m altitude.
- Upon landing, upright the probe, raise the flag, and activate the audio beacon.

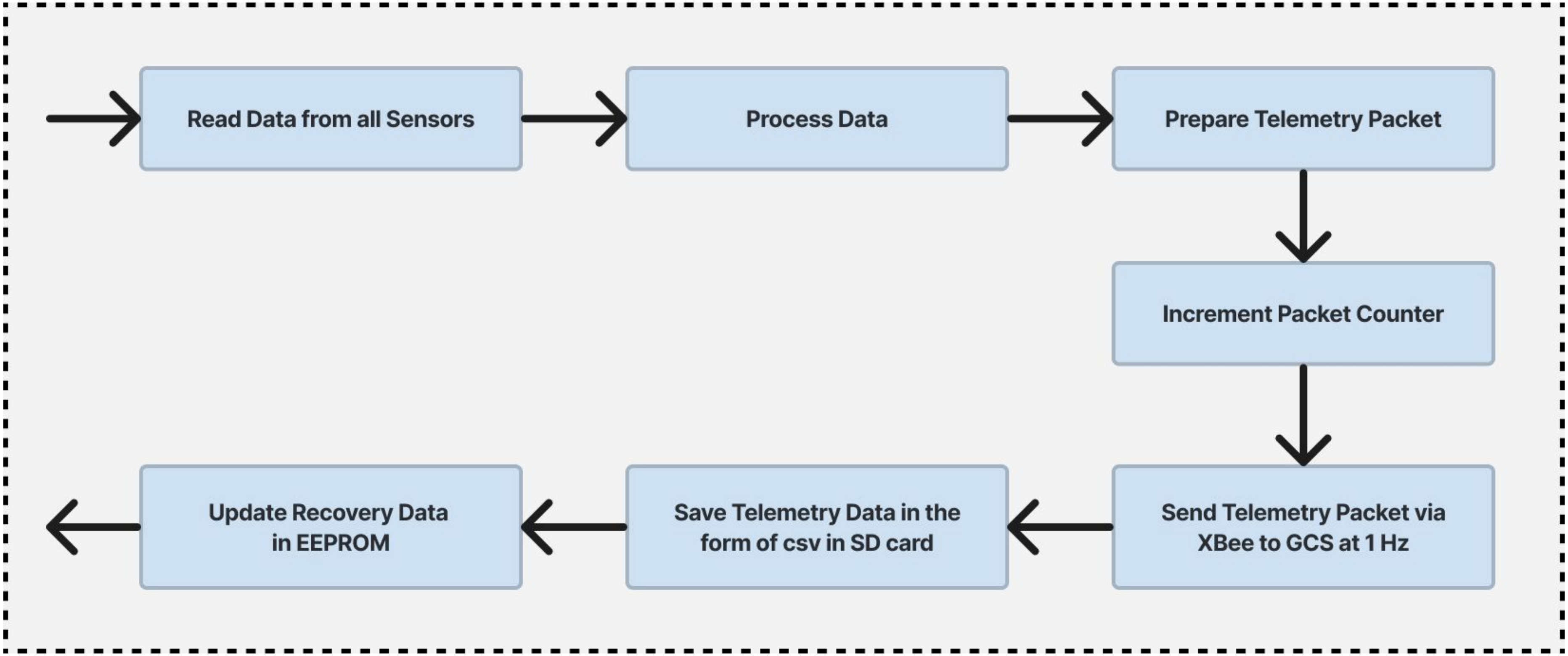
Payload FSW State Diagram(1/4)



Note: Refer to the next slide for elaboration of log data process.

Payload FSW State Diagram(2/4)

LOG DATA PROCESS



Payload FSW State Diagram(3/4)

Mechanism Activations
At 540m i.e. just before the probe is launched, the Probe FSW will command the camera module to start recording. Below 500m and upon detecting free fall through the accelerometer, the Probe FSW will deploy the heat shield. At 200m, the heat shield is released and the parachute is deployed. Once the probe is landed which is detected by low altitude and 0 acceleration, the spider-legs mechanism is activated to make it upright and then the flag is raised.

Sampling of sensors	Communications
The sensors are sampled at 1Hz.	Telemetry packet is sent from probe XBee to GCS once per second. The correct packet format is created by probe FSW.

Data storage	Major Decision Points
EEPROM is used to store recovery data, needed in case of unwanted resets. Telemetry Data is backed up onto the SD card. Video Recording is stored into the SD card which is only connected to the camera.	Most of the decisions are based on conditions of Altitude and that to open the heat shield is based on altitude and acceleration to indicate free fall once probe is deployed.

Payload FSW State Diagram(4/4)

Tackling Unwanted Processor Resets Problem

What data is used to recover?	Reasons for Resets?
1. FSW State No. (integer) 2. Packet Count (integer) 3. Reference Altitude (to calibrate pressure sensor) (float) 4. Simulation Active (boolean) 5. Container Camera started (boolean) 6. Probe Camera started (boolean) 7. Heat Shield deployed (boolean) 8. Parachute deployed (boolean)	1. G-Force impact 2. PCB being exposed to high temperatures. 3. Runtime error 4. Temporary power failure 5. Voltage drop

Methods of Recovery
Once the microcontroller restarts, it will read the recovery file in the EEPROM. It will read the last active FSW State and jump to that state and continue thereafter with the context of other crucial data like reference altitude, packet count, etc.

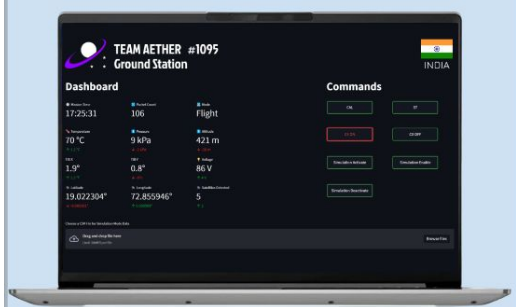
Simulation Mode Software

CMD, 1095, SIM, ENABLE

Wait for ACTIVATE command; sim_flag = 0

CMD, 1095, SIM, ACTIVATE

set sim_flag=1;
stop reading pressure data from sensor and wait for pressure values from GCS



Ground Station

CSV

CMD, 1095, SIM, <PRESSURE>

Use the pressure values received from GCS to calculate altitude

Data with substituted altitude calculated from given pressure

Read data from all other sensors; create telemetry packet with substituted pressure and altitude

Infinite loop until commanded to stop

CMD, 1095, SIM, DISABLE

reset sim_flag=0;
stop listening to pressure data from GCS and start reading pressure data from sensor

Software Development Plan(1/3)

Late Software Development Problem

To reduce this risk and avoid prolonged delays, we started our software development earlier. The testing and development of code for sensors began as soon as they had arrived. Proper development plan was constructed with strict deadlines in order to monitor the progress continuously. Also, GitHub is being made use of for code storage, management and review.

Prototyping and Prototyping Environments

Subject	Environment	Procedure
ESP-32 (Container) and Teensy 4.1 (Probe)	Arduino IDE	The process of programming and identifying issues are carried out using the Arduino IDE and data will be observed through the serial monitor.
Sensors	Breadboard & PCB	Sensors are verified one by one using a breadboard and microcontrollers.

Software Subsystem Development Sequence

Subsystem	Development Sequence
Sensors	1. Selecting sensors and choosing appropriate libraries. 2. Sensor-wise programming : write code for each sensor to process the raw data into required format.
State Switching Mechanism	1. Integrate all sensors. 2. Check whether states are switched automatically under proper conditions.
Xbee Telemetry	1. Write code to gather various sensor data and other fields required in the telemetry packet. 2. Testing GCS and Probe Connection: Test whether probe is able to send the required telemetry packet to GCS at 1Hz via XBEE.
Probe Uprighting Mechanism	1. Develop the code to recognise that the probe has landed and when landing is recognised, signal the MOSFET to pass the current in the metallic wire and heat it, which in turn will snap the elastic material and release the spider legs. 2. Test whether MOSFET is able to heat the metallic wire enough when necessary conditions are met.
Deployment Mechanisms	1. Write the code for releasing mechanisms 2. Test the code using microcontroller and actuator.
Integration	1. A significant amount of time will be dedicated for integration of separate software and hardware components. 2. It will be carried out in a *test-fail-repeat* manner to make debugging more efficient. 3. Afterwards, the system will be tested as a whole. (This is mentioned in the Testing part.)

Software Development Plan(3/3)

Test Methodology

1. All sensors and electrical components are first tested individually before integrating them into a prototype.
2. Telemetry software is assessed by simulating it using the XCTU tool.
3. Test the state switching mechanism for the probe.
4. Test the recovery software for the probe.
5. Test the probe deployment mechanism to be used in container.
6. Test GCS software by sending simulated telemetry packets from processor which is integrated with required sensors and XBee.
7. Test Flight Mode and Simulation Mode implementations with GCS.
8. Check whether FSW complies with requirements stated in the mission guide.

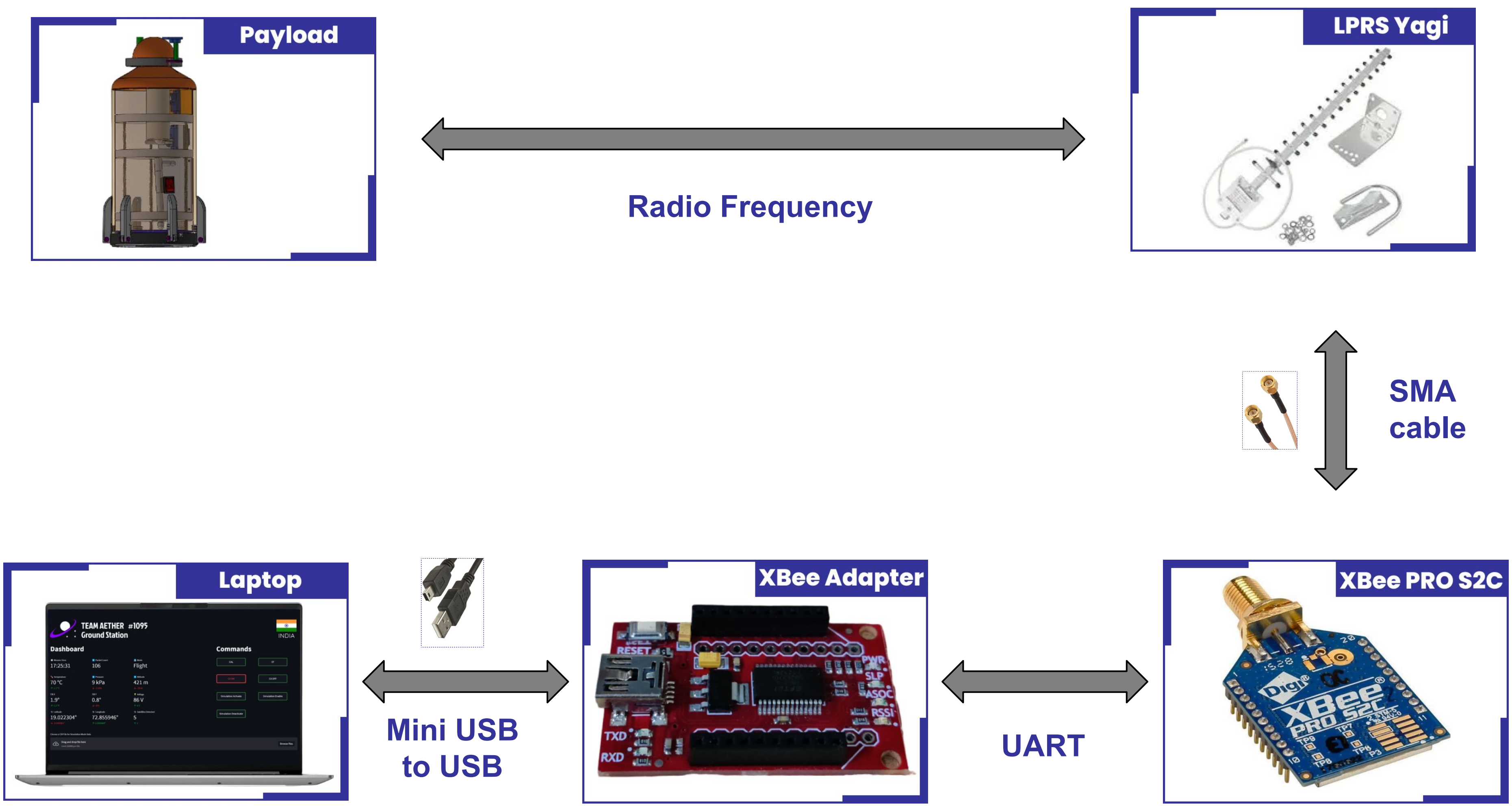
Development Team

Shaunak Natu, Shubham Salunkhe, Yash Kuwalekar	Responsible for developing and testing CanSAT software
Yash Kuwalekar	Responsible for developing and testing GCS software

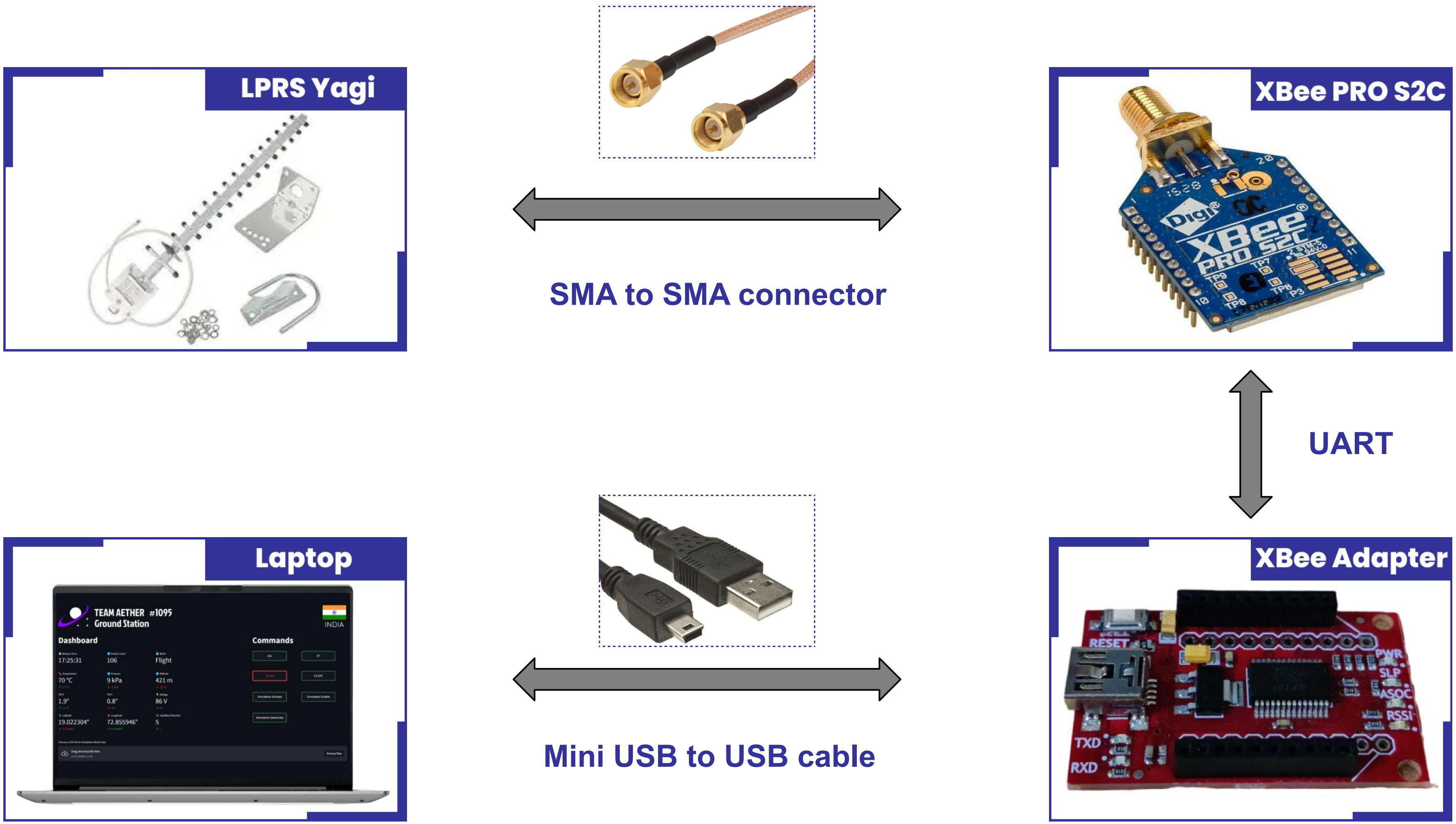
Ground Control System (GCS) Design

Yash Kuwalekar, Ojas Taskar

GCS Overview



GCS Design(1/2)



GCS Design(2/2)

Specifications	
Laptop battery	GCS will be run on a laptop with more than 2 hours of battery life.
Over-heating	The team will use an umbrella to shield the computer from the sun, and a small fan to provide cooling.
Auto-update feature	All other programs will be switched off. Automatic update feature will be turned off. Internet connectivity is turned off.

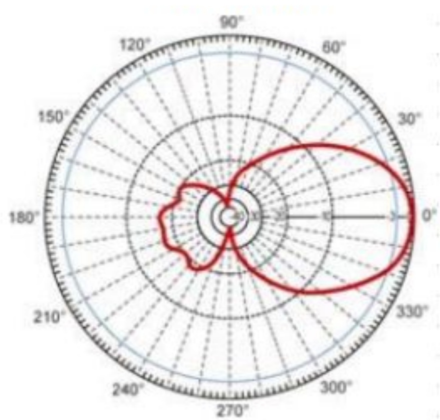
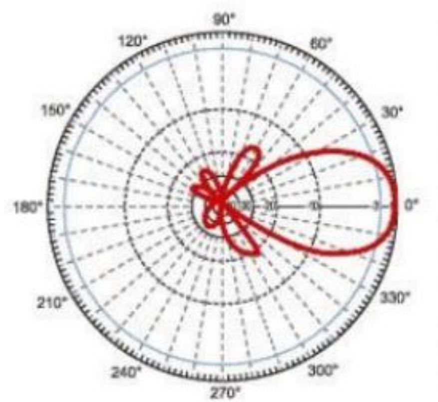
GCS Antenna Trade & Selection(1/5)

Selection Criteria	LPRS 16-2.4G YAGI	NPC Parabolic Grid Antenna 2.4GHz
Frequency (MHz)	2400 MHz	2348 MHz
Gain (dBi)	14	24
Weight (g)	320	2990
Antenna Type	Directional	Directional
Radiation Pattern	(next slide)	(next slide)
Dimensions (mm)	590 x 85 x 45	933 x 396 x 600
Cost	38.21	97.39

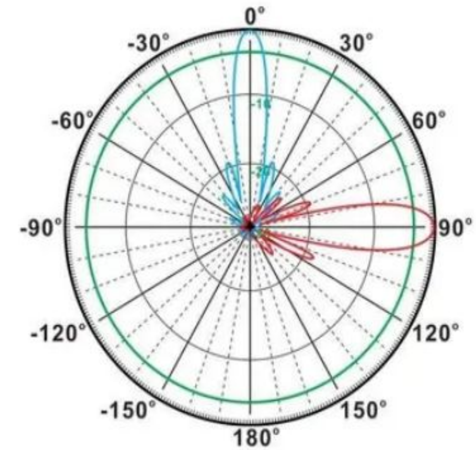
GCS Antenna Trade & Selection(2/5)

Radiation Patterns

LPRS 16-2.4G YAGI

Horizontal	Vertical
	

NPC Parabolic Grid Antenna



Vertical

GCS Antenna Trade & Selection(3/5)

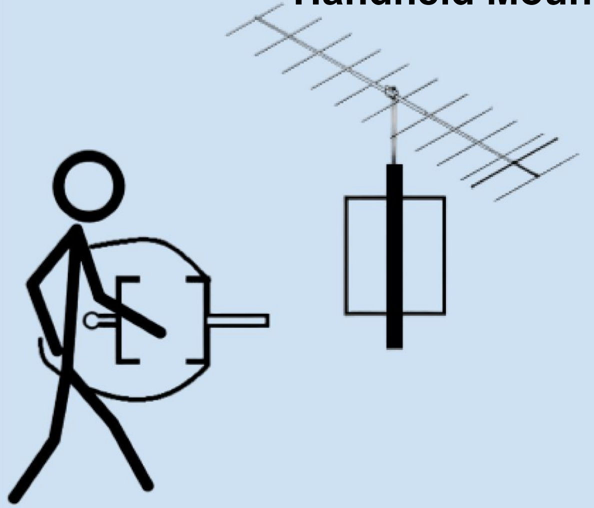
Selection Criteria		Options for Selection			
		LPRS 16-2.4G YAGI		NPC Parabolic Grid Antenna	
Criteria	**Value**	**Score**	**Criteria score**	**Score**	**Criteria score**
Frequency (MHz)	2	5	10	4	8
Gain (dBi)	5	4	20	5	25
Weight (g)	4	5	20	2	8
Antenna Type	2	4	8	4	8
Radiation Pattern	4	4	16	3	12
Dimensions (mm)	4	5	20	2	8
Cost	3	5	15	2	6
Total		**109**		**75**	

GCS Antenna Trade & Selection(4/5)

Selected antenna	Rationale
YAGI-14-2.4	• Relatively high gain for lesser mass and cost. • Wider horizontal and vertical beamwidth allows greater range and lesser scope for error. • The dimensions of antenna are feasible for transporting from India to the U.S.A.

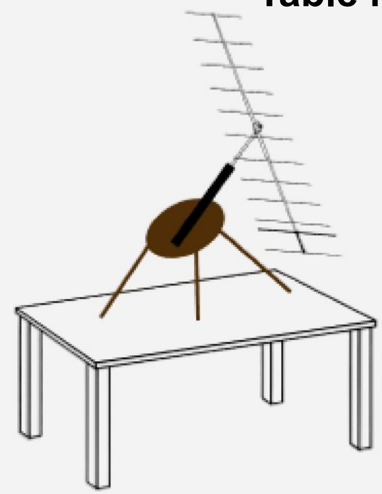
GCS Antenna Trade & Selection(5/5)

Handheld Mount



- A 3D printed bracket will be designed to hold the Yagi Antenna.
- The bracket shall include a handle and wearable band which can be put around the shoulders of the operator.
- It shall also include a view finder of a circular shape in which the CanSAT can be aimed at to maintain connection with the Ground Station.
- This configuration enables greater success of communication and maximal use of Ground Station crew.

Table Mount



- It is kept on a table.
- The laptop is placed beside the setup on the same table.
- The antenna is rigidly mounted.
- It will be aimed in the general direction of the flight fields.

Selection: Handheld Mount

- Provides greater success rate.
- Easier for error debugging

GCS Software(1/6)

Telemetry Display Prototypes

- Telemetry data from the probe will be received and processed by the Ground Station Computer and will be saved in the form of a .csv file.
- This data will be plotted in real-time using graphs and a map. Updating raw telemetry csv data will also be displayed using table. Dashboard is also used to provide a live overview of the data.

Commercial Off The Shelf (COTS) Software Packages Used

- Visual Studio Code
- Anaconda Navigator
- XCTU
- Arduino IDE

Real-time Plotting Software Design

- **streamlit** framework library in Python is used for Ground Station design along with **plotly** library for real-time plotting and maps.

Command Software And Interface

- There will be buttons in the Ground Station GUI which will be used as command executioners.

GCS Software(2/6)

Telemetry Data Recording And Media Presentation To Judges For Inspection

Received Telemetry data in a .csv file and screenshots of the GCS dashboard, graphical visualizations and map will be submitted to the judging table in the thumb drive provided.

Description of .csv Telemetry File Creation For Judges

All the telemetry data received at the Ground Station will be saved in .csv (Comma Separated Value) file format which contains each telemetry field separated with a comma and ending every line with a carriage return character.

Simulation Mode Description

GCS will send two commands, SIMULATION ENABLE and SIMULATION ACTIVATE to the probe, and then GCS will read the row of the .csv file which contains the barometric pressure values and it will be transmitted to flight software at a frequency of 1Hz by Simulated Pressure Data (SIMP) Command.

GCS Software(3/6)

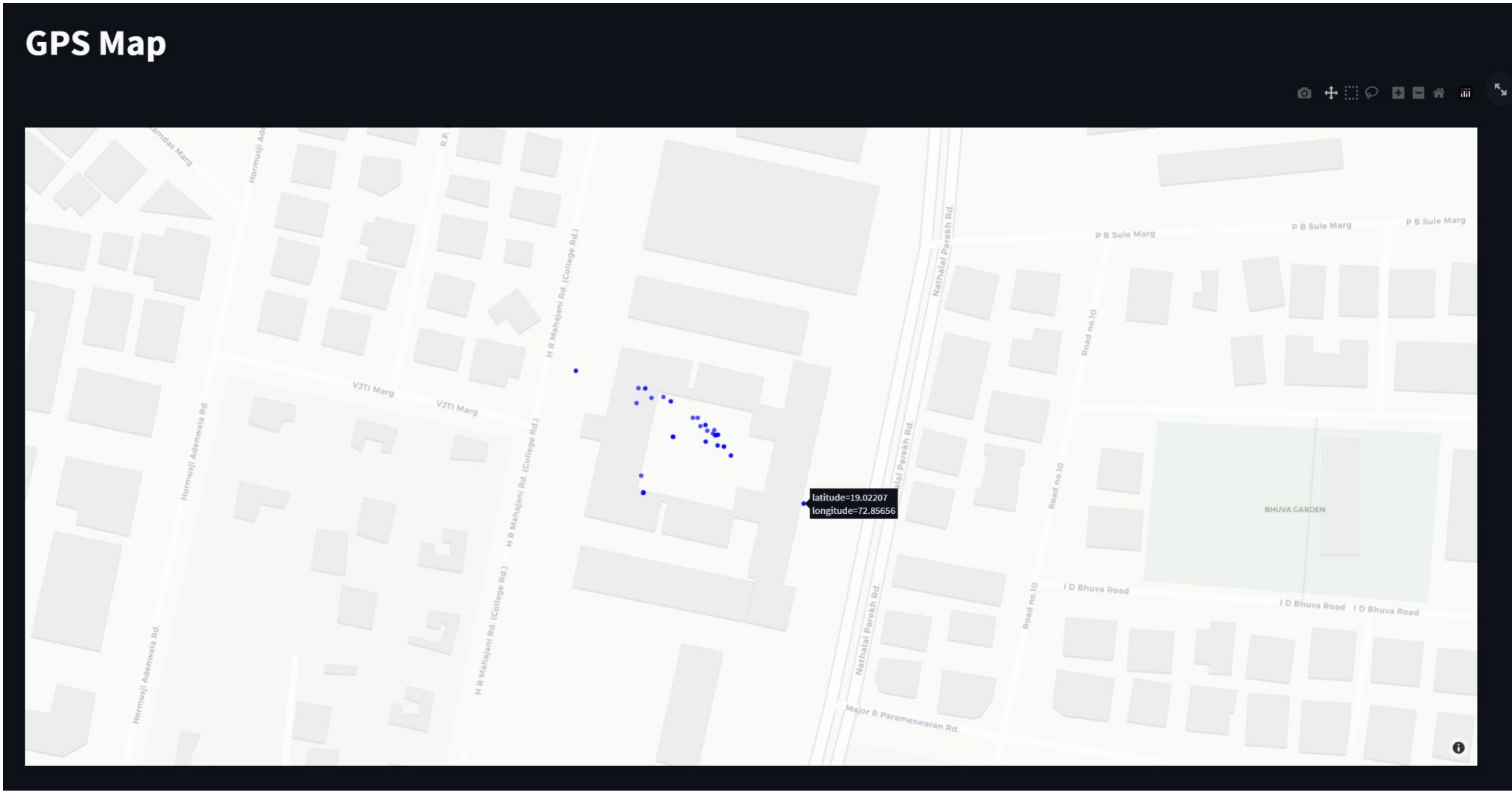
GCS Software(4/6)

GCS Software(5/6)

Telemetry Data CSV

	TEAM_ID	MISSION_TIME	PACKET_COUNT	MODE	STATE	ALTITUDE	HS_DEPLOYED	PC_DEPLOYED	MAST_RAISED	TEMPERATURE	VOLTAGE	PRESSURE	GPS_TIME	GPS_ALTITUDE	GPS_LATITUDE	GPS_LONGITUDE	GPS_SATS	TILT_X	TILT_Y	C
0	1,095.0000	03:12:57	53.0000	F	ASCENT	202.0000	P	C	N	29.1000	91.3000	3.0500	07:33:09	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
1	1,095.0000	03:12:58	54.0000	F	ASCENT	205.0000	P	C	N	29.1000	91.3000	3.0500	07:33:10	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
2	1,095.0000	03:12:59	55.0000	F	ASCENT	206.0000	P	C	N	29.1000	91.3000	3.0500	07:33:11	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
3	1,095.0000	03:13:01	57.0000	F	ASCENT	209.0000	P	C	N	29.1000	91.3000	3.0500	07:33:12	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
4	1,095.0000	03:13:02	58.0000	F	ASCENT	211.0000	P	C	N	29.1000	91.3000	3.0500	07:33:13	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
5	1,095.0000	03:13:03	59.0000	F	ASCENT	212.0000	P	C	N	29.1000	91.3000	3.0500	07:33:14	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
6	1,095.0000	03:13:04	60.0000	F	ASCENT	213.0000	P	C	N	29.1000	91.3000	3.0500	07:33:15	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
7	1,095.0000	03:13:05	61.0000	F	ASCENT	215.0000	P	C	N	29.1000	91.3000	3.0500	07:33:16	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
8	1,095.0000	03:13:06	62.0000	F	ASCENT	216.0000	P	C	N	29.1000	91.3000	3.0500	07:33:17	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
9	1,095.0000	03:13:07	63.0000	F	ASCENT	217.0000	P	C	N	29.1000	91.3000	3.0500	07:33:18	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
10	1,095.0000	03:13:08	64.0000	F	ASCENT	219.0000	P	C	N	29.1000	91.3000	3.0500	07:33:19	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
11	1,095.0000	03:13:09	65.0000	F	ASCENT	219.0000	P	C	N	29.1000	91.3000	3.0500	07:33:20	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
12	1,095.0000	03:13:11	67.0000	F	ASCENT	221.0000	P	C	N	29.1000	91.3000	3.0500	07:33:21	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
13	1,095.0000	03:13:13	69.0000	F	ASCENT	222.0000	P	C	N	29.1000	91.3000	3.0500	07:33:22	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
14	1,095.0000	03:13:15	71.0000	F	ASCENT	224.0000	P	C	N	29.1000	91.3000	3.0500	07:33:23	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
15	1,095.0000	03:13:16	72.0000	F	ASCENT	225.0000	P	C	N	29.1000	91.3000	3.0500	07:33:24	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
16	1,095.0000	03:13:17	73.0000	F	ASCENT	227.0000	P	C	N	29.1000	91.3000	3.0500	07:33:25	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
17	1,095.0000	03:13:18	74.0000	F	ASCENT	229.0000	P	C	N	29.1000	91.3000	3.0500	07:33:26	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
18	1,095.0000	03:13:19	75.0000	F	ASCENT	230.0000	P	C	N	29.1000	91.3000	3.0500	07:33:27	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
19	1,095.0000	03:13:20	76.0000	F	ASCENT	230.0000	P	C	N	29.1000	91.3000	3.0500	07:33:28	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
20	1,095.0000	03:13:21	77.0000	F	ASCENT	232.0000	P	C	N	29.1000	91.3000	3.0500	07:33:29	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C
21	1,095.0000	03:13:22	78.0000	F	ASCENT	233.0000	P	C	N	29.1000	91.3000	3.0500	07:33:30	107.8000	19.0759	72.8776	5.0000	5.0200	78.0900	C

GCS Software(6/6)



CanSat Integration and Test

Yash Kuwalekar

CanSat Integration and Test Overview(1/2)

Preparation for Testing and Testing Priority Overview

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Testing Individual Components

↓

Subsystem-Level Testing

↓

Integration Plan and Functional Testing

↓

Simulation Testing

↓

Environment Testing

Description of Integration and Testing Flow:

- Initially, the **body** of container and payload will be tested along with **mechanisms.**
- Next, the components in working order will be **integrated together** and checked for reliable output.
- These components will then be combined together and tested as a **whole unit.**
- Once the **reliability of electronics** has been verified, they will be put into the mechanical structures.
- The **simulation mode** will be activated as a safe method to verify whether critical flight software algorithms are functioning properly.
- Finally, CanSat will be tested in **environmental conditions** which it will be subject to during the **mission.**

CanSat Integration and Test Overview(2/2)

Phase	Description	Aspects tested
Subsystem level	The working components of subsystem will be checked for functionality in subsystem configuration.	Sensors, CDH, EPS, Radio Communications, FSW, Mechanical, Descent Control
Integration level	Subsystems will be integrated, two or three at at a time, and capacity to perform overall tasks will be verified.	Descent Testing, Communications, Mechanisms, Deployment
Simulation level	CanSat will be operated in simulation mode and required critical point mechanisms will be verified for their working.	Flight mode and Simulation mode
Environmental level	Fully assembled CanSat will be tested for sustenance against environmental effects.	Drop test, Thermal test, Vibration test, Fit check, Vacuum test

Requirements Compliance

Yash Kuwalekar

Requirements Compliance Overview

- Our current design of the CANSAT complies with 61 requirements given in the Mission Guide document.
- All the designing has been done keeping in mind the guidelines mentioned in the *Guidance for Success* document.
- All the environmental tests have been planned following the *Environmental Tests guide.*
- All the estimated values in the budget have been selected keeping in mind all the fail safe margins.

- The colour (green) indicates that the requirement is fully met.
- The colour (yellow) indicates that the requirement is partial/not completely verified yet(theoretical verification).
- The colour (red) indicates that the requirement is not met.

We have compiled all 61 requirements, out of which 55 are green, 6 are yellow and 0 are red.

Management

Shreya Puri

Program Schedule Overview

TC - Team Captain
TL - Technical Lead

SPONS - Sponsorship Team
ALL - All Members

Mech - Mechanical Subsystem
EPS - Electrical Power Subsystem

Task	Assign	Start	End	Days	Status	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
PDR Preparation	ALL	1-Nov-22	31-Jan-23	92	Completed								
Registration	TC	3-Nov-22		1	Completed								
Securing Approval of Funds from College	SPONS	7-Nov-22	11-Nov-22	5	Completed								
End Semester Exams (5th sem)	ALL	28-Nov-22	15-Dec-22	18									
Registration Fee Payment	TC	14-Dec-22		1	Completed								
Ordering Primary Components	TL	16-Dec-22	20-Dec-22	5	Completed								
Sponsorship	SPONS	19-Dec-22	25-Feb-23	69	Ongoing								
PDR Submission	TC	1-Feb-23		1	Completed								
Team Break	ALL	2-Feb-23	5-Feb-23	4									
Ordering Secondary Components	TL	5-Feb-23	7-Feb-23	3	Upcoming								
Building Subsystems and Prototyping Design Concepts	ALL	6-Feb-23	25-Feb-23	20	Upcoming								
CDR Preparation	ALL	6-Feb-23	30-Mar-23	53	Upcoming								
PDR Presentation	ALL	14-Feb-23		1	Upcoming								
Verification of Designs and Changes in PDR (if needed)	ALL	26-Feb-23	12-Mar-23	15	Upcoming								
Mid Semester Test (6th Sem)	ALL	13-Mar-23	18-Mar-23	6									
CDR Submission	TC	31-Mar-23		1	Upcoming								
Manufacturing	MECH,EPS	19-Mar-23	30-Apr-23	43	Upcoming								
Environmental testing (+ repairs if required)	MECH	1-May-23	10-May-23	10	Upcoming								
End Semester Exams (6th sem)	ALL	15-May-23	31-May-23	17									
Environmental Test Submission	TC	26-May-23		1	Upcoming								
Final Testing and Transportation Preparation	ALL	2-Jun-23	5-Jun-23	4	Upcoming								
Competition	ALL	10-Jun-23		1	Upcoming								
PFR submission	ALL	11-Jun-23		1	Upcoming								

Detailed Program Schedule (1/4)

Flight Software Subsystem

Task	Start	End	Days	Status	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Mission Guide Study	1-Nov-22	5-Nov-22	5	Completed								
Recognising FSW Tasks	6-Nov-22	12-Nov-22	7	Completed								
Exploring GCS approaches	8-Nov-22	14-Nov-22	7	Completed								
GCS Software Development	15-Nov-22	28-Jan-23	75	Completed								
Main Algorithm & FSW State Diagram	18-Nov-22	30-Dec-22	43	Completed								
Subsystem Holiday	16-Dec-22	22-Dec-22	7									
Sensor Library Study	23-Dec-22	7-Jan-23	16	Completed								
Individual Sensor Code	10-Jan-23	15-Feb23	37	Ongoing								
GCS integration with CDH	14-Jan-23	14-Feb-23	32	Ongoing								
Team Break	2-Feb-23	5-Feb-23	4									
Simulation Mode Programming	9-Feb-23	26-Feb-23	18	Upcoming								
Code Integration	2-Mar-23	18-Apr-23	48	Upcoming								
Command Test	26-Mar-23	22-Apr-23	28	Upcoming								
Simulation Mode Test	18-Apr-23	30-Apr-23	13	Upcoming								
Refinement and Optimization	25-Apr-23	7-May-23	13	Upcoming								

Detailed Program Schedule (2/4)

Mechanical Subsystem

Task	Start	End	Days	Status	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
CAD software learning and basic modelling	1-Nov-22	25-Nov-22	25	Completed								
Basic courses on aeromodelling and dynamics	15-Nov-22	20-Dec-22	36	Completed								
Segregation of payload and container components and tasks	15-Dec-22	20-Dec-22	6	Completed								
Container and Payload body initial design	21-Dec-22	28-Dec-22	8	Completed								
CAD modelling of electronic components	25-Dec-22	31-Dec-22	7	Completed								
Developing and finalising flight mechanisms	1-Jan-23	9-Jan-23	9	Completed								
Parachute Design	1-Jan-23	4-Jan-23	4	Completed								
Heat shield designing and prototyping	1-Jan-23	7-Jan-23	7	Completed								
Subsystem Holiday	10-Jan-23	14-Jan-23	5									
Design finalisation, PCB placement and PDR preparation	15-Jan-23	25-Jan-23	11	Completed								
Team Break	2-Feb-23	5-Feb-23	4									
3D Printing Parts and prototyping	6-Feb-23	30-Mar-23	53	Upcoming								
Review and Part Redesign	1-Mar-23	21-Apr-23	52	Upcoming								
Prototype Assembly	1-Apr-23	15-Apr-23	15	Upcoming								
Integration Testing	16-Apr-23	20-Apr-23	5	Upcoming								
Environmental Testing	1-May-23	10-May-23	10	Upcoming								
Final integration and mechanisms check	12-May-23	24-May-23	13	Upcoming								

Detailed Program Schedule (3/4) Sensor Subsystem

EPS and Sensor Subsystem

Task	Start	End	Days	Status	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Electronics & Sensors Study	1-Nov-22	25-Nov-22	25	Completed								
Ordering electronic components	16-Dec-22	20-Dec-22	5	Completed								
Preliminary component testing for working	21-Dec-22	25-Dec-22	5	Completed								
Designing configuration of EPS	26-Dec-22	10-Jan-23	16	Completed								
Interfacing of sensors with processor	26-Dec-22	15-Jan-23	21	Completed								
Subsystem Holiday	28-Dec-22	6-Jan-23	10									
EPS Battery selection	11-Jan-23	13-Jan-23	3	Completed								
EPS Design Finalisation and PCB designing	14-Jan-23	17-Jan-23	4	Completed								
PDR preparation	17-Jan-23	25-Jan-23	9	Completed								
Team Break	2-Feb-23	5-Feb-23	4									
Subystem Building	17-Feb-23	11-Mar-23	23	Upcoming								
Integration Level Testing	19-Mar-23	30-Mar-23	12	Upcoming								

Detailed Program Schedule (4/4)

Communication & Data Handling Subsystem

Task	Start	End	Days	Status	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Components Study and Past PDR Reading	1-Nov-22	20-Dec-22	50	Completed								
Antenna Criteria study and selection	15-Dec-22	19-Dec-22	5	Completed								
Subsystem Holiday	20-Dec-22	26-Dec-22	7									
XBee Radio datasheet and modes study	21-Dec-22	27-Dec-22	7	Completed								
XBee Radios interfacing and test	28-Dec-22	4-Jan-23	8	Completed								
Communications related configuration	5-Jan-23	15-Jan-23	11	Completed								
PDR preparation	16-Jan-23	23-Jan-23	8	Completed								
Team Break	2-Feb-23	5-Feb-23	4									
Prototyping entire subsystem and req changes	6-Feb-23	12-Mar-23	35	Upcoming								
Integration level testing	19-Mar-23	30-Mar-23	12	Upcoming								

Conclusions

Major Accomplishments	Major Unfinished work
• PDR document is completed • CanSat Designs are finalized • EPS design and PCB design • Most of the sensors have been received • Individual Sensor Testing and Programming • GCS Software testing with CDH • Testing plans have been finalized • Received Sponsorship for 3D Printing • Received Funds from the Institute	• Mechanism Testing • Improvements in designs based on Test results and analysis • Antenna not tested • CanSat PCBs yet to be put for manufacturing • FSW code integration • Integration Level Testing • Sponsorship for other needs

Readiness to proceed to next stage of development

- Preliminary Design Phase of all subsystems has been completed and we are ready to move into the Development Phase.
- Proper plan for Development and Testing and regular meetings are conducted to track the progress of our team.
- CanSat Designs are compliant with most of the requirements.
- Significant portion of required funds have been alloted to proceed with the competition.