CanSat 2021
Preliminary Design Review (PDR)
Outline
Version 1.1

1231

UCASAL

Presentation Outline

Contents	Presenter
Team Organization	Jorge Royon
Acronyms	Jorge Royon
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Sensor Subsystem Design	Nicole Castro
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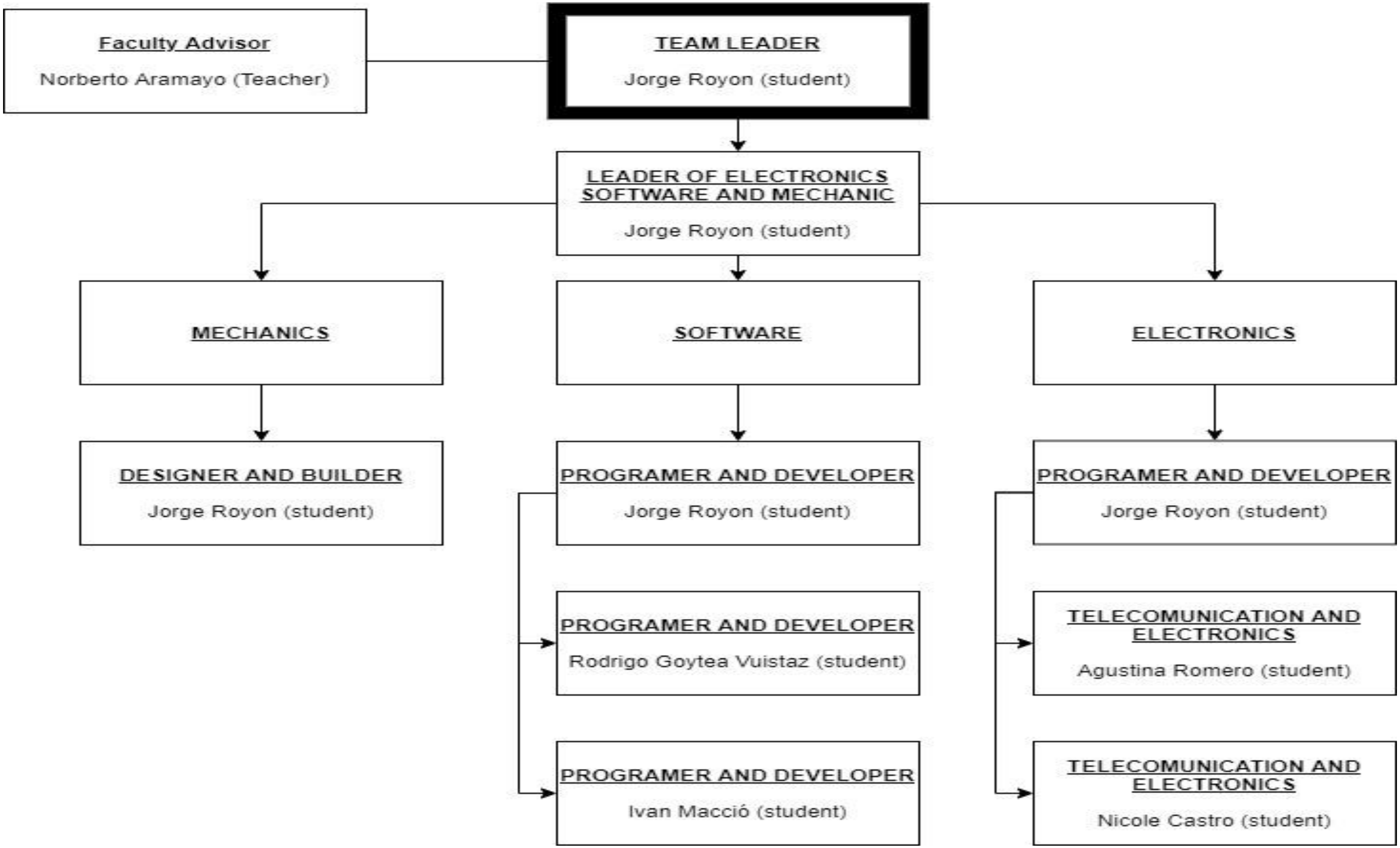
Mechanical Subsystem Design	Jorge Royon
Communication and Data Handling (CDH) Subsystem Design	Nicole Castro Agustina Romero
Electrical Power Subsystem (EPS) Design	Nicole Agustina Castro Agustina Romero
Flight Software (FSW) Design	Ivan Maccio
Ground Control System (GCS) Design	Ivan Maccio
Cansat Integration and Test	Ivan Maccio

Presentation Outline

Contents	Presenter
Mission Operations & Analysis	Jorge Royon
Requirements Compliance	Jorge Royon
Management	Rodrigo Goytea Vuistaz

Team Organization



Acronyms

Acronyms	Analysis
CDR	Critical design review
Hz	Frequency
DCS	Descent Control System
FRR	Flight Readiness Review
GCS	Ground Control Station
CG	Center of gravity
LCO	Launch Control Officer
RPM	Revolution per minute

Systems Overview

JORGE ROYON

Mission Summary

Main Objectives

The mission will explore the use of two auto rotating maple seed science payloads. The container shall contain electronics to release the payloads and relay data from the payload to a ground station.

- **Just after container is deployed from rocket, container shall open a parachute**
- **The descent rate shall be kept at 15 meters/sec till 500 meters.**
- **At 500 meters, the container shall release one auto rotating maple seed science payload. At 400 meters, the container shall release the second auto rotating maple seed science payload.**

Mission Summary

Main Objectives

- Transmit data at 1 sample per second before released.
- The payloads shall descend after being released and spin rapidly enough so its descent rate is less than 20 m/s.
- The science payloads shall transmit for five minutes after being released.

Mission Summary

Bonus Objective

- Installation of a integrated video camera in the container and that point toward the ground. The camera shall capture the release of both science payloads and capture the descent of the science payloads.
- The video shall be spin stabilized with the view not rotating more than +/- 30 degrees.

System Requirement Summary

RQ	Description
1	Total mass of the CanSat (science payloads and container) shall be 600 grams +/- 10 grams.
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.
4	The container shall be a fluorescent color; pink, red or orange.
5	The container shall be solid and fully enclose the science payloads. Small holes to allow access to turn on the science payloads is allowed. The end of the container where the payload deploys may be open.
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.
7	The rocket airframe shall not be used as part of the CanSat operations.
8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.

System Requirement Summary

RQ	Description
9	The Parachutes shall be fluorescent Pink or Orange
10	The descent rate of the CanSat (container and science payload) shall be 15 meters/second +/- 5m/s.
11	All structures shall be built to survive 15 Gs of launch acceleration.
12	All structures shall be built to survive 30 Gs of shock.
13	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.
14	All mechanisms shall be capable of maintaining their configuration or states under all forces.
15	Mechanisms shall not use pyrotechnics or chemicals.
16	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.
17	Both the container and payloads shall be labeled with team contact information including email address.

System Requirement Summary

RQ	Description
18	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.
19	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.
20	XBEE radios shall have their NETID/PANID set to their team number.
21	XBEE radios shall not use broadcast mode.
22	The science payload shall descend spinning passively like a maple seed with no propulsion.
23	The science payload shall have a maximum descent rate of 20 m/s.
24	The wing of the science payload shall be colored fluorescent orange, pink or green.
25	The science payload shall measure altitude using an air pressure sensor.

System Requirement Summary

RQ	Description
26	The science payload shall measure air temperature.
27	The science payload shall measure rotation rate as it descends.
28	The science payload shall transmit all sensor data once per second.
29	The science payload telemetry shall be transmitted to the container only.
30	The science payload shall have their NETID/PANID set to their team number plus five. If team number is 1000, sensor payload NETID is 1005.
31	The container shall include electronics to receive sensor payload telemetry.
32	The container shall include electronics and mechanisms to release the science payloads.
33	The container shall include a GPS sensor to track its position.
34	The container shall include a pressure sensor to measure altitude.

System Requirement Summary

RQ	Description
35	The container shall measure its battery voltage.
36	The container shall transmit its telemetry and the payload telemetry received once per second in the format described in the Telemetry Requirements section.
37	The container shall stop transmitting telemetry when it lands.
38	The container and science payloads must include an easily accessible power switch that can be accessed without disassembling the cansat and science payloads and in the stowed configuration.
39	The container must include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the cansat and in the stowed state.
40	An audio beacon is required for the container. It may be powered after landing or operate continuously.
41	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.
42	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.

System Requirement Summary

RQ	Description
44	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.
45	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.
46	The Cansat must operate during the environmental tests laid out in Section 3.5.
47	The Cansat shall operate for a minimum of two hours when integrated into the rocket.
48	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.
49	The container must maintain mission time throughout the whole mission even with processor resets or momentary power loss.
50	The container shall have its time set to UTC time to within one second before launch.

System Requirement Summary

RQ	Description
51	The container flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.
52	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the container altitude.
53	The container flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.
54	The ground station shall command the Cansat to start transmitting telemetry prior to launch.
55	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.
56	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.
57	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.

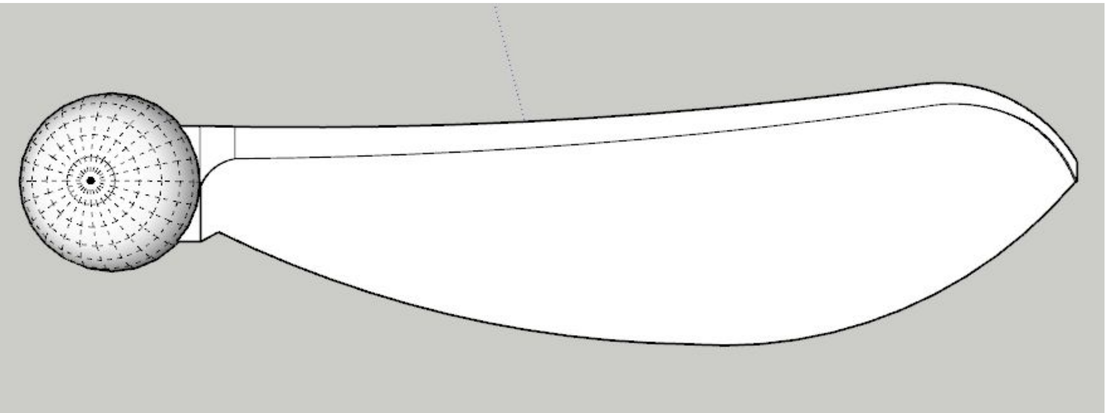
System Requirement Summary

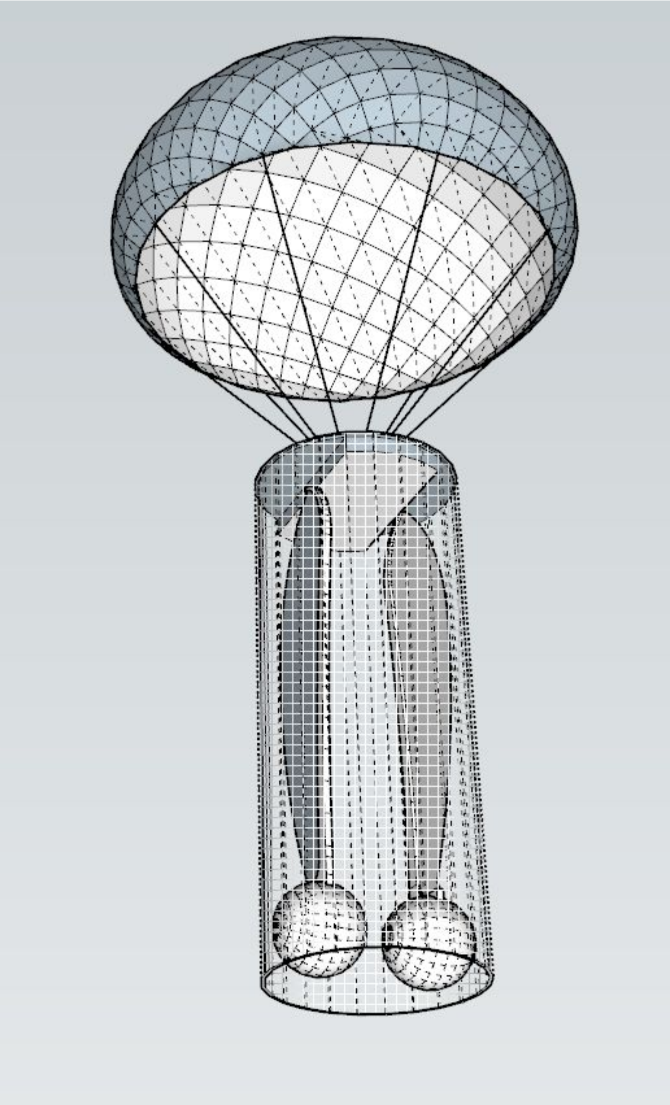
RQ	Description
58	Each team shall develop their own ground station.
59	All telemetry shall be displayed in real time during descent on the ground station.
60	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)
61	Teams shall plot each telemetry data field in real time during flight.
62	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.
63	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.
64	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.
65	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the container.

System Requirement Summary

RQ	Description
66	The science payloads shall not transmit telemetry during the launch, and the container shall command the science payloads to begin telemetry transmission upon release from the container.

System Level CanSat Configuration Trade & Selection

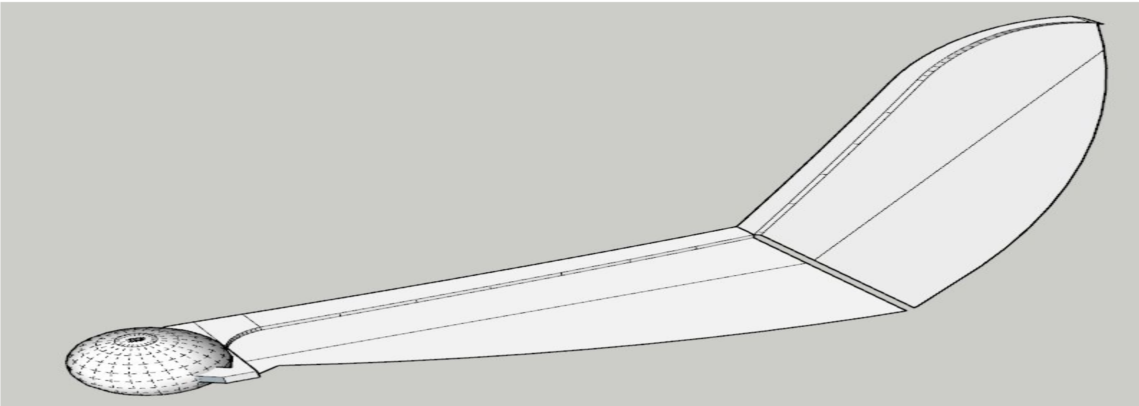


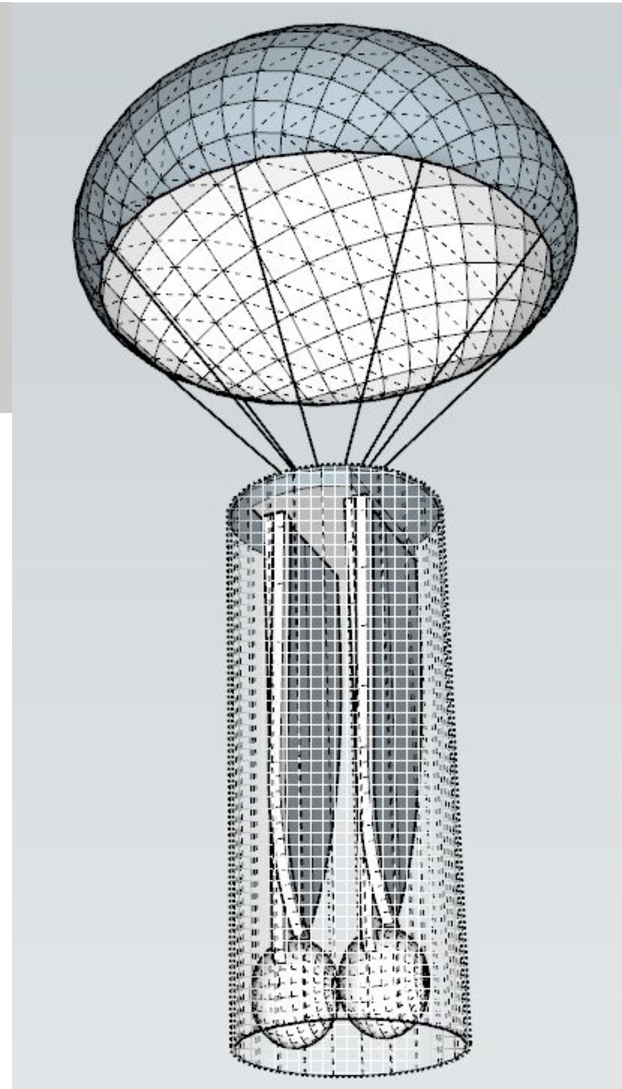


The option A we consider is the use of a two typical flying maple seed.

PROS	CONS
Easy to deploy	complex to build
more space to allocate electronics	more hard to enter in auto-rotation
Inexpensive	Require a considerable amount of time to build
Good room for electronics	Container must had thin walls

System Level CanSat Configuration Trade & Selection



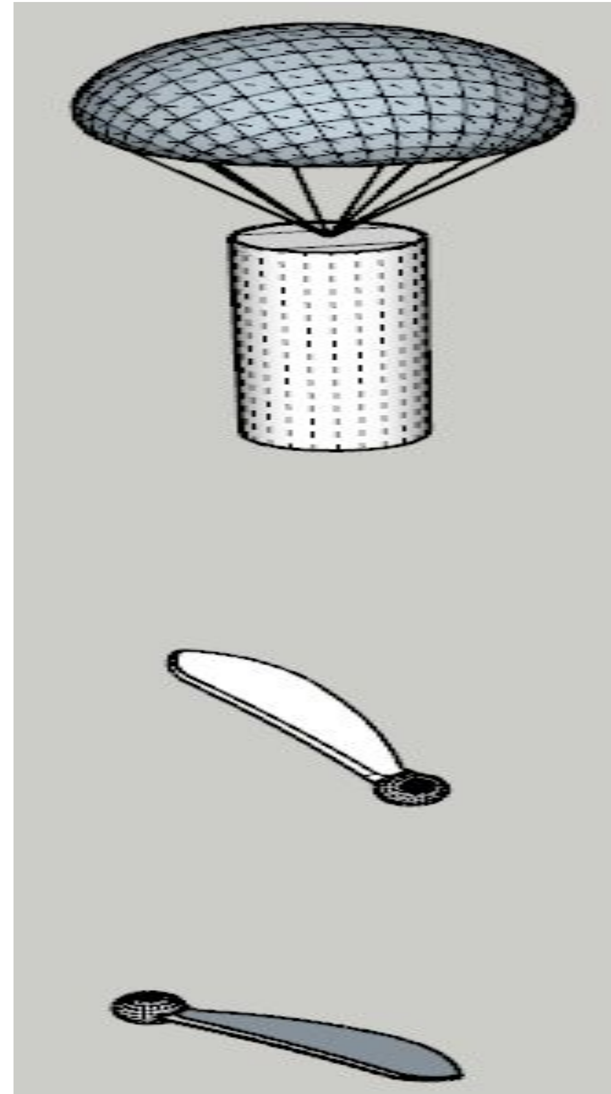


The option B we consider is the use of a two typical flying maple seed with a foldable wing

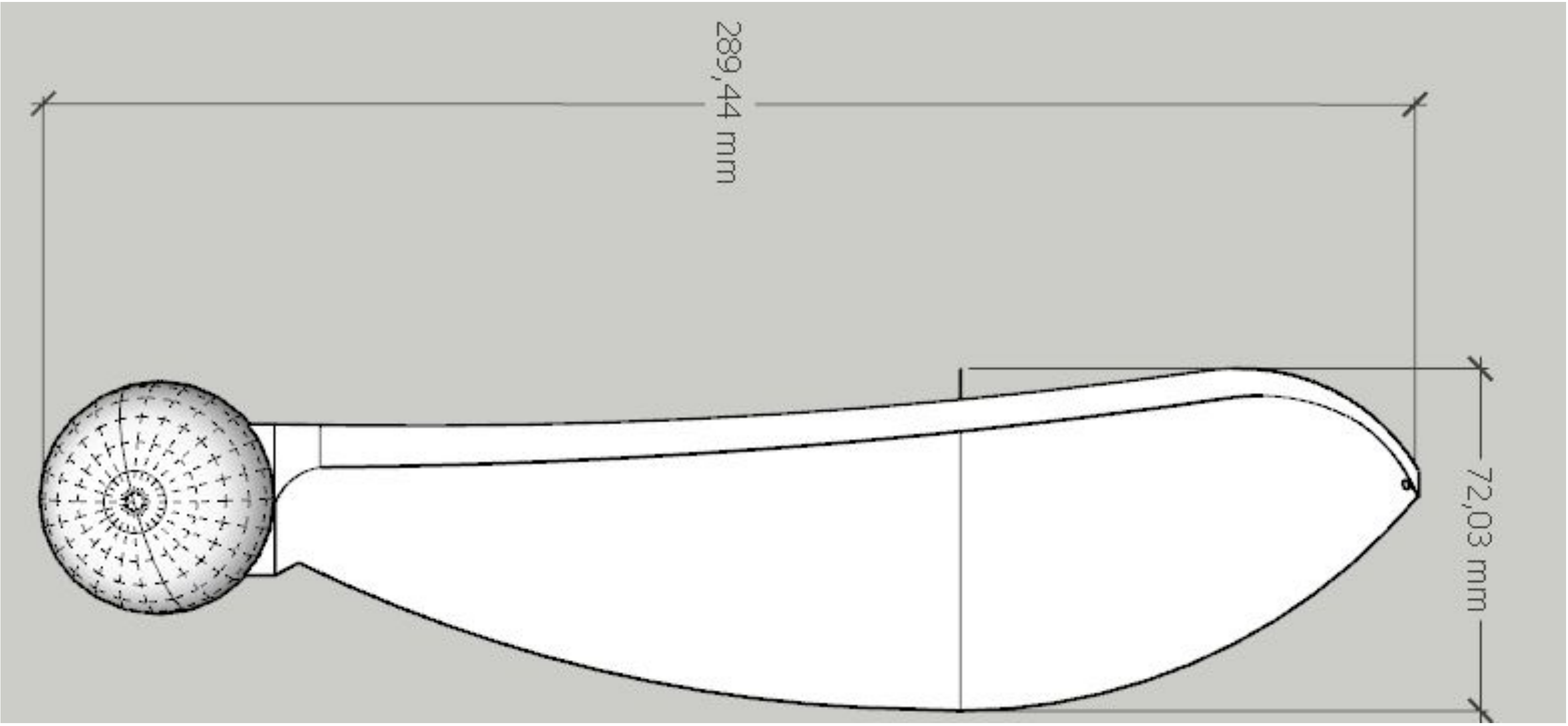
PROS	CONS
More wing area	Container must be made of thin walls
Easy auto-rotation	Tight tolerances inside the container
Can hold more weight	Complex and hard to build
Cheap materials	need a folding mechanism

We choose the design A due the main advantage of easy of construction and there's no need for holding more weight

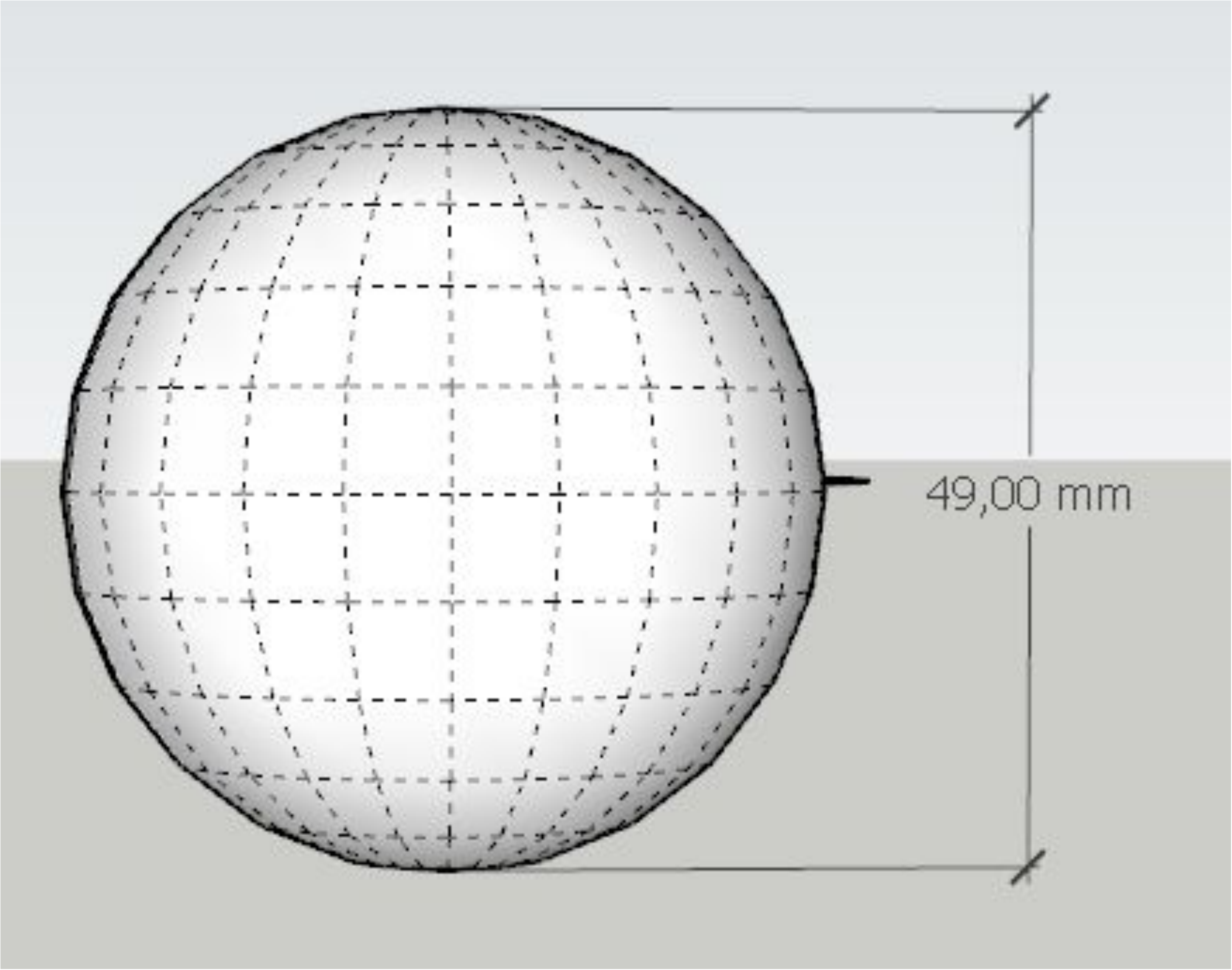
- Camera vision angle is not blocked
- Access to electronics is easy, by hatches in the top of the container
- Payload wing made of lightweight balsa wood
- Easy to deploy



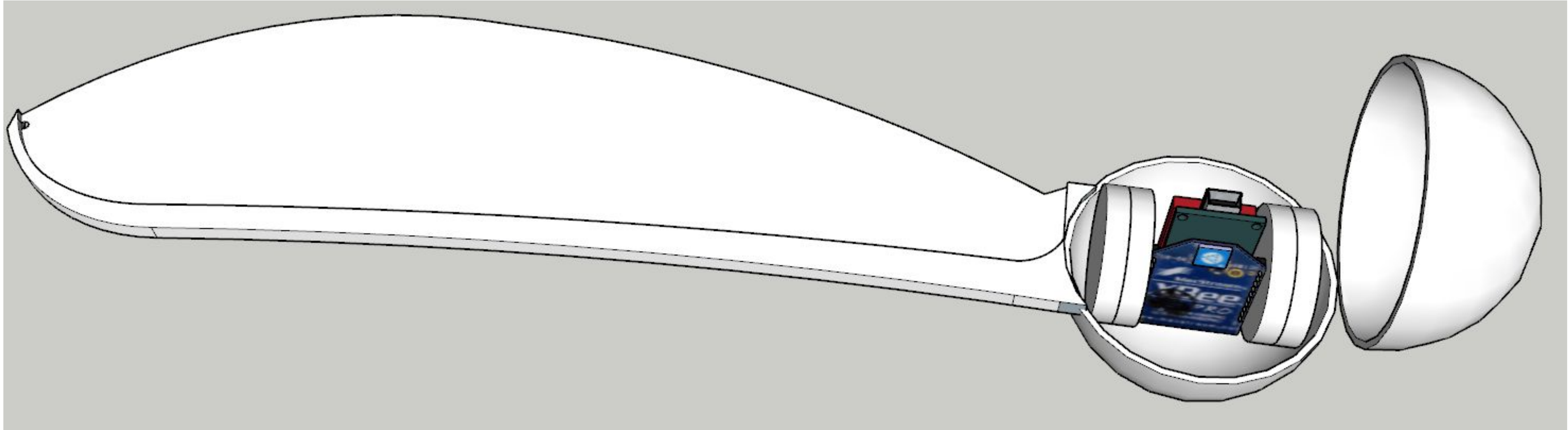
Physical Layout



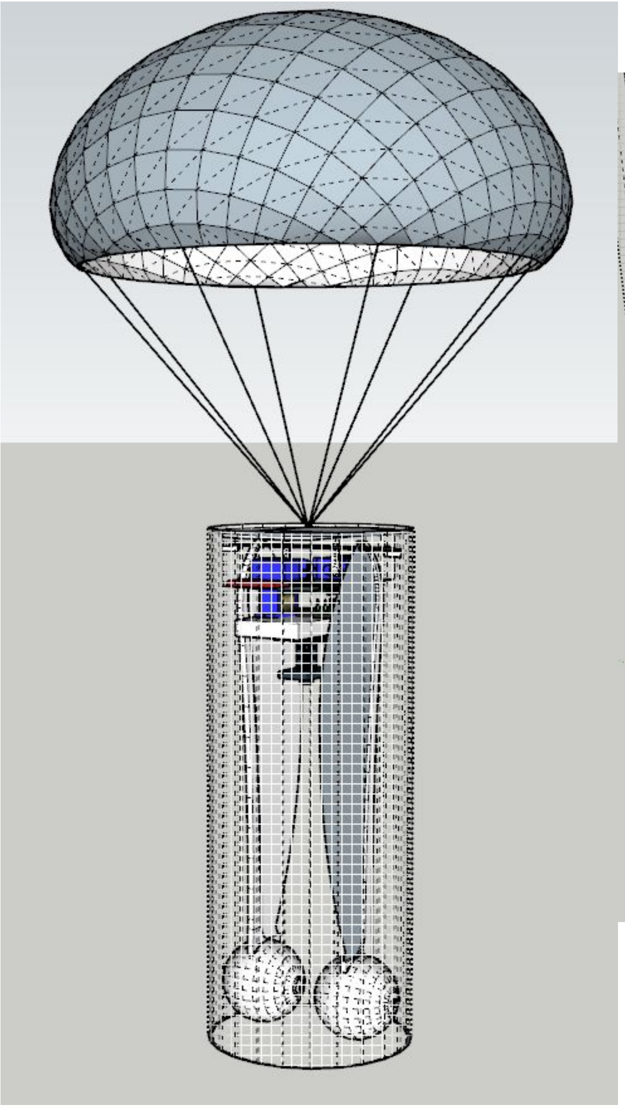
Physical Layout

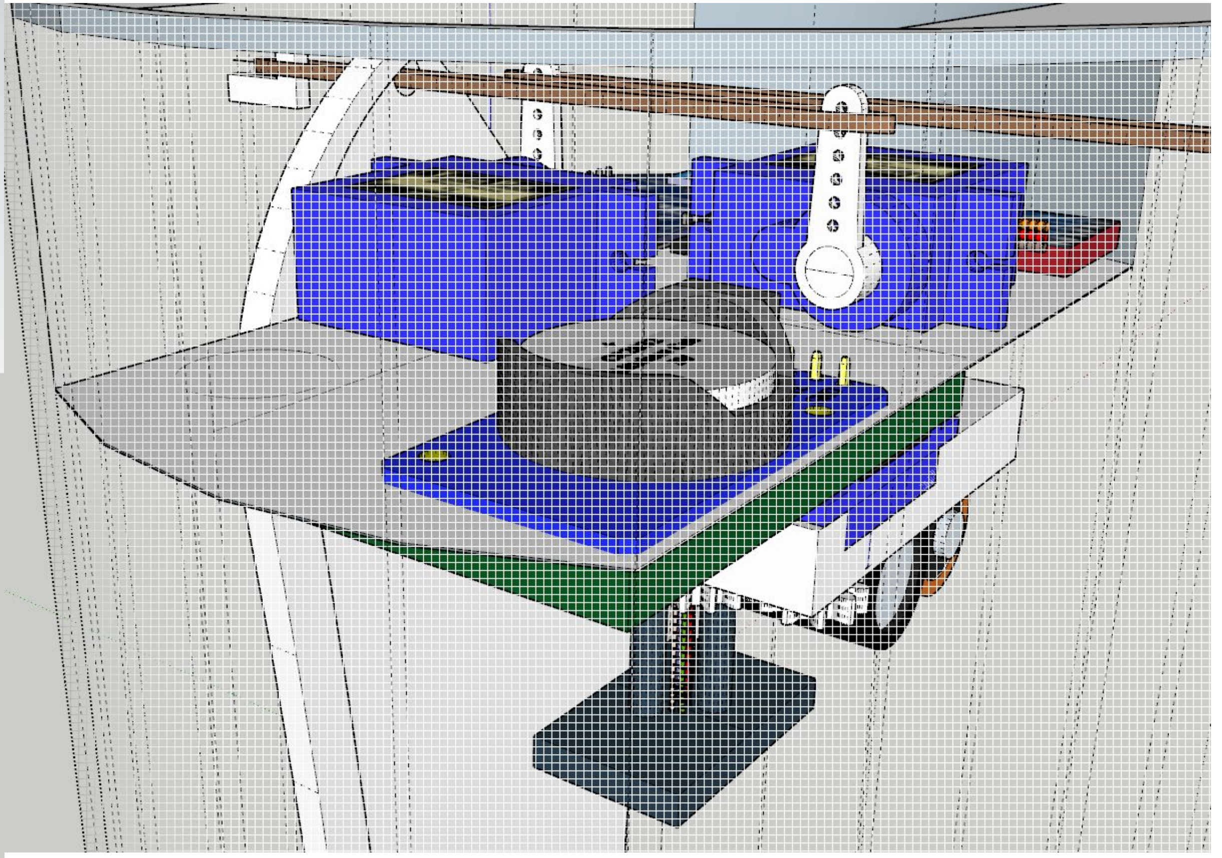


Physical Layout

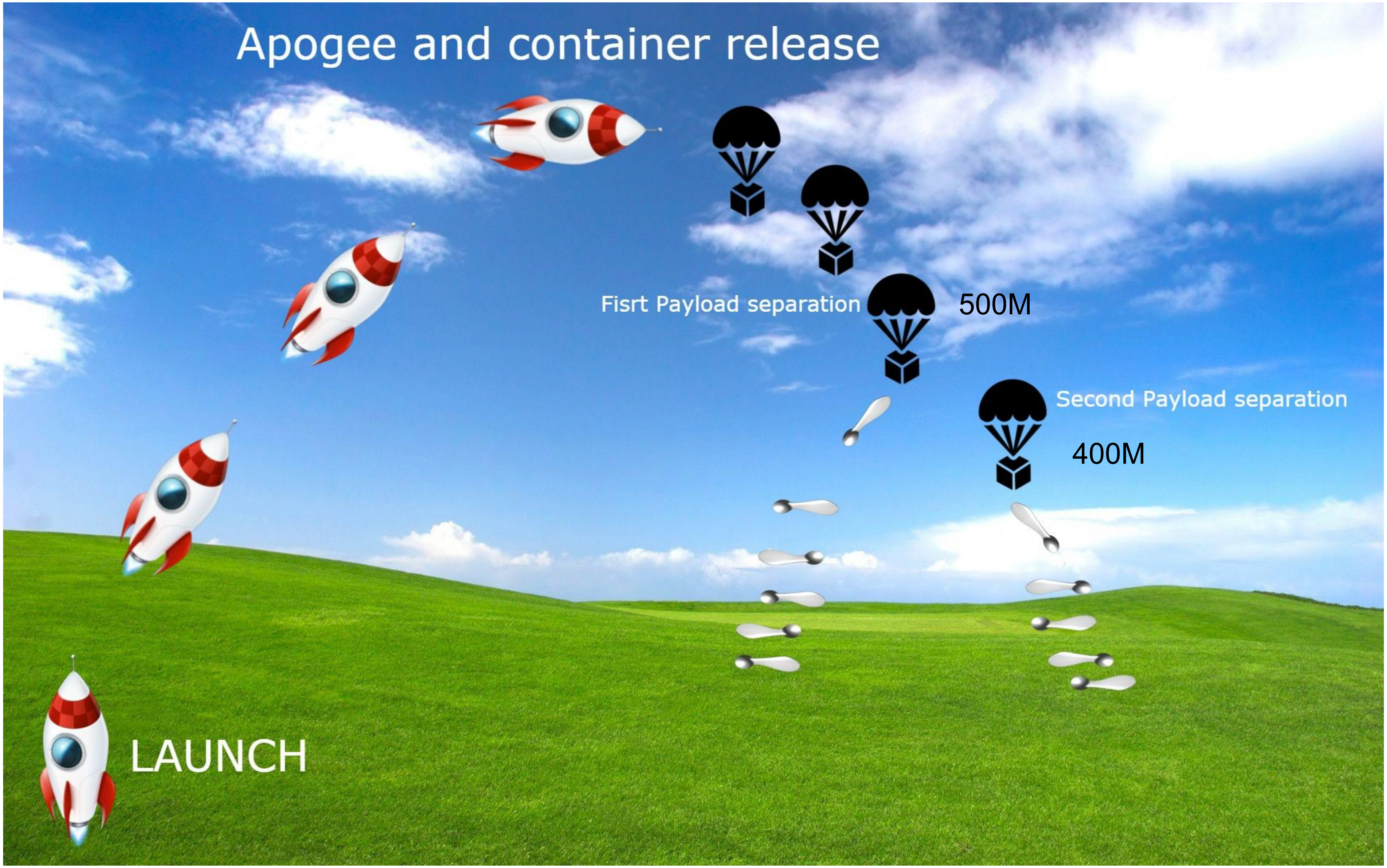


Physical Layout





System Concept of Operations



System Concept of Operations

1 → 2 → 3

●Competition area arrival
●Team briefing
●Checklist of materials
●Deploy Ground Control Station
●Last check of fully integrated CanSat
●Placement of CanSat into the rocket payload section

●Launch CanSat.
●Container deploy.
●First Payload deploy.
●Second Payload deploy.
●Record telemetry.

●Recovery of Payload and Container
●Analysis of sampled data
●Preparation of the PFR
●PFR presentation and delivery

Launch Vehicle Compatibility

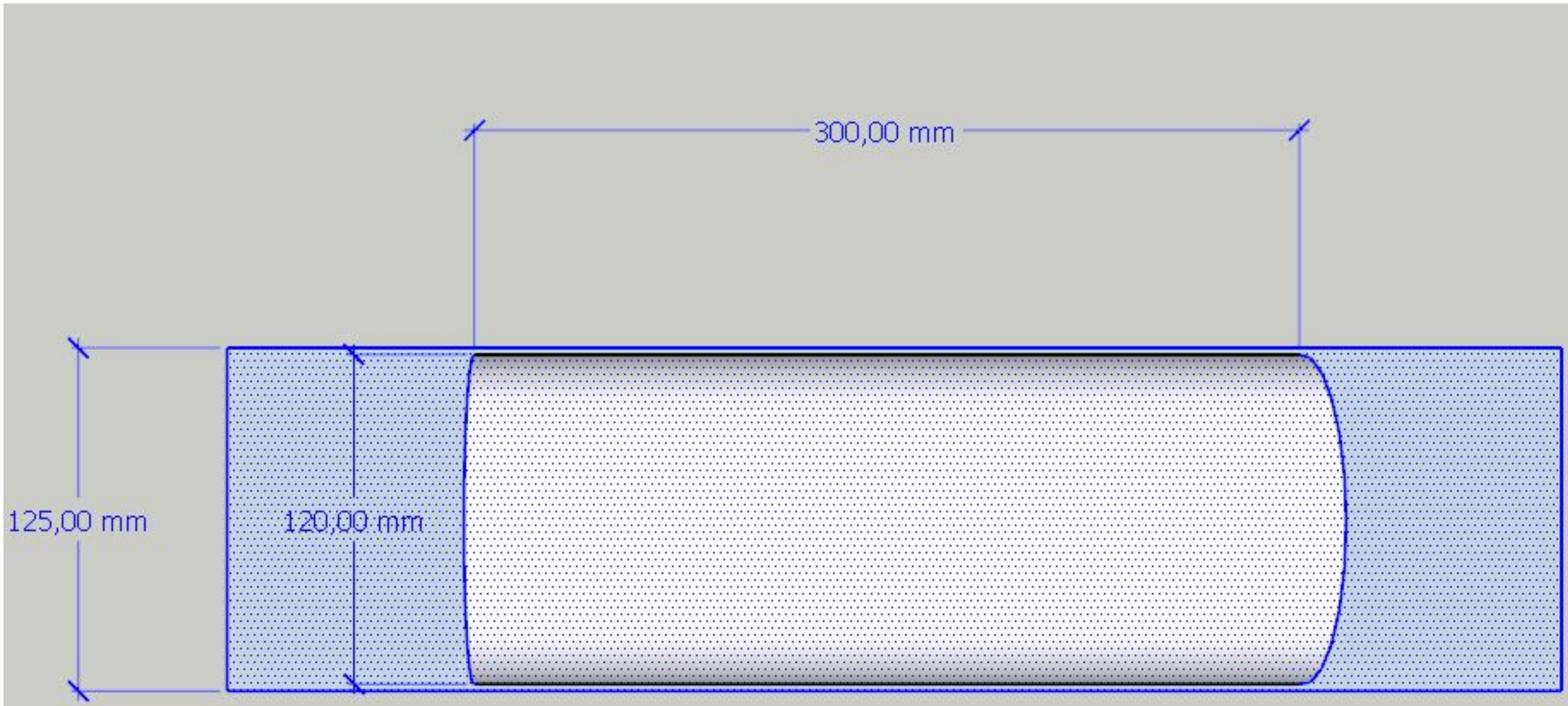
★Rocket payload section dimensions based on Mission Guide:
- Height: 310 mm
- Diameter: 125 mm

★CanSat dimensions:
- Height: 300 mm
- Diameter: 120 mm

★Payload dimensions:
- Wing span: 240mm
- Length: 290 mm

★Parachute dimensions:
- Diameter: 190 mm
- Spill Hole Diameter: 42.56 mm

Launch Vehicle Compatibility



There's sufficient margin allow the container slide freely inside the rocket payload

Sensor Subsystem Design

Nicole Castro

Sensor Subsystem Overview

- **Container**

Sensor	Model	Purpose
Air Pressure	BMP280	measure air pressure
GPS Sensor	Adafruit Ultimate GPS Sensor	get gps position
Voltage Sensor	Arduino ADC pin	measure voltage

- **Payload**

Sensor	Model	Purpose
Air Pressure	BMP280	measure air temperature and pressure
Air Temperature	BMP280	measure air temperature and pressure
Rotation Sensor	MPU9250	measure rotation

Sensor Subsystem Requirements

ID	Requirement	Rationale	Priority
25	The science payload shall measure altitude using an air pressure sensor.	CReq	High
26	The science payload shall measure air temperature.	CReq	High
27	The science payload shall measure rotation rate as it descends.	CReq	High
28	The science payload shall transmit all sensor data once per second.	CReq	High
29	The science payload telemetry shall be transmitted to the container only.	CReq	High
31	The container shall include electronics to receive sensor payload telemetry.	CReq	High
33	The container shall include a GPS sensor to track its position.	CReq	High
34	The container shall include a pressure sensor to measure altitude.	CReq	High
35	The container shall measure its battery voltage.	CReq	High

Payload Air Pressure Sensor Trade & Selection

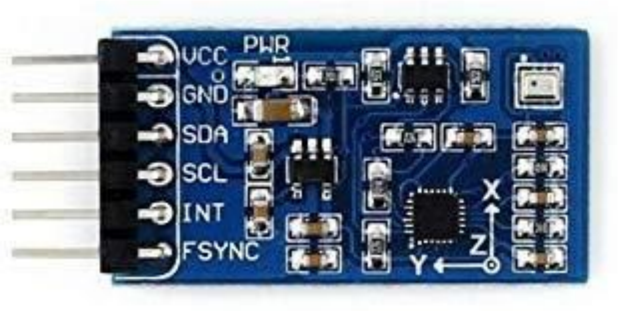
MODEL	INTERFACE	RANGE	ACCURACY	SIZE	MASS	COST
BME280	I2c	300 hPa / 1100 hPa	± 1 hPa	14 mm x 12 mm x 2 mm	0.9gr	$8.99
Waveshare 10 DOF IMU with bmp280	I2c	300 hPa / 1100 hPa	± 1 hPa	31.2 mm x 17 mm x 3 mm	2gr	$17.99

- **Selected Air Pressure Sensor: Waveshare 10DOF IMU with bmp280**
- **Considering 1 hPa, high measurement accuracy .**
- **Wide range for healthy measurement.**
- **Easy to access and useful library.**
- **One small board that save cost for the price of three sensors.**
- **Small size.**

Payload Air Temperature Sensor Trade & Selection

MODEL	INTERFACE	RANGE	ACCURACY	SIZE	MASS	COST
BME280	I2c	-40 °C/85 °C	± 1°C	14 mm x 12 mm x 2 mm	0.9gr	$8.99
Waveshare 10 DOF IMU with bmp280	I2c	-40 °C/85 °C	± 1°C	31.2 mm x 17 mm x 3 mm	2gr	$17.99

- **Selected Air Temperature Sensor: Waveshare 10DOF IMU with bmp280**
- **Considering** 1°C **, high measurement accuracy .**
- **Wide range for healthy measurement.**
- **Easy to access and useful library.**
- **One small board that save cost for the price of three sensors.**
- **Small size.**



Payload Rotation Sensor Trade & Selection

MODEL	INTERFACE	RANGE	ACCURACY	SIZE	MASS	COST
Adafruit 9-DOF-BNO055	I2c	2000 °/s	±3%	20mm x 27mm x 4mm	3gr	$34.95
Waveshare 10 DOF IMU with bmp280	I2c	2000 °/s	±3%	31.2 mm x 17 mm x 3 mm	2gr	$17.99

- **Selected Air Temperature Sensor: Waveshare 10DOF IMU with bmp280.**
- **Considering** ±3% **, high measurement accuracy.**
- **Wide range for healthy measurement.**
- **Easy to access and useful library.**
- **One small board that save cost for the price of three sensors.**
- **Small size.**

Container Air Pressure Sensor Trade & Selection

MODEL	INTERFACE	RANGE	ACCURACY	SIZE	MASS	COST
BME280	I2c	300 hPa / 1100 hPa	± 1 hPa	14 mm x 12 mm x 2 mm	0.9gr	$8.99
Waveshare 10 DOF IMU with bmp280	I2c	300 hPa / 1100 hPa	± 1 hPa	31.2 mm x 17 mm x 3 mm	2gr	$17.99

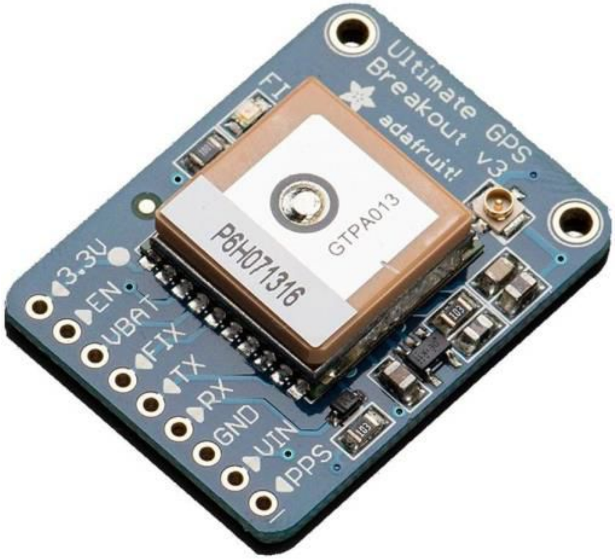
- **Selected Air Pressure Sensor: Waveshare 10DOF IMU with bmp280.**
- **Considering 1 hPa, high measurement accuracy .**
- **Wide range for healthy measurement.**
- **Easy to access and useful library.**
- **One small board that save cost for the price of three sensors.**
- **Small size.**

Container GPS Sensor Trade & Selection

MODEL	INTERFACE	ACCURACY	SIZE	MASS	COST
GPS NEO-6M	UART/USB/SPI	± 2m	27.6 mm x 26.6 mm x 6.5 mm	9g	$12.99
Adafruit Ultimate GPS	UART	± 1.8 m	25 mm x 35 mm x 6.5 mm	8,5g	$39.95

Selected GPS Sensor: Adafruit Ultimate GPS

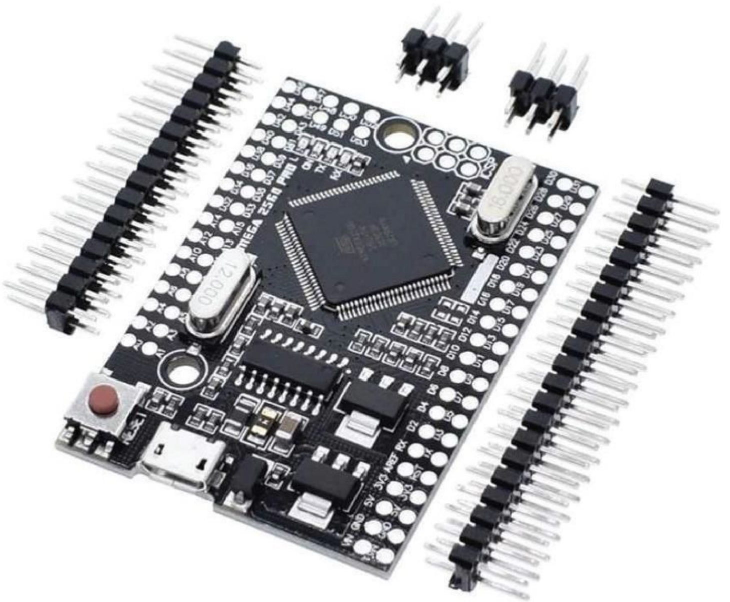
- **Considering its affordable cost, satisfies high position accuracy as 1.8 meter.**
- **Antenna of Adafruit Ultimate GPS is onboard, so it is useful in terms of volume.**
- **According to other projects experiences , Adafruit Ultimate GPS works stable.**



Container Battery Voltage Sensor Trade & Selection

MODEL	ACCURACY	SIZE	MASS	COST
Hitelgo Voltage sensor	±0.0049C	27.6 mm x 26.6 mm	0.8gr	$ 5.39
Arduino analog pin	±0.0049v	108 mm x 54 mm	34,9g	$ 0

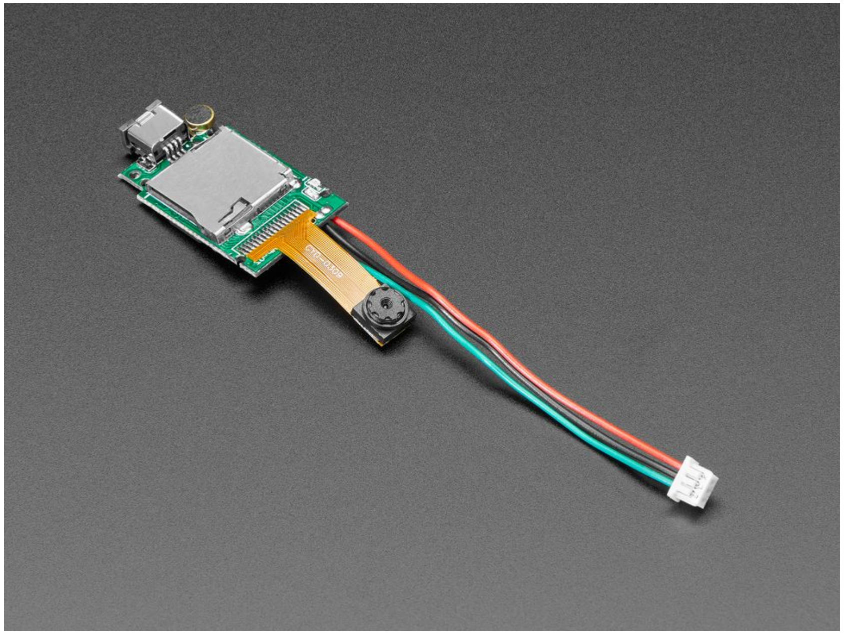
Selected Voltage Sensor: Arduino analog pin
•Considering its come with the controlling electronics and high precision there's no need to invest in other sensor



Bonus Camera Trade & Selection

MODEL	INTERFACE	RESOLUTION	SIZE	MASS	COST
GENERIC SPY PEN CAMERA	USB	1280×960	85 mm × 12.5 mm × 12.5 mm	2g	$ 5,00
Adafruit MINI SPY CAMERA	USB/ANALOG	640x480	28.5 mm x 17mm x 4.2mm	2.8g	$ 12.50

Selected Camera: Adafruit camera
•Considering its size that is easy to fit in a slip tray to ease rotation.
•Easy interface with arduino, only one signal wire to start and stop recording.

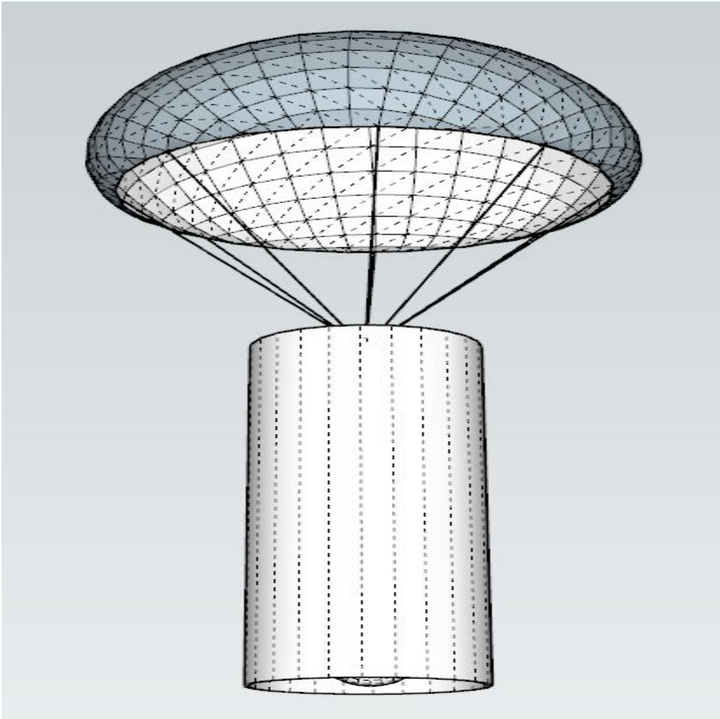


Descent Control Design

Jorge Royon

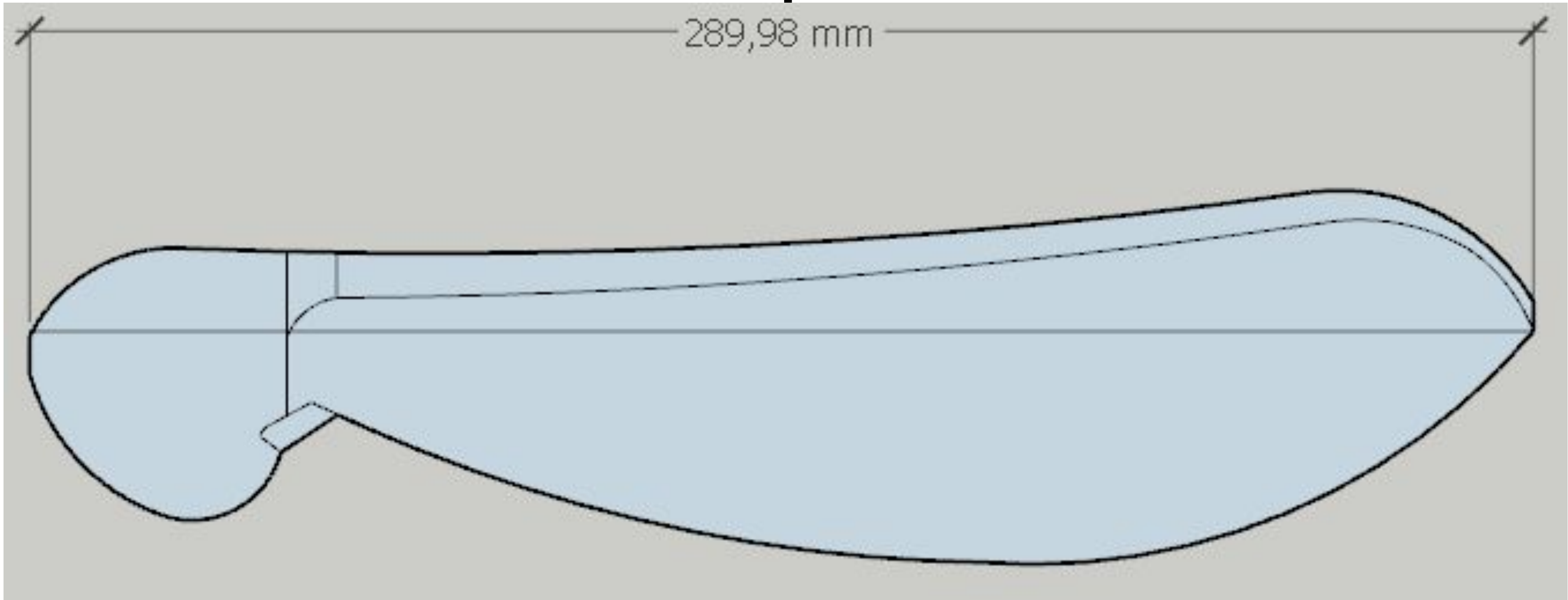
Container Descent Control System

The parachute has 19 cm diameter to reach 15 m/s. It has been made from plastic and It has 2.28 cm radius spill hole to stabilize container during descent

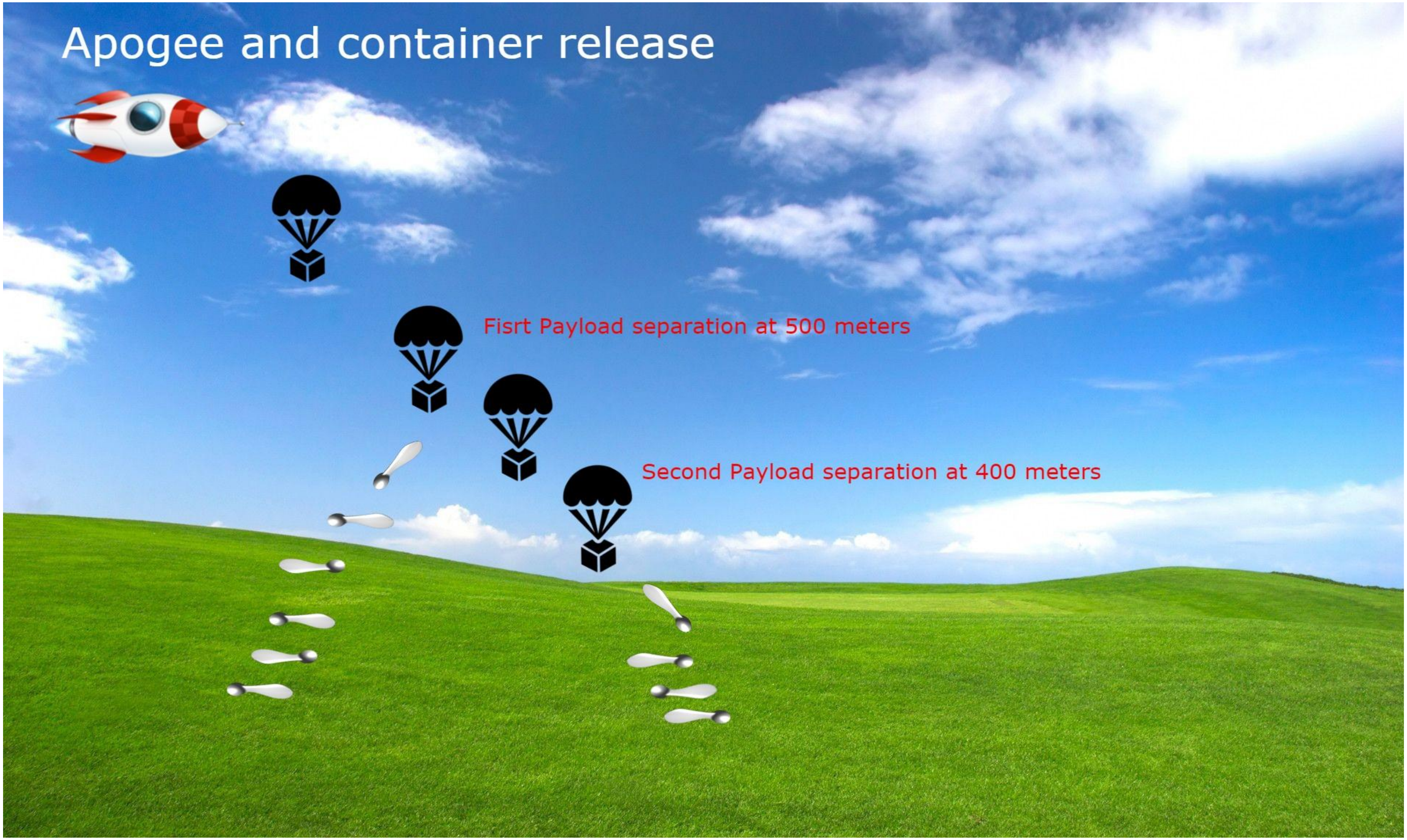


Payload Descent Control System

The payload is a auto rotating scaled samara seed, it's autostable by design and descent is achieved in a passive way, when enter in autoration the wing generate a lift force that slow down the descent speed



Descent Control Overview



Descent Control Requirements

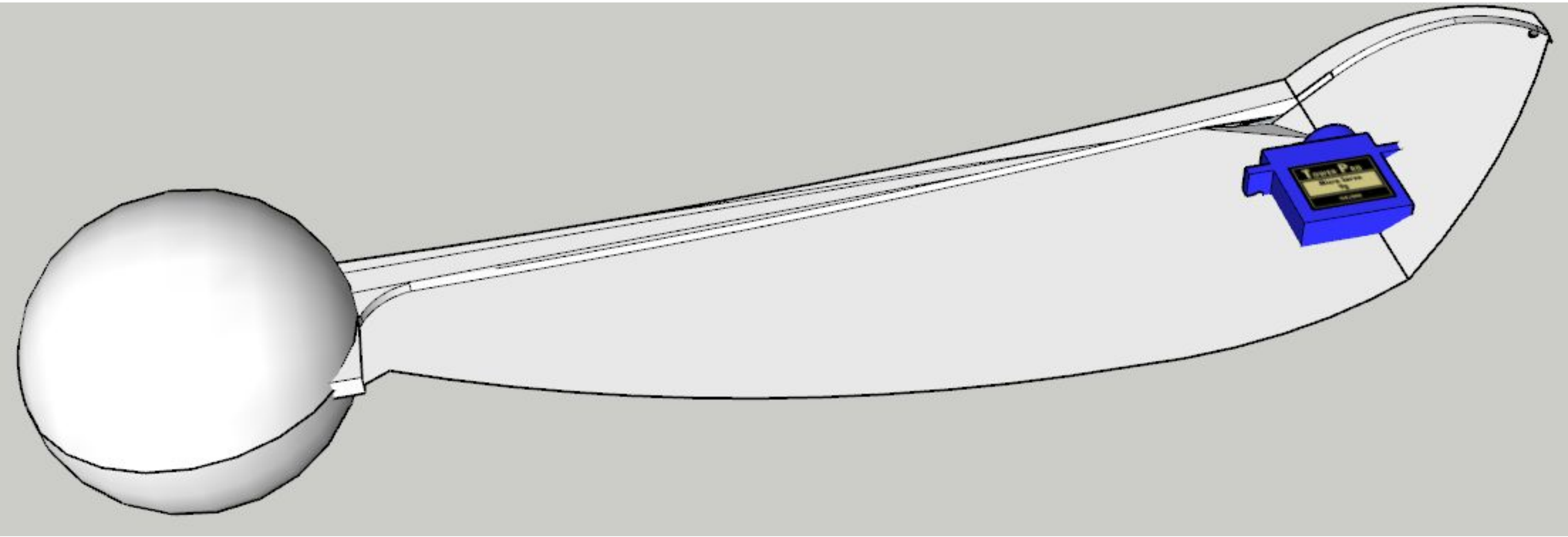
RQ	Description	Rationale
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	CReq
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	CReq
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	CReq
7	The rocket airframe shall not be used as part of the CanSat operations.	CReq
8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	CReq
9	The Parachutes shall be fluorescent Pink or Orange	CReq
10	The Parachutes shall be fluorescent Pink or Orange	CReq
11	All structures shall be built to survive 15 Gs of launch acceleration.	CReq
12	All structures shall be built to survive 30 Gs of shock.	CReq

Descent Control Requirements

RQ	Description	Rationale
22	The science payload shall descend spinning passively like a maple seed with no propulsion.	CReq
23	The science payload shall have a maximum descent rate of 20 m/s.	CReq

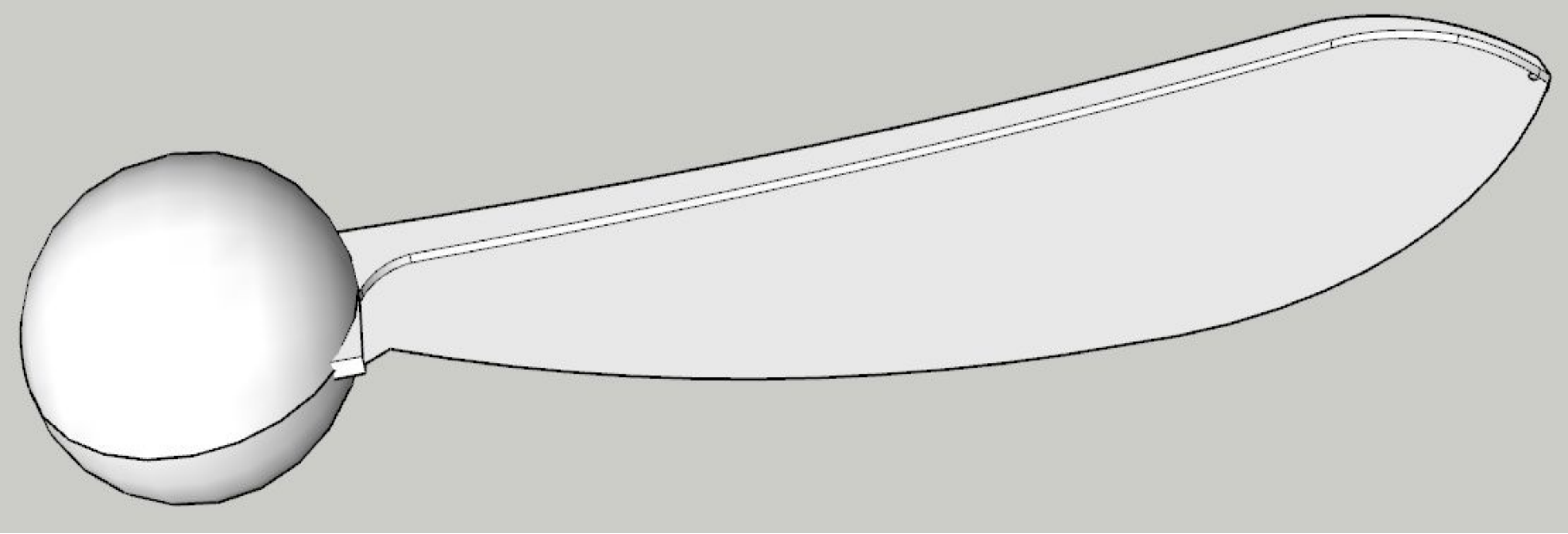
Payload Descent Control Strategy Selection and Trade

OPTION A



A servo driven wing tip

OPTION B



Passive descent

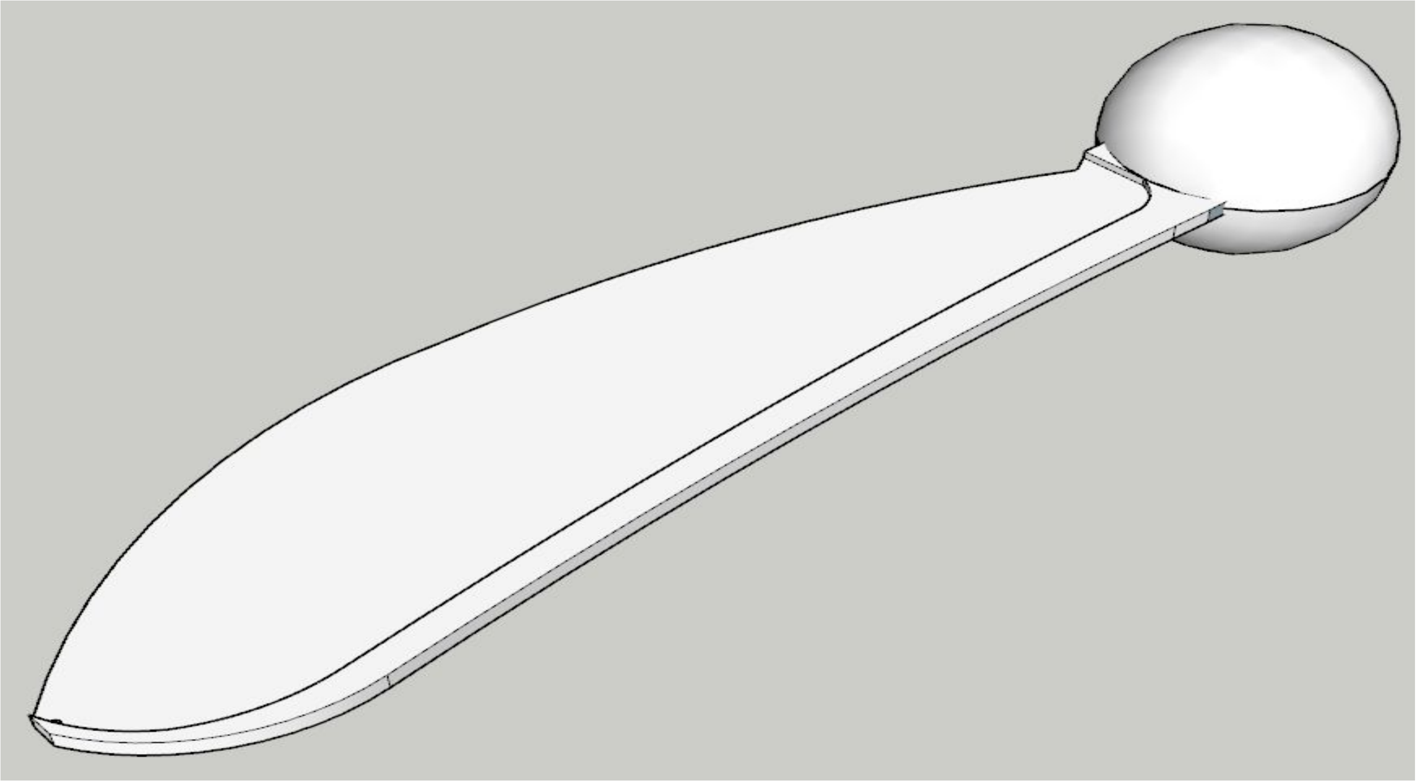
Payload Descent Control Strategy Selection and Trade

OPTION A	OPTION B
Controllable wing tip allows easy descent control by modifying wing area and escape velocity in the wing	Passive descent control by design, cannot be modified
Complex to build, CG is altered badly by the weight of the servo	Easy to build but relies on a good design to work

We choose option B because with a well balanced CG and correct weight it will perform good.

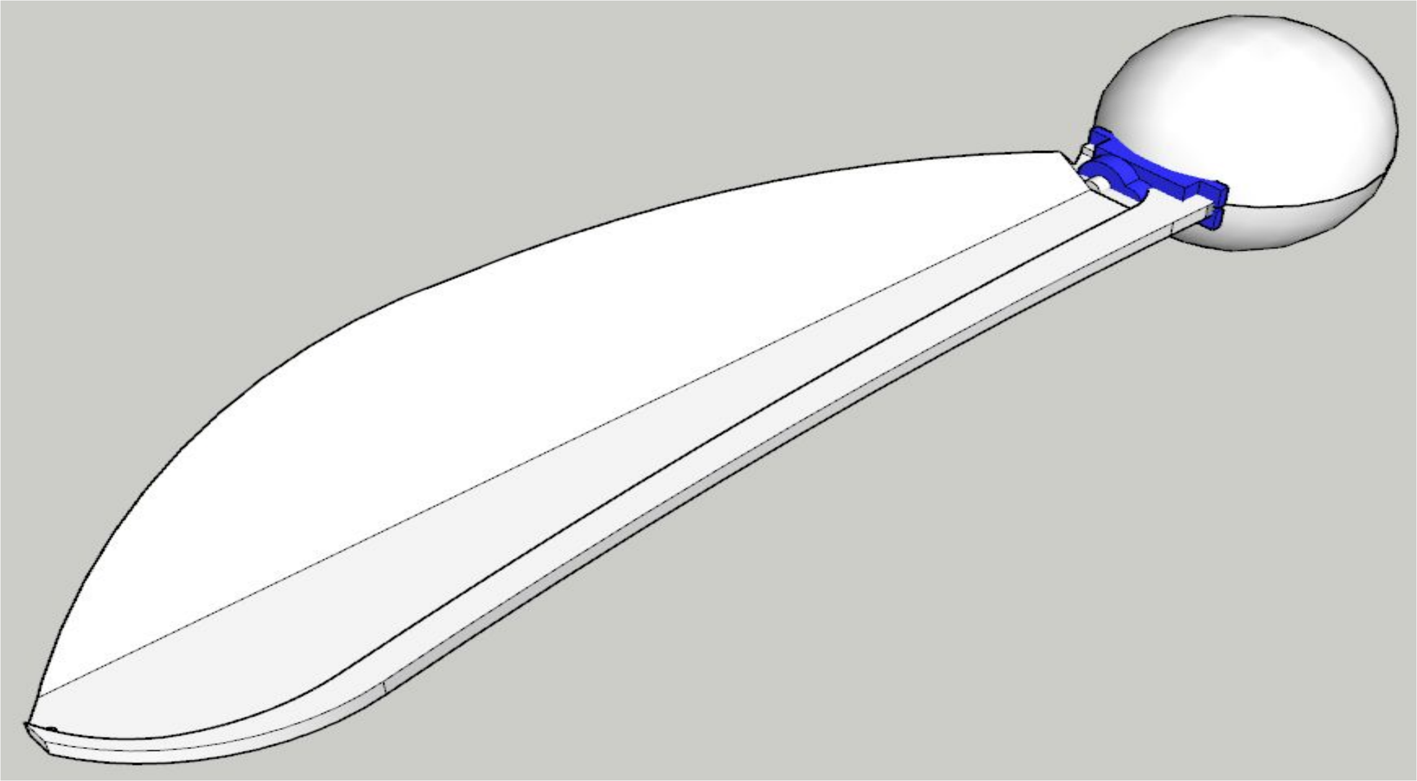
Option A is too complex to build, plus the CG is altered and plumb will be needed to correct CG position increasing weight too much.

OPTION A



We consider the passive stabilization characteristic of the samara wing.

OPTION B



We consider the use of a servo to deflect up and down the middle part of the wing.

Payload Descent Stability Control Strategy Selection and Trade

OPTION A	OPTION B
Easy to build	Complex to build
Lightweight	More weight, considering adding more weight will make it more unstable
Proven design	Need complex algorithms to control the surface

We choose the option A because the option B is far more complex, plus the servo weight will make it more unstable, the flying algorithm could be complex to program.The samara seed had billions of years of evolution, nature has already design a reliable flying geometry

Container Descent Control Strategy Selection and Trade

DOME PARACHUTE

X TYPE PARACHUTE

Container Descent Control Strategy Selection and Trade

DOME PARACHUTE	X TYPE PARACHUTE
Stability is easily ensured by a spill hole.	Easy to stack.
High drag coefficient.	Low drag coefficient.
Easy to make.	Easy to manufacture.
Requires less space when stacked.	Lightweight.
Horizontal displacement is low.	

We selected the Parachute Dome due the following reasons:

- Apogee model 29126 is cheap
- Apogee model 29126 accomplish all requirement
- Apogee model 29126 Will be painted orange to meet requirements

Container Descent Rate Estimate

The area formula of a parachute with spill hole is

$$S_p = \frac{2 \times m \times g}{\rho \times V^2 \times C_D}$$

where

Sp= Area of the parachute with a spill hole ($m2$)

D= The diameter of the parachute mm

V= Descent speed m/s

CD= 1.5 Drift coefficient of parachute

ϱ= 1.225 kg/m3(Air density at +15 C from sea level)

m=0.600kg Container+Payload

g=9.81m/s2

S_(s_H) =Spill hole area

S_Hr =Spill hole radius

Container Descent Rate Estimate

Replacing the data gives the following results

$$S_p = \frac{2 \times (0{,}6kg) \times \left(9{,}81\,\frac{m}{s^2}\right)}{(1{,}225\,\mathrm{kg}/m^3) \times \left(15\,\frac{\mathrm{m}}{\mathrm{S}}\right)^2 \times 1{,}5}$$

Sp=0.02847$m2$

The diameter can be calculated from the formula

$$S_p = \frac{1}{4}\pi D^2$$

Container Descent Rate Estimate

Clearing terms and replacing the data give us

$$D = \sqrt{\frac{4 \times S_P}{\pi}} = \sqrt{\frac{4 \times 0{,}02847m2}{\pi}} = 0{,}1904036m = 190mm$$

The spill house area is chosen to be 5% of the total parachute area

$$S_{S_H} = S_p \times 5\% = \mathbf{0.02847m2} * \mathbf{0,05} = \mathbf{0,0014235m2}$$

Container Descent Rate Estimate

The spill house radius can be determined by

$$S_{Hr} = \sqrt{\frac{S_{sH}}{\pi}} = \sqrt{\frac{0{,}0014235\text{m2}}{\pi}} = 0{,}0212864\text{m} = 21{,}28\text{mm}$$

This give us a parachute of a 190 mm in diameter with a spill house radius of 21,28 mm

Container Descent Rate Estimate

Now we can estimate the descent speed of the container with the two payloads

$$V = \sqrt{\frac{2 \times F_{Drag}}{\rho \times S_P \times C_D}}$$

$$V = \sqrt{\frac{2\times(0.6kg)\times(9.81m/s2)}{1.225kg/m3\times(0.02847m2)\times(1.5)}} = 15m/s$$

With these result we accomplish the mission requirements

Container Descent Rate Estimate

Now we can estimate the descent speed of the container after release of the first payload

$$V = \sqrt{\frac{2\times(0.494kg)\times(9.81m/s2)}{1.225kg/m3\times(0.02847m2)\times(1.5)}} = 14m/s$$

Now we can estimate the descent speed of the container after release of the second payload

$$V = \sqrt{\frac{2\times(0.389kg)\times(9.81m/s2)}{1.225kg/m3\times(0.02847m2)\times(1.5)}} = 12m/s$$

Payload Descent Rate Estimate

Samara wing are simply auto rotating mechanism with billions of years of evolution, however the physic of their flight are very complex.We had collected several samara seed and study them.

Payload Descent Rate Estimate

After several test we choose the best flyer

Payload Descent Rate Estimate

Samara seed flights are difficult to predict, there's a lot of variables that changes the flying pattern and descent speed like air temperature, and there's some important factors that are almost impossible to predict like air speed driven by the weather of the day launch. However it’s possible to estimate the descent rate basing some assumptions:

- Constant temperature
- No horizontal wind
- Vertical release of the payload from repose

A high definition camera and a white wall where used to record videos of the launches of the samara wings, after we choose the best performer we made some other launches and we were able to collect important data.

Payload Descent Rate Estimate

This was our setup, a little mark on the wall was marked with a pen to had a reference tof drop point

Payload Descent Rate Estimate

Property	Value	Units
Mass	50	mg
Span	0.047	m
Max chord length	0.0106	m
Swept disk radius	0.023	m
Swept disk area	0.0017	m2
descent velocity	0.71	m/s

Payload Descent Rate Estimate

According to A. Azuma, K. Yasuda, Flight performance of rotary seeds, Journal of Theoretical Biology 138 (1) (1989) 23–53 and Gessow and Myers Aerodynamics of the Helicopter, Frederick Ungar, 1952 researches in samara seed flying characteristic had establish a relationship between the falling speed V, mass G, air density ρ ,and area described in descent flight without horizontal wind A

$$v = \sqrt{\frac{2mG}{\rho A}}$$

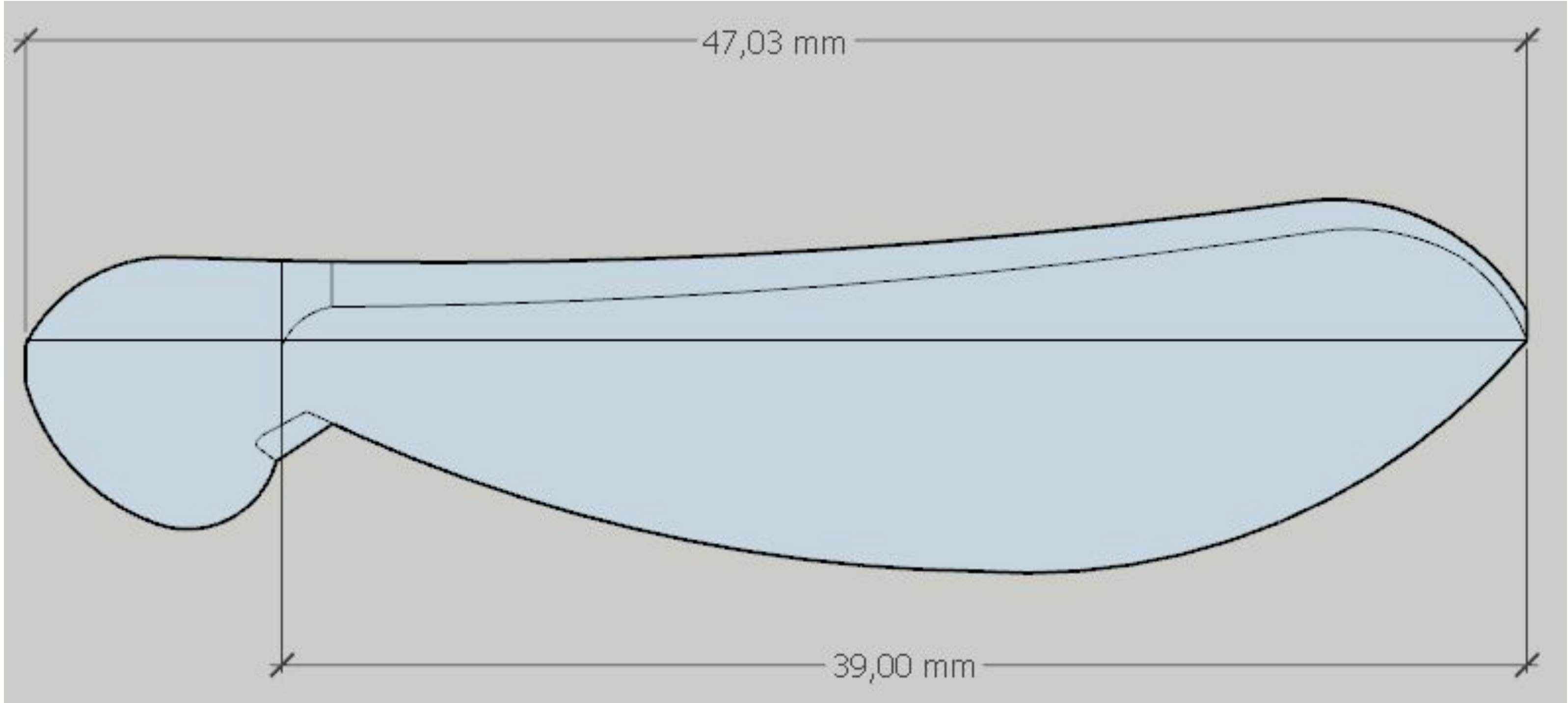
After replacing the data of the selected samara wing we get very approximate results, some difference can occur due human error factor in taking the samples

$$\sqrt{\frac{2 * 0{,}00005kg * 9{,}8\ m/s\hat{}2}{1{,}225\text{kg/m}\hat{}3 * 0{,}0017m\hat{}2}} = 0{,}68m/s$$

Payload Descent Rate Estimate

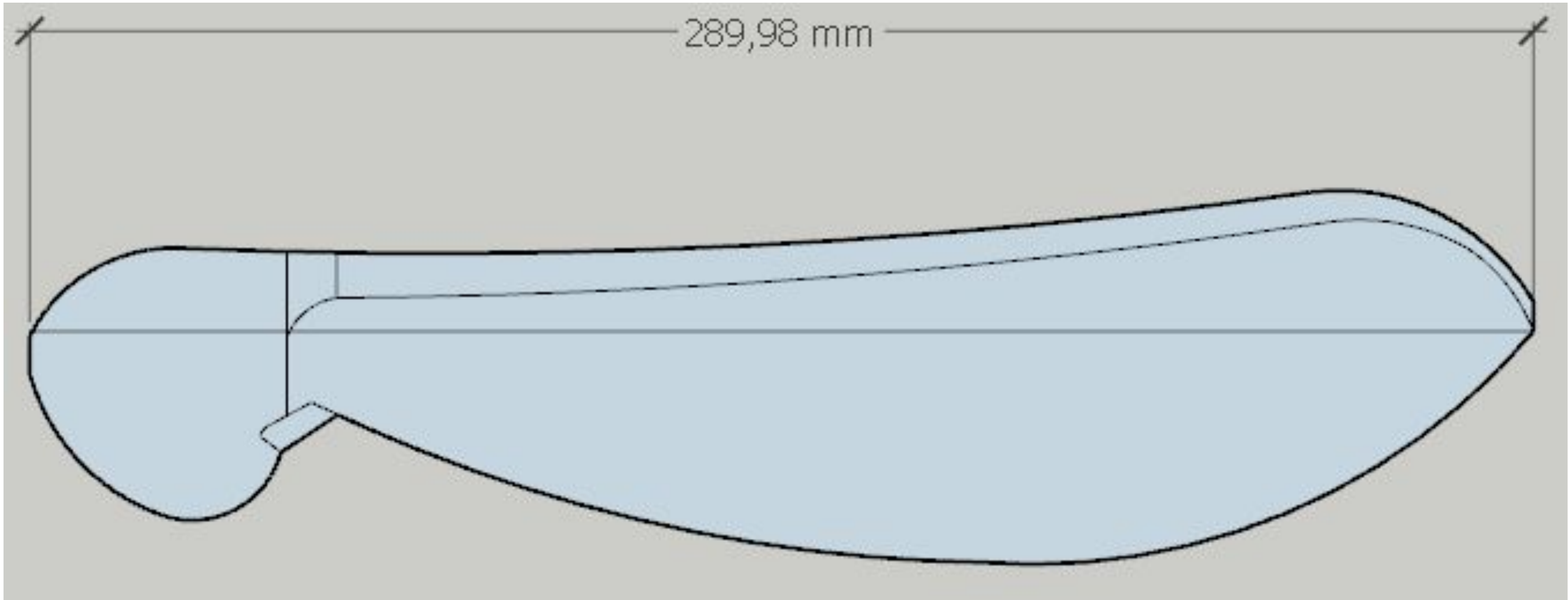
Now given the container size restriction we come to the conclusion that the maximum length must be 290mm of length, taking the original samara seed and scaling it up taking by reference the wingspan this give us a scale of 6,16.

Original samara seed



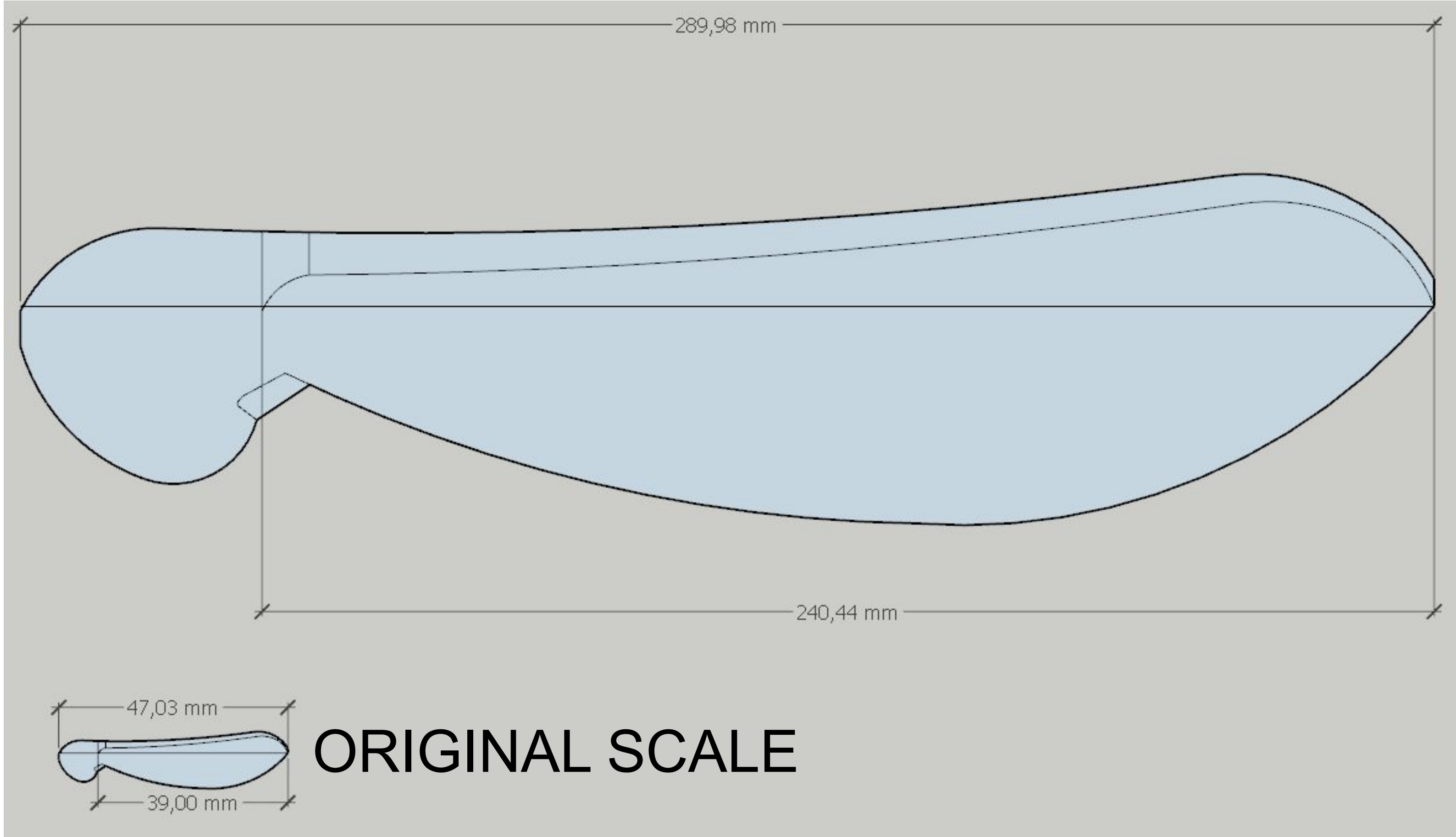
Payload Descent Rate Estimate

We scale it up and draw the profile in a CAD software.



Payload Descent Rate Estimate

Scaled samara seed



Payload Descent Rate Estimate

Assuming that the scaled wing seed will be performing similarly in proportion of 6,16 we can assume that the swept area would be 6,16 times either, so using the previous equation we can estimate the descent velocity of the scaled model.

$$V = \sqrt{\frac{2\times(0.1052kg)\times\left(9{,}81\,\frac{m}{s^2}\right)}{1.225\,\frac{kg}{m^3}\times(0.010472m^2)}} = 12{,}68m/s$$

With this results we accomplish mission requirements

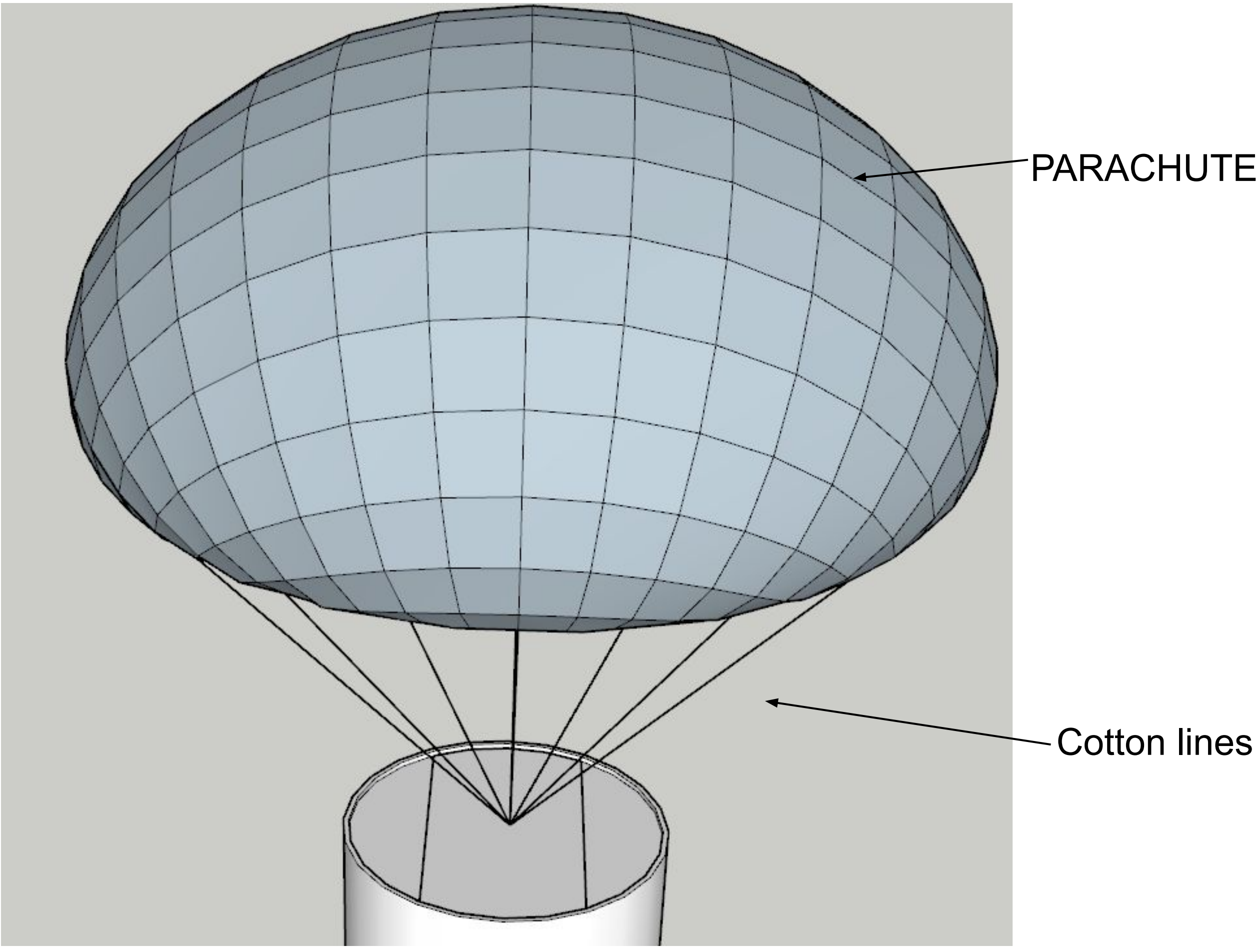
Mechanical Subsystem Design

JORGE ROYON

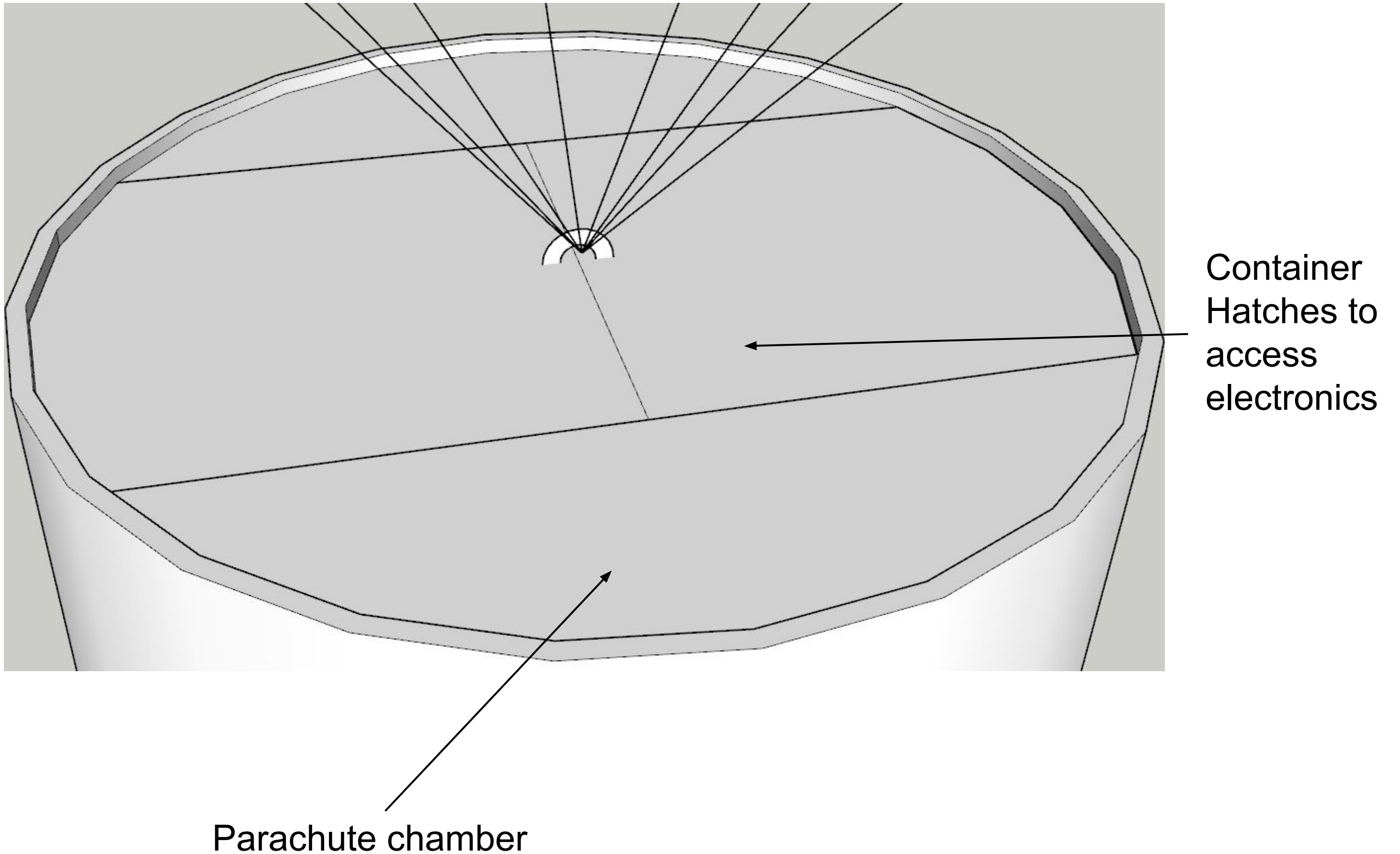
Container

- 12 cm diameter by 30 cm length
- 3D printed in pla in thin walls of 0,8mm
- Estimate weight of 207,5gr

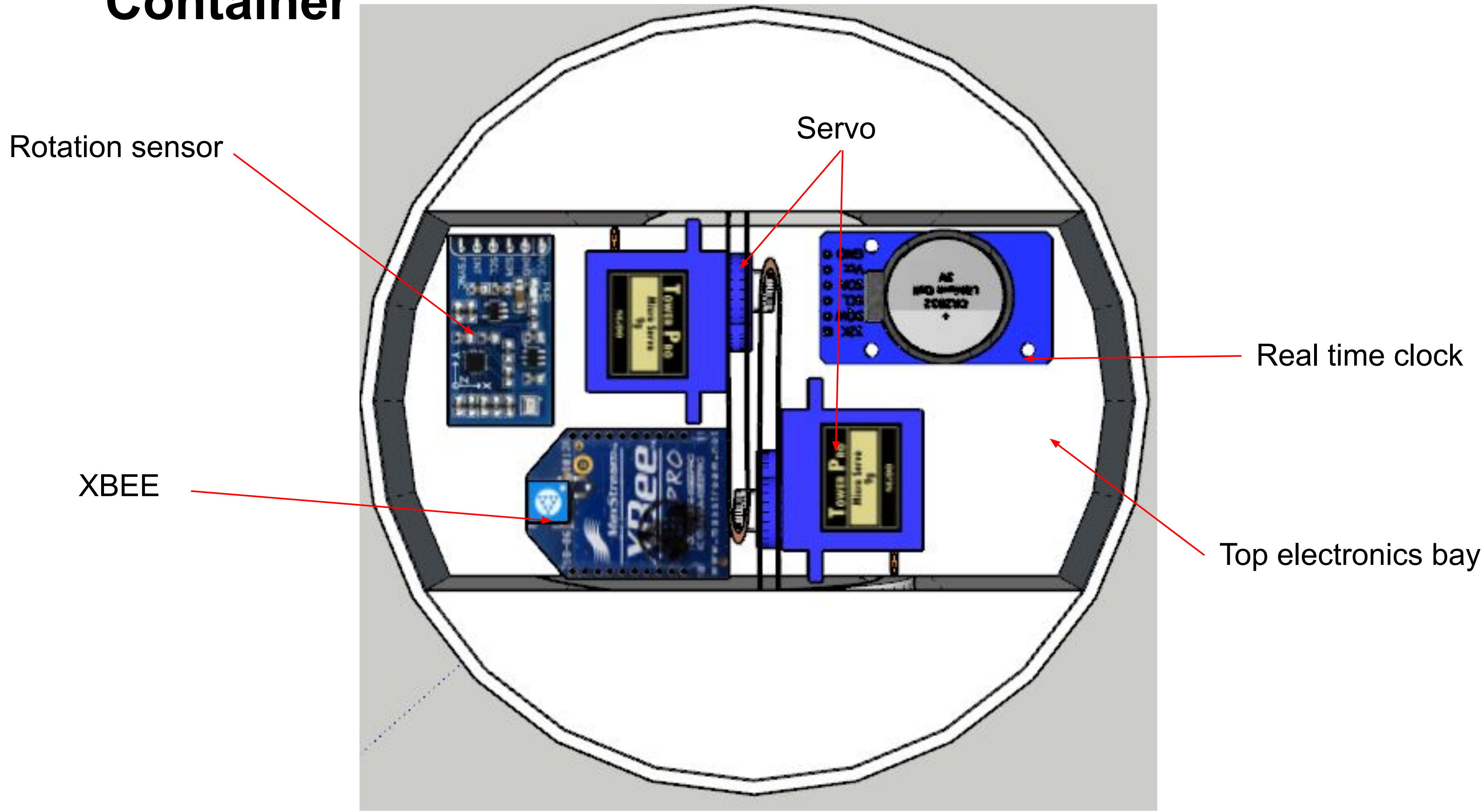
Container



Container

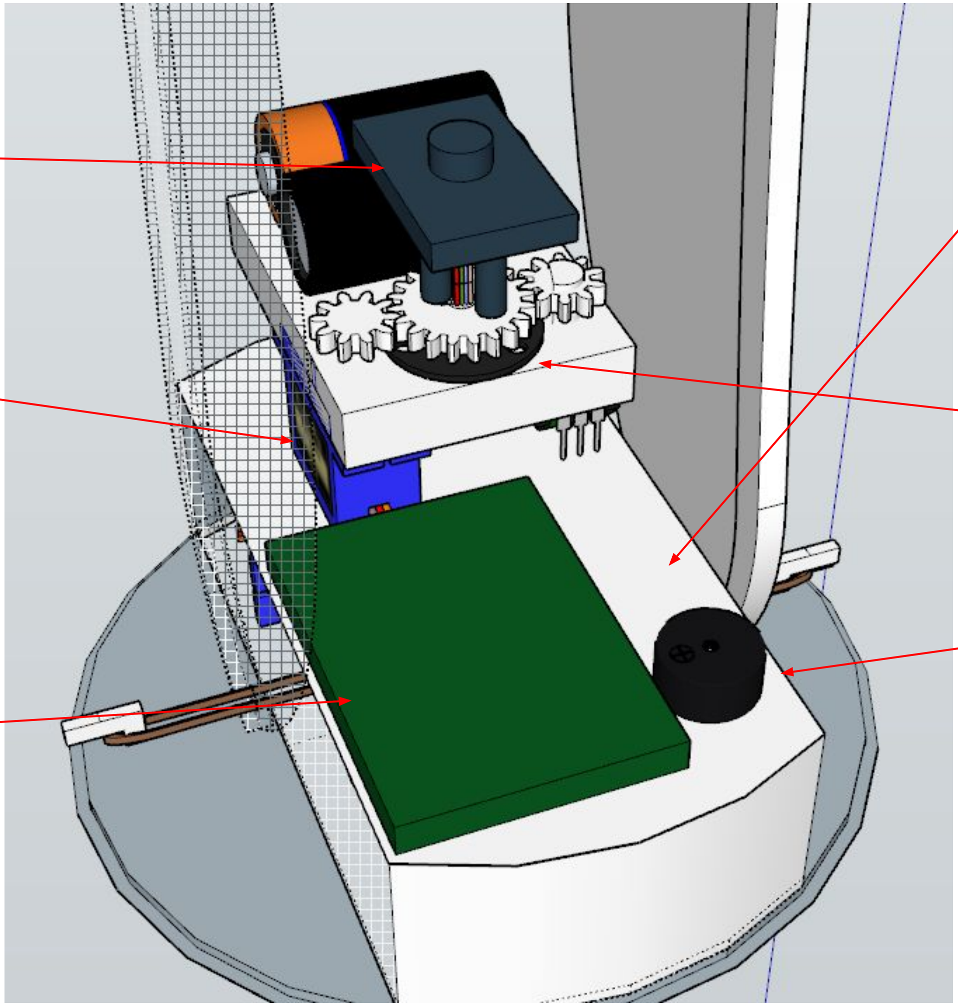

Container
Hatches to
access
electronics
Parachute chamber

Container


Rotation sensor
Servo
Real time clock
XBEE
Top electronics bay

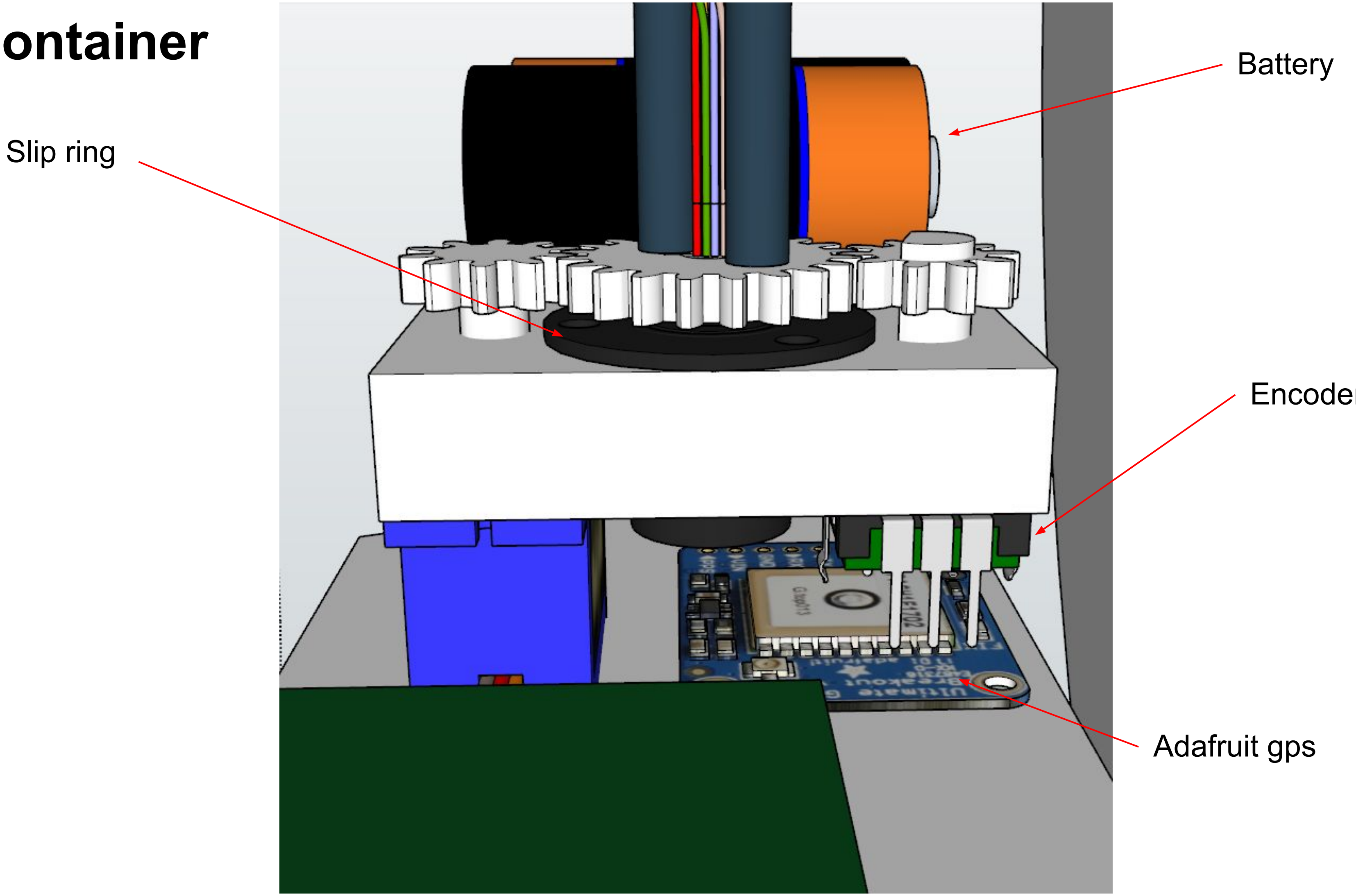
Mechanical Subsystem Overview

Container

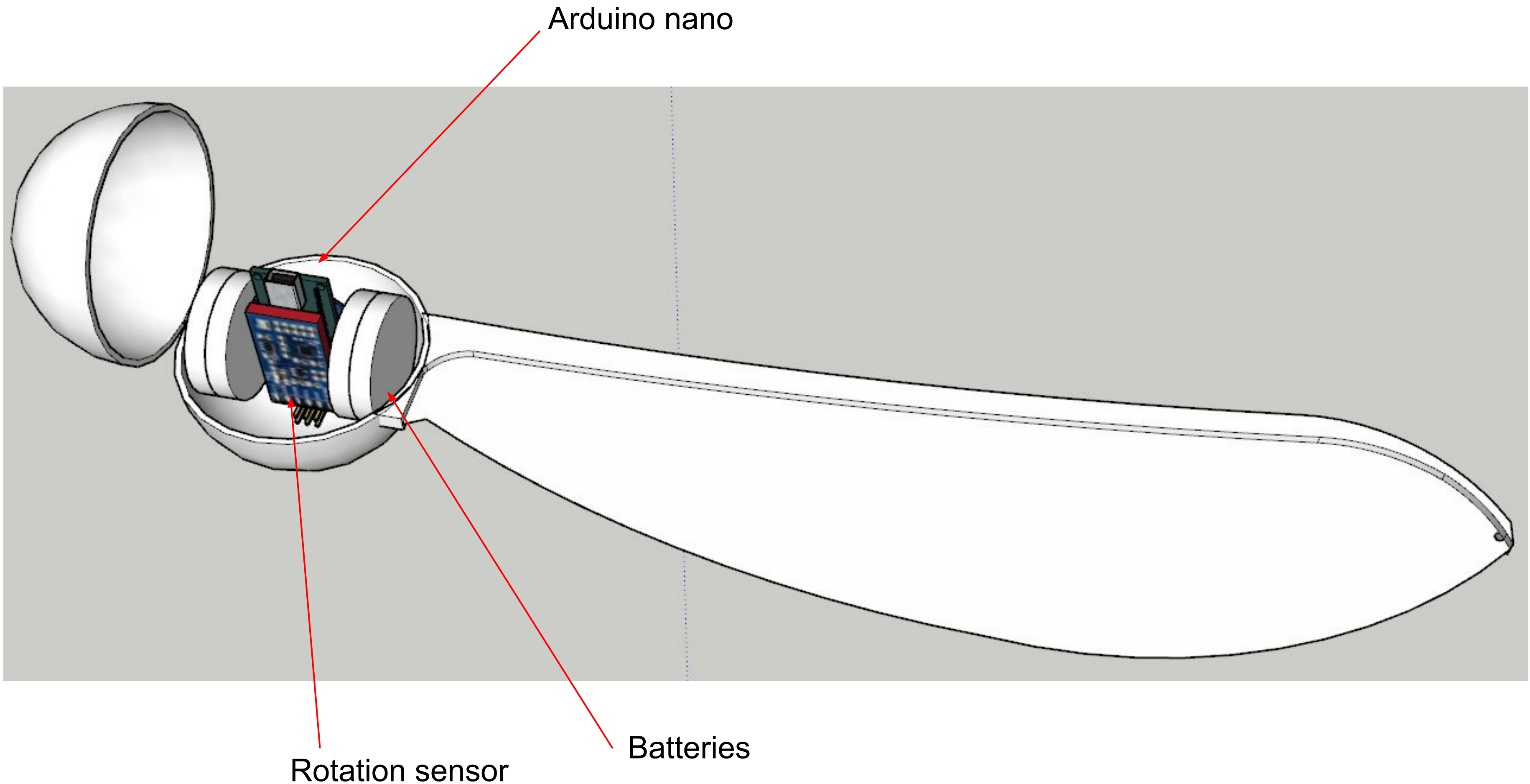


Mechanical Subsystem Overview

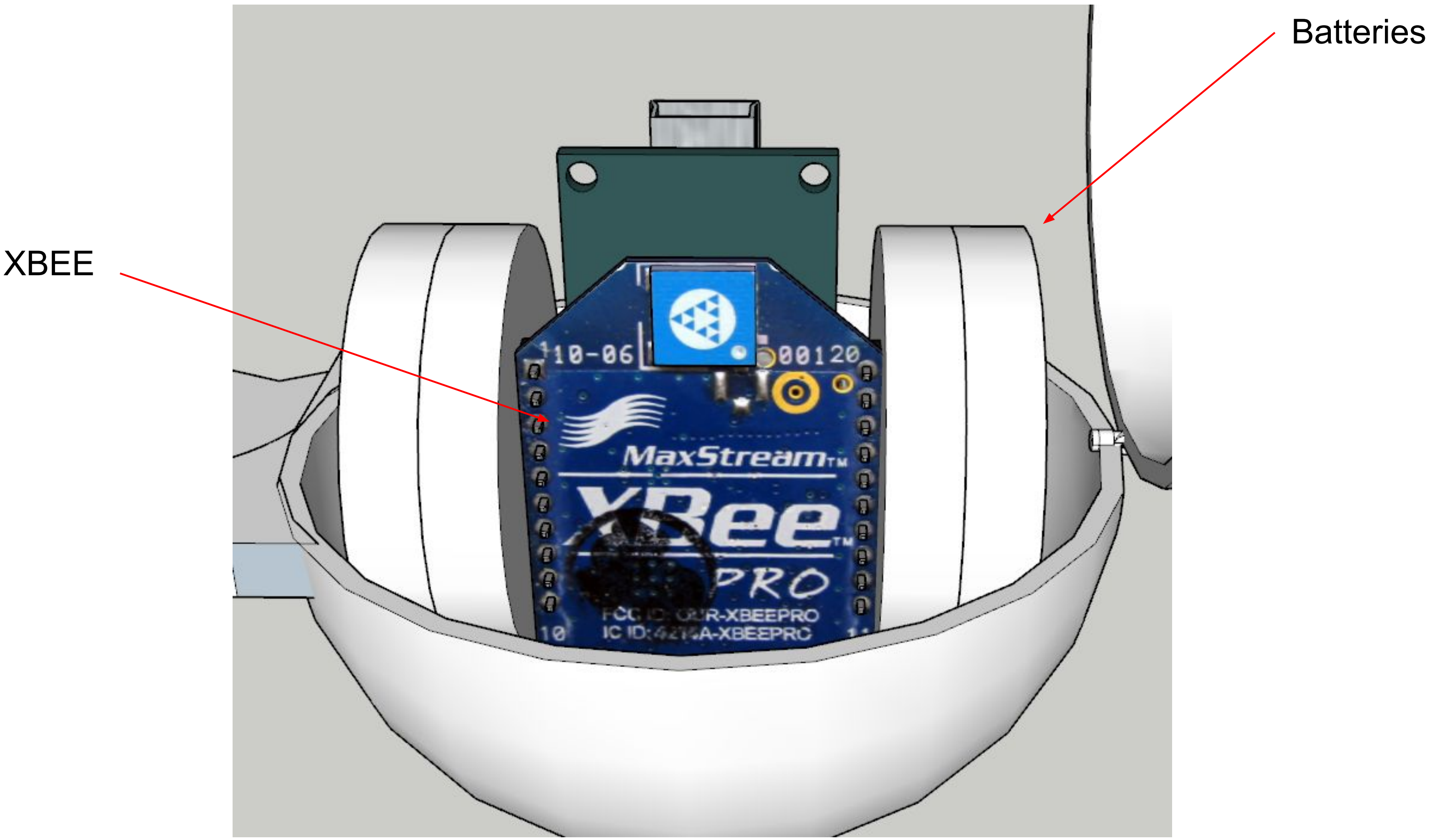
Container



Payload



Payload


XBEE
Batteries
MaxStream
XBee
PRO
FCC ID: OUR-XBEEPRO
IC ID: 4214A-XBEEPRO

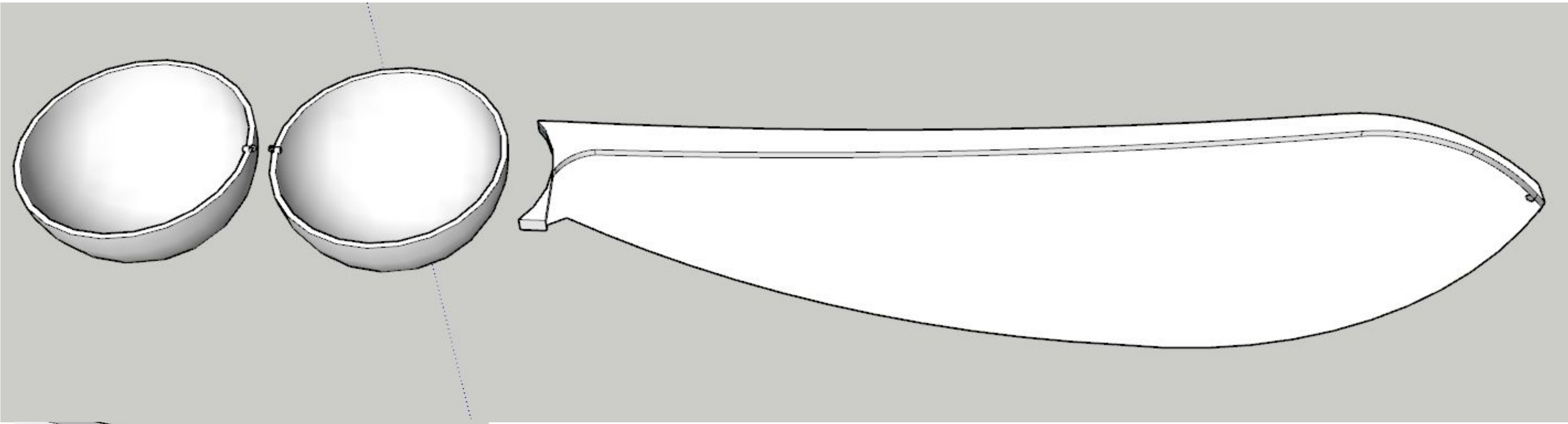
Mechanical Sub-System Requirements

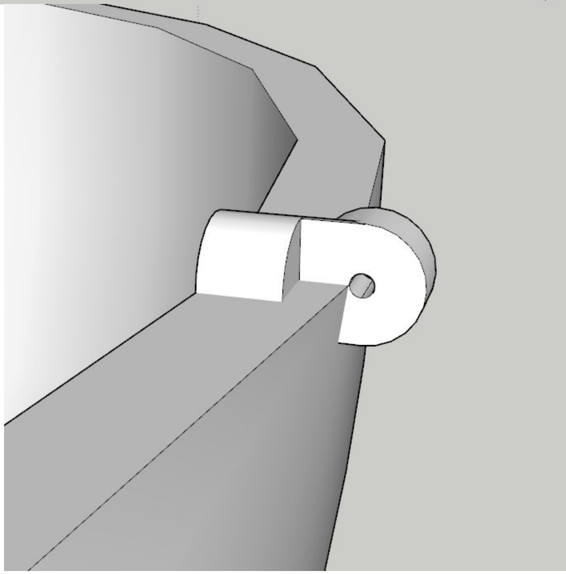
RQ	Description	Rationale
1	Total mass of the CanSat (science payloads and container) shall be 600 grams +/- 10 grams.	CReq
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	CReq
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	CReq
5	The container shall be solid and fully enclose the science payloads. Small holes to allow access to turn on the science payloads is allowed. The end of the container where the payload deploys may be open.	CReq
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	CReq
7	The rocket airframe shall not be used as part of the CanSat operations.	CReq
8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	CReq
11	All structures shall be built to survive 15 Gs of launch acceleration.	CReq

Mechanical Sub-System Requirements

RQ	Description	Rationale
12	All structures shall be built to survive 30 Gs of shock.	CReq
14	All mechanisms shall be capable of maintaining their configuration or states under all forces.	CReq
15	Mechanisms shall not use pyrotechnics or chemicals.	CReq
16	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	CReq
44	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	CReq
45	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	CReq

Payload Mechanical Layout of Components Trade & Selection



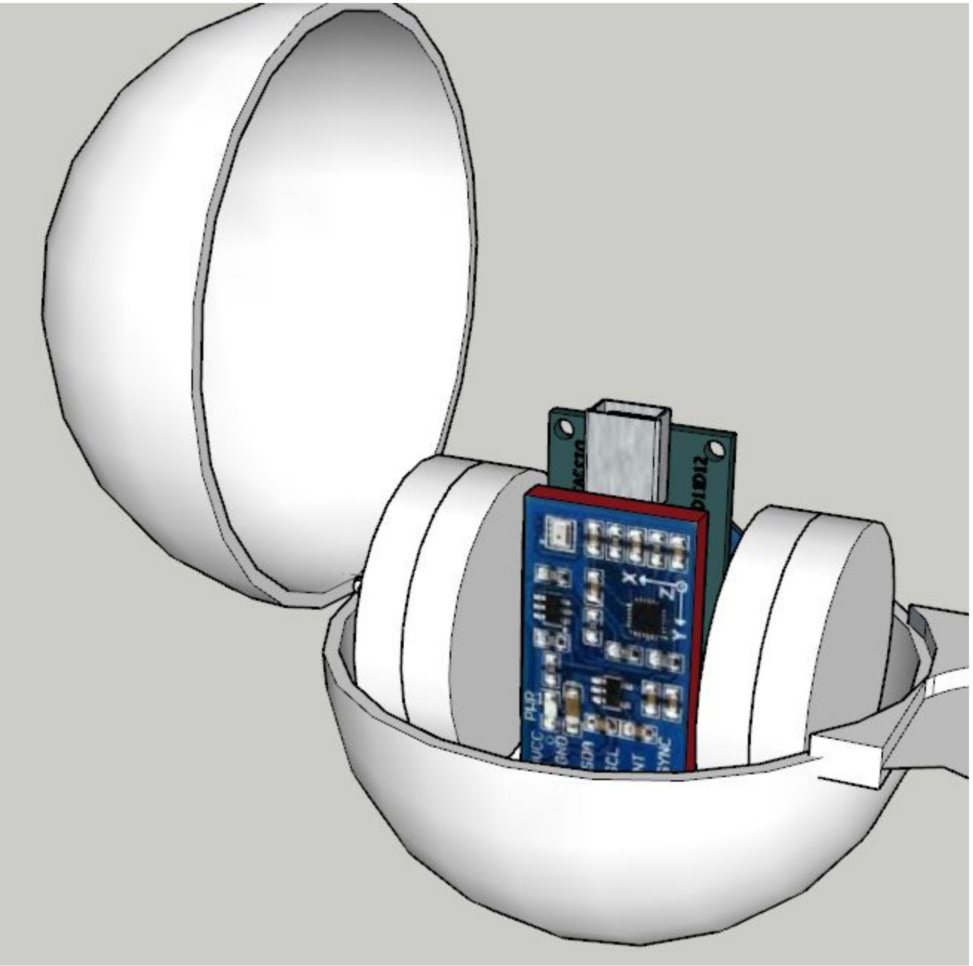


Payload is composed of 3 parts:

1. 3D printed semi sphere with hinge
2. 3D printed semi sphere with hinge
3. Wing made of balsa wood

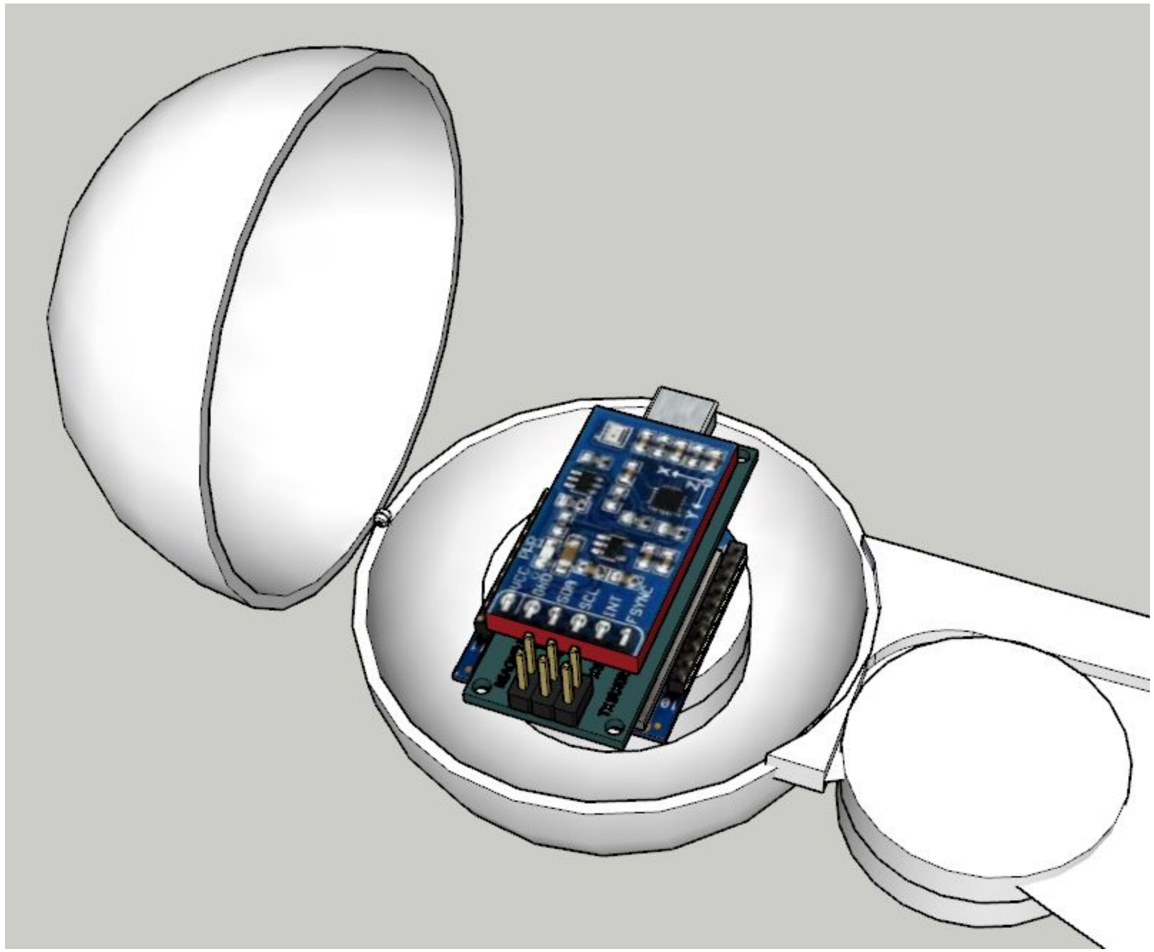
When parts are ready for assembly we glue the wing to a semi sphere and with a piano thin wire we connect the hingue

DESIGN A



Electronics are placed inside the semi sphere in a vertical way and secured
with rubber foam cut to shape with the batteries attached to its laterals with double foam tape and CA glue

DESIGN B



Electronics are placed in a horizontal way inside the semi sphere with the batteries attached to the bottom and the other two glued to the root of the wind

Payload Mechanical Layout of Components Trade & Selection

DESIGN A

PROS	CONS
Better center of gravity	Harder to secure electronics

DESIGN B

PROS	CONS
Easy to secure electronics	Center of gravity is displaced

We choose design A because putting the battery in the root of the wing is complicated and because is a heavy component center of gravity will be heavily modified

Payload Mechanical Layout of Components Trade & Selection

Materials

Component	Material	Pros	Cons
Semi sphere	PLA	Easy to print	Weak and heavy
	ABS	Slight lighter than PLA	Difficult to print
		Stronger and durable	Tends to warp and deform in printing process
		Easy to glue	

For the Semi sphere we choose to 3d printed in abs because is lightweight and easy to glue

Payload Mechanical Layout of Components Trade & Selection

Materials

Component	Material	Pros	Cons
Wing	PLA	Easy to print	Weak and heavy
	ABS	Slight lighter than PLA	Difficult to print
		Stronger and durable	Tends to warp and deform in printing process
		Easy to glue	
	Carbon Fiber	Extreme lightweight	Expensive
		Strong and flexible	Difficult to work it
	Balsa wood	Very lightweight	Weak
		Easy to work it	Time consuming
		Easy to glue	

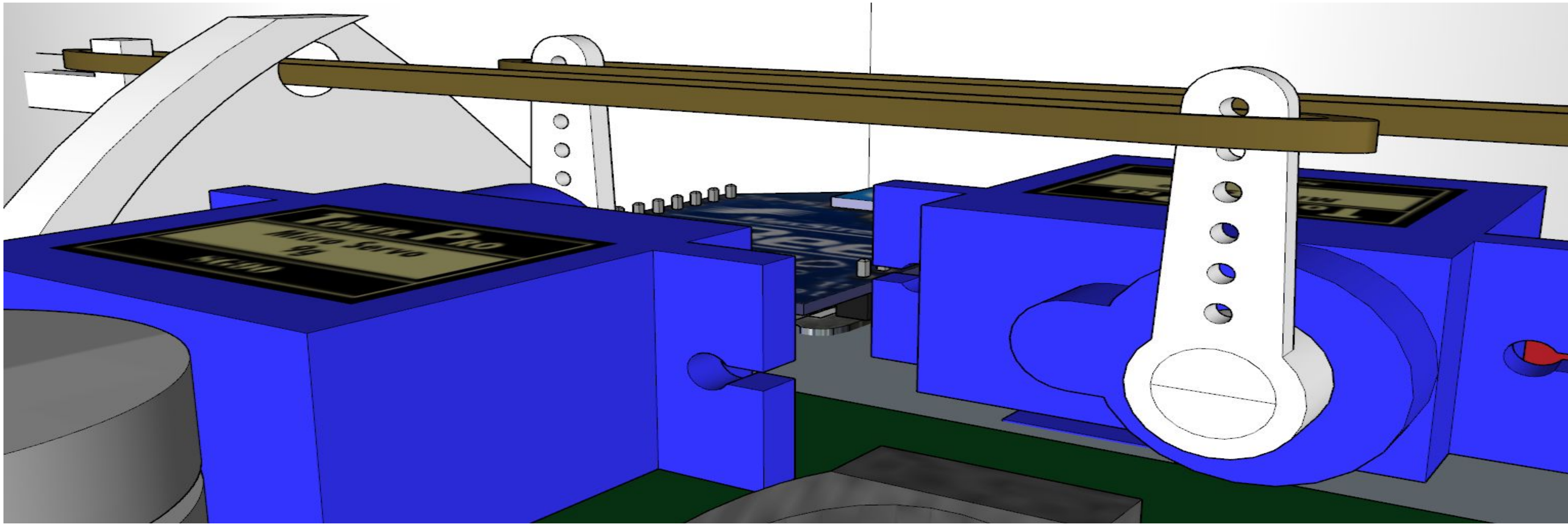
Payload Mechanical Layout of Components Trade & Selection

Materials

For the wing we choose to made it of balsa wood because is very lightweight and easy to glue

Payload Pre Deployment Configuration Trade & Selection

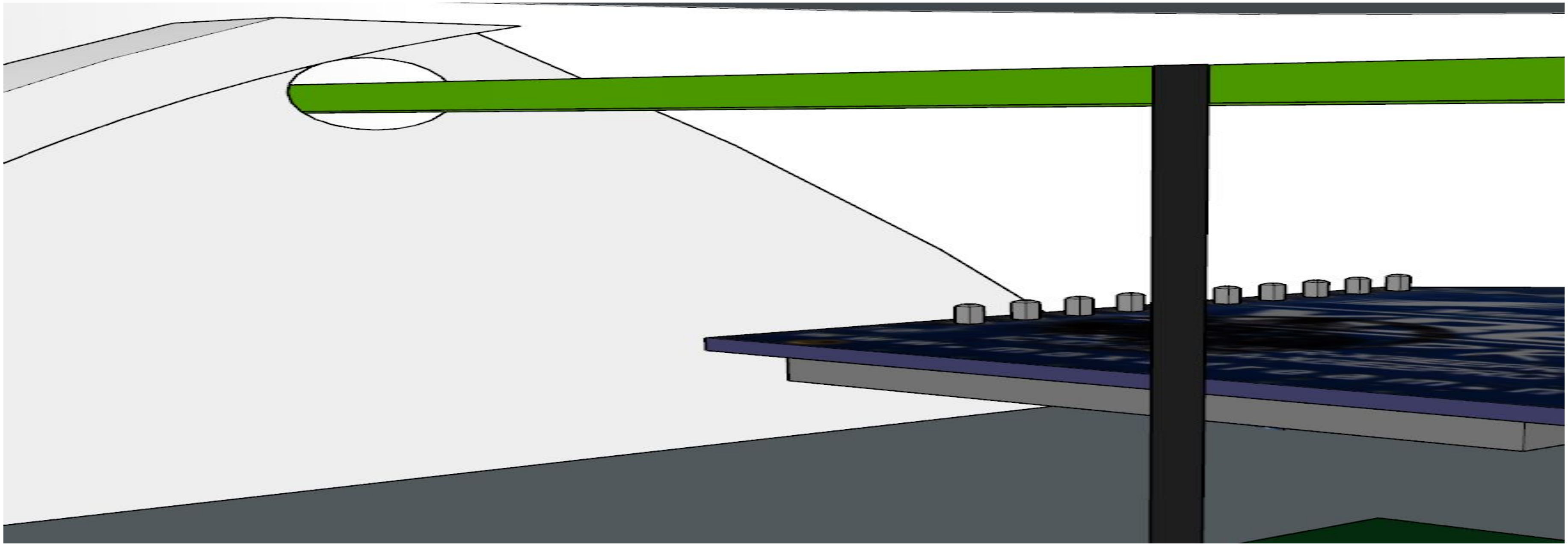
OPTION A



The payloads are released using a servo and a rubber band

Payload Pre Deployment Configuration Trade & Selection

OPTION B



The payloads are released using a fishing line and cut with a kapton tape that melts a fishing line

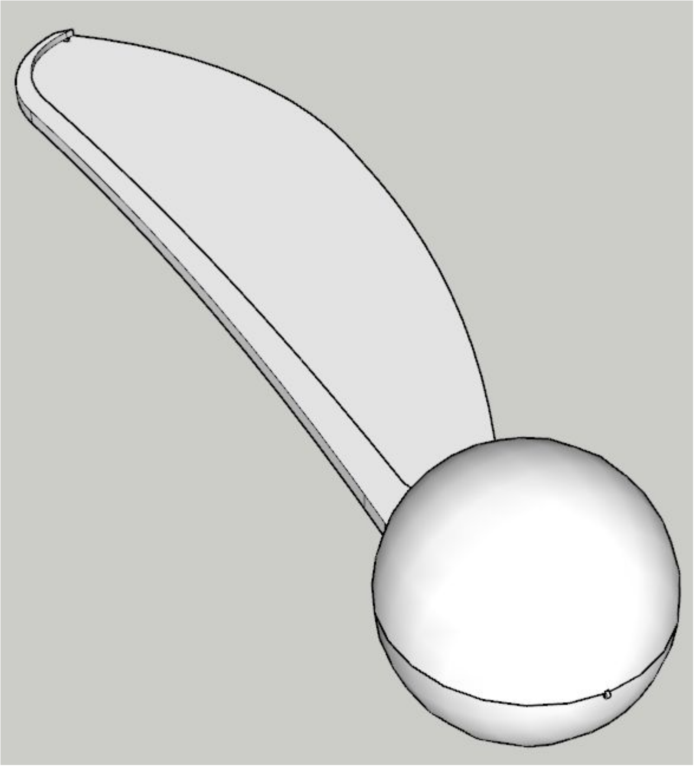
Payload Deployment Configuration Trade & Selection

	PROS	CONS
DESIGN A	Reliable mechanism	Expensive, need two servos for each payload
DESIGN B	Simple design	can fail
		Need a lot of current of the battery

We choose the design A because the nichrome cable need a lot of current that the selected battery can had problem to deliver

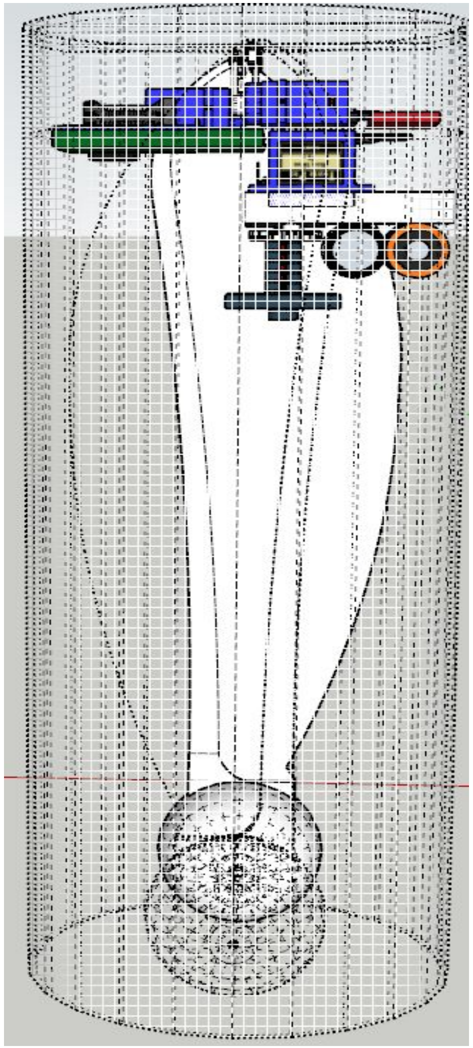
Payload Deployment Configuration Trade & Selection

Payload is designed in a way that it doesn't constrain o expand in any direction, so there's no need for a stowed mechanism



Container Mechanical Layout of Components Trade & Selection

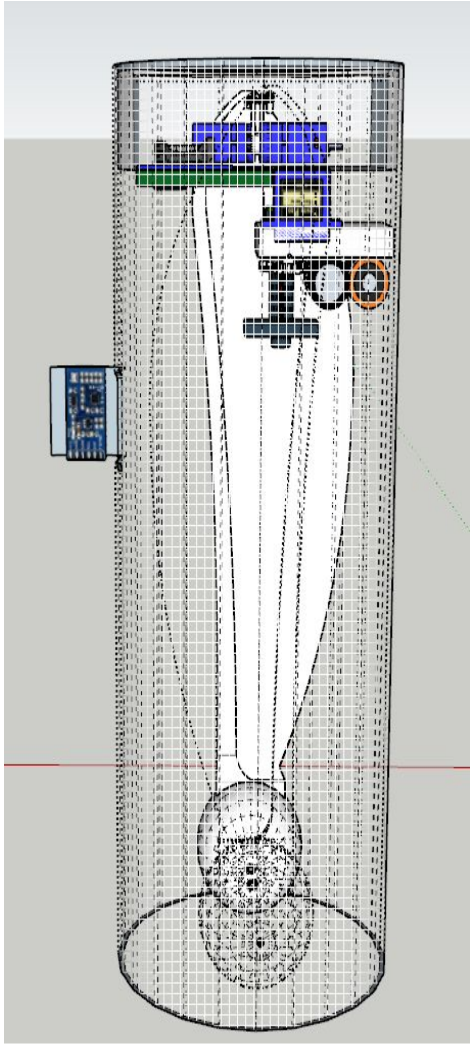
DESIGN A

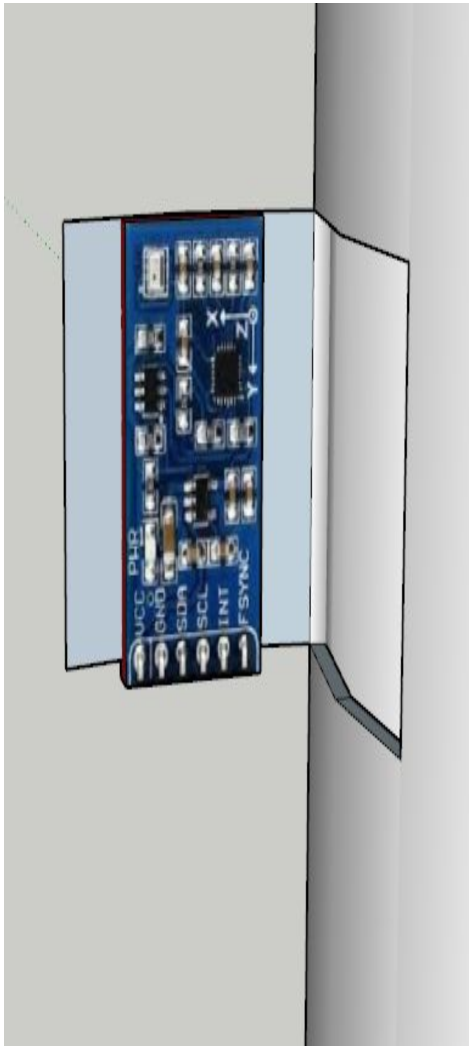


Container has a top compartment with a removable hatches for access electronics

Container Mechanical Layout of Components Trade & Selection

DESIGN B





Container has a top compartment with a removable hatches for access electronics and lateral door for rotation sensor

Container Design

Design	Pros	Cons
A	Simple design	Uncomfortable to install electronics
	Easy to make it	rotation sensor is not vertical
B	Rotation sensor in vertical position	Payload can stuck if the sensor is not well placed
	Rotation sensor is in vertical position what make it easy to measure rotation angles	Need extra hardware, hingues or latches

We choose design A because electronics are agrupated and easy to install

Container Materials

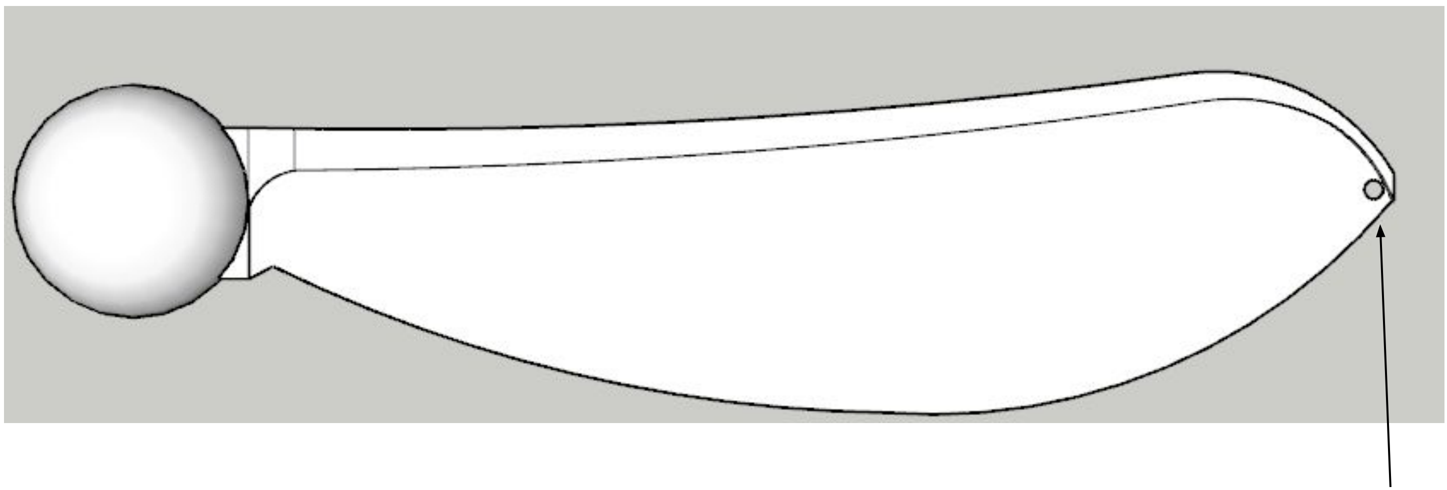
Material	Pros	Cons
Balsa wood	Lightweight	Weak
	Easy to work it	
PLA	Easy to print	Heavy
	3D printed, tight tolerances is easy to achieve	Relative weak
ABS	Hard to print	Must be printed in parts due vertical warping in printing process
	3D printed, tight tolerances is easy to achieve	Acceptable strong
Carbon fiber	Extreme lightweight	expensive
	Strong	Hard to work it

Container

We choose to 3D print the container in thin walls because electronics are installed closed of each other and precision is required

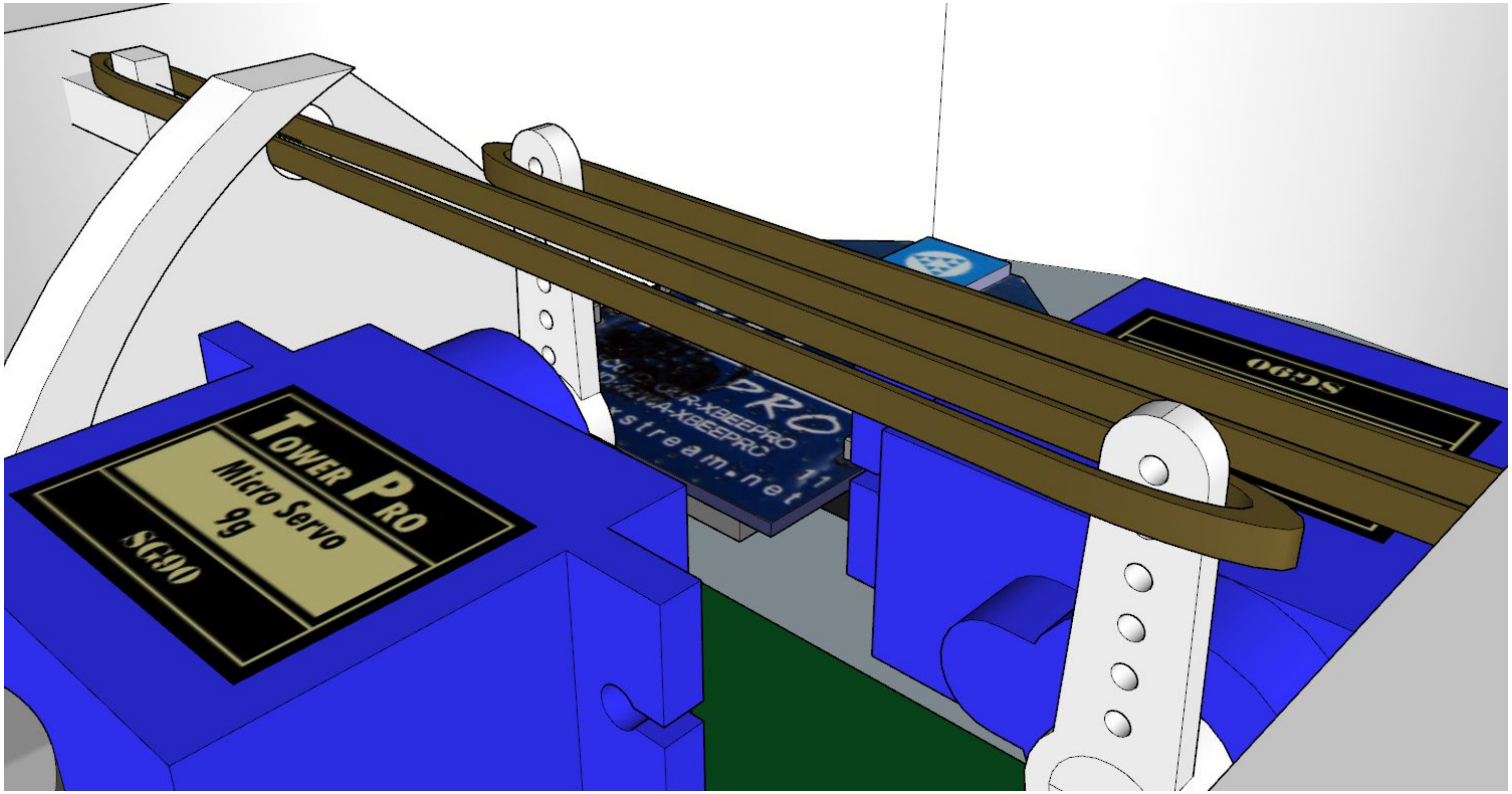
Payload Release Mechanism

Payload has a small hole in the wing that allows a rubber band to pass



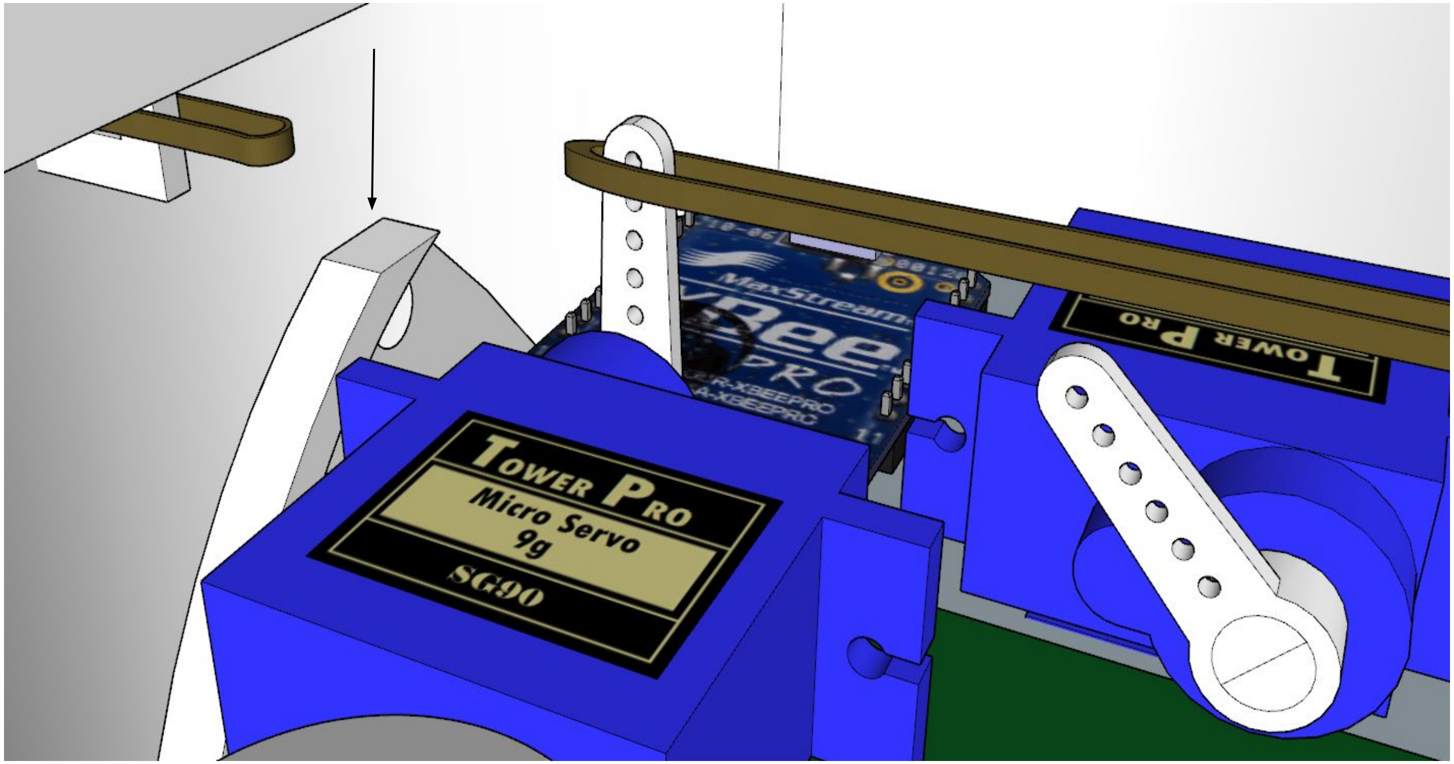
Payload Release Mechanism

The container has a hook in a inner wall, then a servo is used to lock the rubber band



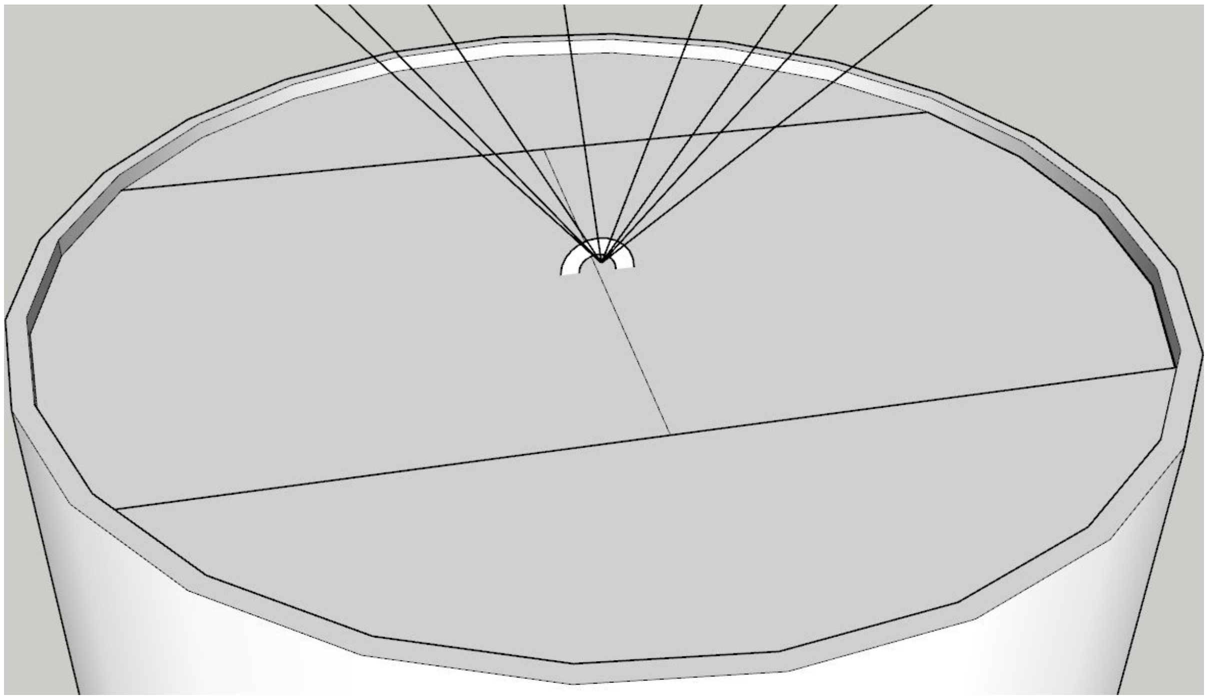
Payload Release Mechanism

Then the servo move the arm and release the rubber band that causes the release of the payload form the container that falls from his own weight



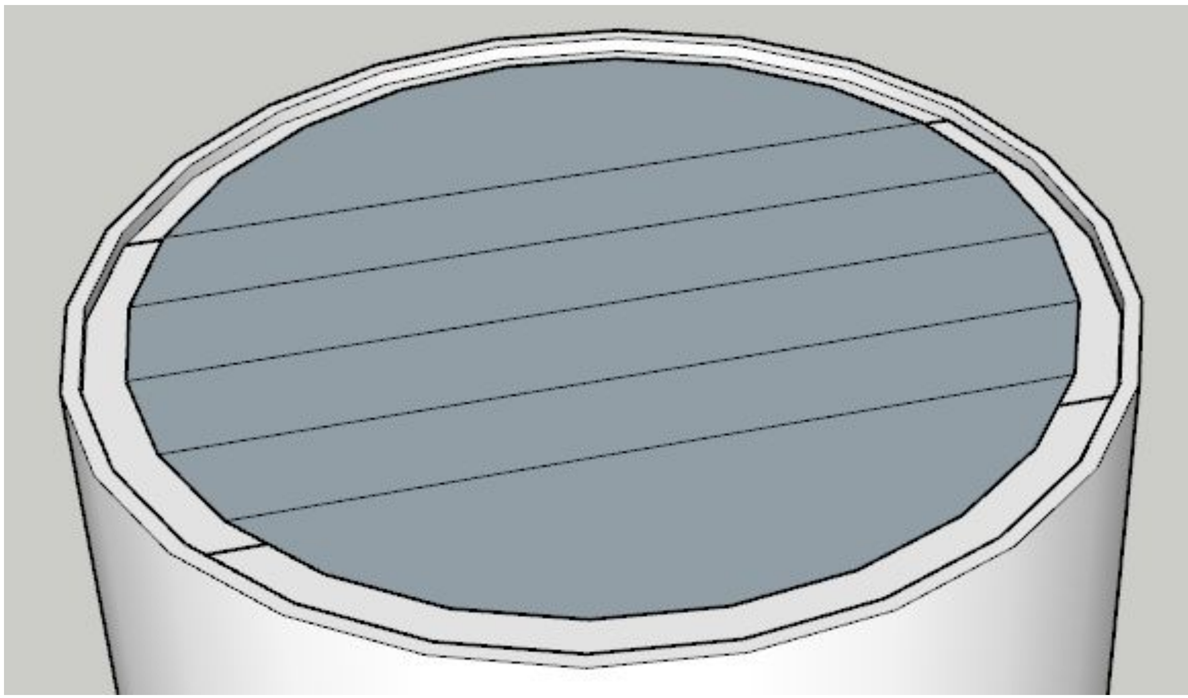
Container Parachute Attachment Mechanism

The container hatches has a small hook to attach the cottom lines of the parachute



Container Parachute Attachment Mechanism

The parachute is packed in and put in the top of the container



Electronics Structural Integrity

Securing Electrical Connections

- **Depending on the connection components, proper methods for securing will be used.**

Electrical connection methods are:

- ➢**Soldering**
- ➢**Cyanoacrylate**
- ➢**Electric tape**
- ➢**Thermo contractible tube**
- ➢**hot glue**

PAYLOAD MASS

PART	mass gr	Data type
XBee	40	D
10 DOF IMU Sensor	4	D
Arduino nano	7	D
lir3048 (x4)	29.2	D
Air frame	25	E
TOTAL PAYLOAD MASS	105.2 gr	

D:Datasheet
E:Estimated

CONTAINER MASS

PART	mass gr	Data type
XBee	40	D
10 DOF IMU Sensor	4	D
Arduino mega 2560 mini	5	D
CR123A (x2)	33	D
Frame	207,5	E
Container parachute	11	E
Adafruit Ultimate GPS	8,5	D
Servo	9	D
Camera	13	D
Buzzer	15	D

Mass Budget

CONTAINER MASS

PART	mass gr	Data type
3D printed parts	3	E
Encoder	4	D
misc, (cotton wires, screw)	8	E
Real time clock	8	d
TOTAL CONTAINER MASS	369 gr	

Mass Budget

CANSAT MASS

PART	Mass gr
PAYLOAD 1	105.2
PAYLOAD 2	105.2
CONTAINER	369
TOTAL	579.4

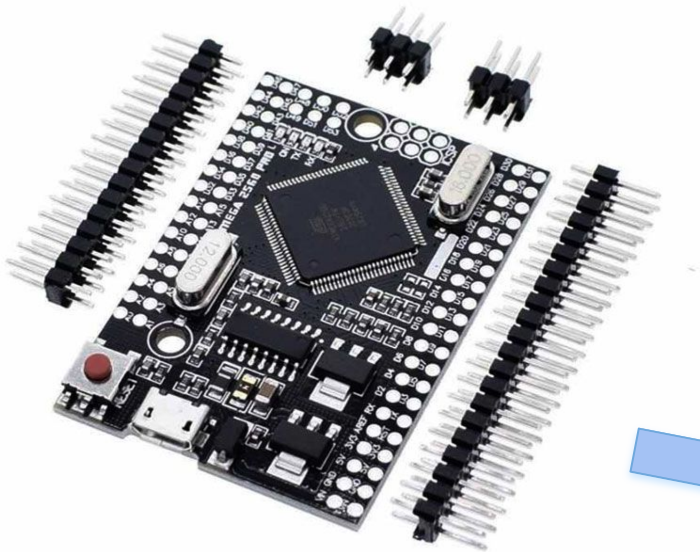
CANSAT MASS

Total mass of the cansat is estimated in 579.4 gr, to reach the 600 gr mark we can add little plumbs in the container, and if its too heavy we can made holes in the lateral walls of the container and cover them with MONOKOTE to reduce weight

Communication and Data Handling (CDH) Subsystem Design

Agustina Romero
Nicole Agustina Castro

Container Command Data Handler (CDH) Overview



Arduino 2560 mega mini: A *Arduino mega*, is used to get data from sensors, transmit it to the XBee PRO S2C and control the container.

XBee PRO S2C: A *XBee PRo S2C module* is a transceiver. It is used to transmit and receive data between the payloads and the ground station.

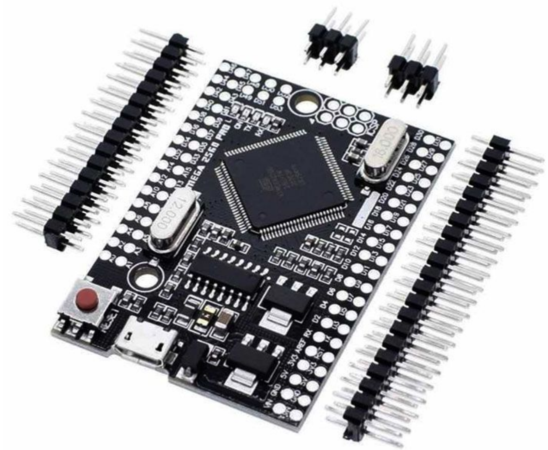
Container CDH Requirements

RQ	DESCRIPTION	RATIONALE	PRIORITY
19	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed	CReq	High
20	XBEE radios shall have their NETID/PANID set to their team number	CReq	High
21	XBEE radios shall not use broadcast mode	CReq	High
31	The container shall include electronics to receive sensor payload telemetry.	CReq	High
32	The container shall include electronics and mechanisms to release the science payloads.	CReq	High
33	The container shall include a GPS sensor to track its position.	CReq	High
34	The container shall include a pressure sensor to measure altitude.	CReq	High
35	The container shall measure its battery voltage.	CReq	High
36	The container shall transmit its telemetry and the payload telemetry received once per second in the format described in the Telemetry Requirements section.	CReq	High
37	The container shall stop transmitting telemetry when it lands.	CReq	High

Container Processor & Memory Trade & Selection

MODEL	BOOT TIME	PROCESSOR SPEED	I/O PINS	INTERFACES	MEMORY STORAGE REQUIRED	SUPPLY VOLTAGE	PRICE
Arduino Nano	4.84 s	16 MHz	Analog In[8] PWM [6] Digital[62]	I2C [1] SPI [1] UART [1]	Flash-32 KB SRAM-2 KB EEPROM-1 KB	5V-9V	$ 22,00
Arduino Mega 2560 mini	3.50 s	16 MHz	Analog In[16] PWM [14] Digital[70]	I2C [1] SPI [5] UART [4]	Flash-256 KB SRAM-8 KB EEPROM-4 KB	5V-12V	$ 24,93

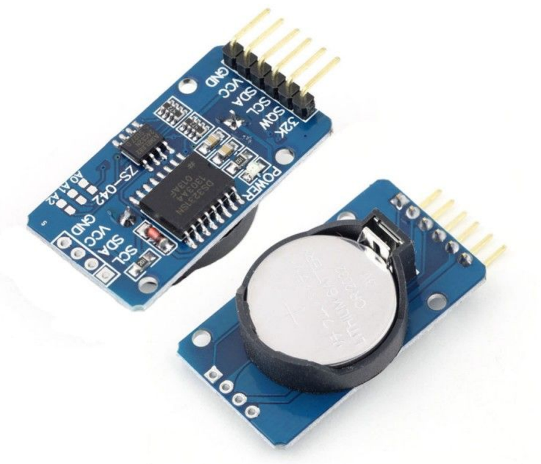
We choose Arduino Mega 2560 mini due to availability and performance



Container Real-Time Clock

MODEL	TYPE	VOLTAGE	CURRENT	ACCURACY	RESET TOLERANCE	PRICE
Raspberry DS1307	Hardware	5V	300 µA	±2 ppm	In reset condition external clock continues keeping time	$ 2,20
Arduino RTC DS 3231	Hardware	3,3V	200 µA	±2 ppm	In reset condition external clock continues keeping time	$ 2,00

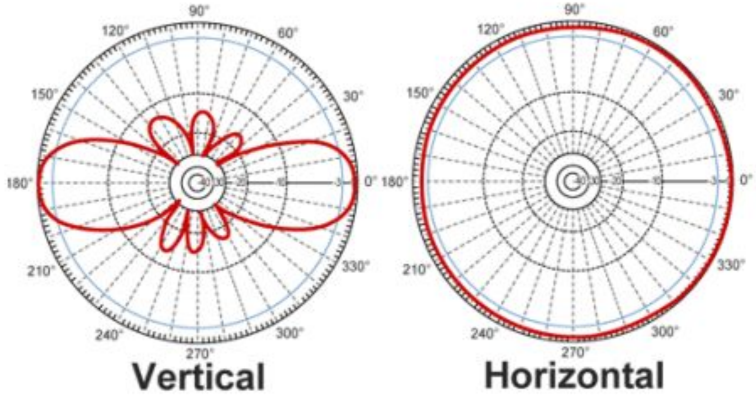
We chose the Arduino DS 3231 because it is cheaper, consumes less energy, and is enough for what we need



Container Antenna Trade & Selection

MODEL	CONNECTION TYPE	FREQUENCY	DIRECTION	GAIN	BEAM WIDTH HORIZONTAL/ VERTICAL	PRICE
LGTERK WiFi Antenna	RP - SMA	2.4 GHz	Omnidirectional	5dBi	360°/32°	$9,59
Generic 2.4GHz	RP - SMA	2.4 GHz	Omnidirectional	2dBi	360°/32°	$2.00

We chose the generic antenna because we can peel off the plastic cover of the antenna to fit inside the container, plus the xbee's range exceeds the operational limit easily, so not as much gain is needed. Transmit power of XBee S2C is 250 mW 24dBm software selectable



Container Radio Configuration

- **XBEE radio selection: XBee PRO S2C**
- **NETID: 1231**
- **TRANSMISSION CONTROL:** The XBee in the container is set as Coordinator and the XBee in the ground station is set at Endpoint In all of the mission phases the Coordinator transmits the telemetry data to the Endpoint. In addition, the coordinator in the container receives the data from the modules in the payloads while they are in flight and sends it to the ground station.
- **Data rate:** The xbee in the container is set to transmit de data to the ground station at 1 Hz transmission rate
- Both xbees communicate in unicast mode

Container Telemetry Format

DATA FORMAT	SAMPLE DATA	DESCRIPTION
<TEAM_ID>	1231	Is the assigned team identification.
<MISSION_TIME>	08:12:55	Is UTC time in format hh:mm:ss, where hh is hours, mm is minutes, and ss is seconds.
<PACKET_COUNT>	1485	Is the count of transmitted packets, which is to be maintained through processor reset. One count is used for transmission of all packets, regardless of type.
<PACKET_TYPE>	C	Is the ASCII character ‘C’ for Container telemetry, characters ‘S1’ for Science Payload 1 (deployed first) relayed telemetry, and characters ‘S2’ for Science Payload 2 (deployed second) relayed telemetry.
<MODE>	F	= ‘F’ for flight (the default mode upon system start) and ‘S’ for simulation
<SP1_RELEASED>	R	= ‘N’ for not released and ‘R’ for released
<SP2_RELEASED>	N	= ‘N’ for not released and ‘R’ for released

Container Telemetry Format

DATA FORMAT	SAMPLE DATA	DESCRIPTION
<ALTITUDE>	84.2	is the altitude in units of meters and must be relative to ground level. The resolution must be 0.1 meters.
<TEMP>	24.3	is the temperature in degrees Celsius with a resolution of 0.1 degrees C.
<VOLTAGE>	4.45	is the voltage of the CanSat power bus. The resolution must be 0.01 volts.
<GPS_TIME>	08:12:55	is the time generated by the GPS receiver. The time must be reported in UTC and have a resolution of a second.
<GPS_LATITUDE>	25.0458	is the latitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees.
<GPS_LONGITUDE>	-160.5804	is the longitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees.

Container Telemetry Format

DATA FORMAT	SAMPLE DATA	DESCRIPTION
<GPS_ALTITUDE>	84.2	is the altitude generated by the GPS receiver in meters above mean sea level with a resolution of 0.1 meters.
<GPS_SATS>	6	is the number of GPS satellites being tracked by the GPS receiver. This must be an integer number.
<SOFTWARE STATE>	SP1_RELEASE	is the operating state of the software. (e.g., LAUNCH_WAIT, ASCENT, ROCKET_SEPARATION, DESCENT, SP1_RELEASE, SP2_RELEASE, LANDED, etc.)
<SP1_PACKET_COUNT>	1065	is the count of relayed telemetry packets from Science Payload 1
<SP2_PACKET_COUNT>	1200	is the count of relayed telemetry packets from Science Payload 2
<CMD_ECHO>	CMD1000SIMP101325	is the fixed text command id and argument of the last received command with no commas.

Container Telemetry Format

- **Data format**

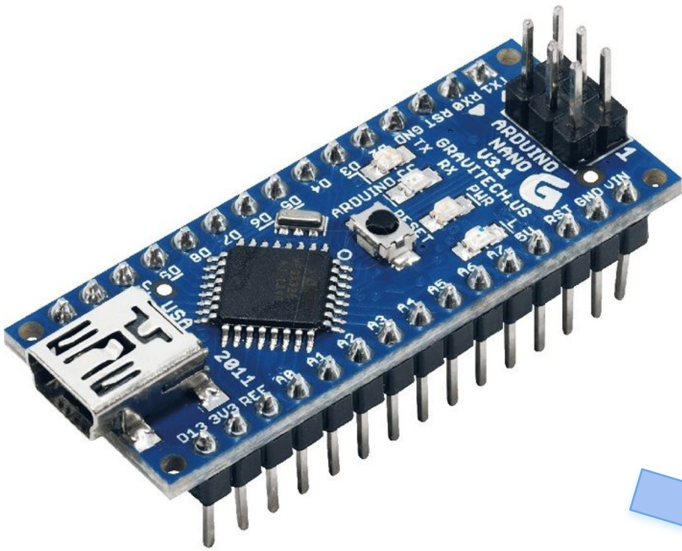
  <TEAM_ID>,<MISSION_TIME>,<PACKET_COUNT>,<PACKET_TYPE>,<MODE>, <SP1_RELEASED>,<SP2_RELEASED>, <ALTITUDE>,<TEMP>, <VOLTAGE>,<GPS_TIME>,<GPS_LATITUDE>,<GPS_LONGITUDE>, <GPS_ALTITUDE>,<GPS_SATS>,<SOFTWARE_STATE>, <SP1_PACKET_COUNT>,<SP2_PACKET_COUNT>,<CMD_ECHO>

- **Telemetry data file name for the Container:**
  - for Container: Fligth_1231_C.csv
- Data from payload shall transmit continuously at 1Hz sample rate

Container Command Formats

COMMAND	DESCRIPTION	DATA INCLUDED	DATA SAMPLE
CX	Container Telemetry On/Off Command	<ON_OFF> is the string 'ON' to activate the Container telemetry transmissions and 'OFF' to turn off the transmissions.	CMD,1231,CX,ON
ST	Set Time	<UTC_TIME> is UTC time in the format hh:mm:ss where hh is hours, mm is the minutes and ss is the seconds.	CMD,1231,ST,13:35:59
SIM	Simulation Mode Control Command	<MODE> is the string 'ENABLE' to enable the simulation mode, 'ACTIVATE' to activate the simulation mode, or 'DISABLE' which both disables and deactivates the simulation mode.	CMD,1231,SIM,ENABLE
PX	Science Payload Transmission On/Off	<ON_OFF> is the string 'ON' to activate the Science Payload transmissions and 'OFF' to turn off the transmissions	CMD,1000,SP1X,ON
SIMP	Simulated Pressure Data	<PRESSURE> is the simulated atmospheric pressure data in units of pascals with a resolution of one Pascal.	CMD,1000,SIMP,101325

Payload CDH Overview



Arduino nano A *Arduino nano*, is used to get data from sensors and transmit it from the XBee³ to the container.

XBee³: An *XBee³ module* is used to transmit data to the payloads and to the ground station.

Payload CDH Requirements

ID	DESCRIPTION	RATIONALE	PRIORITY
19	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	CReq	High
20	XBEE radios shall have their NETID/PANID set to their team number.	CReq	High
21	XBEE radios shall not use broadcast mode.	CReq	High
22	The science payload shall descend spinning passively like a maple seed with no propulsion.	CReq	High
23	The science payload shall have a maximum descent rate of 20 m/s.	CReq	High
24	The wing of the science payload shall be colored fluorescent orange, pink or green.	CReq	High

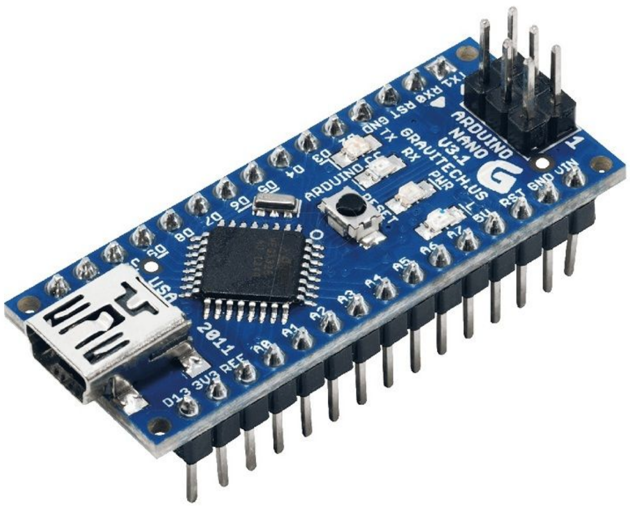
Payload CDH Requirements

ID	DESCRIPTION	RATIONALE	PRIORITY
25	The science payload shall measure altitude using an air pressure sensor.	CReq	High
26	The science payload shall measure air temperature.	CReq	High
27	The science payload shall measure rotation rate as it descends.	CReq	High
28	The science payload shall transmit all sensor data once per second.	CReq	High
29	The science payload telemetry shall be transmitted to the container only.	CReq	High
30	The science payload shall have their NETID/PANID set to their team number plus five. If team number is 1000, sensor payload NETID is 1005.	CReq	High

Payload Processor & Memory Trade & Selection

MODEL	BOOT TIME	PROCESSOR SPEED	I/O PINS	INTERFACES	MEMORY STORAGE REQUIRED	SUPPLY VOLTAGE	PRICE
Arduino Mega 2560 mini	3.50 s	16 MHz	Analog In[16] PWM [14] Digital [70]	I2C [1] SPI [5] UART [4]]	Flash- 256KB SRAM- 8KB EEPROM- 4KB	SV-12V	$ 24,93
Arduino Nano	4.84 s	16 MHz	Analog In[8] PWM [6] Digital[62]	I2C [1] SPI [1] UART [1]	Flash-32 KB SRAM-2 KB EEPROM-1 KB	5V-9V	$ 22,00

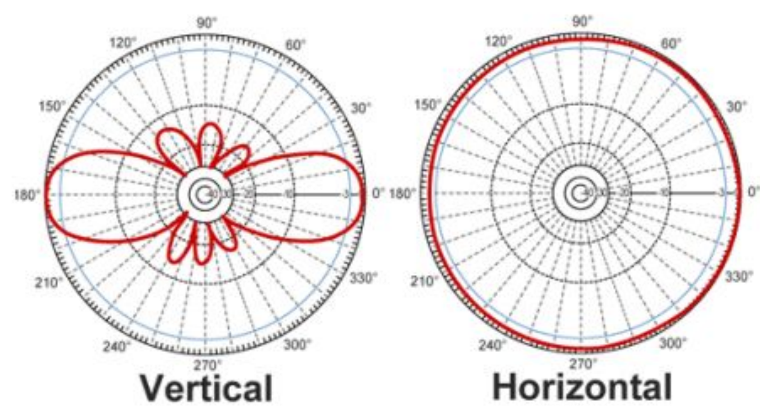
We chose the Arduino Nano because it is more compact and cheaper. It is not as complete as the Arduino Mega mini, but for what we need in the payload it is enough.



Payload Antenna Trade & Selection

MODEL	CONNECTION TYPE	FREQUENCY	DIRECTION	GAIN	BEAM WIDTH HORIZONTAL/ VERTICAL	PRICE
Generic 2.4GHz	RP - SMA	2.4 GHz	Omnidirectional	2dBi	360°/32°	$2.00
Antenna of XBee³ module	-	2.4 GHz	Omnidirectional	2dBi	360°/32°	$0,00

We chose to use the antenna that is included in the XBee module because in this way we reduce costs and and it is enough to cover our needs.



Payload Radio Configuration

- **XBEE radio selection: XBee[3]**
- **NETID: 1236**
- **TRANSMISSION CONTROL:** The XBEEs in the Payloads are set as Endpoint and the XBee in the container is set at Coordinator In all of the mission phases the Endpoints transmit the telemetry data only to the Coordinator, while they are in flight and then, the Coordinator sends it to the ground station.
- **Data rate:** The XBEEs in the Payloads are set to transmit de data to the container at 1 Hz transmission rate
- All the XBEE communicate in unicast mode

Payload Telemetry Format

Data Format	Sample Data	Description
<TEAM_ID>	1231	Is the assigned team identification.
<MISSION_TIME>	10:22:16	Is UTC time in format hh:mm:ss, where hh is hours, mm is minutes, and ss is seconds.
<PACKET_COUNT>	1684	Is the count of transmitted packets, which is to be maintained through processor reset. One count is used for transmission of all packets, regardless of type.
<PACKET_TYPE>	S1	Is the ASCII character ‘C’ for Container telemetry, characters ‘S1’ for Science Payload 1 (deployed first) relayed telemetry, and characters ‘S2’ for Science Payload 2 (deployed second) relayed telemetry.
<SP_ALTITUDE>	84.1	Is the altitude in units of meters and must be relative to ground level. The resolution must be 0.1 meters.
<SP_TEMP>	28.5	Is the measured temperature in degrees Celsius with a resolution of 0.1 degrees C.
<SP_ROTATION_RATE>	120	Is the science payload rotation rate around the axis perpendicular to the center of the rotor in RPM.

Payload Telemetry Format

- **Data format**

  <TEAM_ID>,<MISSION_TIME>,<PACKET_COUNT>,<PACKET_TYPE>,<SP_ALTITUDE>,<SP_TEMP>,<SP_ROTATION_RATE>

- **Telemetry data file name:**
  - for Science Payload 1: **Fligth_1231_SP1.csv**
  - for Science Payload 2: **Fligth_1231_SP2.csv**

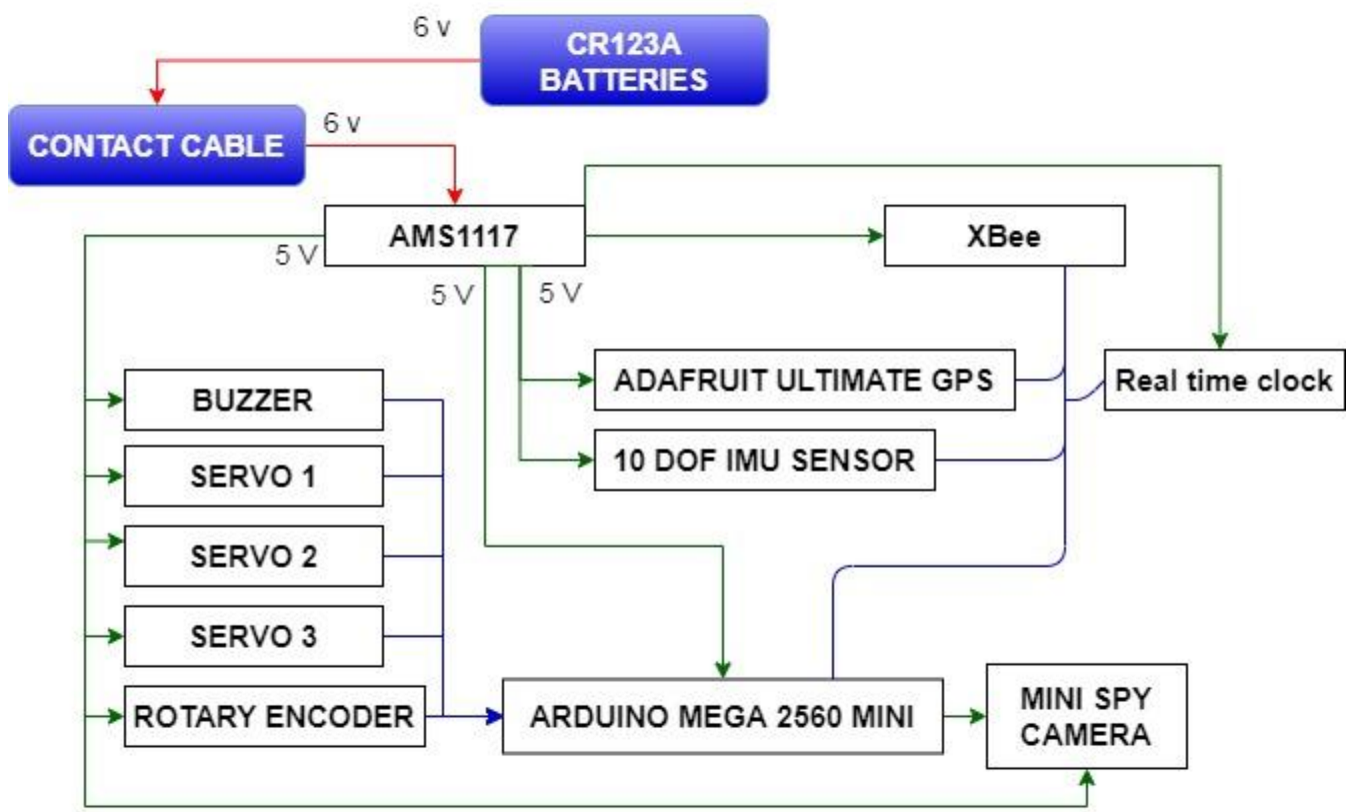
Electrical Power Subsystem (EPS) Design

Agustina Romero
Nicole Castro

EPS Overview (1 of 3)

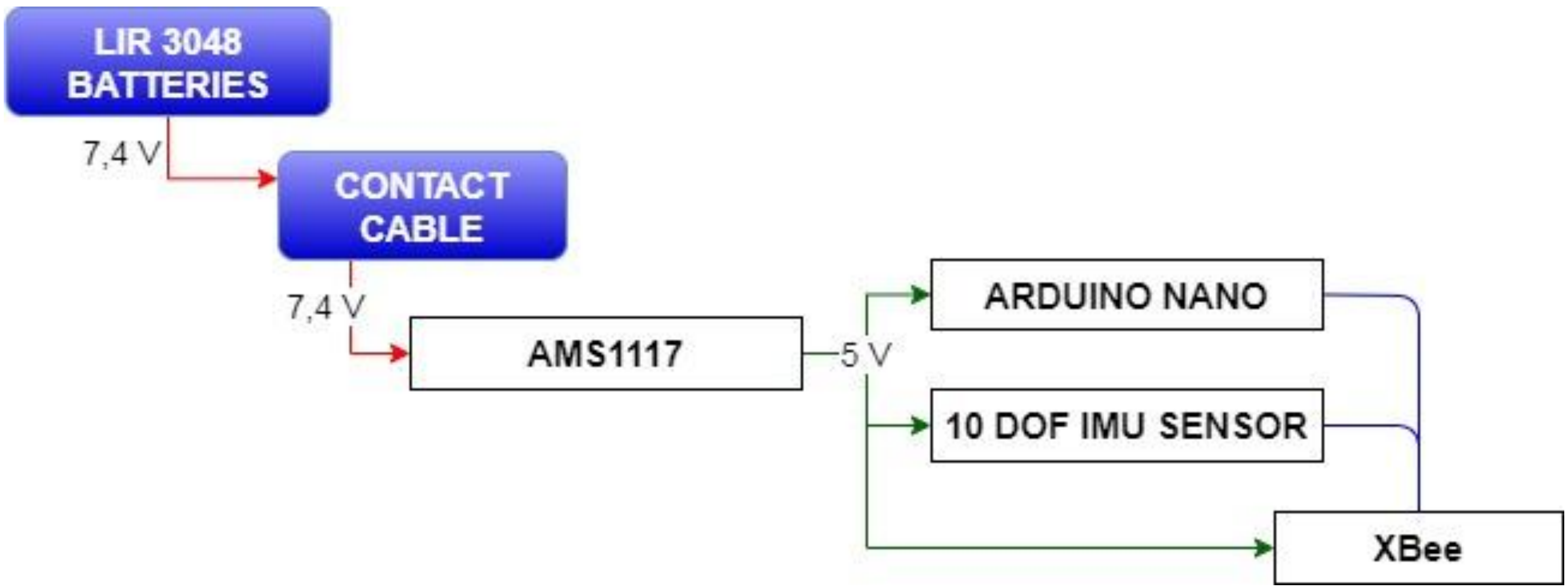
COMPONENT	PURPOSE
Energizer CR123A	Power source
AMS1117	Provides clean 5 volts supply
XBee RX	Radio communicator
10 DOF IMU Sensor	Stabilization, navigation, temperature and pressure sensor
GP2Y1010AU0F	Dust sensor
Adafruit Ultimate GPS	GPS Sensor
Mini Spy Camera	Bonus objective

Container overview



AMS117: Arduino voltage regulator

Payload overview



AMS117: On board Arduino voltage regulator

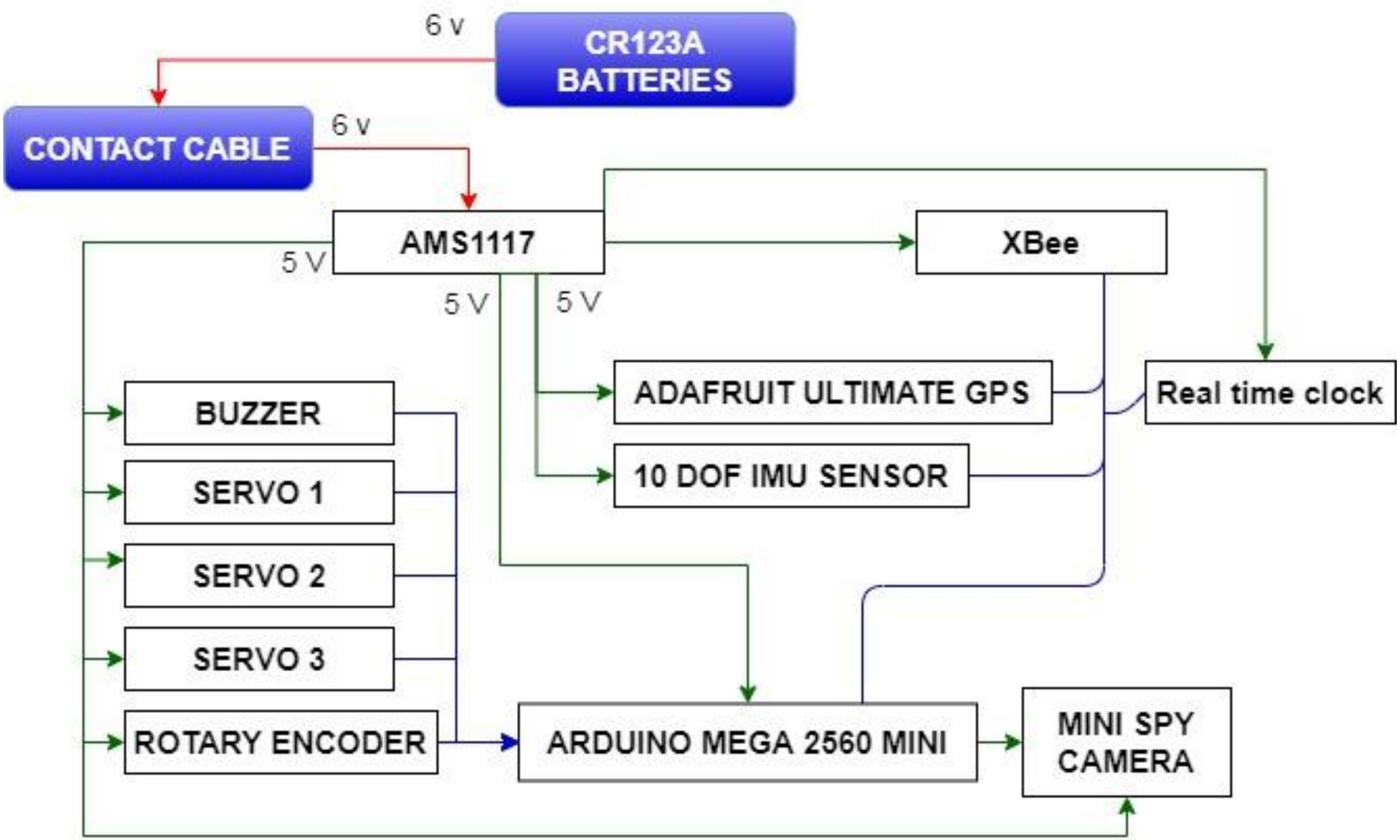
EPS Requirements

RQ	DESCRIPTION	RATIONALE	PRIORITY
1	Total mass of the CanSat (science payloads and container) shall be 600 grams +/- 10 grams.	CReq	High
13	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	CReq	High
31	The container shall include electronics to receive sensor payload telemetry.	CReq	High
32	The container shall include electronics and mechanisms to release the science payloads.	CReq	High
38	The container and science payloads must include an easily accessible power switch that can be accessed without disassembling the cansat and science payloads and in the stowed configuration.	CReq	High
39	The container must include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the cansat and in the stowed state.	CReq	High

EPS Requirements

RQ	DESCRIPTION	RATIONALE	PRIORITY
40	An audio beacon is required for the container. It may be powered after landing or operate continuously.	CReq	High
41	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	CReq	High
42	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	CReq	High
44	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	CReq	High
45	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	CReq	High
47	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	CReq	High

Container Electrical Block Diagram



Container Power Trade & Selection

MODEL	VOLTAGE (V)	CURRENT (mA)	WEIGHT (g)	DIMENSION (mm)	PRICE ($)	BATTERY CHEMISTRY
IMR 18350	3,7	700	48	18mm x 65mm	$11,00	Li-on
ENERGIZER CR123A	3	1500	16,5	17mm x 34,5mm	$1,50	LiMnO2

We chose the Energizer because it is cheaper, and because of size. Two batteries welded in series are used in the container

Container Power Budget

COMPONENT	POWER CONSUMPTION (wh)	CURRENT (mA)	VOLTAGE (V)	DUTY CYCLES (hr)	SOURCE
Arduino Mega 2560 mini	0,0051	0,51	5	2	Datasheet
Adafruit Ultimate GPS	0,2	20	5	2	Datasheet
10 DOF IMU Sensor	0,42	42	5	2	Datasheet
Mini Spy Camera	0,055	110	5	0,10	Datasheet
Servo 1	0,052	650	5	0,016	Datasheet
Servo 2	0,052	650	5	0,016	Datasheet
Servo 3	0,10725	325	5	0,066	Datasheet
XBee	0,1518	23	3,3	2	Datasheet
Rotary Encoder	0	0,001	5	0,10	Datasheet

(Servo 1 and Servo 2 hold payloads in container)

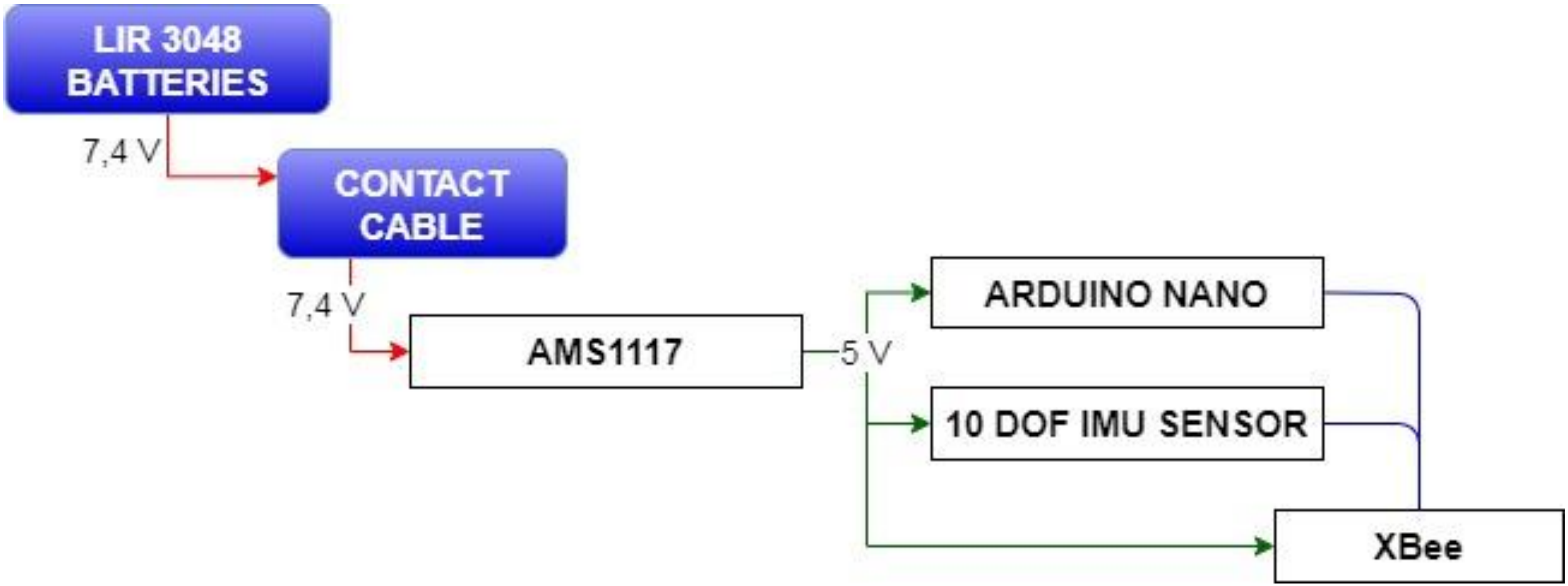
Container Power Budget

COMPONENT	POWER CONSUMPTION (wh)	CURRENT (mA)	VOLTAGE (V)	DUTY CYCLES (hr)	SOURCE
Buzzer	0,04	500	5	0,016	Datasheet
AMS1117	0,12	10	6	2	Datasheet
Arduino Mona DS3231	0,002	0,2	5	2	Datasheet
Total	1,20515				

AVAILABLE TOTAL POWER CAPACITY (for two batteries)	TOTAL POWER CONSUMED (for two hours)	MARGIN OF POWER CONSUMPTION
9 wh	1,20515 wh	7,79484 wh

Conclusion: Our batteries are enough to power all components for two hours

Payload Electrical Block Diagram



AMS117: On board Arduino voltage regulator

Payload Power Trade & Selection

MODEL	VOLTAGE (V)	CURRENT	WEIGHT (g)	DIMENSION (mm)	PRICE ($)	BATTERY CHEMISTRY
LIR2032	3.6	40mAh	3.1	20mm x 3.2mm	$2.20	Li-ion
LIR3048	3.7	180mAh	7.30	30mm x 4.8mm	$3.45	Li-ion

We choose LIR3048 because its current best suits our needs

Payload Power Budget

COMPONENT	POWER CONSUMPTION (wh)	CURRENT (mA)	VOLTAGE (V)	DUTY CYCLES (hr)	SOURCE
Arduino Nano	0,001	0,2	5	2	Datasheet
10 DOF IMU Sensor	0,42	42	5	2	Datasheet
XBee	0,1518	23	3,3	2	Datasheet
AMS117	0,06	10	6	2	Datasheet
Total	0,6328				

The total energy consumed in two hours would be 1,2656 wh. Each battery provides 0.666 wh

AVAILABLE TOTAL POWER CAPACITY (for two batteries)	TOTAL POWER CONSUMED (for two hours)	MARGIN OF POWER CONSUMPTION
1,332 wh	1,2656 wh	0,0664 wh

Conclusion : Our batteries are enough to power all components for two hours

Flight Software (FSW) Design

Ivan Maccio

FSW Overview

Programming Languages:

- **C/C++**

Development environments:

- **Arduino IDE**

Summary of FSW tasks:

- **To collect sensors data and convert it to a value that complies with CanSat requirements.**
- **Send data to the Ground control station and store it to an onboard backup EEPROM.**
- **Monitor altitude changes to trigger payload releases.**
- **Activate audio beacon after landing.**
- **Activate mechanisms in the correct time**
- **Ensure telemetry frequency is 1Hz**
- **Design a software architecture such that the processor can fully**
- **Recover from a sudden power loss that might occur in any time during the mission and for arbitrary duration**

FSW Overview

FSW Task:

Container	Payload
To collect sensors data and convert it to a value that complies with CanSat requirements.	**To collect sensors data and convert it to a value that complies with CanSat requirements.**
Send data to the Ground control station and store it to an onboard backup EEPROM.	**Send data to the container and store it to an onboard backup EEPROM.**
Monitor altitude changes to trigger payload releases	**Ensure telemetry frequency is 1Hz**
Activate audio beacon after landing	**Recover from a sudden power loss that might occur in any time during the mission and for arbitrary duration**
Activate mechanisms in the correct time	
Ensure telemetry frequency is 1Hz	

FSW Overview

FSW Task:

Container	Payload
Recover from a sudden power loss that might occur in any time during the mission and for arbitrary duration	**Recover from a sudden power loss that might occur in any time during the mission and for arbitrary duration**

FSW Requirements

RQ	Description	Rationale
25	The science payload shall measure altitude using an air pressure sensor.	CReq
26	The science payload shall measure air temperature.	CReq
27	The science payload shall measure rotation rate as it descends.	CReq
28	The science payload shall transmit all sensor data once per second.	CReq
29	The science payload telemetry shall be transmitted to the container only.	CReq
30	The science payload shall have their NETID/PANID set to their team number plus five. If team number is 1000, sensor payload NETID is 1005.	CReq
36	The container shall transmit its telemetry and the payload telemetry received once per second in the format described in the Telemetry Requirements section.	CReq
37	The container shall stop transmitting telemetry when it lands.	CReq
48	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	CReq

FSW Requirements

RQ	Description	Rationale
36	The container shall transmit its telemetry and the payload telemetry received once per second in the format described in the Telemetry Requirements section.	CReq
37	The container shall stop transmitting telemetry when it lands.	CReq
48	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	CReq
49	The container must maintain mission time throughout the whole mission even with processor resets or momentary power loss.	CReq
50	The container shall have its time set to UTC time to within one second before launch.	CReq
51	The container flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.	CReq
52	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the container altitude.	CReq

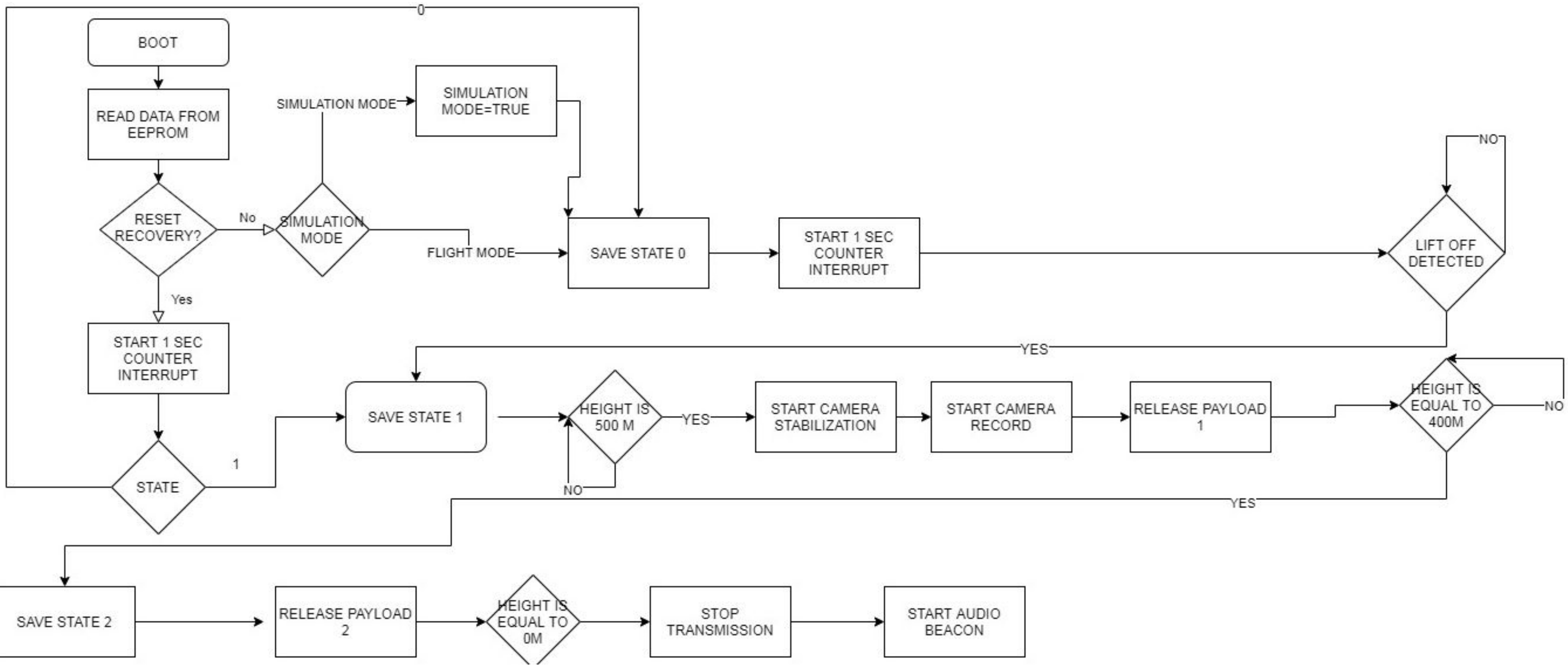
FSW Requirements

RQ	Description	Rationale
53	The container flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	CReq
54	The ground station shall command the Cansat to start transmitting telemetry prior to launch.	CReq
55	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	CReq
56	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	CReq
57	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	CReq
59	All telemetry shall be displayed in real time during descent on the ground station.	CReq
60	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	CReq
61	Teams shall plot each telemetry data field in real time during flight.	CReq

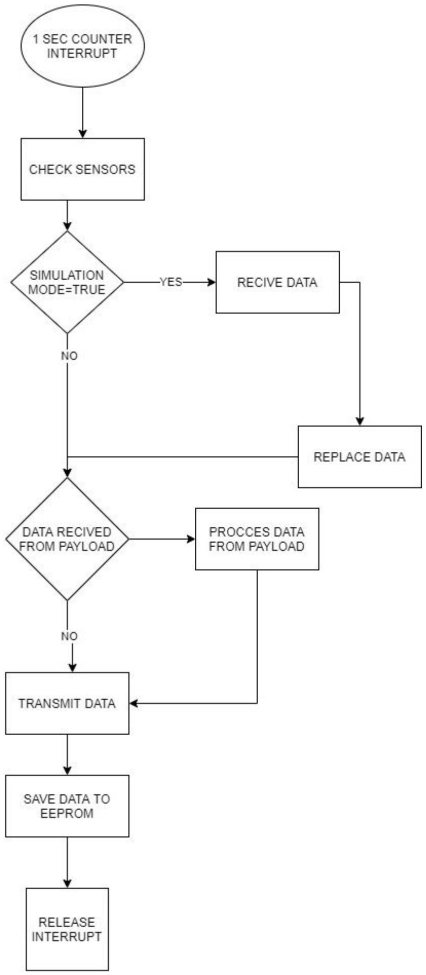
FSW Requirements

RQ	Description	Rationale
64	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	CReq
65	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the container.	CReq
66	The science payloads shall not transmit telemetry during the launch, and the container shall command the science payloads to begin telemetry transmission upon release from the container.	CReq

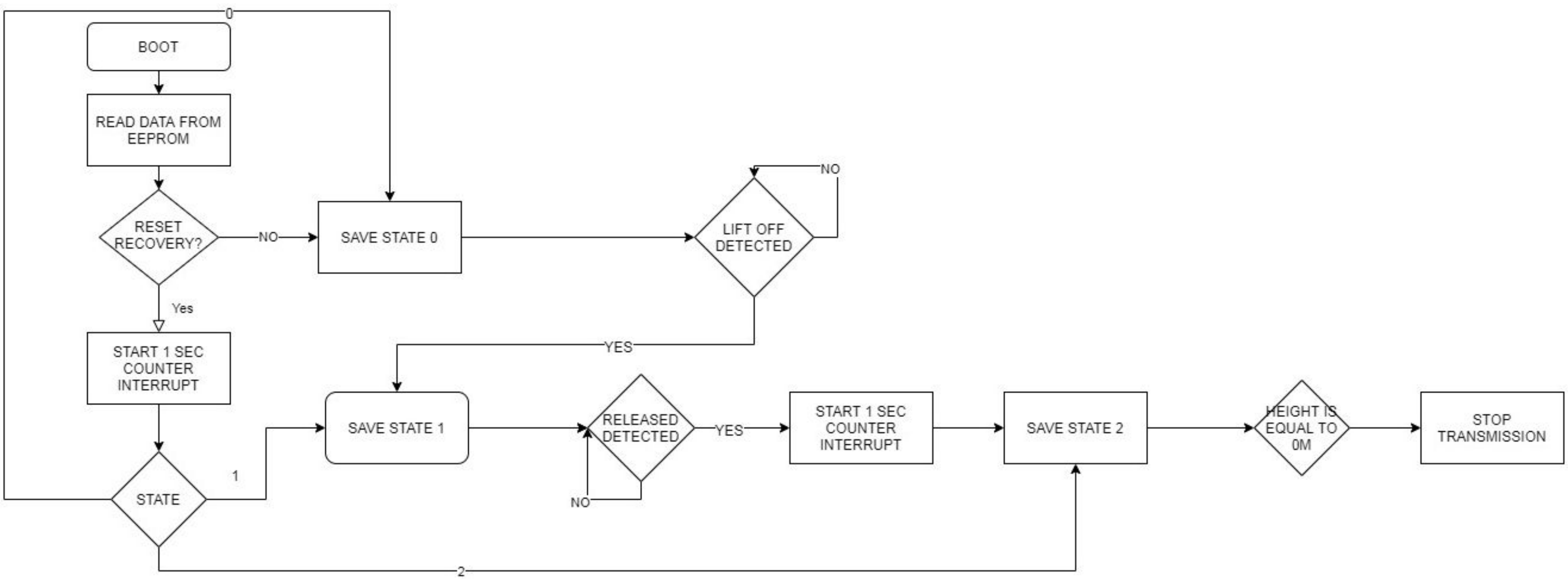
Container FSW State Diagram



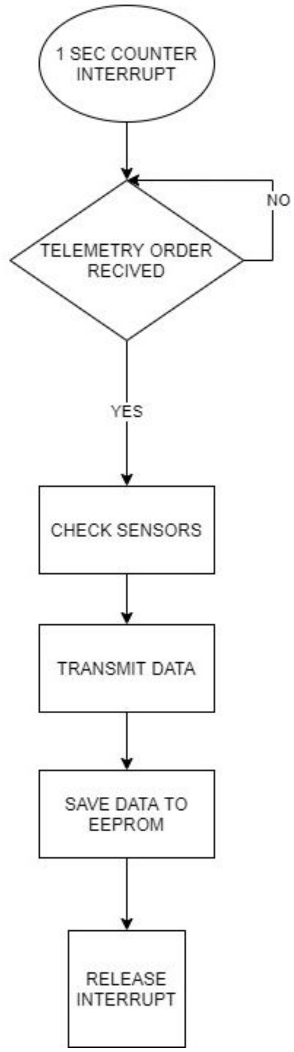
Container FSW State Diagram



Payload FSW State Diagram



Payload FSW State Diagram



Simulation Mode Software

Simulation mode

The ground station will receive a file with the simulated data, then the data is transmitted to the container where the container firmware would calculate the altitude with the supplied data, then it will be formatted to complain requirements and transmitted to the ground station

Simulation commands

The simulation commands are:

- CMD,<TEAM_ID>,SIM,<MODE>
  Where: 1. CMD and SIM are static text.
  2. is the assigned team identification.
  3. is the string 'ENABLE' to enable the simulation mode, 'ACTIVATE' to activate the simulation mode, or 'DISABLE' which both disables and deactivates the simulation mode.
  Example: Both the CMD,1000,SIM,ENABLE and CMD,1000,SIM,ACTIVATE commands are required to begin simulation mode.
- CMD,<TEAM ID>,SIMP,<PRESSURE>
  Where: 1. CMD and SIMP are static text.
  2. is the assigned team identification.
  3. is the simulated atmospheric pressure data in units of pascals with a resolution of one Pascal.
  Example: CMD,1000,SIMP,101325 provides a simulated pressure reading to the Container (101325 Pascals = approximately sea level).

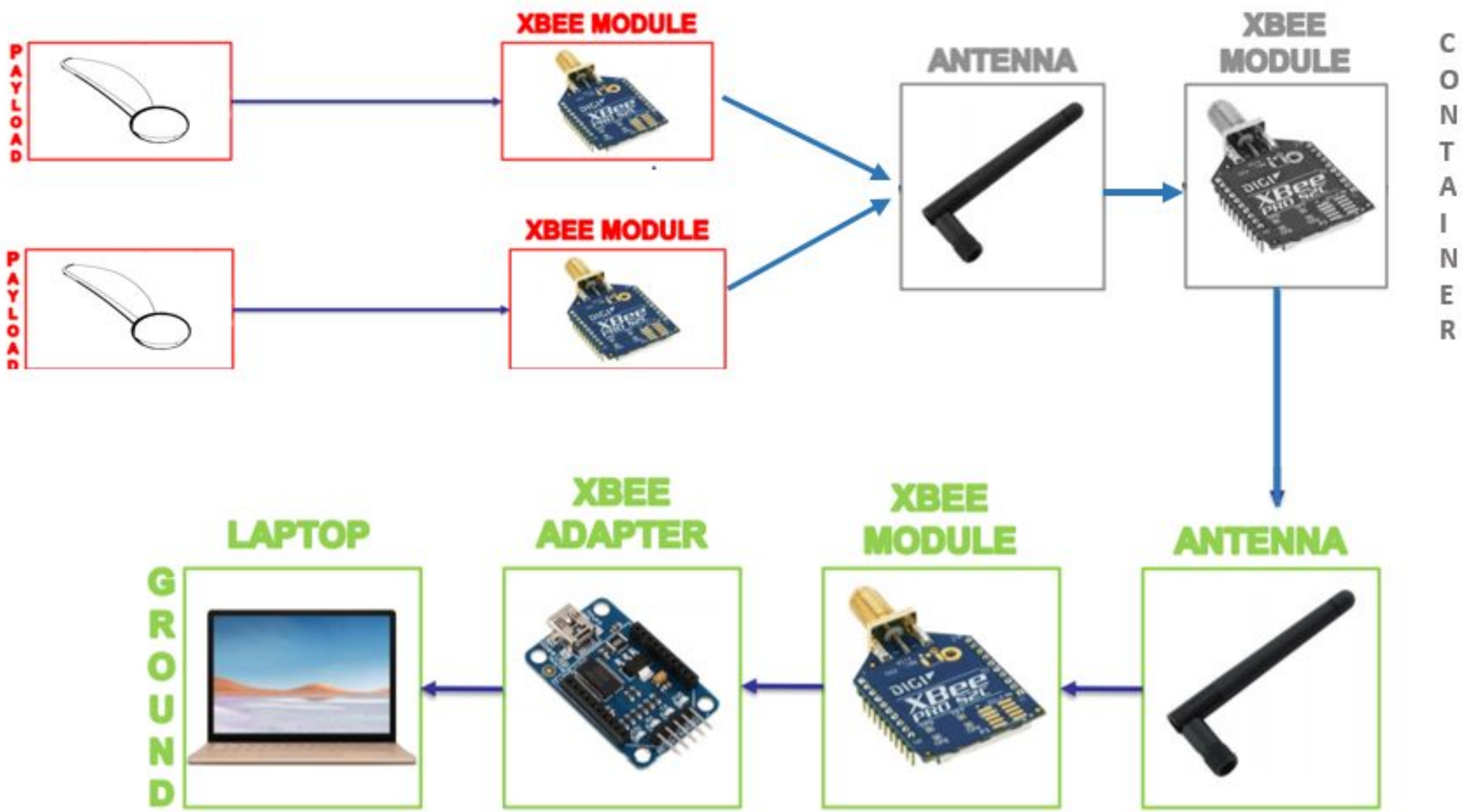
Software development plan

Component	Description
Ground station	Program interface
	Program Xbee
Container	Program arduino for each sensor
	Servo module
	Simulation module
Payload	Program Xbee
	Program sensors
Final integration	Full test of all function

Ground Control System (GCS) Design

Iván Macció

GCS Overview



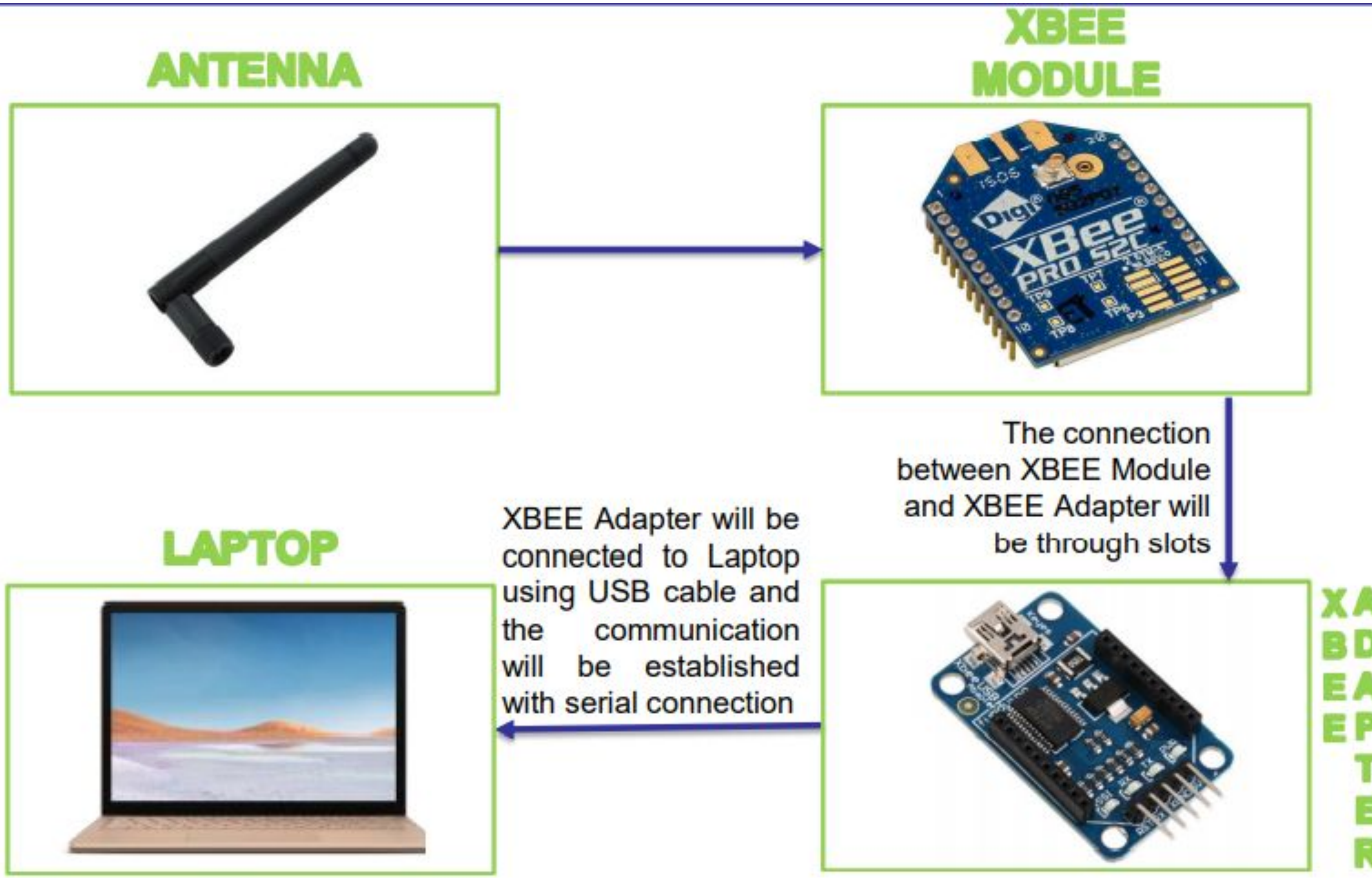
GCS Requirements

RQ	Description	Rationale
51	The container flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.	CReq
55	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	CReq
58	Each team shall develop their own ground station.	CReq
59	All telemetry shall be displayed in real time during descent on the ground station.	CReq
60	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	CReq
61	Teams shall plot each telemetry data field in real time during flight.	CReq
62	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	CReq
63	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	CReq

GCS Requirements

RQ	Description	Rationale
64	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	CReq
65	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the container.	CReq

GCS Design


ANTENNA
XBEE MODULE
The connection between XBEE Module and XBEE Adapter will be through slots
XBEE Adapter will be connected to Laptop using USB cable and the communication will be established with serial connection
LAPTOP
XBEE ADAPTER

GCS Design

- **Specifications**

- Battery: The Ground Control Station Laptop can operate 3 hours with battery.
- Overheating Mitigation: There will be an umbrella to avoid direct sun exposure
- Auto update mitigation: The option of auto update will be disabled before the launch

GCS Antenna Trade & Selection

Model	Connection Type	Frequency	Direction	Gain	Beam Width Horizontal / Vertical	Price
Generic 2,4ghz antenna	RP-SMA	2,4 ghz	Omnidirectional	2dBi	360°/ 32°	$ 2,00
Bingfu Dual Band WiFi 2.4GHz	RP-SMA	2,4 ghz	Omnidirectional	9dBi	360°/ 32°	$ 7,99

We choose the BingFu antenna because it can receive in all directions and the Xbee Pro s2c has enough outdoor range and power output to work fine with stock antennas

GCS Software

- **Telemetry display prototypes**

  - <TEAM_ID>, <MISSION_TIME>, <PACKET_COUNT>, <PACKET_TYPE>, <MODE>, <SP1_RELEASED>, <SP2_RELEASED>, <ALTITUDE>, <TEMP>, <VOLTAGE>, <GPS_TIME>, <GPS_LATITUDE>, <GPS_LONGITUDE>, <GPS_ALTITUDE>, <GPS_SATS>, <SOFTWARE_STATE>, <SP1_PACKET_COUNT>, <SP2_PACKET_COUNT>, <CMD_ECHO>

- **Commercial off the shelf (COTS) software packages used**
  - MATLAB GUI Package for Visual Studio 2015

GCS Software

- **Real-time plotting software design**
  - GCS Software will be designed with MATLAB GUI Package for Visual Studio 2015
  - The software will receive data from XBEE Module through USB cable
  - The received data will be displayed on the real time plots
- **Command software and interface**

- The Ground Station will send the following commands from the container:
  - <u>CX - Container Telemetry On/Off Command</u>
    - Generic one: CMD,<TEAM_ID>,CX,<ON_OFF>
    - Example of command to be sent: CMD,1231,CX,ON, where:
      - CMD and CX are static text
      - ON is set to activate the Container telemetry transmissions. OFF would be use to turn off the transmissions
  - <u>ST - Set Time</u>
    - Generic one: CMD,<TEAM_ID>,ST,<UTC_TIME>
    - Example of command to be sent: CMD,1231,ST,13:35:59, where:
      - CMD and ST are static text
      - 13:35:59 is the parameter -in UTC format- which sets the mission time to the value given

GCS Software

- **Command software and interface**

- The Ground Station will send the following commands from the Ground Station:
  - SIM - Simulation Mode Control Command
    - Generic one: CMD,<TEAM_ID>,SIM,<MODE>
    - Example of command to be sent: CMD,1231,SIM,ENABLE, where:
      - CMD and SIM are static text
      - ENABLE enables the simulation mode. ‘ACTIVATE’ activates the simulation mode, and ‘DISABLE’ both disables and deactivates the simulation mode.
  - PX - Science Payload Transmission On/Off
    - Generic one: CMD,<TEAM_ID>,SP1X/SP1X,<ON_OFF>
    - Example of command to be sent: CMD,1231,SP1X,ON. This will trigger the Container to relay a command to the Science Payload 1 to begin telemetry transmissions.
    - SP1X and SP2X are static text indicating to control telemetry for SP1 and SP2,respectively
  - SIMP - Simulated Pressure Data (to be used in Simulation Mode only)
    - Generic one: CMD,<TEAM ID>,SIMP,<PRESSURE>
    - Example of command to be sent: CMD,1231,SIMP,101325, which provides a simulated pressure reading to the Container (101325 Pascals = approximately sea level)

GCS Software

- **Telemetry data recording and media presentation to judges for inspection**
  - All telemetry data will be displayed on real time plots.
  - When software will obtain telemetry data, these shall be recorded in a commas separated value (.csv) file.
  - This .csv file will be presented to judges on an SD Card

GCS Software

- **Describe .csv telemetry file creation for judges**

- .csv telemetry file will be created during the setup of ground station
- Telemetry data will be appended to this .csv file meanwhile software be on
- The name of the .csv file will be “Flight_1231.csv”

MQTT Integration

Once the ground station is turned on, we will proceed to connect it with the MQTT server:

Client.connect("mqtt://username:password@cansat.info");

When the ground station software saves a data line to a file, that line will be sent to the broker (1 line per second):

mqttc.publish("teams/1231", "<TEAM_ID>,<MISSION_TIME>,<PACKET_COUNT>,<PACKET_TYPE>,<MODE>,<SP1_RELEASED>,<SP2_RELEASED>,<ALTITUDE>,<TEMP>,<VOLTAGE>,<GPS_TIME>,<GPS_LATITUDE>,<GPS_LONGITUDE>,<GPS_ALTITUDE>,<GPS_SATS>,<SOFTWARE_STATE>,<SP1_PACKET_COUNT>,<SP2_PACKET_COUNT>,<CMD_ECHO>");

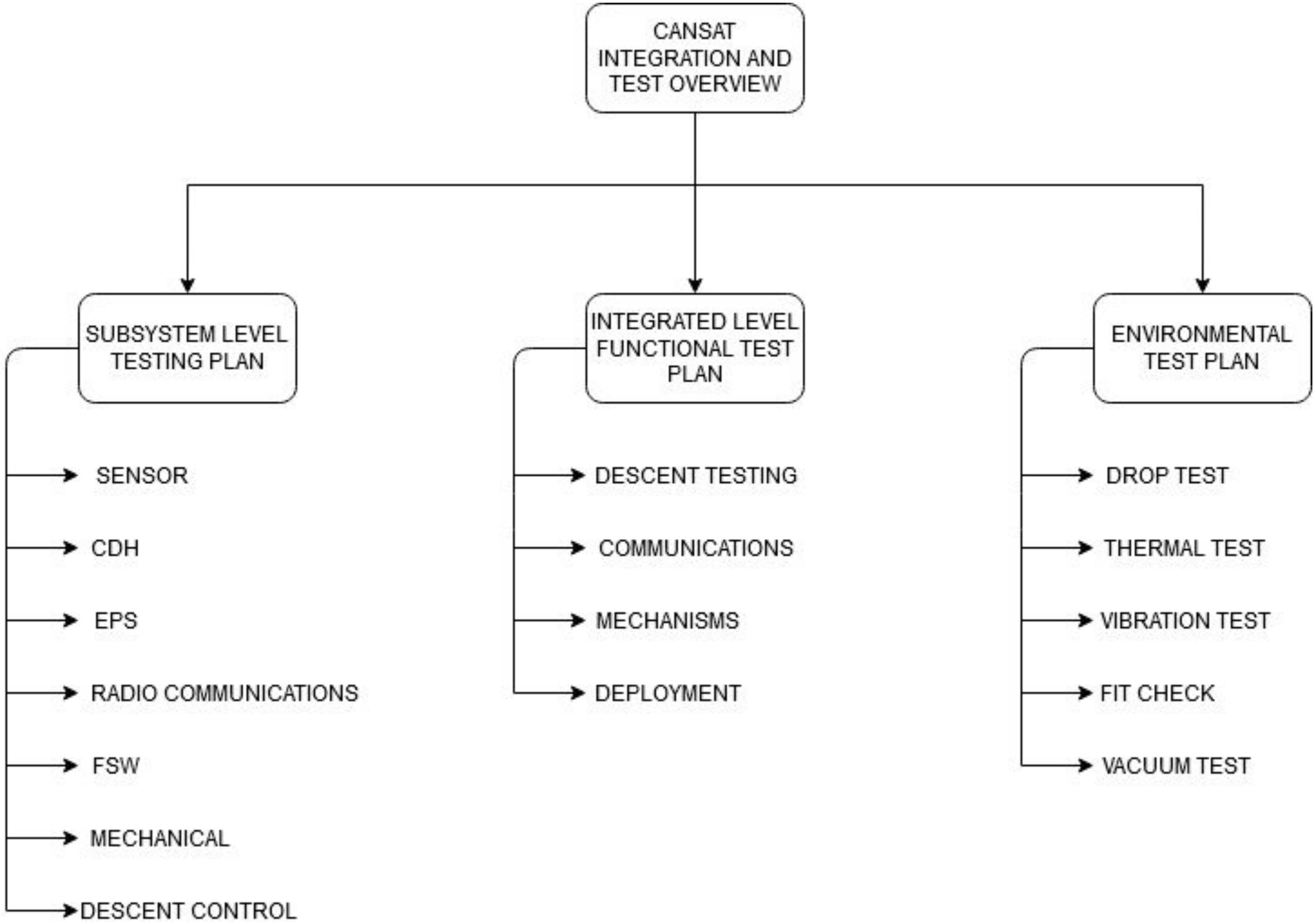
At the end of sending all the lines, the client will be disconnected from the server:

Client.disconnect();

CanSat Integration and Test

Ivan Maccio

CanSat Integration and Test Overview



Subsystem Level Testing Plan

In order to make sure everything works as designed, a series of tests will be conducted:

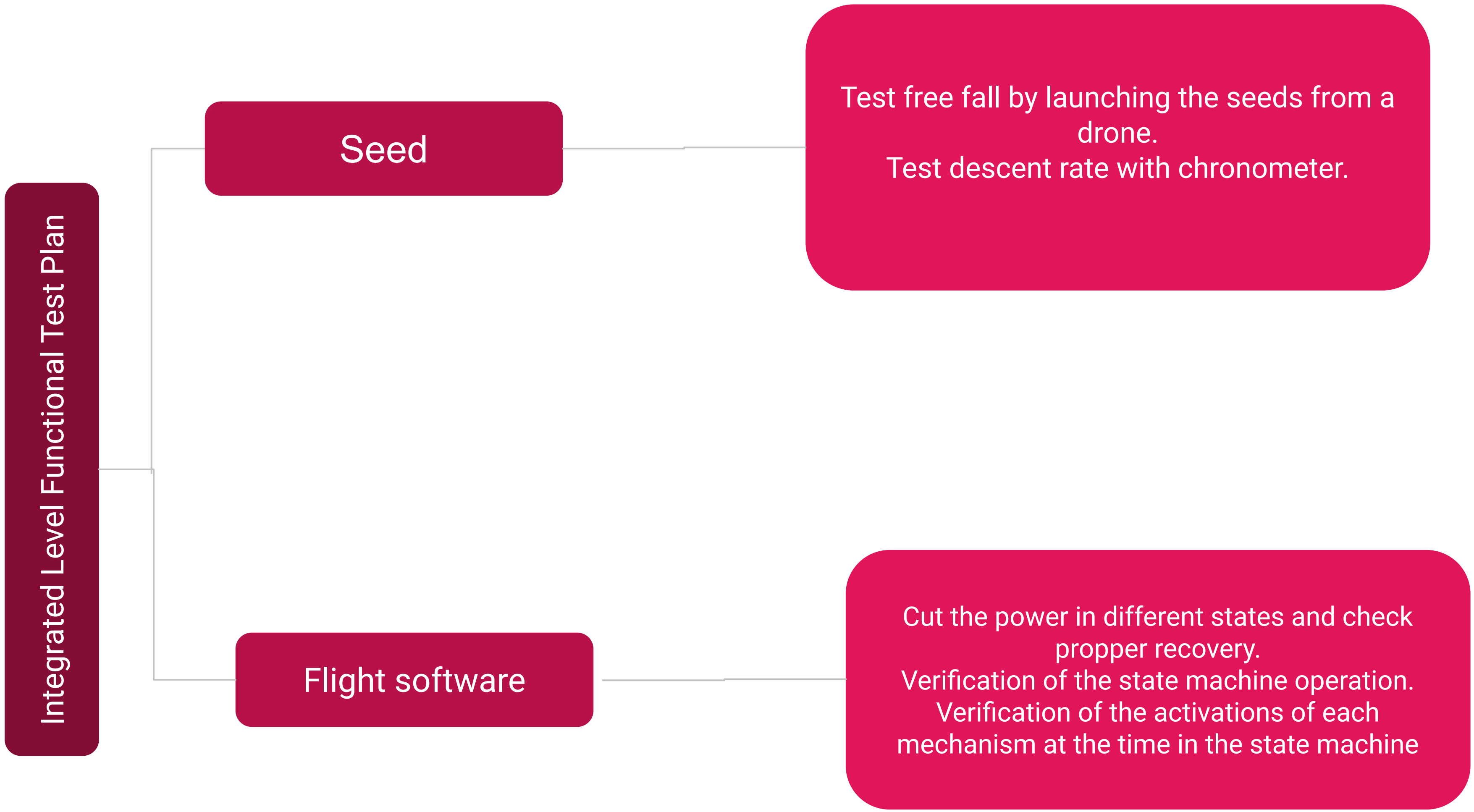
- We are planning to test every sensor alone with an Arduino mega.
- Then, we are going to test the sensor in additive way, meaning that when we finish testing all sensors individually, we are start to test two sensors at once,then three sensors at once, then four, etc., until full integration is completed.
- In parallel we are going to make mechanical tests to the seeds.
- We are going to drop it from a drone and fly it like a normal seed.
- There will be a Flight Software test as well, which consists in simulating all possible processor shut down -in any period of time- and check if the software works correctly in the facing of mentioned situation.
- The sending of data in the correct order will be tested
- We will check the accuracy of the received data from sensors

Integrated Level Functional Test Plan

Integrated Level Functional Test Plan

- **Container**
  - Mass test.
    Free fall test with parachutes.
    Test descent rate with chronometer.
- **Electronics sensors**
  - Test each sensor individually with an arduino uno.
    Test xbee configuration with one arduino and a arduino pc adaptor.
    Xbee modules should had radio link in ground of about 120 m to ensure air link.
- **Ground station**
  - Simulate payload data in excel and compare results.
    Repeat the simulation with an xbee connected with an arduino that only transmit the simulation data.

Integrated Level Functional Test Plan



Environmental Test Plan

The tests are going to be executed as suggested in the mission guide, for the drop test we are going to use a non flexible string of the spec detailed in mission guide ,for the thermal test we are going to build a isolated foam box and use a hair dryer or a heat gun with temperature regulation for rise the temperature.
For the vibration test we had an orbital sander, we are going to 3D print a locking mechanism to hold the CanSat to the sander.

Simulation Test Plan

The tests are going to be executed as suggested in the mission guide.
We are going to use dummy data to test that the ground station correctly sends the data to the MQTT server. Corroborating them from cansat.info/plot.html.

Mission Operations & Analysis

Rodrigo Goytea Vuistaz

Overview of Mission Sequence of Events

Event	Duties and Responsibilities
Arrival at the simulation site	• All team members will have to put their own facemasks • Ground Control Station, Container and Payload will be assembled and checked.
Setting up	• Antenna will be checked. • Xbee communications will be checked as well. • Fit check and mass measurement. • Container release mechanism check. • Inspection of electronics. • Battery charge check. • Radio links check.
Pre launch	• Review of the checklist. • Team leader approval in order to proceed.
CanSat preparation	• Integrate payload and container.
Final checks preparation	• Team approval.
Rocket integration	• Integrate CanSat with the rocket.

Overview of Mission Sequence of Events

Event	Duties and Responsibilities
Launch	• Take photos • Record • Stream
Recovery	• Recover CanSat
Data presentation	• Prepare data • Print / graph results • Deliver results • Save the equipment

- **Ground Station**

CanSat Location and Recovery

- We will use a drone with a camera to an easier detection of container and payload.

- Container color will be chosen from red, Pink or orange.

- Team Leader’s phone number and email address and team’s number will be labeling on both container and payload

Requirements Compliance

Jorge Royon

Requirements Compliance (multiple slides, as needed)

RQ	Description	Comply
1	Total mass of the CanSat (science payloads and container) shall be 600 grams +/- 10 grams.	Y
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 400 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Y
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	Y
4	The container shall be a fluorescent color; pink, red or orange.	Y
5	The container shall be solid and fully enclose the science payloads. Small holes to allow access to turn on the science payloads is allowed. The end of the container where the payload deploys may be open.	Y
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Y
7	The rocket airframe shall not be used as part of the CanSat operations.	Y
8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.	Y

Requirements Compliance (multiple slides, as needed)

RQ	Description	Comply
9	The Parachutes shall be fluorescent Pink or Orange	Y
10	The descent rate of the CanSat (container and science payload) shall be 15 meters/second +/- 5m/s.	Y
11	All structures shall be built to survive 15 Gs of launch acceleration.	Y
12	All structures shall be built to survive 30 Gs of shock.	Y
13	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Y
14	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Y
15	Mechanisms shall not use pyrotechnics or chemicals.	Y
16	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Y
17	Both the container and payloads shall be labeled with team contact information including email address.	Y

Requirements Compliance (multiple slides, as needed)

RQ	Description	Comply
18	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Y
19	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE radios are also allowed.	Y
20	XBEE radios shall have their NETID/PANID set to their team number.	Y
21	XBEE radios shall not use broadcast mode.	Y
22	The science payload shall descend spinning passively like a maple seed with no propulsion.	Y
23	The science payload shall have a maximum descent rate of 20 m/s.	Y
24	The wing of the science payload shall be colored fluorescent orange, pink or green.	Y
25	The science payload shall measure altitude using an air pressure sensor.	Y

Requirements Compliance (multiple slides, as needed)

RQ	Description	Comply
26	The science payload shall measure air temperature.	Y
27	The science payload shall measure rotation rate as it descends.	Y
28	The science payload shall transmit all sensor data once per second.	Y
29	The science payload telemetry shall be transmitted to the container only.	Y
30	The science payload shall have their NETID/PANID set to their team number plus five. If team number is 1000, sensor payload NETID is 1005.	Y
31	The container shall include electronics to receive sensor payload telemetry.	Y
32	The container shall include electronics and mechanisms to release the science payloads.	Y
33	The container shall include a GPS sensor to track its position.	Y
34	The container shall include a pressure sensor to measure altitude.	Y

Requirements Compliance (multiple slides, as needed)

RQ	Description	Comply
35	The container shall measure its battery voltage.	Y
36	The container shall transmit its telemetry and the payload telemetry received once per second in the format described in the Telemetry Requirements section.	Y
37	The container shall stop transmitting telemetry when it lands.	Y
38	The container and science payloads must include an easily accessible power switch that can be accessed without disassembling the cansat and science payloads and in the stowed configuration.	Y
39	The container must include a power indicator such as an LED or sound generating device that can be easily seen or heard without disassembling the cansat and in the stowed state.	Y
40	An audio beacon is required for the container. It may be powered after landing or operate continuously.	Y
41	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	Y
42	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells. Coin cells are allowed.	Y

Requirements Compliance (multiple slides, as needed)

RQ	Description	Comply
44	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Y
45	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Y
46	The Cansat must operate during the environmental tests laid out in Section 3.5.	Y
47	The Cansat shall operate for a minimum of two hours when integrated into the rocket.	Y
48	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Y
49	The container must maintain mission time throughout the whole mission even with processor resets or momentary power loss.	Y
50	The container shall have its time set to UTC time to within one second before launch.	Y

Requirements Compliance (multiple slides, as needed)

RQ	Description	Comply
51	The container flight software shall support simulated flight mode where the ground station sends air pressure values at a one second interval using a provided flight profile csv file.	Y
52	In simulation mode, the flight software shall use the radio uplink pressure values in place of the pressure sensor for determining the container altitude.	Y
53	The container flight software shall only enter simulation mode after it receives the SIMULATION ENABLE and SIMULATION ACTIVATE commands.	Y
54	The ground station shall command the Cansat to start transmitting telemetry prior to launch.	Y
55	The ground station shall generate csv files of all sensor data as specified in the Telemetry Requirements section.	Y
56	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Y
57	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	Y

Requirements Compliance (multiple slides, as needed)

RQ	Description	Comply
58	Each team shall develop their own ground station.	Y
59	All telemetry shall be displayed in real time during descent on the ground station.	Y
60	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Y
61	Teams shall plot each telemetry data field in real time during flight.	Y
62	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Y
63	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Y
64	The ground station software shall be able to command the container to operate in simulation mode by sending two commands, SIMULATION ENABLE and SIMULATION ACTIVATE.	Y
65	When in simulation mode, the ground station shall transmit pressure data from a csv file provided by the competition at a 1 Hz interval to the container.	Y

Requirements Compliance (multiple slides, as needed)

RQ	Description	Comply
66	The science payloads shall not transmit telemetry during the launch, and the container shall command the science payloads to begin telemetry transmission upon release from the container.	Y

Management

Rodrigo Goytea Vuistaz

CanSat Budget – Hardware

Component	Quantity	Unit Price ($)	Total ($)	Status
Waveshare 10 DOF IMU C	3	17.99	53.97	NEW
Adafruit Ultimate GPS	1	12.99	12.99	NEW
Arduino mega 2560 mini	1	8.84	8.84	NEW
Arduino nano	2	3.78	7.56	NEW
TowerPro sg90 servo	3	2.42	7.26	NEW
Adafruit spy camera	1	12.5	12.5	NEW
Xbee Pro S2C	2	32.56	65.12	NEW
Xbee Pro 3	2	32.56	65.12	NEW
Parachute Apogee 29126	1	3.74	3.74	NEW
2.4 ghz antenna	3	2.7	8.1	NEW
Buzzer	1	5	5	NEW
3D printed parts	6	7	42	NEW

CanSat Budget – Hardware

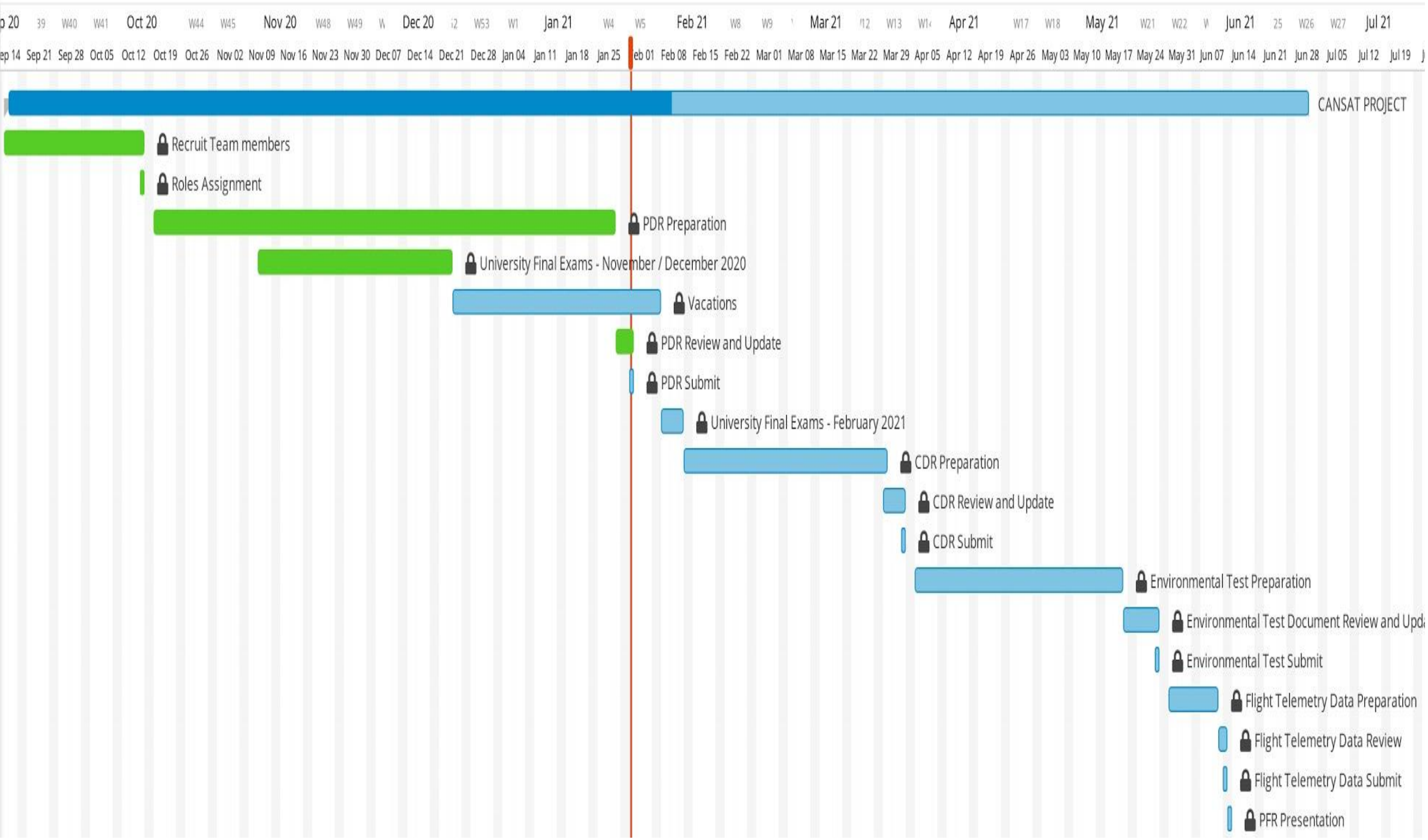
Component	Quantity	Unit Price ($)	Total ($)	Status
LIR3048	8	9	72	NEW
Energizer CR123A	2	1.5	3	NEW
Real clock module	1	2.1	2.1	
Total	369.3$			

The total cost to develop and build the CANSAT is 367.2$ US dollars

CanSat Budget – Other Costs

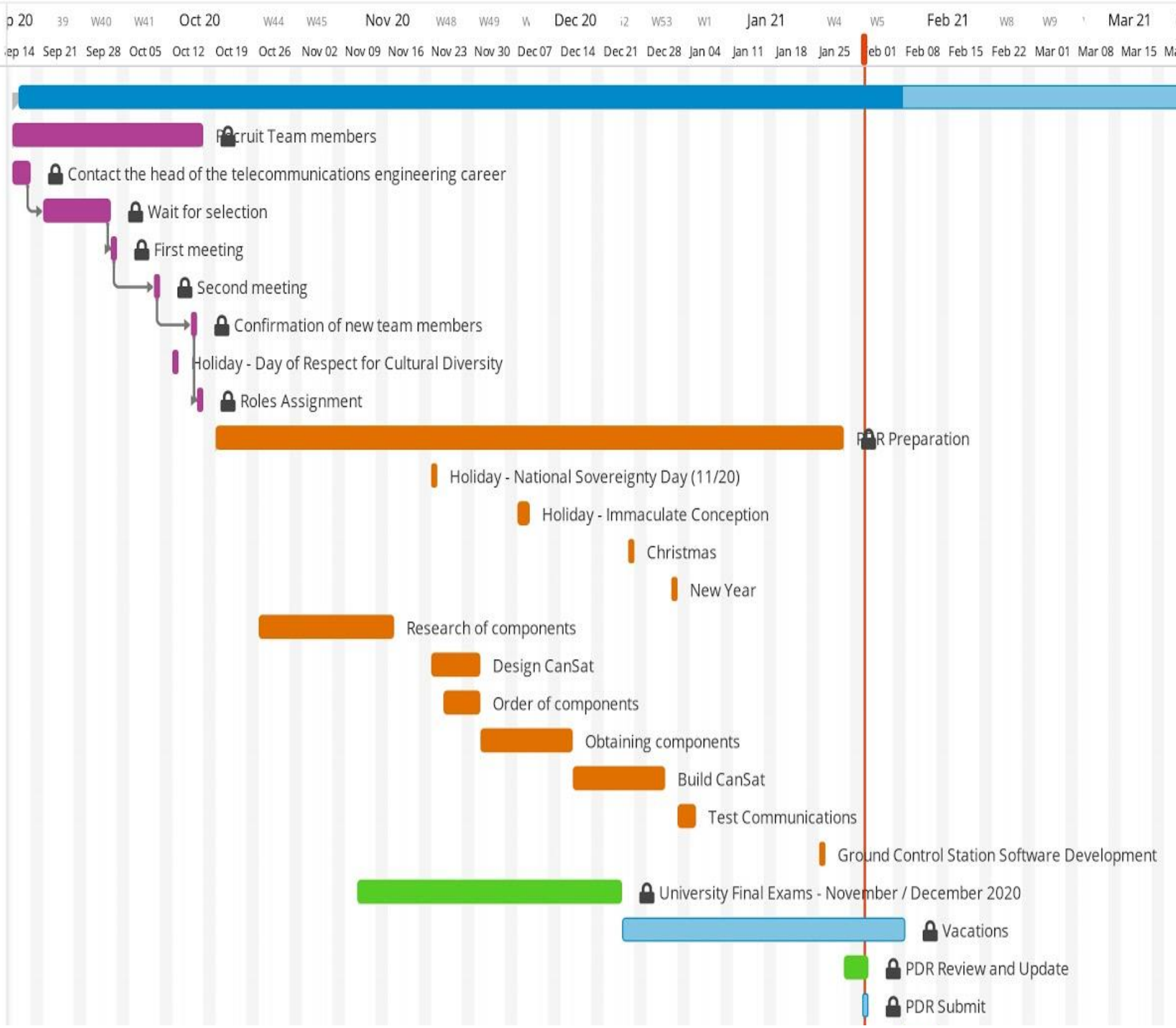
Due the pandemic, it's impossible to determinate and know if it would be possible to travel, so there's no way to predict other associated cost.

Program Schedule Overview



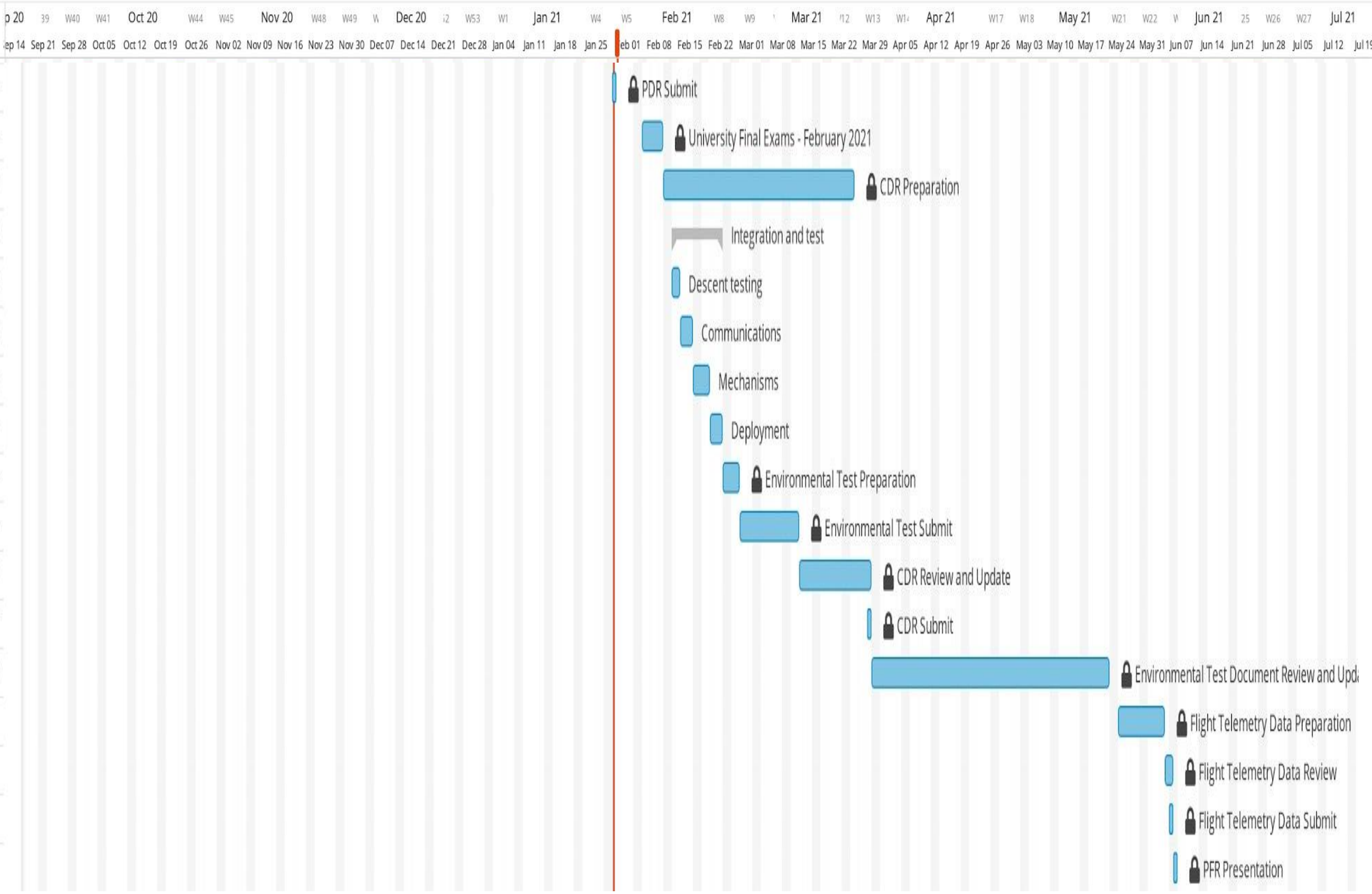
Detailed Program Schedule

#	ACTIVITIES	START	WD	CD	DUE
	CANSAT PROJECT	16/Sep	206d	288d	30/Jun
	Recruit Team members	16/Sep	23d	31d	16/Oct
2	Contact the head of...	16/Sep	3d	3d	18/Sep
3	Wait for selection	21/Sep	9d	11d	01/Oct
4	First meeting	02/Oct	1d	1d	02/Oct
5	Second meeting	09/Oct	1d	1d	09/Oct
6	Confirmation of ne...	15/Oct	1d	1d	15/Oct
7	Holiday - Day of Re...	12/Oct	1d	1d	12/Oct
8	Roles Assignment	16/Oct	1d	1d	16/Oct
	PDR Preparation	19/Oct	74d	102d	28/Jan
10	Holiday - National S...	23/Nov	1d	1d	23/Nov
11	Holiday - Immacula...	07/Dec	2d	2d	08/Dec
12	Christmas	25/Dec	1d	1d	25/Dec
13	New Year	01/Jan	1d	1d	01/Jan
14	Research of compo...	26/Oct	16d	22d	16/Nov
15	Design CanSat	23/Nov	6d	8d	30/Nov
16	Order of components	25/Nov	4d	6d	30/Nov
17	Obtaining compone...	01/Dec	11d	15d	15/Dec
18	Build CanSat	16/Dec	11d	15d	30/Dec
19	Test Communicatio...	02/Jan	1d	3d	04/Jan
20	Ground Control Sta...	25/Jan	1d	1d	25/Jan
21	University Final Exams -...	11/Nov	31d	43d	23/Dec
22	Vacations	24/Dec	32d	46d	07/Feb
23	PDR Review and Update	29/Jan	2d	4d	01/Feb
24	PDR Submit	01/Feb	1d	1d	01/Feb



Detailed Program Schedule

	ACTIVITIES	START	WD	CD	DUE
24	PDR Submit	01/Feb	1d	1d	01/Feb
25	University Final Exams -...	08/Feb	5d	5d	12/Feb
26	CDR Preparation	13/Feb	31d	45d	29/Mar
	Integration and test	15/Feb	10d	12d	26/Feb
28	Descent testing	15/Feb	2d	2d	16/Feb
29	Communications	17/Feb	3d	3d	19/Feb
30	Mechanisms	20/Feb	2d	4d	23/Feb
31	Deployment	24/Feb	3d	3d	26/Feb
32	Environmental Test Pre...	27/Feb	2d	4d	02/Mar
33	Environmental Test Sub...	03/Mar	10d	14d	16/Mar
34	CDR Review and Update	17/Mar	13d	17d	02/Apr
35	CDR Submit	02/Apr	1d	1d	02/Apr
36	Environmental Test Doc...	03/Apr	40d	56d	28/May
37	Flight Telemetry Data P...	31/May	9d	11d	10/Jun
38	Flight Telemetry Data R...	11/Jun	1d	2d	12/Jun
39	Flight Telemetry Data S...	12/Jun	1d	1d	12/Jun
40	PFR Presentation	13/Jun	1d	1d	13/Jun



Conclusions

We accomplish every requirement and develop the PDR with conscience and patience.
We already to proceed to CDR.