Netaji Subhas University of Technology

CanSat 2020
Preliminary Design Review (PDR) Outline
Version 1.1

 # 5160

TEAM G.A.G.A.N.

Gliding Aircraft with GPS Aided Navigation

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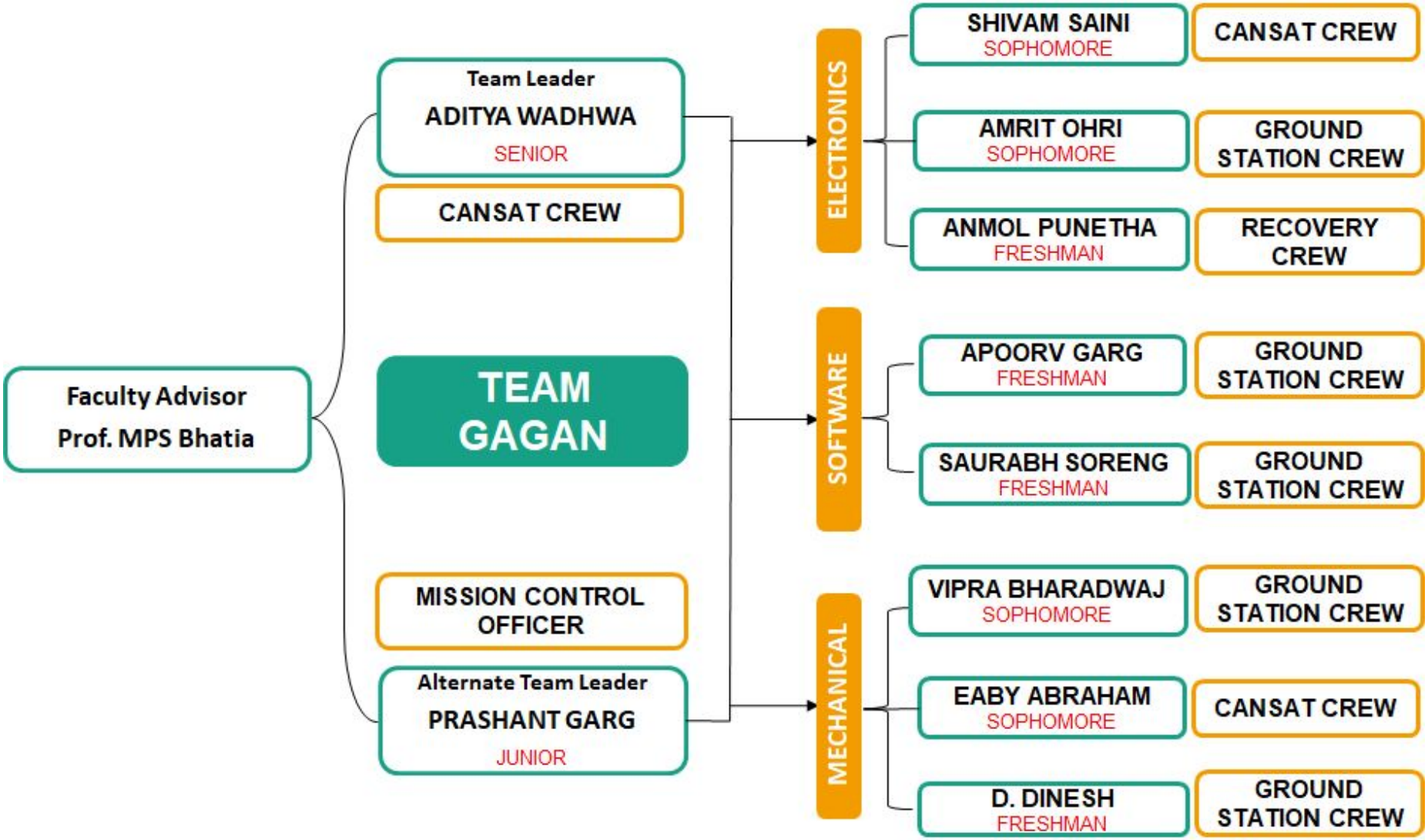
Team Organization



Acronyms

A	Analysis
ADC	Analog to Digital Converter
CD	Coefficient of Drag
CDH	Communication and Data Handling
CDR	Critical Design Review
CL	Coefficient of Lift
COG	Center of Gravity
CONOPS	Concept of Operations
CSV	Comma-Separated Values
D	Demonstration
Ds	Datasheet
E	Estimate
EEPROM	Electrically Erasable Programmable ROM
EPS	Electrical Power Subsystem
FPS	Frames Per Second
FSW	Flight Software Design
GCS	Ground Control System
GPS	Global Positioning System
GUI	Graphical User Interface

HA	Horizontal Accuracy
I	Inspection
ID	Identification Number
IDE	Integrated Development Environment
I^2C	Inter-Integrated Circuit
LDO	Load Dropout Voltage Regulator
LDR	Light Dependent Resistor
M	Measured
MCU	Micro Controller Unit
MS	Mechanical Subsystem
RAD	Rapid Application Development
RF	Radio Frequency
SDLC	Software development Lifecycle
SPI	Serial Peripheral Interface
T	Testing
TA	Time Accuracy
UART	Universal Asynchronous Receiver Transmitter
VA	Vertical Accuracy
VM	Verification Method

Systems Overview

Presenter: Prashant Garg

Mission Summary

MISSION OBJECTIVES

- Deploy CanSat at an altitude ranging 670-725 meters above the launch site.
- Maintain descent rate of 20m/s.
- Deploy the science payload at 450 meters, which will glide in a circular pattern with radius of 250 meters.
- Glider shall deploy a parachute at 100 meters to stop gliding and descend at 10m/s.
- The science payload shall monitor altitude, air speed and the science payload shall be a particulate matter/dust sensor to detect particulates in the air while gliding.
- All telemetry shall be displayed in real time during descent and shall be updated once per second. XBEE radios shall be used for telemetry.

BONUS OBJECTIVE

- A video camera capable of capturing video of 640x480 pixels @30fps in color shall be integrated into the science payload and point toward the coordinates provided for the duration of the glide time.
- The selected bonus objective does not affect the aerodynamic structure.

EXTERNAL OBJECTIVES

- Get an esteemed position in CanSat 2020 .
- Funding for project's hardware and transportation expenses of the team.
- We wish to gain experience and make a student satellite and get it launched.

System Requirement Summary [1/4]

ID	Mission Requirements	VM			
		A	I	T	D
1	Total mass of the CanSat(science payload and container) shall be 600 grams +/- 10 grams.	+		+	
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length.	+	+	+	
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	+	+	+	
4	The container shall be a fluorescent color: pink, red or orange.				+
5	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed.		+		
6	The rocket airframe shall not be used as part of the CanSat operations.	+			+
7	The science payload shall measure altitude using an air pressure sensor..		+	+	
8	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.		+	+	
9	No lasers allowed.		+	+	
10	Payload/Container shall operate for a minimum of two hours when integrated into rocket.		+	+	

System Requirement Summary [2/4]

ID	Mission Requirements	VM			
		A	I	T	D
11	The rocket airframe shall not be used as part of the CanSat operations..	+			+
12	The container shall release the payload at 450 meters +/- 10 meters.	+	+		
13	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	+	+		
14	The science payload shall be a delta wing glider.				+
15	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	+	+		
16	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s	+		+	
17	All descent control device attachment components shall survive 30 Gs of shock.	+	+	+	
18	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	+			
19	All structures shall be built to survive 15 Gs of launch acceleration.	+	+	+	
20	The science payload shall measure particulates in the air as it glides.		+	+	

System Requirement Summary [3/4]

ID	Mission Requirements	VM			
		A	I	T	D
21	The science payload shall provide position using GPS.		+	+	
22	The science payload shall measure its battery voltage.		+	+	
23	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.		+		
24	The science payload shall measure outside temperature.		+	+	
25	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.		+		+
26	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	+	+	+	+
28	The science payload shall measure air speed.		+	+	
29	Telemetry shall be updated once per second		+	+	
30	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	+	+	+	+
31	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.	+		+	+

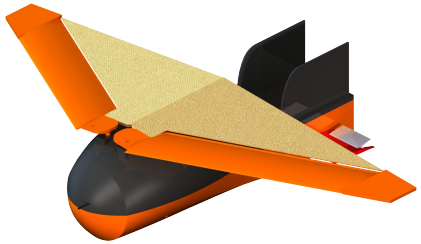
System Requirement Summary [4/4]

ID	Mission Requirements	VM			
		A	I	T	D
32	XBEE radios shall have their NETID/PANID set to their team number.			+	
33	Cost of the CanSat shall be under $1000	+			+
34	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	+	+	+	
35	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	+		+	
36	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	+			+
37	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	+	+		
38	Both the container and probe shall be labelled with team contact information including email address.	+		+	
39	The probe must include an easily accessible power switch that can be accessed without disassembling the Cansat and in the stowed configuration.	+			+
40	An audio beacon is required for the probe. The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	+		+	
41	The Parachutes shall be fluorescent Pink or Orange.				+

System Level CanSat Configuration Trade & Selection [1/3]

Design Strategy 1: Space frame container with high wing delta glider.

- **Servo actuated** payload release and deployment.
- Payload PCBs are placed in vertical fashion.
- Dedicated hole on the lower fuselage for camera and the external switch.
- **High wing** with **actively controlled** elevators are used to facilitate stable descent.



Glider's Deployed State

Pre-Deployment State

Pre-Deployment State

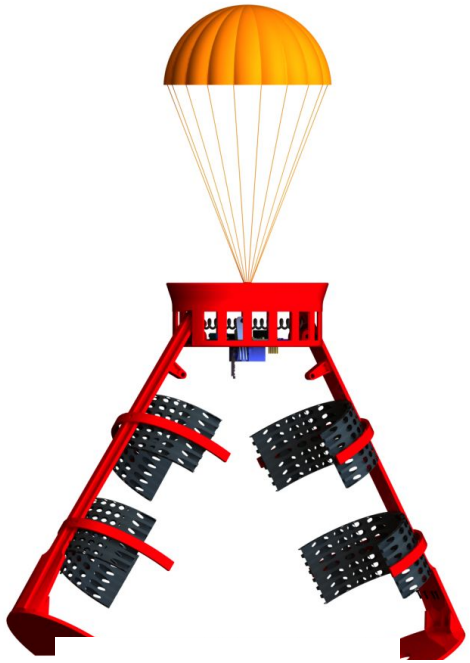
Glider's Deployed State

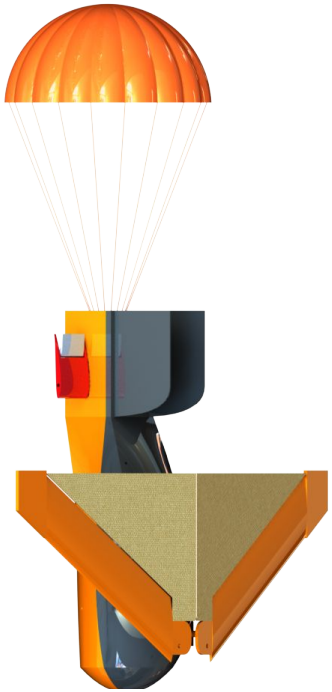
- **Low wing** with **passive horizontal stabilizers** are used for stable descent.
- Camera is placed in a transparent acrylic sheet compartment to provide clear view without affecting the body aerodynamics.
- **Nichrome wire heating** setup is used for payload release.
- Self actuated payload deployment.

Design Strategy 2: Topology optimized monocoque container with low wing delta glider.

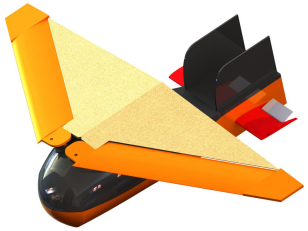
System Level CanSat Configuration Trade & Selection [2/3]

Design Strategy 1: Space frame container with high wing delta glider.





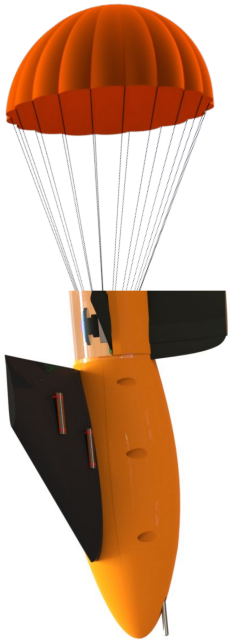
- **The container opens using servo motor thread cutting mechanism.**
- **The electronics are placed in a vertical fashion inside the payload.**



- **High wing configuration has been used along with anhedral angle to enhance maneuverability.**
- **Active stabilisers are used to prevent payload from entering the stall region.**

System Level CanSat Configuration Trade & Selection [3/3]

Design Strategy 2: Topology optimized monocoque container with low wing delta glider.



- **The container opens using nichrome wire heating mechanism.**
- **Camera stabilization system is placed in a transparent compartment to avoid making holes for the camera.**

- **The fuselage is designed to have minimum coefficient of drag.**
- **Passive horizontal stabilizers are used to stabilize the pitching moment.**

System Level Configuration Selection

	Design Strategy 1	Design Strategy 2
PROS	➢ Better protection of payload from launch vibrations.	➢ Better aerodynamic structure with low drag force.
	➢ Lightweight container design.	➢ More rigid container structure.
	➢ Dual rudders facilitates easy integration of payload with container.	➢ Ensures sufficient glide time with better overall glide stability.
CONS	➢ High drag force experienced by the payload body.	➢ High power consumption
	➢ Anhedral (negative dihedral) reduces roll stability.	➢ Relatively less reliable payload deployment mechanism.

Design Strategy	Ease of Operation	Payload Release	Glider Deployment	Gliding Action	Ease of Fabrication	Overall Cost	Overall Stability	Total
1	8	6	8	6	7	6	7	48
2	**7**	**8**	**7**	**9**	**8**	**8**	**9**	**56**

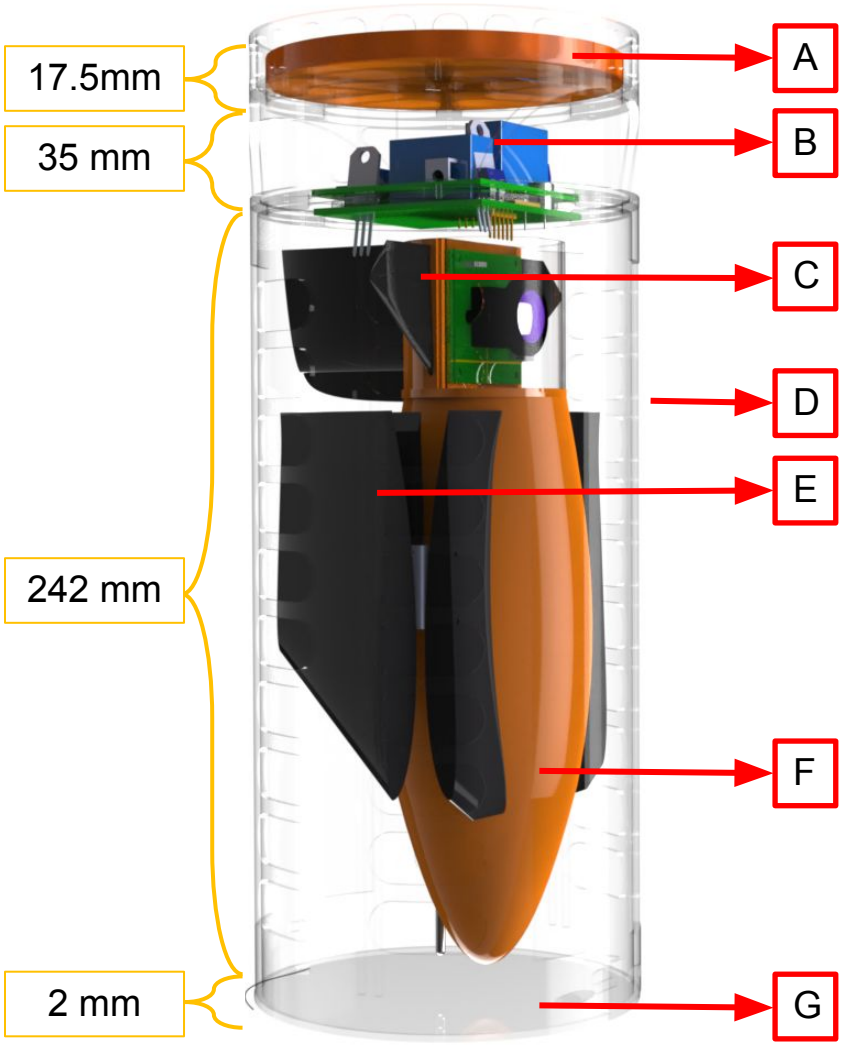
SELECTED

Design Strategy 2

- ➢ Rigid structure makes it less susceptible to shock damage.
- ➢ The glider body experience minimal drag thus facilitates gliding action.
- ➢ Camera subsystem doesn't affect the body aerodynamics.

(0 to 10)
0-Least, 10-Most

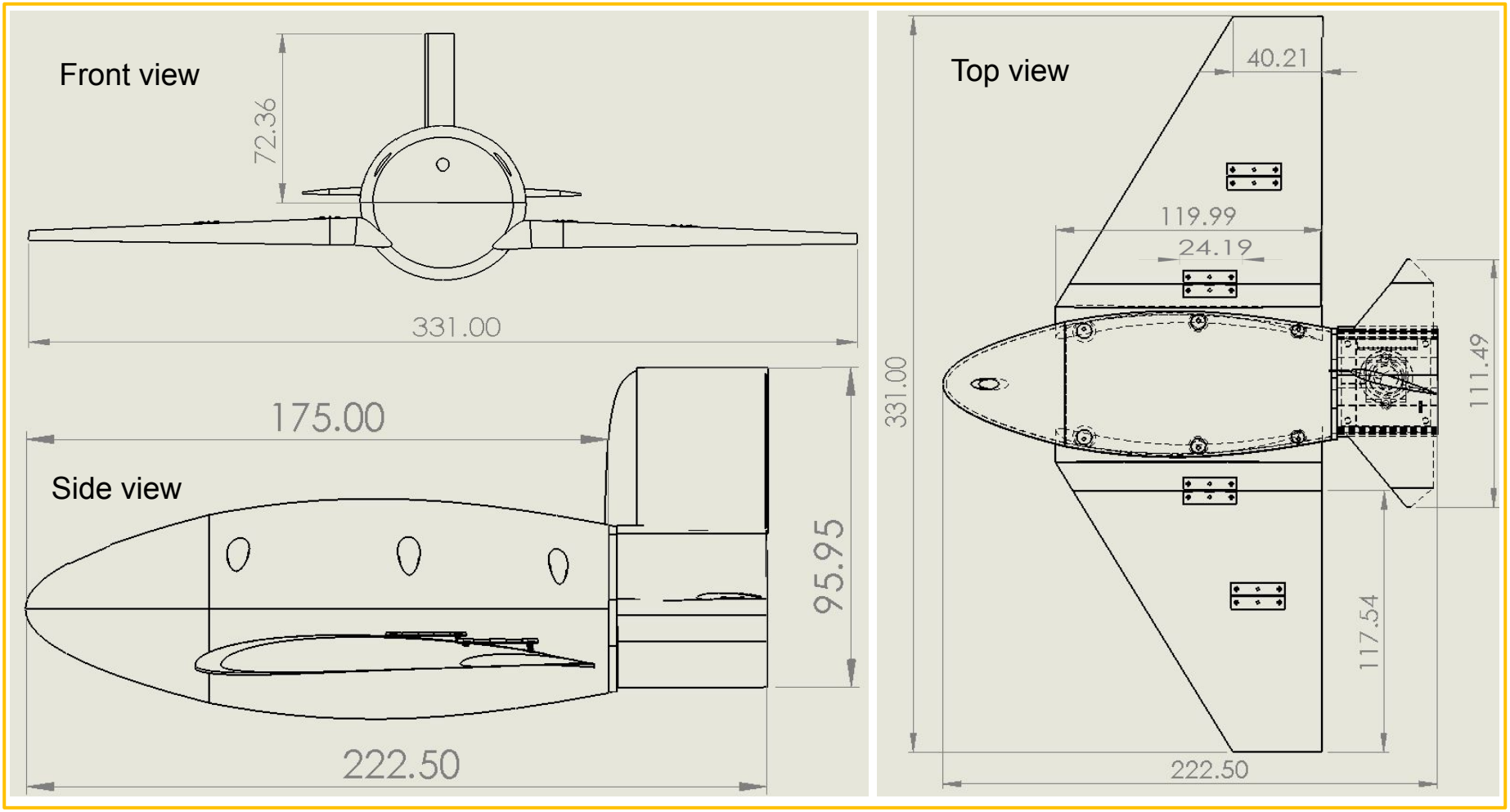
Physical Layout [1/6]



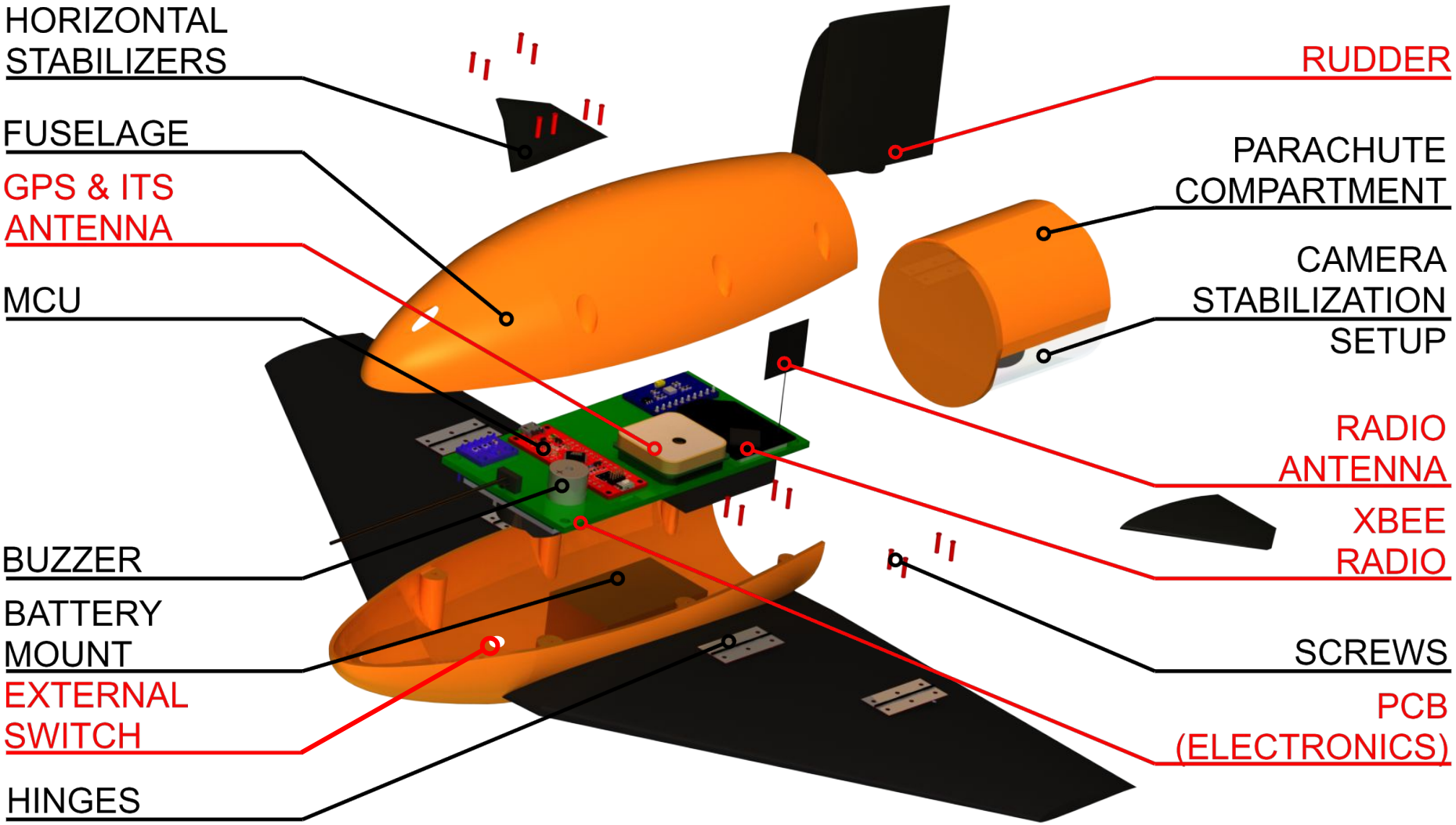
Symbol	Component	Dimension
A	Parachute	DIAMETER : 228.60 mm
B	Container Electronics	LENGTH: 60 mm, BREADTH: 60 mm
C	Horizontal Stabilizers	AREA : 1518 mm^2
D	Payload Housing	LENGTH : 244 mm ,DIAMETER : 120 mm
E	Wings	WING SPAN : 300 mm
F	Fuselage	MAX LENGTH : 237 mm
G	Lid	DIAMETER : 120 mm

Physical Layout [2/6]

- All measurements are in mm.
- Front view, top view and side view are shown.

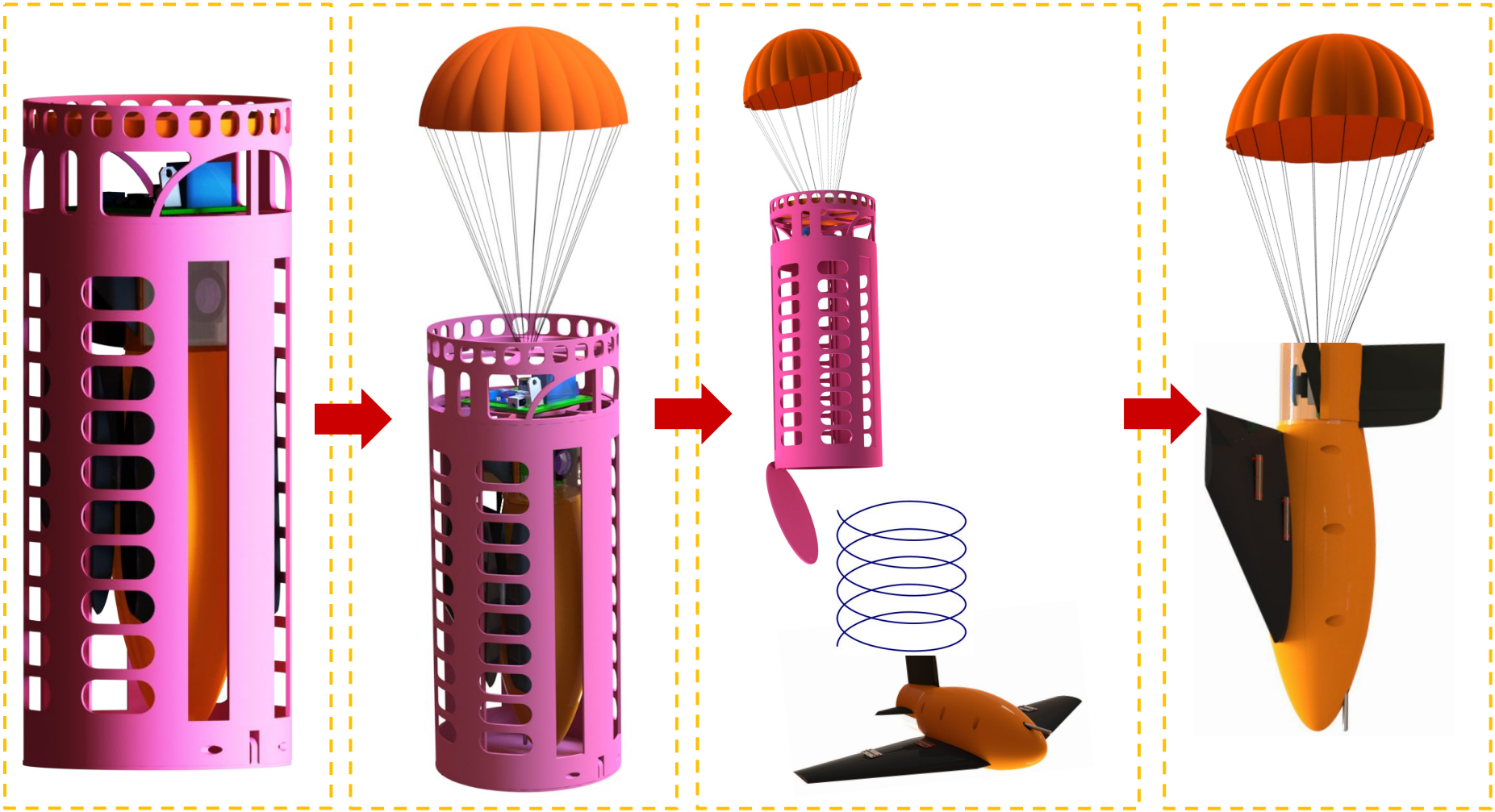


Physical Layout [3/6]



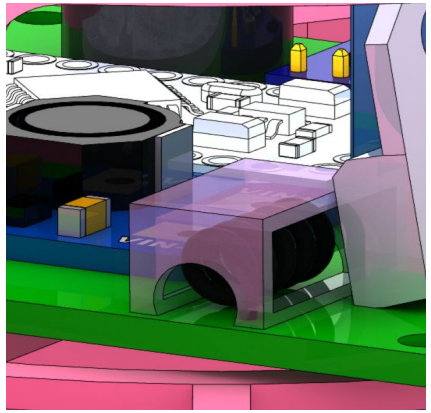
Physical Layout [4/6]

Stowed Configuration	Container Parachute Deployment	Payload Release	Payload Parachute Deployment

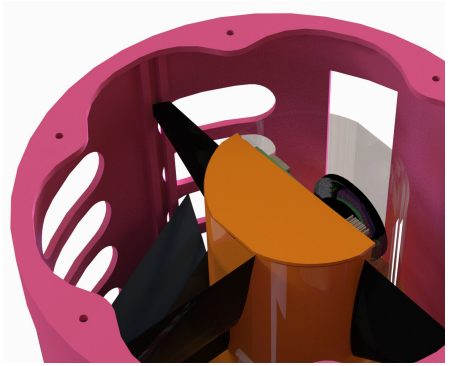


Physical Layout [5/6]

Launch Configuration

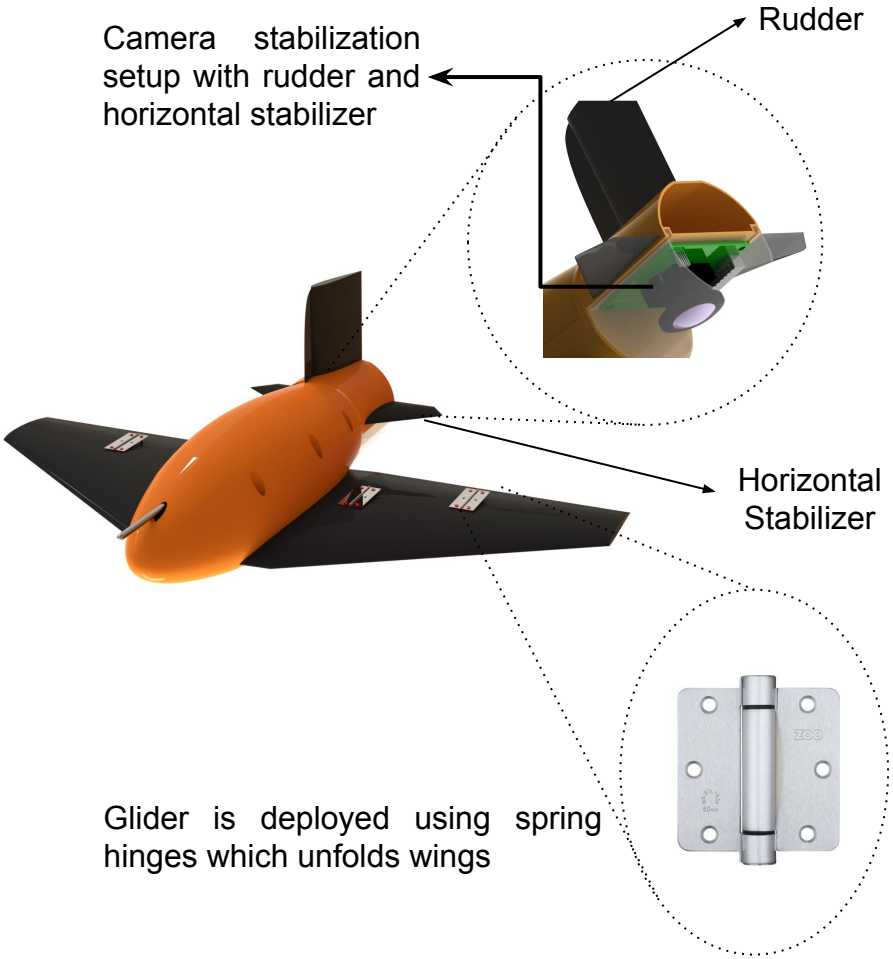


Wire heating setup (insulated) actuates to launch payload



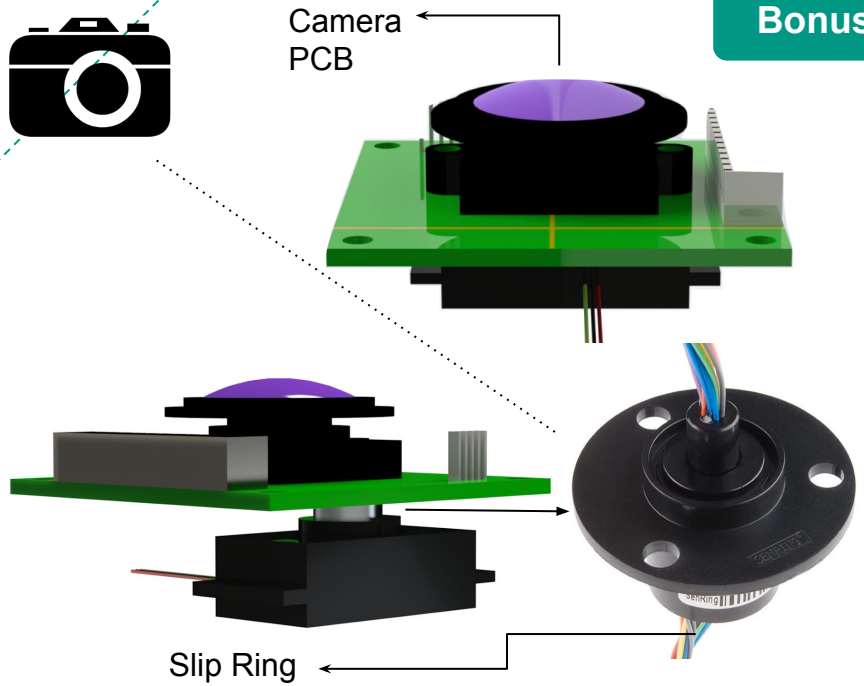
Payload held by guide rails

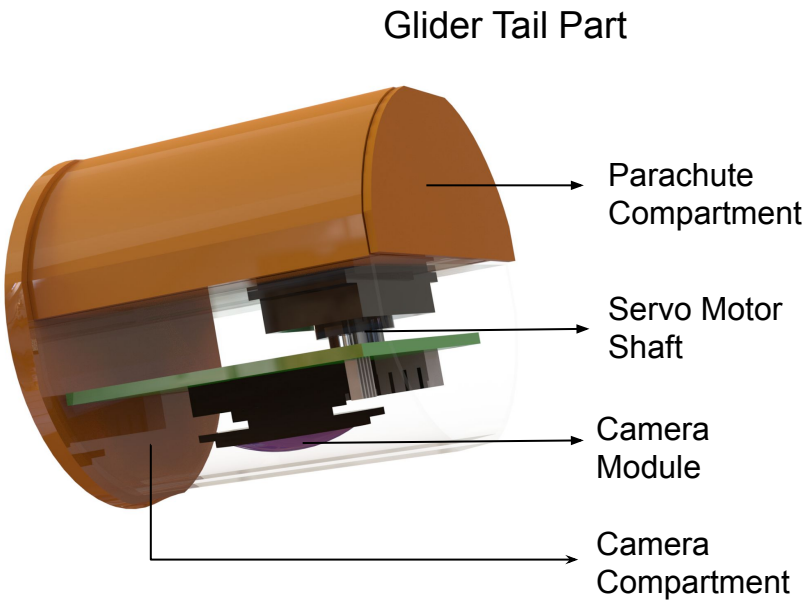
Deployed Configuration



Physical Layout [6/6]

Bonus Objective





The interface between servo and camera PCB is done using a slip ring which prevents wire tangling. These wires from camera PCB carry the data for camera's direction stability.

A transparent Structure for camera is provided. Camera PCB is mounted on a servo motor which receives commands from a dedicated Stabilization Setup.

CAMERA PCB

CAMERA MOUNTING

System Concept of Operations [1/3]

PRE-LAUNCH

- All mechanical parts are checked
- All circuits are checked.
- Functioning of sensors and telemetry is checked.
- CanSat body is checked for protrusions or damages.

LAUNCH

- CanSat electronics is switched ON.
- CanSat is placed safely in the rocket payload section.
- A final system check is done.
- Transmission command and Calibration commands are transmitted.

ROCKET SEPARATION + PARACHUTE DEPLOYMENT

- The CanSat starts sending telemetry data.
- The FSW is active and logging data.
- At apogee, the rocket separates violently and parachute is deployed.

PAYLOAD/GLIDER RELEASE

- At 450 m, payload is released using nichrome wire heating setup.
- The payload wings are deployed and it starts gliding in circular path of 250m radius for a period of one minute.

System Concept of Operations [2/3]

CONTAINER DESCENT WITH PARACHUTE

- Container descends with parachute.
- The terminal velocity of the container is 10m/s.

GLIDER PARACHUTE DEPLOYMENT

- After one minute of gliding payload parachute is deployed.
- The terminal velocity obtained is approximately equal to 10 m/s.

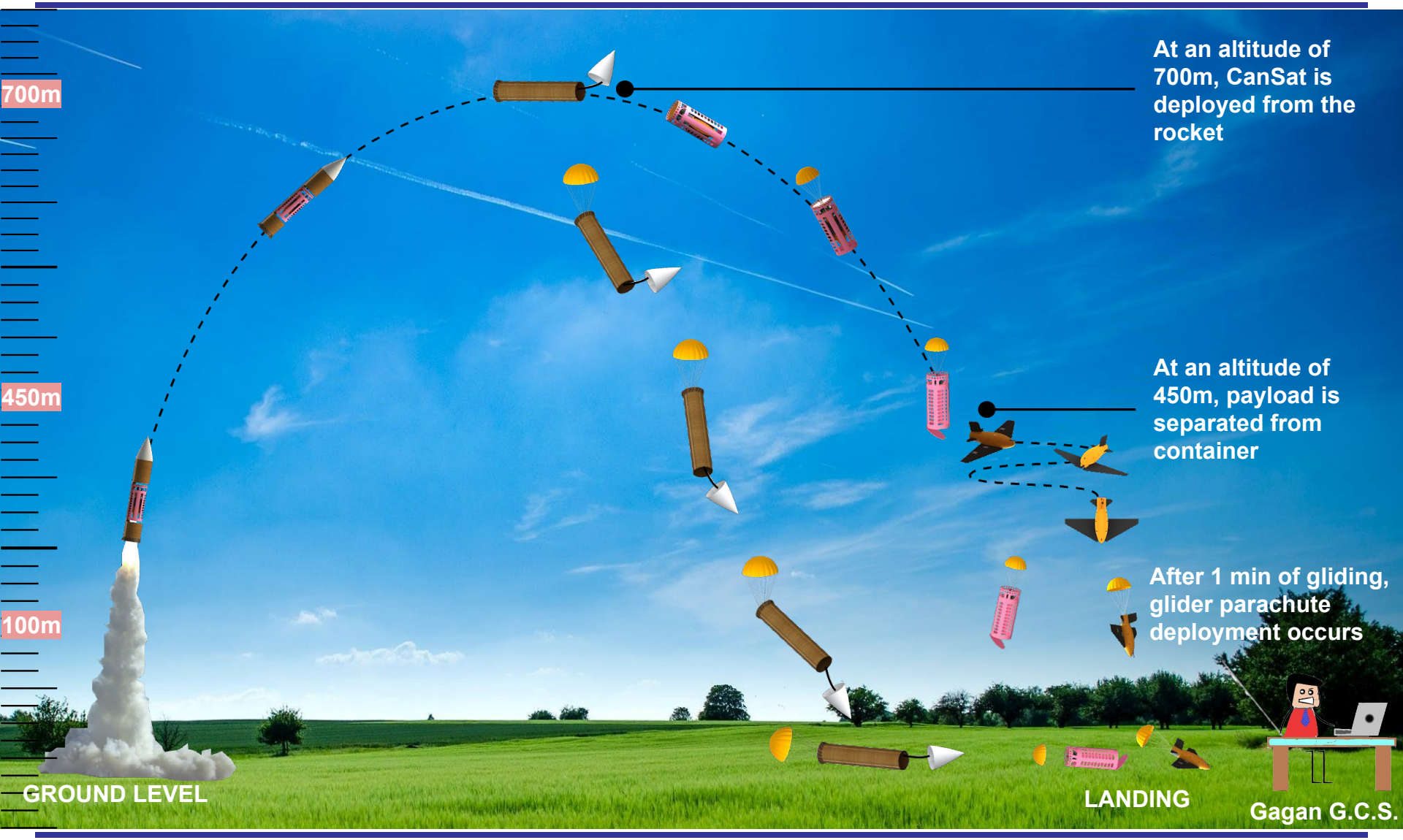
LANDING

- The audio beacons on both container and payload are activated to aid recovery of payload and container.

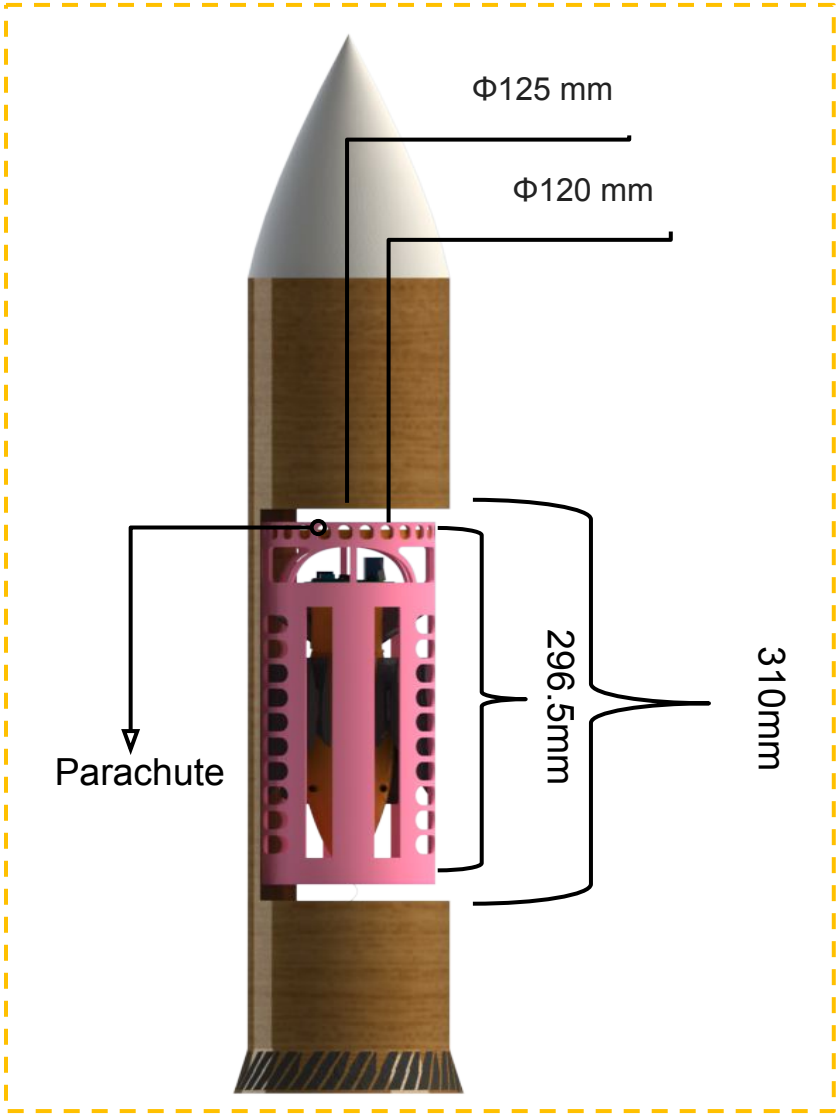
RECOVERY + PFR

- The container and payload are located and the data card is retrieved from the camera.
- The data is saved in the desired format at the GCS.
- The PFR is prepared and presented.

System Concept of Operations [3/3]



Launch Vehicle Compatibility



	Height (mm)	Width(mm)
Cylindrical Envelope	310	125
CanSat (Payload + Container)	296.5	120
Margin	13.5	5

- Height margin of 13.5mm and width margin of 5mm guarantee easy integration of cansat into the rocket.
- There are no sharp edges on the surface of payload and container.
- Fit check is done to make sure it meets launch vehicle compatibility.

Sensor Subsystem Design

Presenter: Shivam Saini

Sensor Subsystem Overview

ID	Sensor Name	Purpose	Sensor Utilised	Quantity	Description
1	Air Speed	To measure the velocity of the wind	**SDP37**	x1 (payload)	Calculation of Air speed using differential air pressure.
2	Air Quality	To determine the amount of PM2.5	**HPMA115S0-004**	x1 (payload)	Measures the Particulate matter during flight.
3	Air Pressure	To measure the altitude	**BMP280**	x2 (payload + container)	Calculation of altitude using the relationship between pressure and altitude. While pressure and temperature served as raw data by sensor
4	Temperature	To measure the outside temperature.	**BMP280**	x1 (payload)	Calculation of external temperature.
5	GPS	To determine the location	**BN-280**	x1 (payload)	Returned values include: Time, latitude, longitude, altitude and number of satellites
6	Power Voltage Measurement	To measure the voltage of battery	**Controller's Analog Pin**	x1 (payload)	To obtain the current system battery voltage.
7	Camera	To record video of the mission	**Turbowing Cyclops DVR3**	x1 (payload)	Bonus requirement: To video record the flight recording.
8	Inertial Measurement	To measure the orientation	**MPU-9250**	x1 (payload)	**BONUS**:Camera Stabilization.

Sensor Subsystem Requirements

ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
SS - 1	The science payload shall measure altitude using an air pressure sensor.	Mission Requirement	BR22	-	High	+		+	+
SS - 2	The science payload shall provide position using GPS.	Mission Requirement	BR23	-	High	+		+	+
SS - 3	The science payload shall measure its battery voltage	Technical Constraint	BR24	EPS02	High	+		+	+
SS - 4	The science payload shall measure outside temperature.	Mission Requirement	BR25	-	High	+		+	+
SS - 5	The science payload shall measure particulates in the air as it glides.	Mission Requirement	BR26	-	High	+		+	+
SS - 6	The science payload shall measure air speed.	Mission Requirement	BR27	-	High	+		+	+
SS - 7	A video camera shall be integrated into the science payload and point toward the coordinates provided for the duration of the glide time.	Bonus Requirement	Bonus	-	Medium	+	+		
SS - 8	Video shall be in color with a minimum resolution of 640x480 pixels and 30 frames per second. The video shall be recorded and retrieved when the science payload is retrieved.	Bonus Requirement	Bonus	-	Medium			+	+

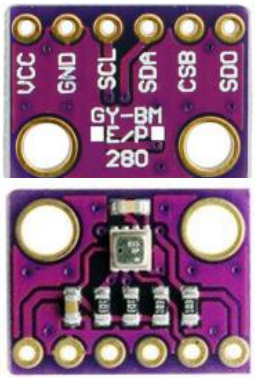
Payload Air Pressure Sensor Trade & Selection

Sensor	Interface	Operating Voltage (V)	Current Consumption (mA)	Resolution (Pa)	Size (mm x mm x mm)	Weight (g)	Cost ($)
MS5607	I^2C / SPI	1.80 - 3.60	12.5	2.40	20.3 x 2.5 x 20.3	1.0	8.90
BME 280	I^2C / SPI	1.71 - 3.60	3.4	0.18	19.0 x 18.0 x 3.0	1.0	5.95
BMP 280	**I^2C / SPI**	**1.71 - 3.60**	**2.7**	**0.16**	**19.7 x 17.0 x 2.9**	**1.3**	**2.60**

SELECTED

BMP 280

- Low power consumption because of **2.7µA** current consumption **@1Hz** sampling rate.
- High relative accuracy (**0.12hPa**) with wide measurement range (**+9000m to –500m** relating to sea level).
- Has digital interfaces: **I^2C (up to 3.4MHz)** and **SPI (up to 10Mhz).** With our past experiences, it becomes easy to use and debug.



$$p0 = \frac{p}{\left[1 - \left(\frac{altitude}{44330}\right)\right]^{\wedge\{5.255\}}}$$

p=measured pressure(hPa)

p0=pressure at sea level(hPa)

BMP 280 (Air Pressure Sensor)

Payload Air Temperature Sensor Trade & Selection

Sensor	Interface	Operating Voltage (V)	Current Consumption (mA)	Resolution (°C)	Size (mm x mm x mm)	Weight (g)	Cost ($)
MCP9808	I^2C	2.7-5.5	200.0	0.0625	21.0 x 13.0 x 2.0	0.9	4.22
MS5607	I^2C/SPI	1.8-3.6	0.9	0.0100	20.3 x 2.5 x 20.3	0.6	8.90
BMP 280	**I^2C / SPI**	**1.71-3.6**	**2.7**	**0.0100**	**19.7 x 17.0 x 2.9**	**1.3**	**2.60**

SELECTED

BMP 280

- Higher level of accuracy @ **±0.5°C** and wide measurement range of **120°C (-40°C - 80°C)**.
- Low power consumption due to **2.7µA** current consumption @1Hz sampling rate.
- Reliable Communication of **I^2C(up to 3.4 MHz)** and **SPI(up to 10MHz)**. Temperature, humidity, pressure measurable in one sensor.Easy to use and debug because of our past experiences.

BMP 280 (Temperature Sensor)

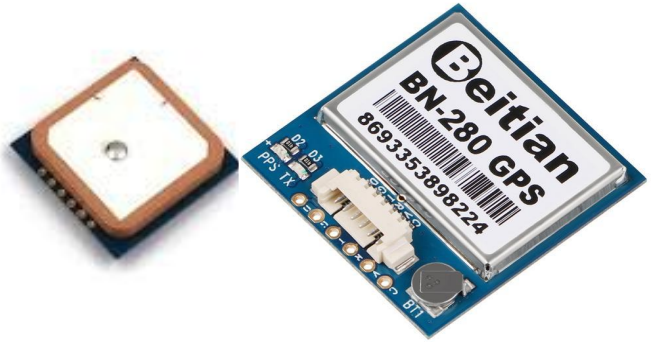
GPS Sensor Trade & Selection

Sensor	Interface	Operating Voltage (V)	Current Consumption (mA)	Resolution	Size (mm x mm x mm)	Weight (g)	Cost ($)
UBLOX NEO 6M	UART	2.7-3.6	39	0.1m/s VA 60 ns TA 2.5m HA	25.0 x 25.0 x 2.4	17.6	8.5
L86	UART	3.0-4.3	30	0.1m/s VA 10 ns TA 2.5m HA	18.4 x 18.4 x 4.0	7.6	9.1
BN-280	**UART**	**3.0-5.5**	**50**	**0.1m/s VA 1µs TA 2.0m HA**	**30.0 x 35.0 x 5.0**	**11.8**	**14.0**

SELECTED

BN - 280

- **Low BOOT TIME:** 26 sec
- High resolution of **–168dB** @ tracking and **–160dB** @ acquisition.
- **1us** synchronization with GPS time.
- Reliable GNSS signal update up to **18Hz** and Concurrent GNSS up to **10Hz.**
- Velocity resolution **0.1m/sec**



Data Protocol	NMEA-0183 or UBX, Default NMEA-0183

BN-280 (GPS Sensor)

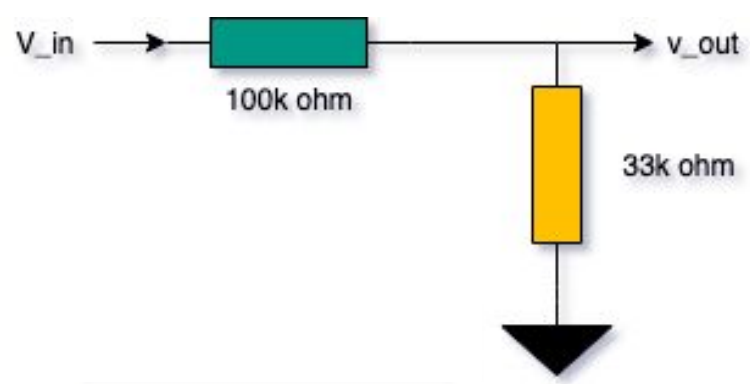
Payload Power Voltage Sensor Trade & Selection

Sensor	Interface	Current Consumption (mA)	Resolution (mV)	Size (mm x mm x mm)	Weight (g)	Cost ($)
LTC2990	I^2C	1.1	3.222	4.9 x 3.0 x 1.4	2.0	7.0
MCP3008T	SPI	0.5	3.222	19.0 x 8.0 x 1.2	0.7	2.0
CONTROLLER'S ADC	**Analog**	**0.1**	**0.806**	**18.0 x 2.0 x 0.5**	**0.5**	**0.1**

SELECTED

CONTROLLER'S ADC

- Simplest method of voltage measurement under required resolution of 10mV.
- Low current consumption (0.1mA).
- No communication protocol required
- No additional sensors required



Formula Used	v_out = 0.2481 * V_in

Power Voltage Sensor Setup

Air Speed Sensor Trade & Selection

Sensor	Interface	Operating Voltage (V)	Current Consumption (mA)	Resolution (Pa)	Size (mm x mm x mm)	Weight (g)	Cost ($)
MPXV7002 DP	Analog	2.7-5.5	10	0.84	10.1 x 13.2 x 9.1	10	12
MS4525DO	I^2C /SPI	2.7-5.5	5.5	0.84	12.4 x 17.4 x 1.0	3	14
SDP37	**Analog**	**2.7-5.5**	**3.8**	**0.08**	**5.0 x 8.0 x 5.0**	**0.2**	**14**

SELECTED

SDP37

- Fastest response time (<5ms) **(Source: Datasheet)**
- Higher level of accuracy and calibration in Analog Interface when coupled with 12 bit ADC of SAMD21.
- Highest Pressure resolution of 0.08 pa.

AOut - Ratiometric Analog Voltage Output, VDD - VDD Supply, DP - Differential Pressure

Formula Used	$DP = 190 \cdot (AOut / VDD) - 38$

SDP37 (Air Speed Sensor)

Particulate/Dust Sensor Trade & Selection

Sensor	Interface	Operating Voltage (V)	Current Consumption (mA)	Resolution (µg/m3)	Size (mm x mm x mm)	Weight (g)	Cost ($)
SPS-30	UART/I^2C	4.5 - 5.5	60	1	40.6 x 40.6 x 12.2	26.0	12
PMS3003	I^2C /SPI	4.5 - 5.5	120	1	65.0 x 42.0 x 23.0	40.0	14
HPMA115S0-004	**UART**	**4.8-5.2**	**80**	**1**	**44.0 x 36.0 x 12.0**	**35.3**	**14**

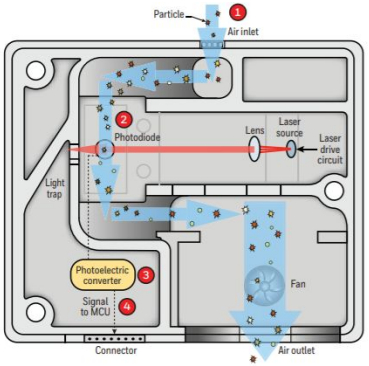
SELECTED

HPMA115S0-004

- Faster response time of <6 s allows the HPM Series to respond to environmental conditions in real time.
- Wide concentration range of 0 µg/m3 to 1,000 µg/m3.
- Low RMS noise 1 mV (MAX).

Working of Sensor

- Fan draws in air through inlet. Air passes through the laser where the light reflected off the particles is captured by the photodiode.
- The photodiode passes information to the photoelectric converter
- The photoelectric converter processes the signal from the particles into density.
- Signal is transmitted to micro control unit.



HPMA115S0-004 (Particulate Sensor)

Bonus Camera Trade & Selection

Sensor	Interface	Operating Voltage (V)	Current Consumption (mA)	Resolution (pixels)	Size (mm x mm x mm)	Weight (g)	Cost ($)
SQ11	Digital	2.7-5.5	200	480	22.0 x 22.0 x 12.0	4.0	3.22
OV7670	I^2C +Parallel Data	2.45-5.5	20	480	30.5 x 30.5 x 7.4	40.0	4.00
Turbowing cyclops dvr3	**Digital**	**4.2**	**220**	**720**	**18.0 x 18.0 x 8.0**	**4.5**	**25.00**

SELECTED

Turbowing cyclops dvr3

- **Stable frame rate of 30fps** compared to OV7670. (Tested)
- Less number of pins required for interface.
- **Higher resolution** of 720p.
- Camera's smaller dimensions helped in Camera Stabilisation,requiring rapid movements of servo motor.

Turbowing cyclops dvr3 (Camera)

Container Air Pressure Sensor Trade & Selection

Sensor	Interface	Operating Voltage (V)	Current Consumption (mA)	Resolution (Pa)	Size (mm x mm x mm)	Weight (g)	Cost ($)
MS5607	I^2C / SPI	1.80-3.60	12.5	2.40	20.3 x 2.5 x 20.3	1.0	8.90
BME 280	I^2C / SPI	1.71-3.60	3.40	0.18	19.0 x 18.0 x 3.0	1.0	5.95
BMP 280	**I^2C / SPI**	**1.71-3.60**	**2.70**	**0.16**	**19.7 x 17.0 x 2.9**	**1.3**	**2.60**

SELECTED

BMP 280

- High absolute accuracy of 1 hPa with an excellent relative accuracy of ±0.12 hPa
- Low power consumption due to **2.7µA** current consumption @1Hz sampling rate.
- High Measurement rate of 157 Hz provides data at much short intervals of time.
- Reliable Communication of **I^2C(up to 3.4 MHz)** and **SPI(up to 10MHz)**. Temperature, humidity, pressure measurable in one sensor.Easy to use and debug because of past experiences.

BMP 280 (Air Pressure Sensor)

Descent Control Design

Presenter: EABY ABRAHAM

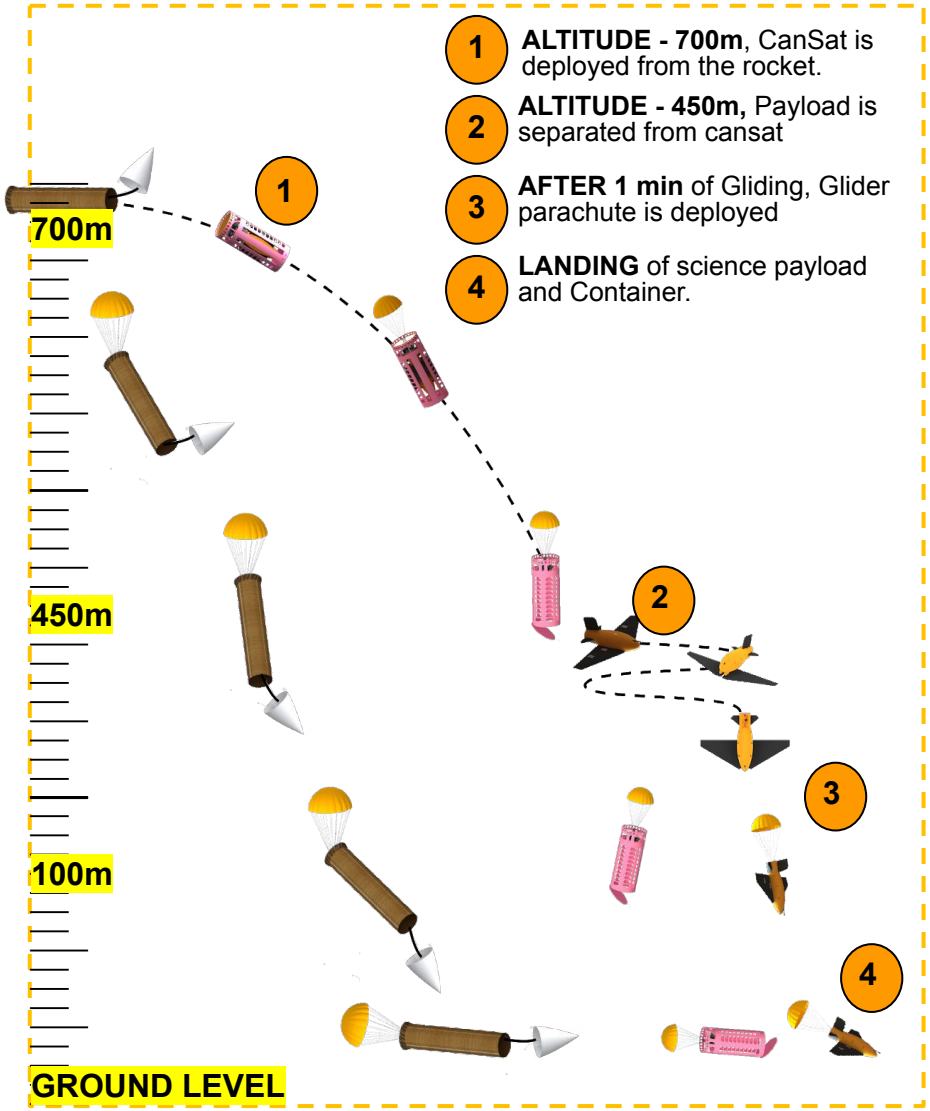
Descent Control Overview

Descent Control System

- **Container Descent**: The container will descend with hexagonal parachute of 22.86cm diameter.
- **Payload Descent**: Delta shaped low wing configuration (with aft tail horizontal stabilizers) is used to facilitate stable payload descent.

Selected Configurations

- **Wings** are made of carbon fibre to provide sufficient stiffness with a root chord length of 120mm and a wingspan of 300mm to provide sufficient amount of lift.**SELIG S7075 airfoil** is selected due to high camber which facilitates gliding even at low velocities.
- **Horizontal stabilizers** made of carbon fibre are added to stabilize the pitching moment of the payload. NACA 0012 airfoil is used.
- **Container parachute** is a hexagonal parachute made up of Nylon, having 22.86cm diameter.
- **Payload parachute** is also a hexagonal parachute made up of Nylon with a diameter of 30.48 cm.



Descent Control Requirements

ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
DCS 1	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	Mission Requirement	BR8	MS 8	High				+
DCS 2	The descent rate of the CanSat (container and science payload) shall be 20 m/s and +/- 5m/s.	Mission Requirement	BR9	-	High	+		+	
DCS 3	The container shall release the payload at 450 meters +/- 10 meters.	Technical Constraint	BR10	MS 9	High	+		+	
DCS 4	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	Mission Requirement	BR11	MS 10	High	+		+	
DCS 5	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s	Mission Requirement	BR13	MS 11	High	+		+	
DCS 6	All descent control device attachment components shall survive 30 Gs of shock.	Mission Requirement	BR14	MS 13	High	+		+	

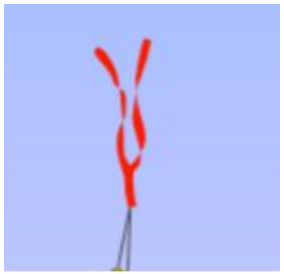
Payload Descent Control Strategy Selection and Trade [1/5]

Pre-Payload Deployment: Stowed Payload Descent Rate Control (Passive) from Apogee to 450 m

Shape	Diameter (cm)	Drag Coefficient	Mass (g)	Cost ($)	Descent Rate (m/s)
Cruciform	30.86	0.75	28	25	19.14
Streamers	20.00	0.50	10	20	20
Flat Round Canopy	24	0.45	16	17	15.21
Hexagonal	**22.86**	**1.09**	**16**	**9**	**16.95**

Cruciform

Hexagonal



Streamers

Flat Round Canopy

SELECTED

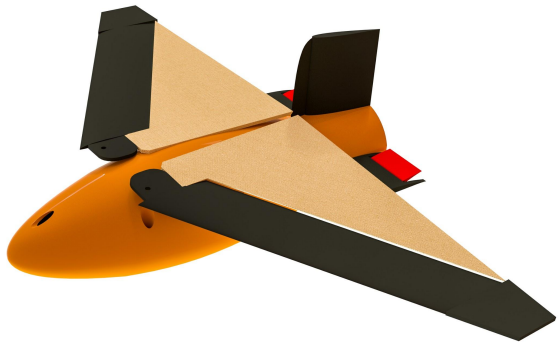
HEXAGONAL PARACHUTE

- High drag coefficient
- Lightweight and compact
- Delivers required descent rate
- Stable descent with minimal pendular motion

Payload Descent Control Strategy Selection and Trade [2/5]

Post-deployment: Deployed Payload Descent Rate Control (Above 100m)

Design Strategy 1: High wing delta glider with servo actuated wing deployment

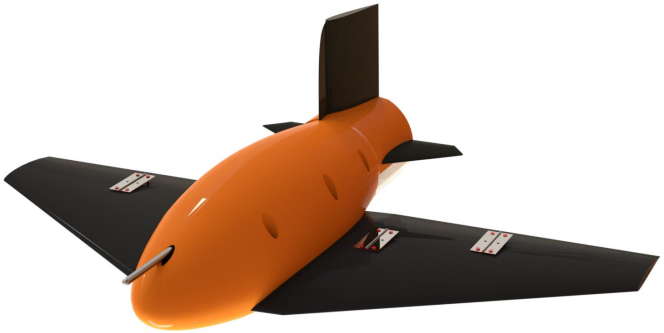


Descent initiation: As soon as the glider is deployed the servo motor is triggered which opens the wings of glider.

Delta shaped fabric is used for easy integration and to produce extra lift which will not only increase the gliding time but also will reduce the weight.

Airfoil Used: **NACA 0012** is used as it has a high stall angle and is quite easy to fabricate. It also provides sufficient lift at ground level which ensures smooth landing of the glider.

Design Strategy 2: Low wing having spring hinge for wing opening



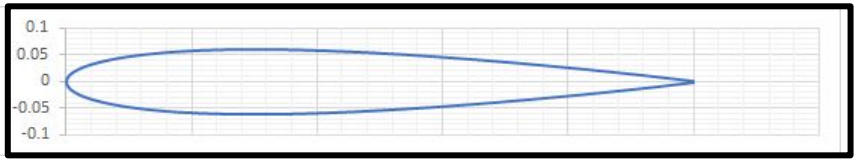
Descent initiation: As soon as the glider is deployed spring hinges placed on the wings unfolds the wings of glider.

Solid Delta shaped wing is used which produces greater lift. By using solid wing airfoil shape is properly used which increases the gliding time.

Airfoil Used: **Selig S7075** is used as it has high coefficient of lift and low coefficient of drag. This will not only increase the gliding time but will also increase the stall speed of the payload.

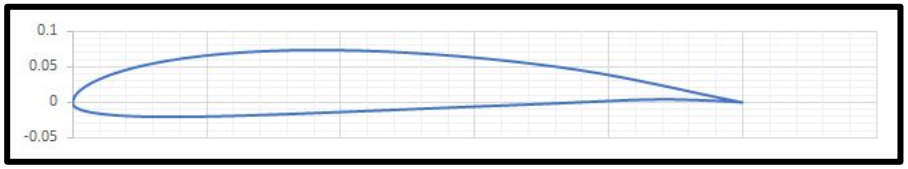
Payload Descent Control Strategy Selection and Trade [3/5]

NACA - 0012

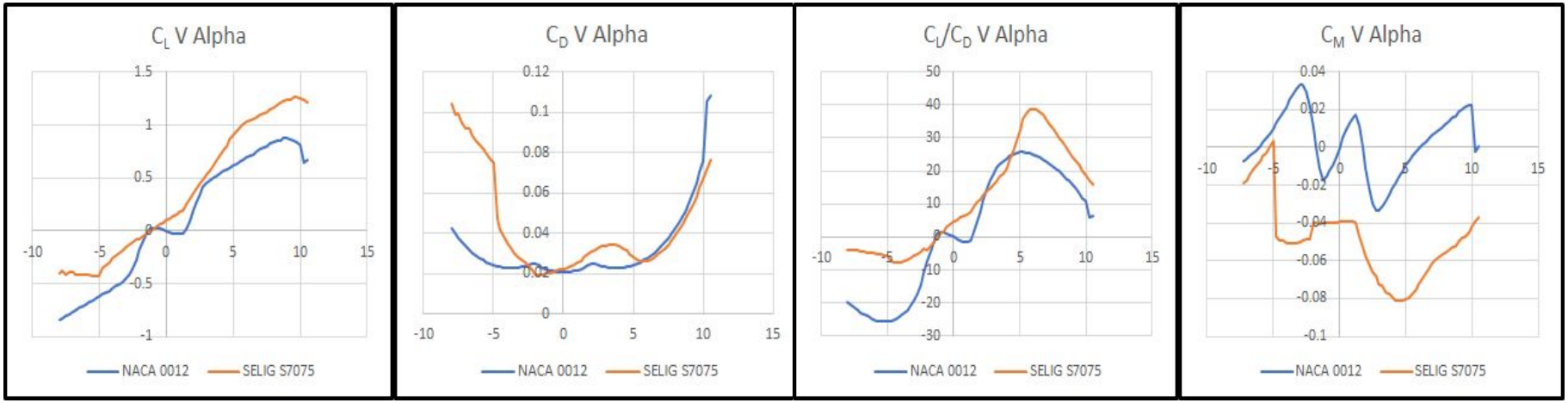


Max thickness 12% at 30% chord.
Max camber 0% at 0% chord

SELIG S7075



Max thickness 9% at 29% chord.
Max camber 2.8% at 46.8% chord



Reasons for selection of **SELIG S7075** Airfoil**:**

- Better lift to drag ratio.
- Low pitching moment.
- Better stall quality in stall region.

Payload Descent Control Strategy Selection and Trade [4/5]

	Design Strategy 1	Design Strategy 2
PROS	➢ More maneuverability of glider due to high wing.	➢ Airfoil provides more lift.
	➢ Airfoil is easy to manufacture.	➢ High stall angle with greater stall recovery.
	➢ Higher lateral dynamic stability.	➢ Low Center of gravity provides stability.
CONS	➢ High center of gravity.	➢ Wingtips are more susceptible to shock damage.
	➢ Low glide ratio with low pitching moment coefficient.	➢ High cost of manufacturing of airfoil.

Design Strategy	Quick Action	Self Sustainable Action	Weight	Cost	Total
1	8	6	7	7	28
2	**9**	**8**	**9**	**8**	**34**

SELECTED

Design Strategy 2

- ➢ Quick and reliable deployment.
- ➢ More effectively controlled payload descent.
- ➢ Minimal electronics required to achieve deployed state.

(0 to 10)
0-Least, 10-Most

Payload Descent Control Strategy Selection and Trade [5/5]

Payload descent Rate Control After One Minute of Gliding

Shape	Diameter (cm)	Drag Coefficient	Mass (g)	Cost ($)	Descent Rate (m/s)
Cruciform	31.86	0.75	47	25	10.67
Circular	30.80	0.85	38	11	9.80
Flat Round Canopy	24	0.45	35	17	11
Hexagonal	**30.48**	**1.09**	**20**	**9**	**10.20**

Cruciform

Circular

Hexagonal

Flat Round Canopy

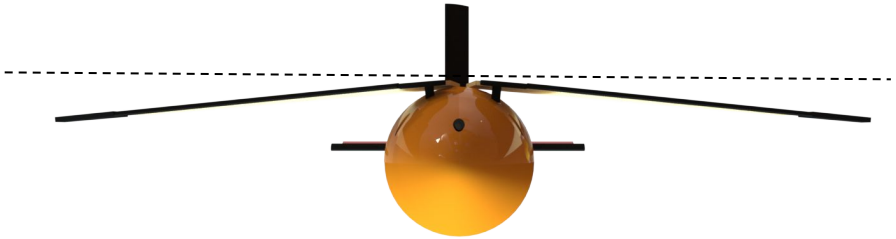
SELECTED

HEXAGONAL PARACHUTE

- High drag coefficient
- Lightweight and compact
- Delivers required descent rate
- Stable descent with minimal pendular motion

Payload Descent Stability Control Strategy Selection and Trade [1/7]

CONFIGURATION 1: ACTIVE STABILIZERS WITH HIGH WING CONFIGURATION

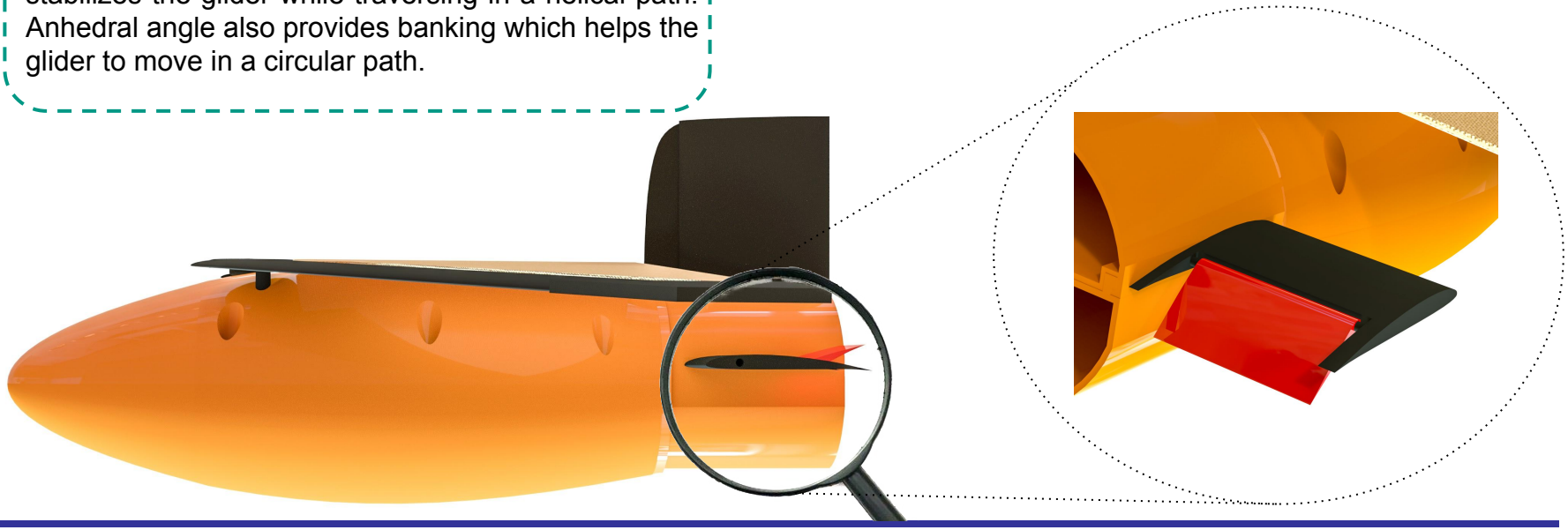


Anhedral Angle

Negative dihedral (anhedral) is provided with high wing configuration. It facilitates maneuverability and stabilizes the glider while traversing in a helical path. Anhedral angle also provides banking which helps the glider to move in a circular path.

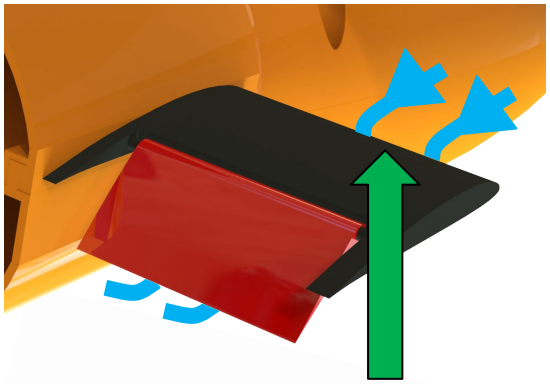
Elevator

Active horizontal stabilizer system is used to control descent stability. This is an efficient system as it is more sensitive and works even if there is a slight change in the orientation of glider due to unwanted forces.

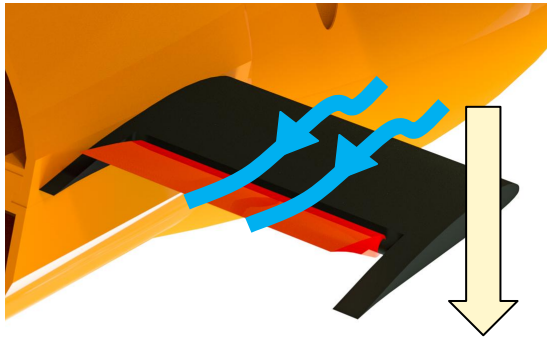


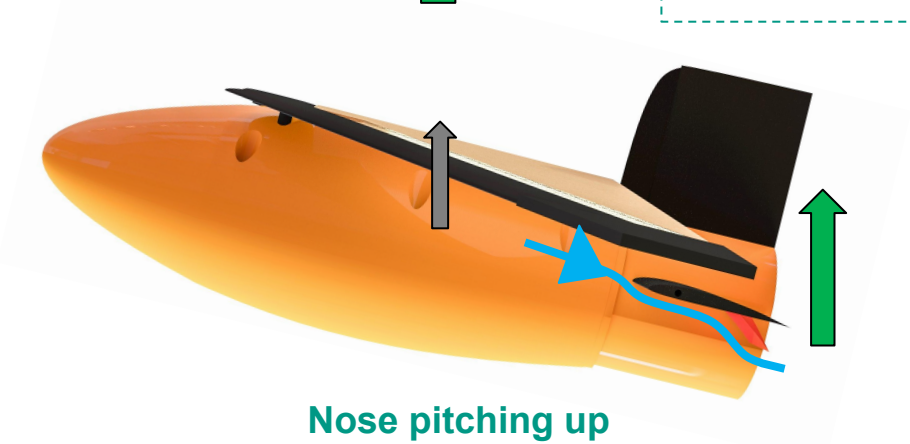
Payload Descent Stability Control Strategy Selection and Trade [2/7]

TYPE OF STABILIZATION USED: ACTIVE



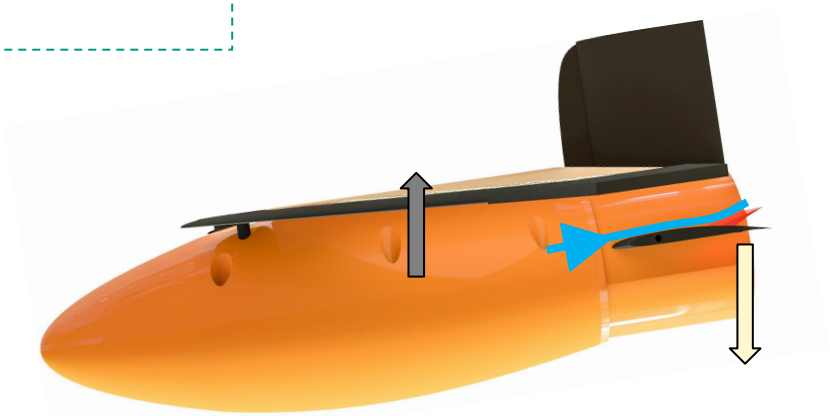
When the nose of the glider is pitching up, the MCU signals the servo to rotate the elevator downwards or upwards to produce an opposing torque which prevents pitching motion of the payload.





Nose pitching up

Stable flight is maintained due to lowering down of elevator in nose up condition

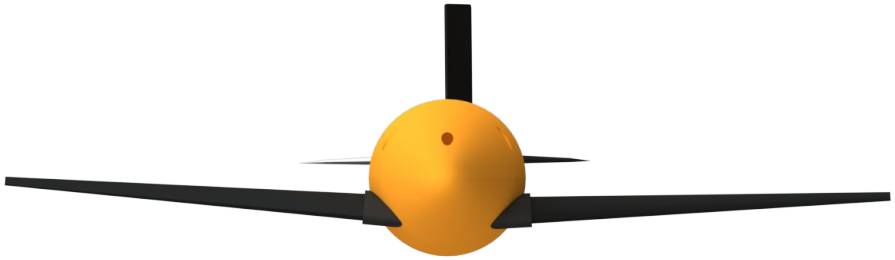


Nose pitching down

Stable flight is maintained due to upward movement of elevator in nose down condition

Payload Descent Stability Control Strategy Selection and Trade [3/7]

CONFIGURATION 2: LOW WING WITH PASSIVE STABILIZERS

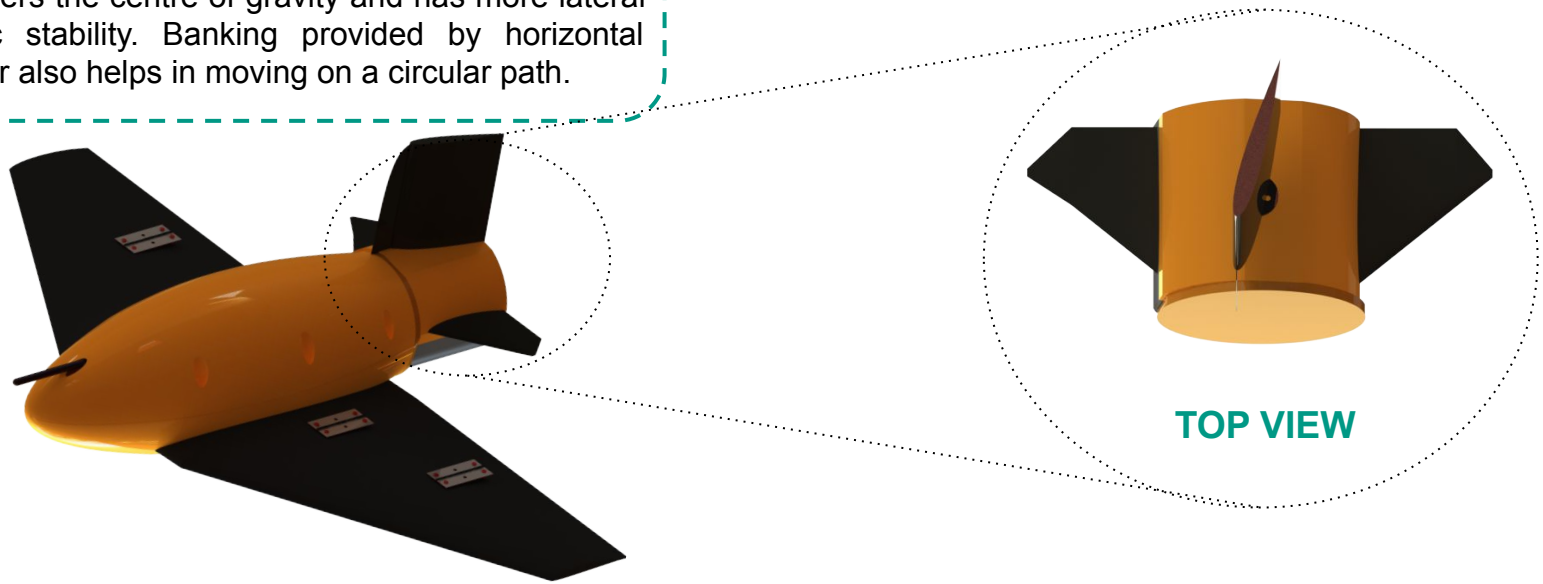


Horizontal Stabilizer

Passive horizontal stabilizer with single rudder is used to stabilize the glider. Passive stabilizer not only reduces the weight but also avoids unnecessary pitch movement.

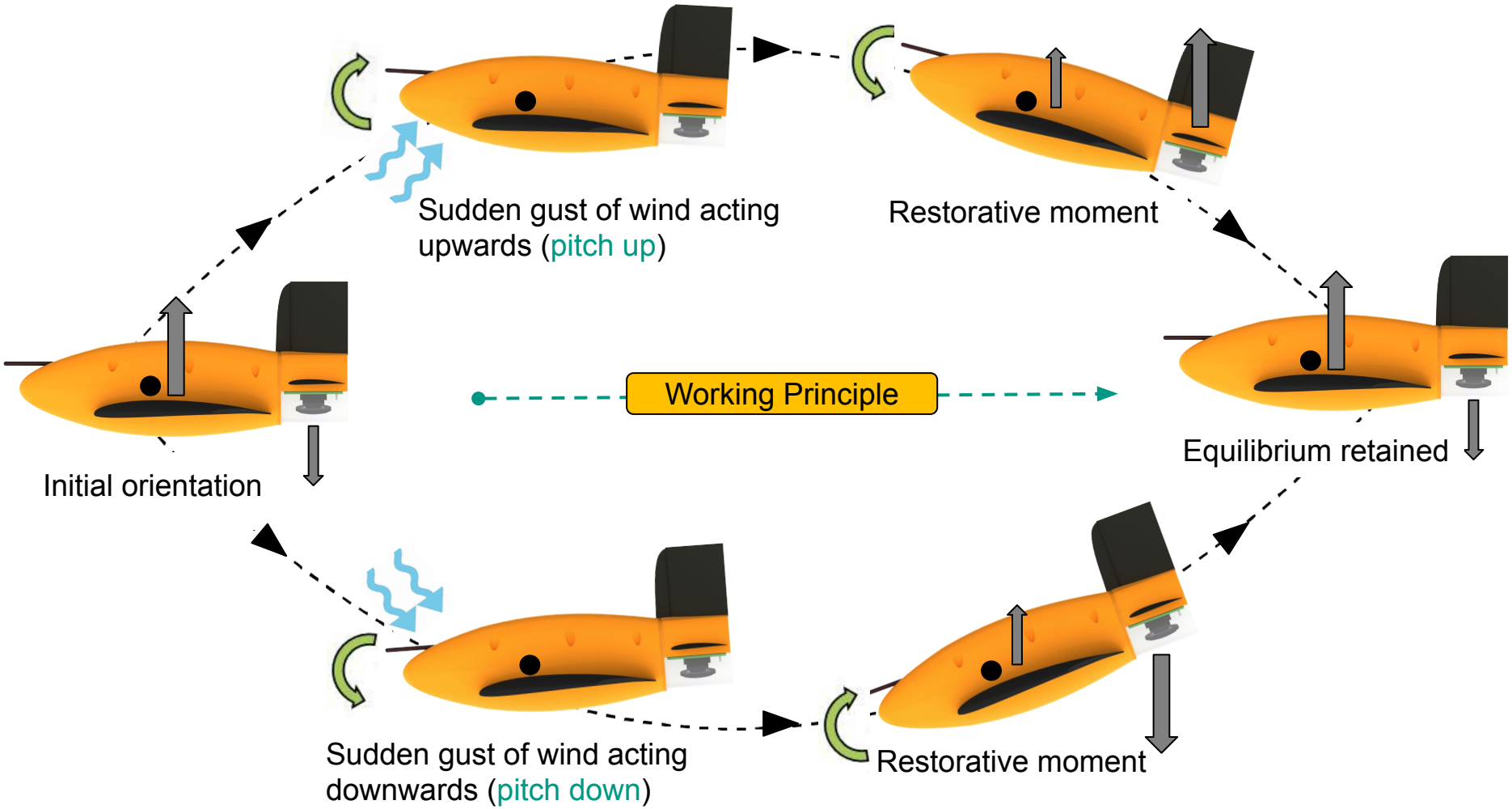
Positive dihedral angle

Positive dihedral provides roll stability and helps glider to maintain its position. Low wing configuration also lowers the centre of gravity and has more lateral dynamic stability. Banking provided by horizontal stabilizer also helps in moving on a circular path.



Payload Descent Stability Control Strategy Selection and Trade [4/7]

TYPE OF STABILIZATION USED: PASSIVE



Payload Descent Stability Control Strategy Selection and Trade [5/7]

	Design Strategy 1	Design Strategy 2
PROS	➢ Active horizontal stabilizers are accurate.	➢ Single rudder prevents turbulence.
	➢ System remains stable even in adverse conditions.	➢ Restoring moment enhances stability.
CONS	➢ Increased weight in parachute compartment shifts COG backwards, hence making it unstable	➢ Passive horizontal stabilizers are less reliable
	➢ More moving parts add to the complexity of the system.	➢ Fails to maximise the lift force on the system

Design Strategy	Effective Control	Ease of Manufacturability	Reliability	Overall Cost	Weight	Total
1	8	6	9	7	6	36
2	**9**	**8**	**7**	**9**	**9**	**42**

SELECTED

Design Strategy 2

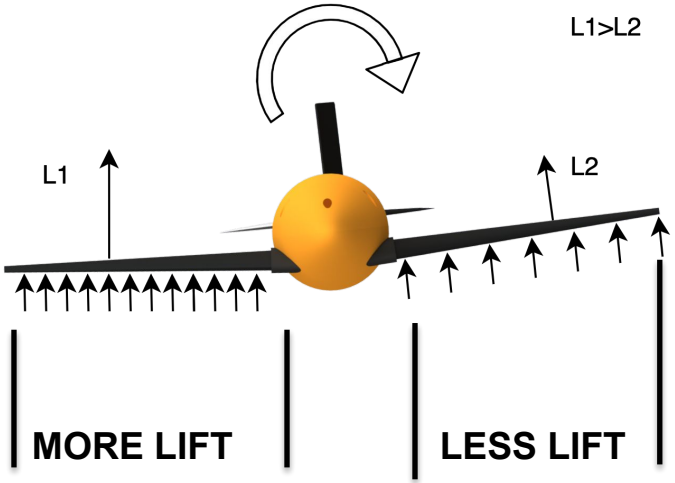
- ➢ Passive system counteract the pitching moment instantly.
- ➢ Doesn't rely on any moving parts, thus reduces the system's complexity.
- ➢ Eliminates the need of secondary power source.

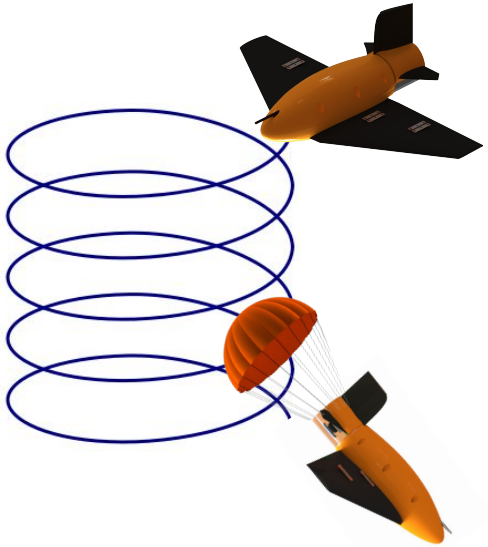
(0 to 10)
0-Least, 10-Most

Payload Descent Stability Control Strategy Selection and Trade [6/7]

Maintaining Nadir Direction and Tumbling Prevention

- Nadir direction is maintained with the help of dihedral angle which provides a restoring roll force present with non-zero angles of sideslip that helps to keep aircraft at wings-level, i.e., the equilibrium position of the glider in the circular path.
- The placement of Center of gravity in front of Center of pressure ensures stable descent. Longitudinal stability is maintained with the help of horizontal stabilizers.
- In order to avoid adverse yaw and provide directional stability, single rudder has been used. This is important when it has to be made sure that nose of the glider is always in the direction of tangent to the circular path at that point. If nose is oriented in some other direction then the glider may lose its desired helical path.
- Slightly variable dihedral angle also gives banking which provides necessary centripetal force to move glider in a circular path.

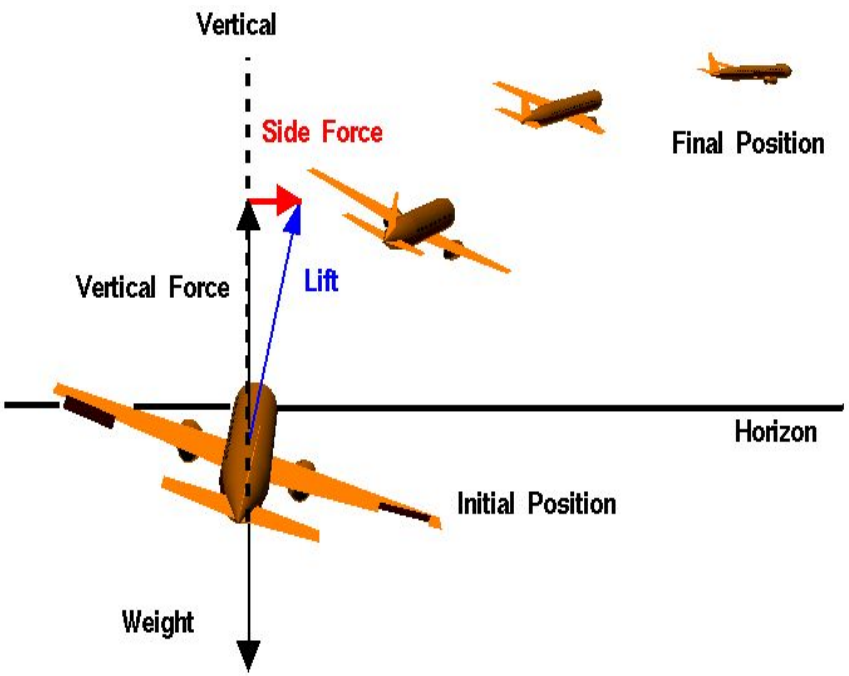




Payload Descent Stability Control Strategy Selection and Trade [7/7]

Maintaining Helical Path

- The glider is banked because of variable dihedral angle which generates unequal amount of lift on the two wings.
- The lift on the wings of the aircraft is a vector quantity which is always directed perpendicular to the flight path and perpendicular to the wings generating the lift.
- The horizontal component of lift force is an unopposed side force which is in the direction of the roll, and perpendicular to the flight path.
- This side force provides necessary centripetal force which turns the glider.
- The vertical component of lift force balances the weight of the glider.
- As long as the aircraft is banked, the side force is a constant, unopposed force on the aircraft.
- The resulting motion of the center of gravity of the aircraft is a circular arc.



Dynamics of helical descent

Descent Rate Estimates [1/4]

$$V = \sqrt{\frac{2mg}{\rho C_d A}}$$

FORMULA USED: (for Descent Using Parachute)

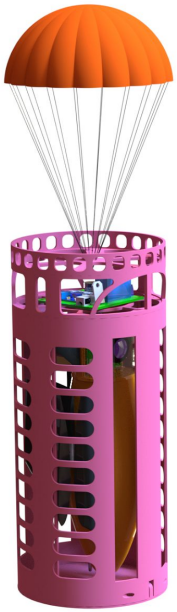
- V = Descent Rate
- Cd = Coefficient of Drag
- m = Mass
- A = Area of Parachute

Assumptions:

- The frontal area of the parachute is approximated to the area of hexagon.
- The effect of crosswind is neglected.
- The effect of change in density with with the altitude is negligible, thus neglected.

Container + Payload

- **m = 595g**
- **Cd = 1.09**
- **A = 0.0339m^2**
- **ρ = 1.10kg/m^3**



V = 16.95 m/s

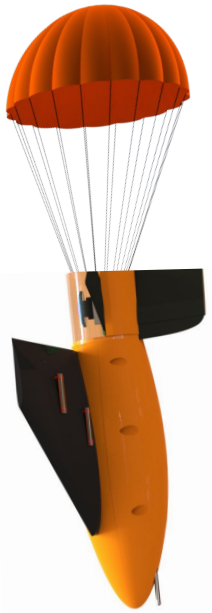
Container Only

- **m = 205g**
- **Cd = 1.09**
- **A =0.0339m^2**
- **ρ = 1.12 kg/m^3**

V = 9.86 m/s

Payload with Parachute released

- **m = 390g**
- **Cd = 1.09**
- **A = 0.0603m^2**
- **ρ = 1.12 kg/m^3**



V = 10.20m/s

Descent Rate Estimates [2/4]

Glider Descent while gliding (Wing Flow Simulation)

Wings			V =	20.62 m/s
Wing Span	=	0.300 m	Alpha =	10.000°
xyProj. Span	=	0.299 m	Beta =	0.000°
Wing Area	=	0.024 m²	CL =	0.855
xyProj. Area	=	0.024 m²	CD =	0.079
Plane Mass	=	0.000 kg	Efficiency =	0.997
Wing Load	=	0.000 kg/m²	CL/CD =	10.776
Tail Volume	=	0.203	Cm =	0.326
Root Chord	=	0.120 m	Cl =	0.000
MAC	=	0.087 m	Cn =	0.000
TipTwist	=	0.000°	X_CP =	0.067 m
Aspect Ratio	=	3.750	X_CG =	0.100 m
Taper Ratio	=	3.000		
Root-Tip Sweep	=	21.801°		
Mesh elements	=	2498		

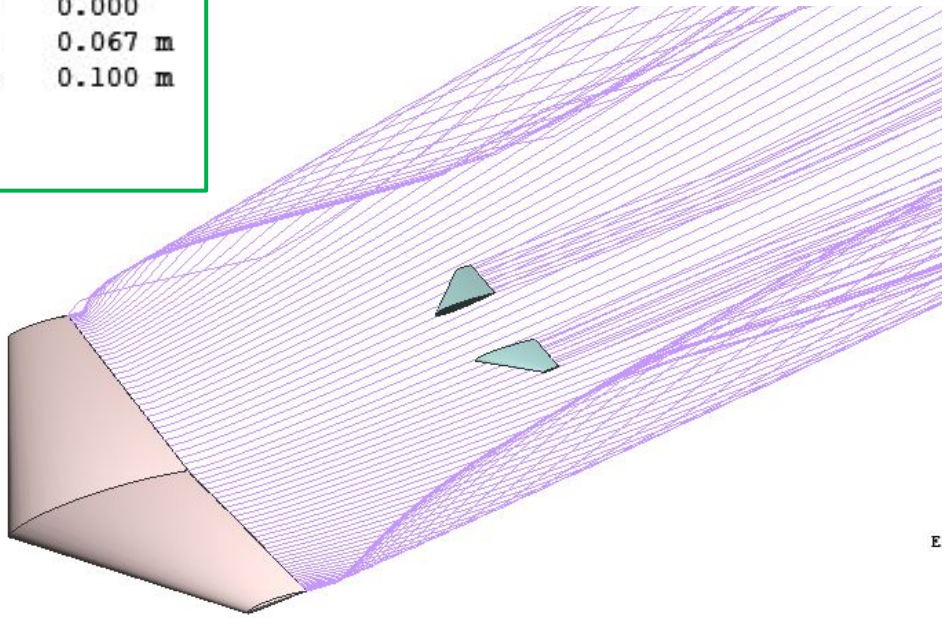
Formulae used

Lift Force $= \frac{\rho \times C_l \times V^2 \times A}{2}$

$=$ **4.596 N**

Drag Force $= \frac{\rho \times C_d \times V^2 \times A}{2}$

$=$ **0.425 N**



Descent Rate Estimates [3/4]

Glider Descent while gliding (Above 100m)

Formulae used

- From the **CFD simulation**, the **horizontal velocity** comes out to be **20m/s** to achieve the desired lift.

- **Glide Ratio** = (Coefficient of lift)/(Coefficient of drag)
  = 0.855/0.077
  =10.81

- **tan(a)**= 0.092 , where a is **glide angle**
  a = 5.25°

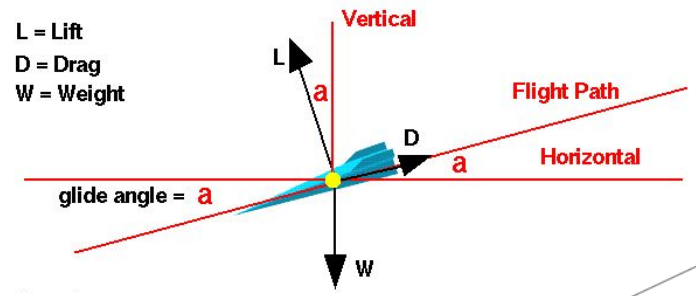
- **Sink speed** = $\frac{Horizontal\ Speed}{glide\ Ratio} = \frac{20}{10.81}$

  = 1.85 m/s

Reference: https://www.grc.nasa.gov/www/k-12/airplane/glidvec.html

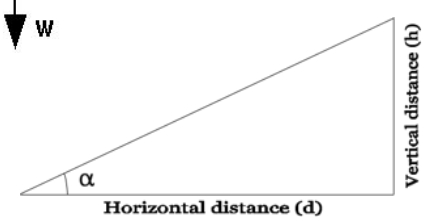
Assumptions for Descent Rate Calculations

- Tip losses around the wings are neglected.
- The effect of crosswind is also neglected.
- The drag due to uneven surfaces is neglected.
- Various coefficients like C_L, C_D and reynold's number are considered constant throughout the flight.



tan(a)= 0.092

a = 5.25°



Descent Rate Estimates [4/4]

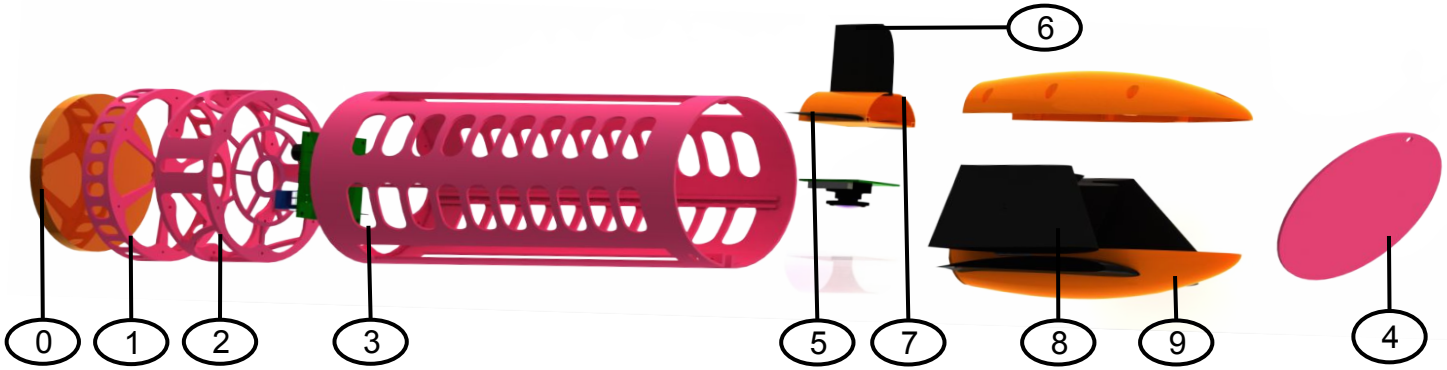
Descent Rates Summary

Configuration	Initial Position During Descent (m)	Mass (g)	Descent Rate Estimates (m/s)
Container with payload	700	595	**16.95**
Container (post release of payload)	450	205	**9.86**
Payload (following separation from container)	450	390	**1.85**
Payload with Parachute released	100	390	**10.20**

Mechanical Subsystem Design

Presenter: Vipra Bharadwaj

Mechanical Subsystem Overview [1/2]



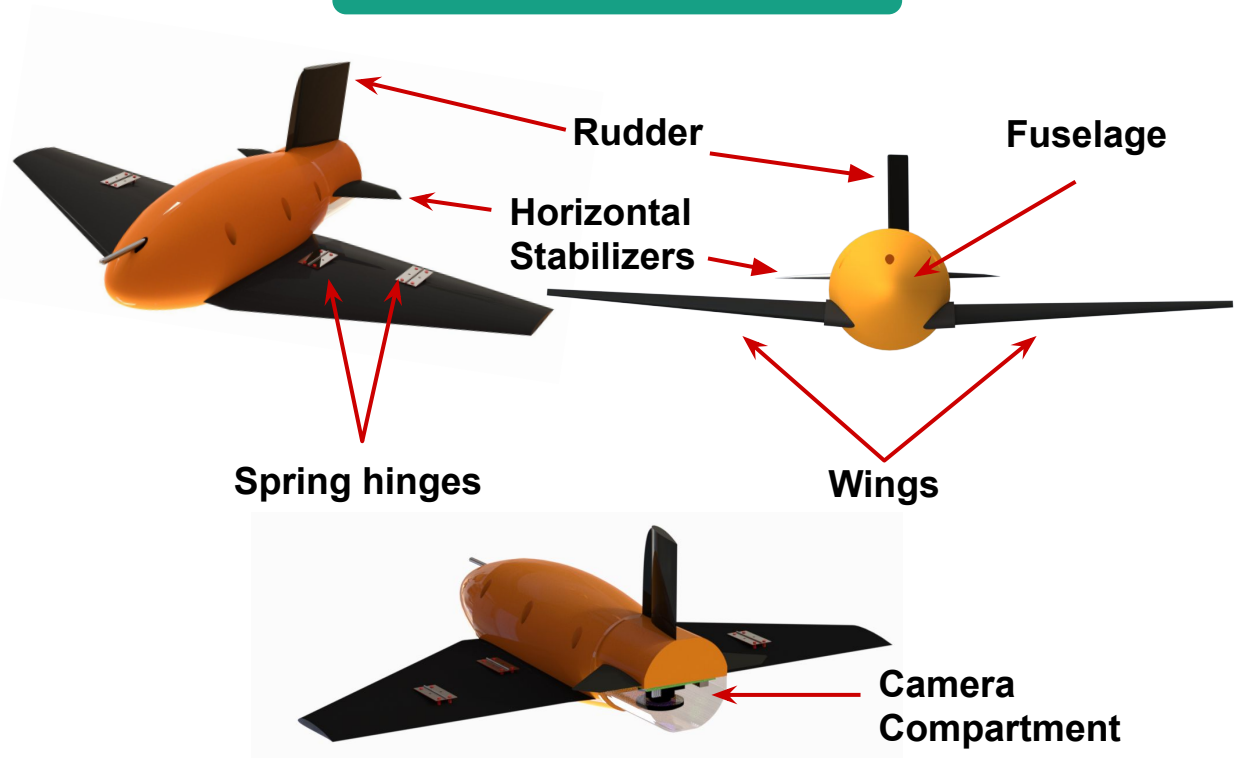
Container	Material
Parachute (0)	Ripstop Nylon
Parachute Compartment (1)	SLS Printed HIPS
Electronics Compartment(2)	SLS Printed HIPS
Main Body (3)	SLS Printed HIPS
Lid (4)	SLS Printed HIPS
Payload	**Material**
Horizontal Stabilizer (5)	Carbon Fiber
Rudder (6)	FDM printed PLA
Parachute Compartment (7)	FDM printed PLA
Wings (8)	Carbon Fiber
Fuselage (9)	SLS Nylon PA 2200

Interface Definitions	
Payload	**Container**
• Modular design based on horizontal modules alignment • Self opening hinges to accommodate large wings. • Parachute is attached to the mount using an O-ring. • Easily accessible power switch to turn on the payload electronics. • BMP and pitot tube are mounted on the body of the payload.	• Bottom lid is closed with nylon thread which will melt due to hot nichrome filament at 450m. • Parachute is mounted using an O-Ring to the parachute mount. • Easily accessible power switch to turn on the container electronics

Mechanical Subsystem Overview [2/2]

Container

Payload / Glider



Container Colour: **PINK** (According to Mission Requirement)

Payload/Glider Colour: **ORANGE***

*The colors of the glider are only for illustration purpose and do not represent the actual colour scheme

Mechanical Sub-System Requirements [1/2]

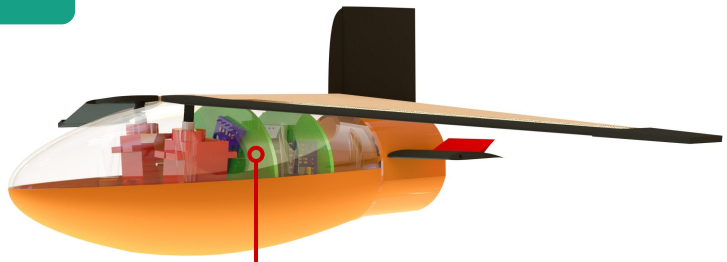
ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
MS 1	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	Mission Requirement	BR1	-	High	+	+	+	+
MS 2	CanSat shall fit in a cylindrical envelope of 125mm diameter x 310mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Mission Requirement	BR2	-	High	+	+	+	
MS 3	The container shall be a fluorescent color; pink, red or orange	Mission Constraint	BR4	-	High			+	+
MS 4	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Mission Requirement	BR3	-	High	+	+		
MS 5	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed	Mission Requirement	BR5	-	High	+	+	+	
MS 6	The science payload shall be a delta wing glider.	Mission Requirement	BR12	-	High	+	+	+	
MS 7	The rocket airframe shall not be used to restrain any deployable parts of CanSat and also not be used as part of CanSat operations	Mission Requirement	BR6, BR7	-	Medium	+			

Mechanical Sub-System Requirements [2/2]

ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
MS 8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket	Competition Requirement	BR8, DCS 1	-	High		+	+	+
MS 9	The container shall release the payload at 450 meters/-10 meters.	Competition Requirement	BR10, DCS 3	-	High	+	+		
MS 10	The science payload shall glide in a circular pattern for one minute and stay above 100 meter after release from the container	Technical Constraint	BR11, DCS 4	-	High	+	+		
MS 11	After one minute of gliding,the glider shall release a parachute to drop the science payload to the ground at 10 m/s +/- 5m/s.	Competition Requirement	BR13, DCS 5	-	High	+	+		
MS 12	Mechanisms that use heat(eg.nichrome wire shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Competition requirement	BR21	-	Medium	+	+	+	+
MS 13	All descent control device attachment components shall survive 30 Gs of shock and 15 Gs of acceleration	Competition requirement	BR14, DCS 6	-	High		+	+	
MS 14	Mechanisms shall not use pyrotechnics or chemicals	Competition requirement	BR20	-	Medium	+	+	+	+

Payload Mechanical Layout of Components Trade & Selection [1/5]

DESIGN STRATEGY 1



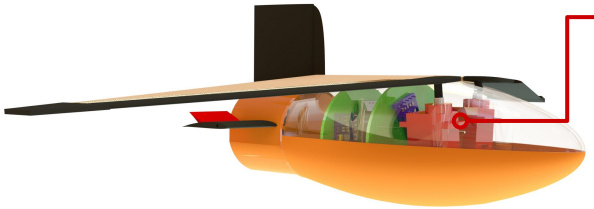
ANHEDRAL

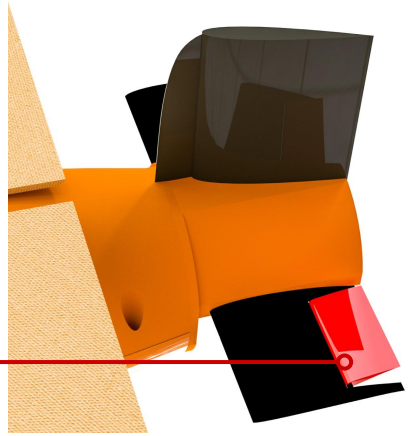
HIGH WING

VERTICAL PCB

SERVO MOTOR

ELEVATORS



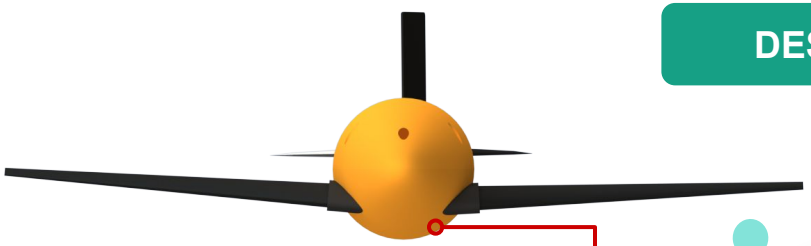


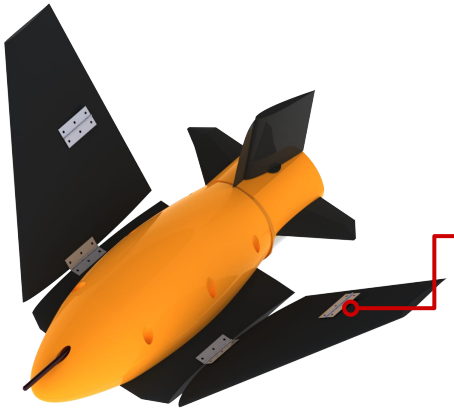
Description

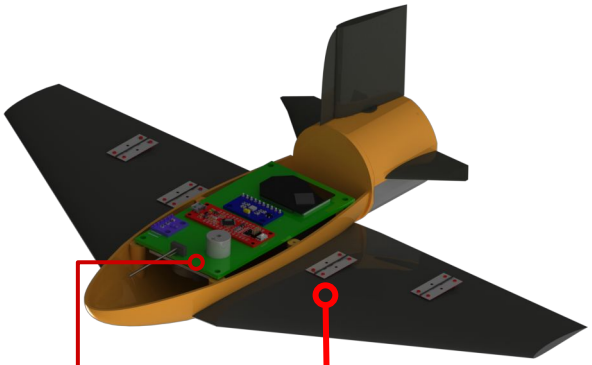
- Servo motors are used for wing deployment.
- Helps to reduce unnecessary force experienced by the wings.
- Active horizontal stabilizers with high wing configuration are used.

Payload Mechanical Layout of Components Trade & Selection [2/5]

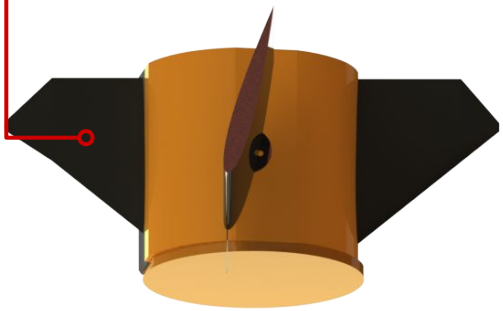
DESIGN STRATEGY 2







Spring Hinge



LOW WING

DIHEDRAL

HORIZONTAL PCB

SPRING HINGES

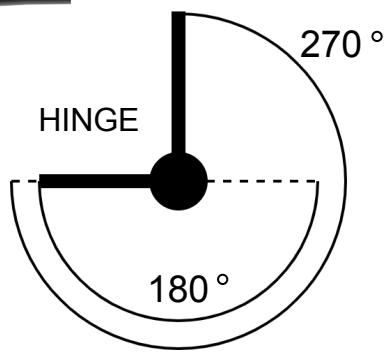
HORIZONTAL STABILIZERS

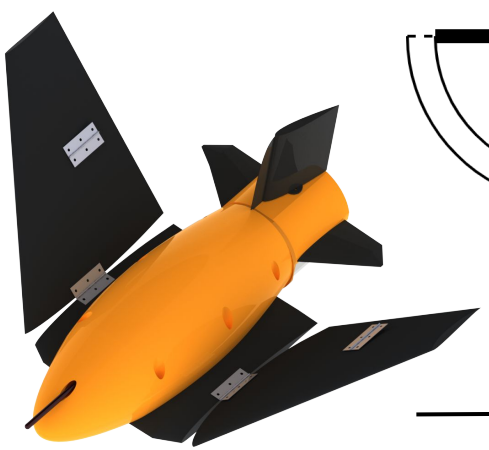
Passively controlled wing opening

- Passive horizontal stabilizers are used.
- Low wing configuration has been used.
- Spring hinges are used to unfold wings.
- Positive dihedral has been given in the wings.
- PCB has been mounted horizontally.

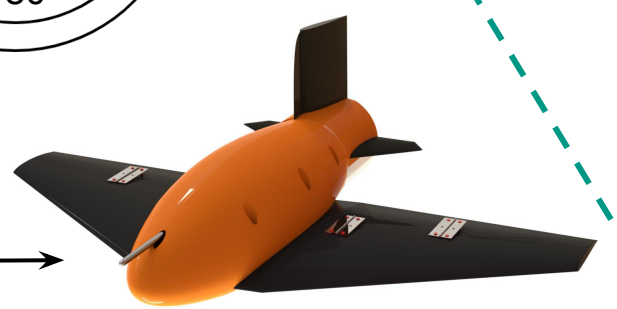
Payload Mechanical Layout of Components Trade & Selection [3/5]

STAGE 1: CLOSED CONFIGURATION

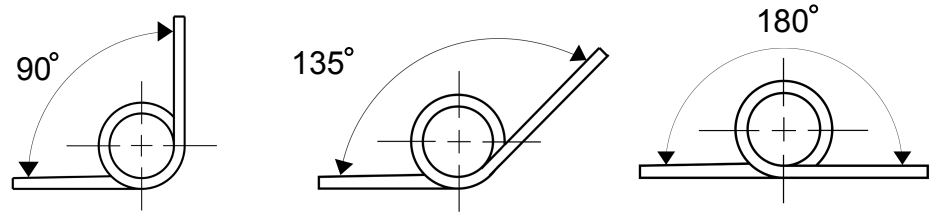




STAGE 2: INTERMEDIATE

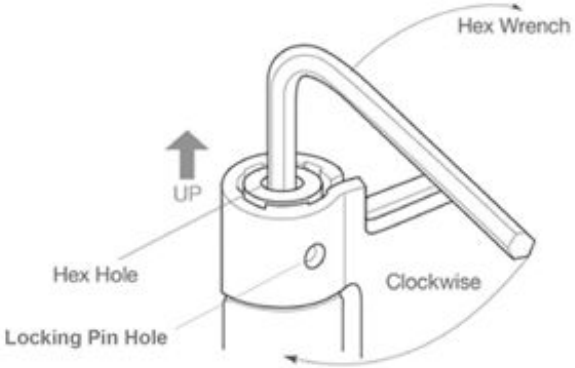


STAGE 3: DEPLOYED



Stage 1 **Stage 2** **Stage 3**

- Wings of glider shall unfold using spring hinges which are screwed on the wings.
- Stage wise opening sequence of spring hinges is shown in the diagram.
- The tension in the spring can be manipulated by using an allen key .



Payload Mechanical Layout of Components Trade & Selection [4/5]

	Design Strategy 1	Design Strategy 2
PROS	➢ Servomotor mechanism provides good locking system.	➢ Spring mechanism is lightweight and no extra mechanism is required.
	➢ Anhedral angle contributes to maneuverability.	➢ Dihedral angle provides roll stability.
	➢ The center of lift is higher in a high-wing thus providing more lift.	➢ Low wings provide lower center of gravity.
CONS	➢ Decreased roll stability.	➢ Low center of lift.
	➢ Heavy weight and more manufacturing cost.	➢ Less maneuverability.

Design Strategy	Lift	Stability	Ease of Operation	Cost	Ease of Fabrication	Total
1	8	7	7	8	6	36
2	**7**	**9**	**8**	**6**	**8**	**38**

SELECTED

Design Strategy 2

- ➢ Design is light in weight and dihedral provides better roll stability.
- ➢ Less manufacturing cost because springs are used instead of servo motor.

.

(0 to 10)
0-Least, 10-Most

Payload Mechanical Layout of Components Trade & Selection [5/5]

Material Selection

Material	Density (g/cm^3)	Impact Strength (KJ/m2)	Machinability (out of 10)	Cost($/cc)
PLA	**1.05**	**26**	**7**	**1**
Nylon PA 2200	**1.25**	**53**	**10**	**1.05**
Carbon Fiber	**1.81**	**2457**	**7**	**3**
ABS	1.17	1360	8	1

FUSELAGE

Reason for selection of Nylon PA 2200

- High impact strength.
- High strength to weight ratio.
- Ease of manufacturing.

RUDDER

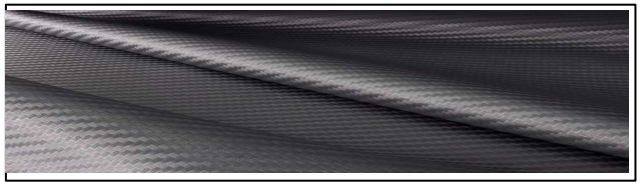
Reason for selection of PLA

- Lightweight and cheap.
- Better resistance to shock.

HORIZONTAL STABILIZERS AND WINGS

Reason for selection of Carbon Fiber

- High resistance to shock.
- High stiffness to weight ratio.
- Excellent tensile strength.



Payload Pre Deployment Configuration Trade & Selection [1/3]

Design Strategy 1

PARACHUTE

CONTAINER ELECTRONICS

THREAD MOUNT

CUTTING BLADE AND SERVO MOTOR

PAYLOAD

DEPRON

LID

DEPRON is used to safeguard payload from launch vibration and to restrict the movement of glider inside the container.

Payload Pre Deployment Configuration Trade & Selection [2/3]

Design Strategy 2

PARACHUTE

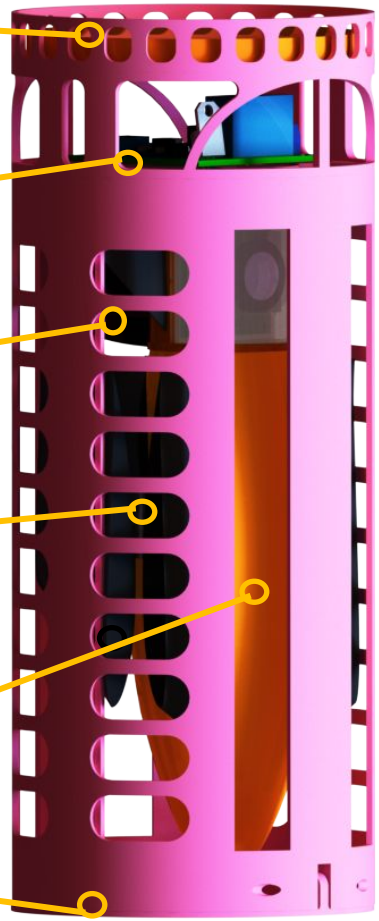
CONTAINER ELECTRONICS

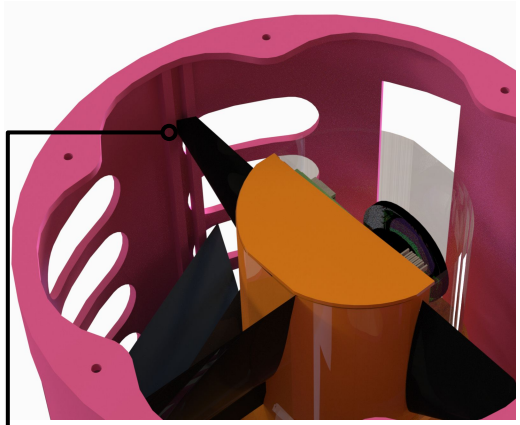
GLIDER TAIL PART

WINGS

FUSELAGE

LID





Guide Rails for horizontal stabilizers are provided in order to restrict the movement of glider inside the container and to facilitate glider deployment.

Payload Pre Deployment Configuration Trade & Selection [3/3]

	Design Strategy 1	Design Strategy 2
PROS	➢ DEPRON safeguards payload from launch vibration.	➢ Rotation of payload is restricted by having L- shape protrusions.
	➢ Easy to design and manufacture.	➢ Could easily sustain the G shock.
CONS	➢ Vulnerable to G shock.	➢ Horizontal stabilizers susceptible to G shock.
	➢ Servo mechanism is prone to failure due to slip between gears.	➢ Nichrome wire heating mechanism requires 700-900mA of current which require high capacity battery.

Design Strategy	Shock Resistance	Ease of Manufacturability	Reliability	Overall Cost	Weight	Total
1	6	8	6	7	8	35
2	**9**	**7**	**9**	**9**	**7**	**41**

SELECTED

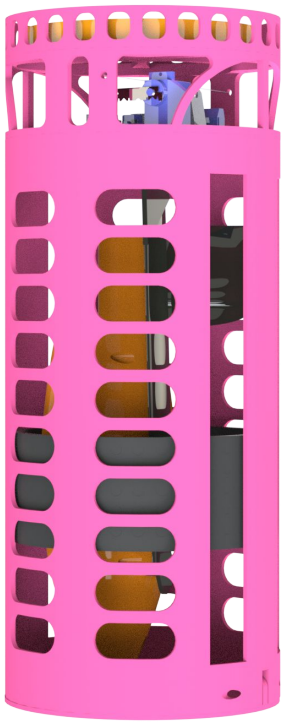
Design Strategy 2

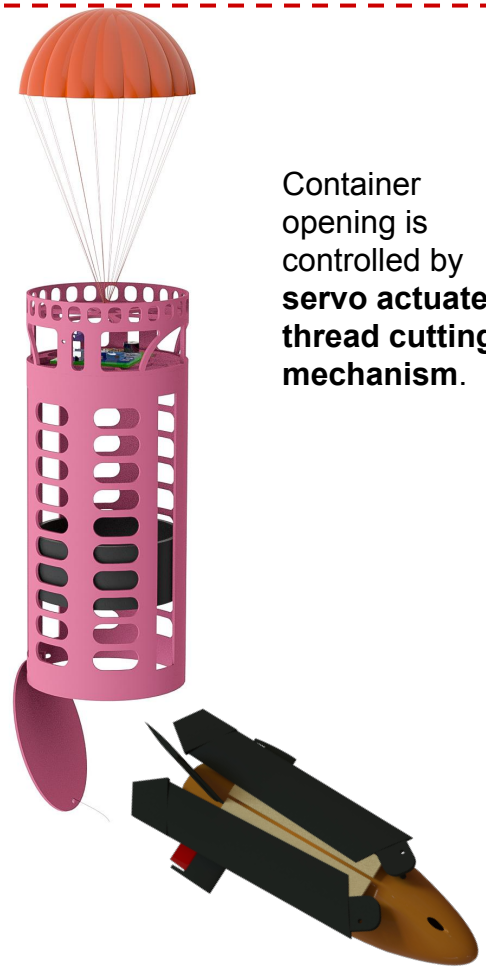
- ➢ Less susceptible to shock damages.
- ➢ High stiffness to weight ratio.
- ➢ Higher rigidity and excellent tensile strength.

(0 to 10)
0-Least, 10-Most

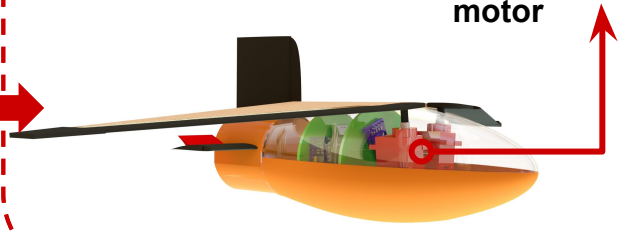
Payload Deployment Configuration Trade & Selection [1/3]

Design Strategy 1 Deployment Sequence

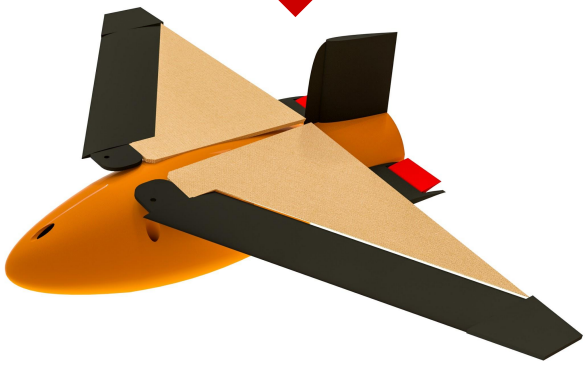




Container opening is controlled by **servo actuated thread cutting mechanism**.



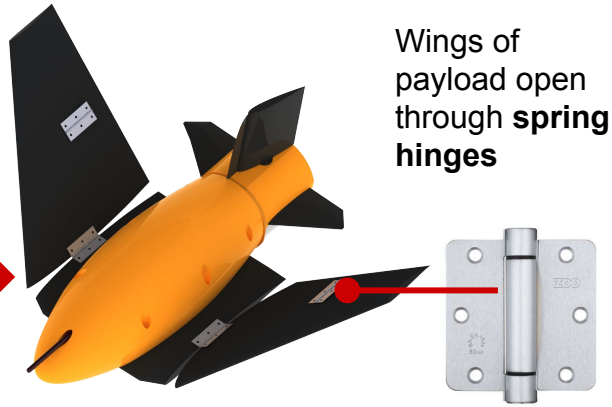
Wings of payload open through **servo motor**



Payload Deployment Configuration Trade & Selection [2/3]

Design Strategy 2 Deployment Sequence

Container opens up by **wire heating** setup. Lid rotates and opens up the container, which in turn releases the glider Nichrome wire setup has been properly insulated.



Wings of payload open through **spring hinges**

Payload Deployment Configuration Trade & Selection [3/3]

	Design Strategy 1	Design Strategy 2
PROS	➢ Ensures better stowed position.	➢ More space for payload electronics.
	➢ Facilitates smooth release from container.	➢ Spontaneous deployment.
CONS	➢ Bulky design and higher manufacturing cost.	➢ Wings have to bear more force due to spring.
	➢ Higher deployment time.	➢ Wing edges are susceptible to damage due to shock.

Design Strategy	Quick Action	Self-sustainable action	Blades Flapping	Weight	Cost	Total (50)
1	7	8	8	7	7	37
2	**9**	**7**	**7**	**9**	**9**	**41**

SELECTED

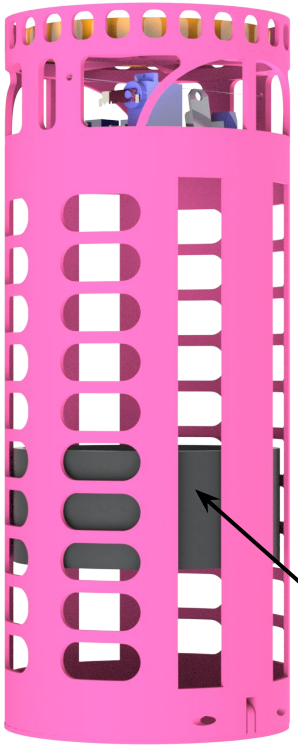
Design Strategy 2

- ➢ Quick deployment facilitates higher glide time.
- ➢ Provides more space for payload electronics.
- ➢ More reliable and self-sustainable action.

(0 to 10)
0-Least, 10-Most

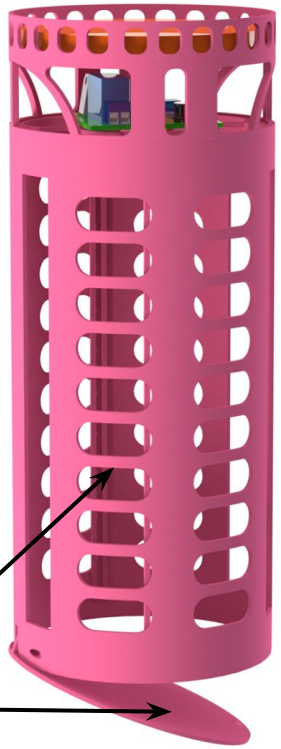
Container Mechanical Layout of Components Trade & Selection [1/3]

Design Strategy 1



Design Strategy 1	Design Strategy 2
PROS	
➢ Better launch vibration absorbing capability. ➢ Easy integration of payload and container.	➢ No swaying as compared to Design Strategy 1. ➢ Uniform load distribution
CONS	
➢ Excessive tumbling after payload deployment. ➢ Less reliable container opening mechanism.	➢ Unable to damp the launch vibration. ➢ High current requirement, drain out the battery.

Design Strategy 2



Deprons

Guide Rails

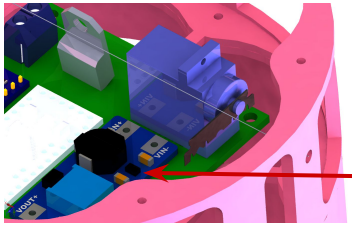
Lid

SELECTED

DESIGN STRATEGY 2

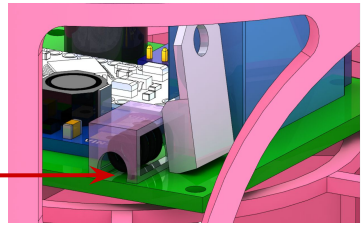
➢ Stable descent after payload deployment.

➢ Higher reliability



Servo Motor thread cutting mechanism

Nichrome Wire heating mechanism



Container Mechanical Layout of Components Trade & Selection [2/3]

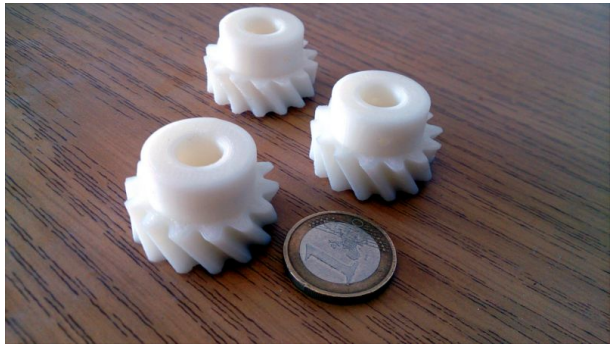
Material	Density (g/cm^3)	Impact Strength (GPa)	Elongation to break	Machinability (out of 10)	Cost ($/cc)
A: HIPS	1.03	2	1.0-1.5	8	1.38
B: Fiberglass	2.55	3	4.8	8	0.5
C: Carbon Fiber	1.81	3.5	1.0-1.5	7	3

Material	Stiffness to weight ratio	Tensile Strength	Elongation	Weight	Cost($/cc)	Total (50)
A: HIPS	**9**	**7**	**9**	**9**	**7**	**41**
B: Fiberglass	5	9	7	4	9	34
C: Carbon Fiber	8	10	9	6	6	39

SELECTED

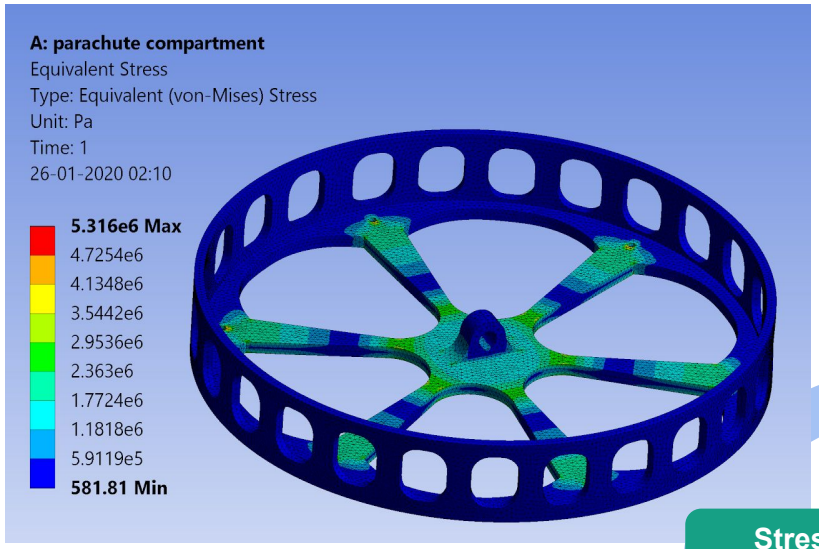
MATERIAL A: HIPS

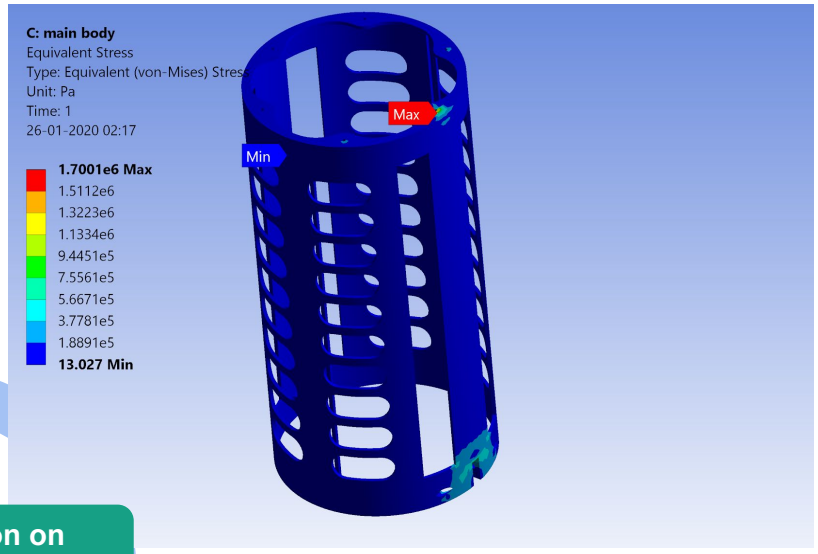
- High strength to weight ratio.
- Ease of manufacturing.
- Less weight.



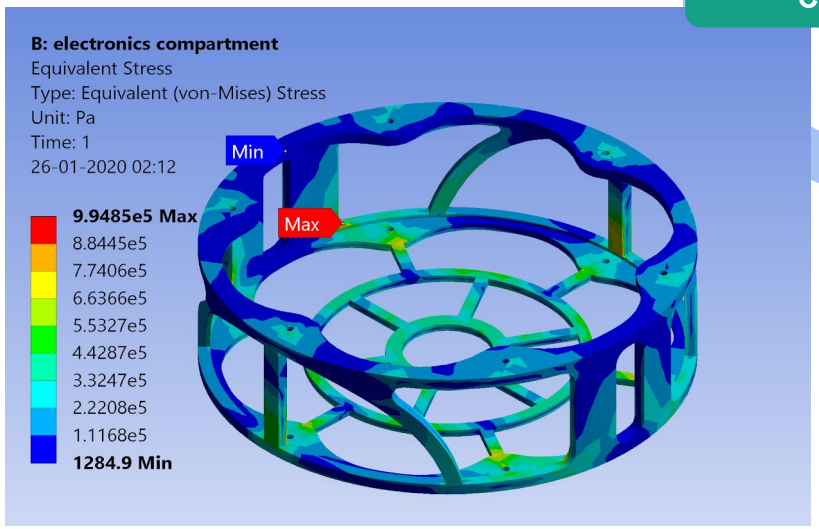
(0 to 10)
0-Least, 10-Most

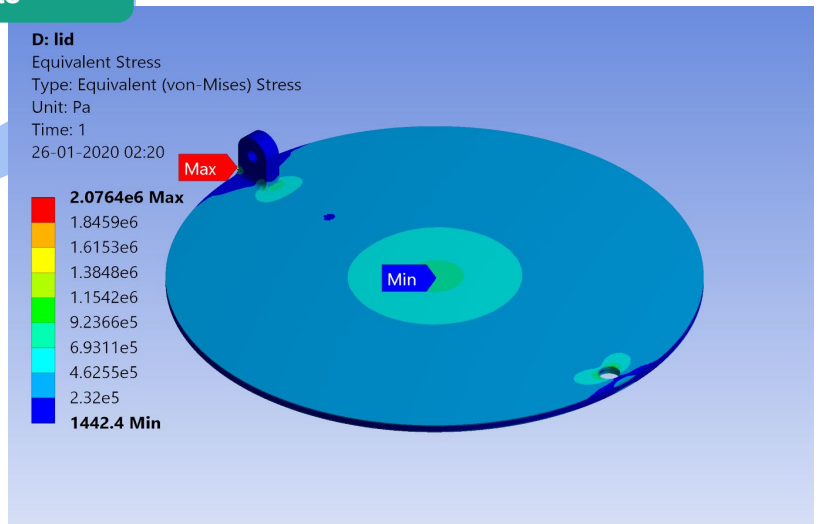
Container Mechanical Layout of Components Trade & Selection [3/3]





Stress Distribution on Container Parts



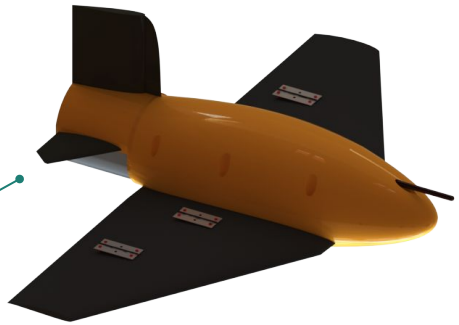


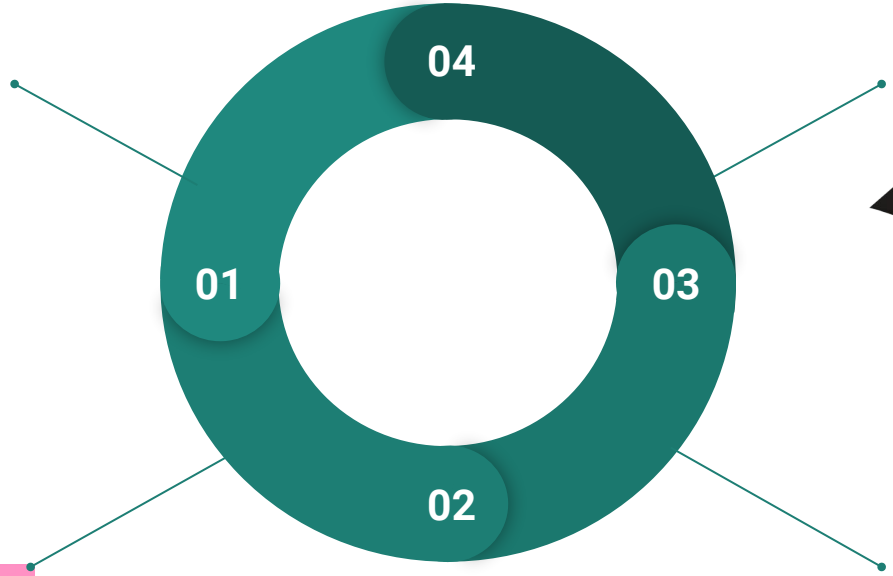
Payload Release Mechanism

Pre-Deployment

- Initially in the stowed configuration the horizontal stabilizers are between the **guide rails** which are provided in order to **restrict the movement of glider** inside the container and to facilitate glider deployment.

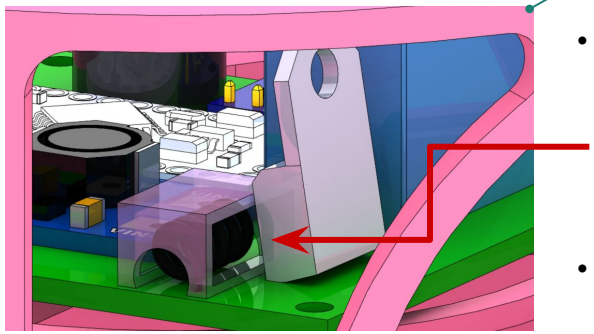
Deployed





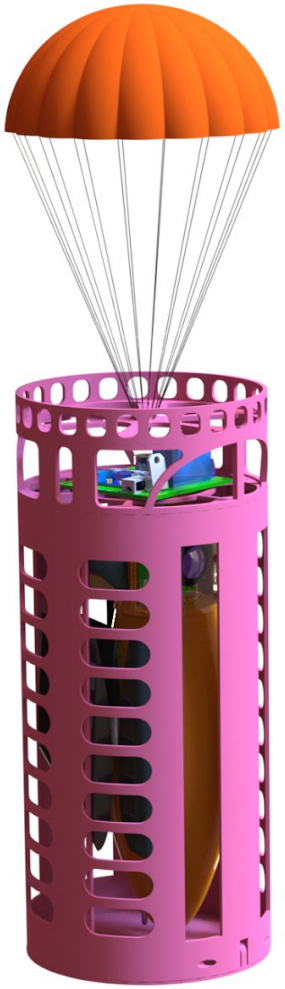
Separation

Transition



- At 450m, the MCU will command the Hot wire setup to pass high amount of current (around 700 mA) through the nichrome wire to melt the nylon thread around which it is wound. **Heat shield is used to cover the nichrome wire heating apparatus.**
- After melting of the nylon thread, the **hinged lid will open**, initiating glider descent.

Container Parachute Attachment Mechanism



Deployed Stage

The parachute is **attached to the container** with the help of **O-ring** and released at an estimated height of 700 meters.

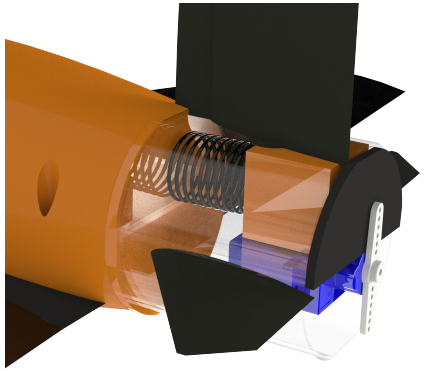
The **air ducts** are provided to utilize the pressure head of the air gushing in to deploy the parachute automatically.

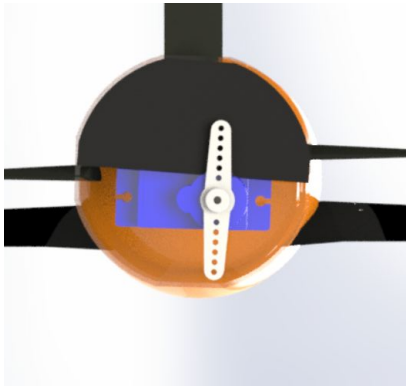
Pre-Deployment

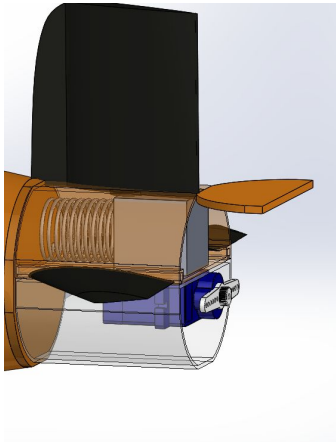
O-Ring

Deployed Stage

Payload Parachute Attachment Mechanism*





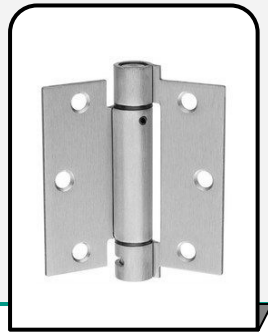


Stowed Parachute Configuration	Servo motor	Deployed parachute configuration
➢ The parachute is folded inside the parachute compartment. ➢ The spring is kept in the compressed state and the lid is held by the servo motor.	The MCU actuate the servo motor after one minute of gliding.	➢ The spring pushes the parachute out of the compartment. ➢ The ambient air inflates the parachute and slows down the glider and hence restricts its gliding motion.

*This slide has been added to show the Payload Parachute Deployment, as required for this year's mission.

Electronics Structural Integrity [1/2]

DESCENT CONTROL ATTACHMENTS



The container and parachute mounts are attached to their respective mounts with the help of swivel.
The wing segments are connected with the help of self-opening hinges.

MOUNTING

The electronic components are soldered on the PCB, which is screwed firmly to the body. The connections are secured via epoxy, resin, hot glue and electrical insulation tape

DESCENT CONTROL ATTACHMENTS

All descent control attachments are securely screwed to respective mounting points. Also, a layer of hot glue is put on the edges to secure the joints..

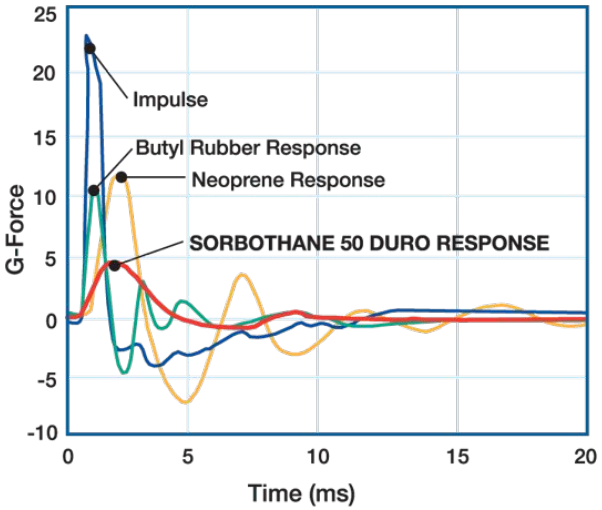
ELECTRONICS COMPONENT ENCLOSURE

Inside the glider's fuselage, electronics is enclosed with the help of screws.
We have also covered the container and the payload with Taffeta nylon.

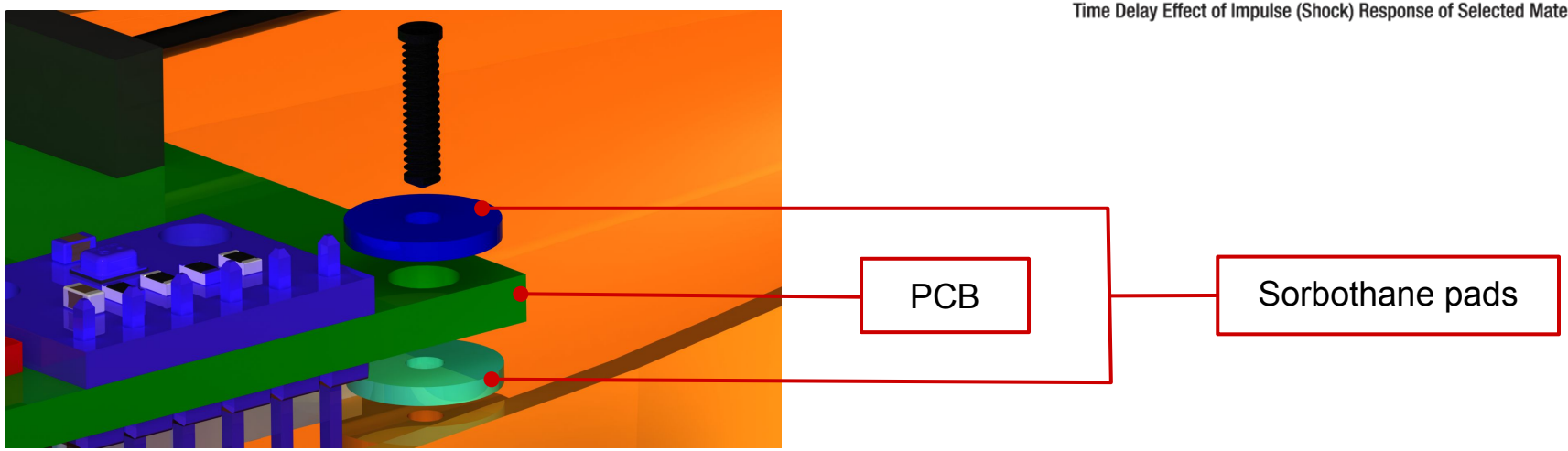
Electronics Structural Integrity [2/2]

Securing Electrical Connections

- The components have been perfectly soldered on the PCB.
- The PCBs are rigidly mounted on the payload and the container via supporting structures, which are then joined with the help of screws.
- PCB is sandwiched between the layers of sorbothane pads.
- Sorbothane pads have excellent shock absorbing properties, thus, are used to absorb 30Gs of shock.



Time Delay Effect of Impulse (Shock) Response of Selected Materials



Mass Budget [1/8]

ELECTRONIC COMPONENTS

CanSat System	Component	Model Name	Quantity	Mass (g)	Uncertainty	Determination
Payload	Temperature sensor	BMP280	1	1.30	0	Datasheet
	Air pressure sensor					
	GPS sensor	BN280	1	11.80	0	Datasheet
	Voltage sensor	SAMD21 ADC	1	-	-	-
	Air Speed Sensor(with pitot tube)	SDP37	1	19.00	± 0.1	Measured
	Particle sensor	HPMA115S0-004	1	35.30	0	Datasheet
	SD Card Shield	Generic SD card shield	1	18.00	± 0.1	Measured
	SD Card	SanDisk Ultra 16GB	1	12.00	0	Datasheet
	Audio Beacon	CPI-137-12T	1	3.02	± 0.1	Measured
	MCU	SAMD21 mini breakout	1	5.09	0	Measured
	Payload RTC	PCF8523	1	2.3	0	Datasheet

Mass Budget [2/8]

CanSat System	Component	Model Name	Quantity	Mass (g)	Uncertainty	Determination
Payload	Pitch and roll sensor	MPU 9250	1	2.72	0	Datasheet
	Payload Antenna	FXP70	1	1.20	0	Datasheet
	Payload Radio	Digi XBee 3 pro	1	10.80	±0.1	Measured
	Battery	Energizer L522	1	33.90	0	Datasheet
	Voltage Regulator	LM7805	1	8.5	±0.1	Measured
	PCB (10% error)	-	1	8.00	±0.1	Measured
	Boost Converter	MT3608	1	4.40	0	Datasheet
	Bonus Camera	Turbowing Cyclops DVR3	1	4.5	0	Datasheet
	360 Servo	MG90S	2	2x9=18	0	Datasheet
	Camera SD Card	Sandisk SD Card	1	1.5	±0.1	Measured
	Miscellaneous	-	-	15.00	-	Estimated
Total				**198.33**	**±0.7**	

Mass Budget [3/8]

CanSat System	Component	Model Name	Quantity	Mass (g)	Uncertainty	Determination
Container	Air pressure sensor	BMP280	1	1.30	0	Datasheet
	MPU	Arduino Pro Mini	1	2.00	±0.1	Measured
	MOSFET	NMOS	1	0.43	±0.1	Measured
	Relay	JQC3F-C-S-DC5V	1	4.00	±0.1	Measured
	External EEPROM	24LC256	1	1.00	±0.1	Measured
	Battery	Envie rechargeable	1	31.80	0	Datasheet
	Nichrome wire	32 Gauge	1	0.40	±0.1	Measured
	Audio Beacon	CPI-137-12T	1	3.02	±0.1	Measured
	Boost Converter	MT3608	1	4.40	0	Datasheet
	PCB (10% error)	-	1	8.50	±0.1	Measured
Total				**67.85**	**±0.7**	

Mass Budget [4/8]

MECHANICAL STRUCTURAL ELEMENTS

CanSat System	Component	Material	Quantity	Mass (g)	Uncertainty	Determination
Payload	Fuselage	SLS printed Nylon PA2200	1	63.34	±1.2	SW estimate
	Wings and stabilisers	Carbon Fiber	2	35.36	±0.3	Measured
	Rudder	FDM printed PLA	1	9.76	±0.1	SW estimate
	Parachute Module	FDM printed PLA	1	12.18	±0.1	SW estimate
	Camera Setup	FDM printed PLA	1	12.32	±0.1	SW estimate
			Total	**132.96**	**±1.8**	
Container	Main Body	SLS printed HIPS	1	72.45	±1.2	Measured
	Electronics module	SLS printed HIPS	1	12.68	±0.1	Measured
	Parachute Module	SLS printed HIPS	1	10.31	±0.1	Measured
	Lid	SLS printed HIPS	1	7.98	±0.1	Measured
			Total	**103.42**	**±1.5**	

Mass Budget [5/8]

MECHANICAL NON - STRUCTURAL ELEMENTS

CanSat System	Component	Dimensions	Quantity	Mass (g)	Uncertainty	Determination
Payload	Sorbothane Pads	2mm thick pads	8	5.46	±0.001	Datasheet
	Parachute	Hexagon with side 15.24cm	1	18	±0.5	Datasheet
	Screws	ST4 cross head screws	12	6.83	±0.001	Measured
	Nut and bolt	M4 Pan Head	3	17.24	±0.001	Measured
	O-Ring	10mm diameter	1	8.62	±0.001	Measured
			Total	**56.15**	**±0.504**	
Container	Parachute	Hexagon with side 22.88cm	1	16	±0.5	Datasheet
	Nut and Bolt	M4 Pan Head	1	5.8	±0.001	Measured
	Screws	ST4 cross head screws	12	6.83	±0.001	Measured
	O-Ring	10mm diameter	1	8.62	±0.001	Measured
			Total	**37.25**	**±0.503**	

Mass Budget [6/8]

Sub-Division	Type	Payload(g)	Uncertainty	Container(g)	Uncertainty
Mechanical	Components (Non - Structural Elements)	56.15	±0.504	37.25	±0.503
	Structural Elements	132.96	±1.8	103.42	±1.5
Electronics	Components	198.33	±0.7	67.85	±0.7

Type	Payload(g)	Uncertainty	Container(g)	Uncertainty
Components (Non Structural Elements)	254.48	±1.2040	105.10	±1.2030
Structural Elements	132.96	±1.8	103.42	±1.5

Type	Total Mass(g)	Uncertainty
Components (Non Structural Elements)	359.58	±2.407
Structural Elements	236.38	±3.3

Sub-Division	Total Mass(g)	Uncertainty
Container	208.52	±2.703
Payload	387.44	±3.004

Total Mass: 595.96±5.707

Mass Budget [7/8]

Limit	Total Mass(g)	Margin(g)	Methods of Correction
Upper	601.667	1.667	*Decrease weight
Lower	590.253	9.747	*Increase weight

Calculated Mass: 593.96 ± 2.6770

Sources of Uncertainties

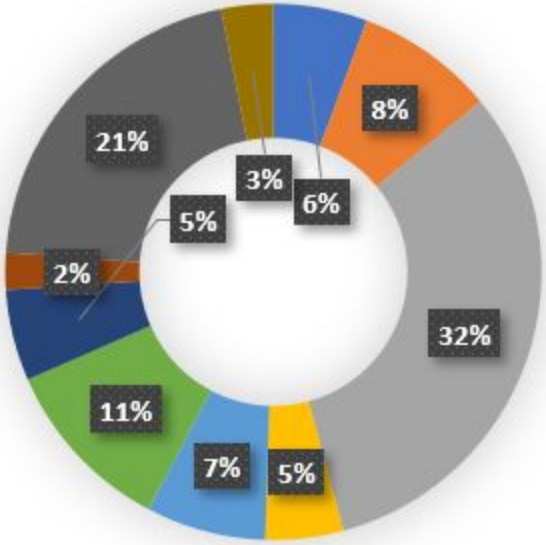
- Least count of the weighing scale used is 0.1 g, an error of ± 0.1 g is introduced in all the components whose weight is measured
- SolidWorks provides an estimated mass of the design based on ideal manufacturing and ideal material properties, which is not achievable so an error of 10% of the estimated weight is considered

Methods of Correction

- Mass of electronic components and mechanical non structural elements is fixed and the uncertainties arising can only be confirmed after complete assembly of the model.
- But a variation in mass can be obtained through optimization of the design, so as to achieve the complete mass in a range of 600g +/-10g.
- Topology optimizations are used to reduce the weight of the structure keeping the factors of strength intact which results in weight reduction.
- At present 30% weight is reduced and this value can be increased up to 50% if complete assembly weighs over 610g or it can be reduced to 20%if the complete assembly weighs less than 590g.

Mass Budget [8/8]

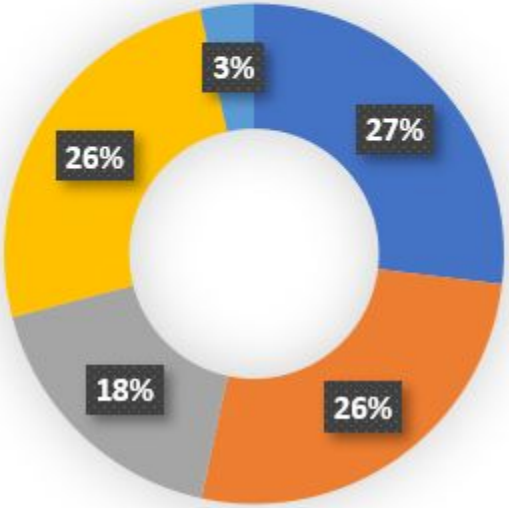
Mechanical Mass Budget



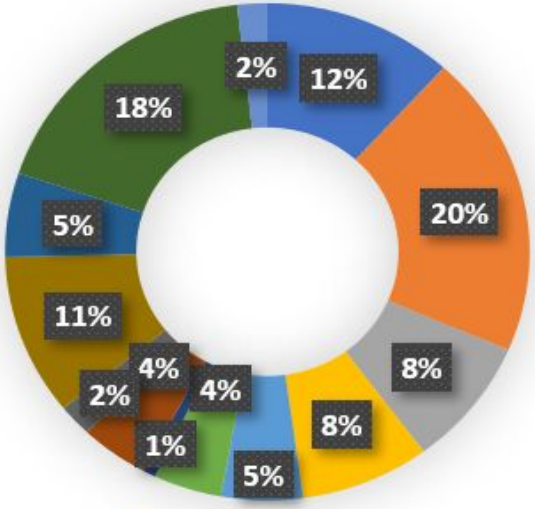
- Parachute section
- Electronics compartment
- Main body
- Lid
- Upper fuselage
- Lower fuselage
- Payload parachute section
- Rudder

Total Mass Budget

- Container(Mechanical)
- Payload(Mechanical)
- Container(Electronics)
- Payload(Electronics)
- Miscellaneous Components



Electronics Mass Budget

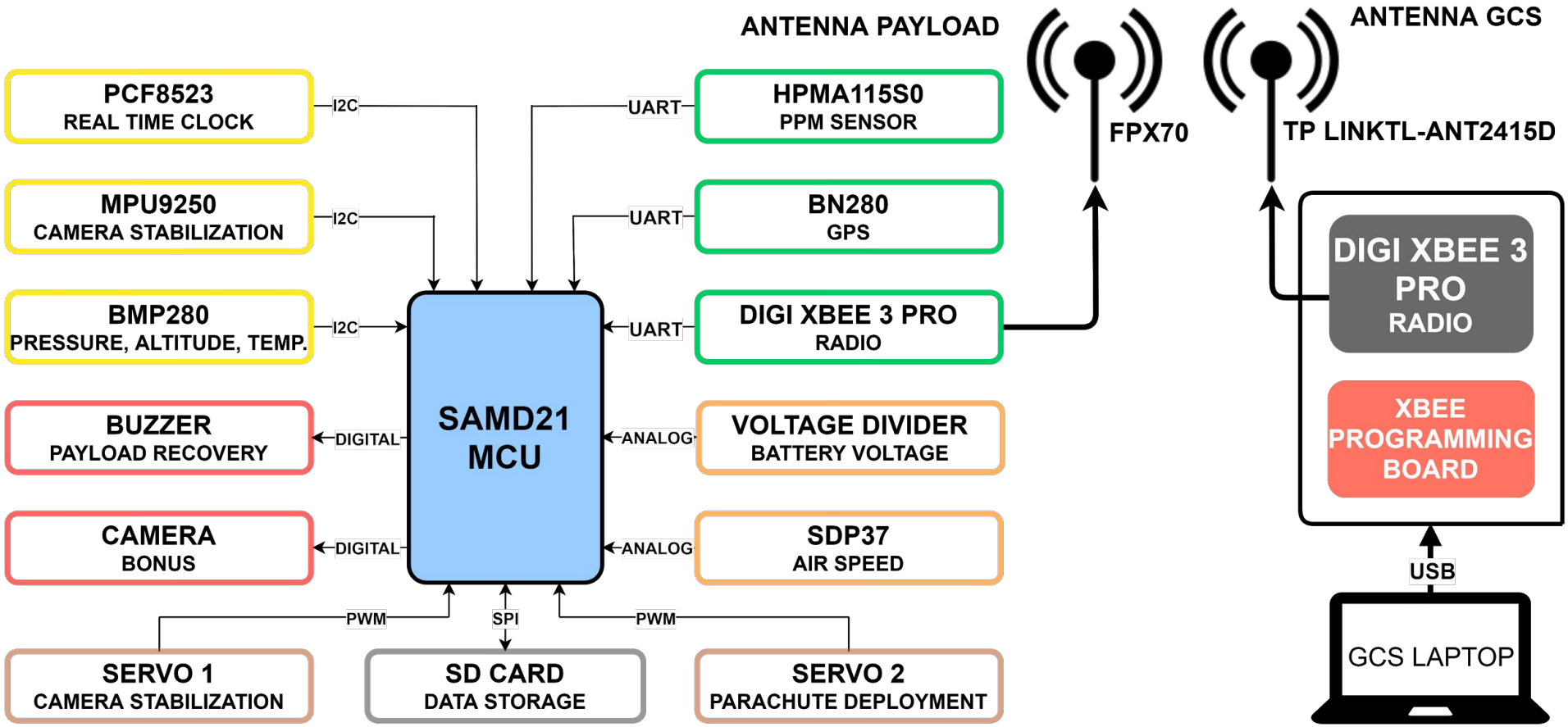


- PCF8523
- SAMD21 mini breakout
- Generic SD card shield
- SDP37
- HPMA115S0
- 360 Servo(x2)
- Arduino Pro Mini
- Buzzer
- Relay
- External EEPROM
- PCB
- Energizer L522
- MT3608

Communication and Data Handling (CDH) Subsystem Design

Presenter: Aditya Wadhwa

Payload CDH Overview



Payload CDH Requirements

ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
PCDH 01	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission	Base Requirement	BR33	-	High	+			
PCDH 03	Telemetry shall be updated once per second.	Base Requirement	BR29	-	High		+		
PCDH 04	XBEE radios shall have their NETID/PANID set to their team number.	Base Requirement	BR36	-	High			+	+
PCDH 05	XBEE radios shall not use broadcast mode.	Base Requirement	BR37	-	Medium	+			
PCDH 06	All telemetry shall be displayed in real time during descent.	Base Requirement	BR40	GS04	High		+	+	
PCDH 07	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Base Requirement	BR41	GS05	Medium		+		
PCDH 08	Teams shall plot each telemetry data field in real time during flight.	Base Requirement	BR42	GS06	Medium		+	+	
PCDH 09	XBEE radios shall be used for telemetry.	Base Requirement	BR35	-	High	+			

Payload Processor & Memory Trade & Selection [1/4]

Sensor	Clock Speed (MHz)	Boot Time (ms)	Memory (Kb)	GPIO (Nos)	Interface (Nos)	Operating Voltage (V)	Current (mA)	Cost ($)
Arduino Nano	16	1500	256	Total [22] Digital [14] Analog [8]	UART[3] SPI[1] I^2C [1]	7-20	40@5V	2.8
ESP8266 NodeMCU	80	3000	4K	Total [17] Digital [14] Analog [3]	UART[2] SPI[2] I^2C [1]	2-3.5	70@3.3V	5.1
SAMD21	**48**	**1700**	**256**	**Total [26] Digital [14] Analog [12]**	**UART[4] SPI[1] I^2C [1]**	**1.63-3.6**	**46@3.3V**	**25.95**

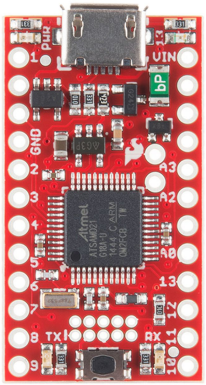
SELECTED

SAMD21

- Higher number of dedicated Interface pins, 4xUART,1xSPI,1xI^2C
- I^2C speed of 1Mhz ,is highest among the choices ,helps flawless data transmission from 5 connected slaves.
- High Precision ADC (12 bit), required for high resolution of sensor readings.
- Supports up to 16 external interrupts

GPIO Description

- ANALOG IN [3]
- ANALOG OUT [1]
- DIGITAL [13]
- PWM [10]
- UART [4]
- SPI [1]
- I^2C [1]



SAMD21

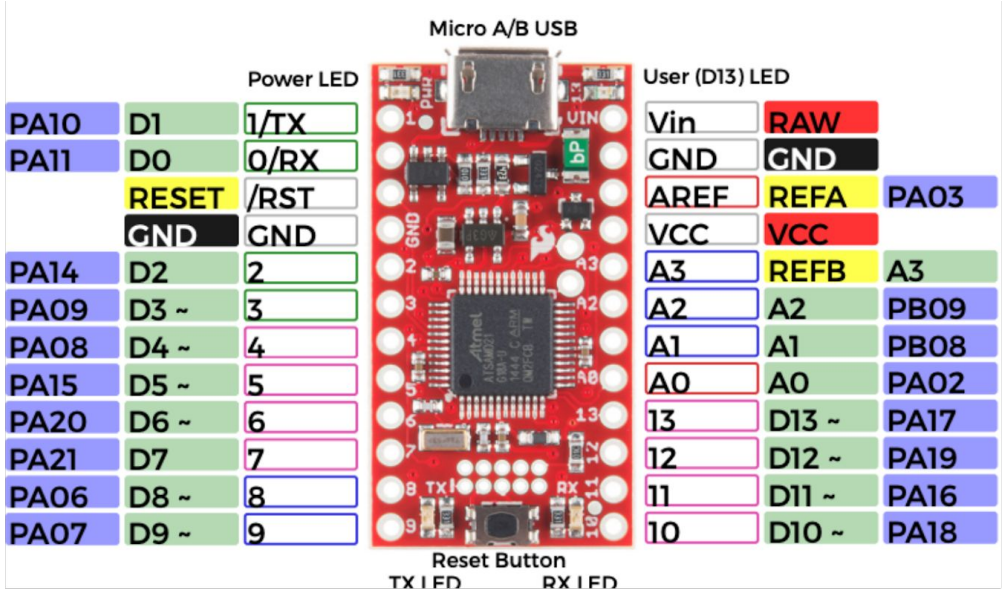
Payload Processor & Memory Trade & Selection [2/4]

GPIO

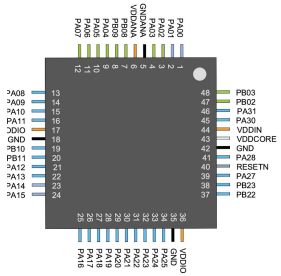
- Total: 22
- Analog Input:3
- Analog Output 1
- Digital: 13
- PWM: 10
- HW Interrupts: 16

INTERFACE

- I^2C up to 3.4Mz
- SPI
- LIN slave
- UART – 4
- I^2C – 1
- SPI - 1



Up to six Serial Communication Interfaces (SERCOM), each configurable to operate as either: USART with full-duplex and single-wire half-duplex configuration



The Atmel | SMART SAM D21 implements the ARM® Cortex™-M0+ processor, based on the ARMv6 Architecture and Thumb®-2 ISA. The Cortex M0+ is 100% instruction set compatible with its predecessor, the Cortex-M0 core, and upward compatible to Cortex-M3 and M4 cores.

PROCESSOR

- CPU ARM Cortex-M0+
- Frequency: 48MHz
- 12 bit ADC with 12 CHANNELS

MEMORY

- 256KB Flash Memory
- 32KB SRAM
- 32KB of EEPROM (Emulated in Flash)

Payload Processor & Memory Trade & Selection [3/4]

Memory Selection

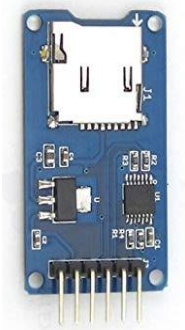
Sensor	Dimensions (mm)	Memory (GB)	Interface	Operating Voltage (V)	Current Consumption (mA)	Weight (g)	Cost ($)
External EEPROM(24LC256)	5.88x3.2	0.25	I^2C	2.5-5.5	0.4	2	0.85
Generic SD card shield (with 16GB sd card)	**60.8x42.5**	**16**	**SPI**	**3.3**	**80**	**22+12 =34**	**6.8+ 4.33 =11.13**

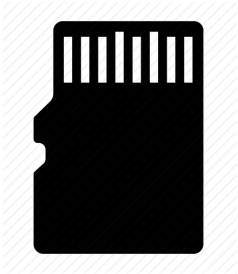
SELECTED

Generic SD card Shield

- Feasibility in handling data on GCS
- Higher Data storage capacity (16GB)
- High data transfer data rate of 25 MB/sec data of the memory card.

External memory is required for ease of data handling at launch site.





Generic SD card shield

Payload Processor & Memory Trade & Selection [4/4]

Memory (SD Card Selection)

Model	Features	Memory Space (GB)	Cost ($)
Sandisk SDSDQM-016G-B35	➢ Read speed up to 15MBps ➢ Write minimum speed up to 10 MB/s.	16	3.93
Sandisk 16 GB	➢ **25MBps data transfer rate.** ➢ **Support SPI Mode.** ➢ **Read speed 96MBps.**	**16**	**4.33**

SELECTED

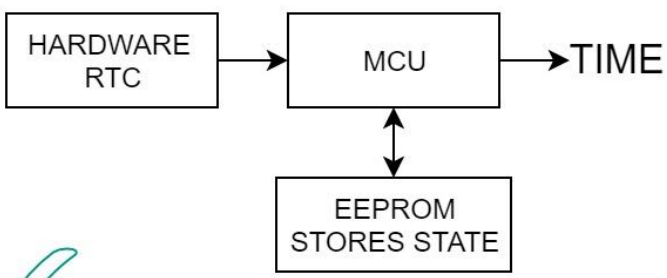
SanDisk Ultra 16 GB

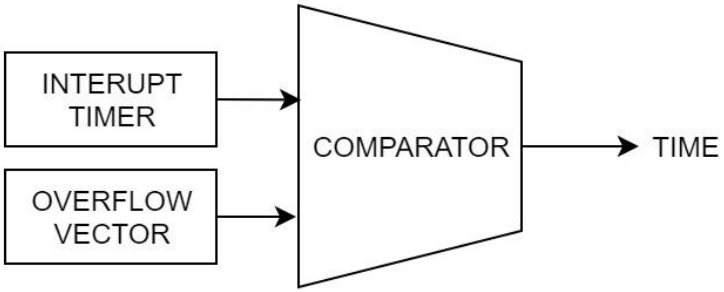
- ➢ Built in writes protection features (permanent and temporary).
- ➢ Up to 25 MB/sec data transfer rate (using four parallel lines).
- ➢ Variable clock rate 0-25 MHz (standard),0-50 MHz (high performance).

SanDisk Ultra 16 GB

Payload Real-Time Clock [1/2]

HARDWARE		SOFTWARE
• Independency from power failure • Precise Time tracking • Low Power Consumption.	PROS	• Hardware cost and mass reduction • Easy to configure
• Hardware cost and mass increment	CONS	• MCU resest may reset the RTC





RESET TOLERANCES

- **Unaffected from MCU reset**
- **Dedicated 3.3V cell ensures independence from failure of main power bus**

Payload Real-Time Clock [2/2]

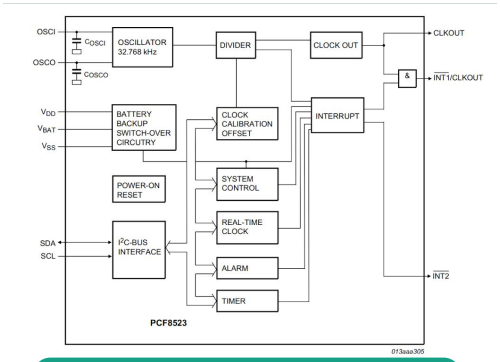
Hardware RTC Model Selection

Sensor	Interface	Operating Voltage (V)	Current Consumption (mA)	Dimensions (mm)	Weight (g)	Cost ($)
DS1307	I^2C	5	0.5	25.8*21.7*5	2.3	7.5
DS3234	SPI	2-5.5	0.7	23*20.8*7.3	2.7	21
PCF8523	I^2C	**1-5.5**	**0.15**	**25*21.8*6**	**2.3**	**10**

SELECTED

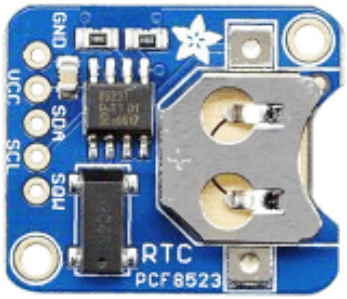
PCF8523

- Self-reliant power Arrangement (3.3v coin cell)
- Low current consumption as compared to other hardware clock choices (0.15mA)
- In case of power loss, the internal variables are configured according the last saved log, thus mission time remains running.
- High speed I2C @ 1MHz
- Lower Number of Interface Pin Requirement in I^2C (2) compared to SPI (4)



g 1.

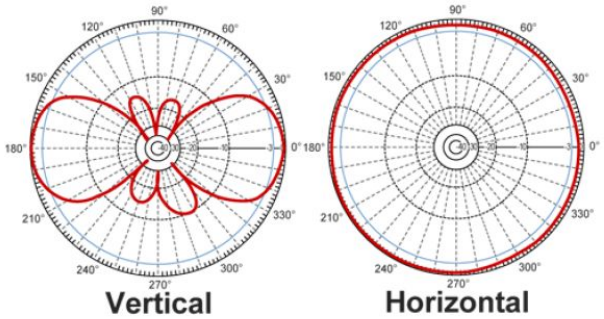
Block Diagram



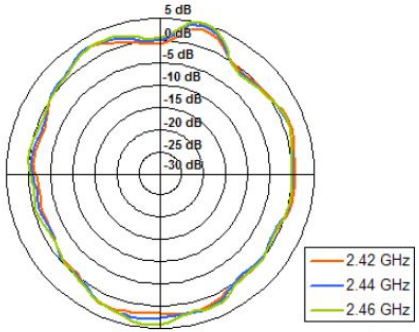
PCF8523

Payload Antenna Trade & Selection [1/2]

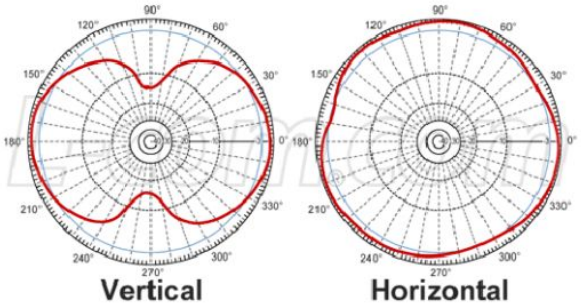
Model	Gain (dBi)	Size (mm)	Directivity	Weight (g)	Connector	Frequency Range (GHz)	Range* (m)	VSWR
DS_HG240 2RD-RSF	2.2	105 (length) 10 (diameter)	Omni	15	RPSMA	2.5-2.5	600	<2
DS_RE04U	4	238(length) 19(diameter)	Omni	421	N-Male	2.4-2.5	600	<1.5-1
FXP70	**5**	**27 x 25 x0.08**	**Omni**	**1.2**	**MHFI (UFL Compatible)**	**2.4**	**850**	**<1.5-1**



Radiation Pattern of DS_RE04U



Radiation Pattern of FXP70



Radiation Pattern of DS_HG2402RD-RSF

*The ranges have been calculated based on our receiver's sensitivity=-**65dB**, for a gain value of **5dB**.

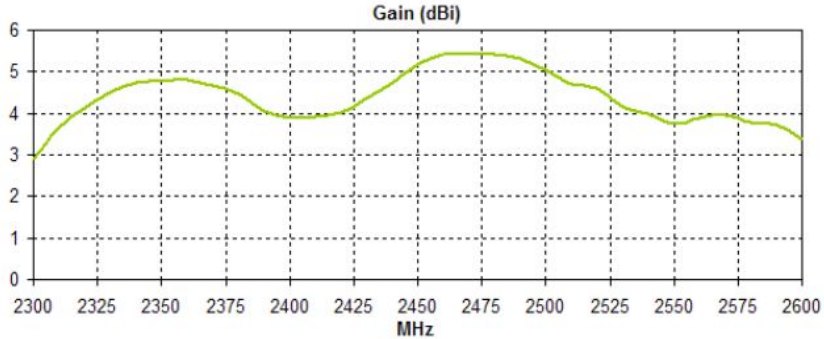
Payload Antenna Trade & Selection [2/2]

SELECTED

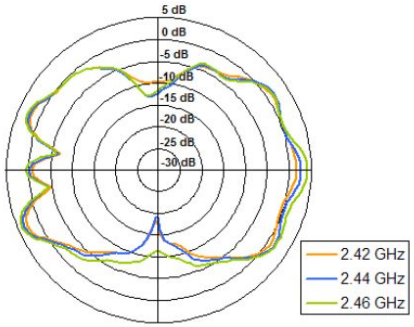
FXP70

- Lesser weight and negligible size helps in accommodation of other components
- Radiation pattern matches with GCS antenna
- Allows data transmission in all the direction as it is omnidirectional in nature
- Better Gain
- Low connector impedance causes low signal loss

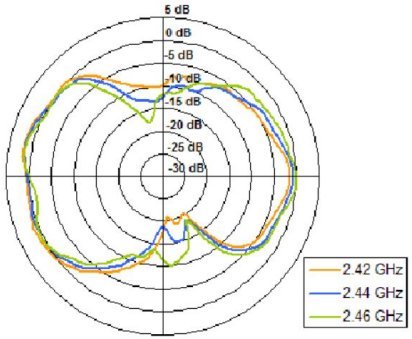
FXP 70



Gain of FXP 70



Radiation Pattern YZ Plane



Radiation Pattern XY Plane

Payload Radio Configuration [1/2]

Device	Operating Frequency (GHz)	Tx Supply Current (mA)	Rx Supply Current (mA)	Sensitivity (dBm)	Size (mm x mm x mm)	Weight (g)	Cost ($)
XBee Pro S2B	2.4	205@3.3V	47@3.3V	-102	24.38 x 32.94 x 1.82	13.5	28.36
XBee Pro S1	2.4	215@3.3V	55@3.3V	-100	24.38 x 27.61 x 1.82	11	29.09
Digi XBee 3 Pro	**2.4**	**135@3.3V**	**17@3.3V**	**-103**	**24.38 x 27.61 x 1.82**	**10.8**	**55.37**

SELECTED

➢ **Digi Xbee 3 Pro**

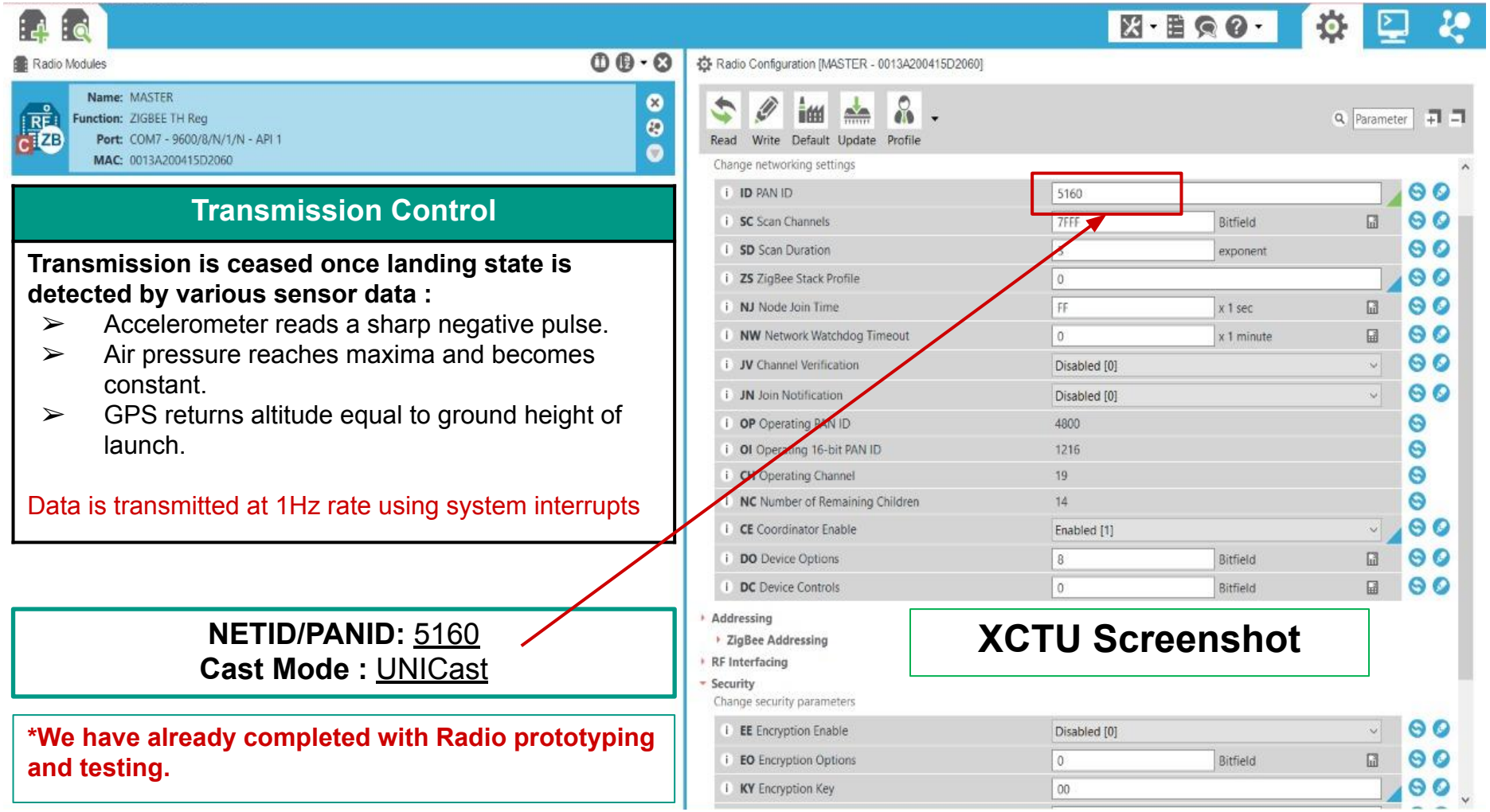
- ➢ Low Tx and Rx Current consumption of **120mA** and **17mA** respectively.
- ➢ Larger range reaching up to **3200m.**
- ➢ High transmit power of **+19dBm.**
- ➢ Highest sensitivity of **–103dBm.**

- ➢ NETID/Team ID : 5160
- ➢ **Transmission** is ceased once landing state is detected by various sensor data (altitude sensor).
- ➢ Upon powering up the CanSat payload shall send the required telemetry at a frequency of **1 Hz**.

Digi Xbee 3 Pro

Payload Radio Configuration [2/2]

Radio Configuration Setup



Transmission Control

Transmission is ceased once landing state is detected by various sensor data :

- Accelerometer reads a sharp negative pulse.
- Air pressure reaches maxima and becomes constant.
- GPS returns altitude equal to ground height of launch.

Data is transmitted at 1Hz rate using system interrupts

NETID/PANID: 5160
Cast Mode : UNICast

XCTU Screenshot

***We have already completed with Radio prototyping and testing.**

Payload Telemetry Format

Data	Description
<TEAM ID>	Team identification number.
<MISSION TIME>	Time in seconds since initial power up.
<PACKET COUNT>	The count of the transmitted telemetry packets.
<ALTITUDE>	The altitude in meters relative to ground level.
<PRESSURE>	The atmospheric pressure in units of pascals.
<TEMP>	The temperature in degree Celsius.
<VOLTAGE>	The voltage of the CanSat power bus.
<GPS TIME>	The time generated by the GPS receiver. Time is reported in UTC .

Data	Description
<GPS LATITUDE>	The latitude generated by the GPS receiver.
<GPS LONGITUDE>	The longitude generated by the GPS receiver.
<GPS ALTITUDE>	The sea level altitude generated by the GPS receiver.
<GPS STATS>	The number of satellites tracked by the GPS receiver.
<AIR SPEED>	The air speed relative to the payload in meters/second.
<SOFTWARE STATE>	The opening state of the Cansat.
<PARTICLE COUNT>	No.of particles present in the atmosphere measured by particle sensor in mg/m3.
<BONUS DIRECTION>	Camera direction required for relative stability

DATA FORMAT

<TEAM ID> , <MISSION TIME> , <PACKET COUNT> , <ALTITUDE> , <PRESSURE> , <TEMP> , <VOLTAGE> , <GPS TIME> , <GPS LATITUDE> , <GPS LONGITUDE> , <GPS ALTITUDE> , <GPS SATS> , <AIR SPEED>,<SOFTWARE STATE> , <PARTICLE COUNT> **<BONUS DIRECTION>**

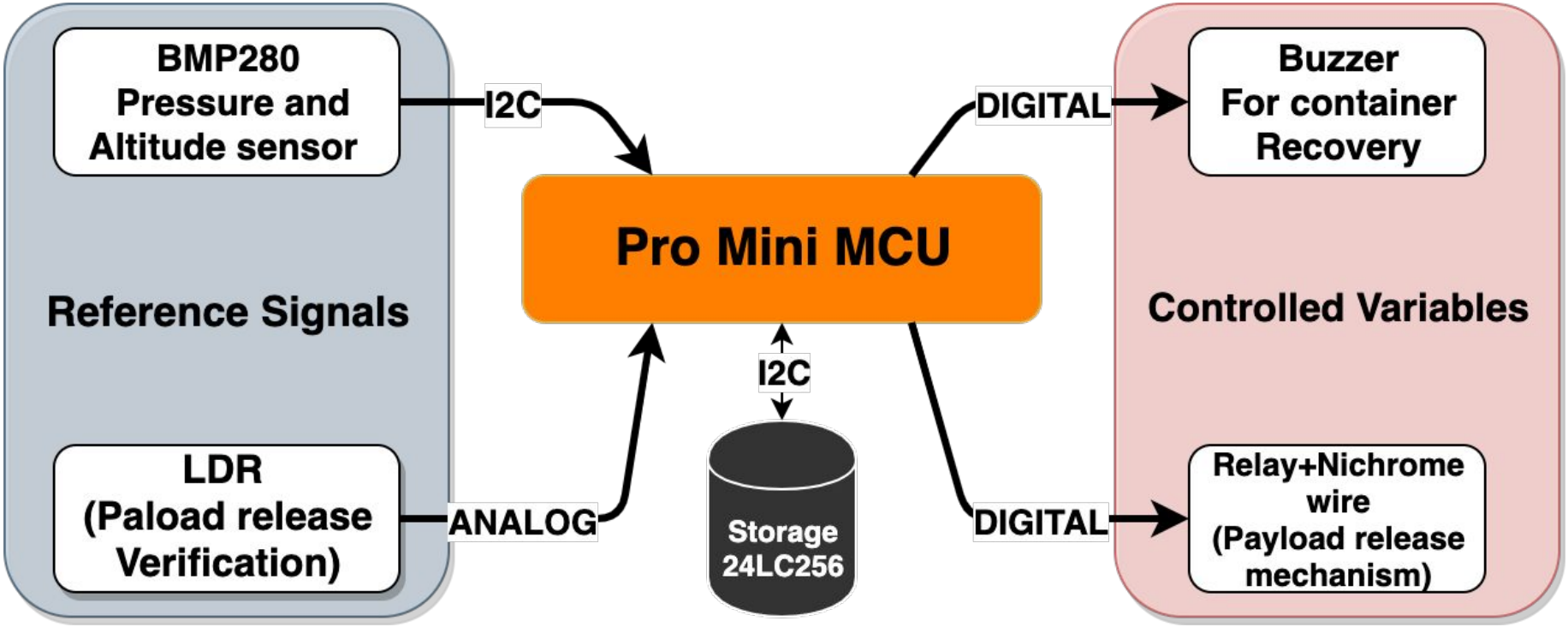
SAMPLE DATA:: 5160,4,4,0.1,996.29,20.35,8.75,12:25:11,27.59,77.73,158.36,7,0.28,1,86.82,**10**

The above Data Format matches the competition Guide Requirements.

DATA RATE OF PACKETS

The data is transmitted at 1 Hz (1 packet per second) to the ground station.
Burst transmission is used to transmit telemetry.

Container CDH Overview



LDR (Light Dependent Resistor)

The LDR and a resistor are connected in voltage divider configuration,upon deployment the Light falling on the LDR decreases its resistance therefore voltage across second resistor will increase,this increase implies successful deployment of Payload.

Payload Release Mechanism Command

The Nichrome wire is connected to a relay. When pressure sensor reads altitude, the MCU commands the relay to turn on,thus high amount of current flows through the wire which heats it up and melts the nylon thread holding the lid.The lid opens up and payload is released.

Container CDH Requirements

ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
CCDH 1	The container shall release the science payload at an altitude of 450+/- 10m during descent	Base requirement	BR-9	FSW-8	High	+			
CCDH 2	Container shall consist of separate microcontroller, BMP280 for measuring altitude and a nichrome wire, powered by a battery	To measure the altitude and command the MCU to melt the nichrome wire at 450m.	-	-	High	+	+		+
CCDH 3	The container shall be opened through nichrome wire heating mechanism by passing a high current through the wire using power BJT	Quite effective mechanism for container opening	-	-	High	+			+
CCDH 4	EEPROM of MCU shall be used to save the height at which container opened	To prove that the container has opened	-	-	High		+	+	+

Container Processor & Memory Trade & Selection [1/2]

MCU	Clock Speed (MHz)	Boot Time (s)	EEPROM (KB)	GPIO (Nos)	Interface (Nos)	Operating Voltage (V)	Weight (g)	Cost ($)
Arduino Nano	16	1.5	256	Total [22] Digital [14] Analog [8]	UART[3] SPI[1] I^2C [1]	7-20	9	2.8
Pro Micro	16	8	1	Total [18] Digital [14] Analog [4]	UART[1] SPI[1] I^2C [1]	6-16	7	5.1
Arduino Pro Mini	**16**	**8**	**1**	**Total [20] Digital [14] Analog [6]**	**UART[1] SPI[1] I^2C [1]**	**3.3-12**	**2**	**25.95**

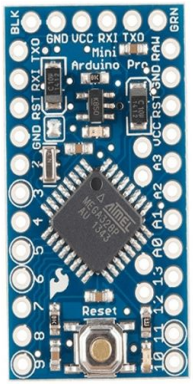
SELECTED

Arduino Pro Mini 328P

- Higher Number of Digital Pins available (14)
- Inbuilt Surge current protection, easy to use with high current drawing sub-units like NICHROME wire.

GPIO Description

- Serial: 0 (RX) and 1 (TX)
- External Interrupts: 2 and 3
- PWM: 3, 5, 6, 9, 10, and 11
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK)
- LED: 13



Arduino Pro Mini 328P

Container Processor & Memory Trade & Selection [2/2]

Memory Trade & Selection

Model	MEMORY (Kb)	Interface	DATA TRANSFER RATE (ms)	TYPE	Cost ($)
External EEPROM 24LC128	128	I^2C	5	EEPROM	1.7
External EEPROM 24LC256	**256**	**I^2C**	**5**	**EEPROM**	**2**

SELECTED

External EEPROM 24LC256

- Fulfil the memory requirement of the container(higher storage of 256KB).
- The method of erasure is electrical and immediate.
- To change the content, additional equipment are not required.

External memory is required for ease of data handling at launch site.

External EEPROM 24LC256

Electrical Power Subsystem (EPS) Design

Presenter: Amrit Ohri

EPS Overview [1/2]

Switches are used to turn on/off the payload and the container separately as and when required.

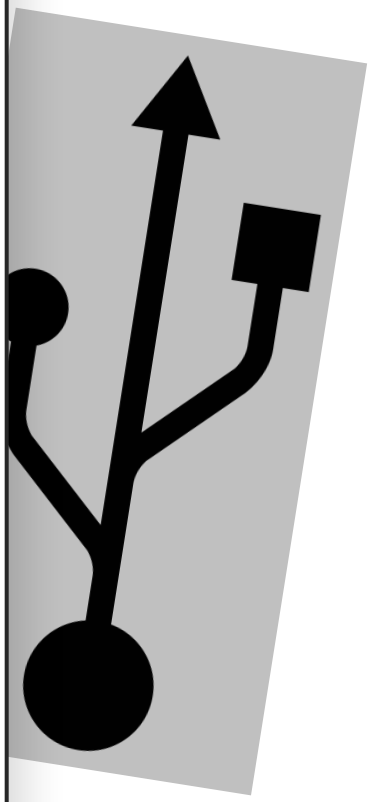
5V(LM7805) Voltage Regulator helps incorporate camera and servos. 3.3V regulators help incorporate all selected sensors in the payload.

A simple Voltage divider circuit brings the battery's voltage down to the acceptable level for ADC.

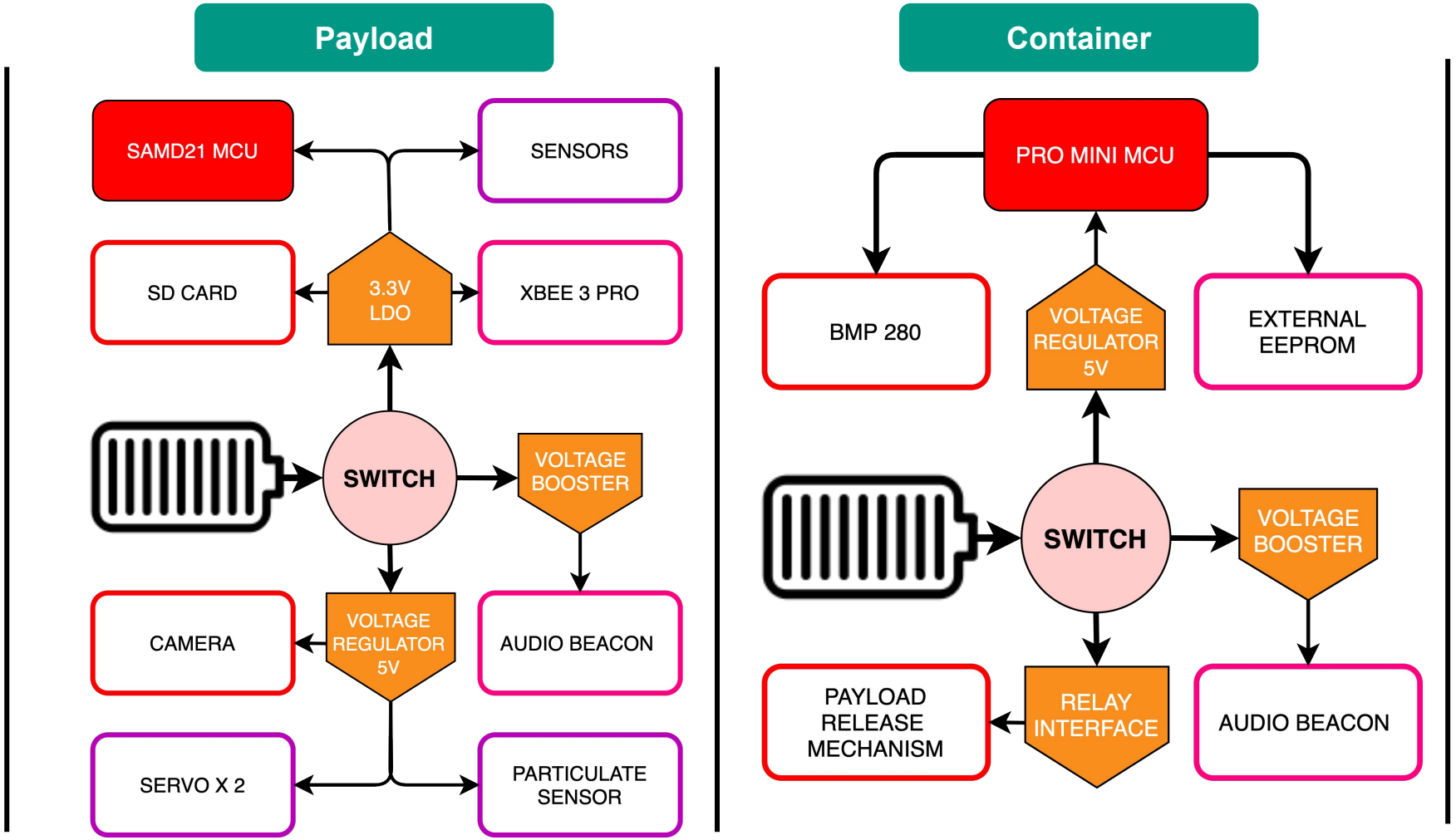
The value of resistors is chosen in such a way that they neither prevent required current flow nor they allow high passage of current.

LIR2032 coin cell is used to power external RTC PCF8523.

Similar 5V Voltage Regulators is used in the container to power the Arduino ProMini which in turn activates the Nichrome Wire burning mechanism.



EPS Overview [2/2]



NOTE: The BJT and MOS in audio beacons is controlled by the respective microcontroller in the container and payload.

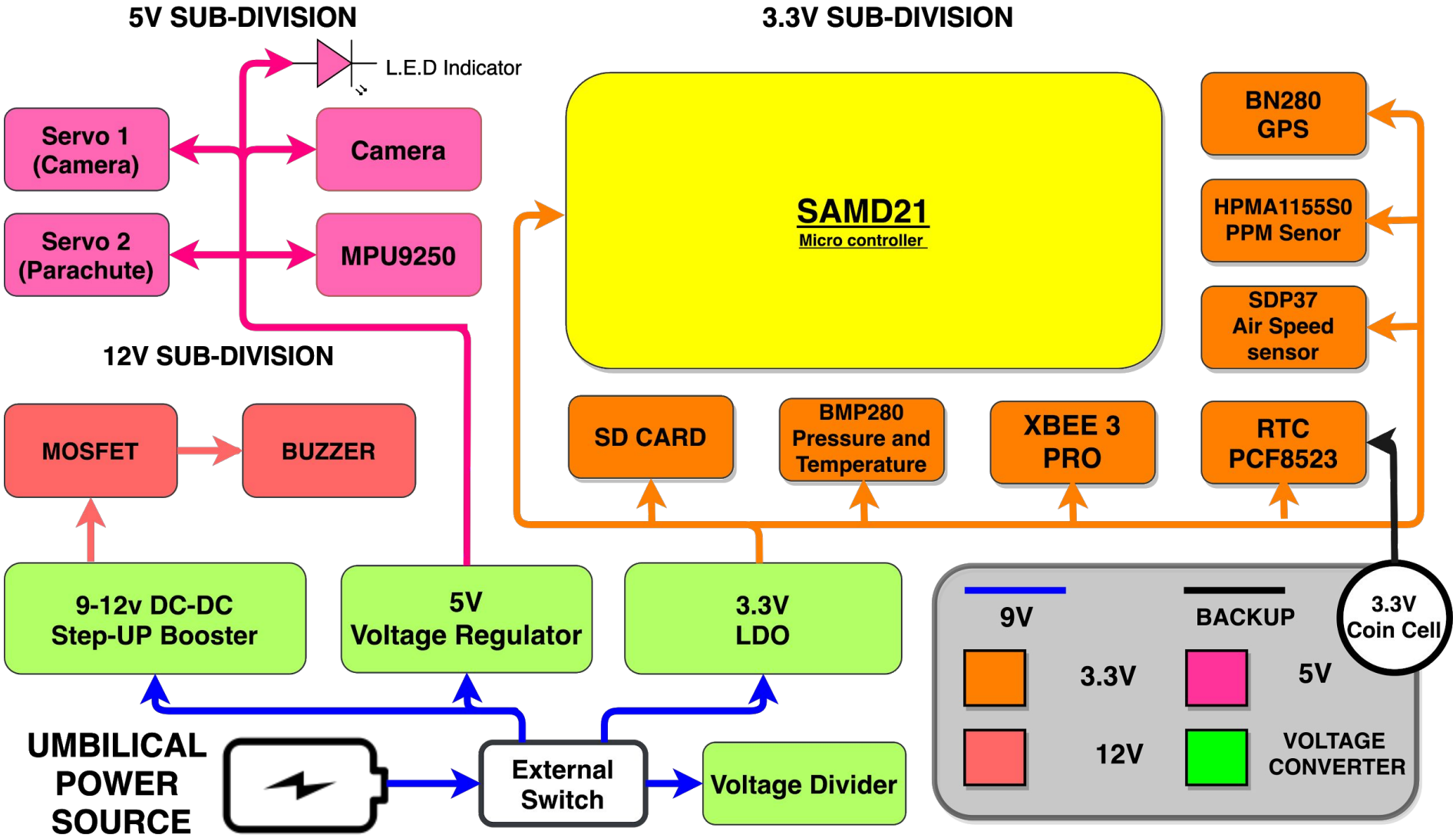
EPS Requirements [1/2]

ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
EPS 01	An audio beacon is required for the probe.It may be powered after landing or operate continuously.	Mission Requirement.	BR51	-	High		+	+	
EPS 02	The science payload shall measure its battery voltage	Mission Requirement.	BR24, SS-3	-	High	+		+	+
EPS 03	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.	Mission Requirement	BR49	-	Medium		+		
EPS 04	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat	Mission requirement.	BR54	-	High		+		
EPS 05	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	Mission and Safety Requirement.	BR53	-	High		+		

EPS Requirements [2/2]

ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
EPS 06	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the cansat and in the stowed state.	Mission requirement. Safety measure, helps finding the CanSat after mission.	BR50	-	High	+	+		
EPS 07	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Mission requirement. Power source must operate during whole mission.	BR57	-	High	+	+		

Payload Electrical Block Diagram



Payload Power Trade & Selection [1/2]

Model	Voltage (V)	Capacity [mAh]	Battery's Composition	Size (mm x mm x mm)	Weight (g)	Cost ($)
DURACELL DL223	6	1400	Lithium [Li/MnO_2]	36.0 x 35.0 x 16.8	38.0	6.00
ENERGIZER L522	**9**	**1000**	**Lithium [Li/MnO_2]**	**48.9 x 26.5 x 17.5**	**33.9**	**8.34**

***No Lithium Polymer battery compared or selected.**

SELECTED

ENERGIZER L522

- The continuous discharge current is appropriate to activate the release mechanism.
- Anti-leak structure ensures much security while handling them , as well as when they are fit into various devices.
- Suitable power/weight ratio and is operable from -40°F to 140°F.

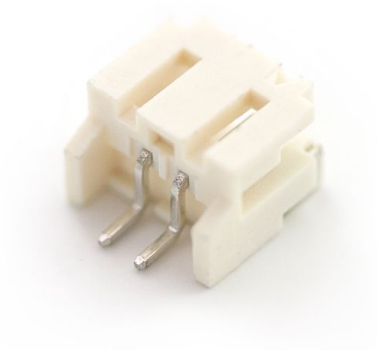
Battery Configuration: Only a single cell is used to power payload, therefore neither series nor parallel connection.

Energizer L522

Payload Power Trade & Selection [2/2]

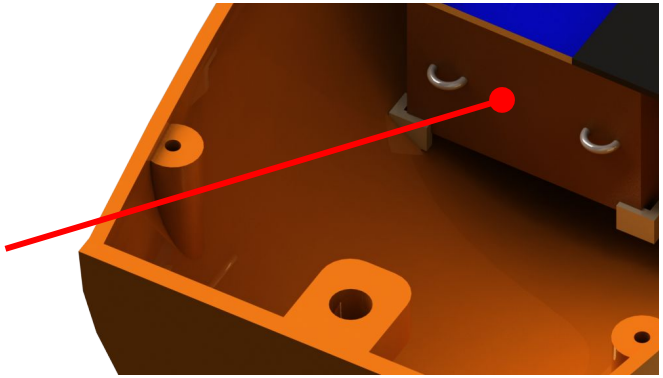
Battery Connection

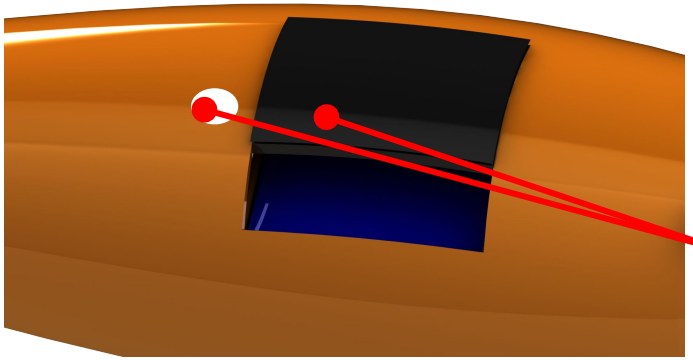
A single battery cell is used and is connected through MO2 connectors on the PCB.



Battery Mounting

A separate battery mounting has been made to keep the battery in fixed position.
The adjacent image shows two terminals on the battery mounting where umbilical power cord is connected.

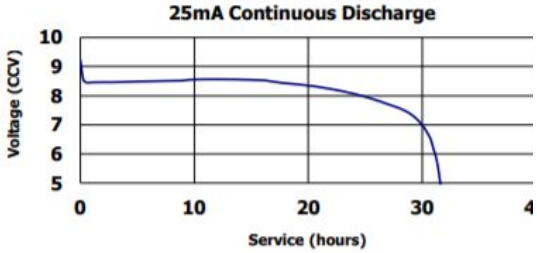


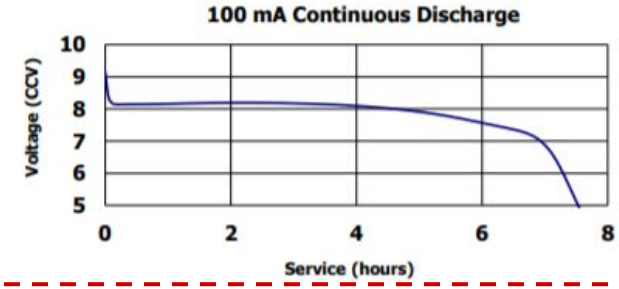


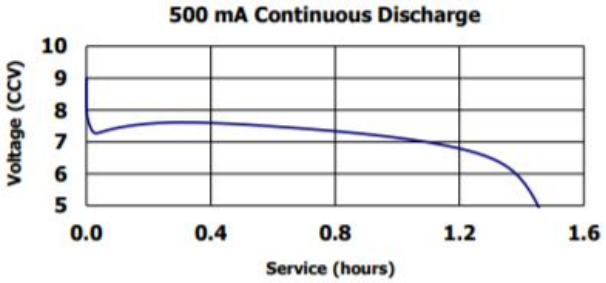
Slider Mechanism and switch hole on outer surface of Fuselage Body

An easily accessible battery compartment, allowing batteries to be installed or removed in less than a minute ,and a switch hole that does not require a total disassembly of the CanSat.

Battery Characteristics:







Payload Power Budget [1/2]

Pre Launch (till CanSat deployment) - 1hr **Flight Duration 213.74s** **Recovery-1hr**

Total functional time required= 7413.74s=123.56 min= 2.06h

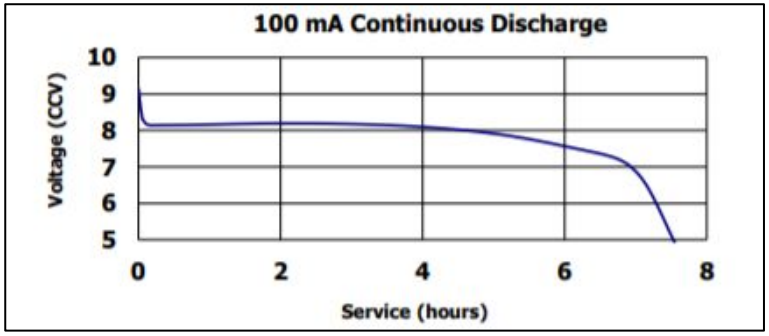
Sensor/Device	Component	Current (mA)	Voltage (V)	Duty Cycle (%)			Overall Power Consumed (Wh)	Source
				Pre-launch	Post-launch	Recovery		
MCU	SAMD21	50	3.3	100	100	100	0.3399	E
Data Storage	SD CARD	80	3.3	2	2	0	0.0056	Ds
Bonus Direction	MPU - 9250	3.7	5	100	100	0	0.0196	Ds
Pressure/Altitude/ /Temp	BMP280	2.7	3.3	100	100	0	0.0095	Ds
Air Speed	SDP37	3.8	3.3	0	100	0	0.0008	Ds
Particle Count	HPMA115S0	80	5	100	100	0	0.4244	Ds
GPS	BN-280	50	3.3	100	100	0	0.1751	Ds
RTC	PCF8523	0.15	3.3	100	100	0	0.0005	Ds
for CAMERA	Servo 1	300	5	0	75	0	0.0695	Ds/E

Payload Power Budget [2/2]

Sensor/Device	Component	Current (mA)	Voltage (V)	Duty Cycle (%)			Overall Power Consumed (Wh)	Source
				Pre-launch	Post-launch	Recovery		
for Wire cutting	Servo 2	300	5	0	6	0	0.0056	Ds/E
Radio	Xbee 3 Pro	47-RX 135-TX	3.3	2	2	0	0.0095	Ds
Audio Beacon	Buzzer	30	12	0	1	100	0.3621	Ds
Camera	Turbowing Cyclops DVR3	220	5	0	75	0	0.0510	Ds
						Total	**1.4731**	

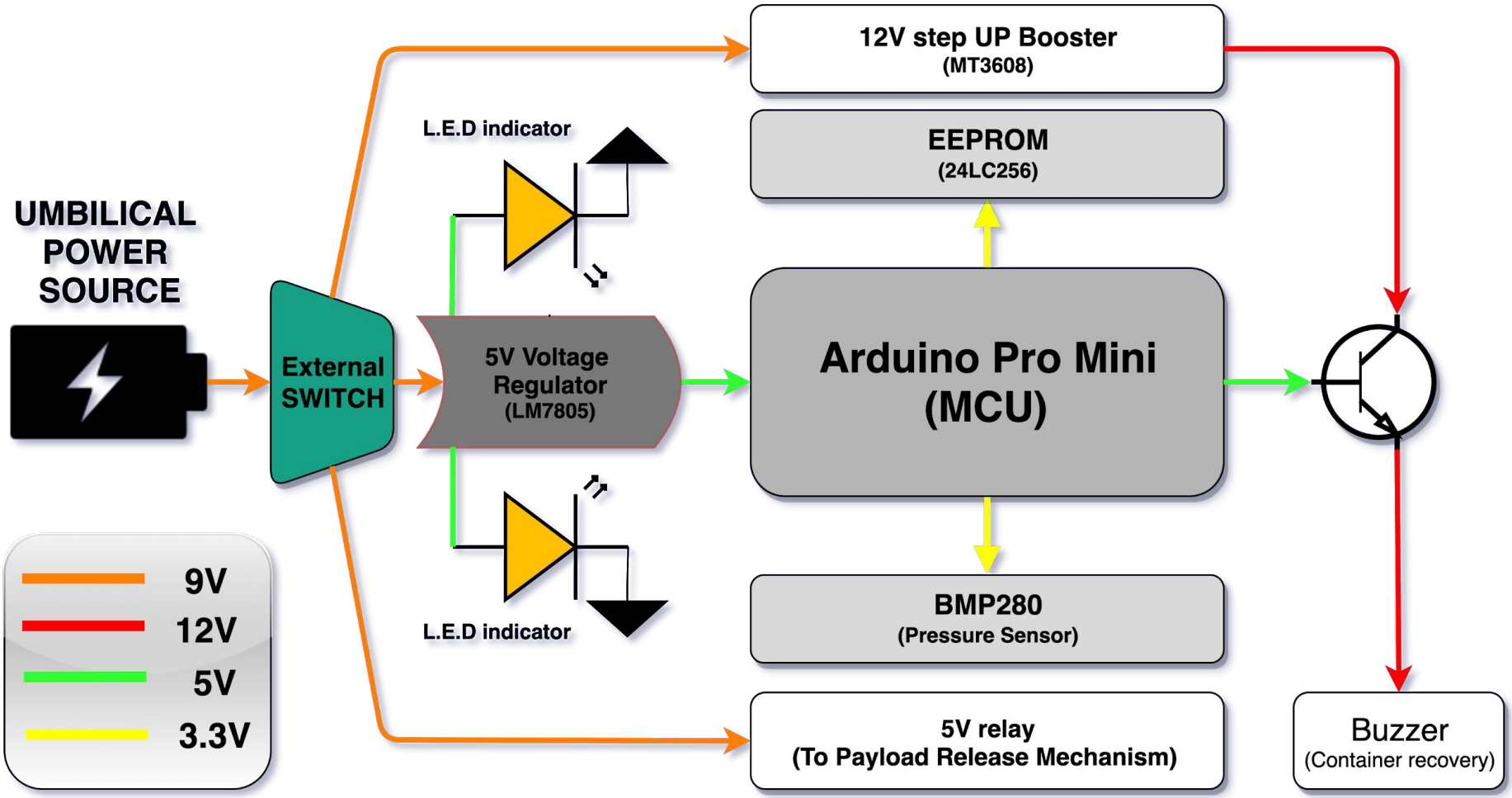
Total Power=Power of nth component∗Σ[Duty Cycle∗Cycle Duration]

Total Power Consumed in 2.06 Hours (Wh)	Total Power Available(From Battery) For 2.06 Hours (Wh)	Margin for Power (Wh)
1.4731	9Wx2.06h=**18.5400**	18.5400-1.4731=**17.0669**



Therefore, only 7.9455% Power of the battery is exhausted.

Container Electrical Block Diagram



Container Power Trade & Selection

Model	Voltage (V)	Capacity (mAh)	Battery's Composition	Size (mm x mm x mm)	Weight (g)	Cost ($)
DURACELL DL223	6	1400	Lithium [Li/MnO_2]	36.0 x 35.0 x 16.8	38.0	6.00
Envie Rechargeable Battery	**9**	**300**	**Nickel Metal Hydride**	**48.5 x 26.5 x 17.5**	**31.8**	**8.84**

***No Lithium Polymer battery compared or selected.**

SELECTED

Envie Rechargeable Battery

- Caters to the need of power subsystem, and eliminates the need for boost, and in turn inefficiency while using inductors.
- Anti-leak structure ensures much security while handling them , as well as when they are fit into various devices.
- Suitable power/weight ratio and is operable from -40°F to 140°F.

Battery Configuration: Only a single cell is used to power payload, therefore neither series nor parallel connection.

Envie Rechargeable Battery

Container Power Budget

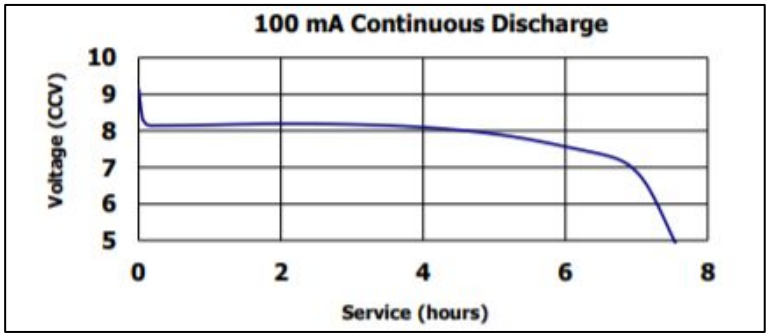
Pre Launch(till deployment of CanSat) - 1hr **Flight Time- 60.39s** **Recovery- 1hr**

Total functional time required= 7260.39s =121.01min= 2.02h

Total Power=Power of nth component∗Σ[Duty Cycle∗Cycle Duration]

Sensor/ Device	Component	Current (mA)	Voltage (V)	Duty Cycle (%)			Overall Power Consumed (Wh)	Source
				Pre-launch	Post-launch	Recovery		
MCU	Arduino ProMini	40	5	100	100	100	0.40400	E
Pressure/Altitude/ Temp	BMP280	2.7	3.3	100	100	0	0.00910	Ds
for activating Nichrome heating	5V relay	34	5	0	1.5	0	0.00005	Ds
Release mech	Nichrome Wire	710	9	0	1.5	0	0.00216	M
Audio Beacon	Buzzer	30	12	0	1.0	100	0.36040	Ds
Data Storage	External EEPROM	3	5	100	100	0	0.01020	Ds
						Total	**0.78591**	

Total Power Consumed in 2.02 Hours (Wh)	Total Power Available (From Battery) for 2.02 Hours (Wh)	Margin for power (Wh)
0.78591	2.7Wx2.02h=**5.45400**	5.45400-0.78591=**4.66809**



Therefore, only 14.41% Power of the battery is exhausted.

Flight Software (FSW) Design

Presenter: Apoorv Garg

FSW Overview [1/2]

Programming language

- C
- C++

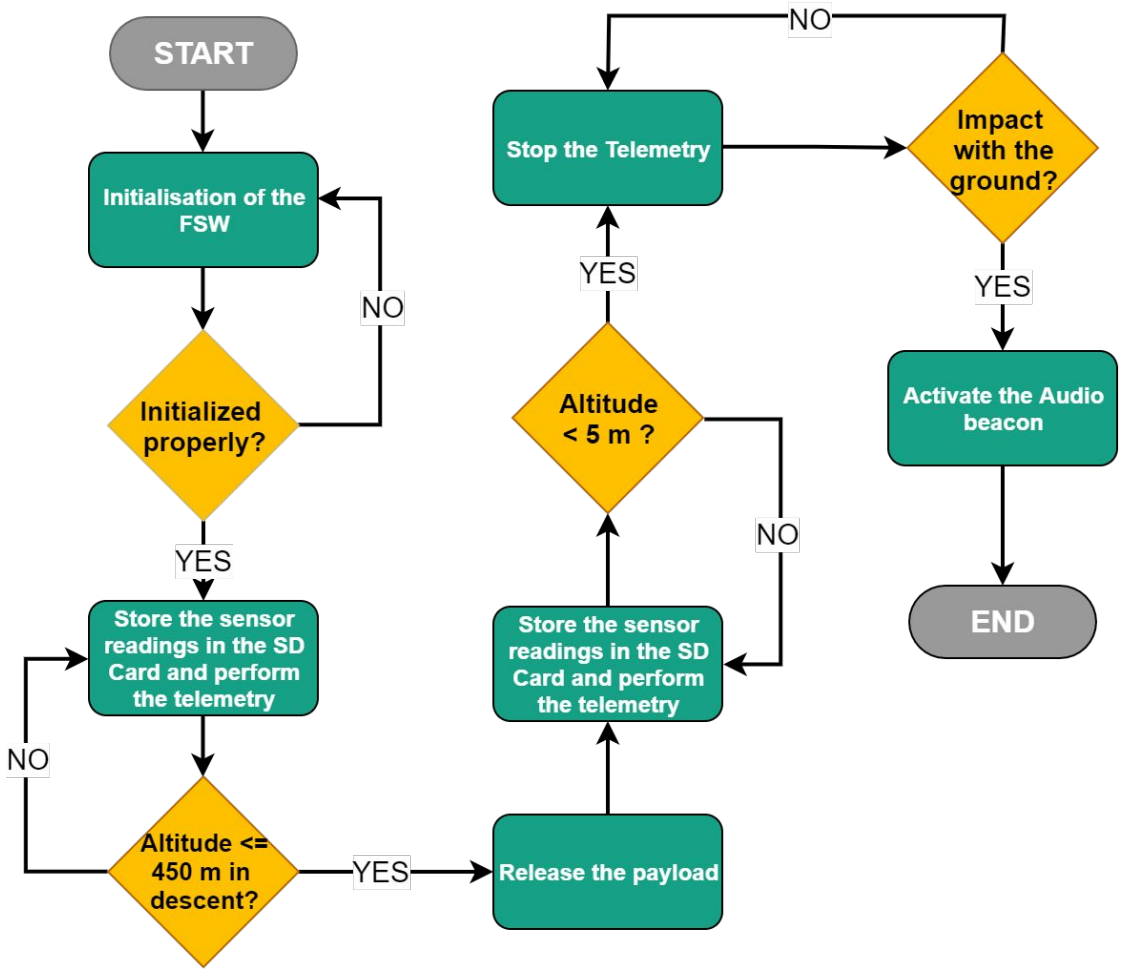
Development Environment

- Arduino IDE

Rationale

- Vast sets of predefined Libraries.
- Reduced hassle of interfacing with PC
- Memory Management of C/C++ extends the support for lower end microcontroller.
- Great community Support.
- Versatile and Robust
- Extremely fast execution as compared to other languages like python.

Basic FSW Architecture

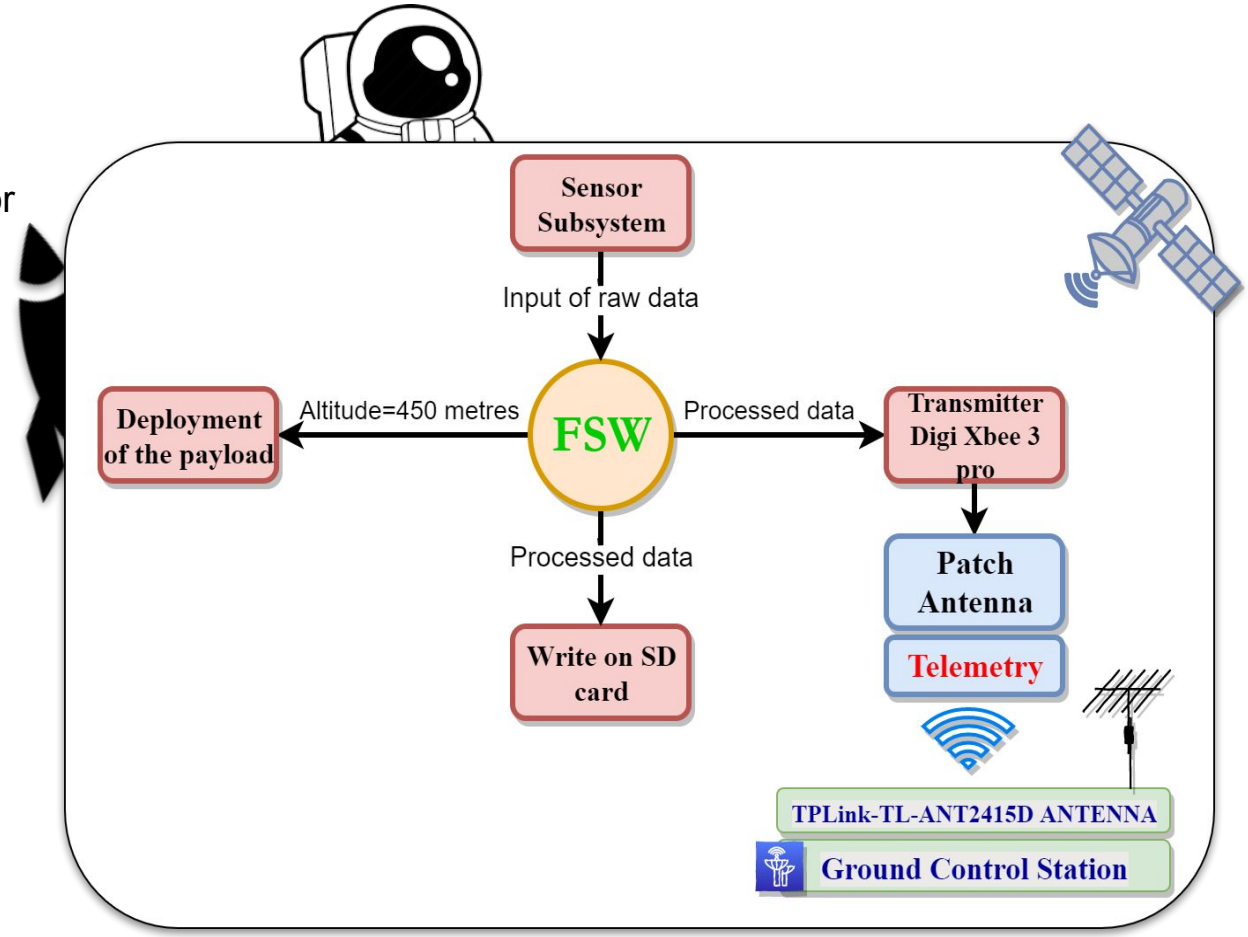


FSW Overview [2/2]

Brief Summary of FSW Tasks

1. Calibrate the sensors and reset the mission time to 0.
2. Read the data from the sensor (in raw format) and process the data.
3. Telemetry of the processed data and storing the data in the SD card.
4. Deployment of payload when altitude reaches 450 meters.
5. Deployment of Payload Parachute after 1 min of Gliding.

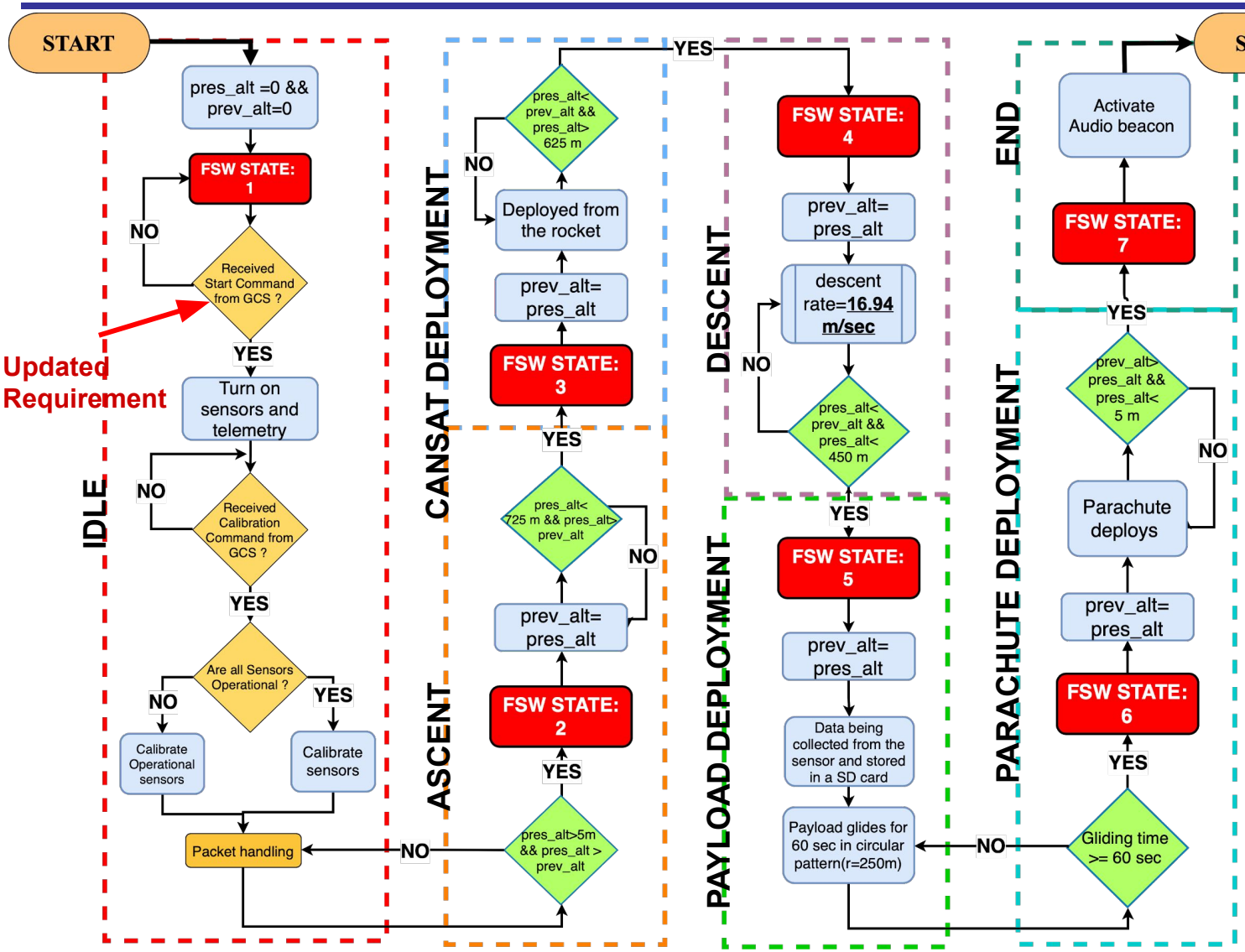
FSW Overview



FSW Requirements

ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
FSW 1	The payload shall sample all the sensor data at a rate of 1Hz	Mission Requirement	BR-29	-	High	+	+		
FSW 2	All the sensor shall calibrate/reset when the payload sits on the launchpad(State: BOOT).	Mission Requirement	-	-	High			+	
FSW 3	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission.	Mission Requirement	BR-47	-	High		+	+	
FSW 4	All the sensor data shall be transmitted through telemetry via Xbee radios	Mission Requirement	BR-35	-	High			+	+
FSW 5	The flight software shall have various software states (idle,ascent ,descent,deployment glides and landed) which changes during flight.	Mission Requirement	-	-	High		+	+	
FSW 6	The flight software shall open the container when the container + payload reaches 450 m and the state : Deployment is achieved	Mission Requirement	BR-10	-	High	+	+		
FSW 7	When the state(Payload gliding) is achieved the science payload shall glide in a circular pattern for one minute and stay above 100 meters after release from the container.	Mission Requirement	BR-11	-	High		+	+	
FSW 8	Once the payload lands ,all the telemetry shall stop with the activation of audio beacon	Mission Requirement	BR-51	-	High		+		

Payload FSW State Diagram [1/5]



INFO

FSW States:

1. Idle
2. Ascent
3. Cansat Deployment
4. Descent
5. Payload Deployment
6. Parachute Deployment
7. End

The Start Telemetry requirement has been Updated in accordance with the new requirement. The payload awaits for the command from the GCS to turn on all the sensors and setup radio into transmitting mode.

Payload FSW State Diagram [2/5]

FLIGHT SOFTWARE STATE DISCUSSION

1

- The rocket has not launched yet.
- Set pres_alt=0 and prev_alt=0.
- Sensors are calibrated
- When the altitude becomes greater than 5m, it moves to the next stage

2

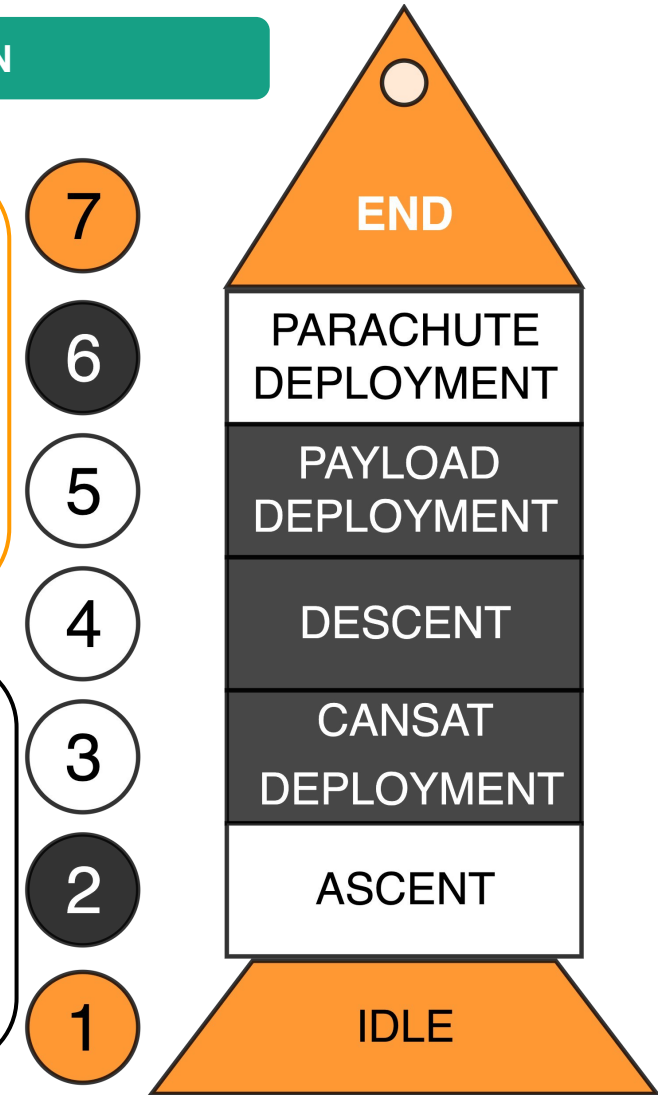
- Rocket ascends till 725m
- As the prev_alt becomes greater than pres_alt, fsw state increases.

3

- Rocket deploys Container+payload.
- Altitude keeps on decreasing.
- When reached 625m, fsw state moves onto the next state.

4

- Cansat descent at rate of **16.94 m/sec** (calculated).
- Altitude decrease.
- When reached at 450m, fsw state moves onto the next state.



Payload FSW State Diagram [3/5]

FLIGHT SOFTWARE STATE DISCUSSION

5

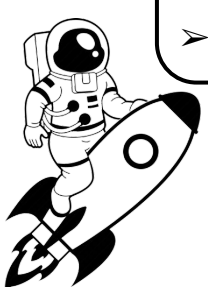
- Container deploys Payload via Nichrome wire Setup
- Gliding is activated and camera gets activated. Data is collected from sensor and saved to a SD card.
- The data is sent to GS at 1Hz. When altitude becomes less than 100m, state increases.

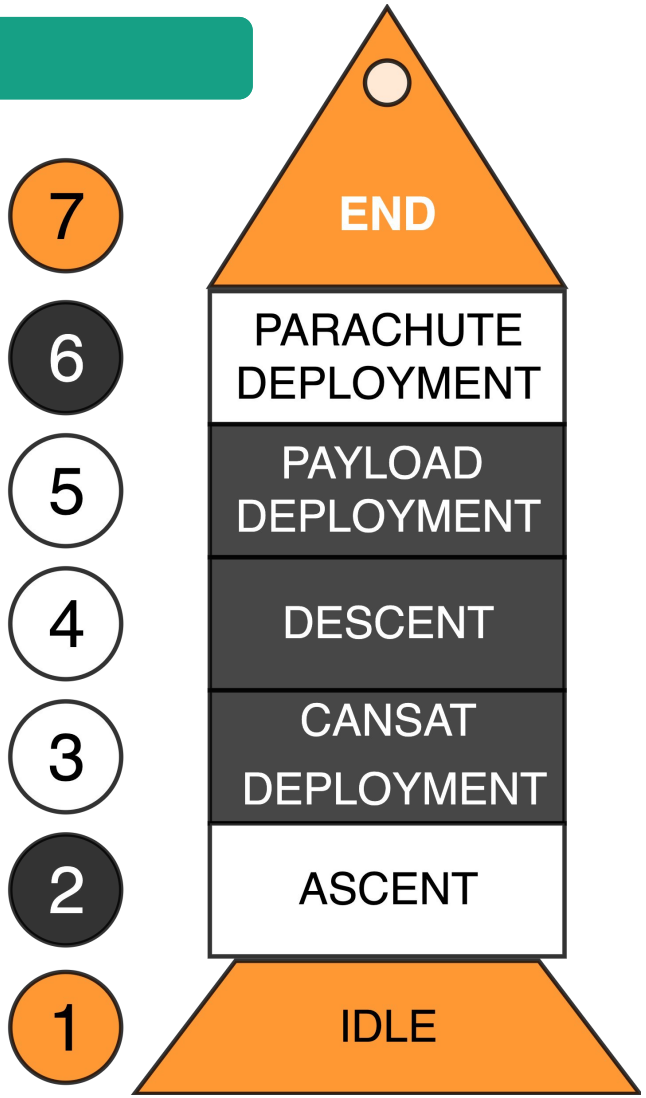
6

- Parachute deploys.
- Data being collected from the sensor and video from camera is stored in an SD card.
- When altitude becomes less than 5m, state increases.

7

- XBee stops transmitting data and stop telemetry.
- Buzzer is activated.
- System in standby mode.





Payload FSW State Diagram [4/5]

Serial No.	Process	Description
1.	**Sampling of sensors**	The sampling of the sensors takes place throughout the flight at 1 Hz frequency.
2.	**Communication**	The communication between the payload and the GCS takes place via RF waves. The half-duplex communication (calibration command) between the payload and the GCS takes from patch antenna(FXP-70) installed in the payload and the GCS Antenna (TPLINK-TL-ANT-2415D).
3.	**Data Storage**	The storage of the camera's data after the initialisation of the camera subsystem takes place on the Camera module 's SD card. The sensor's raw data is stored in the pre–installed SD card present in the SD card shield mounted on PCB.
4.	**Mechanism Activations**	At 450m, the payload is released from the container which results in the kicking in of the auto-gliding mechanism(which is not controlled by software system). After turning off the telemetry , the audio beacon is activated.Here camera (bonus objective) is activated.
5.	**Major Decision Points in Logic**	Backup of the FSW State throughout the flight (refer to the state chart diagram for the details of the same). Parachute deployment After 1 minute of gliding and above 100m.
6.	**Power Management**	The SAMD21 is kept on standby mode and is woken up when the power switch is pushed. It switches unused modules to standby mode when they are not being used to conserve power, except the Radios which remain active until landing is achieved.

Payload FSW State Diagram [5/5]

Processor Reset Control

Data used to recover

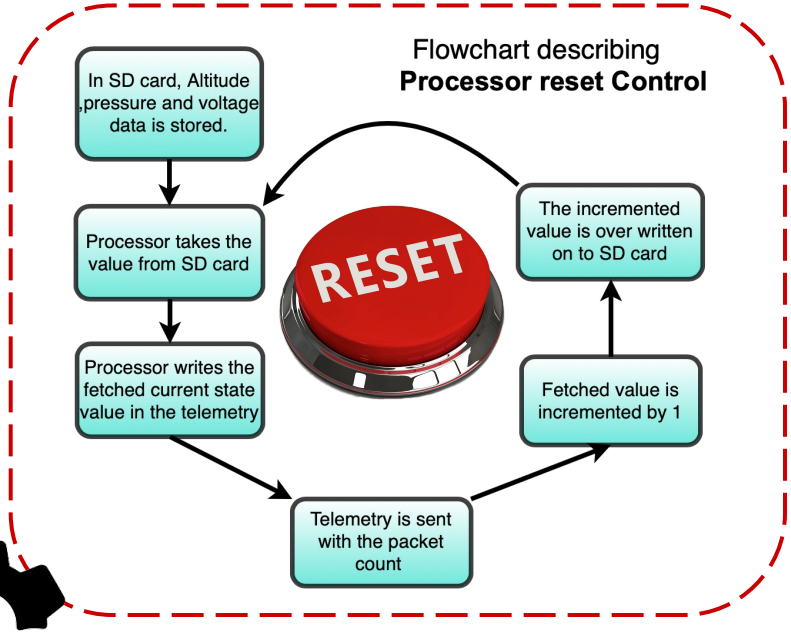
1. **Present Altitude** and **Previous Altitude** variables will be used to recover FSW state if processor resets.
2. **State counter** helps to determine software states.

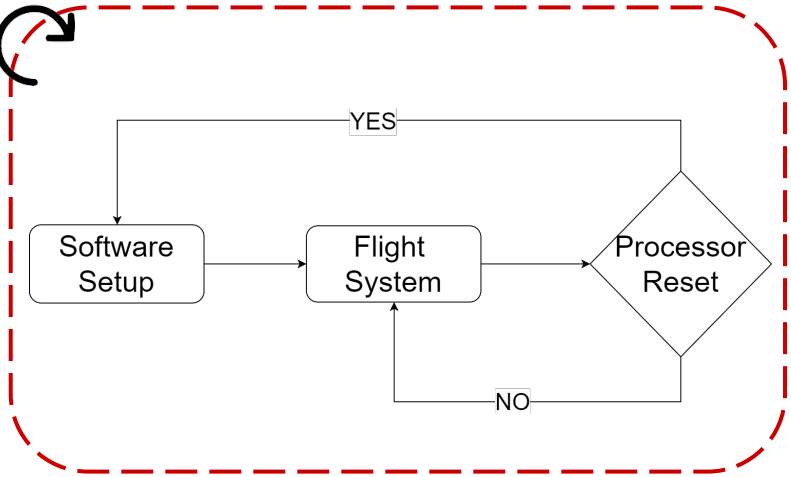
Reasons for Reset

1. A glitch in the power supply rail.
2. Analog input pin connected to a sensor goes to a negative voltage.
3. Run-time error such as division-by-zero or stack overflow.

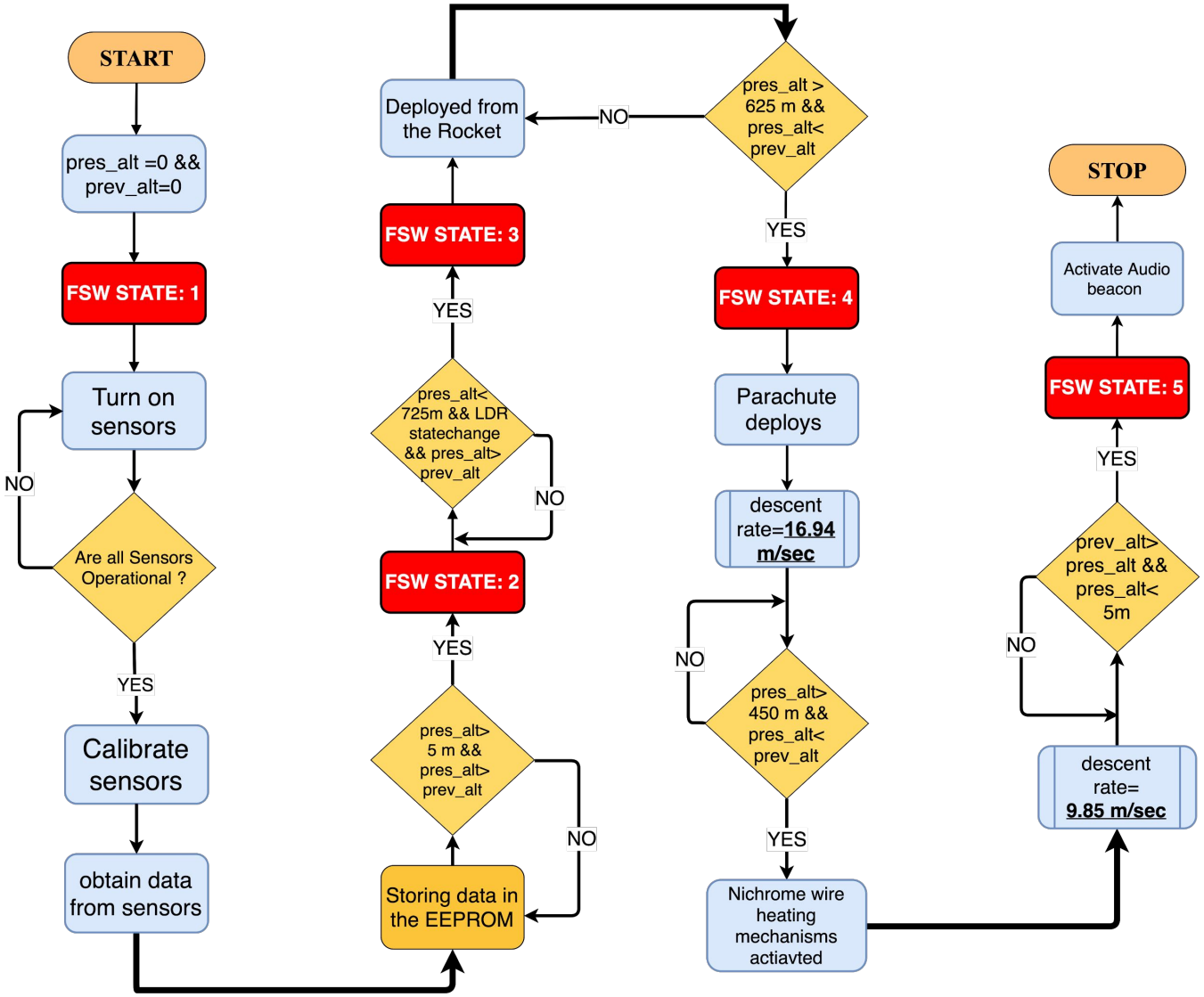
Method of Recovery

State counter is increased after every state transition and is saved to SD card. On the other hand, altitude data is saved to SD card in all states at every one second. If microcontroller resets, the SD card is read. Based on the value of present altitude and the altitude value read from the SD card, a reset can be detected. Then, the value of the state counter is obtained from the SD card. As a result, according to the values of state counter and last altitude data, the last software state will be found.





Container FSW State Diagram [1/2]



INFO

1. Idle
2. Ascent
3. Cansat Deployment
4. Descent
5. End

Processor reset Control

1. The FSW state is stored in the EEPROM by the processor at 1Hz..
2. In case of processor reset, the processor takes the previous state value from the EEPROM.
3. Condition check is performed by the processor(using present altitude) to see if next state has been achieved.
4. If yes, EEPROM is updated , otherwise the the previous state is maintained.

Container FSW State Diagram [2/2]

Serial No.	Process	Description
1.	Sampling of sensors	The sampling of the sensor(BMP) takes place throughout the flight at 1 Hz frequency.
2.	Communication	No direct communication takes place between the container and the GCS, the communication between the payload and the GCS takes place via RF waves. The half duplex communication between the payload and the GCS takes from patch antenna(FXP70) installed in the payload and the GCS antenna (TP-Link-2415D).
3.	Data Storage	The sensor's raw data is stored in the EEPROM.
4.	Mechanism Activations	Activation of the audio beacon when the container makes contact with the ground.
5.	Major Decision Points in Logic	Backup of the FSW State throughout the flight(refer to the state chart diagram for the details).
6.	Power Management	The MCU is kept on normal mode throughout the flight. MCU switches pressure sensor to low power mode when it is not being used.
7.	Method Of Recovery	The processor takes the previous state value from the EEPROM.Condition check is performed by the processor(using present altitude) to see if next state has been achieved.

Software Development Plan [1/3]

To avoid the delay of Software Development

- We have been holding meets regularly.
- By following the RAD SDLC,the testing has been done regularly,

Software Subsystem Development Sequence

- SDLC Model followed for the development of the software is RAPID or RAD.

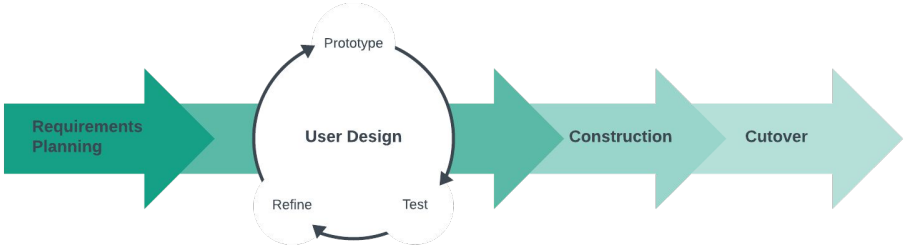
Test Methodology

- The test methodology followed is **functional testing**.
- The sequence of the various types of testing :
  - ***Unit Testing***:Each module is tested independently.
  - ***Integration Testing***:The unit tested modules are integrated and tested.
  - ***System Testing***:The entire system is tested for bugs and errors.
  - ***Functional Testing***:The whole system is tested to check

Prototyping and Prototyping environments

- Real Time Plotting software coupled with regular breadboard and PCB testing.

RAPID SDLC



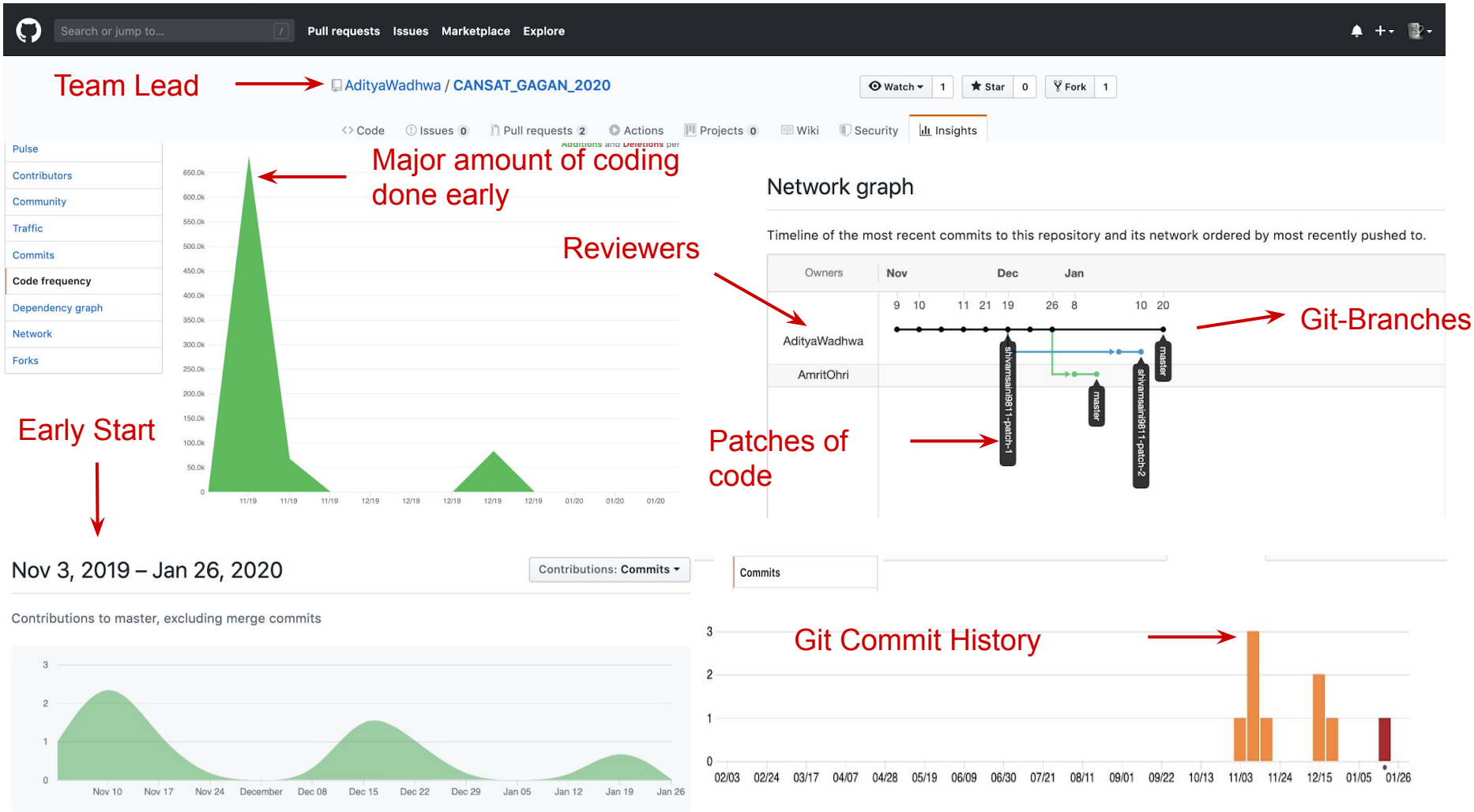
Development Team

Apoorv Garg

Saurabh Soreng

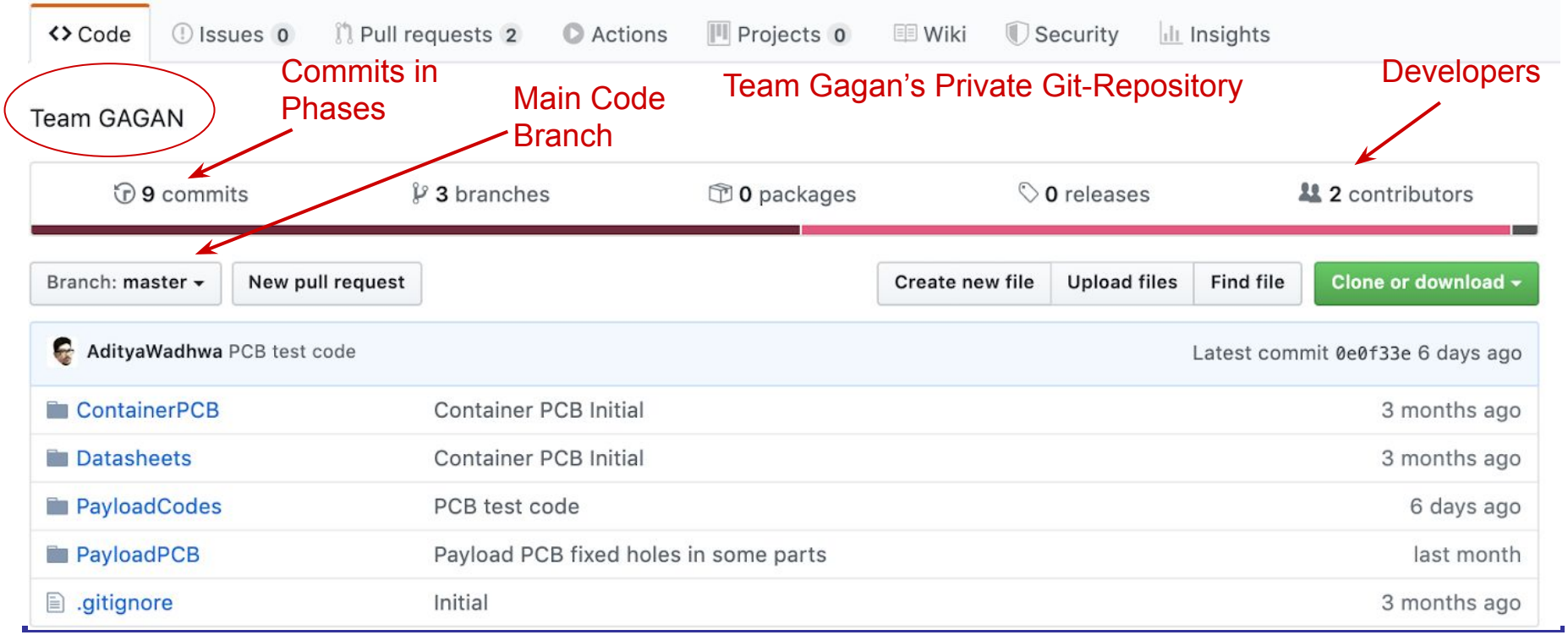
Software Development Plan [2/3]

Code publishing and reviewing process



Software Development Plan [3/3]

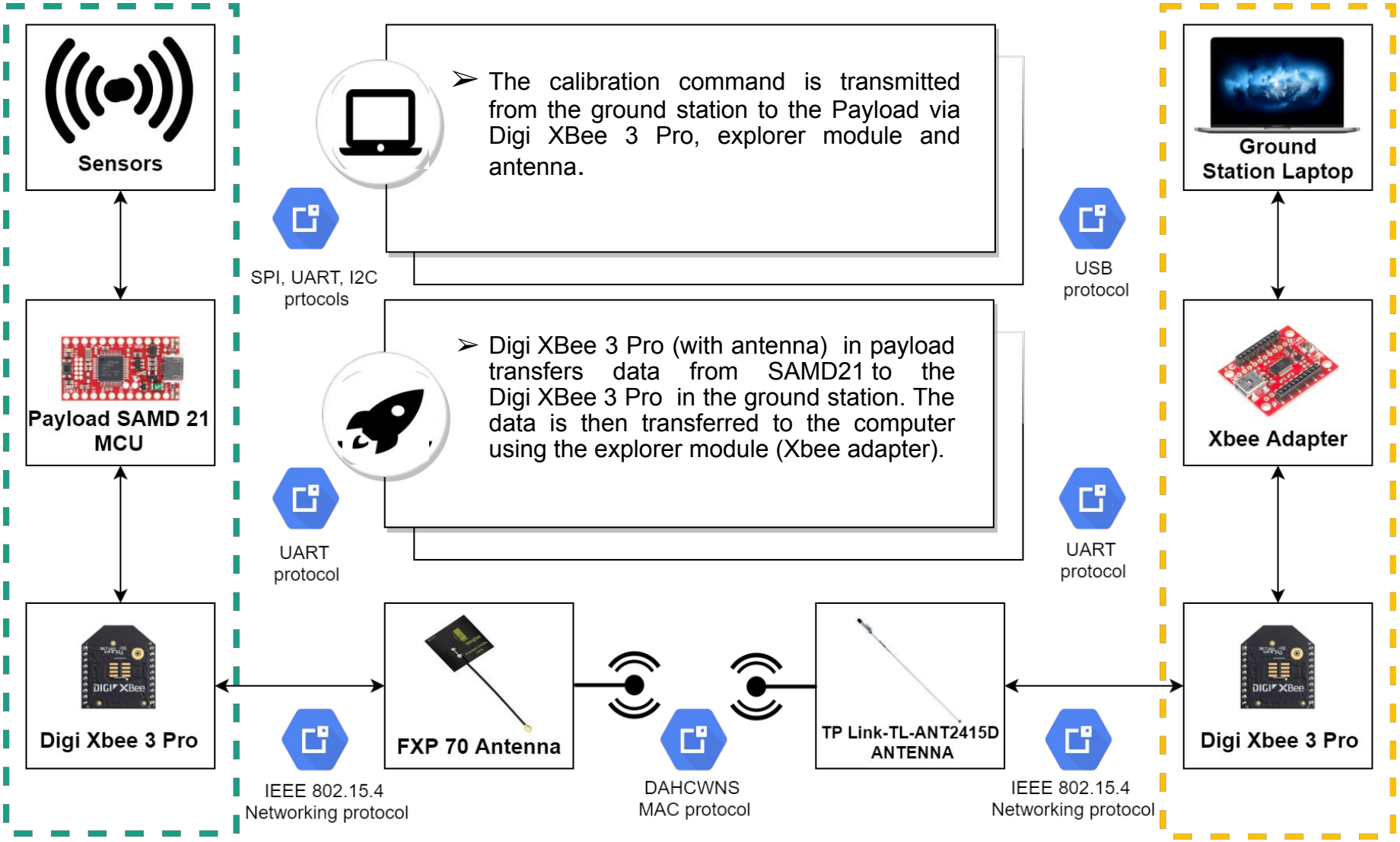
- The Software Development Plan shall be subdivided into stages.
- The Software Developer shall take up one task from the current stage.
- After thorough check by the programmer, the finished code shall be published into the GIT repository on private developers branch.
- Any change made will to be analysed and reviewed by the independent tester.
- After scrutinizing and achieving positive result of code review (desk check) and compilation verification, developer's branch would be merged into master branch.
- Before terminating any stage, all changes performed will be integrated into the existing software from previous stage. At this point, system tests will be executed. The test procedure development teams shall ensure full functionality of the software division and cooperation with the whole software system.



Ground Control System (GCS) Design

Presenter: Saurabh Soreng

GCS Overview



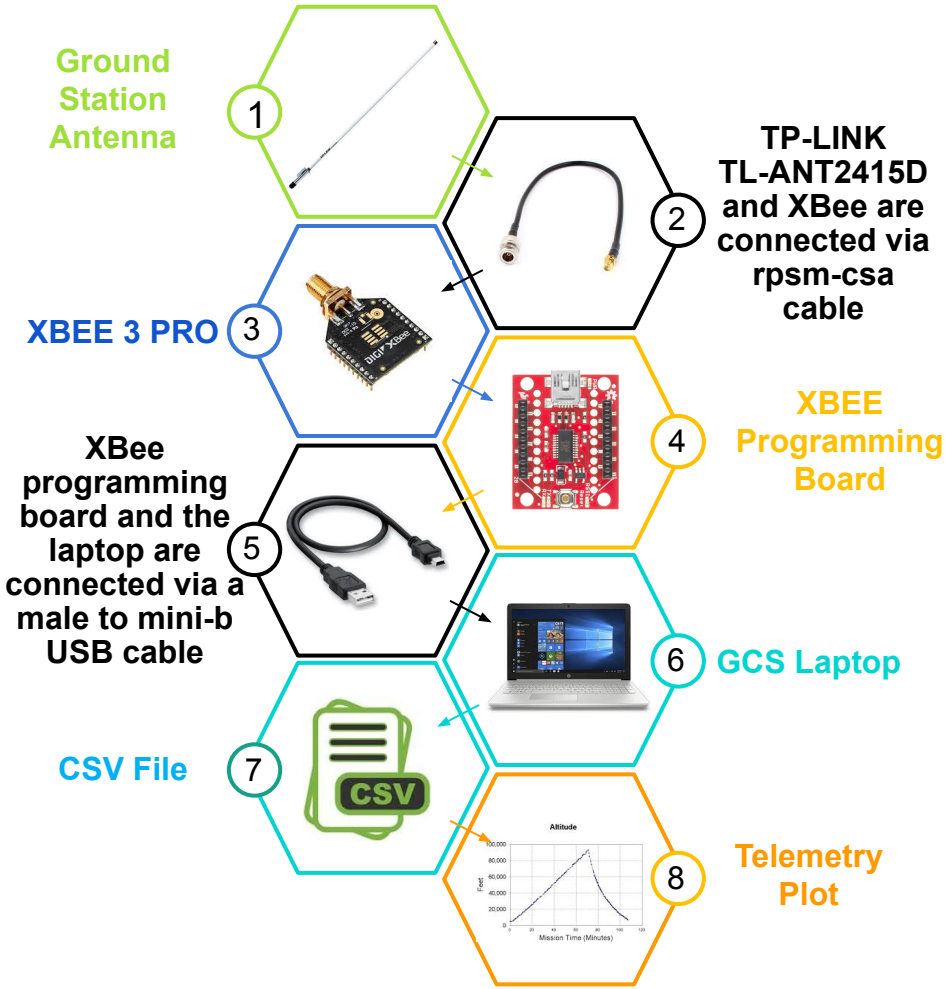
- The calibration command is transmitted from the ground station to the Payload via Digi XBee 3 Pro, explorer module and antenna.
- Digi XBee 3 Pro (with antenna) in payload transfers data from SAMD21 to the Digi XBee 3 Pro in the ground station. The data is then transferred to the computer using the explorer module (Xbee adapter).

GCS Requirements

ID	Requirement	Rationale	Parent	Child	Priority	VM			
						A	I	T	D
GS 01	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	Mission Requirement	BR31	-	High		+		
GS 02	The ground station shall generate A csv file of all sensor data as specified in the telemetry section.	Mission Requirement	BR32	-	High	+	+	+	+
GS 03	Each team shall develop their own ground station	Mission Requirement	BR39	-	High		+		
GS 04	All telemetry shall be displayed in real time during descent.	Mission requirement	BR40, PCDH06	-	High	+	+		
GS 05	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Mission requirement	BR41, PCDH07	-	Medium		+	+	
GS 06	Teams shall plot each telemetry data field in real time during flight.	Mission requirement	BR42, PCDH08	-	High	+	+		
GS 07	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Mission requirement	BR43	-	High	+		+	
GS 08	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.	Mission Requirement	BR44	-	High	+	+		

GCS Design

A diagram to show GCS Design



Specification

BATTERY

Battery backup of the computer will be greater than 3 hours.

OVERHEATING

An external cooler will be there working on its own battery and an umbrella will be used to prevent direct exposure to sunlight.

AUTO - UPDATE

On Windows,the auto update feature will be disabled before the launch.

BACKUP

The ground system software will also be downloaded as backup.

GCS Antenna Trade & Selection [1/3]

Model	Gain (dbi)	Frequency (GHz)	Directivity	Range* (m)	VSWR	Connector	Weight (kg)	Cost ($)
TY-860 Yagi Antenna	12	0.9	Directional	10560	1:5:1	N-Female	1.4	110
Airpath Wireless net Solutton Air Grid Antenna	23	2.4	Directional	14057	1:5:1	N-Female	3.3	170
TPLink-TL-ANT2415D	**15**	**2.4**	**Omni-directional**	**2500**	**2:0:1**	**N-Female**	**1.81**	**140.4**

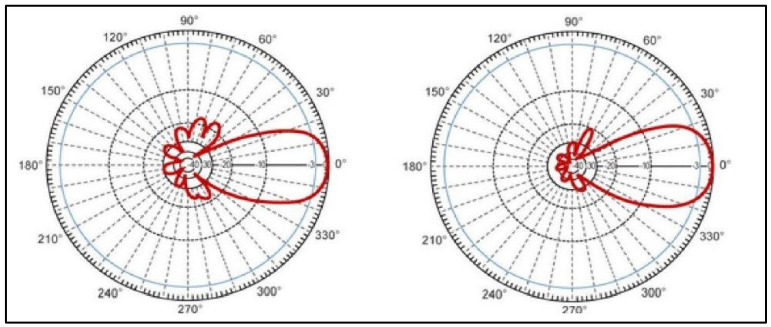
Antenna Mountings	
TPLink-TL-ANT2415D	**Hand-Held**
TY-860 Yagi Antenna	Hand-Held
Airpath Wireless net Solutton Air Grid Antenna	Table Top

TPLink-TL-ANT2415D

*The ranges have been calculated based on our receiver's sensitivity=-**65dB**, for a gain value of **5dB**.

GCS Antenna Trade & Selection [2/3]

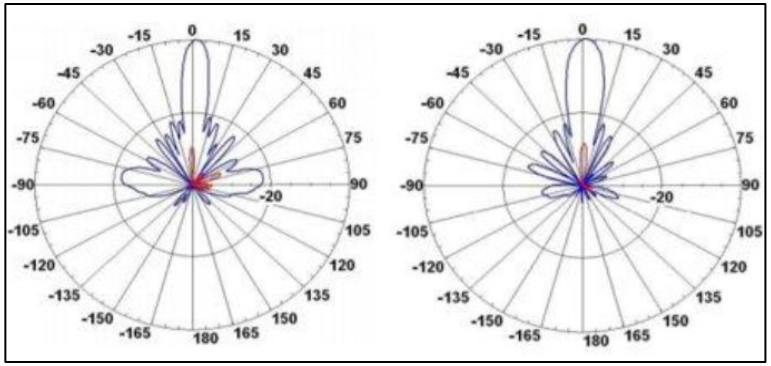
Antenna Radiation Patterns



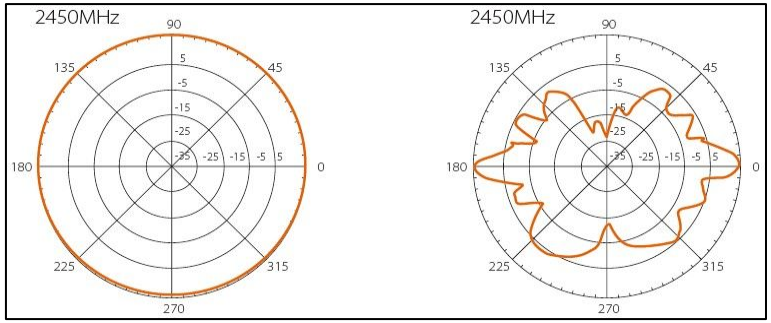
Horizontal Plane Vertical Plane

Radiation Pattern
TY-860 Yagi Antenna

Radiation Pattern
TP link TL-ANT_2415D



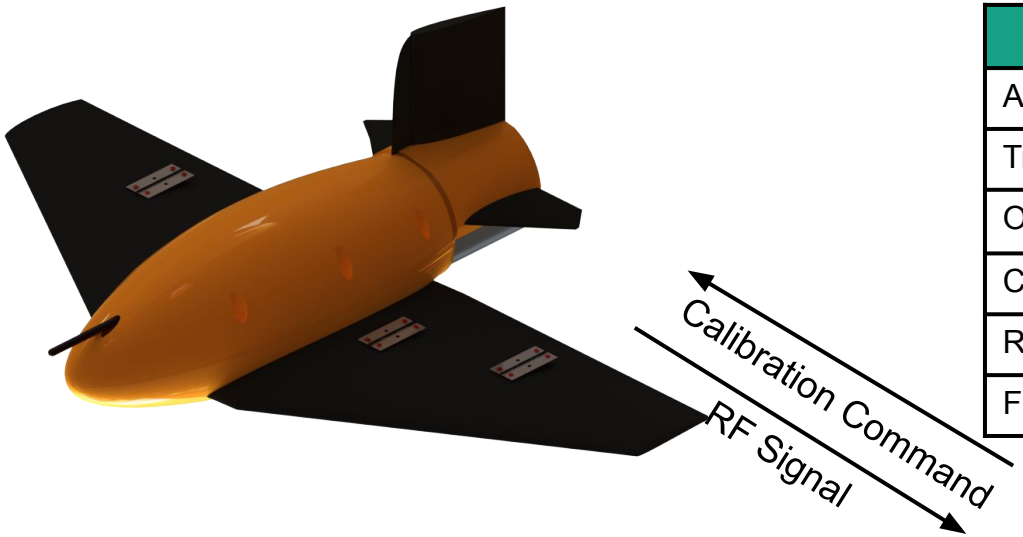
Horizontal Plane Vertical Plane



Horizontal Plane Vertical Plane

Radiation Pattern
Wireless Grid Antenna

GCS Antenna Trade & Selection [3/3]



Parameter	Value
Antenna Gain	15
Transmission Power(dBm)	43.01
Operating frequency(MHz)	2400
Cable Loss(dB)	15
Receiver Sensitivity(dBm)	-65
Free space path loss (dB)	108.01

Antenna will be hand-held

GROUND CONTROL STATION

SELECTED

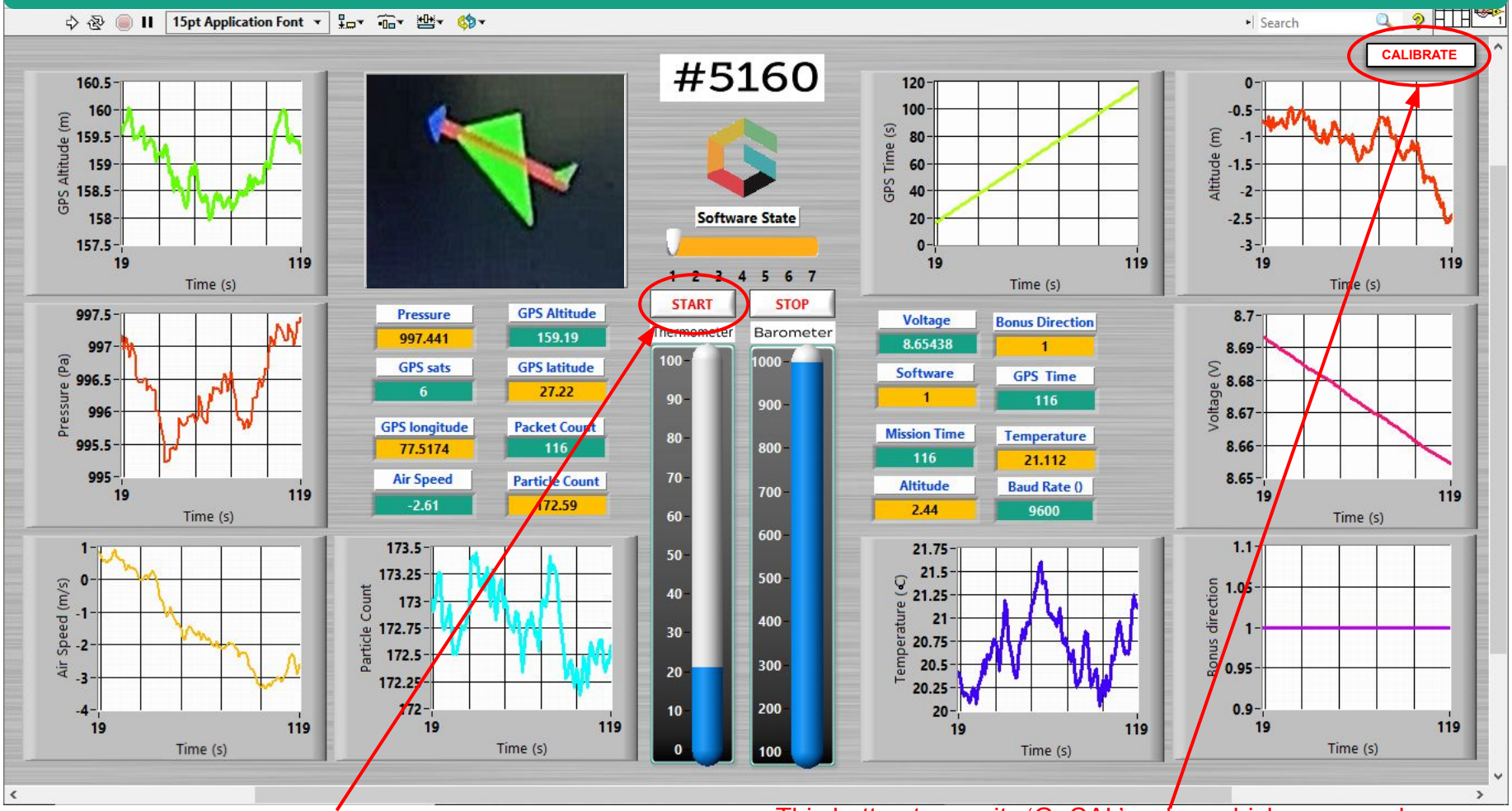
TP Link-TL-ANT2415D ANTENNA

- 15dBi Omni-directional operation highly enlarges the wireless coverage and the lower impedance causes low signal loss.
- Excellent Transmission Range, with N-female connector, compatible with all our electrical equipment.
- Easier estimation of antenna efficiency, as the antenna pattern similar to **FXP70.**

Patch antenna installed in the payload transmits the data.

GCS Software [1/3]

Real-Time Plotting Display Prototype



This Feature has been added in accordance with the updated mission requirement (Update of 30th JAN 2020).

This button transmits 'G_CAL' as key which commands CANSAT to calibrate all the sensor and prepare itself for launch

GCS Software [2/3]

Telemetry Display Prototype

Snapshot of the .csv file generated by our software.All results were according the prescribed format of Mission Guide.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Team ID	Mission Ti	Packet Cou	Altitude(m	Pressure(I	Temperatu	Voltage(V	GPS Time	GPS Lati	GPS Lor	GPS Altit	GPS Sa	Air Spee	Software	Particle	Bonus Di
2	5160	4	4	0.1	996.298	20.351997	8.749999	4	27.5938	77.7310	158.36	7	-0.28	1	86.82	0
3	5160	5	5	0.24	996.6098	20.481997	8.589997	5	27.5037	77.7610	158.18	4	-0.23	1	86.84	0
4	5160	6	6	0.18	996.4198	20.661997	8.759997	6	27.3237	77.9010	158.52	1	-0.04	1	86.75	0
5	5160	7	7	0.4	996.3498	20.901997	8.849997	7	27.5037	77.7210	158.53	0	-0.27	1	86.9	0

Snapshot of **telemetry** on the Serial Port of our software.

GAGAN_GCS_Terminal(COM-3)

```
5160,4.000000,4.000000,0.100000,996.299800,20.351997,8.749999,4.000000,27.593800,77.731087,158.360000,7.000000,-0.280000,1,86.820030,0
5160,5.000000,5.000000,0.240000,996.609860,20.481997,8.589997,5.000000,27.503798,77.761078,158.180020,4.000000,-0.230000,1,86.840027,0
5160,6.000000,6.000000,0.180000,996.419860,20.661997,8.759997,6.000000,27.323797,77.901077,158.520020,1.000000,-0.040000,1,86.750023,0
5160,7.000000,7.000000,0.400000,996.349850,20.701998,8.849997,7.000000,27.583796,77.721077,158.539990,0.000000,-0.270000,1,86.730019,0
5160,8.000000,8.000000,0.490000,996.529910,20.871996,8.909997,8.000000,27.563793,77.721085,158.689990,-1.000000,-0.330000,1,86.900009,0
5160,9.000000,9.000000,0.800000,996.679870,21.211994,9.059996,9.000000,27.323792,77.681084,158.809970,4.000000,-0.390000,1,86.660019,0
5160,10.000000,10.000000,0.870000,996.719910,21.431993,8.769996,10.000000,27.363791,77.371086,158.789960,5.000000,-0.500000,1,86.440025,0
5160,11.000000,11.000000,1.050000,996.759830,21.761992,8.679996,11.000000,27.143787,77.521080,158.659960,4.000000,-0.310000,1,86.280029,0
5160,12.000000,12.000000,1.070000,996.799870,21.551991,8.839998,12.000000,26.843788,77.581078,158.639940,5.000000,-0.370000,1,86.020035,0
5160,13.000000,13.000000,0.950000,996.969790,21.631989,8.849998,13.000000,26.823788,77.561073,158.539920,6.000000,-0.280000,1,86.090027,0
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5160,15.000000,15.000000,1.200000,997.049800,21.891993,8.739996,15.000000,26.853786,77.651077,158.839920,8.000000,-0.590000,1,85.990021,0
```

https://www.youtube.com/watch?v=JPt84CRuqmc

GCS Software [3/3]

Main GCS Operations

Telemetry data recording and media presentation to judges:

- We use charts, labels, listview for analyzing the incoming data from the payload.

Commercial off the shelf software packages used:

- LABVIEW
- XCTU (Xbee Program Software (Free).

Real time plotting software design:

- Data is received via TPLink-TL-ANT2415D Antenna. Each frame is divided into parts with their own axes and directed into the data flow and is sent to software listeners.

Calibration command and verification:

- The payload will be started from the ground station using **'start'** as key.
- The payload will be calibrated from the ground station using **'G_CAL'** as key.
- The calibration verification will be performed according to the telemetry data sent from the barometric sensor(BMP 280). .

Telemetry data recording and media presentation to judges:

- Telemetry data as a .csv file, the screenshot of the interface, media data recorded on the SD card on the camera will be presented to the jury in the USB memory at the end of the mission.

.csv telemetry file creation for judges:

- The CSV file is created by writing every telemetry frame with an End Of Line sign at the end to a file with a proper name.

CanSat Integration and Test

Presenter: Dinesh Dakshanamoorthy

CanSat Integration and Test Overview

Mechanical Test	➢ Total mass of CanSat has been checked. ➢ The Parachute system has been checked to give a descent speed of 20m/s
Descent Control Test	➢ The release of Parachute from Cansat is checked. ➢ The opening of Delta-Wing system is checked.
Testing of CDH &FSW	➢ The communication between receiver and transmitter has been checked. ➢ The accuracy of data packets is checked.
Communication Test	➢ Xbee configurations and signal level tests are actualized with XCTU software
Environmental Test	➢ Fit check was done. ➢ Drop test and Thermal test were performed. ➢ Vibration test will be performed in a steady temperature.
Testing of the sensors	➢ All sensors have been tested and calibrated. ➢ The test codes have been cross checked.
Subsystem Level Testing Plans	➢ All the subsystems have been tested individually. ➢ Defining FSW states for different phases of the flight. ➢ Testing range of Xbee's using inbuilt tool from XCTU.
Integrated Level Testing Plan	➢ Payload and Container combined drop test from the drone. ➢ Packet generation and transmission by collecting data from sensor subsystem. ➢ Complete sensor subsystem and camera subsystem testing with battery.

Subsystem Level Testing Plan [1/7]

CanSat subsystems level tests (before integration)	
CDH	The communication between receiver and transmitter is checked. The accuracy of data packets is checked over large distance.It is made sure that the data obtained is saved and ready to be used.
Radio Communication	Xbee configurations and signal level tests are actualized with XCTU software.Number of data packets sent and received are monitored for data loses. https://www.youtube.com/watch?v=zLAdpydN5CI
EPS	The voltage and current requirements of all sensors and the CanSat is observed. It is made sure that there is no current leakage in PCB. The voltage drain rate of battery is checked.
Sensors	All sensors are tested separately on a breadboard. The sensors are calibrated according to the required conditions. The output is taken and made sure the test codes are correct. https://www.youtube.com/watch?v=arpqQ2Grxns
FSW	The Flight Software was tested to produce expected sensor data, different states of flight were emulated in controlled environment to verify the software's different transition states.

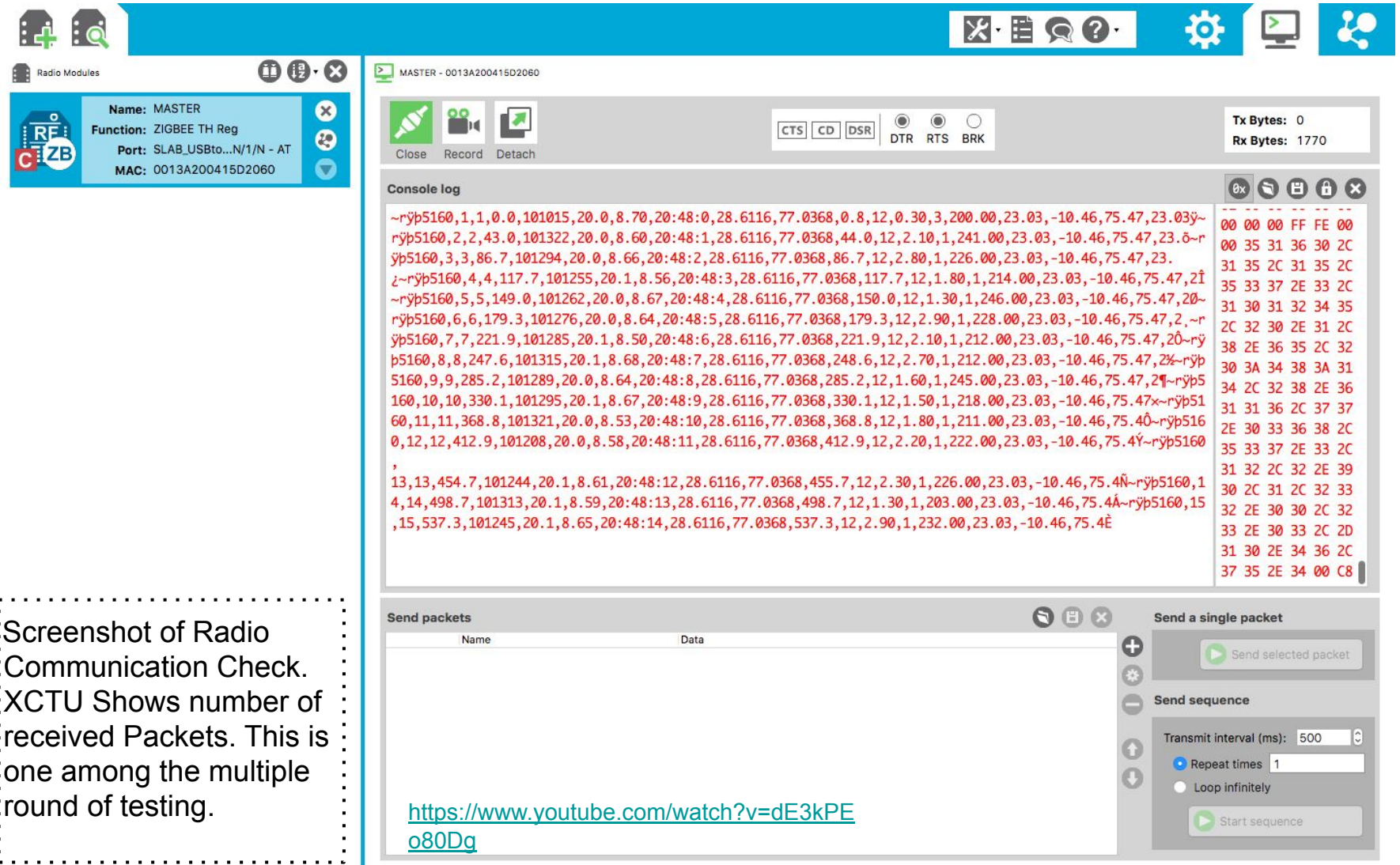
Subsystem Level Testing Plan [2/7]

CanSat subsystems level tests (before integration)

Mechanical	Total mass of CanSat will be checked to be in accordance to competition guidelines. The Delta-Wing gliding system is checked by dropping the payload from suitable height. The Parachute system will be checked to give a descent speed of 20m/s. CanSat's build will be checked.
Descent Control	The glider descent control is planned to be tested using a wind tunnel. Strain gauge would be attached on various position of the glider's body. Various aerodynamic coefficients would be measured and cross checked with the values obtained from theoretical calculations and airflow simulations.

Completing all tests will allow us to move to the main procedure of CanSat integration and checking if all subsystems work as a unit in CanSat.

Subsystem Level Testing Plan [3/7]



https://www.youtube.com/watch?v=dE3kPEo80Dg

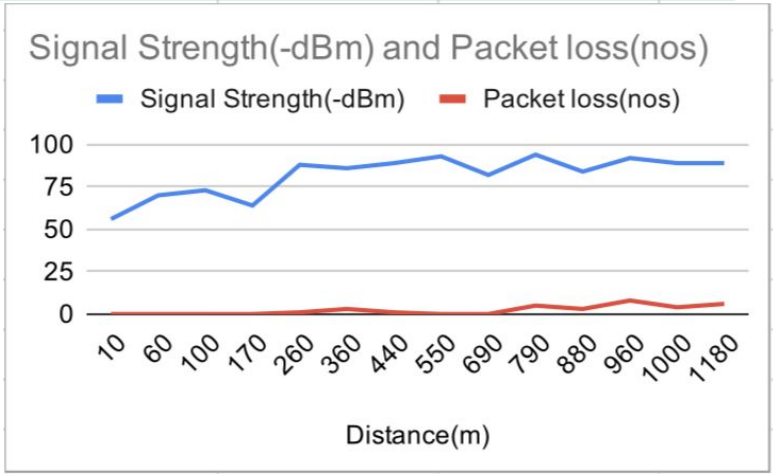
Screenshot of Radio Communication Check. XCTU Shows number of received Packets. This is one among the multiple round of testing.

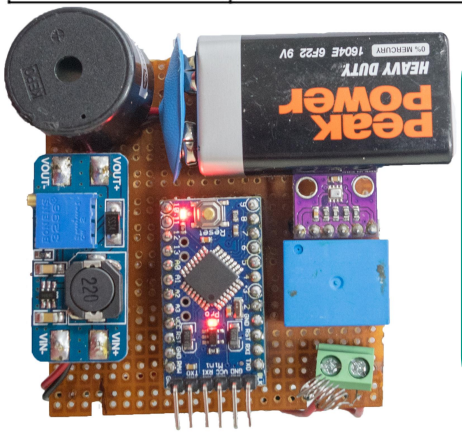
Subsystem Level Testing Plan [4/7]

Distance(m)	Signal Strength(-dBm)	Packet loss(nos)
10	56	0
60	70	0
100	73	0
170	64	0
260	88	1
360	86	3
440	89	1
550	93	0
690	82	0
790	94	5
880	84	3
960	92	8
1000	89	4
1180	89	6

Range test was done on the highway,with electronics in a moving car and antenna being held by a team member thus mimicking the actual Cansat's movements.

https://www.youtube.com/watch?v=zLAdpydN5CI



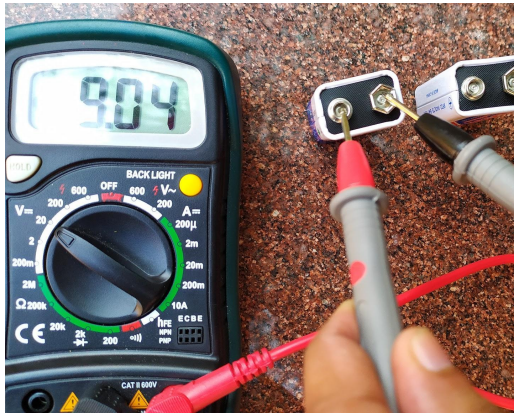


Container Test Board

This is a PERF board, all container electronics reside on it.
The Nylon thread melting mechanism was tested with the following setup.

EPS Test

This is a Multimeter, all the batteries were checked for there voltage level before and after 2 hour long payload electronics test. The behaviour was as expected.

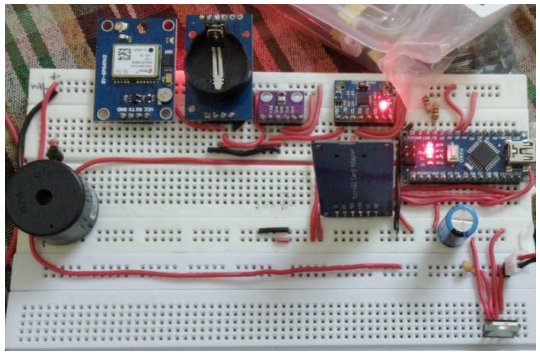


Subsystem Level Testing Plan [5/7]

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Team ID	Mission Tir	Packet Cou	Altitude(m	Pressure(I	Temperatu	Voltage(V	GPS Time	GPS Lati	GPS Lor	GPS Altit	GPS Sa	Air Spee	Software	Particle	Bonus Di
2	5160	4	4	0.1	996.298	20.351997	8.749999	4	27.5938	77.7310	158.36	7	-0.28	1	86.82	0
3	5160	5	5	0.24	996.60986	20.481997	8.589997	5	27.50379	77.7610	158.18	4	-0.23	1	86.84	0
4	5160	6	6	0.18	996.41986	20.661997	8.759997	6	27.32379	77.9010	158.52	1	-0.04	1	86.75	0
5	5160	7	7	0.4	996.34985	20.901997	8.849997	7	27.50379	77.7210	158.53	0	-0.27	1	86.9	0

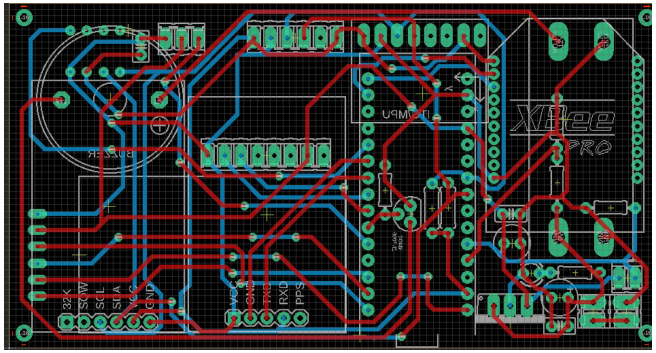
Cansat Telemetry Data from Radio test, this shows the .csv file that were generated by the test setup.

Breadboard



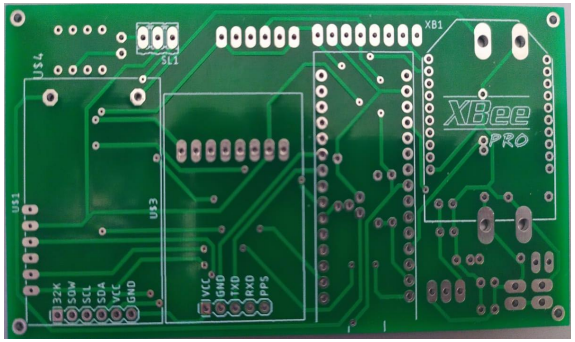
Breadboard Prototyping with all sensors connected.

PCB Schematic



This is eagle CAD schematic of Team GAGAN's Payload PCB.

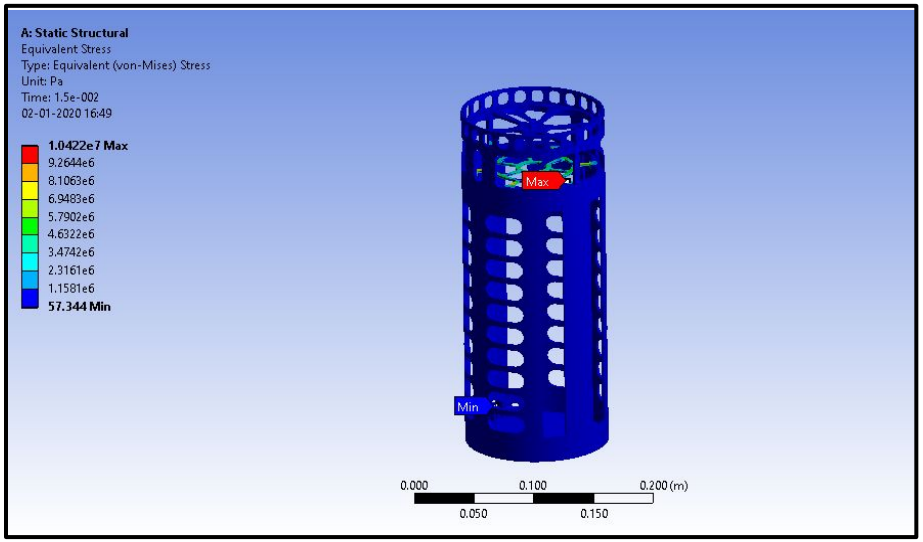
Unsoldered PCB



Unsoldered PCB before implantation of electronics.

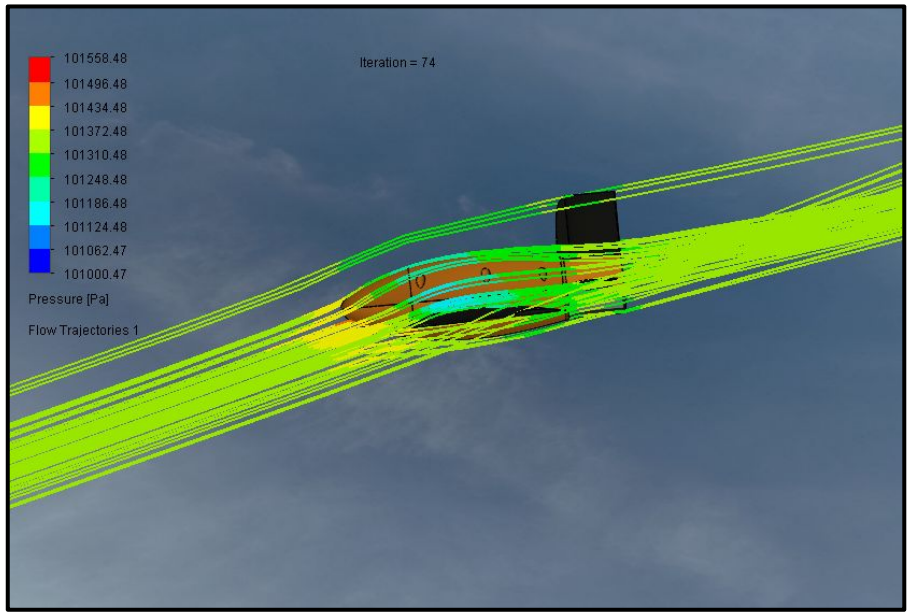
https://www.youtube.com/watch?v=VJ9U9Q9YYm0

Subsystem Level Testing Plan [6/7]



The below image shows the airflow simulation using the resizable k-epsilon model. The results are in line with the calculations and confirms the requirement compliance.

Using the finite element method, the stress distribution on the container body was calculated on Ansys Workbench. The image shown above depict the stress distribution on the container body under 15Gs of launch acceleration.



Subsystem Level Testing Plan [7/7]

The Picture on the right shows descent test, here cansat was released from an arbitrary height to verify its descent potential, which came out to be within the prescribed limit of Mission guide.

The Picture on the left shows Mechanical test, here mass of cansat was measured, which came out to be within the prescribed limit of Mission guide

Integrated Level Functional Test Plan [1/3]

CanSat subsystems level tests (after integration)

Descent Testing	Gliding system will be tested with drone by letting payload free fall from different heights to prepare a prediction for a stable flight. Free fall with drone also give the opportunity to test whole system to ensure proper wings and parachute deployment. To calculate the center of pressure the rope will be tightened around the payload and if the bottom demonstrates the turning direction then the center of pressure can be found on this point. For Further Reference https://www.youtube.com/watch?v=gXdUaZpkE4g
Communications	Communication among components on the PCB has been tested to determine any failure on circuit ways and short circuits by supplying power to the PCB. XBee has been tested between the layers to observe amount of signal quality drop in signal interruption. Telemetry transmission has been tested between endpoint and coordinator XBees at the two sides of the Bosphorus (1.6 km) for determining antenna range which will provide the distance as approximately equal as that we will face in the competition.
Mechanism Test	The performance of melting capability of Nichrome wire system for separation of payload from container on breadboard has been tested. It was observed how much time is required for opening of container during free fall from drone. The hinge used in the payload release mechanism will be tested first on land with hand to make sure that it generates enough force and then the same would be tested with drone to see that the deployment can occur easily. Various environmental test would be performed to ensure the reliability of the system.

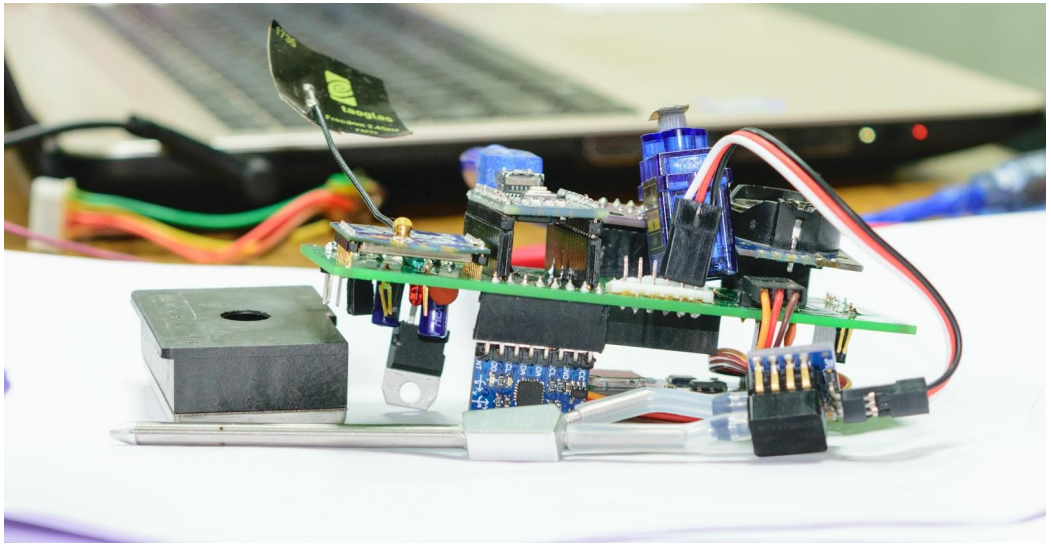
Integrated Level Functional Test Plan [2/3]

CanSat subsystems level tests (after integration)

Deployment Test

Deployment was tested by dropping it off from top of the building. Opening of container was tested during descent.Glider was dropped from the top of a building and it glided in a circular fashion.
Wing opening was verified. Final Testing will be done using a drone where CanSat will be dropped from a height of 700m.
All the sensor values will be recorded at GCS.

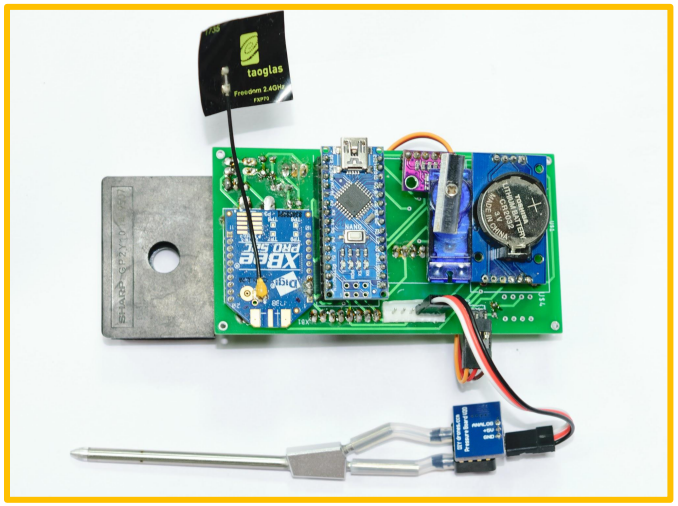
PCB Under Test



PCB is put on a 2 hour run period to simulate the Actual launch environment.
All cansat components are under rigorous testing phase to further refine the performance and design.

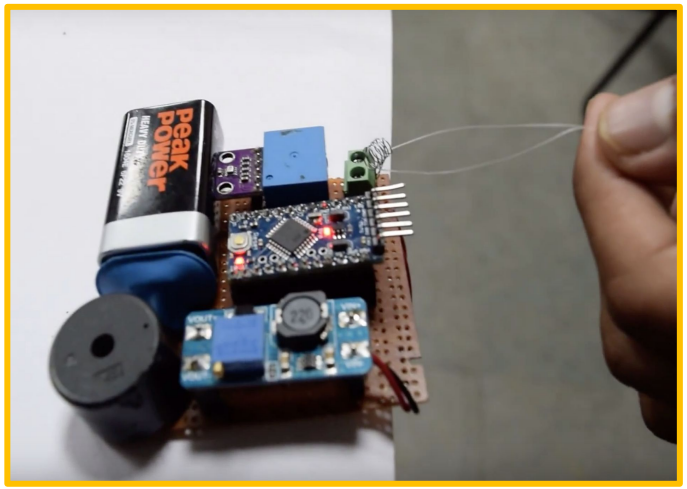
Integrated Level Functional Test Plan [3/3]

Test Plan



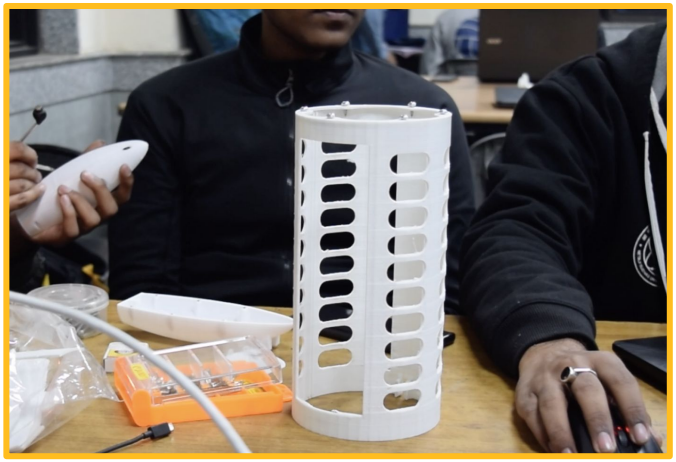
Soldered PCB under the testing phase.

Nylon thread melting mechanism tested on perf board.It takes 900ms to melt the thread.



Integration of fuselage of CanSat's payload

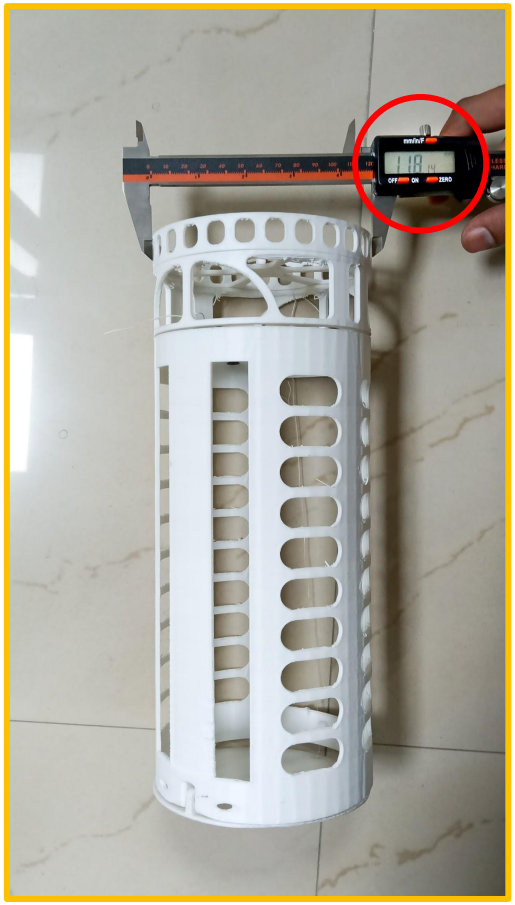
Mechanical Team meet for assembly and testing of CanSat.



Environmental Test Plan [1/2]

CanSat Environmental tests	
Drop Test	This test will determine whether the container parachute and attachment point will survive the deployment from the rocket payload section. In drop test, about 30 Gs of shock is generated.This test is done by attaching one end of the CanSat to a fixed point while tying the other end to a parachute. After releasing the CanSat, inspection for any damage, power loss and detached parts is done.
Vibration Test	Structural integrity, probe strength and fatigue will be determined with vibration test. Mount the payload to the orbit sander.The sander adjusted to its max. power. After the power up, sander is turned off for a time period of 2 seconds.The sander is operated being regularly cycled for one minute durations exposing the CanSat to frequency as high as 233Hz.Then checking is done if there is any damage on payload.
Fit check	This test is to verify the CanSat will properly fit in the rocket payload section and slide out at deployment time.Cut a hole of diameter 125mm in an aluminium sheet.Secure the test fixture so it is rigidly held in place. Slide the CanSat container through the hole to verify it is within the required envelope.The vernier caliper has been used to verify the outer diameter of the container.
Thermal Test	This test will determine if any materials warp, weaken, change characteristics, or fail to function at temperatures up to 333K. A thermal chamber is used to heat the CanSat to 333K for a period of 2 hours. This will allow the components to rise to heat, and verify that they continue to function.

Environmental Test Plan [2/2]



Fit Check
The margin of the cansat was in the permissible limits.

Vibration Test
Orbit sander would be used to test the electronic components interface strength by generating random vibrations along the 3 axis.

Thermal Test

Drop Test
Finite element simulation is done to test the structure's response to the 30Gs of shock.

Mission Operations & Analysis

Presenter: Shivam Saini

Overview of Mission Sequence of Events [1/3]

ARRIVAL

- Cansat is weighed and inspected for any damage.
- Container and payload parachute deployment is checked.
- Sensors' working is checked.
- Payload deployment is checked.
- Camera stabilisation system is tested.
- Cansat is turned on and telemetry is verified..

PRE-LAUNCH

- Arrival of team at launch site.
- Container and payload are integrated.
- Check cansat, antenna, GCS laptop etc. for any structural damage during travel.
- Payload is stowed inside the container.
- Telemetry transmission initialization and calibration commands are transmitted from the ground station.

LAUNCH

- Rocket takes off from the launch pad.
- Telemetry is received for the ascent.
- Rocket reaches the height of 700 meters.
- Cansat is released and parachute is deployed.
- At 450m, the payload is released and the wings are deployed.
- Camera stabilisation system is activated.
- After one minute of gliding, the payload parachute shall deploy.
- Audio beacon is activated.

Overview of Mission Sequence of Events [2/3]

FLIGHT RECOVERY

- Recovery crew accompanies the field judge while scoring.
- With the help of received telemetry the recovery crew starts its hunt for the cansat.
- Audio beacon help to pinpoint the location of cansat.
- The SD Card is retrieved from the cansat.

DATA ANALYSIS

- Received telemetry is analysed.
- Camera video, retrieved from the SD Card is analysed.
- Real time plots are analysed.

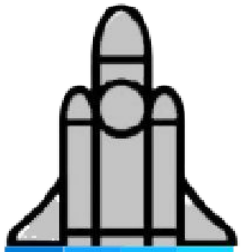
POST FLIGHT REVIEW

- All the analysed data is formatted as per the PFR template and final PFR is made.
- Final presentation on the following day.

Overview of Mission Sequence of Events [3/3]

Role Title	Name	Role Description
Mission control Officer	**Prashant Garg**	Supervision of all CANSAT tasks.This is a single person who is responsible for informing the Flight Coordinator when the team and their CanSat is ready to be launched.
Cansat Crew (**Team Lead**)	**Aditya Wadhwa**	Responsible for preparing the CanSat, integrating it into the rocket, and verifying its status.
Cansat Crew	**Shivam Saini**	
Cansat Crew	**Eaby Abraham**	
Ground Station Crew	**Vipra Bhardwaj**	They are responsible for monitoring the ground station for telemetry reception and issuing commands to the CanSat. Upon Mission Officer's command they will transmit calibration command and perform other tasks.
Ground Station Crew	**Amrit Ohri**	
Ground Station Crew	**Apoorv Garg**	
Ground Station Crew	**Dinesh**	
Ground Station Crew	**Saurabh Soreng**	
Recovery Crew	**Anmol Punetha**	Responsible for tracking the CanSat and going out into the field for recovery and interacting with the field judges.

Mission Operations Manual Development Plan



ALL CANSAT OPERATIONS

Electronics Testing

1. To check all sensors.
2. PCB connection check.
3. Camera stabilization check.
4. Servo motor check.

Structural Testing

1. Parachute visual check.
2. Payload release check.
3. Unfolding mechanism check.

GROUND STATION OPERATIONS

GCS Setup

1. To install sun umbrella.
2. To ensure Ground Station Software ready.
3. To ensure proper connectivity of antenna and Ground Station

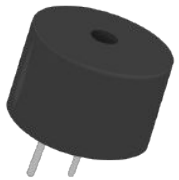
Location and Recovery

1. To monitor the GPS telemetry of payload.
2. On the basis of GPS telemetry, team will rush to possible landing site and recover CanSat.
3. Container will be retrieved by ground team.

CanSat Location and Recovery

1

At 5 metres from the ground buzzer starts beeping and the data telemetry stops.



GPS will give the idea about landing location of the CanSat

2

3

Fluorescent red colour chosen for container and orange coloured parachute for both payload and container makes recovery easy.

We will provide Team Leader's Name, Contact number and address on both container and payload.

4

Requirements Compliance

Presenter: Anmol Punetha

Requirements Compliance Overview

ELECTRONICS

PCB integration of all the sensors has been completed. Team successfully calibrated and fetched air pressure, temperature, pitch and roll, GPS data, Battery voltage, air speed and particulate count. Data transmitted via XBee and tested telemetry at frequency of 1 Hz.

SOFTWARE

Software team has successfully plotted the received XBee data using LABVIEW software.

MECHANICAL

Designs were completed based on calculations done to comply all basic requirements. 3D Models were printed and were integrated with Electronics Subsystem. Payload Release Mechanism and Parachute release mechanisms have been tested.

BONUS

SERVO was successfully tested to provide camera stabilization.

FUTURE PLAN

Electronics and Mechanical subsystems for Camera Stabilization have to be refined. Vibration Test to be done. Wind tunnel test will also be done to refine aerodynamic performances. Electronics and software team will now try to make sensor data free from noises.

Requirements Compliance [1/7]

ID	Requirement	Compliance	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
RC 01	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	Comply	**83-88**	OK
RC 02	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Comply	**19,28**	OK
RC 03	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Comply	**19,20**	OK
RC 04	The container shall be a fluorescent color; pink, red or orange.	Comply	**17,22,23**	OK
RC 05	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.	Comply	**22,23**	OK
RC 06	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Comply	**17,27**	OK
RC 07	The rocket airframe shall not be used as part of the CanSat operations.	Comply	**22,27,28**	OK
RC 08	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	Comply	**17,22,23**	OK

Requirements Compliance [2/7]

ID	Requirement	Compliance	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
RC 09	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Partial	**42,55-58**	Theoretically complies
RC 10	The container shall release the payload at 450 meters +/- 10 meters.	Partial	**41,73**	Theoretically complies
RC 11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	Partial	**42,51,53**	Theoretically complies
RC 12	The science payload shall be a delta wing glider.	Comply	**21,61,65**	OK
RC 13	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s	Partial	**27,55**	Theoretically complies
RC 14	All descent control device attachment components shall survive 30 Gs of shock.	Comply	**76,79**	OK
RC 15	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Comply	**21,23**	OK
RC 16	All structures shall be built to survive 15 Gs of launch acceleration.	Comply	**75,79**	OK

Requirements Compliance [3/7]

ID	Requirement	Compliance	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
RC 17	All structures shall be built to survive 30 Gs of shock.	Comply	**75,79**	OK
RC 18	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	**81,82**	OK
RC 19	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Comply	**54,56**	OK
RC 20	Mechanisms shall not use pyrotechnics or chemicals.	Comply	**68,76**	OK
RC 21	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Comply	**73,78**	OK
RC 22	The science payload shall measure altitude using an air pressure sensor.	Comply	**32**	OK
RC 23	The science payload shall provide position using GPS.	Comply	**34**	OK
RC 24	The science payload shall measure its battery voltage.	Comply	**35**	OK
RC 25	The science payload shall measure outside temperature.	Comply	**33**	OK
RC 26	The science payload shall measure particulates in the air as it glides.	Comply	**37**	OK

Requirements Compliance [4/7]

ID	Requirement	Compliance	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
RC 27	The science payload shall measure air speed.	Comply	**37**	OK
RC 28	The science payload shall transmit all sensor data in the telemetry.	Comply	**103,141**	OK
RC 29	Telemetry shall be updated once per second.	Comply	**103,143**	OK
RC 30	The Parachutes shall be fluorescent Pink or Orange	Comply	**22,43**	OK
RC 31	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	Comply	**142,144**	OK
RC 32	The ground station shall generate a csv file of all sensor data as specified in the telemetry section.	Comply	**143,149**	OK
RC 33	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Comply	**103,142,143, 149**	OK
RC 34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	Comply	**102,142**	OK
RC 35	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Comply	**101**	OK

Requirements Compliance [5/7]

ID	Requirement	Compliance	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
RC 36	XBEE radios shall have their NETID/PANID set to their team number.	Comply	**102,103**	OK
RC 37	XBEE radios shall not use broadcast mode.	Comply	**102**	OK
RC 38	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Comply	**175-177**	OK
RC 39	Each team shall develop their own ground station.	Comply	**136-144**	OK
RC 40	All telemetry shall be displayed in real time during descent.	Comply	**142,143**	OK
RC 41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Comply	**143**	OK
RC 42	Teams shall plot each telemetry data field in real time during flight.	Comply	**142**	OK
RC 43	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Comply	**136,142**	OK
RC 44	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	**139,141**	OK

Requirements Compliance [6/7]

ID	Requirement	Compliance	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
RC 45	Both the container and probe shall be labeled with team contact information including email address.	Comply	**164**	OK
RC 46	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	**143**	OK
RC 47	No lasers allowed.	Comply	**11**	OK
RC 48	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.	Comply	**110,113**	OK
RC 49	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the cansat and in the stowed state.	Comply	**113,118**	OK
RC 50	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	Comply	**110,164**	OK
RC 51	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	Comply	**110,118**	OK
RC 52	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.	Comply	**114,119**	OK

Requirements Compliance [7/7]

ID	Requirement	Compliance	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
RC 53	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Comply	**115**	OK
RC 54	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	**115**	OK
RC 55	The CANSAT must operate during all the environmental tests mentioned.	Comply	**157,158**	OK
RC 56	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Comply	**116,117**	OK
B 1	A video camera shall be integrated into the science payload and point toward the coordinates provided for the duration of the glide time.	Comply	**24**	OK
B 2	Video shall be in color with a minimum resolution of 640x480 pixels and 30 frames per second.	Comply	**38**	OK
B 3	Camera points at the provided coordinates for 30 seconds uninterrupted.	Comply	**-**	OK

Management

Presenter: Eaby Abraham

CanSat Budget – Hardware [1/3]

ID	Part		Model	Quantity	Total Cost ($)	Determination
PAYLOAD	Microcontroller		SAMD21	1	25.95	Actual
	Sensors	Air Pressure	BMP280	1	2.6	Actual
		Temperature				
	Camera Sensor		Turbowing Cyclops DVR3	1	25	Actual
	GPS Sensor		BN280	1	14	Actual
	RTC		PCF8523	1	10	Actual
	Air Speed Sensor		SDP37	1	14	Actual
	XBEE Radio		DIGI XBEE 3 PRO	1	55.37	Actual
	Particle Sensor		HPMA115S0-004	1	14	Actual
	Battery		Energizer L522	1	8.34	Actual
	Cansat Antenna		FXP70 (Patch Antenna)	1	4.95	Actual
	Voltage Regulator		LM1117	1	0.2	Estimate
			LM7805		1	
	Servo		Servo 9g	1	8	Actual
	Circuit Board		PCB	1	2	Actual
	Voltage Booster		MT3608	1	3	Actual
	Magnetometer		MPU9250	1	7	Actual

CanSat Budget – Hardware [2/3]

ID	Part	Model	Quantity	Total Cost ($)	Determination
	Audio Beacon	CPI-137-12T	1	1	Actual
	SD card	Sandisk class 10	1	4.33	Actual
	SD Card Module	Generic SD Card Shield	1	6.8	Actual
	Others	-	-	20	Estimate
			Total (PAYLOAD)	**$227.54**	
CONTAINER	Microcontroller	Arduino Pro Mini	1	2	Actual
	Wire Melting Mechanism	Nichrome Wire	1	2	Estimate
		5V Relay	1	1	Actual
	Detachment Detection	LDR	1	0.2	Estimate
	EEPROM	24LC256	1	2	Actual
	Air Pressure Sensor	BMP280	1	2.6	Actual
	MOSFET	NMOS	1	1	Estimate
	Audio Beacon	CPI-137312T	1	5	Actual
	Circuit Board	PCB	1	2	Actual
	Voltage Booster	MT3608	1	3	Actual
	Battery	Envie Rechargeable	1	8.84	Actual
			Total (CONTAINER)	**$29.64**	

CanSat Budget – Hardware [3/3]

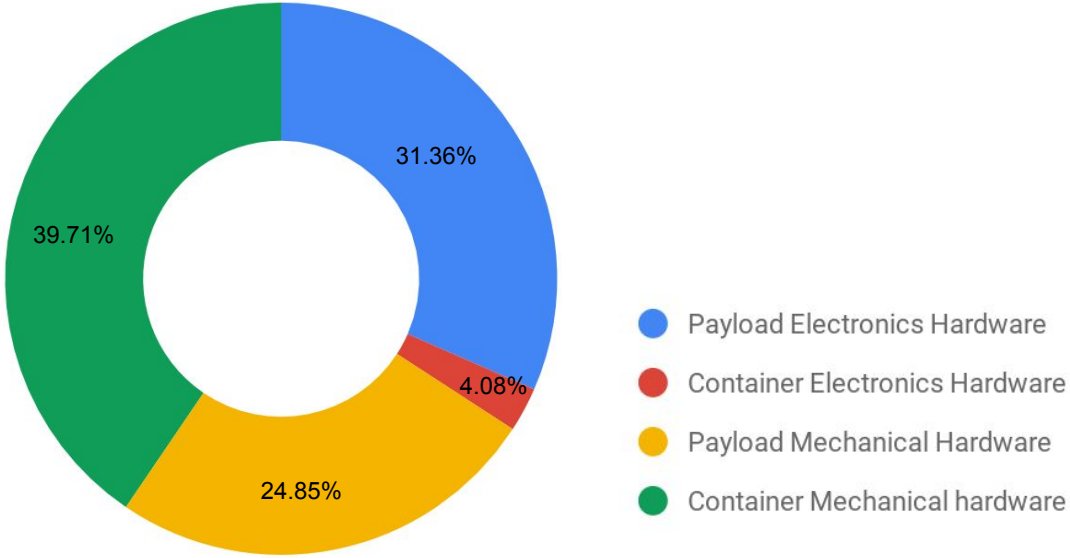
ID	Part	Material	Unit Price	Total Cost ($)	Determination
CONTAINER	Parachute Compartment	SLS 3D Printed HDPE	17.85	17.85	Actual
	Electronics Compartment	SLS 3D Printed HDPE	26.56	26.56	Actual
	Main Body	SLS 3D Printed HDPE	123.9	123.9	Actual
	Lid	SLS 3D Printed HDPE	12	12	Actual
			Total	**$180.31**	
PAYLOAD	Parachute Compartment	FDM 3D Printed PLA	12	12	Actual
	Rudder	FDM 3D Printed PLA	5.84	5.84	Actual
	Horizontal Stabilizer	FDM 3D Printed PLA	1.8	3.6	Actual
	Parachute	Nylon 6,6	4	4	Actual
	Fuselage	SLS 3D Printed Nylon PA 2200	160.7	160.7	Actual
	Wings	Blow molded polycarbonate	41	82	Actual
	Other	Adhesive, Screws, Nuts,etc.	20	20	Actual
			Total	**$288.14**	

CanSat Budget – Other Costs [1/3]

ID	Part	Model	Quantity	Total Cost($)	Determination
GCS	Laptop	Our Own Laptop	1	600	Private
	XBEE	DIGI XBEE 3 PRO	1	55	Actual
	XBEE Adaptor	SparkFun XBee Explorer USB	1	20	Estimate
	Antenna	TP-Link TL- ANT2415D	1	140.4	Actual
	Others	-	-	30	Estimate
			Total	**$845.4**	

ID	Part	Quantity	Total Cost($)	Determination
OTHERS	Cansat Fee	1	200	Actual
	Food	1	180	Actual
	Transport	1	1800	Estimate
	Flight Tickets	10	11000	Estimate
	Accomodation	-	320	Estimate
	Prototyping	-	200	Estimate
		Total	**$13700**	

CanSat Budget – Other Costs [2/3]



Fund Source	Fund Raised($)
College	500
Sponsors	3000

No hardware from previous years used to prevent chances of failure.

Part	Total Cost($)	Section Total($)	Section
Payload Electronics Hardware	**227.54**	**725.63**	**CANSAT MODEL**
Container Electronics Hardware	**29.64**		
Payload Mechanical Hardware	**180.31**		
Container Mechanical hardware	**288.14**		
Ground Station	845.40	845.40	CONTROL CENTER
Others	13700	13700	MISCELLANEOUS
Overall Cost Of Mission		**$15271.03**	

CanSat Budget – Other Costs [3/3]

US Naval Research Laboratory

National Aeronautics and Space Administration

National Aeronautics and Space Administration

The National Aeronautics and Space Administration is an independent agency of the United States federal government. The National Aeronautics and Space Administration (NASA), is responsible for unique scientific and technological achievements in human space flight, aeronautics, space science, and space applications that have had widespread impacts on our nation and the world.

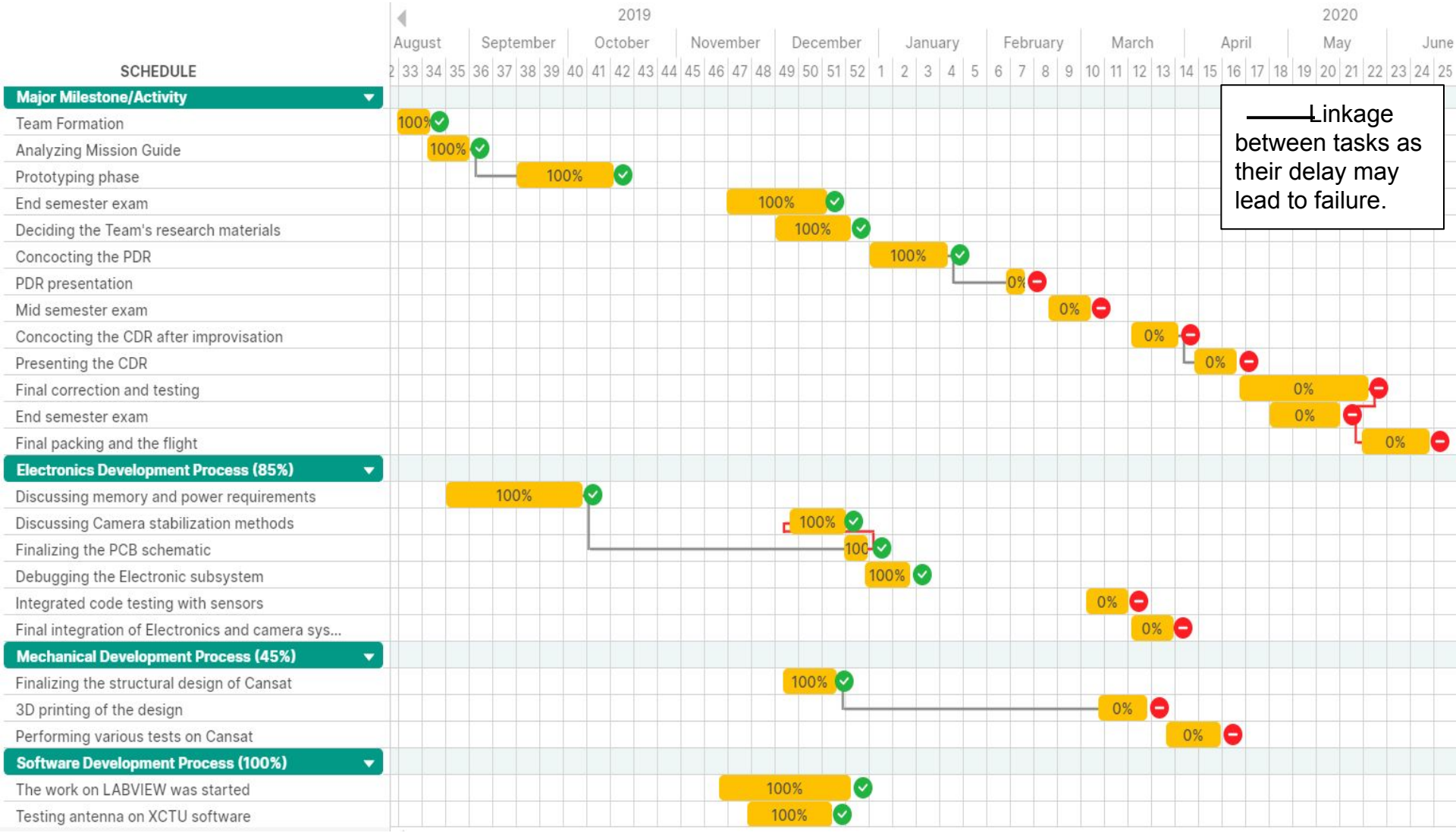
AMERICAN ASTRONAUTICAL SOCIETY

AAS has been an integral part of the aerospace community since it began as a group of science fiction writers dreaming of spaceflight in 1954. AAS and its predecessor societies have supported the aerospace community in so many ways – with publications; public lectures and later, technical conferences; journals, and many other activities. A group of the earliest members even performed their own rocket experiments, later forming a commercial company that became a leader in the industry.

American Astronautical Society

Kratos Comms.

Program Schedule Overview



Detailed Program Schedule [1/3]

Major Milestone/Activity	Start Date	End Date	Assignee
A team of 10 members was formed by taking interview based on the study sessions organized previously.	10 AUG 2019	20 AUG 2019	Aditya Wadhwa Prashant Garg
Studying, Analysing of CanSat Mission Guide 2020 and preparation of competition begun.	21 AUG 2019	30 AUG 2019	Shivam Saini Amrit Ohri
A list of Sensors required was made and the most efficient sensor was chosen. Discussion on Memory and Power requirements was done.	25 AUG 2019	3 OCT 2019	Amrit Ohri Aditya Wadhwa
Designing the software strategy.	12 SEPT 2019	30 SEPT 2019	Aditya Wadhwa Saurabh Soreng
Non-working prototypes that were theoretically correct were made from things in our homes.	14 SEPT 2019	14 OCT 2019	Eaby Abraham Vipra Bharadwaj
The decided sensors and antennas were purchased.	1 NOV 2019	5 NOV 2019	Shivam Saini
End Term Examination	15 NOV 2019	15 DEC 2019	Entire Team
The design and structure of container and payload were discussed.	16 NOV 2019	5 DEC 2019	Prashant Garg
The structure and measurements of the glider for supporting the payload were discussed.	17 NOV 2019	25 NOV 2019	Eaby Abraham Prashant Garg
The testing of sensors and other components were done on beadboard. The antenna were tested on XCTU software.	22 NOV 2019	17 DEC 2019	Amrit Ohri Anmol Punetha

Detailed Program Schedule [2/3]

Major Milestone/Activity	Start Date	End Date	Assignee
Camera integration and stabilisation methods were brainstormed and discussed.	5 DEC 2019	21 DEC 2019	Shivam Saini
Our team's research materials were decided on conditions such as :- Low weight, high strength, availability, cost etc...	1 DEC 2019	23 DEC 2019	Vipra Bharadwaj Prashant Garg
The work on Labview was started.	14 NOV 2019	22 DEC 2019	Apoorv Garg Saurabh Soreng
Upon discussion finalized structural design of cansat amongst the discussed design considering all the pros,cons and CanSat guidelines.	3 DEC 2019	11 DEC 2019	Prashant Garg
Finalising the PCB schematic and the components used.	22 DEC 2019	26 DEC 2019	Aditya Wadhwa
Ordering PCB. Final integration of electronics subsystem and camera.	25 DEC 2020	2 JAN 2020	Shivam Saini
Breadboard testing and debugging of the electronic system completed	27 DEC 2019	5 JAN 2019	Electronics Department
After the work, we documented and concocted the PDR.	29 DEC 2019	20 JAN 2019	Entire Team
PDR Presentation given by the team.	8 FEB 2020	10 FEB 2020	Entire Team
Mid-Semester Examination	20 FEB 2020	1 MAR 2020	Entire Team

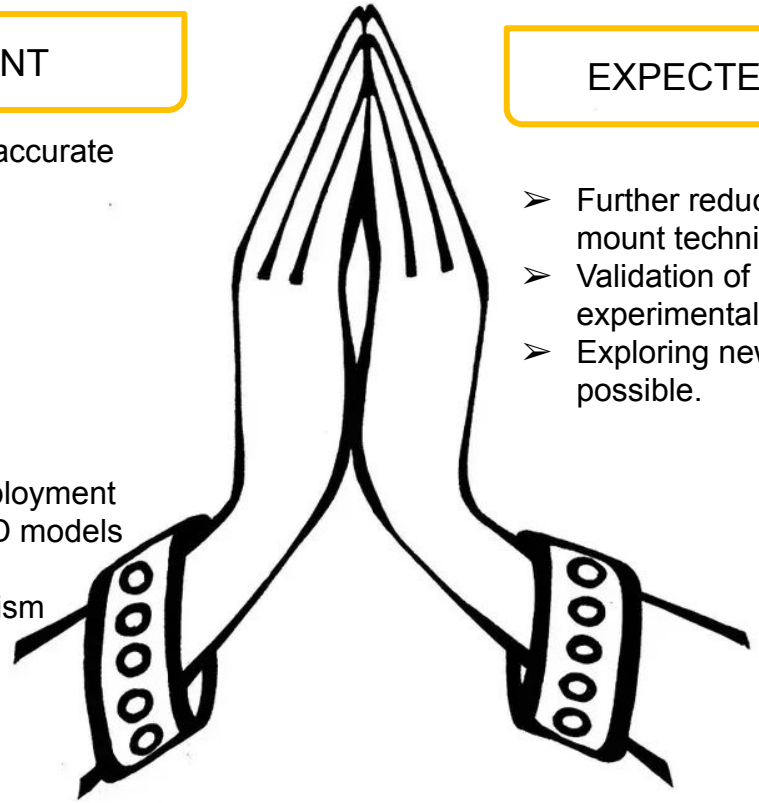
Detailed Program Schedule [3/3]

Major Milestone/Activity	Start Date	End Date	Assignee
The final best design for CDR is chosen that strictly follows the guidelines.	3 MAR 2020	13 MAR 2020	Aditya Wadhwa Prashant garg
Review of integrated code testing with sensors included will be done.	3 MAR 2020	14 MAR 2020	Shivam Saini Amrit Ohri
After finalising the design, it is sent to be 3D printed.	14 MAR 2020	19 MAR 2020	Prashant Garg Dinesh
CDR is concocted after improvisation.	16 MAR 2020	29 MAR 2020	Entire Team
Various test are performed on CanSat.	28 MAR 2020	12 APR 2020	Eaby Abraham Amrit Ohri
The team gives presentation of the CDR before the experts(competition organizers).	4 APR 2020	15 APR 2020	Entire Team
Final Preparation is done. Checking and Re-Checking of all components is done.	15 APR 2020	20 APR 2020	Entire Team
End-Semester Examinations	26 APR 2020	17 MAY 2020	Entire Team
Everything is tested for the last time and packed for the competition.	18 MAY 2020	25 MAY 2020	Shivam Saini Prashant Garg
Every item is checked and packed. Extra items are packed.	23 MAY 2020	11 JUN 2020	Amrit Ohri Dinesh

Conclusions

MAJOR ACCOMPLISHMENT

- All sensors have been tested to get accurate results.
- Telemetry has been tested.
- PCB has been designed and tested.
- GCS Software is ready.
- Descent rate estimations have been done using numerical methods.
- Material selection and basic material testing has been done.
- Payload Release and Parachute deployment mechanisms have been tested on 3D models printed.
- Bonus Camera stabilization mechanism has been tested.
- Validation of FSW state/logics.



EXPECTED ACHIEVABLE GOALS

- Further reducing the size of PCB using SMD mount technique.
- Validation of descent rate estimation with experimental values.
- Exploring new techniques to refine design if possible.

Given the sleepless nights, busy weekends, non-existent vacations and the exhaustion that came along; we strongly believe that it is now our time to shine!!
We believe our dedication and prior hands-on experience with model aerodynamics systems and electronics will help us carve a niche for ourselves in the competition. Our preliminary design with unique and innovative features is up and running. With ambition, hardwork and team spirit we are absolutely ready for the competition.