2020/21 Design Review

Team Bristol Cansat

Team 1412

V1.01

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Team Layout

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Mechanical Subsystem Lead
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Aerospace Eng., 2nd year

Acronyms

Acronym	Meaning
AC	Attitude Control
ACL	Attituddе Control Lead
CL	Communications Lead
ML	Mechanical Lead
CE	Chief Engineer
SL	Structures Lead
A	Analysis
I	Integration
T	Testing
FA	Faculty Advisor

Acronym	Meaning
D	Demonstration
CDH	Control & Data Handling
FSW	Flight Software
GCS	Ground Control Station
I&T	Integration & Testing
PM	Project Manager
GUI	Graphical User Interface
PCB	Printed Circuit Board
TTFF	Time-To-First-Fix
IMU	Inertial Measurement Unit

Systems Overview

Mission Summary

Mission objectives

1. Build a CanSat with an atmospheric-sampling Science Payload and a parachute
2. The CanSat shall be launched in a sounding rocket to an altitude of 250 meters.
3. Once the CanSat is deployed from the rocket, the CanSat shall descend using a parachute at a descent rate of 5 to 10 m/s.
4. The CanSat container must protect the Science Payload from damage during the launch and deployment.
5. The Science Payload shall collect and transmit, in packets, atmospheric pressure and temperature data to a Ground Control Station in real-time throughout its operation phase. Furthermore, it must output a GPS location, mission time, packet count, and the battery voltage.
6. When the Science Payload lands, all telemetry transmission shall stop, and a located audio beacon shall activate.
7. The Ground Control Station shall receive and display CanSat data, as well as storing it in an SD card.

Bonus objectives

1. The position shall be determined by an accelerometer as well as the GPS unit, and the measures must be within 20 m of each other.

The team has no external objectives relevant to the UK CanSat Competition.

System Requirements Summary

N	System requirements	A	I	T	D
1	CanSat mass shall be 250 g +/- 10 g		X		X
2	The CanSat shall fit in a cylindrical envelope with the following dimensions: 66 mm diameter x 160 mm height.	X	X		X
3	The CanSat should not have any sharp edges to cause it to get stuck in the rocket.	X	X		X
4	The rocket should not be used as part of the CanSat operation.		X	X	
5	The CanSat shall deploy from the rocket payload area.			X	X
6	A Descent Control System (parachute) must be deployed immediately after release from therocket, and shall be enclosed prior to deployment.		X	X	X
7	The parachute is deployed through an active mechanism. The mechanism shall not usechemicals, and those that use heat shall not be exposed to the environment.		X	X	
8	The descent rate of the CanSat shall be between 5-10 m/s.	X			X
9	All electronics should be hard mounted or glued using hard adhesives.		X		
10	The frame/structure of the CanSat shall accommodate all electronics.		X		X
11	All electronics components shall be enclosed and shielded from the environment with theexception of sensors.			X	
12	During descent the CanSat shall collect and transmit air pressure, outside temperature,battery voltage, and GPS longitude and latitude at least once a second.			X	X
13	The CanSat shall determine altitude with respect to ground level based on pressure andtemperature readings.			X	X
14	Each sensor data packet shall be tagged with mission time and packet count.			X	X

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System Requirements Summary

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N	System requirements	A	I	T	D
15	Packet count and mission time do not reset with processor reset.			X	X
16	The sensor data packet shall meet the following structure: packet count, mission time, pressure, temperature, altitude, battery voltage, GPS longitude, GPS latitude, soft state,Bonus.			X	X
17	The CanSatshall store all sensor data packets onboard.				X
18	The CanSat shall transmit all sensor data packets to the Ground Control Station during flight.			X	X
19	The CanSat shall include a power indicator such as an LED or buzzer, which shall indicate asuccessful startup and that the CanSat is operational.			X	X
20	The audio beacon is required to sound at least once a second after landing.			X	X
21	The audio beacon shall indicate if any electronics is not functioning.			X	X
22	Battery source may be alkaline or lithium. No lithium polymer or lithium ion.		X		
23	The battery shall be easy to remove/replace in 60 seconds.		X		X
24	It shall be possible to program the microcontroller with a USB plug, without having todisassemble the CanSat in its entirety, within 60 seconds.				X
25	The ground station shall include one laptop computer with a minimum of two hours ofbattery operation and a hand-held antenna.		X		X
26	All received data packets must be displayed in real time, in SI units.			X	X
27	A box shall be used to carry all necessary tools and equipment to the launch site.		X		
B4	An accelerometer is included to establish the location of the CanSat separate to the GPS. The final position recorded by the accelerometer should be within 20 m of the GPS position of the CanSat.			X	X

System Level CanSat Overview

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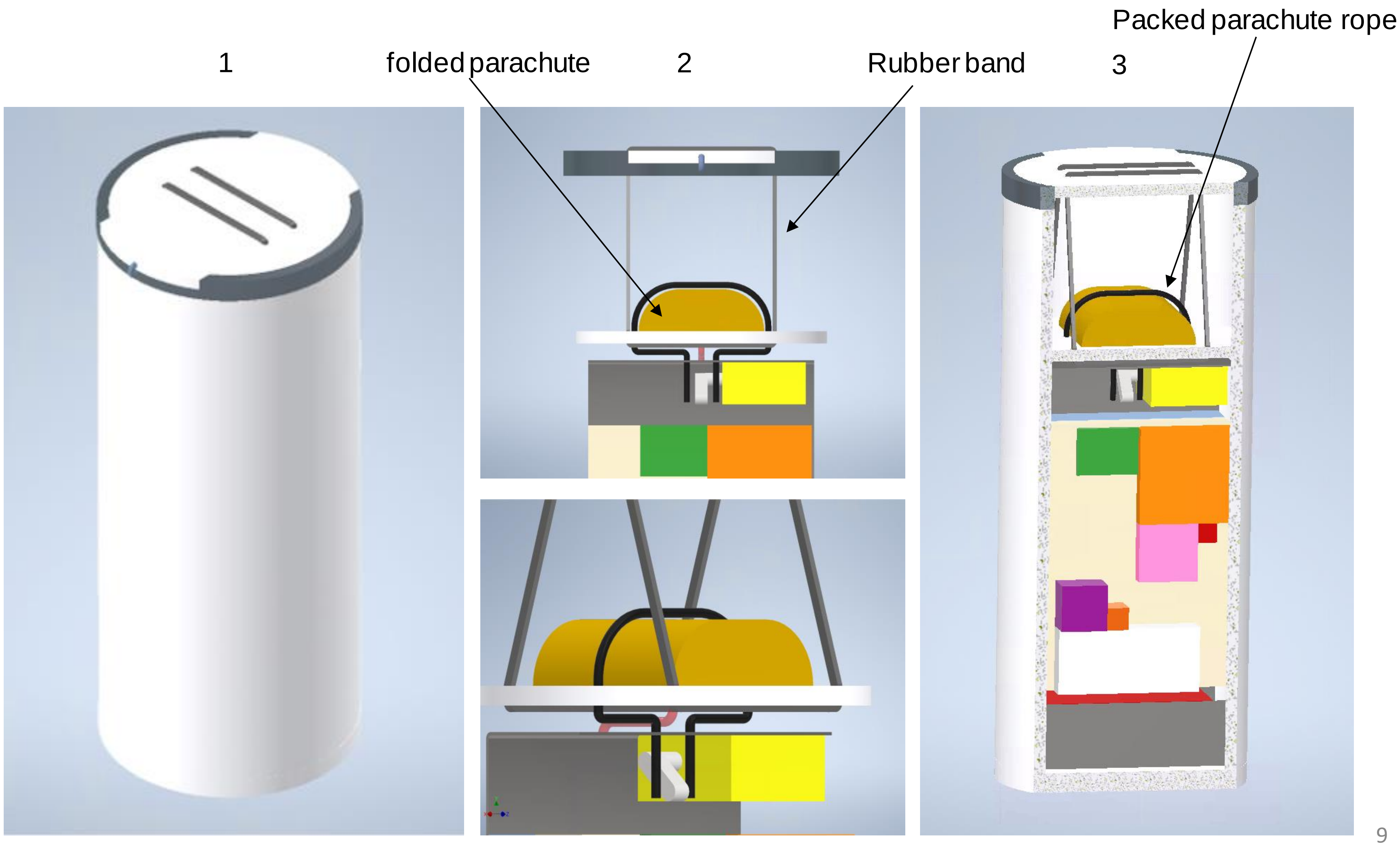
Satellite Pre-Deployment

1. CanSat with casing.
2. Close-up of packed parachute with release mechanism and lid.
3. Half-section view of CanSat.

Colour	Component
Blue	Arduino UNO
Beige	Motherboard
Yellow	Servo motor
Orange	Inertial system
Green	GPS module
Pink	Barometer
Dark red	Thermistor
Purple	Audio beacon
Dark orange	LED
White	Radio tansmitter
Red	Battery

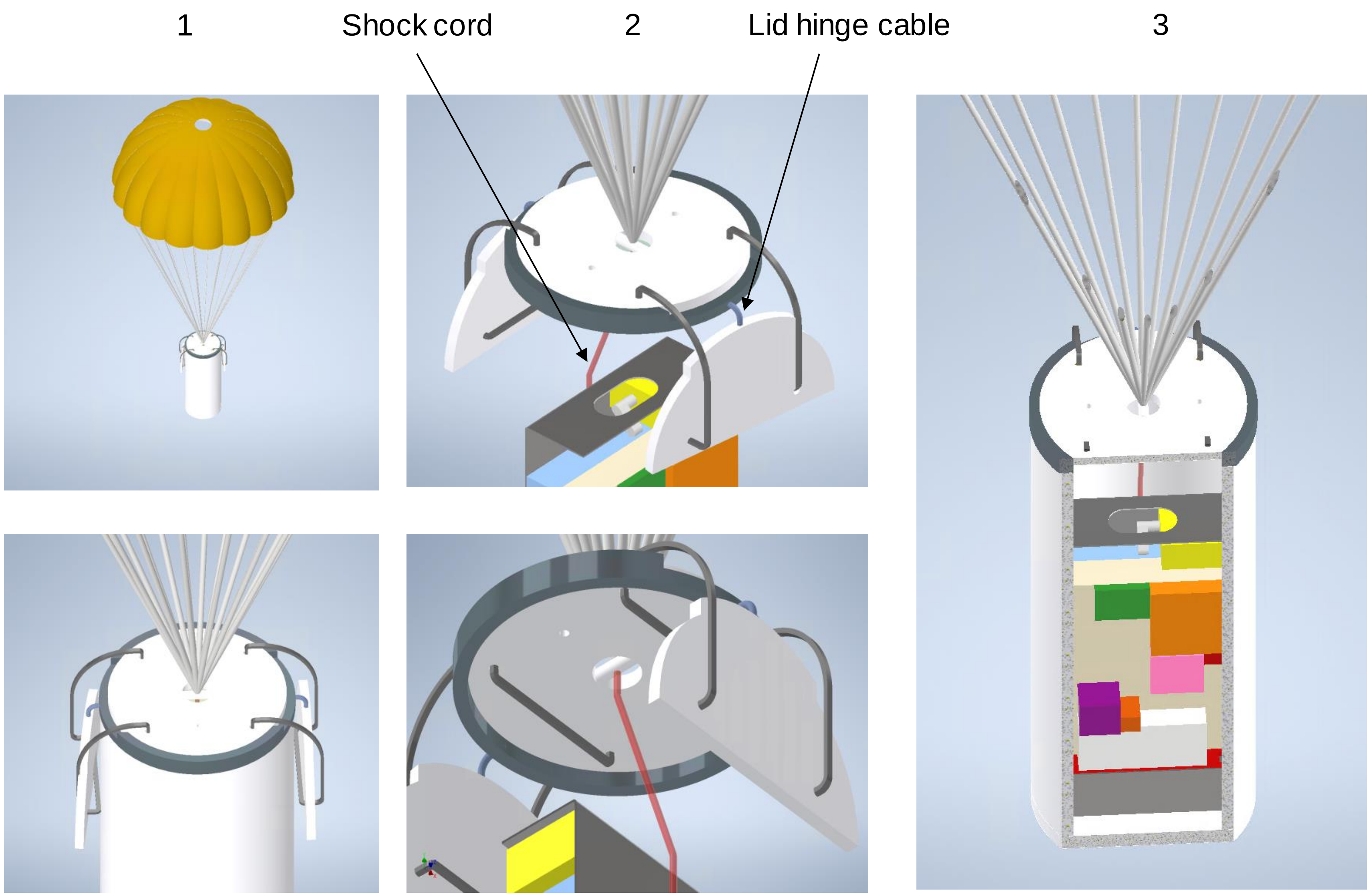


System Level CanSat Overview

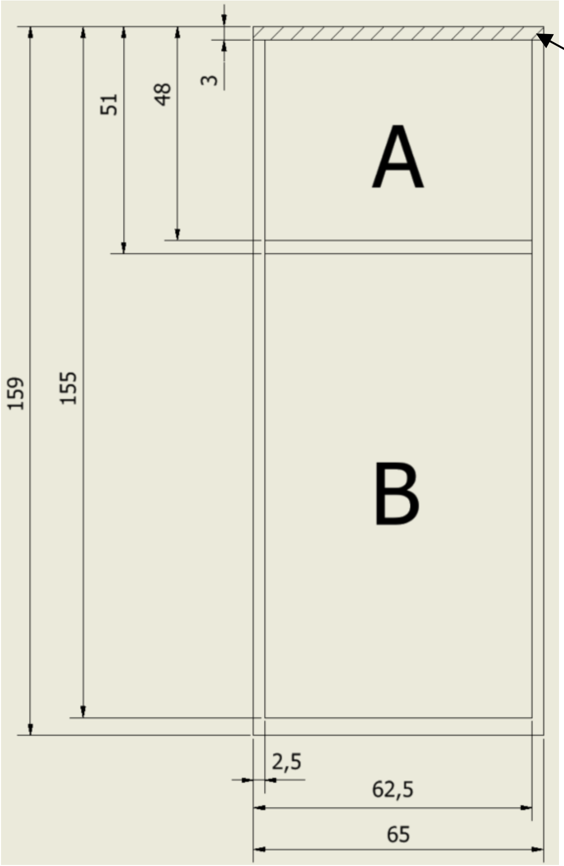
Satellite Post-Deployment

1. CanSat with casing.
2. Close up of release mechanism when parachute is released.
3. Half-section view of CanSat.

Colour	Component
Blue	Arduino UNO
Beige	Motherboard
Yellow	Servo motor
Orange	Inertial system
Green	GPS module
Pink	Barometer
Dark red	Thermistor
Purple	Audio beacon
Dark orange	LED
White	Radio tansmitter
Red	Battery



System Level CanSat Overview



Top lid closed

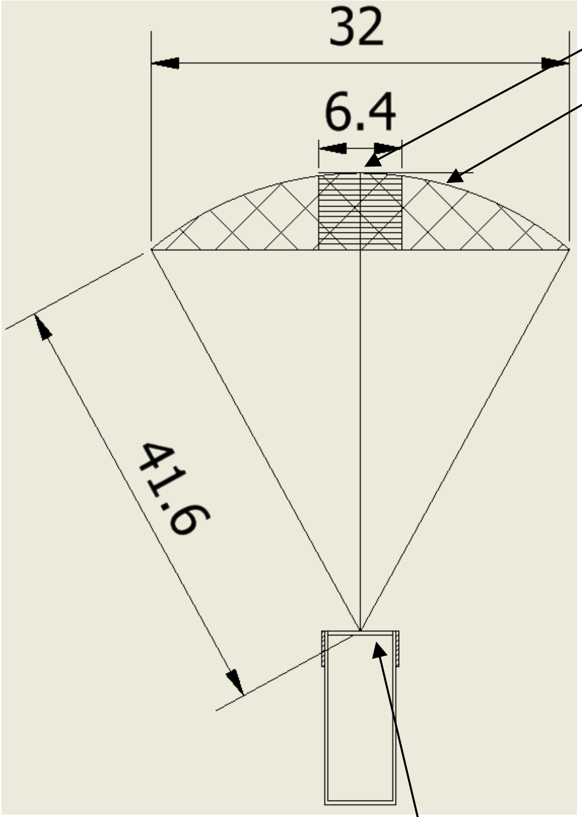
Dimensions in mm

A – Parachute section
B – payload section

1. Parachute Section sized to allocate folded parachute as well as to keep rubber-bands in tension.

2. Payload Section sized to allocate single metal plate supporting the payload while also falling under cylindrical envelope constraints.

3. Plate length constraints minimum diameter and payload bay height as well as parachute bay height constraint minimum height.



Spill hole

Parachute deployed

Dimensions in cm

Top lid opened

1. Parachute sized to have enough area to keep descent rate within acceptable boundaries, while also fitting inside parachute bay without going over cylindrical envelope constraints.

2. Spill hole sized to control descent rate while also controlling stability by controlling air flow.

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System Level CanSat Overview

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Key Design Aspects	Method	Chosen Design Justification
Single plate configuration	Mounting motherboard with PCB and all electronics on it on a PLA plate that also accomodates 1 battery	Structurally simple, as it has small number of parts and integration components
		Easy to integrate or disassemble as the entire plate with all the components can be taken off together
		Provides great protection for the motherboard
Removable bottom lid	Bottom lid held shut by screws	Easy removal of the payload from the can
		Enables quick access to the USB port without making a whole specially to access this port, which would reduce the structural integrity of the CanSat
Mechanical parachute deployment	Servo motor & elastic bands mechanism hold parachute in platform in place due to tension, and this energy can be released to propel the parachute bay outward when servo motor is activated	Does not require energy through heat, and therefore can be powered by battery
		Opens an unobstructed path for the parachute to be deployed
Stability control parachute	Spill hole in the parachute	Spillhole controls airflow by making it go through, which results in a more stable fall for the CanSat
		Reduces tumbling
		Reduces drag-generated vibrations

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System Level CanSat Configuration

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Team member roles during Cansat Operations

Pre-launch
- CL sets up GCS
- Everyone performs final testing
- CE handles GPS and oversees testing

Launch
- SL standsby with tracking antenna

Separation
- SL tracks CanSat with antenna

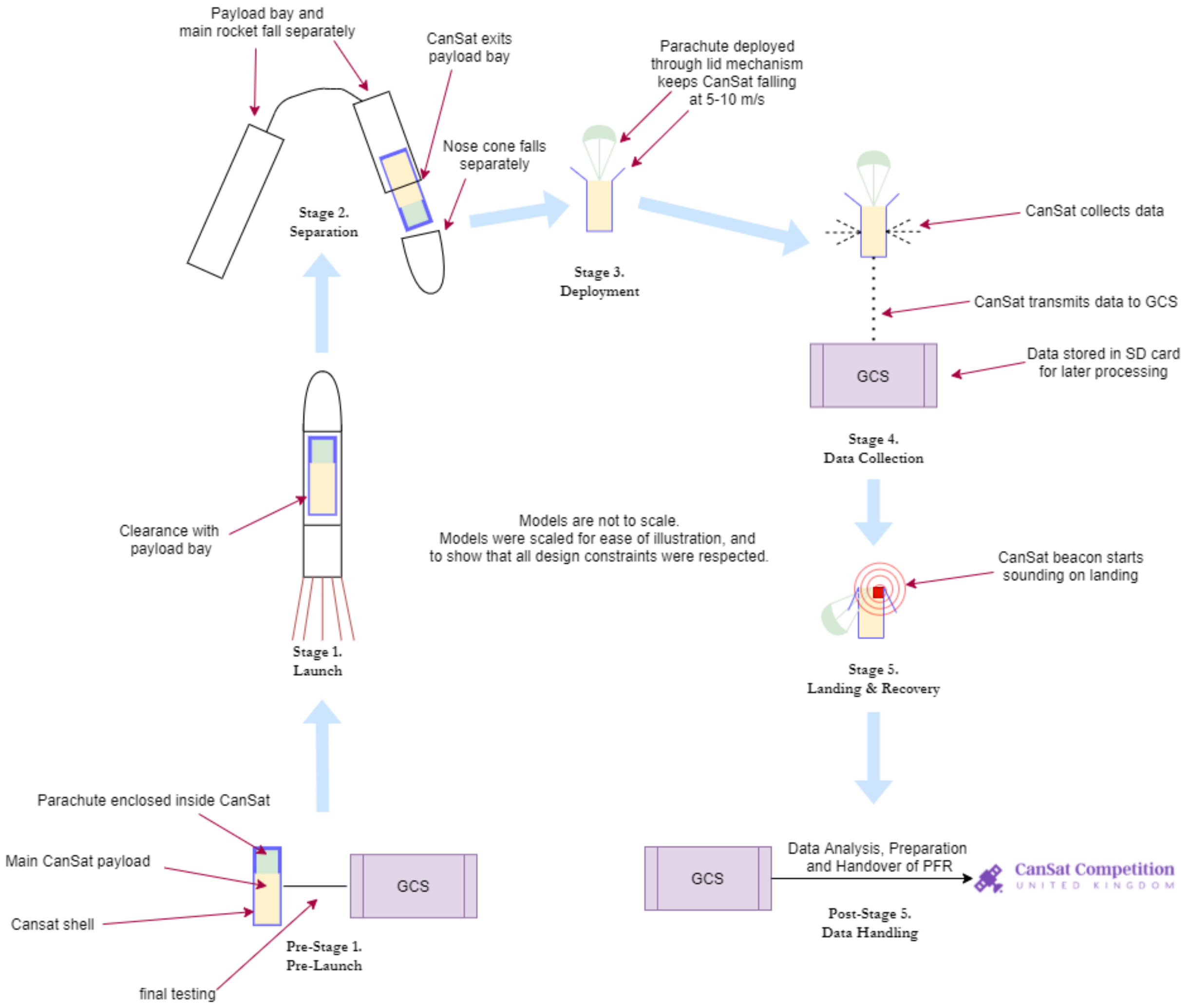
Deployment
- SL tracks CanSat with antenna

Data Collection
- SL tracks CanSat with antenna
- CL, CE, and ACL check data at GCS
- ML observes parachute performance

Landing & Recovery
- SL, ML recover and verify strcutural integrity of CanSat

Data Handling
- CL verifies CGS performance
- CE, ACL analyse and verify data
- Everyone prepares data for showcase

CanSat Operations Diagram



System Level CanSat Configuration

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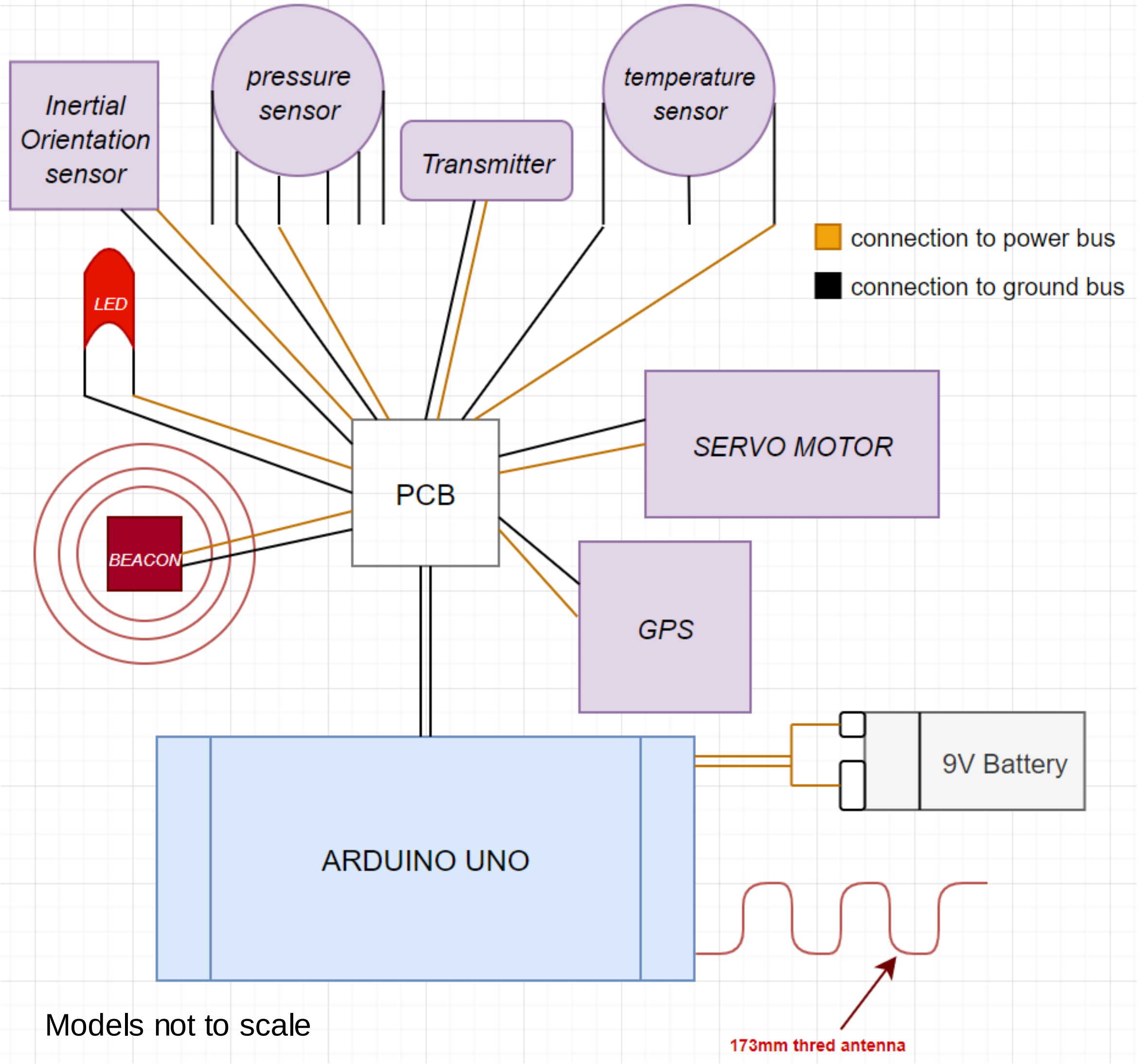
Stage Progression

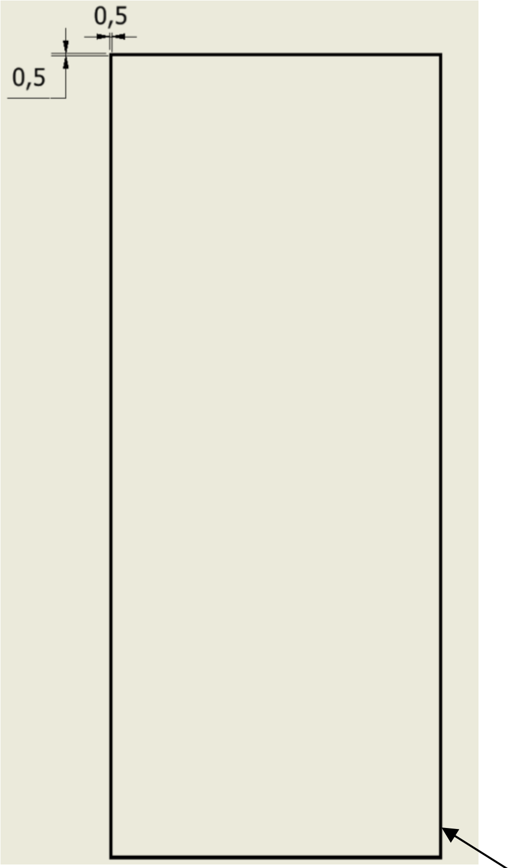
Pre-launch	Launch	Separation	Deployment	Data Collection	Landing & Recovery	Data Handling
CGS preparation and Cansat turned on	CanSat integration into rocket payload bay	Nose and payload bay separate from main body at apogee	Servo motor releases elastic bands holding CanSat lid	CanSat collects atmospheric, battery, and GPS data	Data transmission stops when FSW realises altitude variation stops	Data processed and formatted in GCS
GPS module Fix time	Ignition and ascension to apogee at 250m above launch site	CanSat exits payload bay via gravity	Cansat parachute deployment	CanSat determines altitude from atmospheric data	Audio beacon starts sounding when FSW realises altitude variation stops	Analysis of data
Communication, strctural integrity, and mechanical testing		Payload bay, attached to rocket main body, and nose cone fall separately using parachutes	Cansat descends at a rate of 5-10m/s	Cansat transmits all data in packets to GCS	Cansat Switched off and structural integrity verification	Preparation of data for showcase

System Level CanSat Configuration

Payload Configuration



Launch Vehicle Compatibility



Clearance space

Constraints

- 66 mm diameter x 160 mm height cylindrical envelope
- No sharp protrusions or edges

Design solution

- 0.5 mm clearance on all sides
- No components protruding from CanSat holes
- Circular perimeter edges and bottom bolts to be smoothed if necessary

Although all design constraints have been met, this clearance is relatively small. This may be beneficial as CanSat won't suffer as much damage when bouncing arund inside the payload bay, but may contribute to more vibrational damage. Furthermore, it makes deployment potentially more difficult, as it is likely that the CanSat will be colliding with the payload bay walls more. For this, the team will continue striving for a better clearance design solution.

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Sub-Systems Overview

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Sensors Overview

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Sensor Type	Sensor Function	Sensor Models: Chosen & Considered	Reason(s) for selection	Mass(g)	Dimensions(mm)
GPS Module	Get position data	✓ **Ublox NEO-6M** GNSS M9N-5883 NEO-M9N	Smaller, lighter, cheaper, acceptable TTFF Cold Start.	~3	16 x 12.2 x 2.4
Temperature Sensor	Measure temperature	✓ **LM35DZ** B59840C0120A070 EPCOS	Primary cause being higher data reliability and precision in normal atmospheric conditions.	~1	5.2 x 4.2 x 19.4 (14.2 hidden in CB)
Pressure sensor	Measure pressure	✓ **MPX4115A** GY-BMP280	Both small, light, cheap and easy to integrate. Reason for chosen sensor is having less components	4.0	~27.4 (12.00 hidden in CB) x ~15.00 x ~5.50
Voltage reader	Measure battery voltage	✓ **Arduino UNO**	Heritage, autonomous, no reason to look for a dedicated component as the main processor can already read voltage	(slide 14)	(slide 14)
IMU	Measure acceleration and orientation	✓ **ICM-20948** ADXL335 Triple-Axis accelerometer	Small, light, high accuracy. Chosen mainly becuase additional orientation information can increase accuracy massively for relatively little mass and cost increase	~6	25 x 25 x 5
LED	Demonstrate that CanSat is turned on	✓ **Standard LED**	Small, light, easy to integrate	~1	5.8 x 5.8 x 25.4 (14.2 hidden in CB)
Audio Beacon	Aid in CanSat finding and annouce malfunctions	✓ **Piezoelectric passive buzzer** Thin Speaker	Both small, light, and simple, but chosen component is louder and easier to program for higher frequencies which aid in finding.	~1	12 x 12 x 15(5.5 hidden in CB)

CDH Overview

Component type	Component Models: Chosen & Considered	Function	Reason(s) for selection	Mass(g)	Dimensions(mm)
Central Processor	✓ **Arduino UNO** Raspberry Pi 3 Model B	Store sensor data onboard and organize it in packets	Heritage, simpler interfaces, including with chosen transmitter. Easier to program.	25	68.6 x 53.4 x 10
Transmitter	✓ **APC220 Transmitting (TX) Radio** NRF24L01 Module	Encode data to be sent to GCS	Heritage, small, light, more detailed datasheet	5	37 x 17 x 6.6
Antenna	✓ **Transmitting thread antenna** Duck antenna	Transmits data to GCS	Small, light, omnidirectional, can be used without having protrusions from the CanSat	~5	~173 long

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Power Overview

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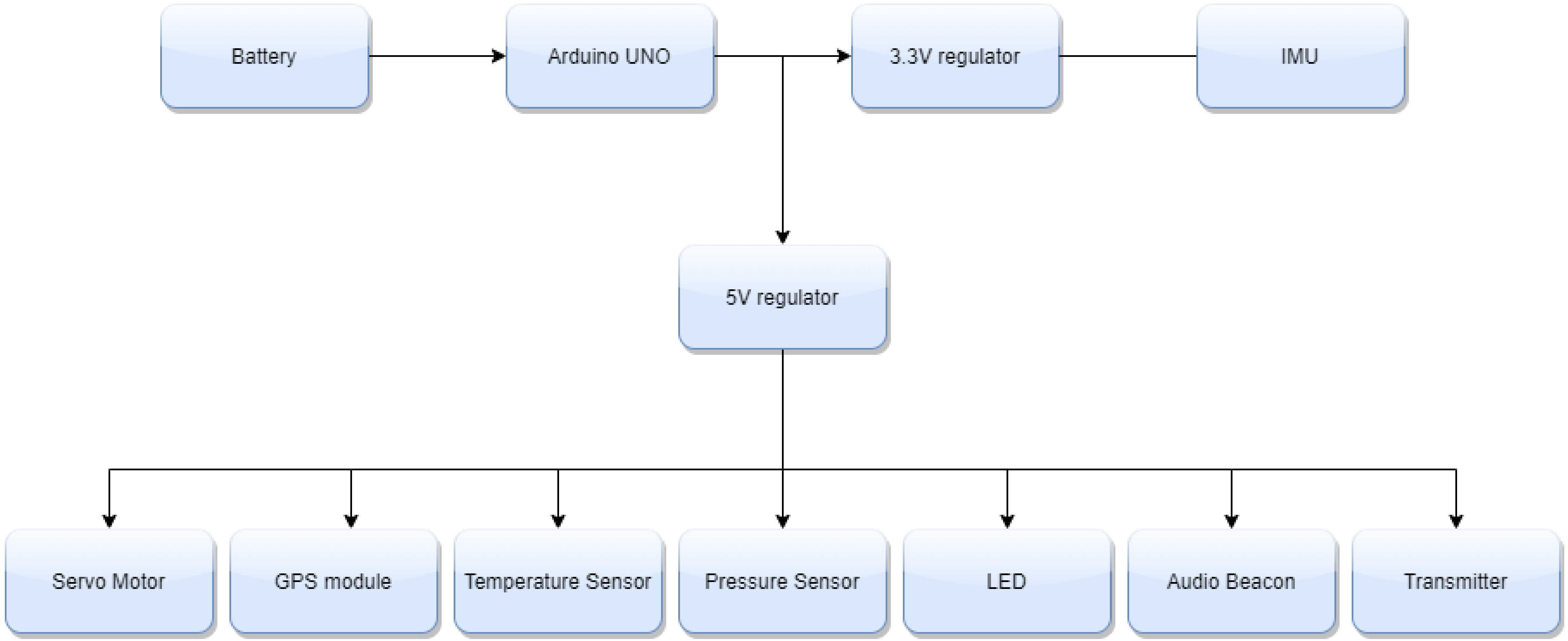
Component type	Component Models	Power	Reason(s) for selection	Mass(g)	Dimensions(mm)
Battery(ies)	✓ **ENERGIZER 522 9V Alkaline battery** BONAI Li-ion Rechargeable 9V Batteries (considered)	9V supply	Single battery supplies enough power. Cheaper than Lithium. Resists leaking and corrosion.	45	48.5 x 24.5 x 17.5
Voltage regulator	Arduino UNO	5V and 3.3V regulated output	Heritage. No reason to use dedicated voltage regulator if the Arduino's processor already performs this function	25	68.6 x 53.4 x 10
PCB	Arduino UNO PCB Shield	Provides power and ground buses from motherboard	Any PCB sized for an Arduino UNO can be used. It is required to accomodate all the electronics.	17	68.6 x 53.4 x 10 (8mm for connectors)
Servo Motor	FS90 Micro 9g servo	5V	Light, small, gear rotation sufficient for deployment mechanism	9	23.2 x 12.5 x 22.0
GPS module	Ublox NEO-6M	5V	Already mentioned in previous slides		
Transmitter	APC220 Transmitting (TX) Radio	5V			
Temperature sensor	LM35DZ	5V			
Pressure sensor	MPX4115A	5V			
IMU	ICM-20948	3.3V			
LED	Standard LED	5V			
Audio beacon	Piezoelectric passive buzzer	5V			

Power Overview



FSW Overview

Programming language selected was Arduino as it is the language designed to operate our central circuit board – Arduino Uno. Reasons for selection were its heritage, easiness in coding and familiarity with C++. It is also important to mention that since we are using an Arduino board then we do not have another choice for a programming language.

Our Development environment includes the Arduino IDE as it is the IDE that supports our chosen programming language and better allows for software development written in Arduino.

To FSW development stages are described as follows.

- **First stage** –development testing where the code is tested with only the Arduino board and its sensors .
- **Second stage** – preliminary assembly (without soldering or permanent adhering) with testing in simulated conditions (altitude variation and temperature variation, etc.). This should reveal any possible bugs and unforeseen issues left unchecked by the first stage and is the last stage before assembly.
- **Third stage** – soldering and assembly and final testing before launch – does not happen on launch day because if problem-solving is still required then doing this on launch day would be chaotic.

The team is currently on the first stage of FSW development.

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FSW mission tasks flowchart

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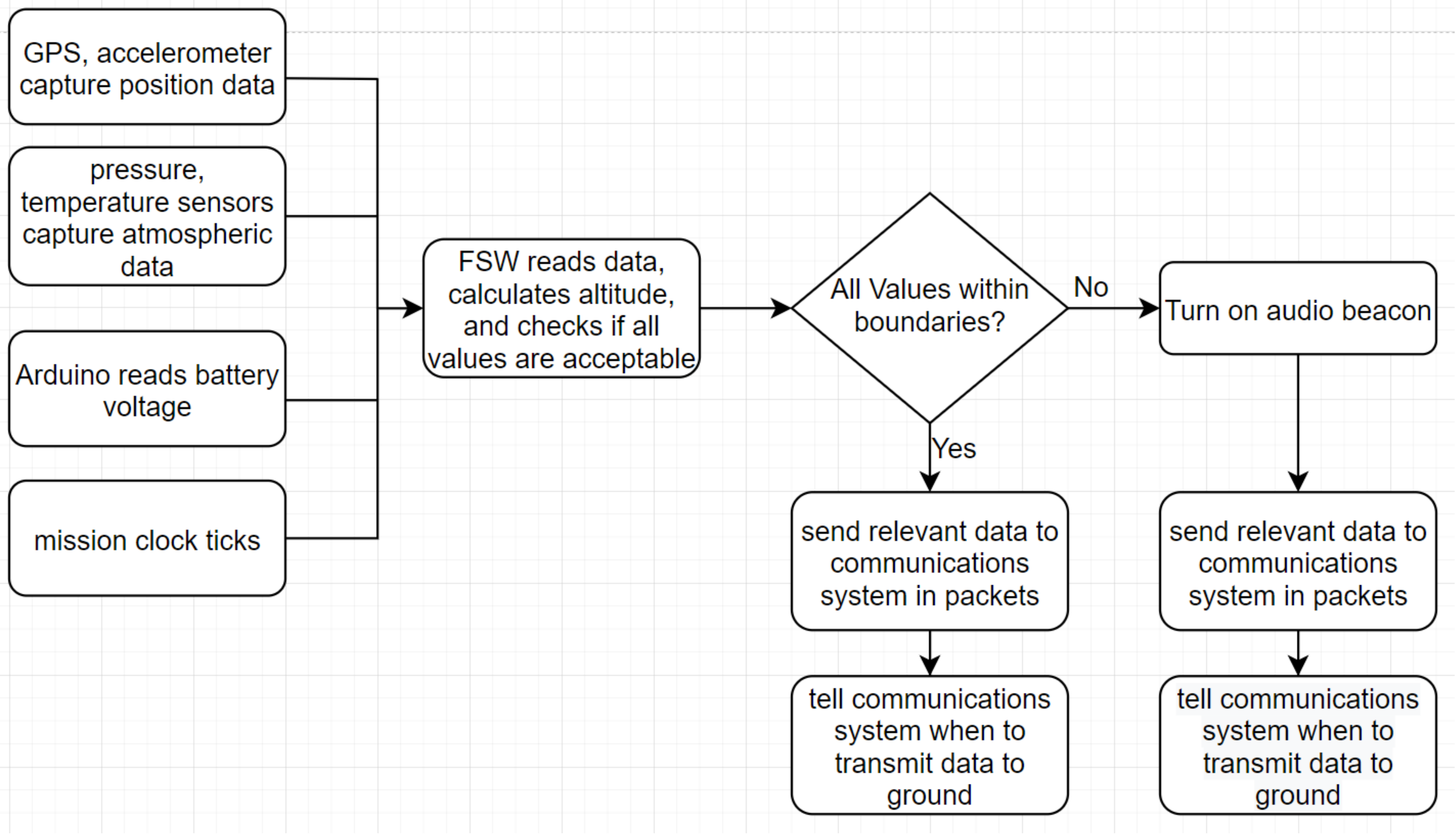

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GCS Overview

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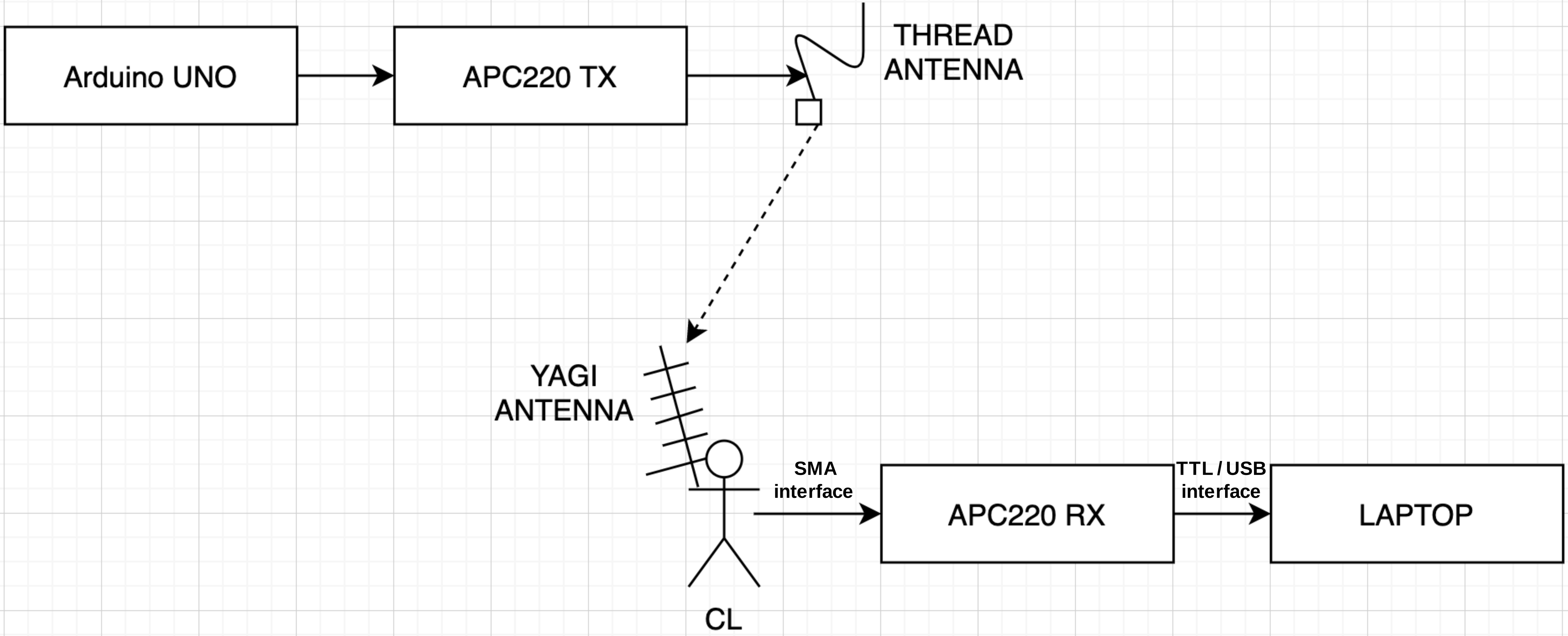
Component type	Component Models: Chosen & Considered	Interfaces	Function	Reason(s) for selection
Receiving Antenna	✓ **433MHz YAGI radio antenna** Duck antenna	SMA	Capture data from the CanSat	Heritage, larger range, flexible directional control
Receiver	✓ **APC220 Receiving (RX) Radio** HC-05 tranceiver module	SMA TTL / USB (for computer)	Decode received data	Second part of the transmitting radio, heritage, simpler, more detailed datasheet

GCS Overview



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Mechanical Overview

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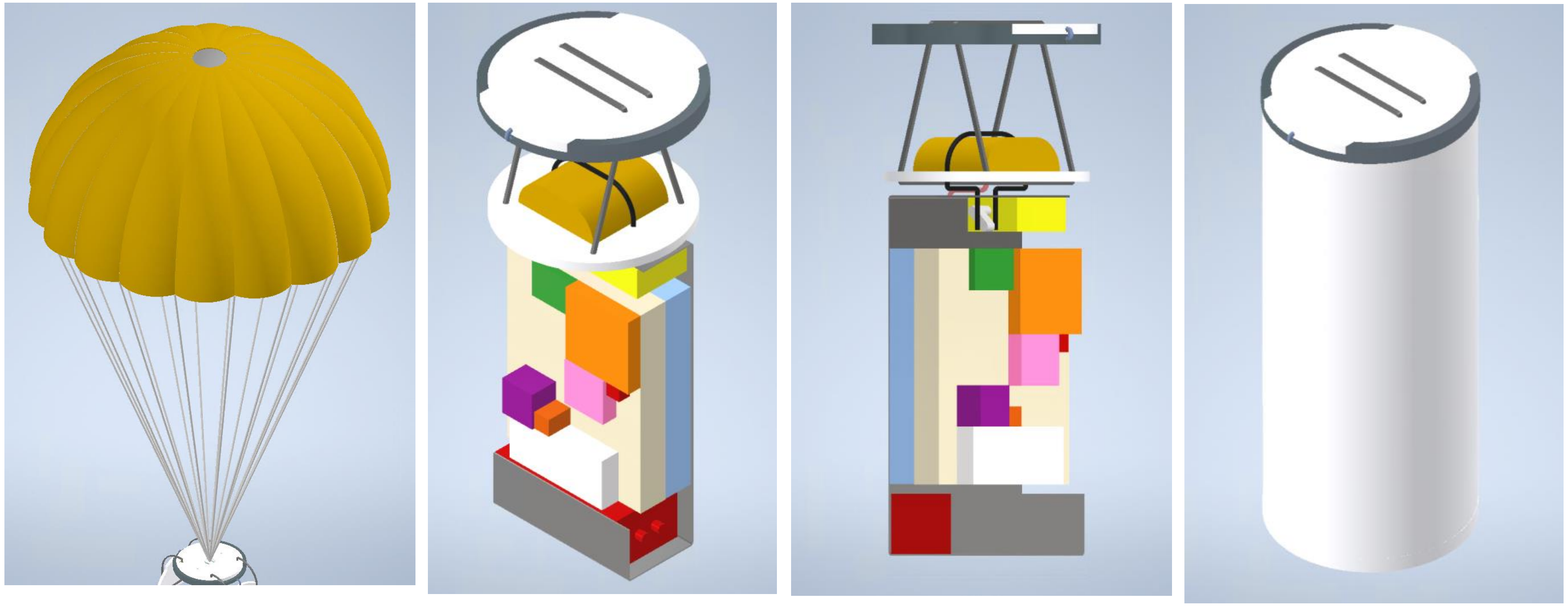
General overview

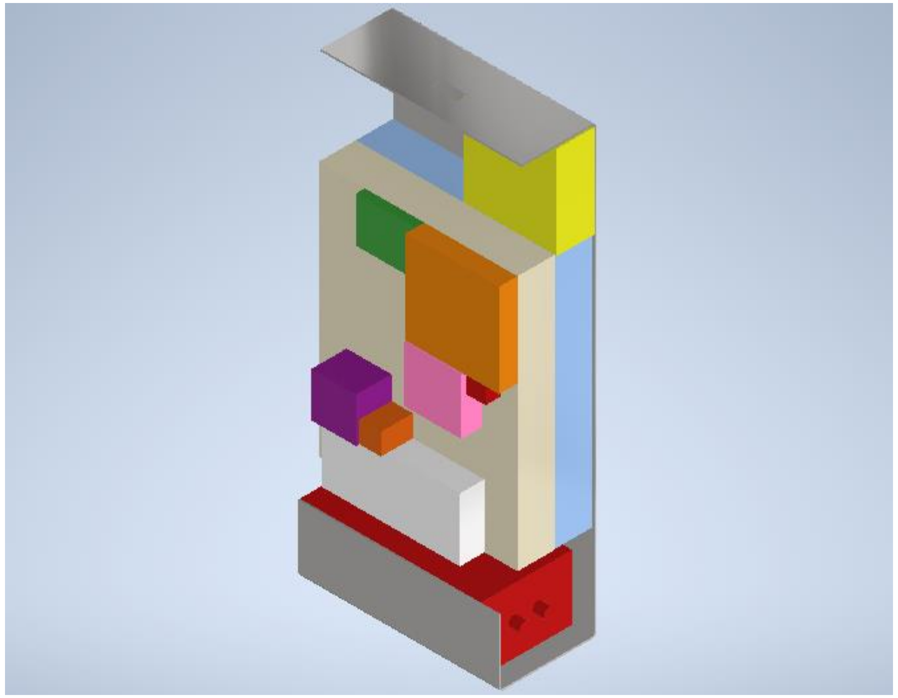


Component	Function
Parachute	Provide a smooth descent
Rubber bands	Push the parachute out of the can
Lid	Allow for parachue deployment
Casing	Structural protection

The satellite consists of a PLA shell with an opening at the top from where the parachute can be deployed, and a screwed lid at the bottom from where the electronics can be extracted. This, allows for easy access to all elements of the CanSat, while at the same time offering protection of the delicate circuitry. On the left is the whole satellite, while on the right is a schematic of all its components.

Mechanical Overview

Electronics (schematic)



Colour	Component
Blue	Arduino UNO
Beige	Motherboard
Yellow	Servo motor
Orange	Inertial system
Green	GPS module
Pink	Barometer
Dark red	Thermistor
Purple	Audio beacon
Dark orange	LED
White	Radio tansmitter
Red	Battery

All electronics are mounted on the PCB which is itself mounted on the Arduino. The sole exception is the servo, which is above the rest in order to lock the parachute mechanism in place. The metal plate accommodates all electronics, since the Arduino is glu ed to it. Both the battery and the servo are glued to the plate as well by using a hard adhesive during launch, although removable tape will be used during testing for ease of replacement..

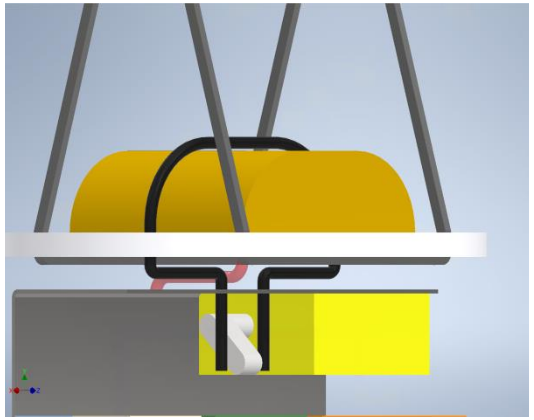
Parachute Release Mechanism

Description

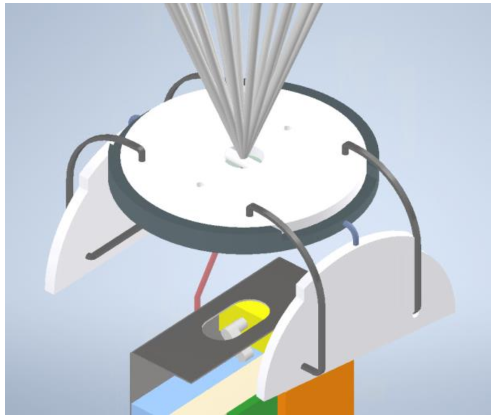
The parachute release mechanism consists of a platform holding the packed parachute, which is held in place by a rope that hooks around the servo arm from both sides (photo 1). The platform is connected to the half-lid sections with rubber bands, held in tension at this point so the mechanism has elastic potential energy. The rubber bands in tension and the lid hinge cable work together to prevent the lids from moving up or down in the can.

When the servo arm turns, the holding rope is released hence the EPE in the rubber bands is converted to kinetic energy in the parachute platform. The platform with packed parachute pushes the half-lids open to the position shown in the second photo. The hinge wire ensures the half-lids move around to the outside of the can instead of only vertically upwards.

The exposed parachute therefore expands due to surrounding airflow and its strings are connected to a rail in the centre of the parachute platform. A red shock cord connects to this same rail and the bottom of the can so that the platform stops rising when it reaches the original position of the lids. Since the half-lids initially fit flush at the top of the can, forming jigsaw like connection with the casing, when the parachute platform rises to this position part of the casing is still flush. This prevents the platform from moving around in its new position.



1. Release mechanism pre-deployment



2. Release mechanism post deployment

Justification

This mechanism is active as it uses stored elastic potential energy (and the movement of a servo arm) to push the lids open and expose the parachute to surrounding airflow for passive expansion. It is a practical solution as the rubber bands are easily attainable and have a simple implementation to the CanSat. The parachute platform is also held at a vertical distance of 43mm from the lid so there can be sufficient EPE stored in the rubber bands. Moreover, this can be easily adjusted by changing the stiffness of rubber bands used.

The solution is also feasible as components consisting of rubber bands, cords, PLA and a micro servo motor are all inexpensive and can be obtained in various shapes and sizes (or desired properties such as stiffness) as required.

Descent Control Overview

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2 factors to consider: the descent rate and maintaining CanSat orientation.

Descent Rate

Requirement: 5-10 ms-1 velocity.
Potential mass range: 240g – 260g

$$r := \sqrt{\frac{2 \cdot m \cdot g}{\pi \cdot C_d \cdot \rho \cdot V^2}}$$

Assumptions: Cd = 1.5, p = 1.225 Nm-2,
g = 9.81ms-2 , Rs = 0.2*Rp

The Cd value is dependent on the shape of parachute used. This value is subject to change through testing of our parachute. As we are aiming for a true dome shape, 1.5 is an appropriate estimation.

p = parachute
s = spill hole

For highest mass, minimum descent rate (i.e., best possible parachute design):
Rp = 19.2 cm

For lowest mass, maximum descent rate (i.e., worst possible parachute design):
Rp = 9.2 cm

9.2 cm <= Rp <= 19.2 cm
1.84 cm <= Rs <= 3.84 cm

Rp is dependent on the total mass of the CanSat, however the total mass is dependent on the parachute mass (which varies with Rp). Consequently, in order to find Rp and descent rate we must trial different values.

At Rp = 16cm, total CanSat mass = 252.3g.

Rearranging descent rate equation, we find
v = 5.9 m/s
This provides a suitable margin from 5 m/s

Therefore Rp = 16 cm, Rs = 3.2 cm

Parachute Plan view

Orientation Control

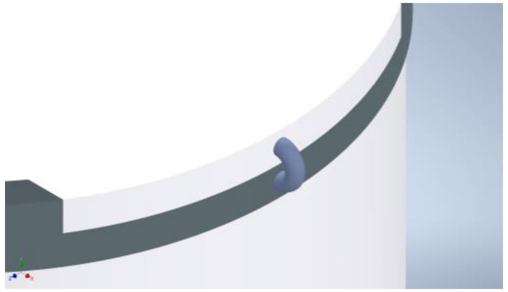
- Spill hole : This hole allows excess air to be released from the top of the parachute. This is necessary as without it, the excess air will spill from the edges of the parachute causing twisting moments and instabilities which can potentially lead to collapse. The diameter of this hole has been chosen at 20% of the total parachute diameter, therefore the air can 'spill' from the top of the parachute in a controlled fashion. The disadvantage is it increases the descent rate of the parachute; therefore, the parachute radius has been increased accordingly to mitigate this impact.

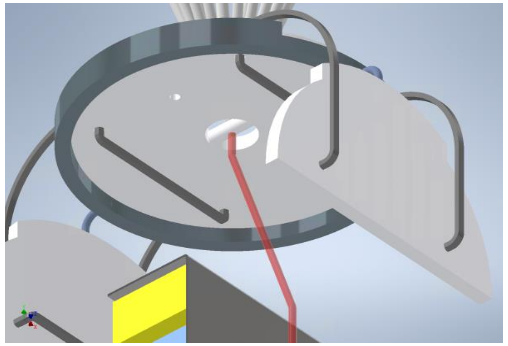
$$A = \frac{2mg}{Cd \cdot p \cdot v^2} \qquad Rp^2 - Rs^2 = \frac{2mg}{Cd \cdot p \cdot v^2 \cdot \pi}$$

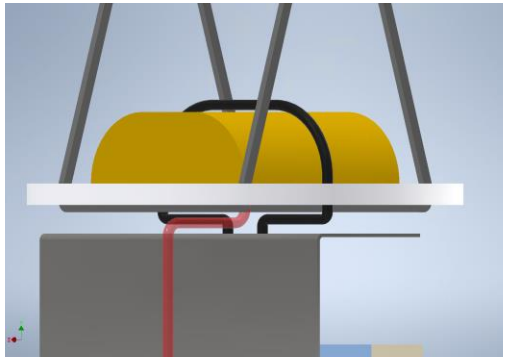
$$0.96 \cdot Rp^2 = \frac{2mg}{Cd \cdot p \cdot v^2 \cdot \pi}$$

Descent Control Overview

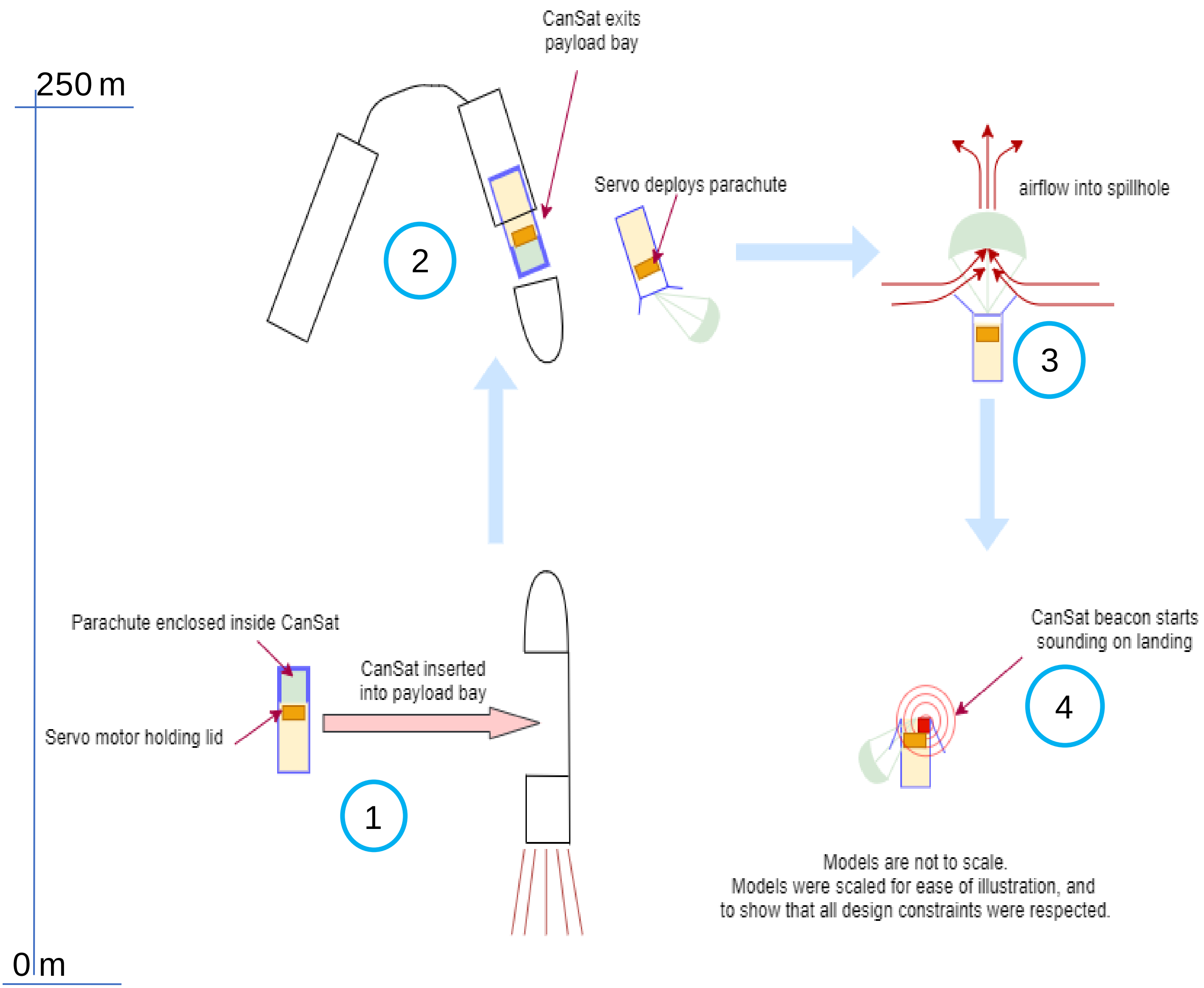
Component	Material	Mass (g)	Dimensions (cm)
Parachute	Ripstop Nylon	3.2	Diameter: 32
Parachute shroud lines	Paracord (Nylon)	4.5	Diameter: 0.1 Length: 41.6 x12
Shock cord (red)	Nylon	1.4	Diameter: 0.3 Length: 17
Packed parachute rope (black)	Nylon	0.5	Diameter: 0.3 Length: 6
Lid hinge cable	Silicone Rubber	0.1	Diameter: 0.1 Length: 1.5
Parachute Platform	PLA	10.5	Diameter: 3 Thickness: 0.3
Rubber bands	Natural rubber + EPDM synthetic rubber	2.3	30x1x3







Descent Control Overview



Pre-Launch 1

CanSat will be closed properly, thus ensuring there are no loose components. Parachute shall be correctly folded and placed inside upper compartment of CanSat. Lid must be locked with servo motor in correct orientation.

Ejection 2

CanSat exits rocket. Servo activation deploys parachute. Servo activation based on FSW realizing that the CanSat is falling due to altitude variation.

Descent 3

CanSat reaches and maintains a terminal velocity of 5-10 m/s. Spill hole directs airflow in a controlled way, so sway, drift, and instability are minimized.

Landing 4

Audio Beacon is automatically triggered and sounds once a second upon contact with the ground.

I&T Overview

The main areas for failure are:

- **Communications** – Yagi antennas might be too sensitive to directional input; the person holding the antenna might need to get better at tracking; interfaces might not be properly connected or might be faulty, so ways of minimising connection issues, like cleaning or protecting the interfaces might need to be used.
- **Parachute** – design or fabric used might prove to be unviable with the chosen design, and as such further research into more suitable design or material will be required.
- **Parachute deployment** - elastic-band & servo motor system might show that the elastic bands are not strong enough, or that the servo motor does not provide enough rotation of its gears to release the elastic bands, or that the mechanism is overall too unreliable, and as such further research into deployment systems will have to be undertaken.
- **Configuration** – during testing it might be found that the architecture used for our CanSat is not suitable for quick access to the USB port as it is intended, or that the LED needed to report that the CanSat is turned on might be too weak or too out of sight, and as such an improved system configuration will have be created. Furthermore, the chosen configuration might also make it difficult to accommodate all the wiring in the most efficient way, and as such improvements will have to be made to trade-off space for reliable and safe wiring.
- **FSW** - software related to the outputting of data might be faulty, resulting in loss of data or faulty data, and as such further software development is required; the coding process for flight operations is still in its earlier phases and requires much testing, so during the testing phase it is the team's expectation that a large amount of trial and error will have to go into programming for the FSW.

I&T Overview

Component Testing	Subsystem Testing	System Testing
Antennas Transmit data at different lengths and directions and check for reception - connects to CDH Subsystem testing		
Ground Receiver Feed data to receiver and check if data processing works as planned – connects to CDH Subsystem Testing	**CDH** Output data from cansat and check if processed data checks out - can be verified through ground receiver component testing.	
Cansat Transmiter Transmit data from Cansat and check for quality and quantity of transmitted data - connects to CDH Subsystem testing		
Pressure sensor, Temperature sensor, GPS module, IMU Connect sensors to Arduino (using breadboard if needed); control respective physical variables and process sensor data through software to check if data readings are working properly - connects to Altitude and CDH Subsystem Testing	**Altitude** Raise Cansat and set up antenna and ground receiver. Control altitude and check if data matches.	Lift Cansat with all its sensors and components built into it, and allow it to fall and deploy its parachute while receiving data and processing it through the Ground Station, and finally checking if the data matches controlled values.
Arduino Uno Use dummy codes and different power sources – connects to Power, Altitude, and CDH Subsystem Testing	**Power** Connect all components necessary for final build to the Arduino, connect Arduino to power and check if everything turns on. Do the same for ground station equipment connected to mains.	
Parachute Drop from a small height connected to a body of similar mass to check for resistance and stability control, and to check if deployment mechanism is working as expected - connects to Deployment Subsystem Testing	**Deployment** Attempt to reproduce the scenario in which the Cansat would deploy its parachute by throwing it up or dropping it in a control led fashion (upside down).	

Mass Budget

Payload mass budget - Electronics			
Subsystem	**Component**	**Mass (g)**	**Justification**
Sensors	GPS module	10	Estimated
	Temperature sensor	1	Estimated
	Barometer	4	Datasheet
	Inertial system	6	Estimated
CDH	Arduino UNO	25	Datasheet
	APC220 transmitting radio	5	Datasheet
	Thread antenna	5	Esimated
Power	9V battery	45	Datasheet
	PCB	17	Measured
Localisation	LED	1	Measured
	Buzzer	1	Measured
Parachute	Servo motor	9	Datasheet

Mass Budget

Payload mass budget - Container		
Component	**Mass (g)**	**Justification**
Casing	69	Estimated
Bottom lid	11.1	Calculated
Upper lid	6.7	Calculated
AS 1427 – M2 x 10 screw (x2)	0.8	Measured

Payload mass budget - Sructures		
Component	**Mass (g)**	**Justification**
Electronics mounting	13.2	Calculated
Parachute platform	10.5	Calculated
Parachute	3.2	Calculated
Rubber bands	2.3	Measured
Parachute shroud lines (x12)	4.5	Calculated
Shock cord	1.4	Calculated
Lid hinge cable	0.1	Calculated
Release mechanism rope	0.5	Calculated

Mass Budget

PLA is the material that takes most of the weight due to forming the main structural components. Among the many advantages is the ability to control the percentage of fill-in inside the components' walls, which allows for some weight manipulation. By doing a trade-off between mass limits and desired sturdiness, we get a 60% fill-in, which gives the following mass budget:

Total mass budget (g)	
Container mass	87.6
Payload mass - structures	35.7
Payload mass - electronics	129
Total mass	252.3
Allowed mass	260
Margin	7.7

Conclusions

Lessons learned

The research done for this design has revealed that many design solutions, especially when configuration is concerned, are possible. However, major discoveries including using an Arduino device as the motherboard makes programming quite simple, even for novices; the use of PLA, due to its variable fill-in volume, makes it an excellent material choice for the overall structure; and that elastic-bands can serve as an efficient and useful component in the parachute-deployment mechanism. Most important lesson learned so far, however, is that the mass budget is a highly volatile table, constantly changing as the design is reviewed and components are traded-off.

What still needs to be done

Much coding is still required to get the software ready for Flight Operations. Moreover, the structure still needs printing. However, the largest amount of work is now focused on testing, as many different levels of testing will need to be made and evaluated to make sure the system functions as intended on Flight Day and that it does not fail.

Major accomplishments

Starting with the goal of designing for simplicity and efficiency and reaching a feasible single plate design is one of the major accomplishments thus far. Additionally, defining the boundaries for acceptable values of collected data to monitor the functioning of all sensors is also an area that represents great advancements. Finally, finding and working with a device that could fulfil bonus requirement B4 has taken a lot of research and the team is now confident with the chosen component.

Major Unfinished work

Major unfinished work concerns coding and configuration. The team believes a code can be written that allows the FSW to deal with all Flight Operations in a way to fulfils all requirements; the selected architecture for the CanSat is assumed to work, but much testing is still necessary to confirm this.

Justification to the next stage (e.g. funding acquired, good progress etc.)

With funding from Bristol's SEDS society, as well as the hard work that the team has put into learning, designing, trading-off, and above all else researching for the CanSat that is to be built, it is the team's collective belief that due to our good, hard-earned progress, the team can and should move on to the next stage.