CanSat 2022
Preliminary Design Review (PDR)

Team ID : 2022ASI-018
Team Name : NexSat IITJ

|| त्वं ज्ञानमयो विज्ञानमयोऽसि ||

Presentation Outline

Presentation Outline

Team Organisation

SOMSHUVRA BASU
Team Lead
Electronics & Power

SHUBHAM MISHRA
Structure and Software

SARVESH BAHETI
Structure and Software

LOKESH TANWAR
Structure and Software

TALE SAI SAATHWIK
Electronics & Power

PECHETTI SAI AKHIL
Communications & Data Handling

HRISHIKESH MAKWANA
Communications & Data Handling

ANUPAMA BIRMAN
Communications & Data Handling

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Faculty Advisor

DR. ARUN KUMAR R
Faculty Mentor

DR. ASHOK JOSHI
Faculty Mentor

Acronyms

General	
FSW	Flight Software
EPS	Electrical Power Subsystem
CDH	Communication and Data Handling subsystem
I,A,D,T	(verification method) inspection,analysis,demonstration,testing

Mechanical	
ABS,PLA,PETG	3D Printing material name

Electrical	
PCB	Printed Circuit Board
RTC	Real Time Clock

Software	
GUI	Graphical User Interface
GCS	Ground Control Station

System Overview

Mission Overview (1/2)

Design and manufacture a **CanSat** system:

- ➔ CanSat is a canister that contains various sensors and subsystems.
- ➔ CanSat has a diameter of 0.125 m and a height of 0.310 m.
- ➔ CanSat shall automatically deploy a parachute at apogee and communicate with GCS.
- ➔ The CanSat shall collect all the data from sensors and send it to GCS.

Design and build a **Ground Station** :

- ➔ The GS should receive data from CanSat.
- ➔ The GS should also display all the data along with generating a csv file.

Mission Overview (2/2)

Bonus Mission Objectives:

- ➔ The Bonus Camera present should record footage and take pictures at equal intervals during the descent.
- ➔ The IMU would record the acceleration data and obtain magnetometer data.
- ➔ The vibration sensor would record the vibration experienced by the CanSat during descent.

Allied Objectives:

- ➔ Understanding the intricacies of designing a satellite/upper atmosphere device from scratch.
- ➔ Integrating multiple subsystems together including mechanical, electrical etc.
- ➔ Handling a Interdisciplinary project to design and develop the CanSat.
- ➔ Processing the recorded data for useful conclusions.

System Requirement Compliance

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System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
1.	Total mass of the CANSAT shall be under 0.700 kg (+/- 0.050 kg)		X		X
2.	CANSAT shall fit in a cylindrical body of 0.125 m diameter x 0.310 m height. Tolerances are to be included to facilitate container deployment from the rocket fairing.		X	X	X
3.	Any sharp edges on the container body shall be avoided as it can cause interfere during the CANSAT ejection from the rocket.	X	X	X	X
4.	Color of the CANSAT body shall be fluorescent i.e., pink, red or orange, and shall embody the Indian flag.	X			
5.	Rocket Airframe will not be allowed to be used as a part of any CANSAT operation.	X	X	X	X

X: Denotes the verification method used

System Requirement Compliance

S.NO	REQUIREMENTS	A	I	T	D
6.	The CANSAT shall consist of necessary sensors to provide the following mandatory Real-time datasets: Position data, altitude, pressure, temperature, orientation data, power data & system status.	X	X	X	X
7.	Each data field shall be displayed in real-time on the ground station user interface/software.		X		X
8.	CANSAT shall also record the data and save it into an onboard SD card in case of telemetry connection loss		X	X	X
9.	All electronics shall be enclosed and shielded from the environment. No electronics can be exposed except for sensors. There must be a structural enclosure.	X	X		X
10.	CANSAT structure shall be built to survive 15 Gs of launch acceleration & 30 Gs of shock.	X	X	X	X

System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
11.	Electronic circuit boards must be hard mounted using proper mounts such as standoffs and screws. High-performance adhesives can also be used.		X		X
12.	Team number, email address and phone number must be placed on the structure in English, Hindi and the Regional language of the launch state to aid in recovery.		X		X
13.	An audio beacon shall be installed on CANSAT as a recovery assist. It may be powered after landing or operate continuously. The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	X	X	X	X
14.	The CANSAT shall have an external power switch with an indicator light or sound for being turned on or off, in order to avoid the disassembling of CANSATs on the launch pad.		X	X	X

System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
15.	The CANSAT shall have a battery capacity to support up to 2 hours of wait in on the launch pad with additional time for flight operations.	X	X	X	X
16.	The battery source may be alkaline, Ni-Cad, Ni-MH or Lithium ion. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells.		X		X
17.	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require total disassembly of the CANSAT.	X	X	X	X

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System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
18.	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.		X	X	X
19.	The CANSAT shall contain a total of 2 descent control mechanisms, to be used at different stages while descent.	X	X	X	X
20.	CANSAT shall immediately deploy the first parachute after ejection from the rocket.	X	X	X	X
21	The first parachute shall be connected to the outer body of the CANSAT and no ejection mechanism shall be attached to it.	X	X	X	X
22	The descent rate of the 1st parachute shall be 20 m/s +/- 5m/s	X		X	X

System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
23.	The second descent control mechanism shall open at an altitude of 500m (+/-10 m) to further decrease the descent rate of the CANSAT to 1 to 3m/s.	X		X	X
24.	The descent control system shall not use any hazardous chemical-based explosive or pyrotechnic devices. However, green propulsion is allowed if being used under the same weight constraint.		X		
25.	CANSAT shall stabilize itself during the decent using the mechanical gyro mechanism.	X		X	X
26	The CANSAT communications radio shall be the XBEE radio series 1/2/pro		X	X	X

System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
27.	The XBEE radios shall have their NETID/PANID set to the team number.		X		X
28.	The XBEE radio shall not use the broadcast mode.		X		X
29.	The XBEE radio can operate in any mode as long as it does not interfere with other XBEE radios.	X		X	X
30.	Each team shall develop and use their own ground station. All telemetry shall be displayed in real-time during launch and descent. All telemetry shall be displayed in engineering units (meters, meters per second, Celsius, etc.). Teams shall plot data in real-time during flight.		X	X	X

System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
31.	The ground station shall command the CANSAT to start transmitting telemetry prior to launch.				X
32.	The ground control station antenna shall be elevated from ground level to ensure adequate coverage and range.	X	X	X	X
33.	Stability of the ground station must be ensured.	X		X	X
34.	The CANSAT shall not transmit telemetry until commanded by the team ground station. Command can be executed while the CANSAT is in the rocket on the launch pad.			X	X

System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
35.	The ground station shall be able to command the CANSAT to calibrate gyros, barometric altitude, accelerometer to command the parameters to zero as the CANSAT sits on the launch pad.		X	X	X
36.	The ground station shall generate .csv files of all sensor data as specified in the Telemetry Requirements section.				X
37.	Telemetry shall include mission time with one second or better resolution.				X
38.	Mission time/timestamp and system status states shall not be affected in the event of a processor reset during the launch and mission.			X	X

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System Requirement Compliance

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S.NO	REQUIREMENT	A	I	T	D
39.	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.		X		X
40.	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line and if required the team can also move to a different location in case of distant landing location in order to locate the CANSAT.	X	X	X	X
41.	The flight software shall maintain and telemeter an indicator of the CANSAT flight software state. An example set of states is 0 (BOOT), 1 (TEST_MODE), 2 (LAUNCH_PAD), 3 (ASCENT), 4 (ROCKET_DEPLOY), 5 (DESCENT), 6 (AEROBREAK_RELEASE), and 7 (IMPACT).				X

System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
42	Upon powering up, the CANSAT shall collect the required telemetry at a 1 Hz sample rate or more. The telemetry data shall be transmitted with ASCII comma-separated fields followed by a carriage return in the following format: <TEAM ID>,<TIME STAMPING>,<PACKET COUNT>,<ALTITUDE>, <PRESSURE>, <TEMP>,<VOLTAGE>,<GNSS TIME>,<GNSS LATITUDE>,<GNSS LONGITUDE>, <GNSS ALTITUDE>,<GNSS SATS>,<ACCELEROMETER DATA>, <GYRO SPIN RATE>, <FLIGHT SOFTWARE STATE>,<ANY OPTIONAL DATA>			X	X
43.	The received telemetry for the entire mission shall be saved on the ground station computer as a comma-separated value (.csv) file that will be examined by the competition judges. Teams will provide the file to the judges immediately after the launch operations via USB drive. The .csv file shall include headers specifying each field of data.			X	X

System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
43.	The telemetry parameters display format with resolution needs to be provided as given in the table below. The telemetry data file shall be named as follows: A. Flight_<TEAM_ID>.csv. It is recommended the ground software produce this file, with the correct name, easily from the ground system user interface.		X	X	X

System Requirement Compliance

S. No.	TM Parameter	Function	Resolution /Format
1.	<TEAM ID>	Team Number	2022ASI-XXX
2.	<TIME STAMPING>	Time since the initial power	Seconds
3.	<PACKET COUNT>	Count of transmitted packets	
4.	<ALTITUDE>	Altitude in units of meters and must be relative to ground	0.1 meters

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System Requirement Compliance

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S. No.	TM Parameter	Function	Resolution /Format
5.	<PRESSURE>	Measurement of atmospheric pressure	1 pascal
6.	<TEMP>	Temperature in Celsius	0.1 ^{o}C
7.	<VOLTAGE>	Voltage of the CANSAT power bus	0.01 Volts
8.	<GNSS TIME>	Time generated by the GNSS receiver	Seconds

System Requirement Compliance

S. No.	TM Parameter	Function	Resolution /Format
9.	<GNSS LATITUDE>	Latitude generated by the GNSS receiver	0.0001 degrees
10.	<GNSS LONGITUDE>	Latitude generated by the GNSS receiver	0.0001 degrees
11.	<GNSS ALTITUDE>	Altitude generated by the GNSS receiver	0.1 meters

System Requirement Compliance

S. No.	TM Parameter	Function	Resolution /Format
12.	<GNSS SATS>	GNSS satellites connected	integer number
13.	<ACCELEROMETER DATA>	Data received from the gyroscopic sensor i.e acceleration and roll & pitch parameters	m/s^2
14.	<GYRO SPIN RATE>	Spin rate of Mechanical Gyro wrt. CANSAT	deg/s

System Requirement Compliance

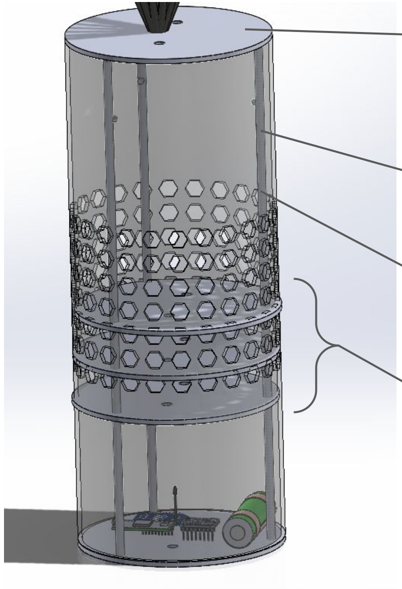
S. No.	TM Parameter	Function	Resolution /Format
15.	<FLIGHT SOFTWARE STATE>	Operating state of the software	(boot, idle, launch detect, deploy, etc.)
16.	<OPTIONAL DATA>	Any data coming from the optional mission objectives	

System Requirement Compliance

S.NO	REQUIREMENT	A	I	T	D
43.	B. Additional data fields may be appended after the required fields as determined necessary by the team's design C. It is suggested that teams make use of onboard data storage. Only the transmitted telemetry is graded, however, the backup data can be used when completing the Post Flight Review.		X	X	X

System Level Configuration

Concept 1



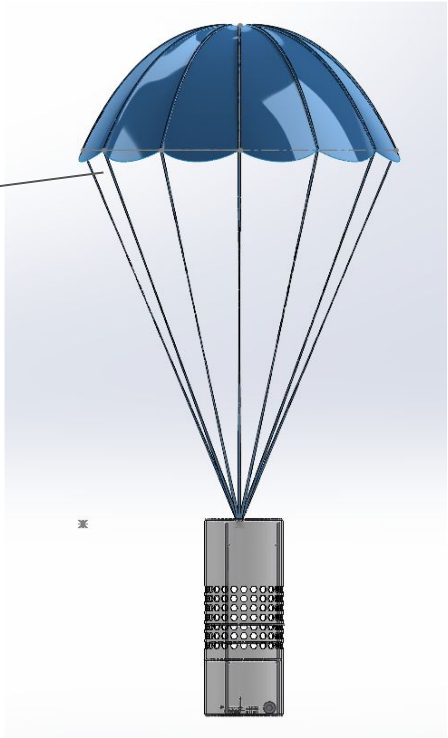
Outer cap

Parachute

Support rod of carbon fibre

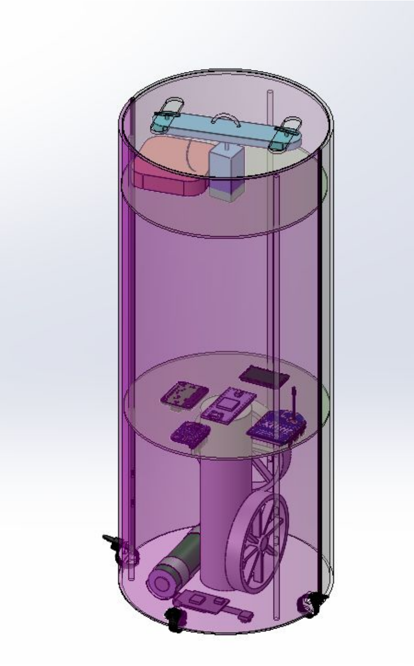
Outer cylindrical shell of ABS

Stacked platform for PCBs



System Level Configuration

Concept 2

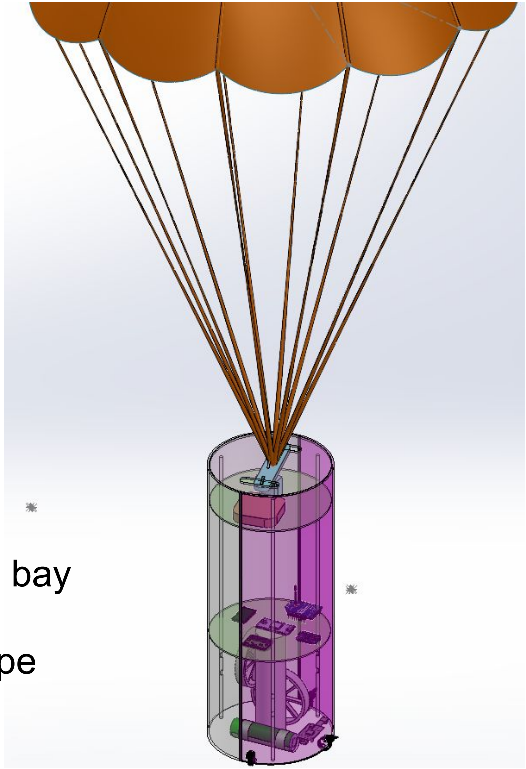


Upper Cap

Servo

Electronic subsystem bay

Gyroscope

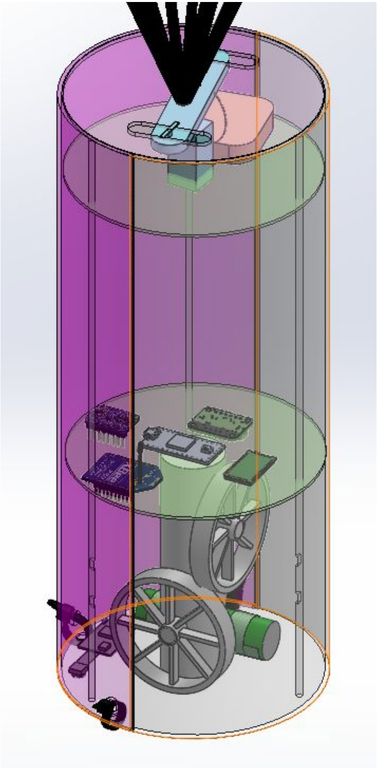


System Level Configuration

Comparison

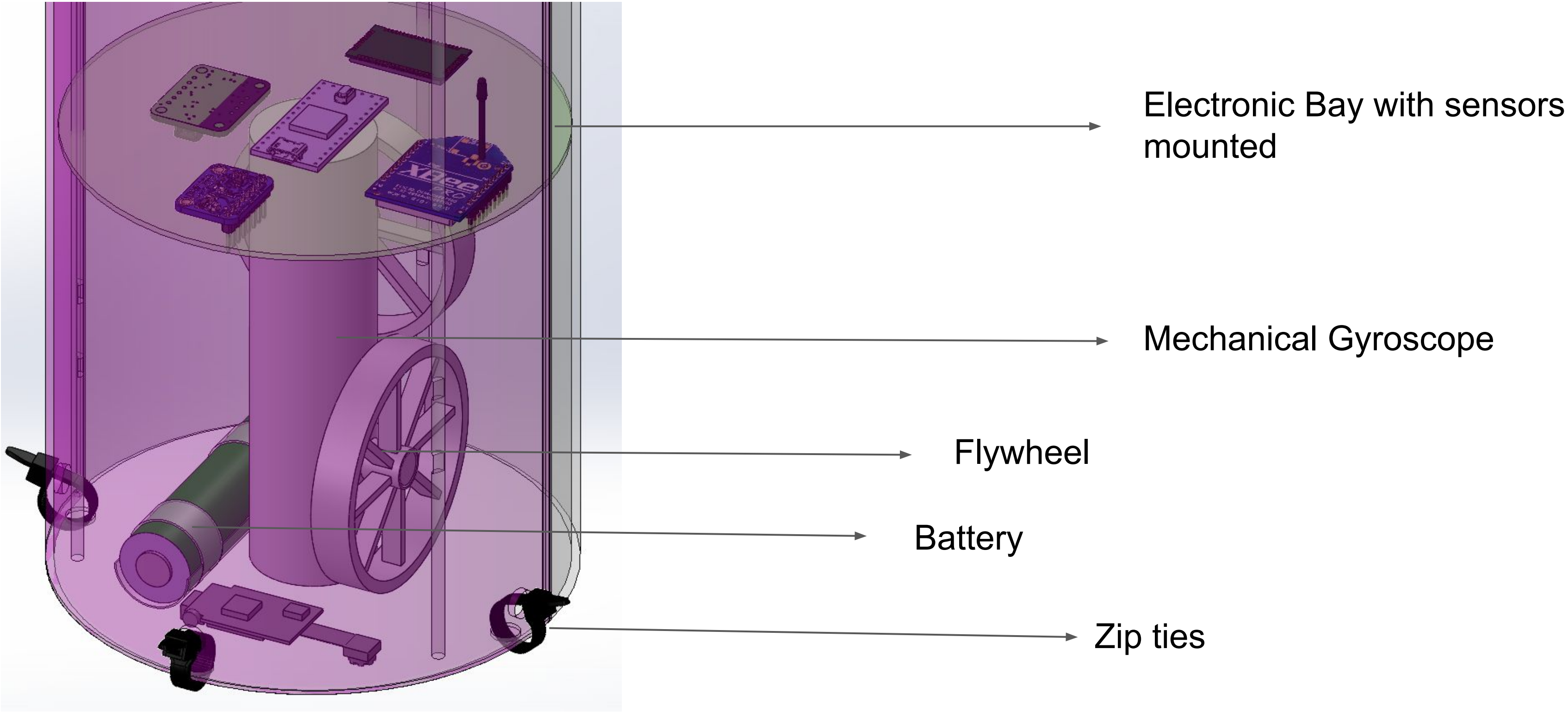
Concept 1	Concept 2
Simple cylinder with hexagonal holes.	Two part of half cylinder which can skid into each other.
Parachute is attached directly to top.	Parachute is connected through a ring that can slide from cap slit for second parachute
Single Cylindrical System	Two sliding part over one other.

Physical Layout

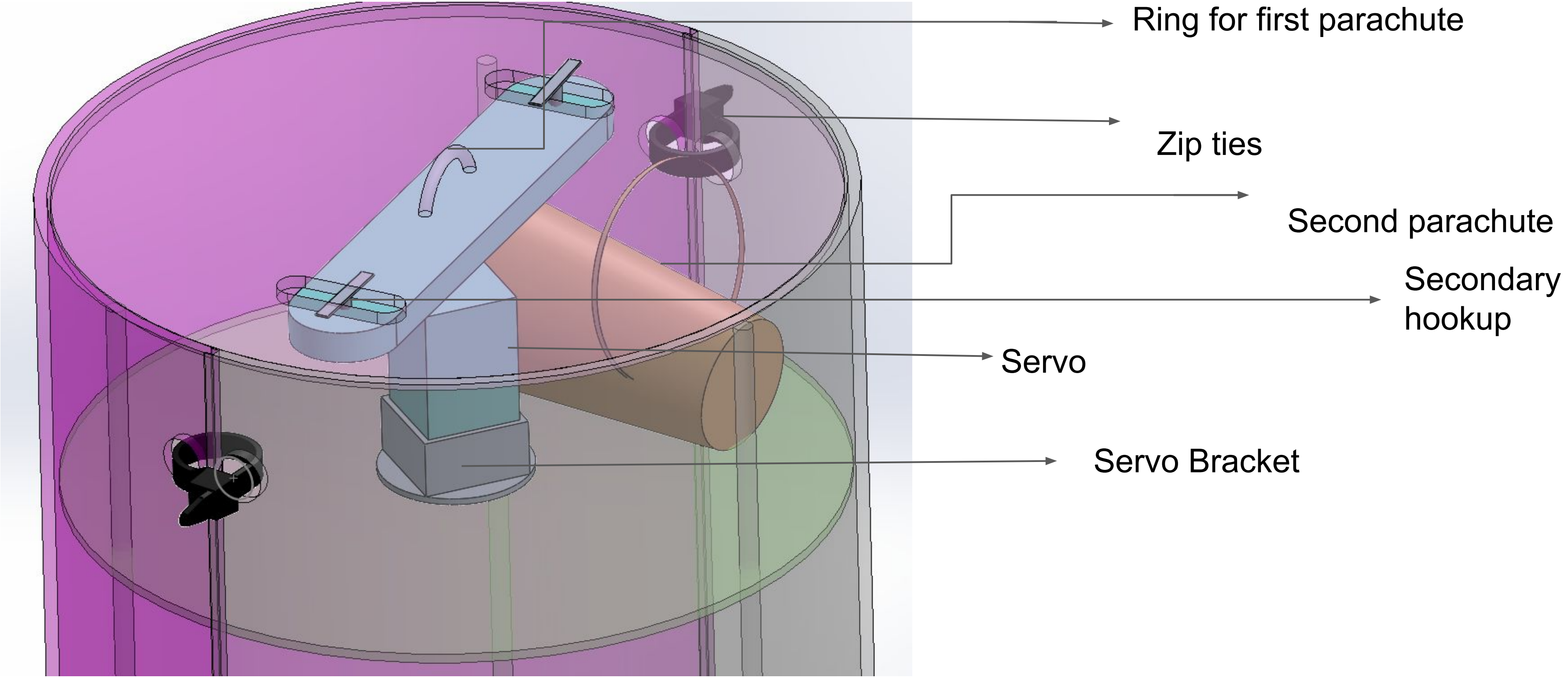


Major components: ● 2nd Parachute Bay ● Electronics platform ● Stability control mechanism
Electronic subsystem: ● Micro-controller ● XBEE ● Altimeter sensor ● GNSS ● IMU ● Radio

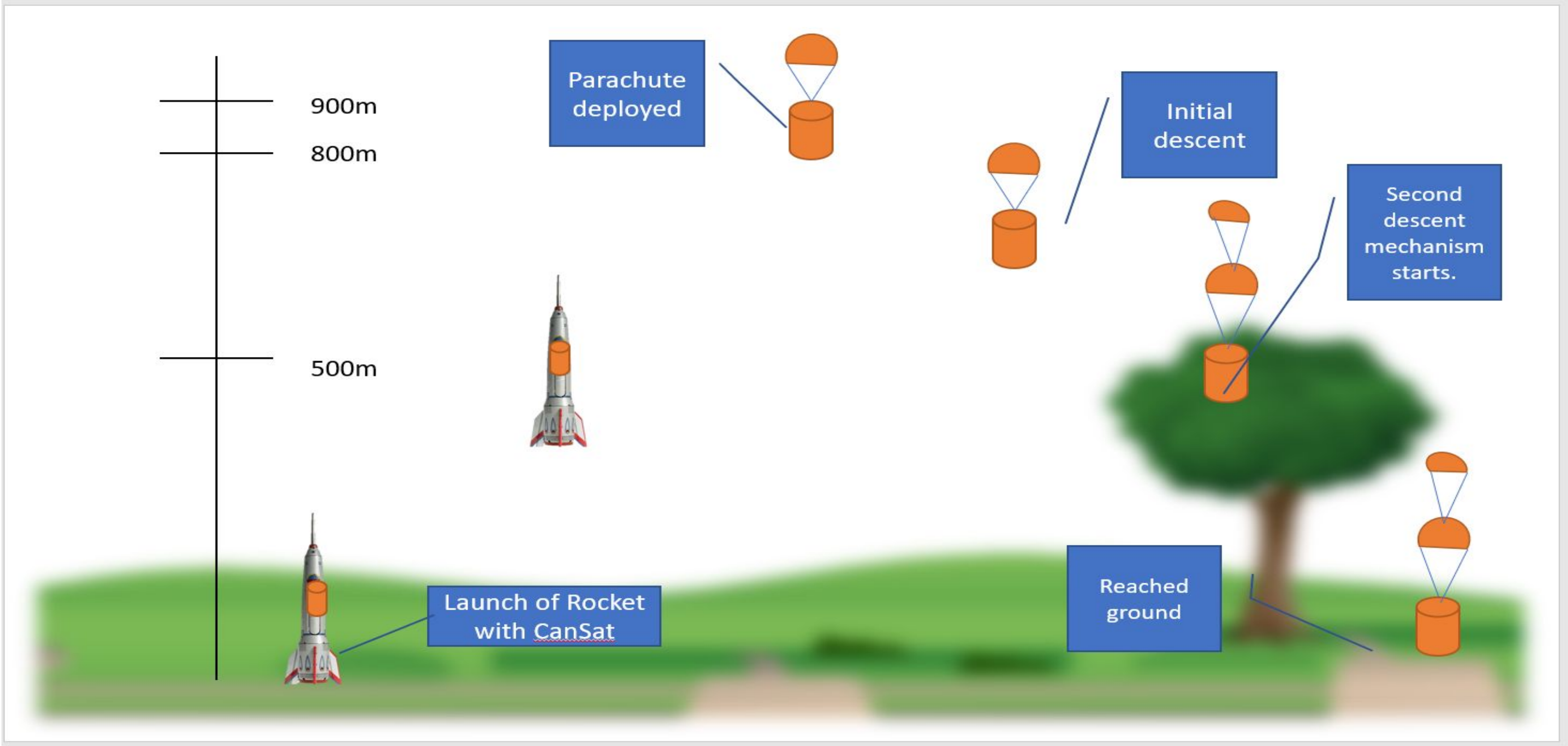
Physical Layout



Physical Layout



System concept of Operation



Sensor Subsystem Overview

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Sensor Subsystem Overview

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Selected Component	Type	Function
BMP388	Altimeter, Pressure and Temperature sensor	To measure altitude, pressure and temperature
L89 Breakout	GNSS/IRNSS Sensor	Location of CanSat, supports both NavIC & GPS
BNO055 9-DOF	IMU Sensor	Acts as a gyroscope, accelerometer & magnetometer
XBP24CASIT-001 (XBee S2C Pro)	Radio	Communication with Ground Station
Adafruit 3202	Camera	Records video with a resolution of 640 x 480

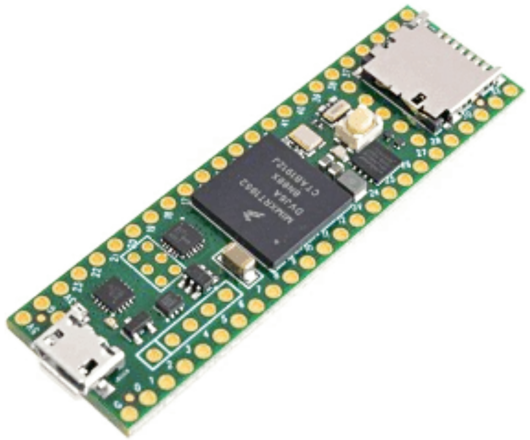
On-board Computer (1/3)

Name	Weight	Dimensions (mm)	Power (Peak)	Power (Low Power)	Operating Voltage	Micro-SD Card Slot	Price
RPI Zero 2 W	16 gm	65(67 with SD)x 30	3W (0.6 A)	0.7 W	5V	Present	₹ 3200
ESP32	6.4gm	57 x 28	0.9 W	8.25 Micro W	3.3V	Absent (Add-on)	₹ 700
Teensy V4.1	13gm	60.96 x 17.78	0.825 W	0.33 W 600 MHz	3.3V	Present	₹ 4800

On-board Computer (2/3)

Name	RAM	CPU	WLAN Support	Bluetooth	GPIO Pins	Boot-up Time	Environment
RPI Zero 2 W	512 MB	4 x Cortex A53 cores	Yes	4.2	40	10s	Linux Based OS
ESP32	520 KB+ 4 MB PSRAM	2 x Xtensa LX6 cores	Yes	4.2	48	192ms	MicroPython or C++ using Arduino IDE
Teensy V4.1	1024 KB	Cortex M7	No, Ethernet	No	55	5ms	Arduino IDE with Teensyduino

On-board Computer (3/3)



Selected On-board Computer	Reasons
Teensy v4.1	• Low power consumption with a decent processing power. • Has lesser boot up time • Can be programmed with Arduino IDE (Teensyduino)

Altimeter (1/2)

Name	Weight	Dimensions (mm)	Resolution	Operating Voltage	Max Current Drawn	Interface	Price
DPS310 Adafruit	9 gm	24 x 42 x 7	0.06 Pa	3-5V	345μA	I2C/SPI	₹ 600
BMP 388	1.2gm	32 x 20	0.16Pa	1.7-3.6V	800 μA	I2C/SPI	₹1,600
GY-BMP 280	0.8	15.5 x 12 x 2.4		3.3-5V	1120 μA	I2C/SPI	₹1,300

Altimeter (2/2)

Selected Altimeter	Reasons
BMP 388	• Presence of multiple sensors • Compact design • Good Resolution

Pressure (1/2)

Name	Weight	Dimensions (mm)	Resolution	Operating Voltage	Max Current Drawn	Interface	Price
DPS310 Adafruit	9 gm	24 x 42 x 7	0.06 Pa	3-5V	345μA	I2C/SPI	₹ 600
BMP 388	1.2gm	32 x 20	0.16Pa	1.7-3.6V	800 μA	I2C/SPI	₹1,600
GY-BMP 280	0.8	15.5 x 12 x 2.4		3.3-5V	1120 μA	I2C/SPI	₹1,300

Pressure (2/2)

Selected Altimeter	Reasons
BMP 388	• Presence of multiple sensors • Compact design • Satisfies the given resolution of 1 pascal

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Temperature (1/2)

Name	Weight	Dimensions (mm)	Resolution	Operating Voltage	Max Current Drawn	Interface	Price
DPS310 Adafruit	9 gm	24 x 42 x 7	0.06 Pa	3-5V	345μA	I2C/SPI	₹ 600
BMP 388	1.2gm	32 x 20	0.16Pa	1.7-3.6V	800 μA	I2C/SPI	₹1,600
GY-BMP 280	0.8	15.5 x 12 x 2.4		3.3-5V	1120 μA	I2C/SPI	₹1,300

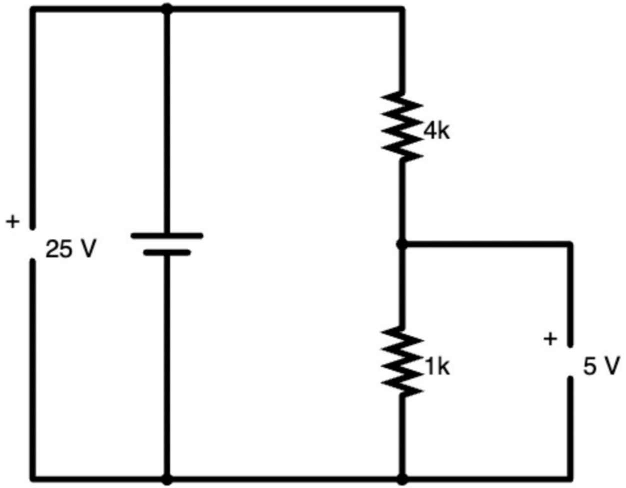
Temperature (2/2)

Selected Altimeter	Reasons
BMP 388	• Presence of multiple sensors • Compact design • Good Resolution

Voltage Status Sensor (1/2)

Name	Weight	Dimensions (mm)	Resolution	Input Voltage	Interface	Price
Voltage Sensor	4g	28 x 14 x 13	0.00489 V	0-25 V	GPIO	₹ 70
Using Resistor	0.25	15 x 3.2		0-5 V	ANALOG INPUT	₹ 2

Voltage Status Sensor (2/2)



Selected Voltage Status Sensor	Reasons
Using Resistor	• Requires less space and is lighter • Easy to integrate • Easily Available

GNSS/IRNSS Sensor (1/2)

Name	Weight	Dimensions (mm)	Power (mW)	Resolution	Operating Voltage	Current Drawn	Interface	Price (INR)
S1216F8-GI2	1.6g	16 x 12.2	363	Position 2.5m CEP Velocity 0.1m/sec Time 12nsec	3.3V	110mA	NavIC L5, GAGAN/GPS L1 C/A code Venus 8 engine	1200
L89 Breakout Included chip and patch antenna	8.2g	26.4 × 18.4 × 6.8	495	Position 1.8m CEP Velocity 0.1m/sec Time 3.9nsec	3.3V	150mA	GPS, IRNSS, GLONASS, BeiDou, Galileo and QZSS	1883
TEL0094 (only GPS sensor)	40g	37 x 48 x 16	150	Accuracy 2.5m (Autonomous)	5V	30mA	Arduino	1185

GNSS/IRNSS Sensor (2/2)

Selected Sensor	Reasons
L89 Breakout	● Includes chip and patch antenna ● Supports variety of signals like GPS, IRNSS, GLONASS, Galileo. ● Good Sensitivity ● Low operating voltage

IMU Sensor (1/2)

Name	Weight (g)	Dimensions (mm)	Power (mW)	Resolution	Operating Voltage (V)	Max Current Drawn (mA)	Idle Current Drawn (mA)	Price
BNO055 9-DOF	0.15	5.2 x 3.8 x 1.1	44.28	±2g, 4g, 8g, 16g	3.3	12.3	0.04	3835
MPU9250	3	25 x 15 x 3	11.55	±2g, 4g, 8g, 16g	3.3	3.5	0.084	599
MPU6050	2.1	21 × 16 × 3.3	12.87	±2g, 4g, 8g, 16g	3.3	3.9	1.39	118

IMU Sensor (2/2)

Selected Sensor	Reasons
BNO055 9-DOF	9 Axis accelerometer - Contains onboard magnetometer, accelerometer and gyroscope - Less weight and volume consumption than other sensors - It allows for sensor fusion to reduce noise.

Payload Subsystems Overview

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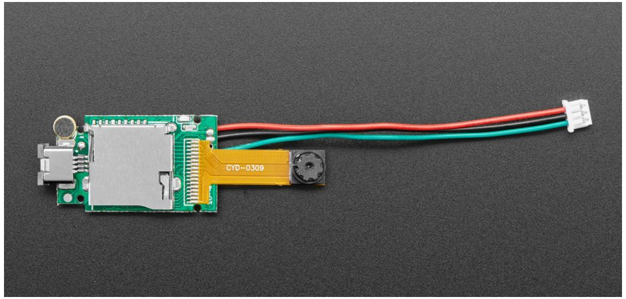
Bonus Camera (1/2)

Name	Weight (g)	Dimensions (mm)	SD Card	Resolution	Operating Voltage	FPS	Current Drawn	FoV
Adafruit 3202	3	29 x 17 x 5	Present	640 x 480	3.7-5.0	30	110	120
ESP32 CAM		40 x 27 x 12	No	1600 x 1200	5	15	310	56
Pi Cam	3	20 x 25 x 9	No	1920 x 1080	1.7-3.0	30		67

Bonus Camera (2/2)



Selected Camera	Reasons
Adafruit 3202	● Smaller Dimensions ● Onboard SD Card Slot Present ● Good enough resolution ● Recording in colour

Bonus Accelerometer (1/2)

Name	Weight (g)	Dimensions (mm)	Power (mW)	Resolution	Operating Voltage (V)	Max Current Drawn (mA)	Idle Current Drawn (mA)	Price
BNO055 9-DOF	0.15	5.2 x 3.8 x 1.1	44.28	±2g, 4g, 8g, 16g	3.3	12.3	0.04	3835
MPU9250	3	25 x 15 x 3	11.55	±2g, 4g, 8g, 16g	3.3	3.5	0.084	599
MPU6050	2.1	21 × 16 × 3.3	12.87	±2g, 4g, 8g, 16g	3.3	3.9	1.39	118

Bonus Accelerometer (2/2)

Selected Sensor	Reasons
BNO055 9-DOF	● 9 Axis accelerometer ● Contains onboard magnetometer, accelerometer and gyroscope ● Less weight and volume consumption than other sensors

Bonus Magnetometer (1/2)

Name	Weight (g)	Dimensions (mm)	Power (mW)	Resolution	Operating Voltage (V)	Max Current Drawn (mA)	Idle Current Drawn (mA)	Price
BNO055 9-DOF	0.15	5.2 x 3.8 x 1.1	44.28	±2g, 4g, 8g, 16g	3.3	12.3	0.04	3835
MPU9250	3	25 x 15 x 3	11.55	±2g, 4g, 8g, 16g	3.3	3.5	0.084	599
MPU6050	2.1	21 × 16 × 3.3	12.87	±2g, 4g, 8g, 16g	3.3	3.9	1.39	118

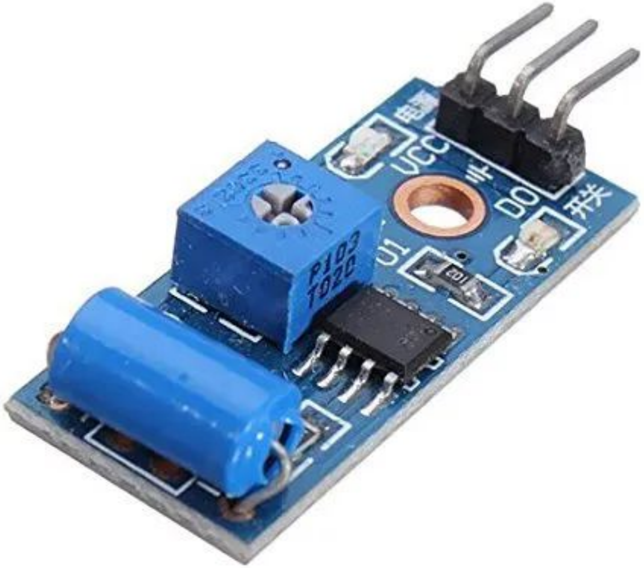
Bonus Magnetometer (2/2)

Selected Sensor	Reasons
BNO055 9-DOF	● 9 Axis accelerometer ● Contains onboard magnetometer, accelerometer and gyroscope ● Less weight and volume consumption than other sensors

Bonus Vibration Sensor (1/2)

Name	Weight (g)	Dimensions (mm)	Operating Voltage	Current Drawn	Price
SW-420	3	40 x 15 x 7	3.3 - 5V	15mA	₹ 75
SW1802 0P		19 x 4.8		5mA	₹ 11
KY 002		20 x 15 x 18	12V	20mA	₹ 60

Bonus Vibration Sensor (2/2)

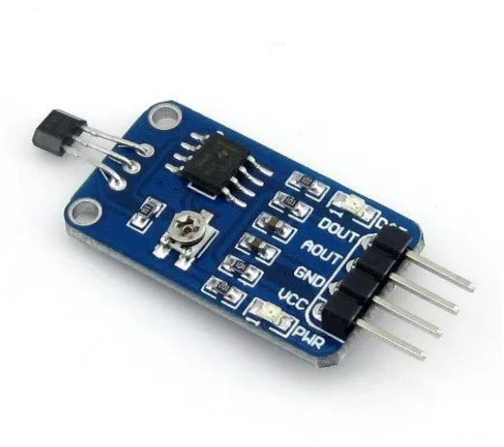


Selected Sensor	Reasons
SW-420	● Lower power consumption ● Easily Available

Bonus Hall Sensor (1/2)

Name	Weight	Dimensions (mm)	Operating Voltage	Current Drawn	Price
AH49E	2	26 x 16	2.3-5.3V	5mA	₹ 250
A3144	2	20 x 16	5V	8mA	₹ 55
Grove Hall Sensor	9	20 x 24	3.8-5V	24mA	₹ 600

Bonus Hall Sensor (2/2)



Selected Sensor	Reasons
AH49E Hall Sensor Module	• Lowest weight and power consumption of above options

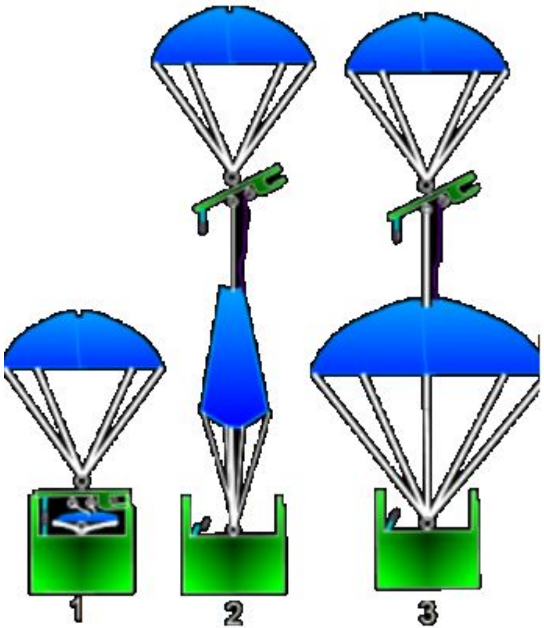
Descent Control Design

Descent Control Design

Concept 1

Co-Axial Parachutes

1) First parachute will deploy naturally.
2) There is a slit cut which will open after command from the system, that contains second parachute connected directly to the top of second parachute.
3) Both parachutes are deployed, together contributing to the drag force on CanSat

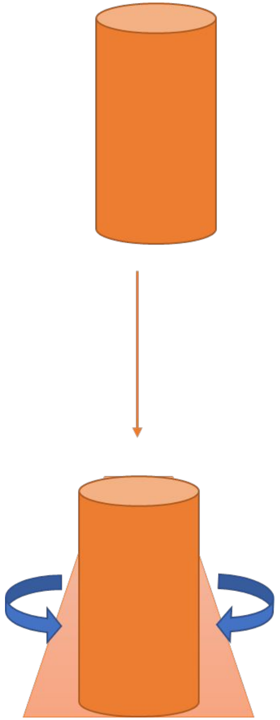


Descent Control Design

Concept 2

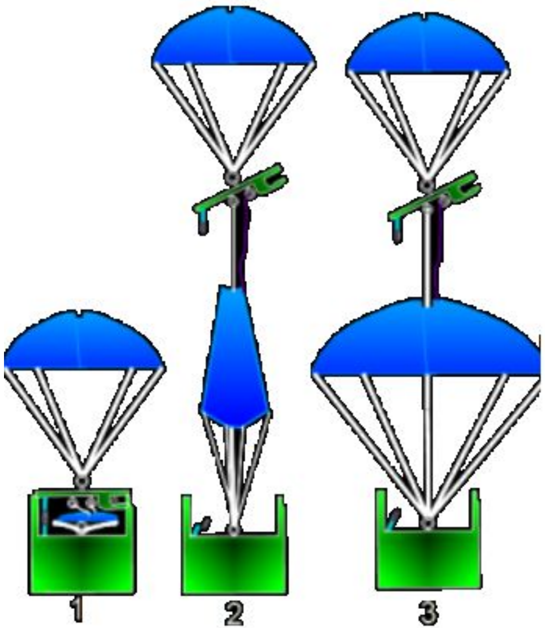
Using gliders

1) First parachute will deploy naturally.
2) As soon as 500 m is reached glider from both the side of the CanSat will open to give it the shape of the aeroplane and will glide in the air.
3) Helps in achieve great descent rate control.



Gliders opens

Descent Control Design



Selected Design	Reasons
Concept 1:Co-Axial Parachute	● Easier to fabricate ● Provide higher descent control and less deviation .

Descent Rate Estimates (1/1)

Assumptions Made:

- Drag is equal to weight at terminal velocity
- There is no wind presence or other whether effects
- When fully deployed parachutes are fully inflated and contribute to the drag on the CanSat provided they are far enough apart

Constants		Other Variables used in equations	
g	Acceleration due to gravity = $9.814\ m/s^2$	F_D	Drag Force
ρ	Density of air (assumed constant) = $1.225\ kg/m^3$	A	Area of Parachute
C_D	coefficient of drag for parachute	R_1 & R_2	Radius of Parachute 1 and 2
M	Mass of Cansat	V_T	Terminal velocity of Cansat

Known Formulas:

$$F_D = \frac{1}{2} C_D \rho A v^2$$

At terminal velocity, Gravitational Force = Drag Force

$$F_G = F_D$$

$$Mg = \frac{1}{2} C_D \rho A V_T^2$$

$$V_T = \sqrt{\frac{2mg}{C_D \rho A}}$$

Descent Rate Estimates (2/11)

For the first stage (900 m - 500 m), Parachute used is Round Canopy type with Cd = 0.75. Therefore, to find effective area and radius of parachute:

$$V_T = \sqrt{\frac{2mg}{C_D \rho A}}$$

Rearranging, $A = \frac{2mg}{C_D \rho {V_T}^2}$

Therefore, effective area:

$$A_{eff} = \frac{2(0.7\,kg)(9.814\,m/s^2)}{(0.75)(1.225\,kg/m^3)(15\,m/s)^2}$$

$$A_{eff} = 0.0665\,m^2$$

Effective radius:

$$R_{eff} = \sqrt{\frac{A_{eff}}{\pi}}$$

$$R_{eff} = 0.145\,m = 145\,mm$$

Descent Rate Estimates (3/11)

Shroud length: $l_{shroud} = 1.15 \times D_{eff}$

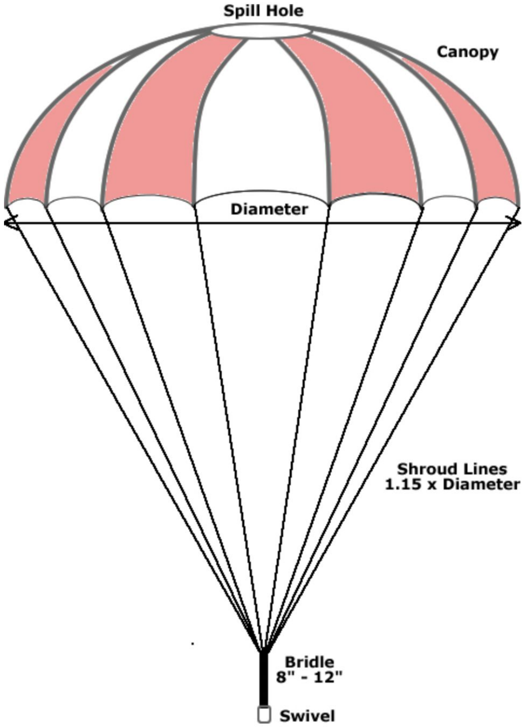
$$l_{shroud} = 0.335\,m = 335\,mm$$

Spill hole diameter: 20% of diameter

$$D_{spill\ hole} = 0.2 \times D_{eff}$$

$$D_{spill\ hole} = 0.058m = 58\,mm$$

$$A_{spill\ hole} = \frac{\pi D_{spill\ hole}^{2}}{4} = 0.0026\,m^{2}$$



Descent Rate Estimates (4/11)

For the second stage (500 m - 0 m), Parachute used is Round Canopy type with Cd = 0.75. Therefore, to find effective area and radius of parachute:

$$V_T = \sqrt{\frac{2mg}{C_D \rho A}}$$

Rearranging, $A = \frac{2mg}{C_D \rho {V_T}^2}$

Therefore, effective area:

$$A_{eff} = \frac{2(0.7\ kg)(9.814\ m/s^2)}{(0.75)(1.225\ kg/m^3)(2\ m/s)^2} - A_{parachute\ 1}$$

$$A_{eff} = 3.672\ m^2$$

Effective radius:

$$R_{eff} = \sqrt{\frac{A_{eff}}{\pi}}$$

$$R_{eff} = 1.081\ m\ =\ 108.1\ mm$$

Descent Rate Estimates (5/11)

Shroud length: $l_{shroud} = 1.15 \times D_{eff}$

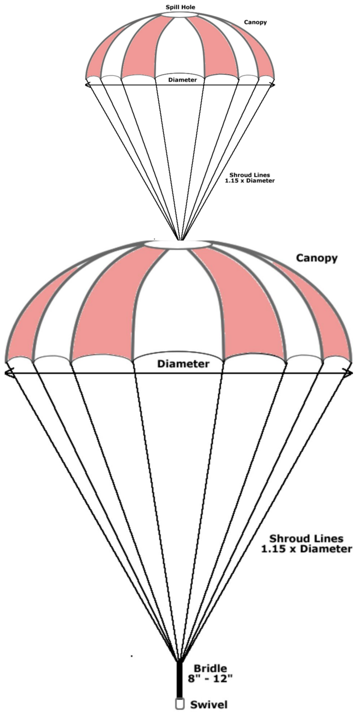
$$l_{shroud} = 2.509\ m = 2509\ mm$$

Spill hole diameter: 20% of diameter

$$D_{spill\ hole} = 0.2 \times D_{eff}$$

$$D_{spill\ hole} = 0.436m = 436\ mm$$

$$A_{spill\ hole} = \frac{\pi D_{spill\ hole}^{2}}{4} = 0.149\ m^{2}$$



Descent Rate Estimates (6/11)

Velocity-time relationship (general):

Downward acceleration = a

By Newton's Second law of motion,

$$Ma = Mg - \frac{1}{2}C_D \rho A v^2$$

$$a = \frac{dv}{dt} = g - \frac{1}{2m}C_D \rho A v^2$$

$$\Delta t = \int_{v_i}^{v} \frac{1}{g - \frac{1}{2m}C_D \rho A v^2} dv$$

$$\Delta t = \frac{V_T}{2g} ln(\frac{(V_T + v)(V_T - v_i)}{(V_T - v)(V_T + v_i)})$$

Simplifying,

$$v = -\frac{dh}{dt} = V_T(\frac{V_T(1 - e^{-2gt/V_T}) + v_i(1 + e^{-2gt/V_T})}{V_T(1 + e^{-2gt/V_T}) + v_i(1 - e^{-2gt/V_T})})$$

Height-time relationship (general):

$$\Delta h = -V_T \int_{t_1}^{t_2} (\frac{V_T(1 - e^{-2gt/V_T}) + v_i(1 + e^{-2gt/V_T})}{V_T(1 + e^{-2gt/V_T}) + v_i(1 - e^{-2gt/V_T})})dt$$

Descent Rate Estimates (7/11)

Descent rate estimates for CanSat with first parachute released:

Descent Velocity-Time Calculation for CanSat:

Assuming vertical initial velocity from the

900 m Apogee is 0 m/s, the CanSat

descends 400 m from Apogee with

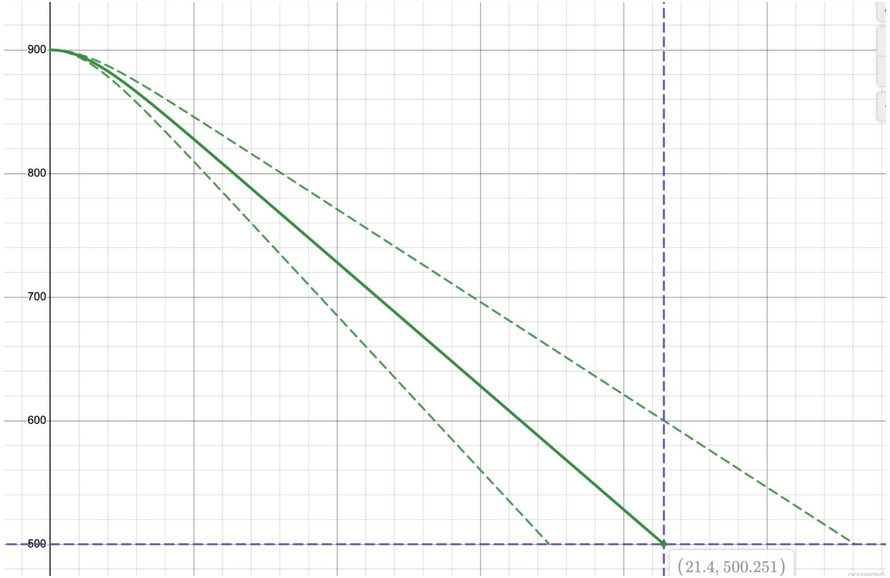
velocity of 20.0 m/s for 21.4 s.

Descent Rate Estimates (8/11)

Descent rate estimates for CanSat with first parachute released:

Descent Altitude-Time Calculation for CanSat:

Assuming vertical initial velocity from the 900 m Apogee is 0 m/s, the CanSat descends 400 m from Apogee with velocity of 20.0 m/s for 21.4 s.



Descent rate estimates for CanSat with second parachute released:

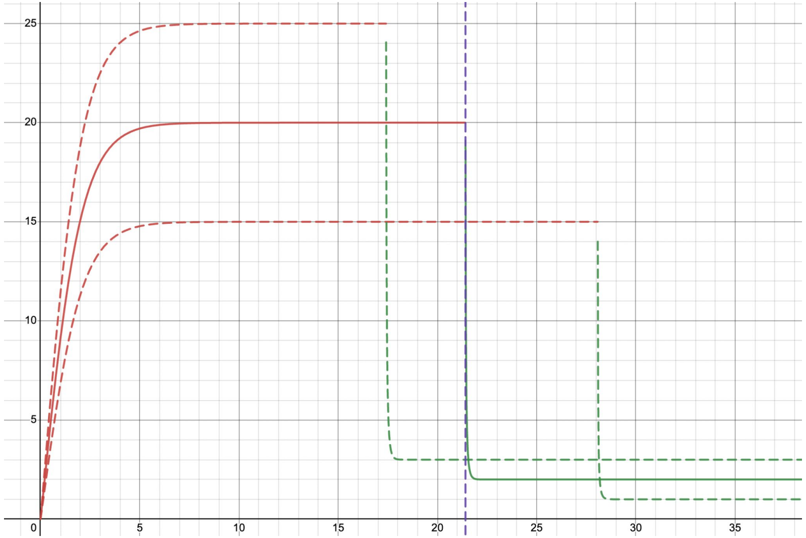
Descent Velocity-Time Calculation for CanSat:

Assuming vertical initial velocity from the

500 m Apogee is 15 m/s, the CanSat

descends 500 m to ground with

velocity of 2.0 m/s for 271 s.

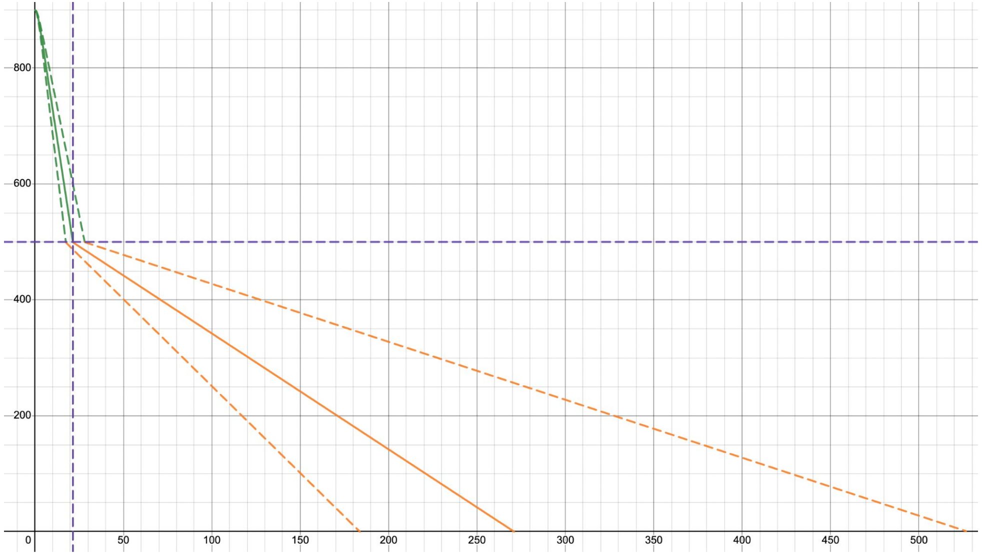


Descent Rate Estimates (10/11)

Descent rate estimates for CanSat with first parachute released:

Descent Altitude-Time Calculation for CanSat:

Assuming vertical initial velocity from the 500 m Apogee is 15 m/s, the CanSat descends 500 m to ground with velocity of 2.0 m/s for 271 s.



Descent Rate Estimates (11/11)

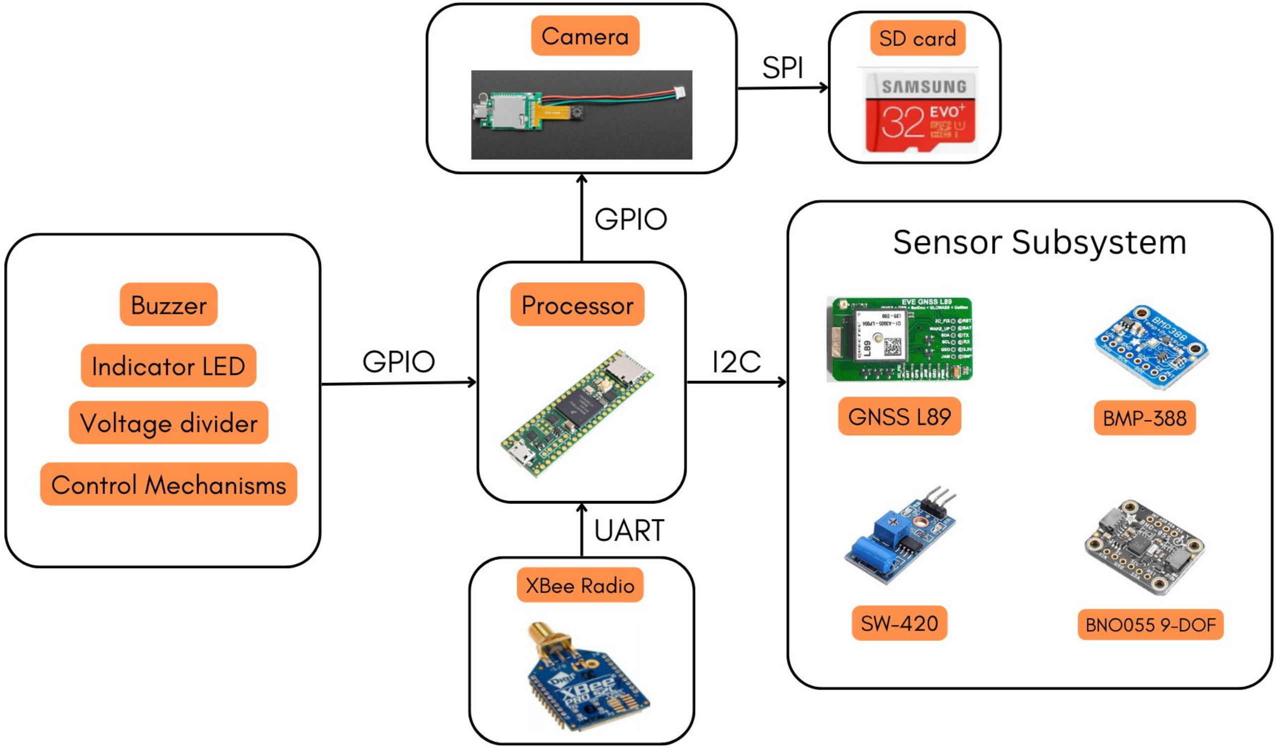
Final Result:

Descent Rate Estimates for CanSat:

Phase	Height	Descent rate	Descent time
1st Parachute release	900 m - 500 m	20 m/s	21.4 s
2nd Parachute release	500 m - 0 m	2 m/s	271 s
Total Descent time			292.4 s

Communication and Data Handling Subsystems

Command Data Handler overview



Radio Selection (1/2)

Name	Operating voltage [V]	Operating current [mA]	Sensitivity [dBm]	Operating frequency [MHz]	Transmit power [mW/dBm]	Range [km]
XB24CASIT-001 (XBee S2C)	2.1 to 3.6V	TX: 33 mA RX: 28mA	-100 dBm	2.4 GHz	3.1mW/5dBm	~1.2km
XBP24CASIT-001 (XBee S2C PRO)	2.7 to 3.6V	TX: 120mA RX: 31mA	-101 dBm	2.4 GHz	63mW/18dBm	~3.2km

Radio Selection (2/2)

Selected Radio	Rationale
XBP24CASIT-001 (XBee S2C Pro)	● High transmitting power ● RP SMA (Screw type) Antenna connector

Payload antenna selection (1/2)

Name	Connector type	Frequency range(s) [GHz]	Weight [g]	Peak gain [dBi]	Height(cm)
Seritta delta 15	RP-SMA (female)	2.4GHz	11.2g	2dBi	5.3cm
ANT-916-CW-RCL	UFL, SMA	2.4 GHz	12.5 g (+adapter)	3dBi	14 cm
XBP24CZ7SIT-004 Antenna	RP-SMA (male)	2.4 GHz	17 g	3.2dBi	19 cm

Payload antenna selection (2/2)

Selected Antenna	Rationale
Seritta delta 15	● Less height ● Needs no external connector

GCS antenna selection (1/2)

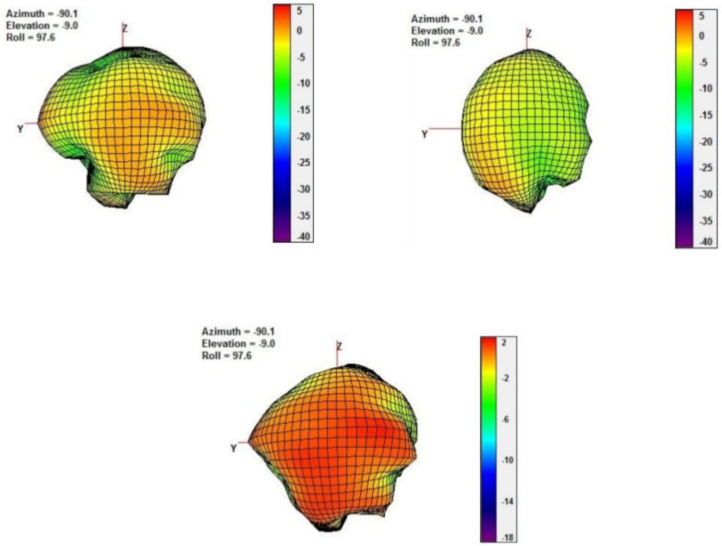
Name	Connector type	Frequency range(s) [GHz]	Weight [g]	Peak gain [dBi]	Height(cm)
Seritta delta 15	RP-SMA (female)	2.4GHz	11.2g	2dBi	5.3cm
ANT-916-CW-RCL	UFL, SMA	2.4 GHz	12.5 g (+adapter)	3dBi	14 cm
2.4 Ghz Omni antenna	RP-SMA (male)	2.4 GHz	17 g	3.2dBi	19 cm

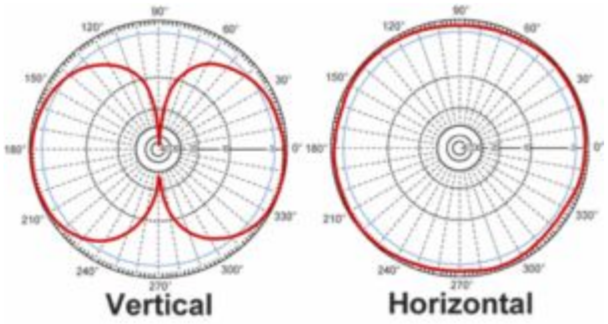
GCS antenna selection (2/2)

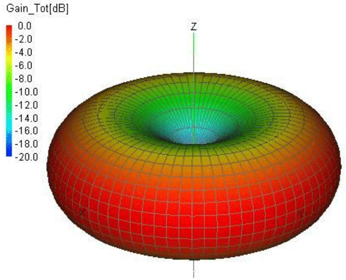
Selected Antenna	Rationale
2.4 Ghz omni antenna	● More gain ● Needs no external connector

Antenna Radiation pattern

Both antennas are vertically polarized and omni-directional in nature







Source: Datasheet

Radio Configuration

- Selected XBee S2c pro will be used in both CanSat and GCS.
- XBee's PANID/NETID will be set to 018 (team number), as per requirement.
- XBee in CanSat is used as Router and XBee connected to GCS is used as Coordinator
- We do not use broadcast mode, but rather communication is done in unicast mode, as per requirement.
- Data will be transmitted to GCS at 1Hz throughout the mission, as per requirement.
- Data is also stored onboard locally to allow retrieval of lost packets, as per requirement.

NexSat IITJ

Telemetry Format (1/4)

S.No	TM Parameter	Function	Resolution/Format
1	<TEAM ID>	Team Number	2022ASI-018
2	<TIME STAMPING>	Time since initial power	seconds
3	<PACKET COUNT>	Count of transmitted packets	Not Applicable
4	<ALTITUDE>	Altitude in units of meters and must be relative to ground	0.1 meters
5	<PRESSURE>	Measurement of atmospheric pressure	1 pascal
6	<TEMP>	Temperature in Celsius	0.1 °C
7	<VOLTAGE>	Voltage of the CANSAT power bus	0.01 Volts
8	<GNSS TIME>	Time generated by the GNSS receiver	Seconds

Telemetry Format (2/4)

S.No	TM Parameter	Function	Resolution/Format
9	<GNSS LATITUDE>	Latitude generated by the GNSS receiver	0.0001 degrees
10	<GNSS LONGITUDE>	Latitude generated by the GNSS receiver	0.0001 degrees
11	<GNSS ALTITUDE>	Altitude generated by the GNSS receiver	0.1 meters
12	<GNSS SATS>	GNSS satellites connected	integer number
13	<ACCELEROMETER DATA>	Data received from the gyroscopic sensor i.e acceleration and roll & pitch parameters	m/s2
14	<GYRO SPIN RATE>	Spin rate of Mechanical Gyro wrt. CANSAT	deg/s

NexSat IITJ

Telemetry Format (3/4)

S.No	TM Parameter	Function	Resolution/Format
15	<FSW STATE>	Operating state of the software	Integer paired to a state
16	<MAGNETOMETER DATA>	Data received from Magnetometer	±2g, 4g, 8g, 16g
17	<VIBRATION SENSOR DTA>	Data received from vibration sensor	0.01 Hz
18	<CMD ECHO>	Last command received	Not Applicable

Telemetry Format (4/4)

Telemetry Data Format:

```
<TEAM_ID>,<TIME_STAMPING>,<PACKET_COUNT>,<ALTITUDE>
<TEMP>,<PRESSURE>,<VOLTAGE>,<GNSS_TIME>,<GNSS_LATITUDE>
<GNSS_LONGITUTE>,<GNSS_ALTITUDE>,<GNSS_SATS>,<ACCELOROMETER_DATA>
<GYROSPIN_RATE>,<FSW_STATE>,<MAGNETOMETER_DATA>,<HALLSENSOR_DATA>
<VIBRATION_DATA>,<CMD_ECHO>
```

- Data is comma separated
- Using \0 to show the end of message
- Presented format matches the competition guide requirements

Link Budget

Assumption: Max range = 4 km

Transmit power (T_x) = 18 dBm

Receiver Sensitivity (R_x) = -101 dBm

Antenna Gain (T_x) = 2 dBi

Antenna Gain (R_x) = 3.2 dBi

Free Space Loss = $100 + 20^* \log_{10}(d) = 112$ dB

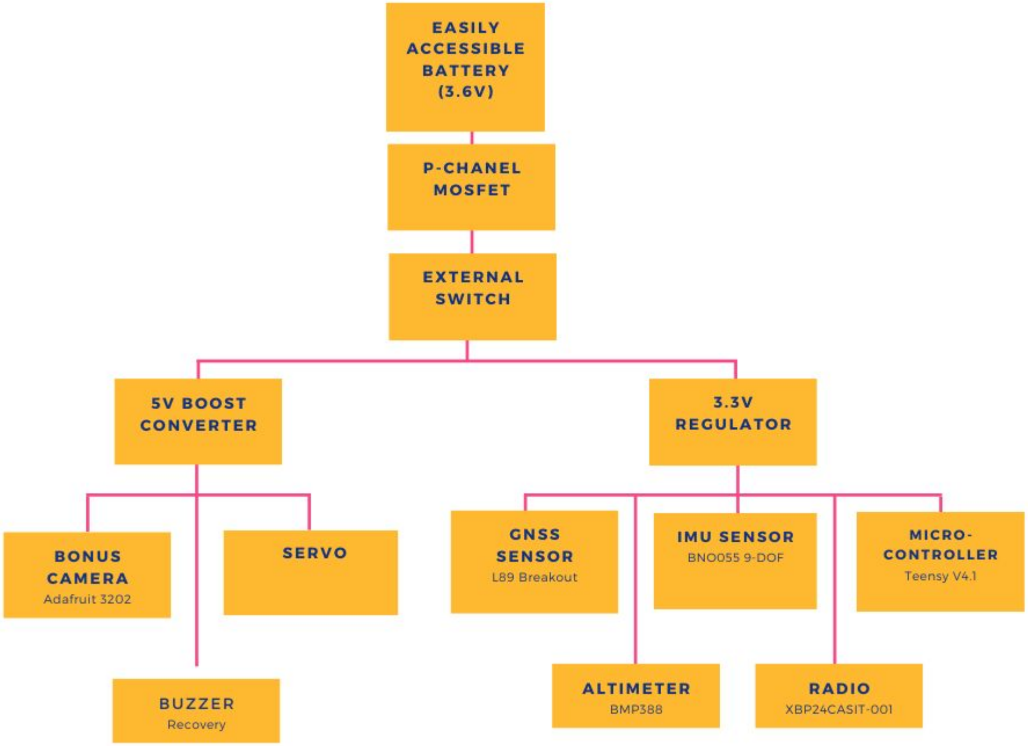
$\boxed{\text{Link Margin} = 18 + 3.2 + 2 - 112 - (-101) = 12.2 \text{ dBm}}$

FSW States

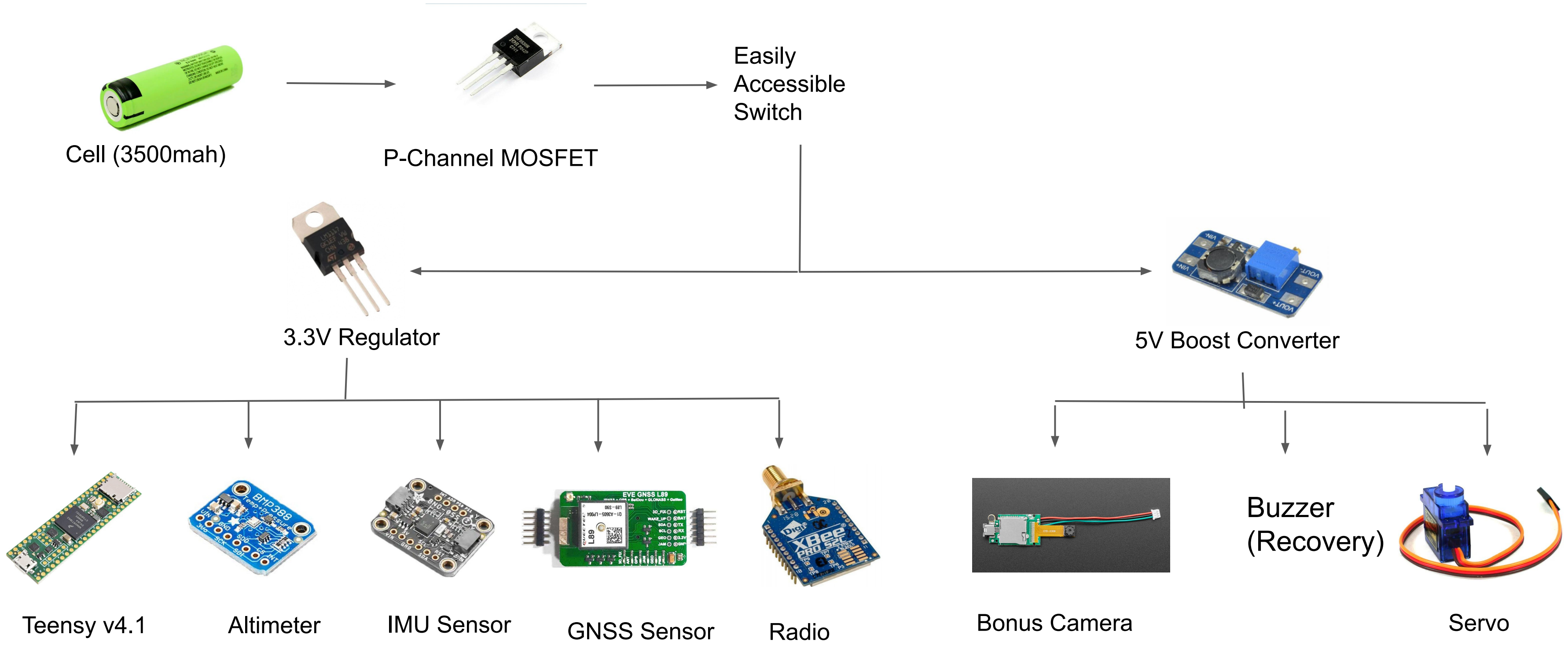
FSW State	Integer Assigned
BOOT	0
SIM_MODE	1
PRE_FLIGHT	2
ASCENT	3
ROCKET_DEPLOY	4
DESCENT	5
SEC_PARA	6
LANDED	7

Power Subsystem Design

Power System Overview (1/3)



Power System Overview (2/3)



Power System Overview (3/3)

A 3500mah cell powers the CanSat satellite. To prevent reverse polarity, a p-channel MOSFET is used to power the CanSat. It is connected to a switch that is conveniently located. 3.3V regulator and 5V boost converter are then given power as the cell's output voltage, which is 3.6V, is distributed. The 5V Boost Converter powers the camera, buzzer, and servo, while the 3.3V converter powers the Teensy v4.1 microcontroller, altimeter, IMU sensor, GNSS sensor, and radio.

Cell Selection (1/2)

Name	Weight (g)	Dimensions (mm)	Voltage (V)	Capacity	Max Current (A)	Cell Type	Price (INR)
SONY VTC6	46.6	65.20 x 18.5	3.6	3000	20	LI-ION 18650	1299
Panasonic NCR 18650GA	50	65 x 18.5	3.6	3500	10	LI-ION 18650	950
SAMSUNG INR18650-30 Q	45	65 x 18	3.7	3000	20	LI-ION 18650	649

Cell Selection (2/2)

Selected Sensor	Reasons
Panasonic NCR 18650GA	• Higher Capacity • Affordable and available • Conforms with the given requirements

Flight Software Design

Flight Software Overview

OverView

Flight software is based on concept of state machine model in which we have finites number of states.Based on the current state and the input given by the machine the output is produced

Programming Language used

- Java
- C++

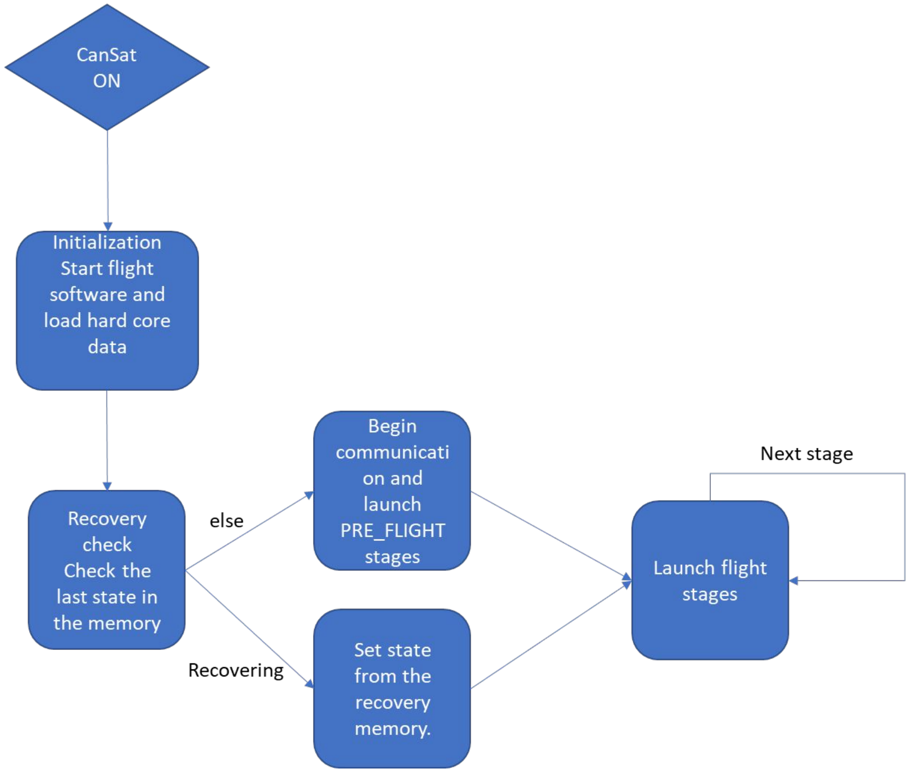
Development environment

- VS Code
- Arduino IDE

Flight Software Overview

1. Configuration of sensor subsystem.
2. CanSat saves sensor data to SD card and send it to GCS via XBEE
3. Apogee detected parachute is deployed
4. At 500 m,second parachute is deployed
5. The buzzer keeps buzzing after landing till turned off

Flight Software Overview



RECOVERY:A processor may get reset due to shock.

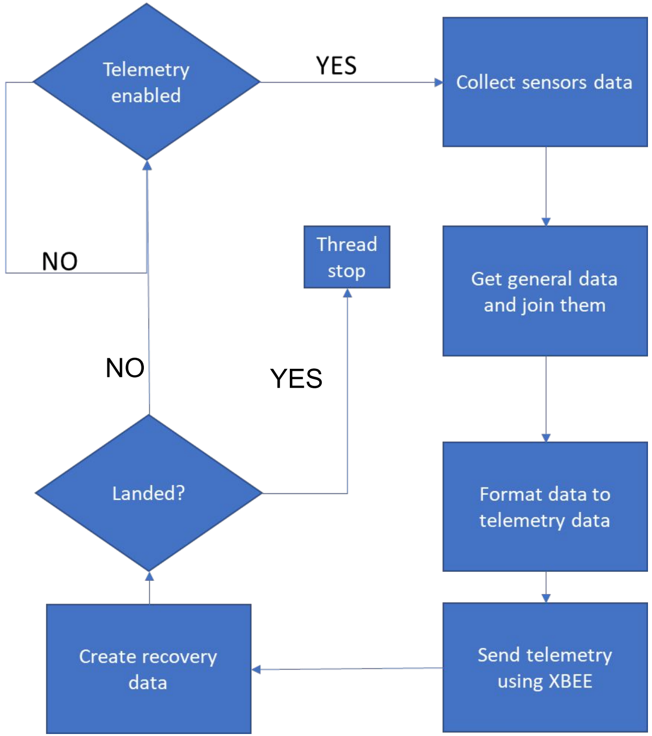
PRE_FLIGHT: Process command and calibrate sensors and check RTC.

The Recovery data consists of :

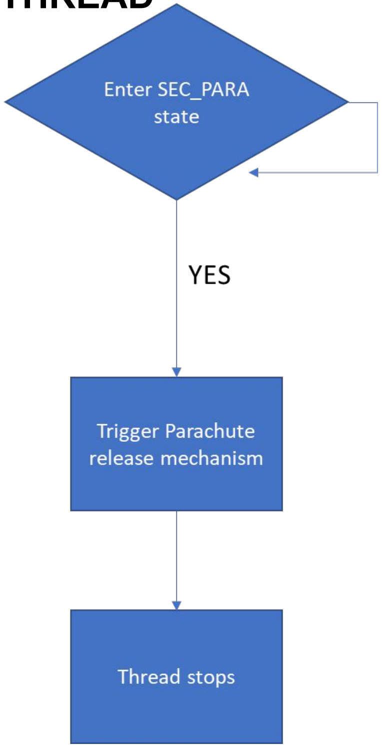
1. Flight stage
2. Mission Start Time
3. Altitude
4. Calibrated values

Flight Software Overview

TELEMETRY THREAD

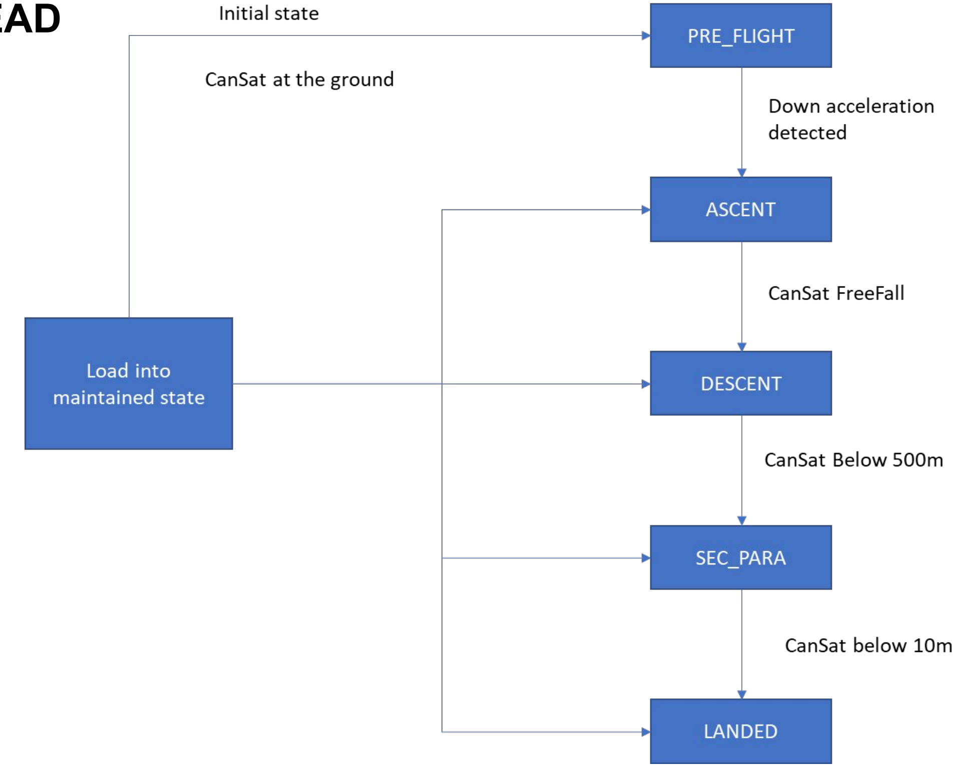


PARACHUTE THREAD



Flight Software Overview

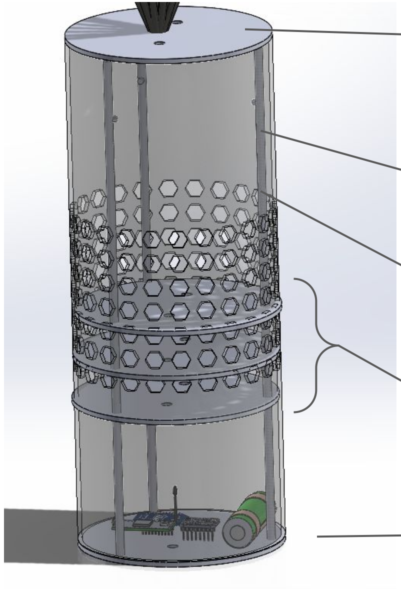
FSW STATE THREAD



Mechanical Subsystem Design

Mechanical Subsystem Design

Design 1



Outer cap

Support rod of carbon fibre

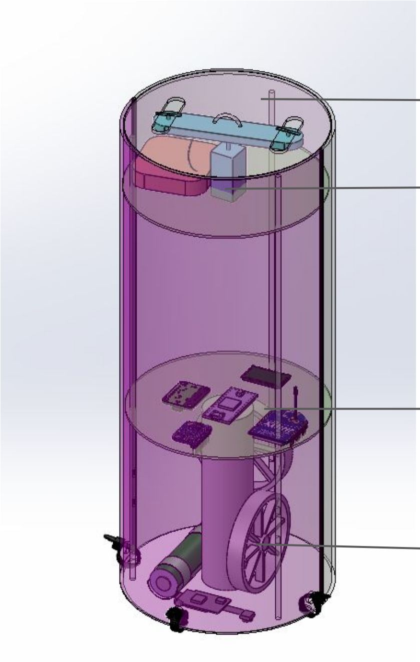
Outer cylindrical shell of ABS

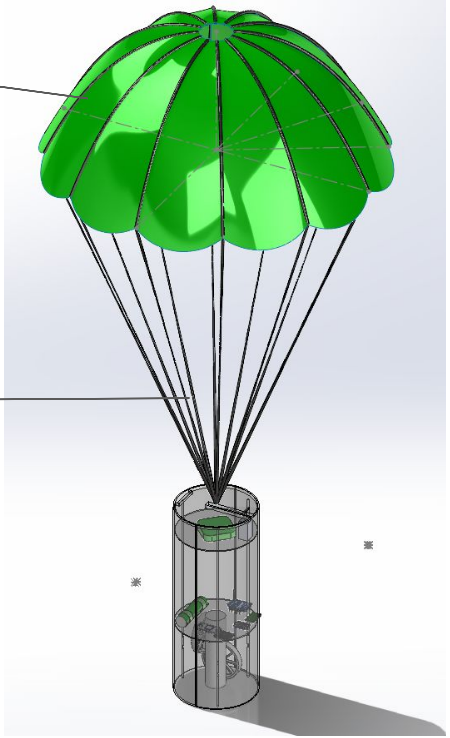
Stacked platform for PCBs

- This design consist of a straight cylinder with equally spaced hexagonal holes.
- Can be opened from the top
- It has layered electronic subsystem bay

Mechanical Subsystem Design

Design 2





Mechanical Subsystem Design

Design 2

Upper Cap

Servo

First half shell

Second parachute folded

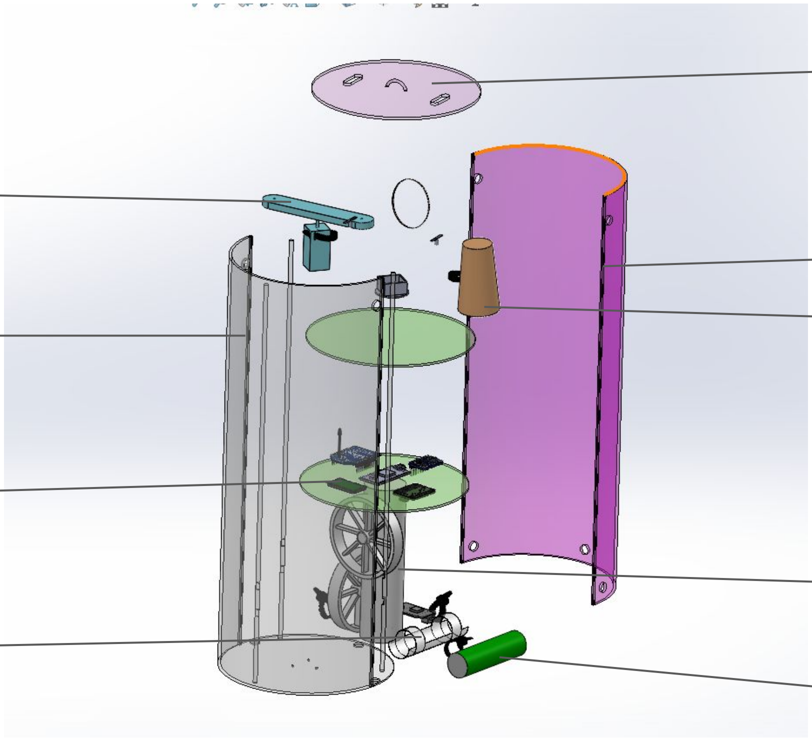
Second shell

Electronic Bay

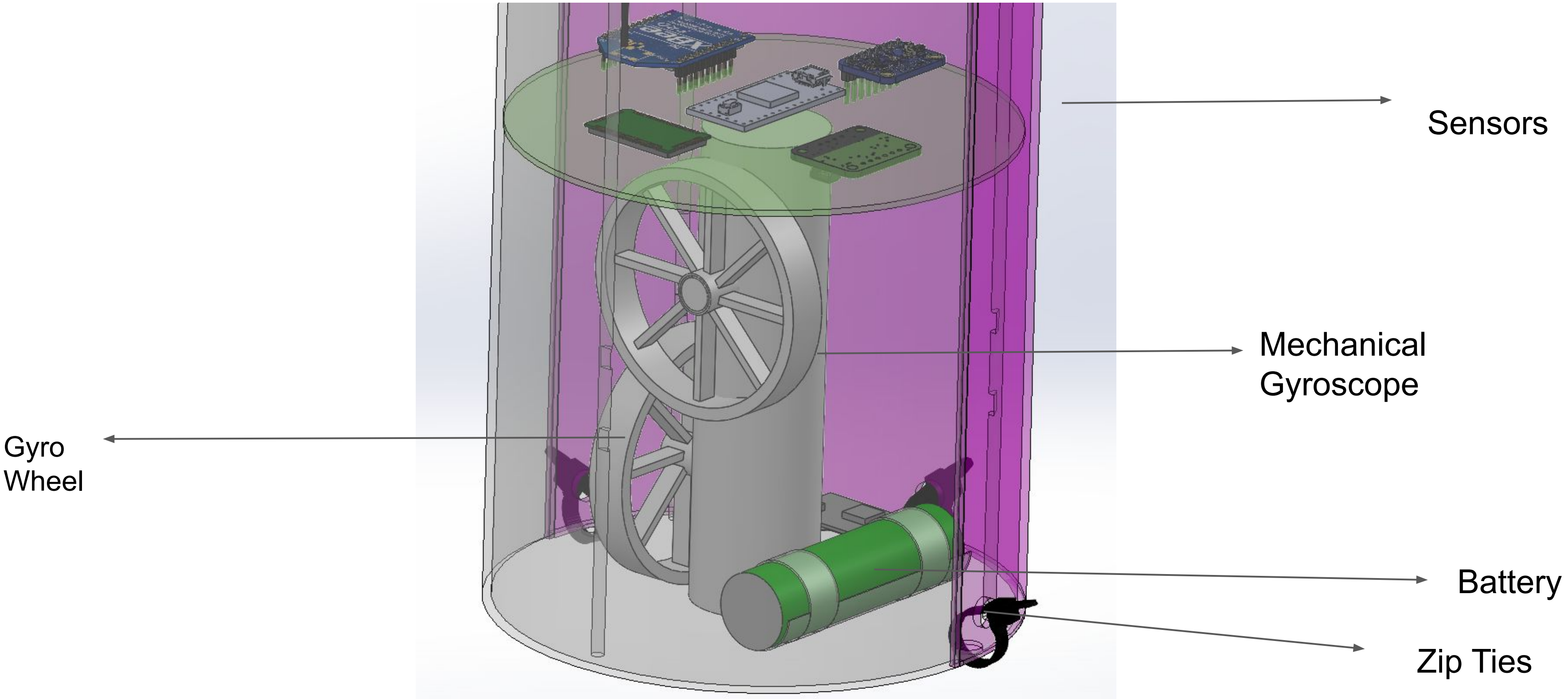
Mechanical Gyroscope

Battery Holder

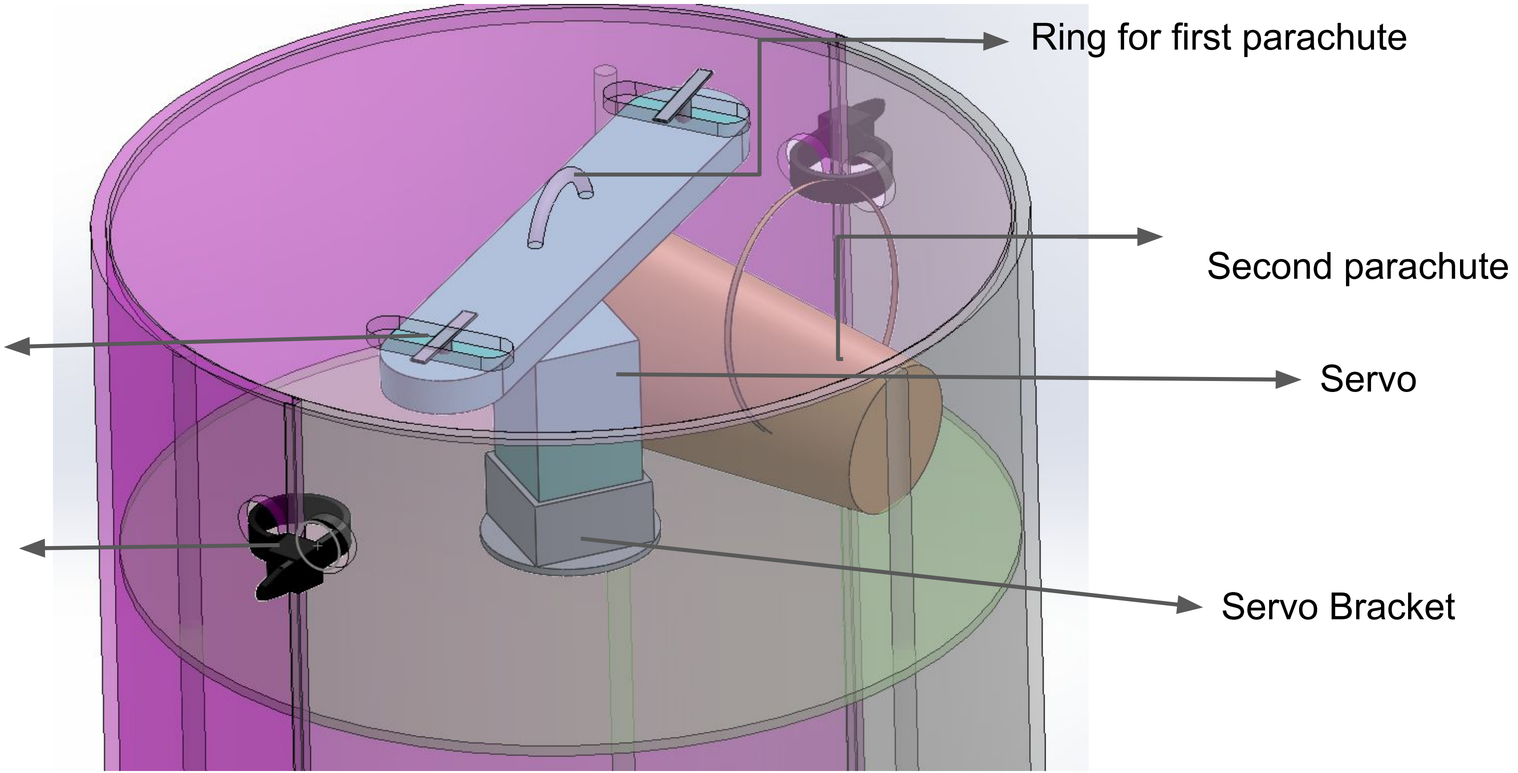
Battery



Mechanical Subsystem Design



Mechanical Subsystem Design



CanSat Material Selection

For Container:

Material	Density(kg/m^3)	Tensile Strength(MPa)	Manufacture	Advantage	Disadvantage
ABS	1080	37.75	3D printing	• High hardness and impact resistance • Low Density	Hard to print
PLA	1430	60	3D printing	• Stronger than ABS	Low durability
PETG	1270	50	3D printing	• High impact strength	High density

CanSat Material Selection

For Support Rods:

Material	Density(kg/m^3)	Manufacture	Advantage	Disadvantage
Carbon Fibre Tubes	1750	Manually	High strength and weight ratio	Brittle
Steel tubes	1430	Manually	High tensile strength	Heavy
Aluminium tubes	1270	Manually	Easy mounting and machining	Heavy

CanSat Material Selection

For Parachute:

Material	Density(g/cc)	Manufacture	Advantage	Disadvantage
Nylon-6,6	1.14	Off the shelf	High durable and heat resistant	Hygroscopic and lack UV resistance
Kevlar-29	1.44	Off the shelf	High durable and heat resistance	Expensive

For Tether:

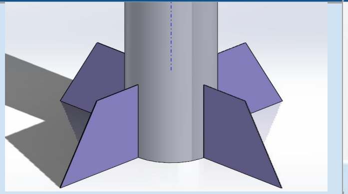
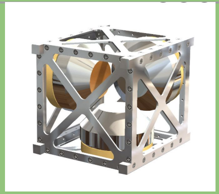
Tether	Material	Diameter(mm)	Break Strength(N)
Nano Cord	Nylon	0.75	18
Micro Cord	Nylon/Polyester	1.18	45

CanSat Material Selection

Material selection summary and rationale

Component	Material	Rationale
Container shell	ABS	Provide durability and lightweight
Support Rods	Carbon Fibre	Low density helps in mass saving
Parachute	Nylon-6,6	Low density and high strength and common availability
Tether	Nano Cord -Nylon	Less mass and better spooling

CanSat Stabilization Mechanism

Design Feature	Static Fins	PID fins	Gyroscopic Wheel
Diagram			
Function	Maintains directional stability.	Servo rotates fins on the basis of input given by PID.	Heavy rotating mass to counteract any change in direction
Advantages	• Zero Power • Directional Stability	High precision and accuracy.	High precision and accuracy,
Disadvantages	• No effect on swaying. • Design complexity	• Servo power required. • Power is also variable	• High variable power required. • High mass

CanSat Stabilization Mechanism

Chosen Stabilization and Rationale

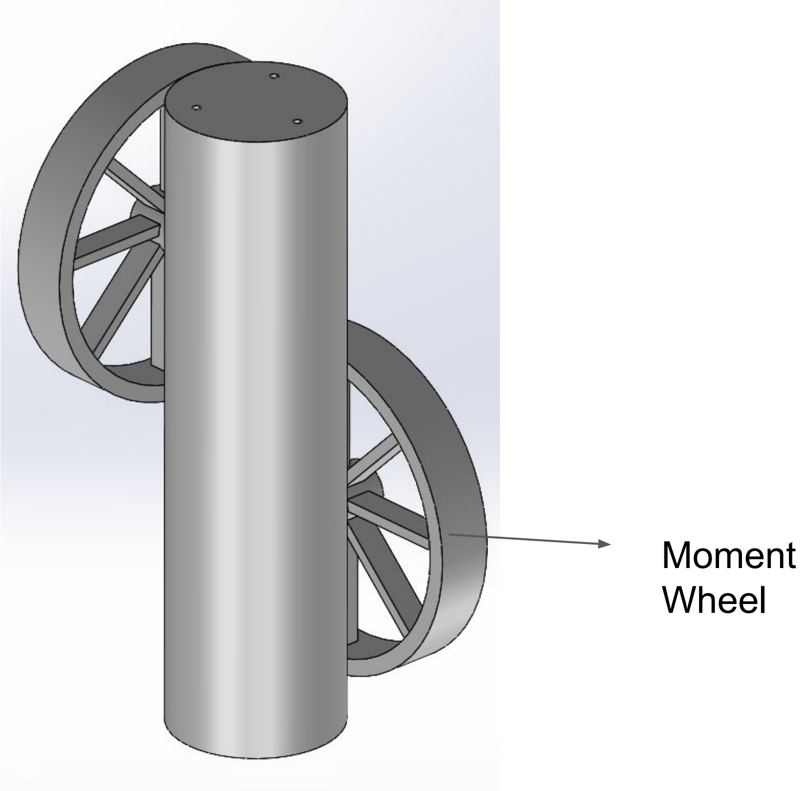
- Control Moment Gyroscope(CMG)

Rationale

- Easy and automatic control
- High precision and accuracy

Note

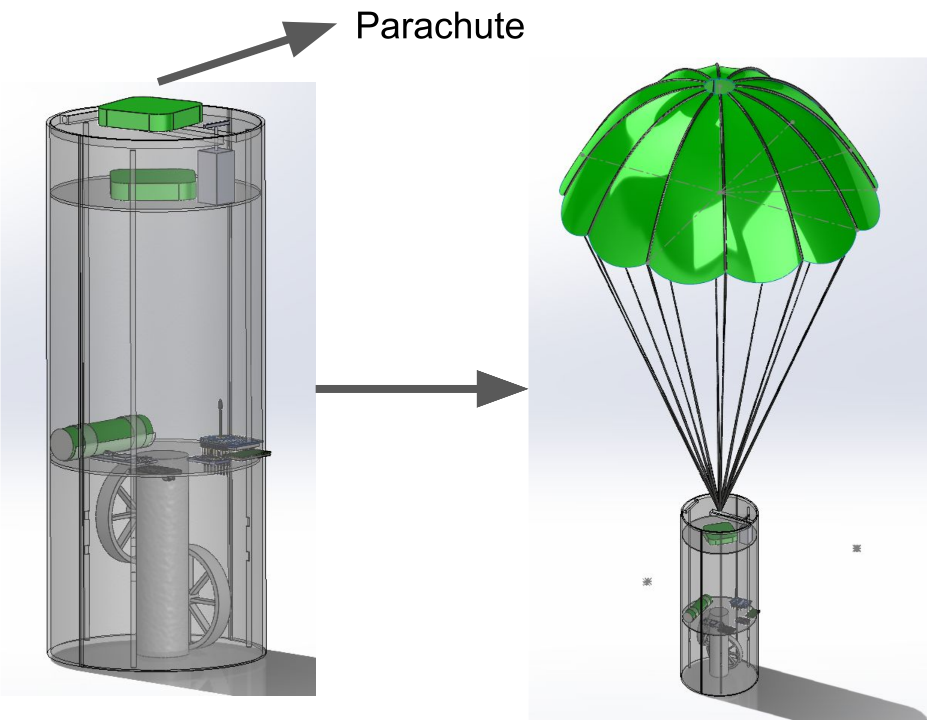
- All the parameter as in weight and size of CMG are tentative and are subjected to change after repeated testing in CDR phase.



Deployment Mechanism Design & Selection

Deployment Mechanism

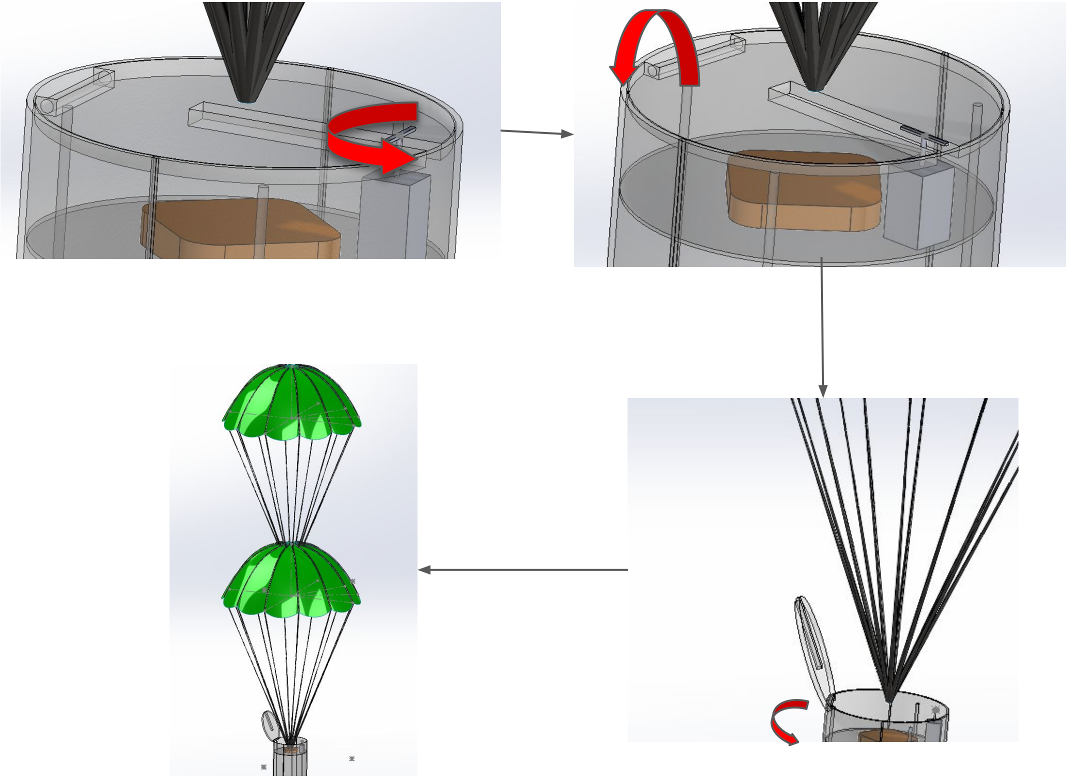
- The first parachute will be folded and simply placed in the outer volume of the CanSat and will release immediately after CanSat is deployed.



Deployment Mechanism

Configuration 1

- The second parachute is inside the CanSat volume and will be released as soon as desired altitude is reached
- The second parachute is placed between the lid and attached to container using nylon ropes.
- The upper lid is connected to cylindrical using hinge joint and has a latch from which ropes of first parachute will pass through.
- At 500 meters the servo will turn 90 degrees and lid will be pushed.
- The second parachute is deployed.

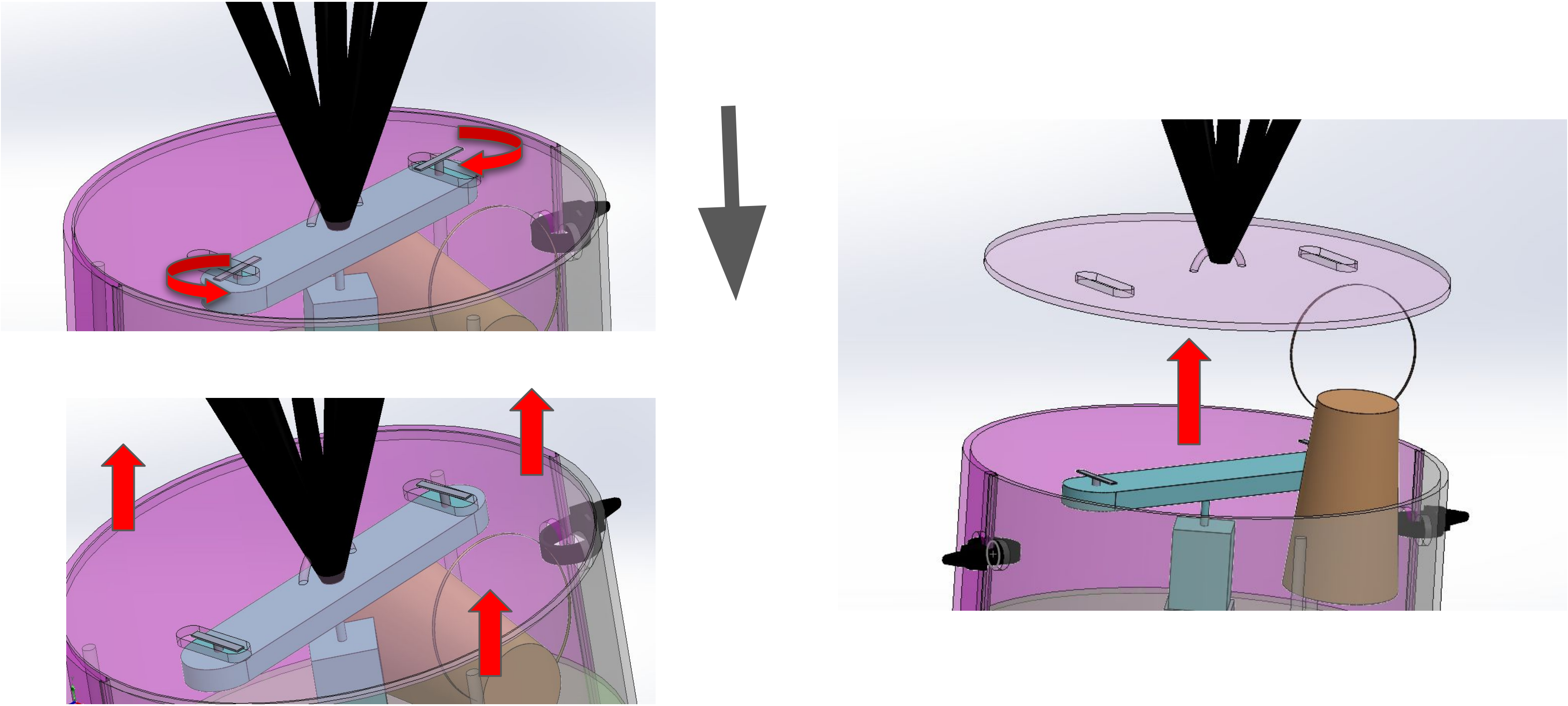


Deployment Mechanism

Configuration 2

- The second parachute is inside the lid and parachute bay.
- At 500m the servo will rotate to make cap free to go up due to force by first parachute
- The second parachute is also connected to the cap of the which will cause the second parachute to deploy.

Deployment Mechanism



Power Budget

Power Budget (1/3)

Component	Quantity	Current	Voltage (V)	Power (mW)	Source
Teensy V4.1	1	100 mA	3.3	330	Datasheet
BMP 388	1	3.4 μA	1.7-3.6	0.012	Datasheet
L89 Breakout	1	150 mA	3.3	495	Datasheet
BNO055 9-DOF	1	12.3 mA	3.3	40.59	Datasheet
Adafruit 3202	1	80-110 mA	3.7-5	450	Estimate

NexSat IITJ

Power Budget (2/3)

Component	Quantity	Current	Voltage (V)	Power (mW)	Source
SW-420	1	15 mA	3.3-5	49.5	Datasheet/ Estimate
AH49E	1	5 mA	2.3-5.3	16.5	Datasheet/ Estimate
XBP24CASIT-001	1	120 mA	2.7-3.6	432	Datasheet
Buzzer	1	25 mA	5	125	Estimate
Servo	2	100-250	3-7.2 (Op at 4.8 V)	2000	Estimate

Power Budget (3/3)

Total Power	2138.6 mW
Total with 25% Margin	2673.25 mW

Cell Voltage	3.6 V
Cell Charge	3500 mAh
Cell Energy	12600 mWh
Deducting 10% Margin	11340 mWh

Operation Time Available at Max Current Draw	4 Hour 14 Minutes

Mass Budget

Mass Budget (2/3)

Structural			464.4
	Container	261	
	Support Rod*3+Screws	30.4	
	Cap	33	
	Parachute	140	
Communication			14.2
	XBee	3	
	Antenna	11.2	
Navigation			111
	Mechanical Gyro	100	
	GNSS	11	
Power source			75
	3000 mah	50	
	Wires	25	
Total		**700.3**	**700.3**

Mass Budget (3/3)

Total Mass of CanSat	700.3
Deviation from 700g	+0.3 g
Percentage Deviation	+0.042%

Hardware Budget

Hardware Budget (1/3)

SUBSYSTEM	COMPONENTS	COST (INR)	SUB TOTAL (INR)
On Board Computer	Teensy v4.1 SD Card*2	5000 1000	6000
Sensor	Essential Add-Ons	2000 3000	5000
Structural	Container Support Rod*3 Parachute Stabilising Structure	2000 1000 6000 2000	11000
Communication	XBee*2 Antenna*2	6000 1000	7000

Hardware Budget (2/3)

Navigation	Gyroscope sensor GNSS	4000 2000	8000
Power source	Cell(3500 mAh)*2 Charger	4000 2000	6000
Recovery module	Others	1000	1000
Camera	3202 Camera	4000	4000

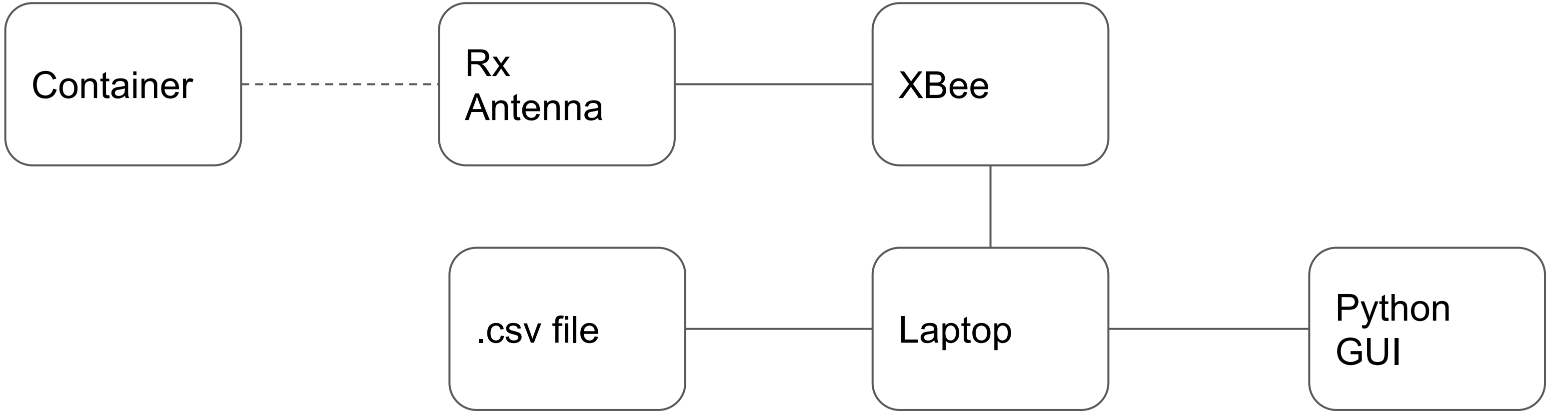
Hardware Budget (3/3)

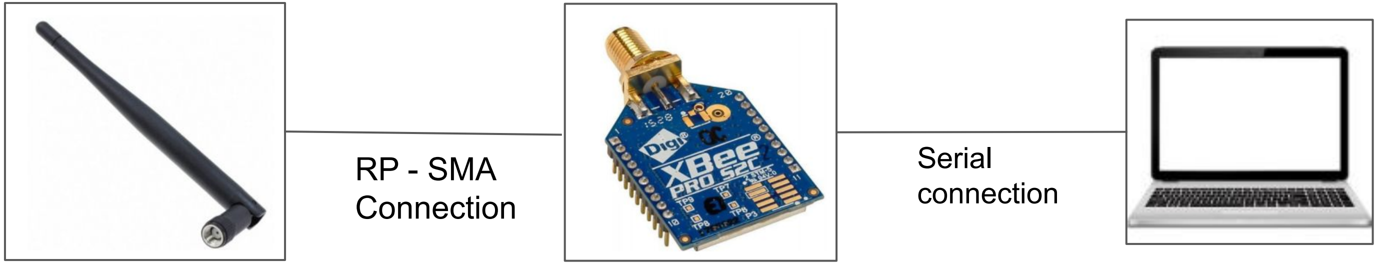
Graphics	Paints, Labels and etc	2000	2000
General Items and spares	Solder, insulators, spares, packaging,etc	3000	3000
TOTAL		**53000**	**53000**

Hardware Budget	Rs. 53000

Ground Control Station Design and Overview

GCS Overview





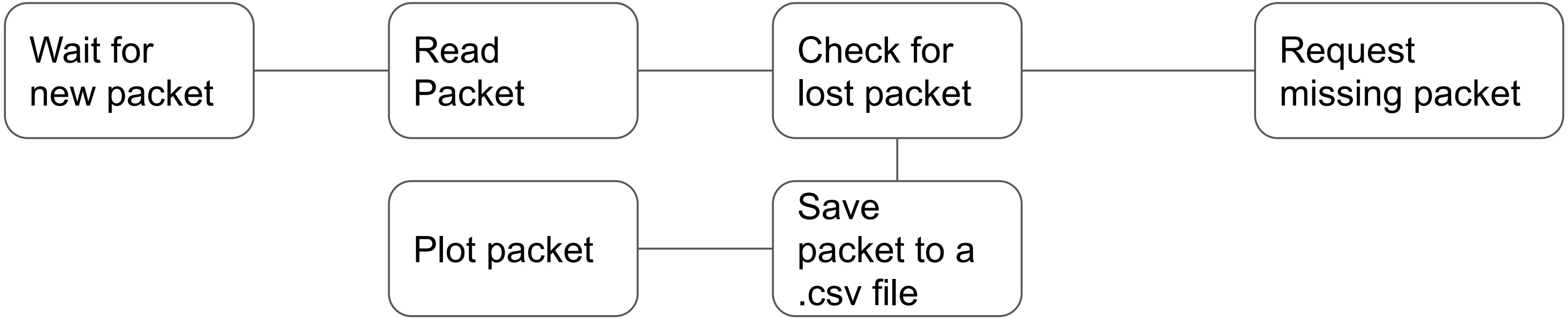
NexSat IITJ

GCS Components

Component	Description
Container	Sends data and receives command from GCS via the on board XBee
GCS antenna	Used for receiving data and transmitting command to the container.
XBee Radio	Communicates with Laptop using serial communication.
Laptop	Main operating unit, handles input from the XBee by graphing the data on a GUI and outputting the data into .csv files. Also sends commands from GUI.

GCS software

Ensuring correct transmission	To ensure that each packet is received the ‘PACKET_COUNT’ variable will be used to compare from previous packet. If a number is skipped the GCS will request that it is sent again this should allow us to pick up any ‘lost’ packets. So that we know commands are being received correctly the GCS will also hold the last sent command and compare it to the ’CMD_ECHO’ variable received and ensure that they are the same.



CanSat Integration & Testing Plan

CanSat Integration and Test Plan

Test Overview

Subsystem Level Testing	Simulation Test Plan	Integrated Level Function Testing	Environmental Test
• Sensors • CDH • EPS • Radio Communications • FSW • Mechanical • Descent Control	• GCS • Flight software	• Descent Testing • Communications • Mechanism • Deployment	• Housing fit test • Thermal Test • Vibration Test • Drop Test

CanSat Integration and Test Plan

Subsystem Level Testing Plan

Subsystem	Test case	Acceptance Criteria
Sensors	Sensors and devices initialized, Communication is possible	Sensors data can be displayed
	Altitude Properly calculated	Measured value has a correct value along with a given threshold error
	Temperature measuring	Temperature is measured correctly
	Voltage measuring	Voltage is measured correctly
	Pressure measuring	Pressure is measured correctly
	GPS data	GPS data can be read by FSW
	Sensors are properly calibrated	Readings are zeroed at desired condition

Subsystem Level Testing Plan

Subsystem	Test case	Acceptance Criteria
CDH	SD card is accessible ,data can be read	System is allowing reading files,and data in files are correct
	SD card is ready for writing data	File system returns success after saving the file
	Data saved survives after reset or power off	Files are consistently available
	Real-Time clock measures time	Time of CanSat and GS are in-sync

Subsystem Level Testing Plan

Subsystem	Test case	Acceptance Criteria
EPS	Pressure sensor is powered	Proper voltage is measured on necessary pins
	Temperature sensor is powered	Proper voltage is measured on necessary pins
	GPS sensor is powered	Proper voltage is measured on necessary pins
	Voltage sensor is powered	Proper voltage is measured on necessary pins
	Camera is powered	Proper voltage is measured on necessary pins
	Processor is powered	Proper voltage is measured on necessary pins
	MicroSD card is powered	Proper voltage is measured on necessary pins

CanSat Integration and Test Plan

Subsystem Level Testing Plan

Subsystem	Test case	Acceptance Criteria
EPS	PCB has no short circuit	PCB has no shorts
	CanSat can operate for 2.5 Hours	CanSat does not turn off if left for 2.5 hours in idle state
	XBee is powered	Proper voltage is measured on necessary pins
	PCB has proper solderings	Joints are proper and have no cold joints
	Battery withstand high power	Battery can work properly under high current

Subsystem Level Testing Plan

Subsystem	Test case	Acceptance Criteria
FSW	Microcontrollers is correctly installed	Blinking LED
	Debug logs can be sent via serial interface	Serial interface transmits data
	After initialization FSW jumps to MSM	Debug log indicates FSW entered MSM
	MSM can progress through mission states	Each state sends signed debug log
	FSW Can survive power cuts	MSM starts with last state, sensors are still calibrated

Subsystem Level Testing Plan

Subsystem	Test case	Acceptance Criteria
Mechanical	CanSat does not split apart under shock	The cylindrical halves don't get detached
	2nd parachute release mechanism working properly	There is no tangling of parachute cords
	Electronic mounting withstand shocks and vibrations	Electronics area working properly under shocks and vibrations
	Container parachute opens after release from rocket	Parachute cords don't tangle

CanSat Integration and Test Plan

Subsystem Level Testing Plan

Subsystem	Test case	Acceptance Criteria
Descent Control	Parachute is maintaining correct descent speed	The cylindrical halves don’t get detached
	State machine detects change in flight phases	There is no tangling of parachute cords

Simulation Test Plan

Test	Test case	Acceptance Criteria
GCS	Simulating GCS command	Getting .csv file with correct data
Flight Software	Testing FSW for corner cases	Retrieving valid and consistent output

CanSat Integration and Test Plan

Integrated Level Function Testing

System	Test Overview
Descent testing	CanSat will be released from the required height using a drone.Both stability and camera will be verified.Along with this achievement of desired terminal velocity at 500 m and at ground will be verified.
Communications	Using a field test we will check the range of radio communication and bandwidth.We will check the status of radio communication after placing CanSat on the drone.
Mechanisms	Testing of mechanical control systems such as releasing ,G-Force test will be performed on the CanSat at integrated Level
Deployment	Test regarding parachute release and upper cap ejection will be done to ensure proper deployment of the system

Environmental Test Plan

Environmental Test Plan (1/2)

Housing Fit Test

- The entire outer model would be used to perform this test.
- An enclosure of the dimension given for launcher would be fabricated to simulate the launcher.
- The Canister of the CanSat would be inserted in it to test for fitting

Pass Criteria:

- The CanSat should be able to comfortably fit inside the enclosure and pass through it so that it can be easily inserted or removed

Thermal Test

- This test is to be done with a prototype in which most of the systems are present .
- A stimulating environment would be created for the test using available options.
- The test would be run for 60-90 mins to simulate the entire descent stage
- The Temperature sensor would be recording the temp. And Transmitting it.

Pass Criteria:

- All components should remain functional at the end of test duration.
- The structural integrity of the CanSat should be maintained.

Environmental Test Plan (2/2)

Vibration Test

- This test is to be done with a prototype in which most of the systems are present .
- A stimulating environment would be created for the test using available test beds or lab equipments.
- The test would be run for 60-90 mins to simulate the entire descent stage
- The Vibration sensor would be recording all the vibrations involved.

Pass Criteria:

- The structural and connection integrity needs to be maintained throughout the test.
- The Mechanical system should be able to bear the vibrations involved in-flight.

Drop Test

- This test is to be done with a prototype in which most of the systems are present .
- A stimulating environment would be created for the test using available test beds or lab equipments.
- The test would be run for 60-90 mins to simulate the entire descent stage while transmitting the data over the radio.

Pass Criteria:

- The structural and connection integrity needs to be maintained throughout the test.
- The Mechanical/electrical system should be able to bear the vibrations involved in-flight.

Mission Operation & Analysis

Mission Operation & Analysis

Setup	Pre-Launch	Rocket Integration
• Reach at Launch site • Final assembly • Setup GCS and antenna	• Final checking of various subsystem • Weight and Dimension check • Ensure tethered payload stowed firmly.	• Final inspection and integration. • Setting GCS communication.

Mission Operation & Analysis

Mission	Recovery	Data Analysis
• Rocket Launch with CanSat inside • Flight monitoring and data collection with real time plotting on FSW.	• Rocket Landing • Recovery team heads towards CanSat • CanSat returned to launch site. • Retrieve data from SD card.	• Data analysis by the judges. • CanSat switched off completely.

Mission Operation & Analysis

Team	Responsibility	Team Members
Team Leader(TL)	Coordination among the subteams.	Somshuvra Basu
Ground Station Team (GST)	Monitoring the ground station.	Hrishikesh Makwana Sarvesh Baheti
Recovery Team (RT)	Going to field for recovery and interacting with the judges.	Anupama Birman Lokesh Tanwar Pechetti Sai Akhil
CanSat Team (CT)	Responsible for integrating and verifying its status.	Tale Sai Saathwik Somshuvra Basu Shubham Mishra

CanSat Location & Recovery

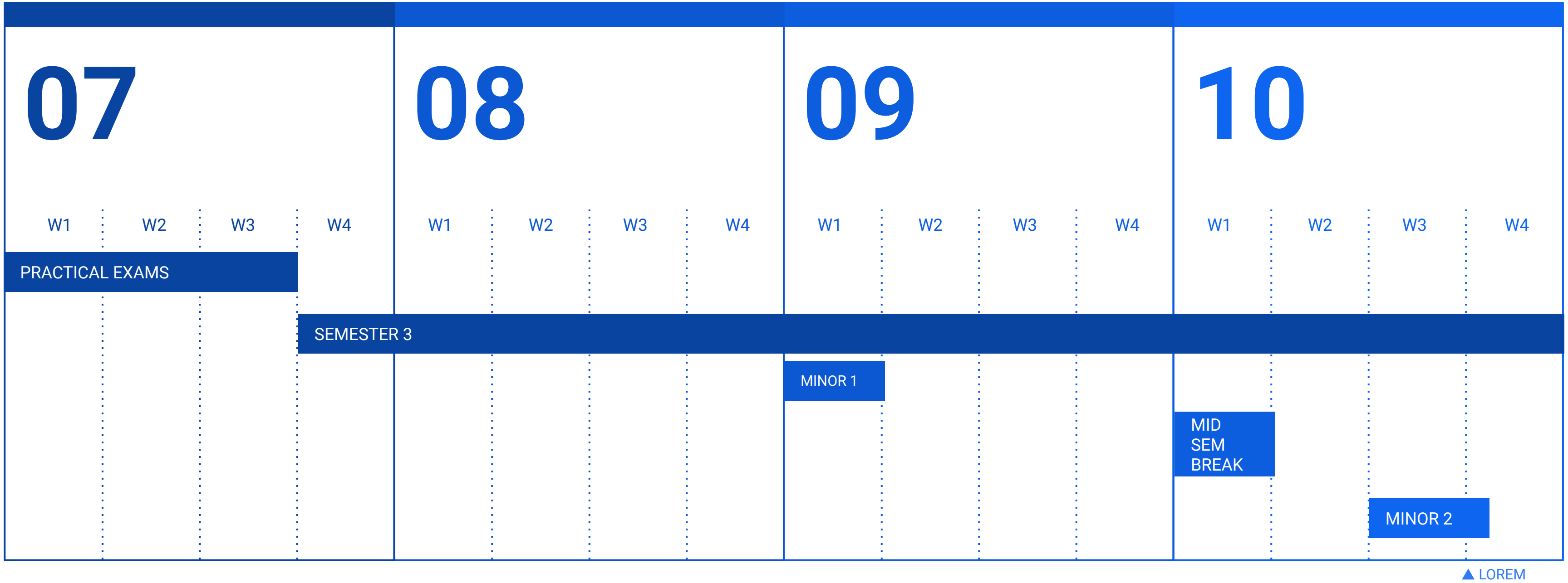
CanSat Location & Recovery

- The structure of CanSat would be made of ABS plastic and would be fluorescent pink in colour to aid in visual identification.
- The location of landing of the CanSat would be estimated at GCS by using the data from onboard sensors like IRNSS sensor etc.
- Identification CanSat Label in local languages would be used on the outer body.
- The Parachutes involved would also be of bright colours so that it can also be located easily by the recovery team.
- An Buzzer would be added to help locate the landing site.

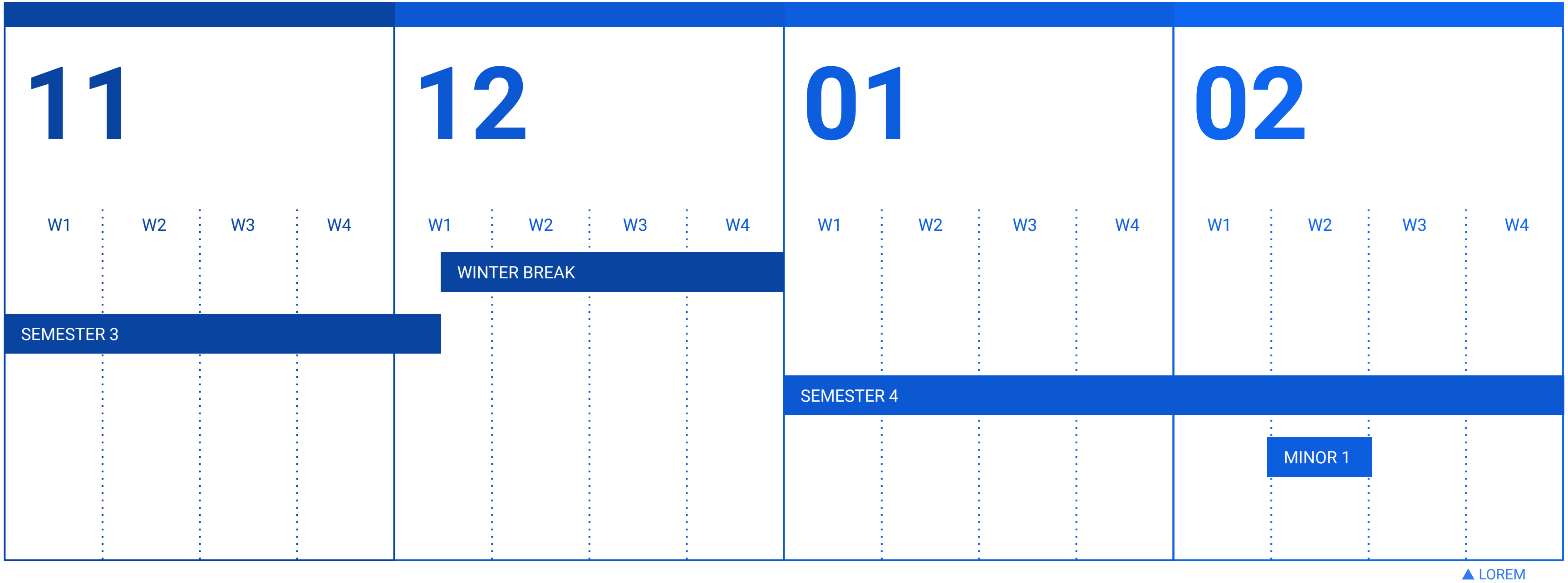
CanSat Location & Recovery

Program Schedule

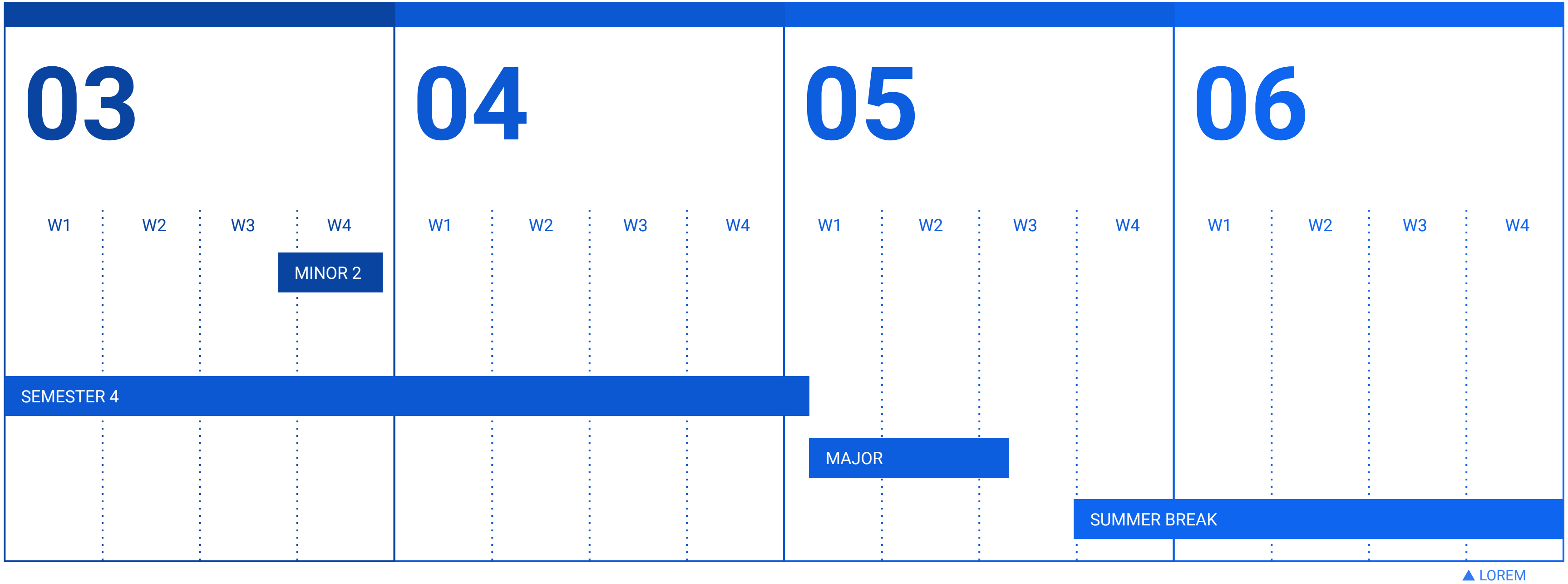
Academic Schedule



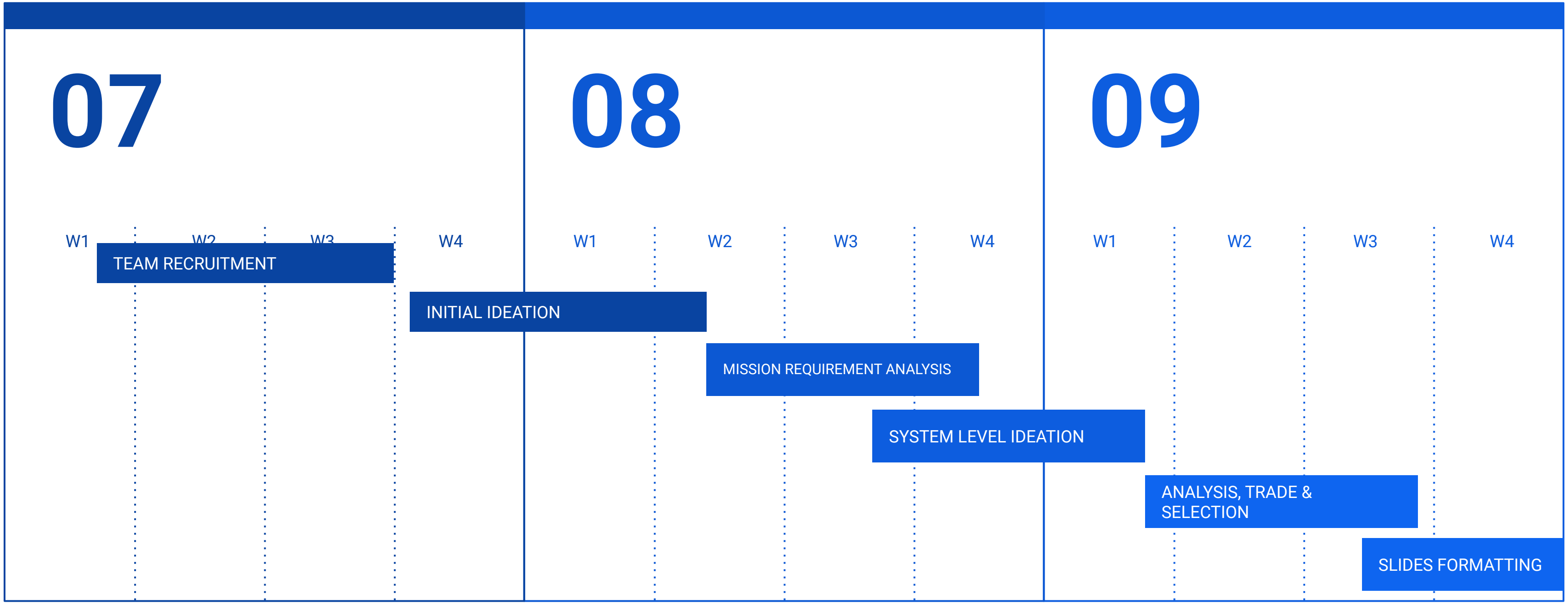
Academic Schedule



Academic Schedule



Program Schedule



Tentative program Schedule

Tentative program Schedule

02				03				04				05				06			
W 1	W 2	W 3	W 4	W1	W2	W3	W4	W 1	W 2	W 3	W 4	W1	W2	W3	W4	W1	W2	W3	W4

CRITICAL DESIGN REVIEW COMPLETION

FLIGHT READINESS REVIEW AND LAUNCH WINDOW

POST FLIGHT REVIEW AND RESULT DECLARATION

▲ LOREM

Conclusion

Conclusion

Going through the mission guidelines, we first created a rough draft of each subsystem with the components that would be involved.After having multiple discussions amongst ourselves and with our mentors we refined our subsysteams gradually and finalised the conceptual design.

After that we moved on to creating CAD models and other visual aids to help the ideation process while simultaneously collecting data points required.

The conceptual design has been finalised theoretically and by simulations, which would be further evaluated and established during the CDR phase.

What we have accomplished ?	What major work is left ?
• Complete Trajectory has been established. • Material and component selection is completed. • Descent control has been decided.	• Real life test of individual subsystem and integrated test plan. • Fabrication of the CanSat container and various subsystem • Fabrication of parachute and testing