CanSat 2020 Critical Design Review (CDR) Outline

Version 1.0

Team ID 1360

UHMC Onipa’a

Presentation Outline

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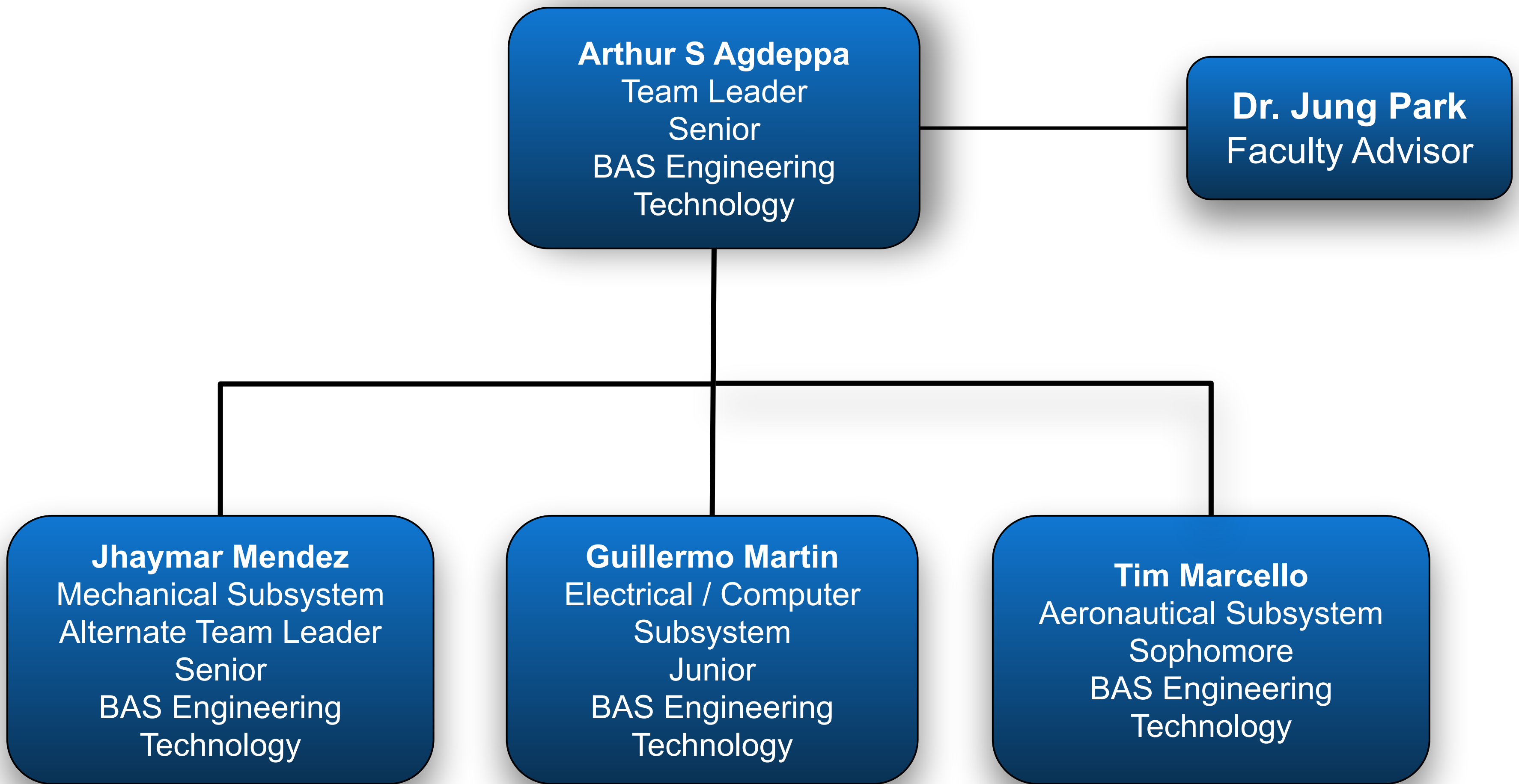
Team Organization



Acronyms

B.A.S	Bachelor of Applied Science
CS	Computer Science
CONOPS	Concept of Operation
dB	Decibel
DCS	Distributed Control System
DAC	Digital to Analog Converter
EE	Electrical Engineer
g	Grams
Gs	Gravitational Force
GPS	Global Positioning System

GCS	Ground Control Station
hPa	HectoPascal
Hz	Hertz
I2C	Inter-Integrated Circuit
m	Meters
mA	MilliAmps
m/s	Meters per second
mm	Millimeters
PCB	Printed Circuit Board
PETG	Polyethylene Terephthalate

Acronyms

RTC	Real Time Clock
SPI	Serial Peripheral Interface
STEM	Science, Technology, Engineering and Mathematics
V	Volts
Vin	Voltage Input
W	Watts
Wh	Watt Hour
Y	Yes
N	No
GUI	Graphical User Interface

AC	Alternating Current
OS	Operating System
EEPROM	Electrically Erasable Programmable Read-Only Memory
CDH	Communication and Data Handling
EPS	Electrical Power Subsystem
FSW	Flight Software
C	Celcius
GHz	Gigahertz
LED	Light Emitting Diode
GB	GigaBytes

System Overview

Jhaymar Mendez

Mission Summary (1/2)

Design a CanSat that will include a container and a science payload.

- The CanSat will be launched to an altitude of 670m to 725m and will be deployed near apogee.
- The CanSat container shall protect the payload from damage during launch and deployment.
- The CanSat shall descend at a rate of 20m/s once released.
- The payload which is a glider shall be released at an altitude of 450m.
- The glider, once released, shall glide in a circular pattern with a radius of 250m for one minute and stay above 100m while collecting sensor data.
- At 100m, the payload shall deploy a parachute so it can descend at 10m/s
- The payload shall monitor altitude, air speed, and particulate concentration in the air while gliding

Mission Summary (2/2)

Bonus Objective

- A minimum of 640x480 resolution 30 Hertz color camera will be integrated to the payload.
- The video will be retrieved when the payload is retrieved.
- The video shall maintain pointing at the provided coordinates for 30 seconds.

External Objective

- To promote STEM to our community and to gain the confidence of young aspiring engineers.
- To increase enrollment to STEM classes by presenting our project to various presentation opportunity.
- To gain experience in working on Engineering project, adapting to a teamwork environment, implementing project and time management.

Summary of Changes Since PDR

- **There are no changes at system level since PDR**

System Requirement Summary

Requirements	Level	Description
1	Very High	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.
2	Very High	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerance are to be included to facilitate container deployment from the rocket fairing.
3	Very High	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	High	The Container shall be a fluorescent color ; pink, red, or orange
5	Very High	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on thes science payload is allowed. The end of the container where the payload deploys may be open.
6	Very High	The rocket airframe shall not be used to restrain any deployable parts of the CanSat
7	Very High	The rocket airframe shall not be used as part of the CanSat operation
8	Very High	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
9	Very High	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.

System Requirement Summary

Requirements	Level	Description
10	Very High	The container shall release the payload at 450 meters +/- 10 meters.
11	Very High	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.
12	Very High	The science payload shall be a delta wing glider.
13	Very High	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5m/s
14	Very High	All descent control device attachment components shall survive 30 Gs of shock.
15	Very High	All electronics components shall be enclosed and shielded from the environment with the exception of sensors.
16	High	All structures shall be built to survive 15 Gs of launch acceleration.
17	Very High	All structures shall be built to survive 30 Gs of shock.
18	Very High	All Electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.
19	Very High	All mechanism shall be capable of maintaining their configuration or states under all forces.

System Requirement Summary

Requirements	Level	Description
20	Very High	Mechanism shall not use pyrotechnics or chemicals.
21	Very High	Mechanism that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.
22	Very High	The science payload shall measure altitude using an air pressure sensor.
23	Very High	The science payload shall provide position using GPS.
24	Very High	The science payload shall measure its battery voltage.
25	Very High	The science payload shall measure outside temperature.
26	Very High	The science payload shall measure particulates in the air as it glides.
27	Very High	The science payload shall measure airspeed.
28	Very High	The science payload shall transmit all sensors data in the telemetry.
29	Very High	Telemetry shall be updated once per second.
30	Very High	The parachutes shall be fluorescent Pink or Orange
31	High	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.

System Requirement Summary

Requirements	Level	Description
32	Very High	The ground station shall generate a csv file of all sensor data as specified in the telemetry section.
33	Very High	Telemetry shall include mission time with one second or better solution. Mission time shall be maintained in the event of processor reset during the launch and mission.
34	Very High	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.
35	Very High	XBEE radios shall be used for telemetry. 2.5 GHz Series radios are allowed. 900 MHz XBEE Pro radios also allowed.
36	Very High	XBEE radios shall have their NETIP/PANID set to their team number.
37	Very High	XBEE radios shall not use broadcast mode.
38	High	Cost of CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.
39	Very High	Each team shall develop their own ground station.
40	Very High	All telemetry shall be displayed in real time during descent.
41	Very High	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)

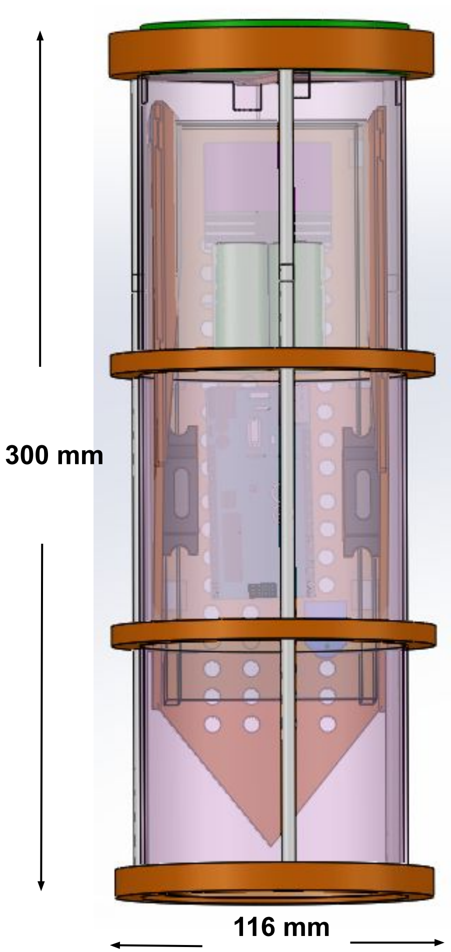
System Requirement Summary

Requirements	Level	Description
42	Very High	Team shall plot each telemetry data field in real time during flight.
43		
44	High	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.
45	Very High	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.
46	Very High	Both the container and probe shall be labeled with team contact information including email addresses.
47	Very High	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 process resets.
48	Very High	No lasers allowed.
49	Very High	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.
50	Very High	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the cansat and in the stowed state.

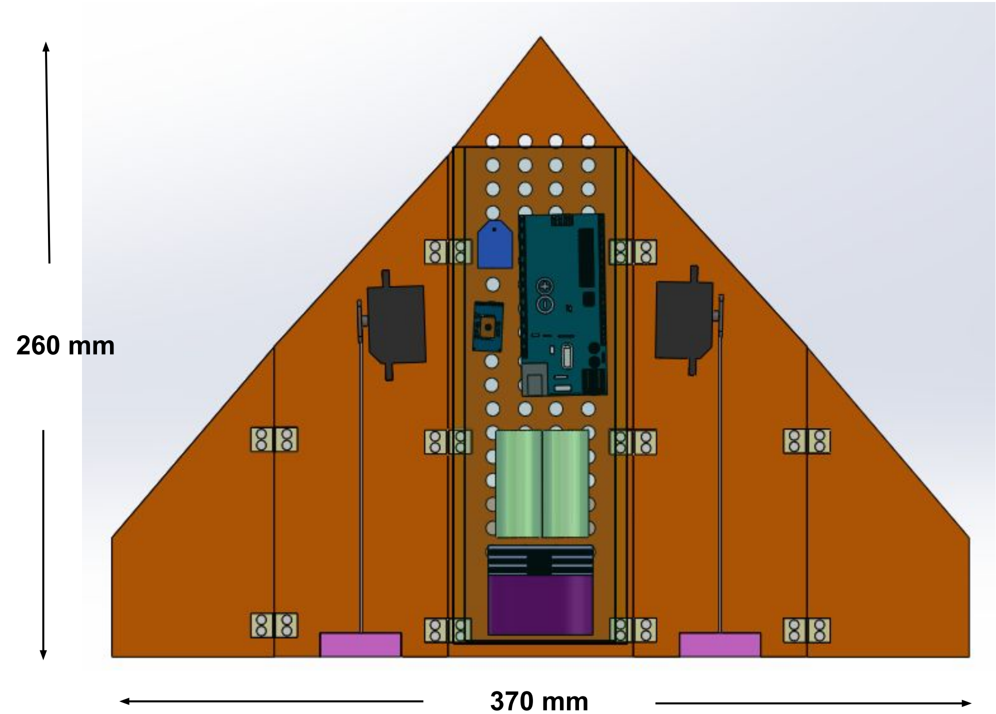
System Requirement Summary

Requirements	Level	Description
51	High	Audio beacon is required for the probe. It may be powered after landing or operate continuously.
52	High	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.
53	Very High	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells.
54	Very High	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.
55	Very High	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.
56	Very High	The CANSAT must operate during the environmental tests laid out in Section 3.5.
57	Very High	Payload/Container shall operate for a minimum of two hours when integrated into rocket.

Payload Physical Layout (1/4)

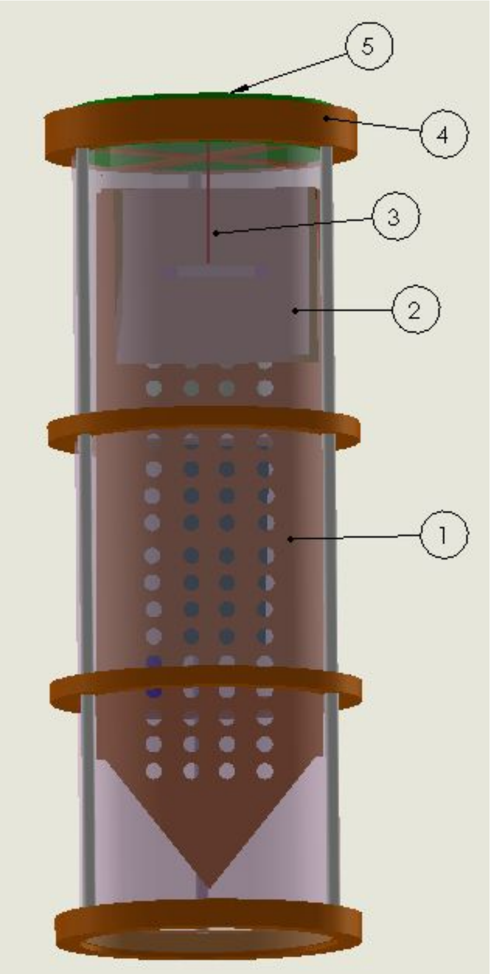


Launch Configuration



Configuration Deployment

Payload Physical Layout (2/4)

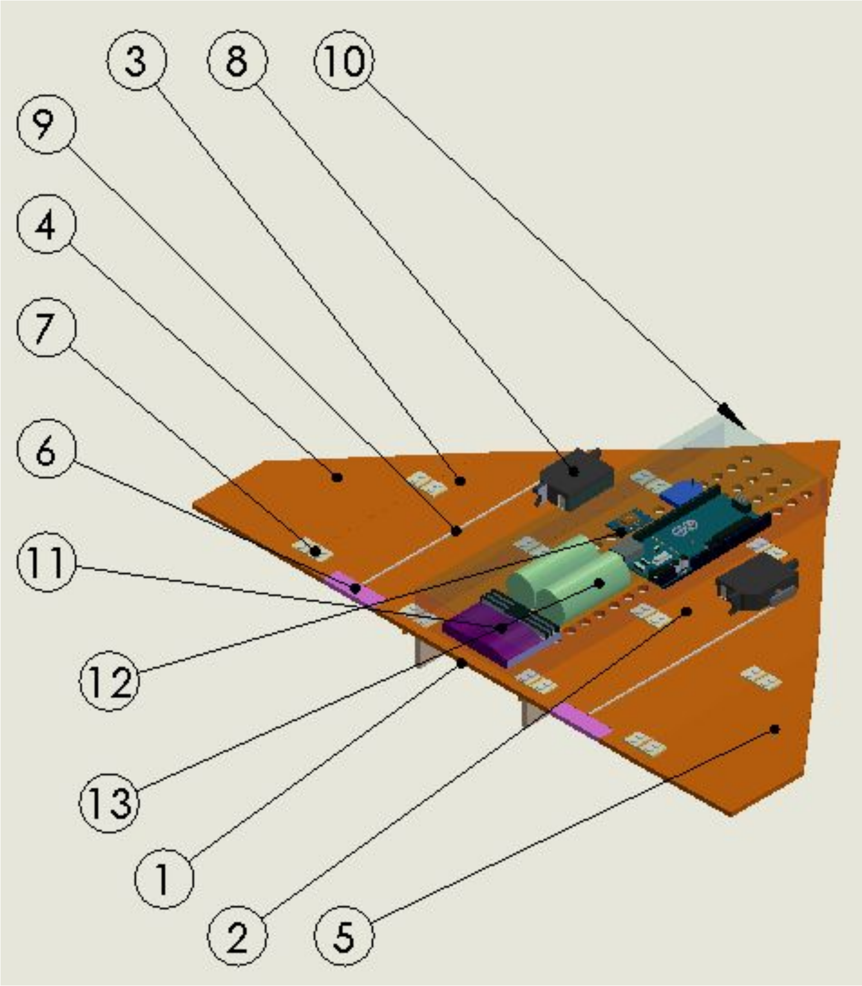


Part Number	Description
1	Payload
2	Release Mechanism/nichrome wire
3	Fishing line
4	Container
5	Parachute

Container Mechanics

Payload Physical Layout (3/4)

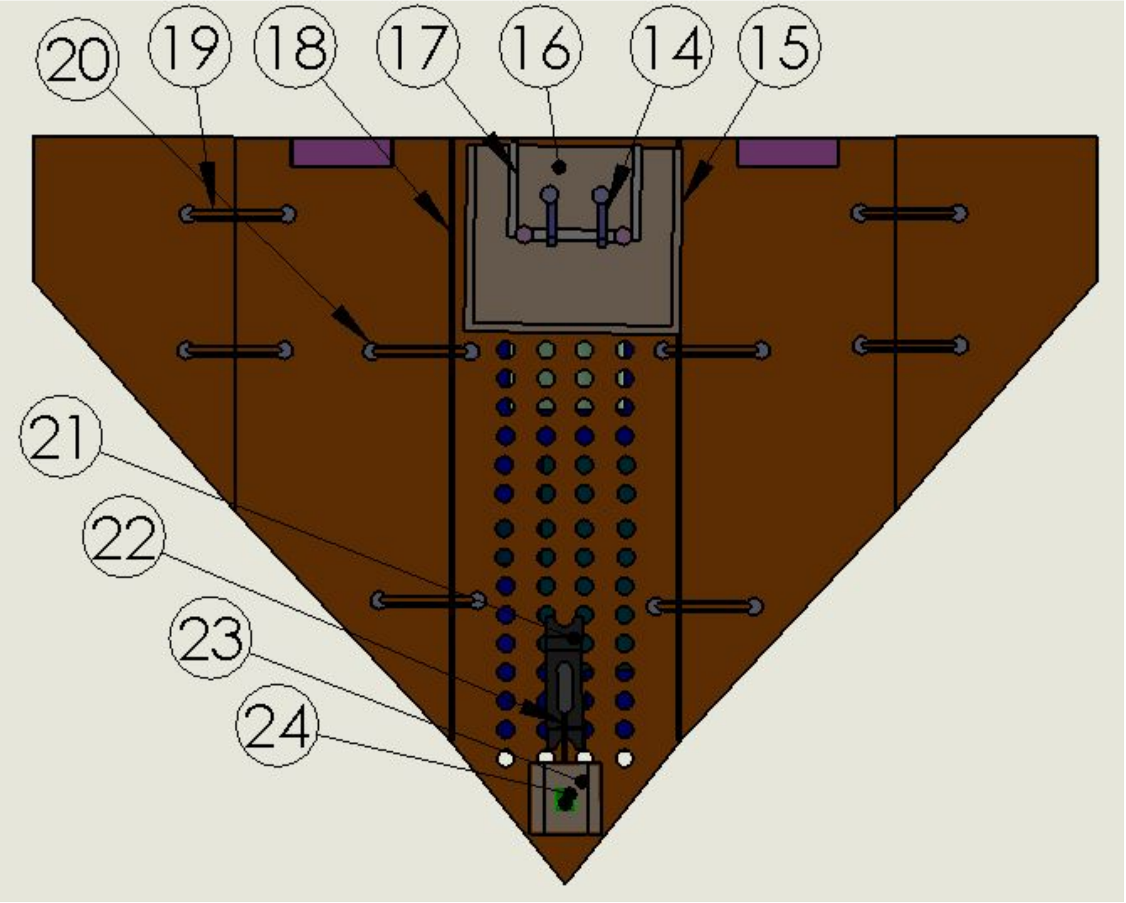
Part Number	Description
1	Main Frame
2	Right Wing Frame
3	Left Wing Frame
4	Left Winglet
5	Right Winglet
6	Ailerons
7	Hinges
8	Servos
9	String
10	Component Cover
11	Parachute
12	Electronics
13	Batteries



Payload Mechanics

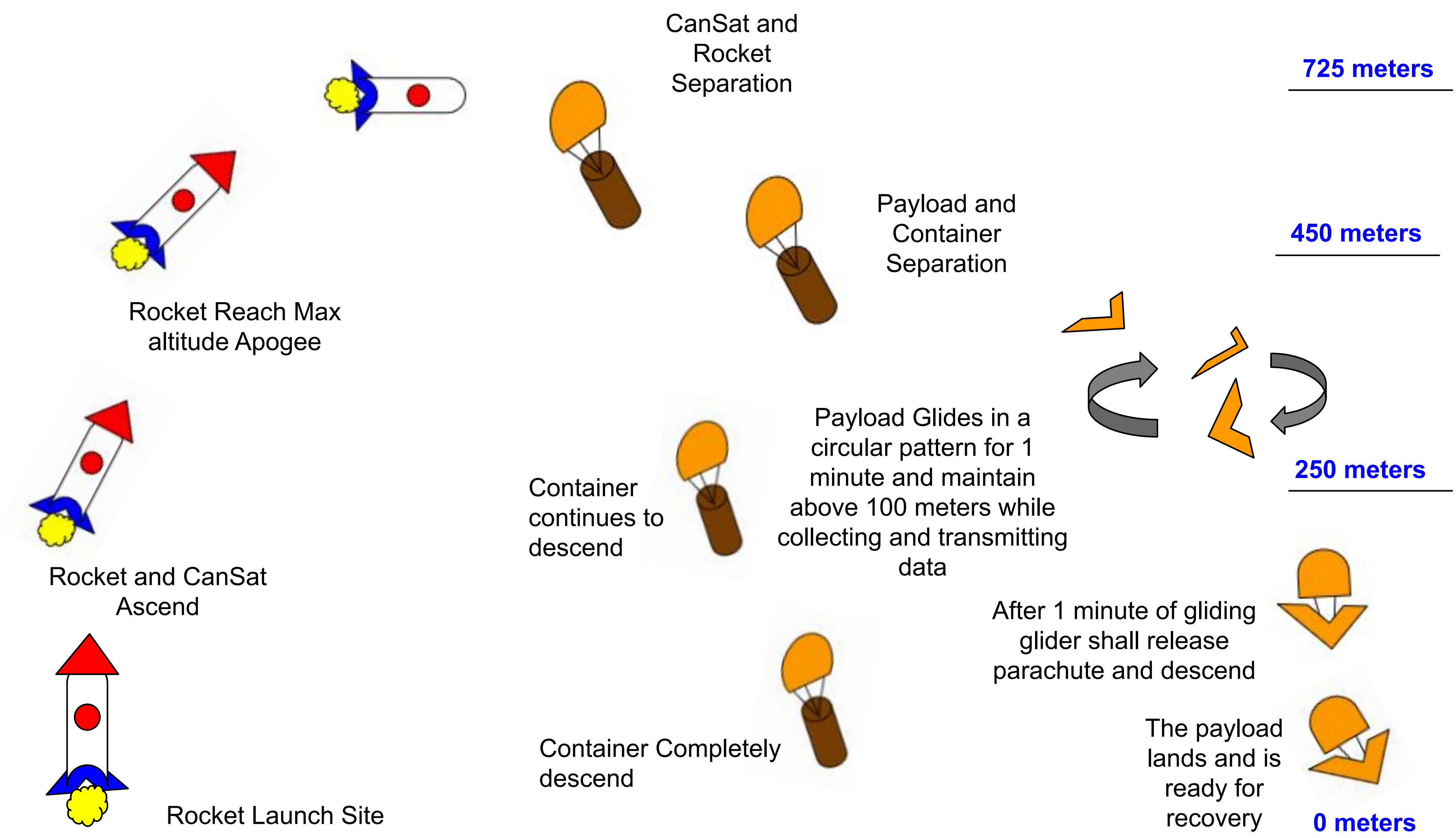
Payload Physical Layout (4/4)

Part Number	Descriptions
14	Nichrome Wire
15	Release Mechanism Cover
16	Release Mechanism Frame
17	Fishing Line
18	Stopper
19	Rubber Band
20	Hooks for Rubber Bands
21	Servo
22	Directional String
23	Flexiglass Cover
24	Camera



Payload Mechanics

System Concept of Operations (1/2)



System Concept of Operations (2/2)

- Arrive at launch site
- Team Discussion
- Make final Adjustments on CanSat
- Set up Ground Station
- Make final Check on telemetry / configuration
- Turn in CanSat for launch

Pre-Launch

- CanSat Ascend with the rocket
- Separation of Rocket and CanSat
- Container and Payload Separation
- Gather Data telemetry save to .cvs file

Launch

- Recover Payload and Container
- Analyze the condition of Payload and Container
- Analyze Data
- Prepare for PFR
- Presentation of PFR

Post - Launch

Launch Vehicle Compatibility (1/2)

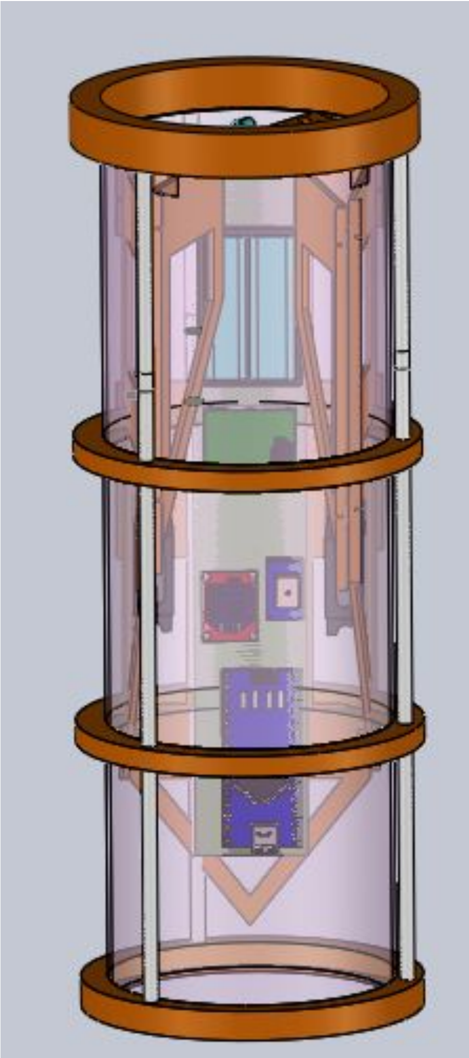
Mission Guide Rocket Payload dimensions:
- Height : 310 mm
- Diameter : 125 mm

CanSat Dimensions:
- Height : 300 mm
- Diameter : 116 mm

Payload Dimensions after deployment:
- Wing Span : 370 mm
- Tail to Nose : 260 mm

Parachute Dimensions:
- Diameter: 228.6 mm
- Spill Hole Diameter:

**Selection of CanSat based on Container dimension for payload to fit with sufficient margin*
** Reduce weight also to prevent possible failure on deployment and no sharp protrusions*



Launch Vehicle Compatibility (2/2)

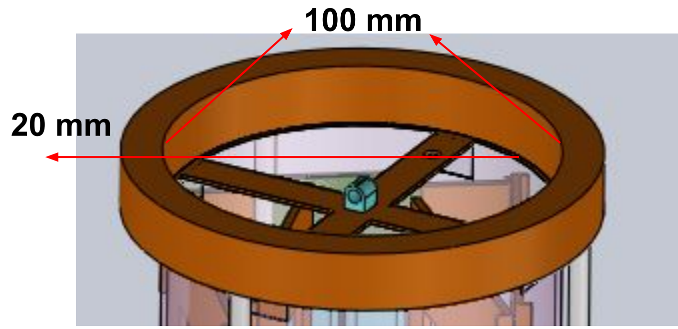
Rocket (Purple color) and Payload Dimensions:

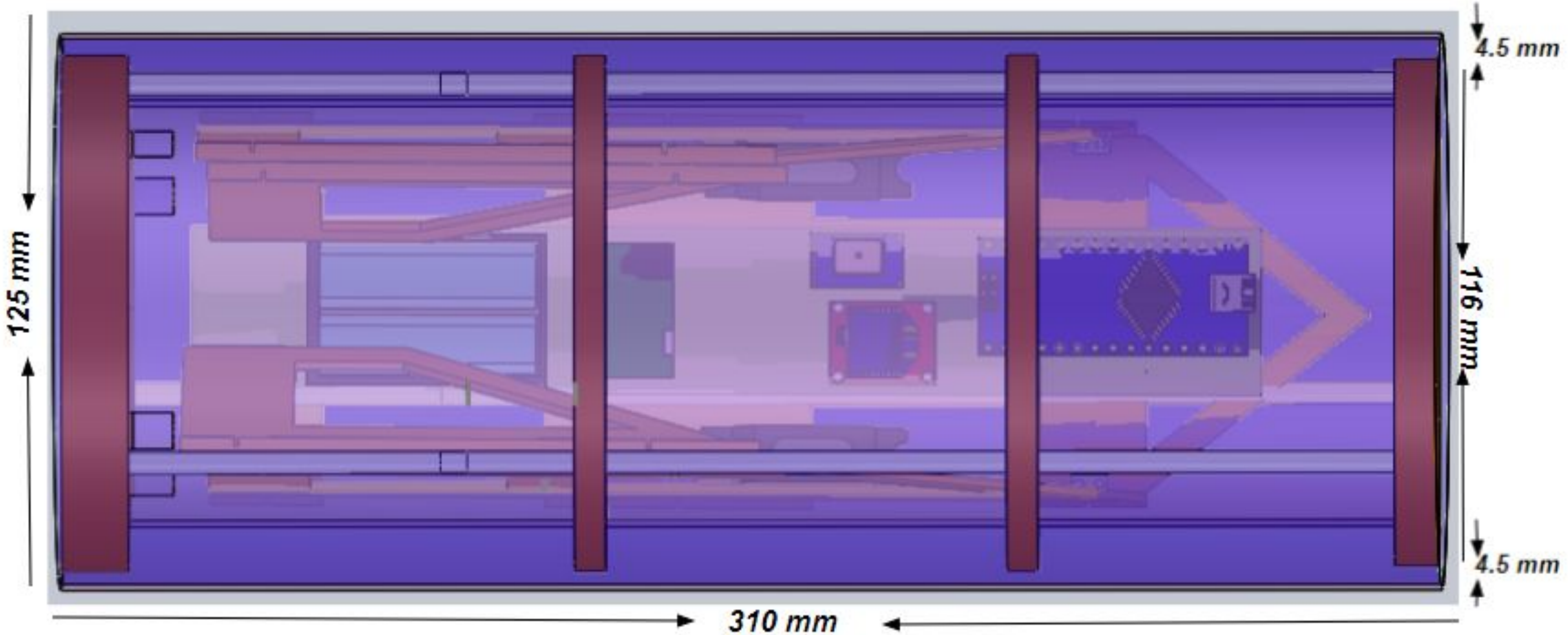
- Margin : 4.5 mm

CanSat Parachute Shell

- Height : 20 mm
- Diameter : 100 mm

**Dimensions and margins comply to the safety during deployment from the rocket and reduce the risk of failure*





Sensor Subsystem Design

Guillermo Martin

Sensor Subsystem Overview

Sensor Type	Model	Purpose	CanSat Location
Outside Thermometer	LM35DT	Detect outside temperature	Payload
Air Speed Sensor	MPXV7002DP	Detect True Air Speed	Payload
GPS	Adafruit Ultimate GPS	Detect longitude and latitude	Payload
Altitude	BME280	Detect altitude	Payload
Voltage	Series 10K resistor	Detect battery voltage	Payload
Particulate Sensor	SPS30	Measure air particulates	Payload
Pitch and Roll	MPU6050	Detect glider's pitch and roll	Payload

Sensor Changes Since PDR

There is no sensor changes since PDR.

Sensor Subsystem Requirements

Requirements	Description
15	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.
18	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.
22	The science payload shall measure altitude using an air pressure sensor.
23	The science payload shall provide position using GPS.
24	The science payload shall measure its battery voltage.
25	The science payload shall measure outside temperature.
26	The science payload shall measure particulates in the air as it glides.
27	The science payload shall measure air speed.

Payload Air Pressure Sensor Summary

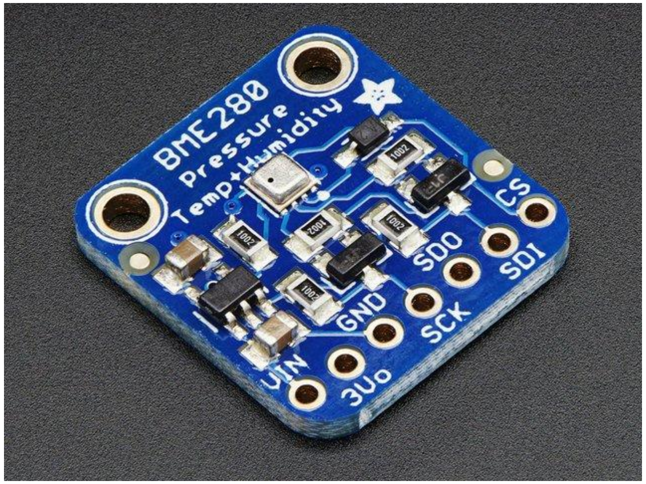
Sensor	Current @1Hz	Temperature range	Port	Resolution (hPa)	Voltage Usage	Size	Weight	Sensitivity error
BME280	3.6 uA	-40 to +85 °C	I2C or SPI	.03	1.65V ~ 3.6V	19mm x 18mm x 3.0mm	1.2g	1m @ Δ400m

Accuracy	+/- 1 hpa @ 0-60 deg Celcius

Data Processing

#define SEALEVELPRESSURE_HPA (GCS_SEA_HPA)
altitude=bme.readAltitude(SEALEVELPRESSURE_HPA);
pressure=bme.readPressure();
Serial.println(altitude,1);

Output	46.6 47.7 46.7



Payload Air Temperature Sensor Summary

Sensor	Vin	Temperature Range	Margin of Error	Sensitivity (Analog port)
LM35DT	4V-30V	-55℃ to 150℃	±0.75℃	10mV/Celcius

Accuracy	+/- 0.75 degree Celcius

Data Processing

val=analogRead(A0);
temp=val* 0.217226044 - 61.1111111;
Serial.println(temp,0);

Output	25 25 25

GPS Sensor Summary

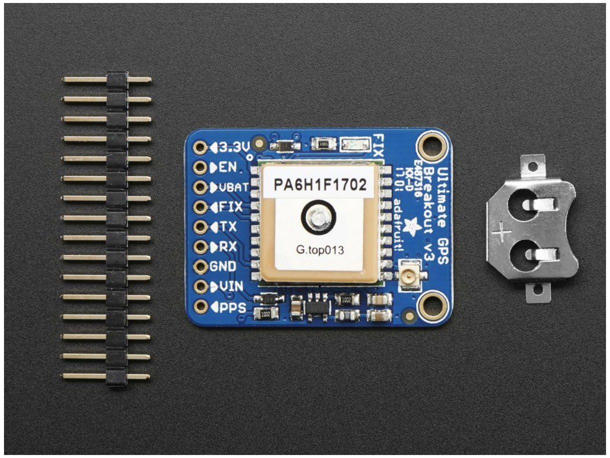
Name	Sensitivity	Weight (g)	Size (mm)	Operating Voltage (V)	Current Usage (mA)	Update Rate (Hz)
Adafruit Ultimate GPS breakout	-165 dBm	8.5	15 x 15 x 4	3.0 - 5.5	20	1 - 10

Data Processing

```
lat=fix.latitude();
longt=fix.longitude();
gpsalt=fix.altitude();
sat=fix.satellites;
Serial.print(lat,4);
Serial.print(longt,4);
Serial.print(gpsalt);
Serial.print(sat);
```

Accuracy	5-10 meters

Output	20.8917 -156.4788 40.40 4 20.8917 -156.4788 40.30 4 20.8917 -156.4788 40.40 4



Payload Voltage Sensor Summary

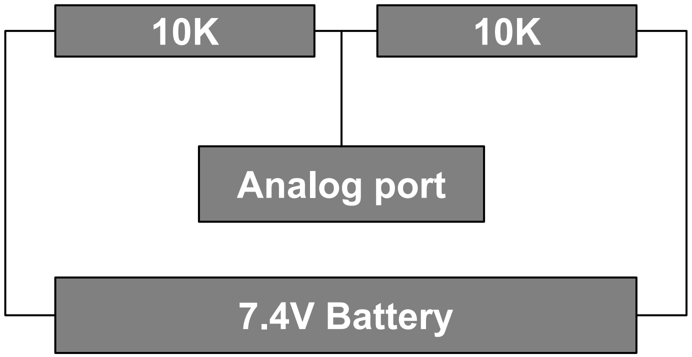
Name	Sensitivity (Analog port)	Weight (g)	Size (mm)	Operating Voltage (V)	Current Usage (mA)
Series Resistor	1mV	< 1	5 x 1	.1 - 10	.740

Accuracy	+/- 0.5V

Data Processing

value=analogRead(A1);
voltage=value*5.0/1023;
voltage*=2;
Serial.println(voltage);

Output	7.59 7.84 7.87



Air Speed Sensor Summary

Name	Weight / Size	Sensitivity	Power	Operational Environment Ambient Temperature/ Storage Temperature	Interface	Resolution/Accuracy
MPXV7002/kit	16.76 x 7.62 x 13.21	1V/kPa	10mA	10 to 60 Celsius	Analogue	1.0V/kPa

Accuracy	+/- 2.5%

Data Processing

adc_avg+= analogRead(A2)-offset;
veloc = -sqrt((-10000.0*((adc_avg/1023.0)-0.5))/rho);
Serial.print(veloc);

Output	17.00 16.50 13.00

Particulate/Dust Sensor Summary

Name	Weight (g)/ Size (mm)	Sensitivity	Power	Operational Environment Ambient Temperature/ Storage Temperature	Detectable particle size(min)(µm)	Relative Humidity (non-condensing)	Interface
Sensirion SPS30	26 21.0 x 18.0 x3.0mm	10µg/m3	80 mA x 5V	-10 - 60 Celcius -40 - 70 Celcius	1 2.5 4 10	10 - 95%	I2C

Accuracy	+/- 10 ug/m^3

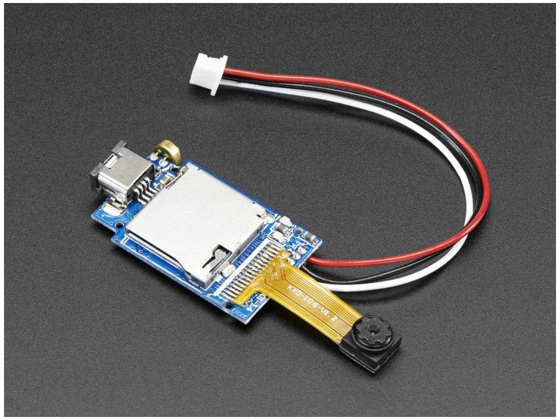
Data Processing
M1=sps30val.MassPM1; M2=sps30val.MassPM2; M3=sps30val.MassPM4; M4=sps30val.MassPM10;

Output	1.14 1.44 1.63 1.67 1.14 1.44 1.63 1.67 1.14 1.44 1.63 1.67

Bonus Objective Camera Summary

Name	Weight (g)/ Size (mm)	Cost (USD)	Power mA(5V)	Resolution	SD Card	Interface
Adafruit Mini Spy Camera	2.8 28 x 17 x 4.2	$12.50	110	640 x 480	Yes	Digital I/O

Meets Requirements
640 x 480 resolution pixels in color



Container Air Pressure Sensor Summary

This slide does not pertain to our team's design.

Our team's container does not have components relating to this slide.

Descent Control Design

Arthur S. Agdeppa

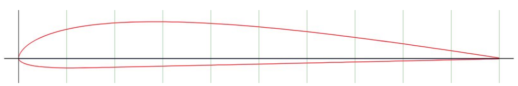
Descent Control Overview (1/3)

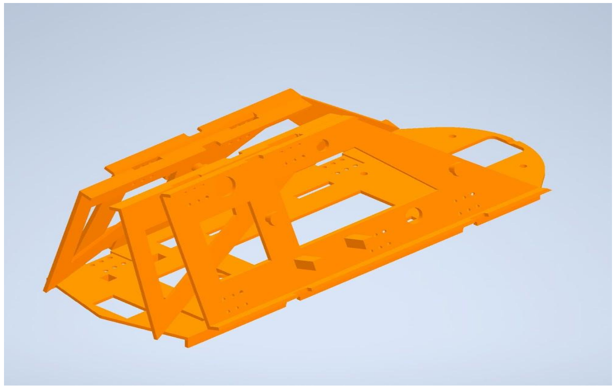
Airfoil (Flat bottom AG03)

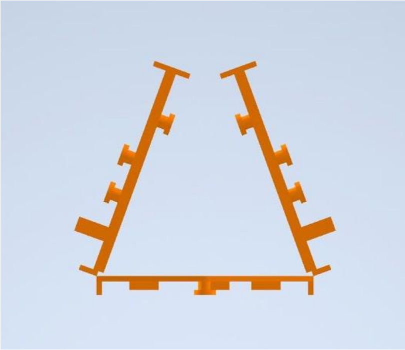
We chose flat bottom airfoil because it makes it easier for us to design our payload. Our configuration, the wing fold and the placement of the hinges will cause the flat part of the folded wing to touch each other. Making it fit in our container.

Parachute

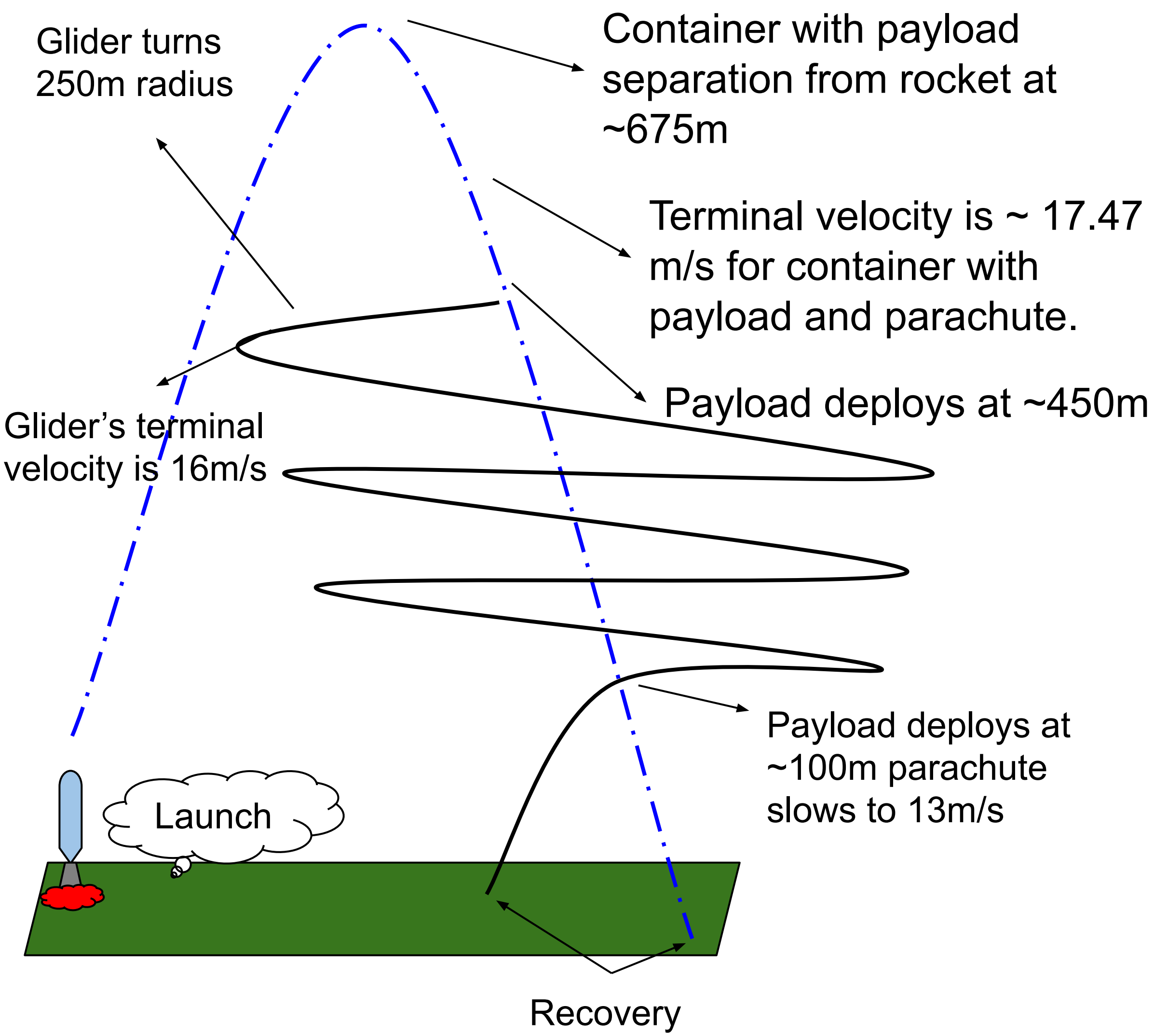
Our parachute is hexagon shape with 22.86 centimeter diameter. It will hold our container with the payload to approximately 17.47 m/s descent rate. Our payload will have the same size and it will hold it to approximately 12.36 m/s descent rate.







Descent Control Overview (2/3)



Event 1
Pre-flight Operations. Communications check.

Event 2
Rocket Launched

Event 3
Apogee has been reached deploying container with payload.

Event 4
Payload separates from container. Glider engages autopilot.

Event 5
Payload deploys parachute

Event 6
Landing and recovery

Descent Control Overview (3/3)

Configuration Selected: Cropped Delta wing glider with 50mm tip chord, 260mm root chord and a wing span of 370mm.

Components:

Component	Material Used
Glider wing support structure	PETG 3D printed
Hinges	Nylon hinges
Wing body	Foamboard
Parachute	Ripstop nylon
Parachute cord	Nylon Shroud

Descent Control Changes Since PDR

- **List changes since the PDR**
- **Include rationale**
- **Prototype testing**

Changes	Rationale
Recalculated descent rates.	Our payload mass changed from 281 to 377 grams. As a result, we also adjusted our mass budget for our container as well.

Descent Control Requirements

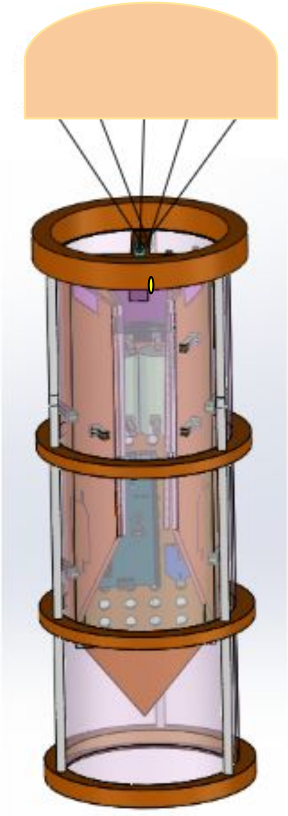
Requirements	Description
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.
4	The container shall be a fluorescent color; pink, red or orange.
8	The container parachute shall not be enclosed in the container structure. It shall be external and attached to the container so that it opens immediately when deployed from the rocket.
9	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.
10	The container shall release the payload at 450 meters +/- 10 meters.
11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.
13	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5 m/s

Payload Descent Control Hardware Summary (Stowed Configuration)

Flat hexagon parachute

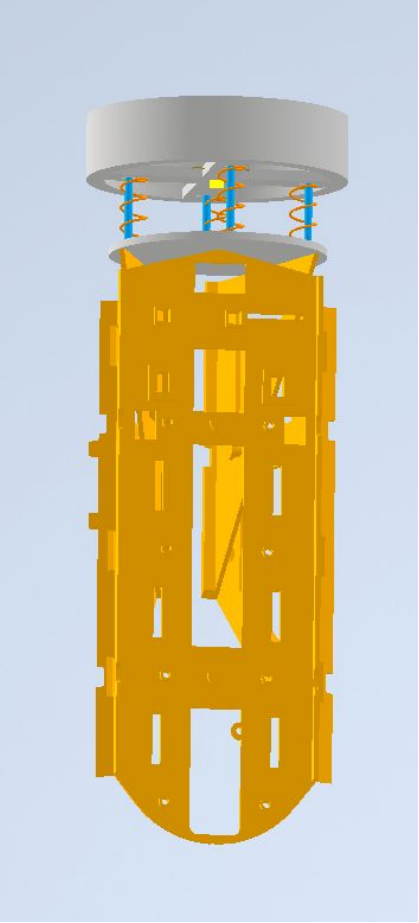
- Lightweight
- Low drag coefficient
- Easy to manufacture
- Premade parachute is available

- Parachute is attached to the container by tying the cords to a central eye bolt.
- Central eye bolt on the container will have bushings to prevent the container from twisting with the parachute.



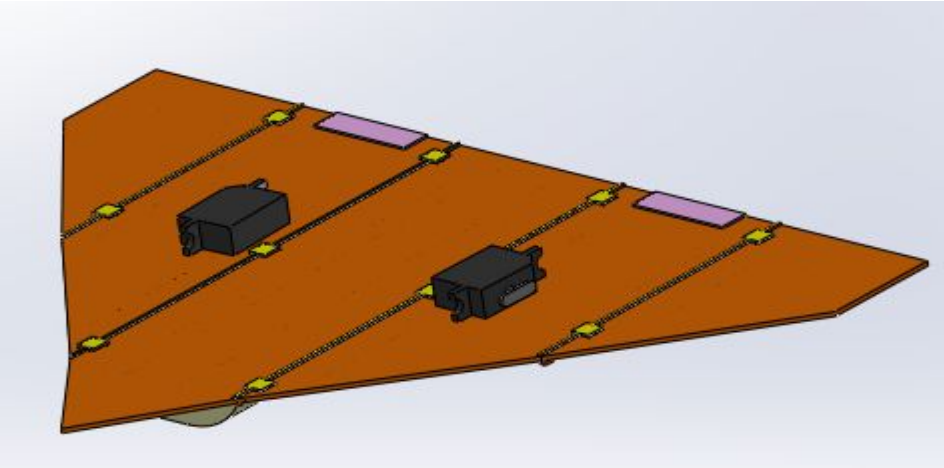
Payload Descent Control Hardware Summary (Deployment Method)

- A 3D printed plate with four rods guided by holes of the container top
- The rods are spring loaded and secured with bolts
- When the release mechanism is activated, the plate is pushed by the springs which pushes the payload downward

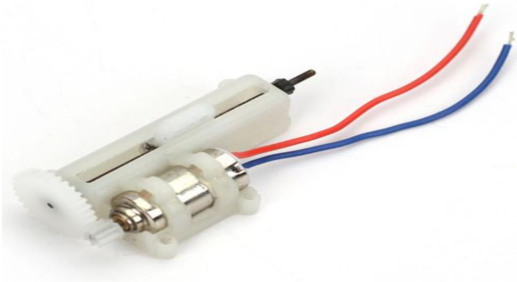


Payload Descent Control Hardware Summary (Deployed Configuration)

Selected: Active
- Closed loop control system that controls left and right servo connected to an elevon
- **Nadir** direction will be determined by the accelerometer
- Tumbling will be prevented by tuning the control system to fastest possible response



Linear servo to elevon active control
- Closed feedback
- MPU6050 sensor
- PID controller
- Will activate after deployment from container
- Lower profile than micro servo
- Lower possibility of getting stuck inside container



Payload Descent Control Hardware Summary

Name	Weight / Size (mm)	Sensitivity	Power	Voltage	Interface	Operating Temperature
MPU6050	15 x 20	+-250 degree/s	3.5mA	5V	i2C	-40 to 105 deg Celcius

Accuracy	Depends on programming

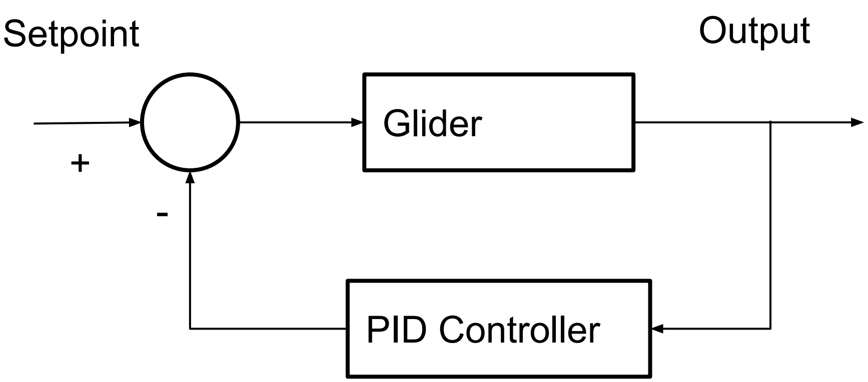
Data Processing (mpu6050 library)

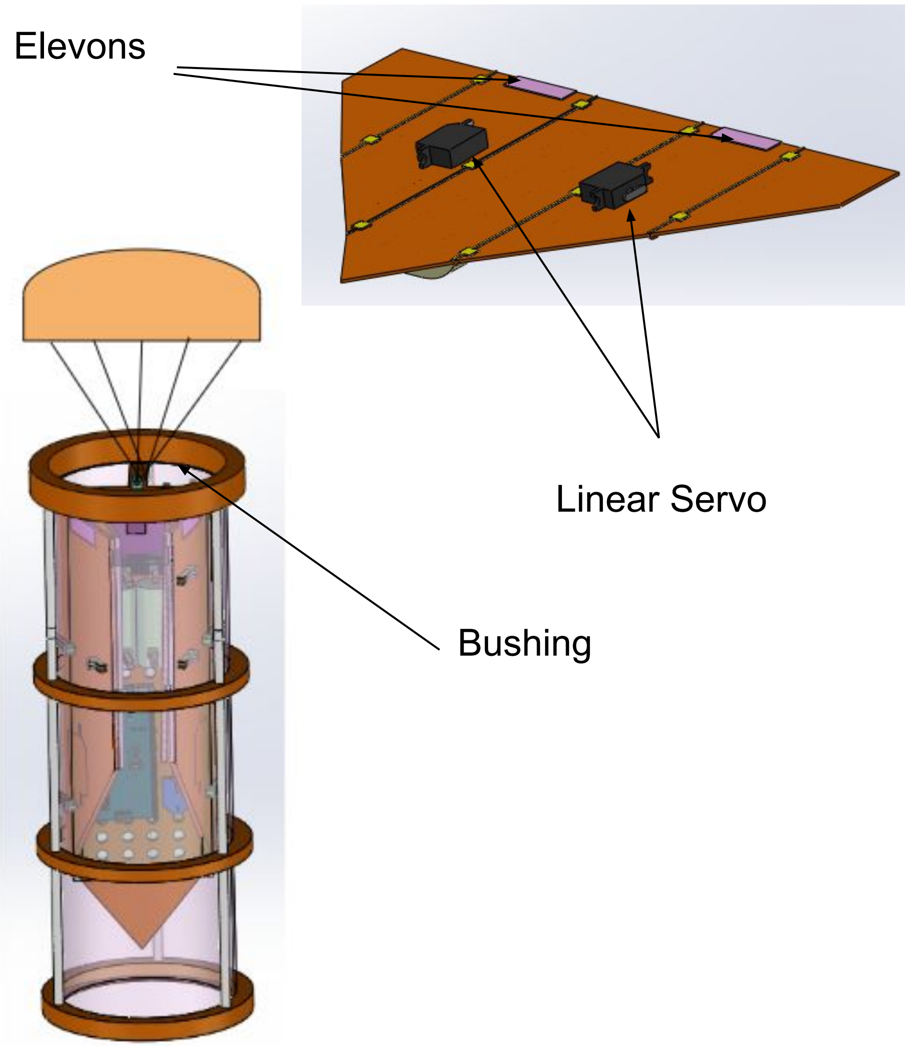
read_mpu_6050_data()
 	
gyro_x -= gyro_x_cal;
gyro_y -= gyro_y_cal;
gyro_z -= gyro_z_cal;
 	
mpu_timer/=65.5;
angle_pitch += gyro_x * mpu_timer;
angle_roll += gyro_y * mpu_timer;

Complementary filter will be applied to our data processing to correct drift.

Payload Descent Stability Control Design

1. **Parachute eyebolt attachment will have bushing to prevent it from twisting the container**
2. **Closed loop control system with PID controller feedback will control the servos with direct link to the elevons. The glider orientation is the output of our control system. The control system is tuned using Matlab and simulation.**
3. **Nadir direction will be maintained by the control system using the accelerometer.**

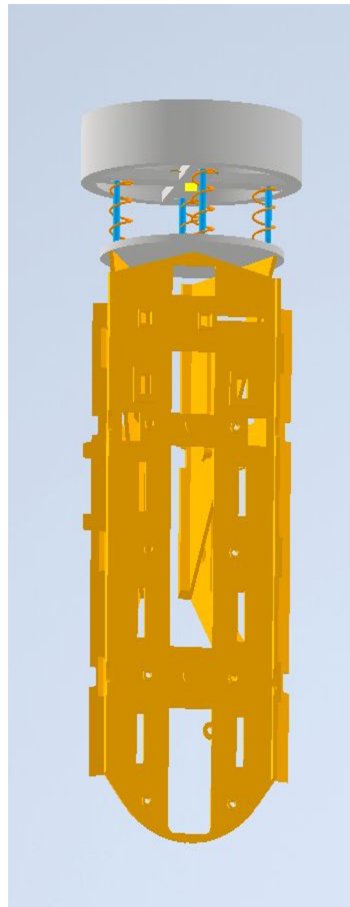




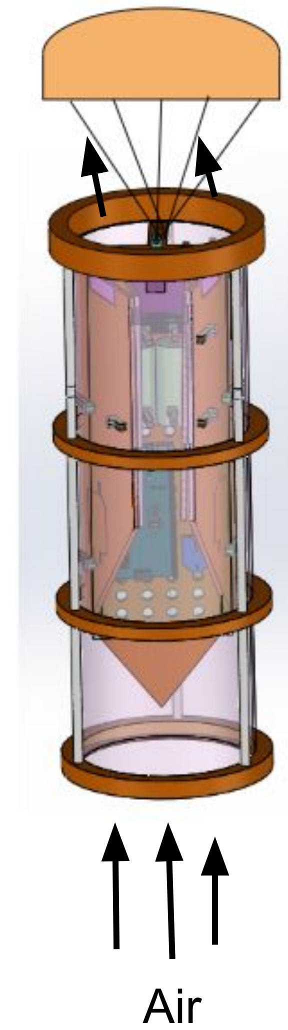
Container Descent Control Hardware Summary (1/2)

Deployment Method

- A 3D printed plate with four rods guided by holes of the container top
- The rods are spring loaded and secured with bolts
- When the release mechanism is activated, the plate is pushed by the springs which pushes the payload downward



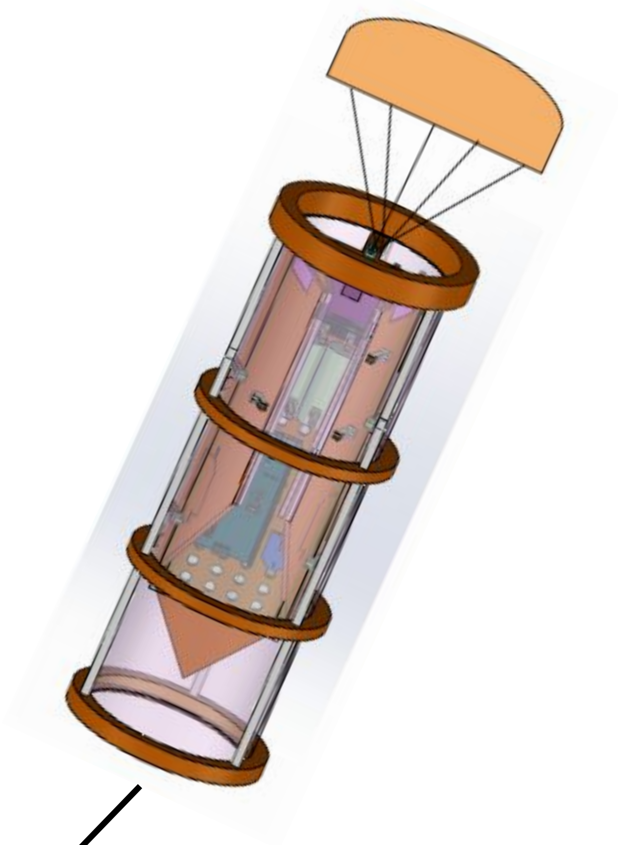
- Passive deployment of parachute using air from the bottom of the container through the opening on top

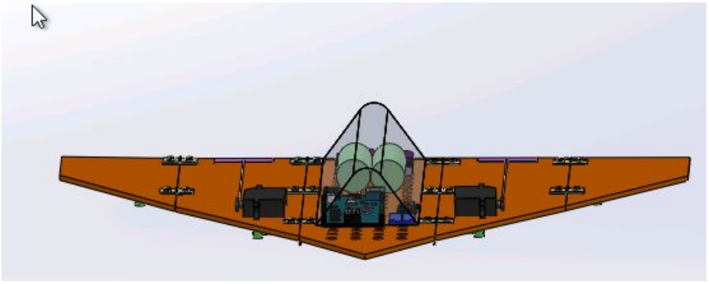


Container Descent Control Hardware Summary (2/2)

Deployed Configuration

- After the fishing line is burnt by nichrome wire, the spring loaded plate will push the payload downward.
- The container after separation will continue it’s descent using parachute





Descent Rate Estimates

Container and payload with parachute descent velocity:

$$v = \sqrt{\frac{2(m)(g)}{\rho(S)(C_d))}} = \sqrt{\frac{2(.6kg)(9.8m/s^2)}{1.225kg/m^3(.866(.22^2m))(.75)}} = 17.47m/s$$

- $\boldsymbol{v}$ is terminal velocity
- m is mass of container and payload (~.6kg)
- g is gravity
- ρ is air density
- S is area of parachute (.866 * (Diameter)^2 for hexagon)
- D is diameter of parachute estimated to be 22cm
- Cd is drag coefficient (.75 for hexagon ripstop)

Descent Rate Estimates

Container after payload release:

$$v = \sqrt{\frac{2(m)(g)}{\rho(S)(C_d)}} = \sqrt{\frac{2(.213kg)(9.8m/s^2)}{1.225kg/m^3(.866(.35^2))(.75))}} = 10.4m/s$$

- $\boldsymbol{v}$ is terminal velocity
- m is mass of container (~.32kg)
- g is gravity
- ρ is air density
- S is area of parachute {.866*(Diameter)^2 for hexagon}
- D is estimated to be 22cm
- Cd is drag coefficient (.75 for hexagon ripstop)

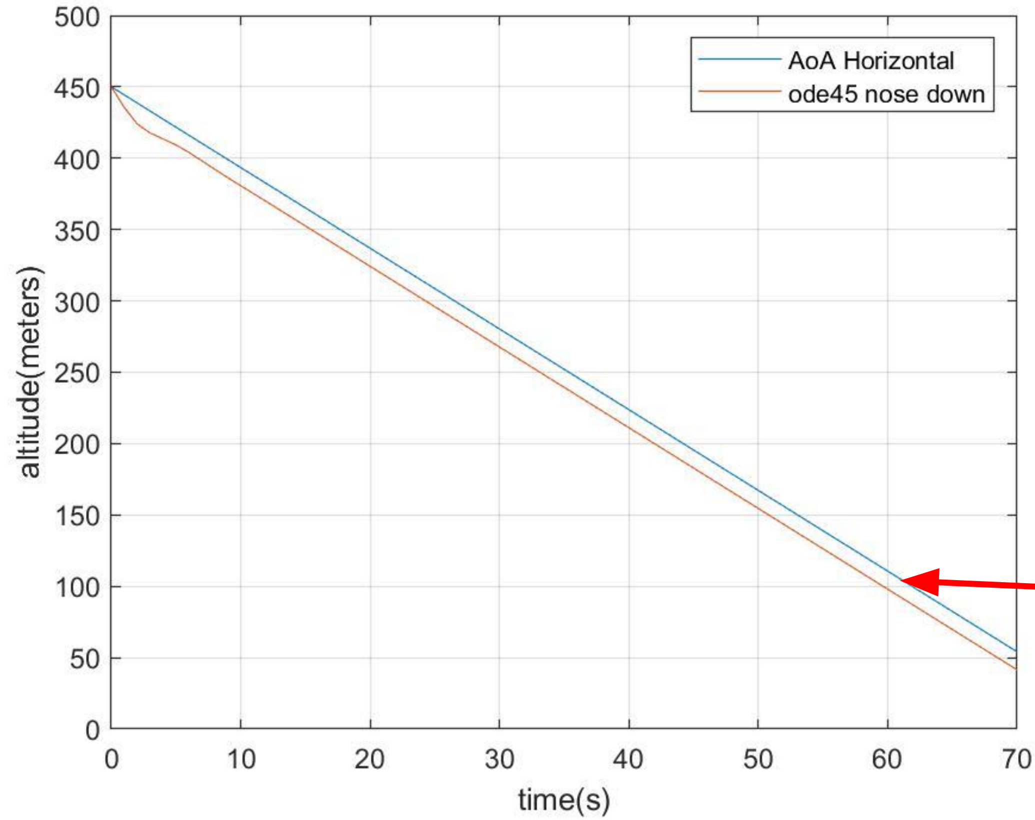
Descent Rate Estimates

Payload Descent terminal velocity:

$$v = \sqrt{\frac{2(m)(g)}{\rho(S)(\sqrt{C_l^2 + C_d^2})}} = \sqrt{\frac{2(.377kg)(9.8m/s^2)}{1.225kg/m^3(.066m^2)(\sqrt{.32^2 + .15^2})}} = 16m/s$$

- Wingspan = .370m
- Root chord = .260m
- Tip chord = .1m
- *S* is Wing area = .066m^2
- *Cl* is Lift coefficient = .32
- *Cd is* Drag coefficient = .15
- *m* is mass = .377kg
- *g* is gravity = 9.8m/s^2

Glider Travel Matlab Simulation (Altitude vs Time(s))

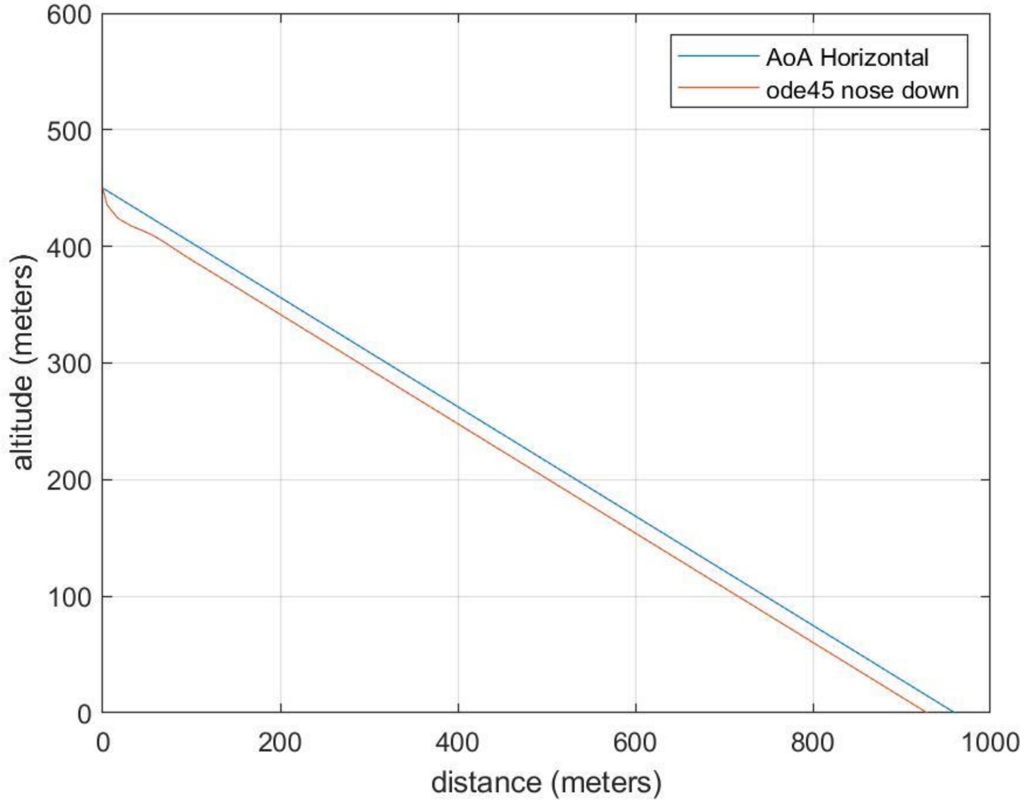


$$h = v\ sin(\theta)$$
$$d = v\ cos(\theta)$$
$$v = \frac{1}{m}\left(-\frac{\rho}{2}(S)(C_D)(v^2) - m(g)(sin(\theta))\right)$$
$$\theta = \frac{1}{m(v))}\left(\frac{\rho}{2}(S)(C_L)(v^2) - m(g)(cos(\theta))\right)$$

$h = height,\ m = mass,\ v = velocity$
$\theta = Angle\ of\ attack,\ S = surface\ of\ wing$
$d = distance,\ \rho = air\ density, g = gravity$
$C_D = drag\ coefficient,\ C_L = Lift\ coefficient$

Just made it!
60 seconds gliding before 100 meter altitude.

Glider Travel Matlab Simulation (Altitude vs Distance(m))



Descent Rate Estimates

Payload Control System Setpoint:

- Pitch = 0 degrees
- Yaw = 0 degrees

$$roll(\theta) = tan^{-1}\left(\frac{TAS/r}{g}\right)$$

Air Speed (m/s)	Radius of turn (m)	Roll Angle (degrees)
16.19	250	.4
16.19	150	.6
16.19	50	1.8
16.19	15	6.3

- **TAS** is True Air Speed
- ***r*** is radius of turn (250m)
- ***g*** is gravity

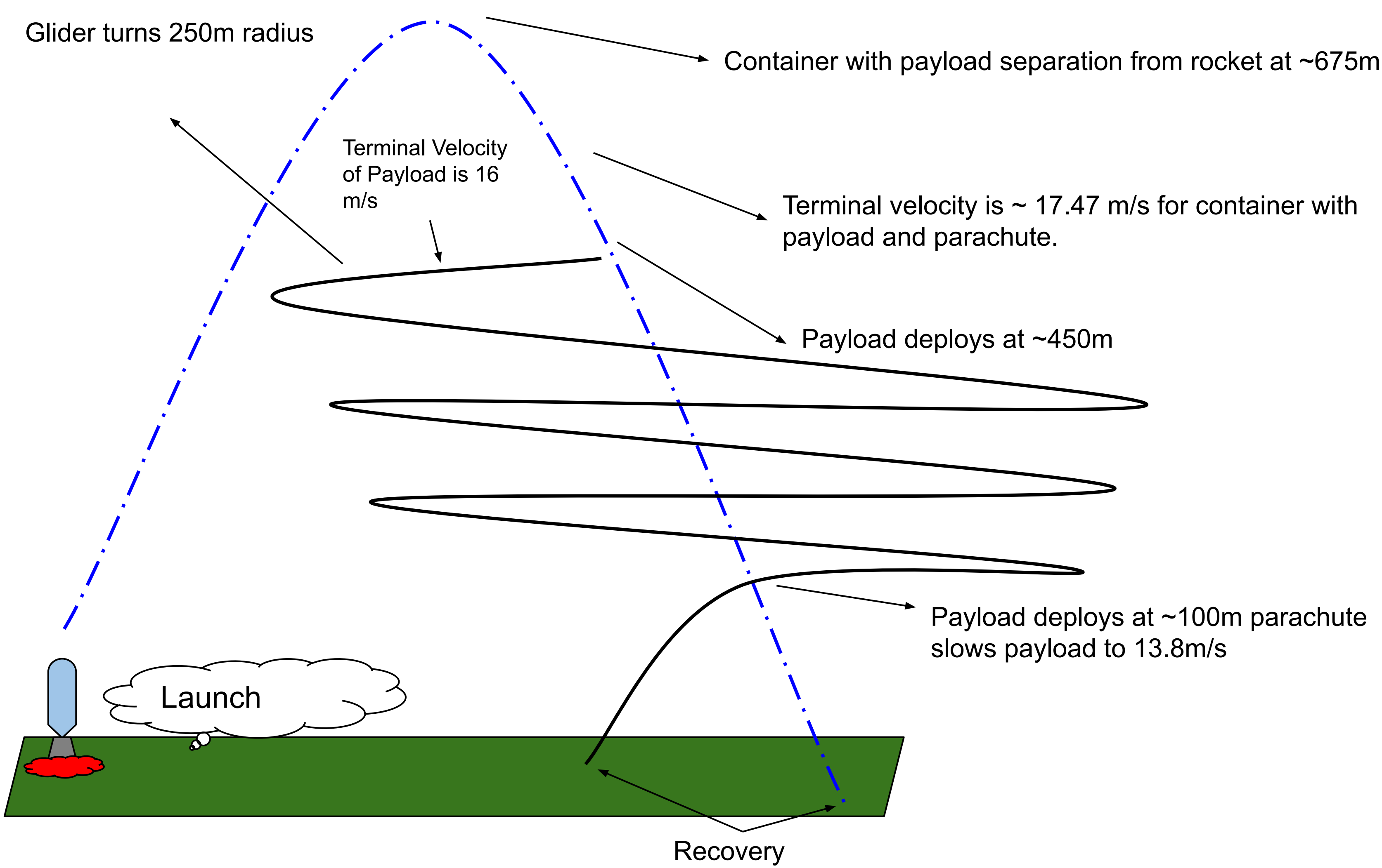
Descent Rate Estimates

Payload with parachute deployed descent velocity:

$$v = \sqrt{\frac{2(m)(g)}{\rho(S)(C_d)}} = \sqrt{\frac{2(.377kg)(9.8m/s^2)}{1.225kg/m^3(.866(.35^2))(.75))}} = 13.8m/s$$

- $\boldsymbol{v}$ is terminal velocity
- m is mass of container and payload (~.3kg)
- g is gravity
- ρ is air density
- S is area of parachute {.866 * (Diameter)^2 for hexagon}
- D is diameter of parachute estimated to be 22cm
- Cd is drag coefficient (.75 for hexagon ripstop)

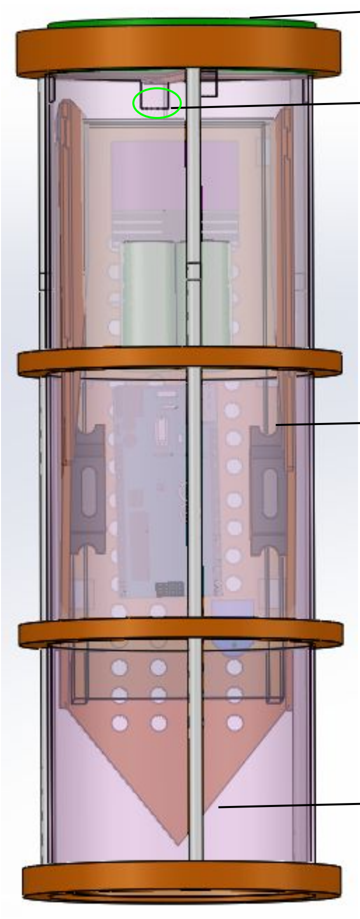
Descent Rate Estimates



Mechanical Subsystem Design

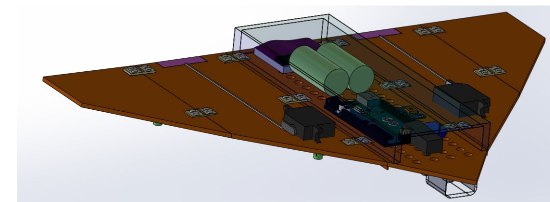
Jhaymar Mendez

Mechanical Subsystem Overview



Parachute

Payload release Mechanism

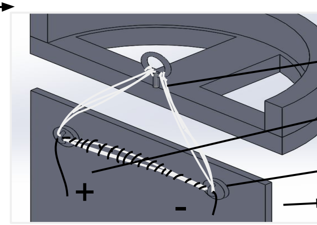


Fishing line

Nichrome Wire

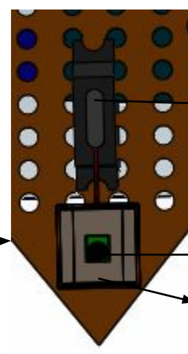
Fishing line holders

Release Mechanism Shield



Payload

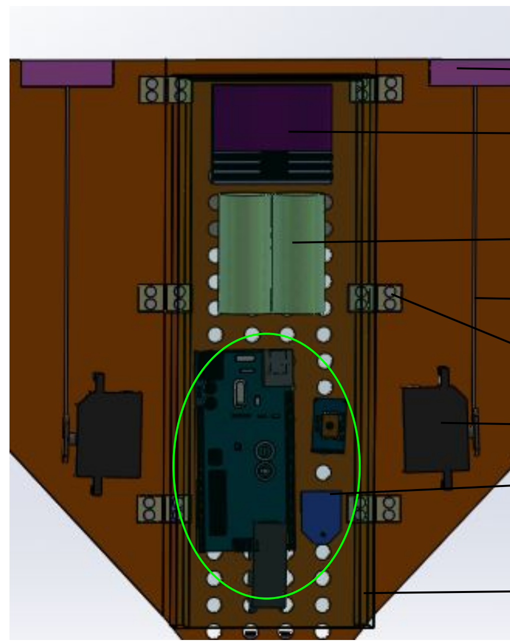
Bottom View



Servo

Camera

Flexiglass shield



Ailerons

Parachute

Battery

String

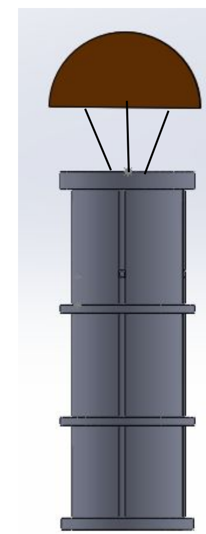
Hinges

Servo

Electronics in PCB

Flexiglass shield

Top View



Container

No Lasers!

Mechanical Subsystem Changes Since PDR

Changes	Reason
Payload Mass has increased from 281 to 377 grams. We redistributed our mass budget to comply with CanSat guideline.	- The electronic devices has been integrated into their respective PCB modules. The mass of the PCB modules has been considered.
Reduced mass of our payload deployment from 131 to 38 grams.	- Instead of using 4 rods, we use 2 instead. Instead of a solid piston plate, we will use a plate with holes to reduce mass.
We are going to use high temp elastic band instead of regular elastic band	- Folding wings has to remain as rigid as possible. Regular elastic band loses elasticity in high temp environment.

Mechanical Sub-System Requirements

Requirements	Description
1	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerance 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 payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.
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 operation
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

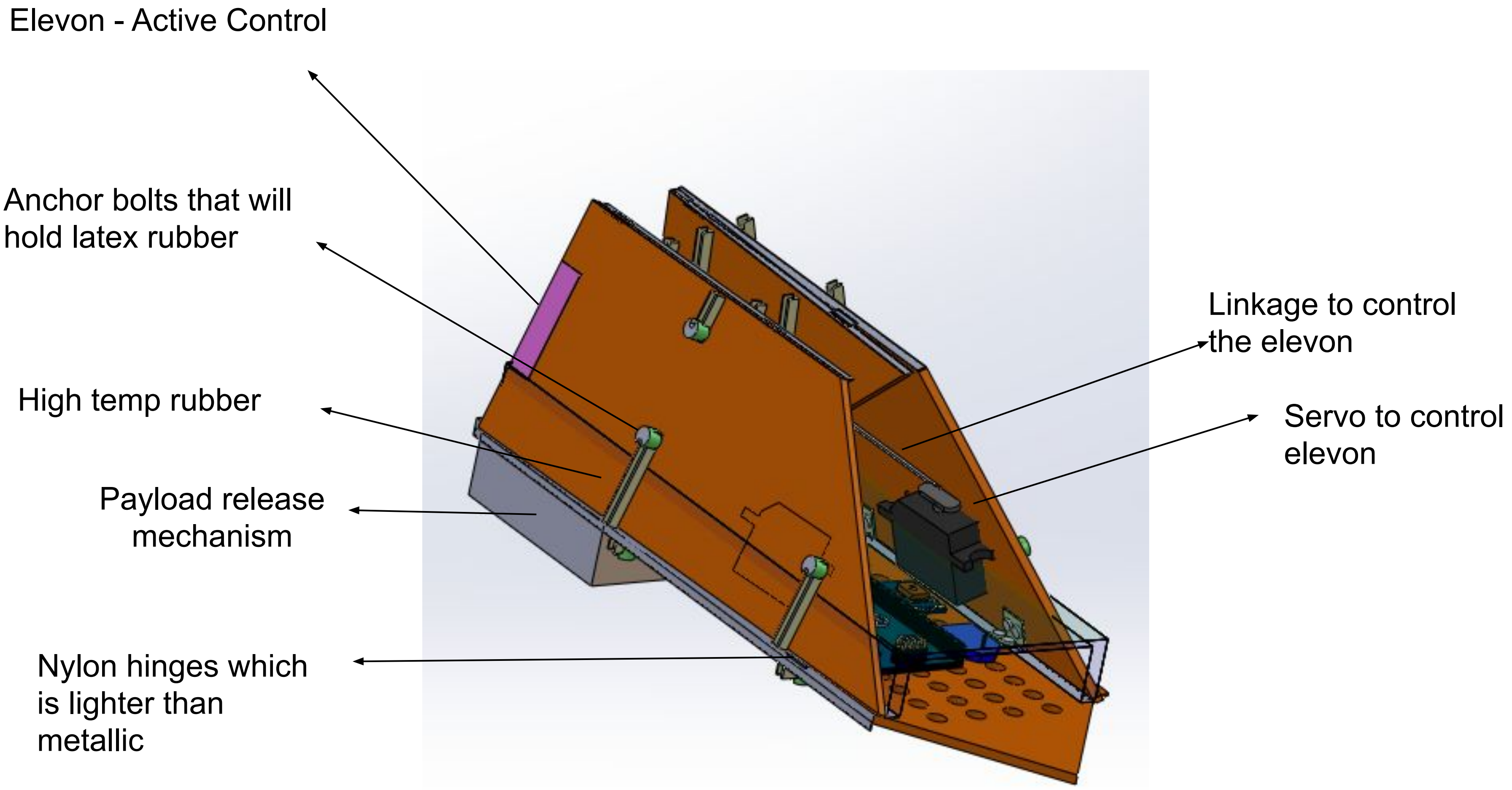
Mechanical Sub-System Requirements

Requirements	Description
12	The science payload shall be a delta wing glider.
14	The science payload shall be a delta wing glider.
15	All electronics components shall be enclosed and shielded from the environment with the exception of sensors.
16	All structures shall be built to survive 15 Gs of launch acceleration.
17	All structures shall be built to survive 30 Gs of shock.
18	All Electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.
19	All mechanism shall be capable of maintaining their configuration or states under all forces.
20	Mechanism shall not use pyrotechnics or chemicals.
21	Mechanism that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.

Mechanical Sub-System Requirements

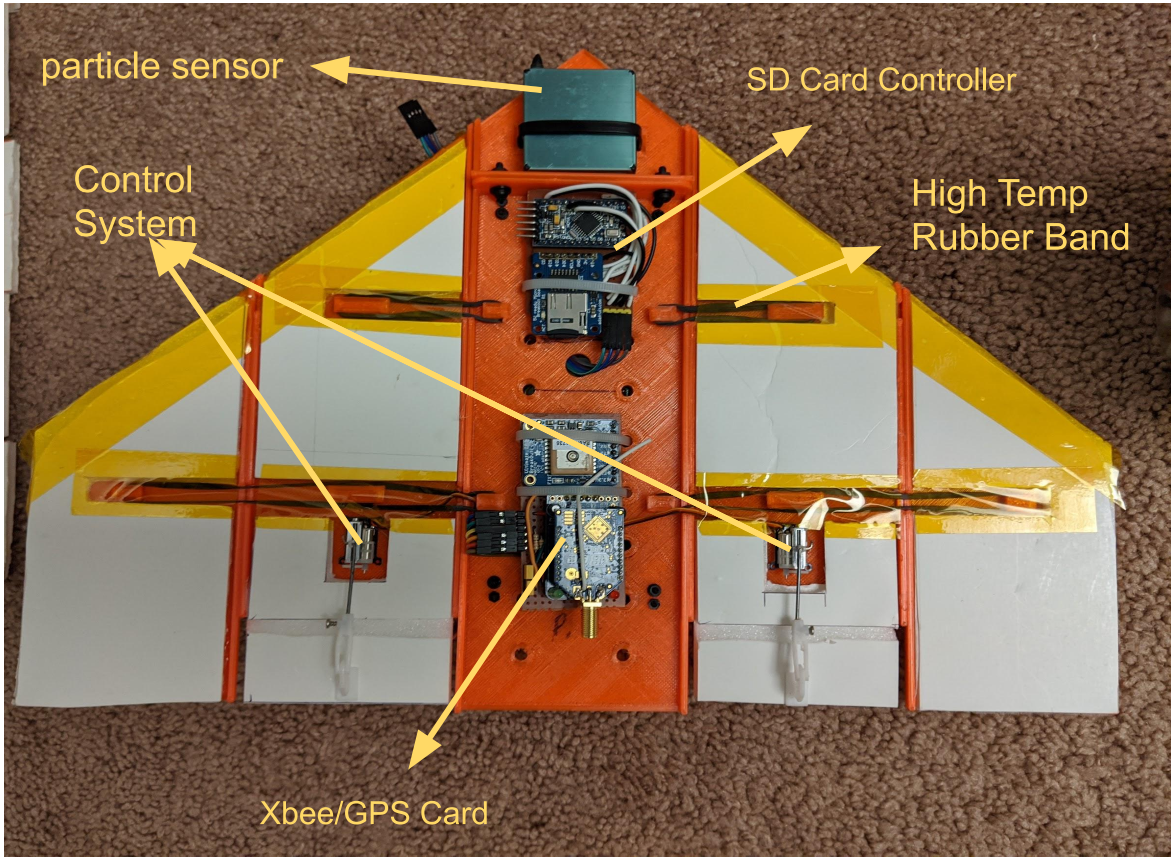
Requirements	Description
30	The parachutes shall be fluorescent Pink or Orange
38	Cost of CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.
46	Both the container and probe shall be labeled with team contact information including email addresses.
49	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.
50	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the cansat and in the stowed state.

Payload Mechanical Layout of Components (1/4)



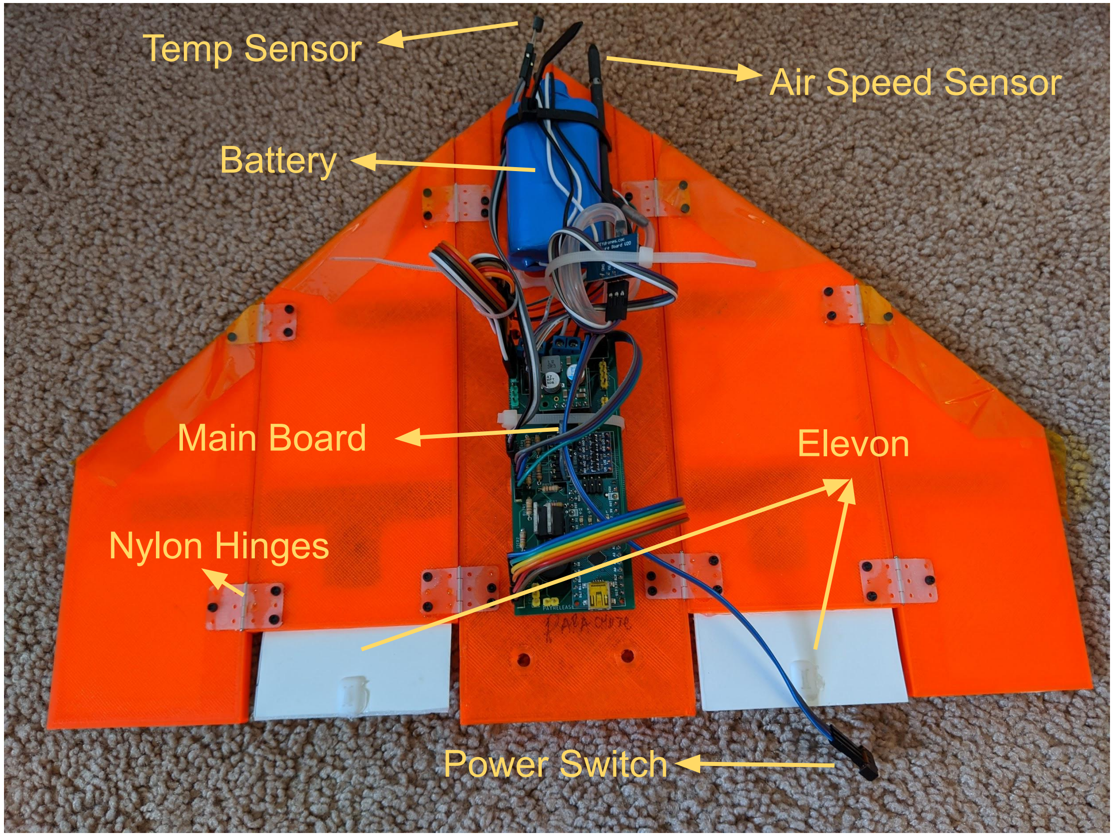
Payload Mechanical Layout of Components (2/4)

TOP VIEW - Actual Prototype

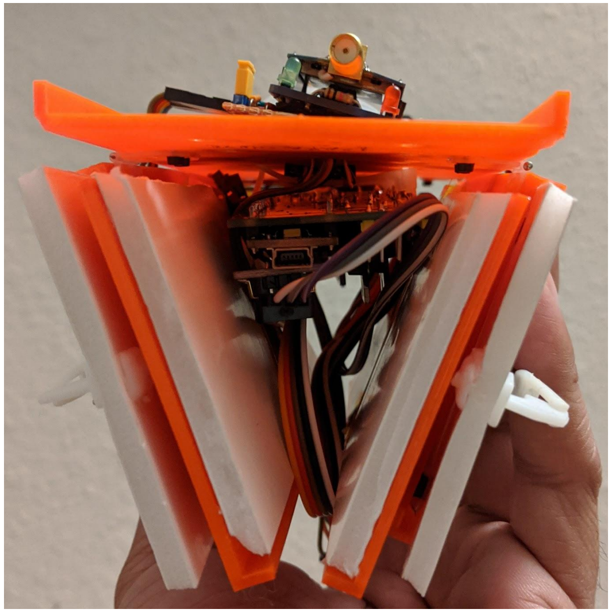


Payload Mechanical Layout of Components (3/4)

Bottom View -- Actual Prototype

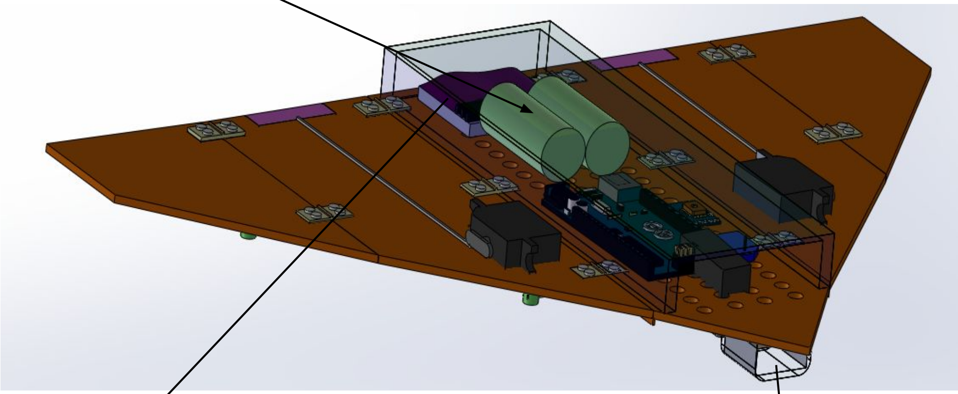


Actual Prototype Folded



Payload Mechanical Layout of Components (4/4)

Easily accesible battery connected to a screw terminal

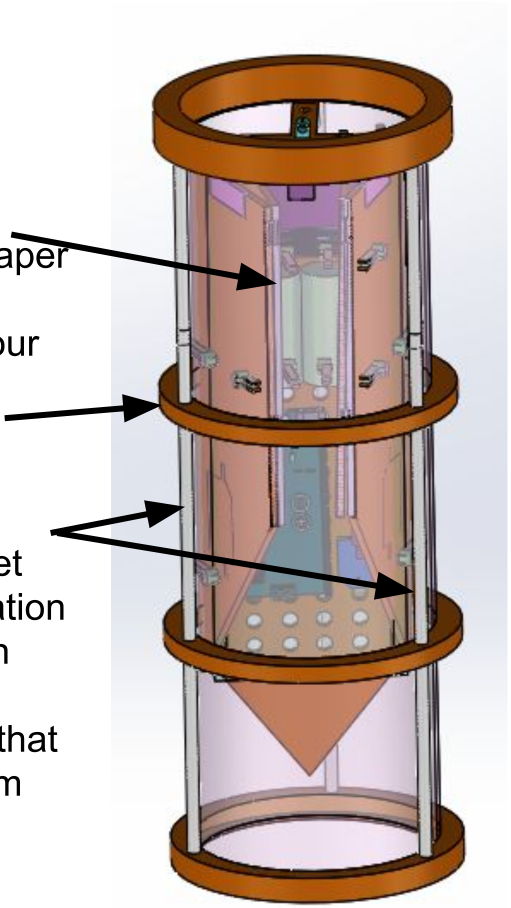


Parachute release mechanism

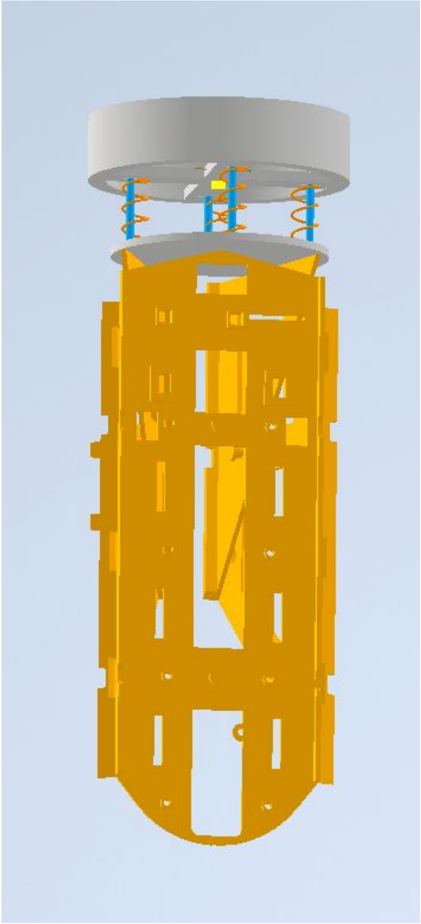
Camera Gimbal

Container Mechanical Layout of Components

- Wall is a thin but durable double laminated pink paper
- The wall is reinforced with four 3D printed rings
- The rings are attached to four vertical rods
- It won't use rocket for CanSat operation
- No electronics on the container
- No sharp edges that will prevent it from deploying



- A 3D printed plate with two rods guided by holes of the container top
- The rods are spring loaded and secured with bolts
- When the release mechanism is activated, the plate is pushed by the springs which pushes the payload downward



Container Mechanical Layout of Components

Actual Container Prototype

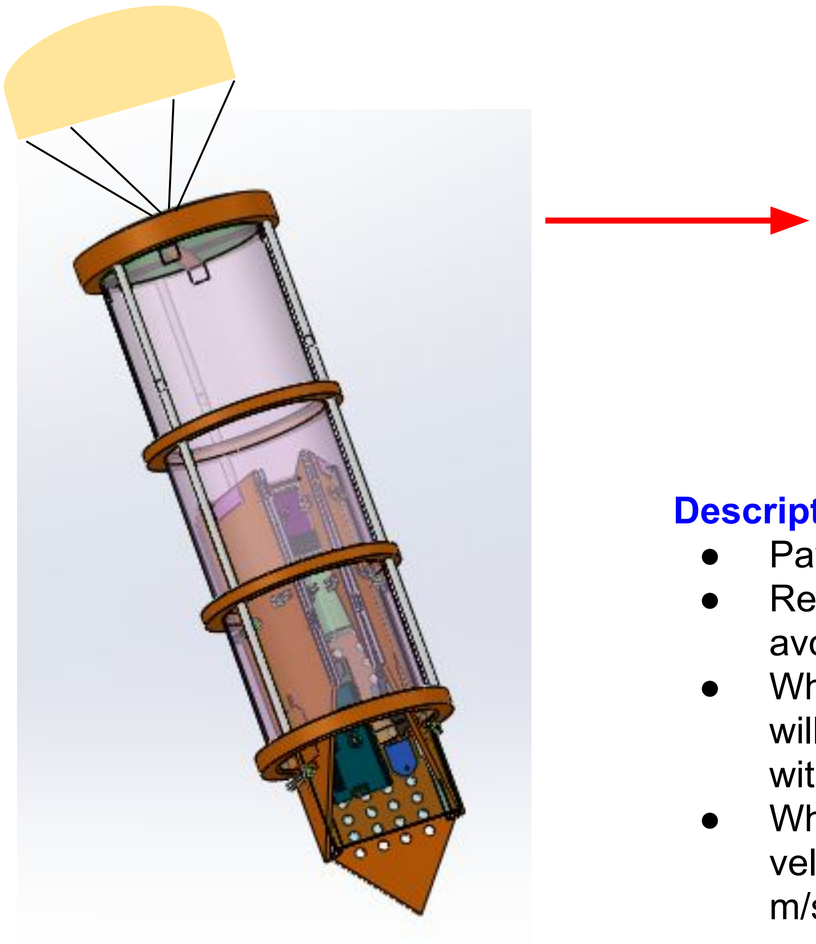
Parachute

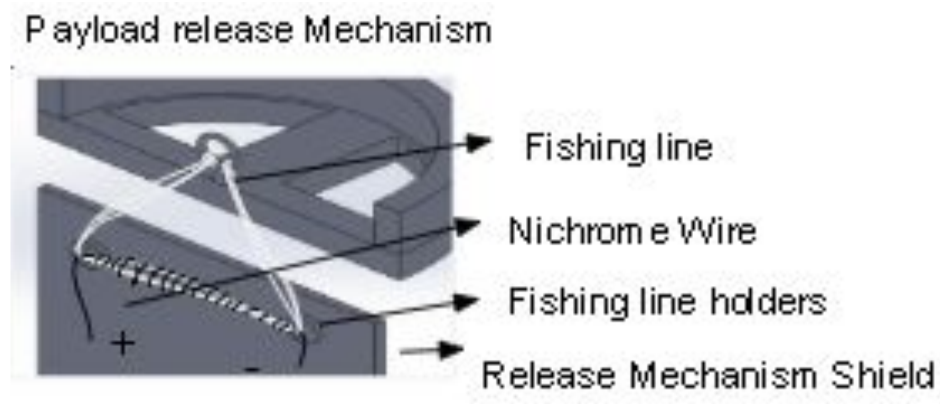
Carbon Fiber Rods

3D printed Rings

Double Laminated Body

Payload Release Mechanism



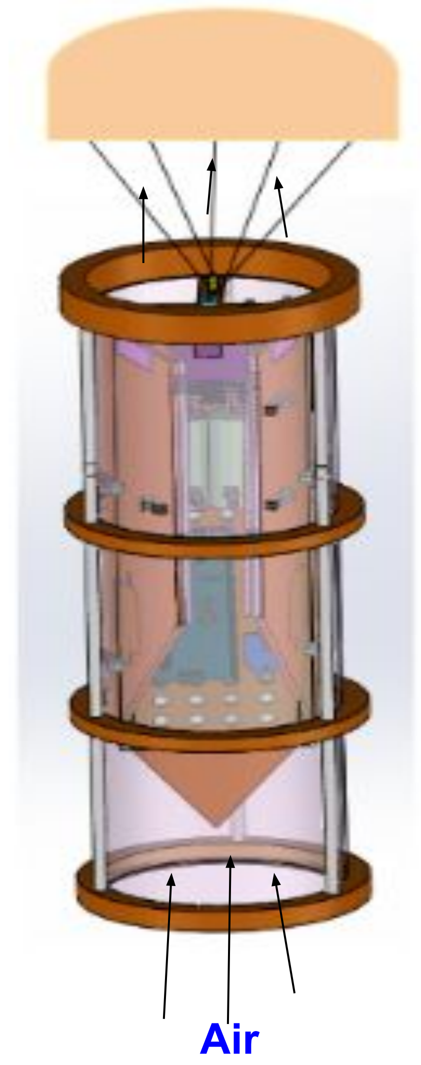


Description:

- Payload is attached to the container using fishing line
- Release mechanism will be housed inside a fireproof box to avoid fire or parts meltdown
- When CanSat descends at ~450 meters the nichrome wire will be activated by the controller using MOSFET transistor with 7.4V
- When the fishing line is melted the difference of terminal velocity of the container (~12.76 m/s) and the payload (~16 m/s) will separate the two.

Container Parachute Attachment Mechanism

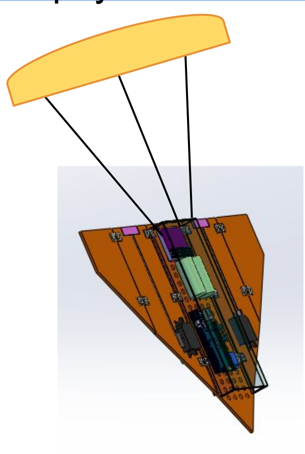
- Parachute will passively sit on top of container while inside the rocket
- The air flows from the bottom to the opening on top that will deploy the parachute
- During descent, top of container will provide air flow to ensure parachute deployment.

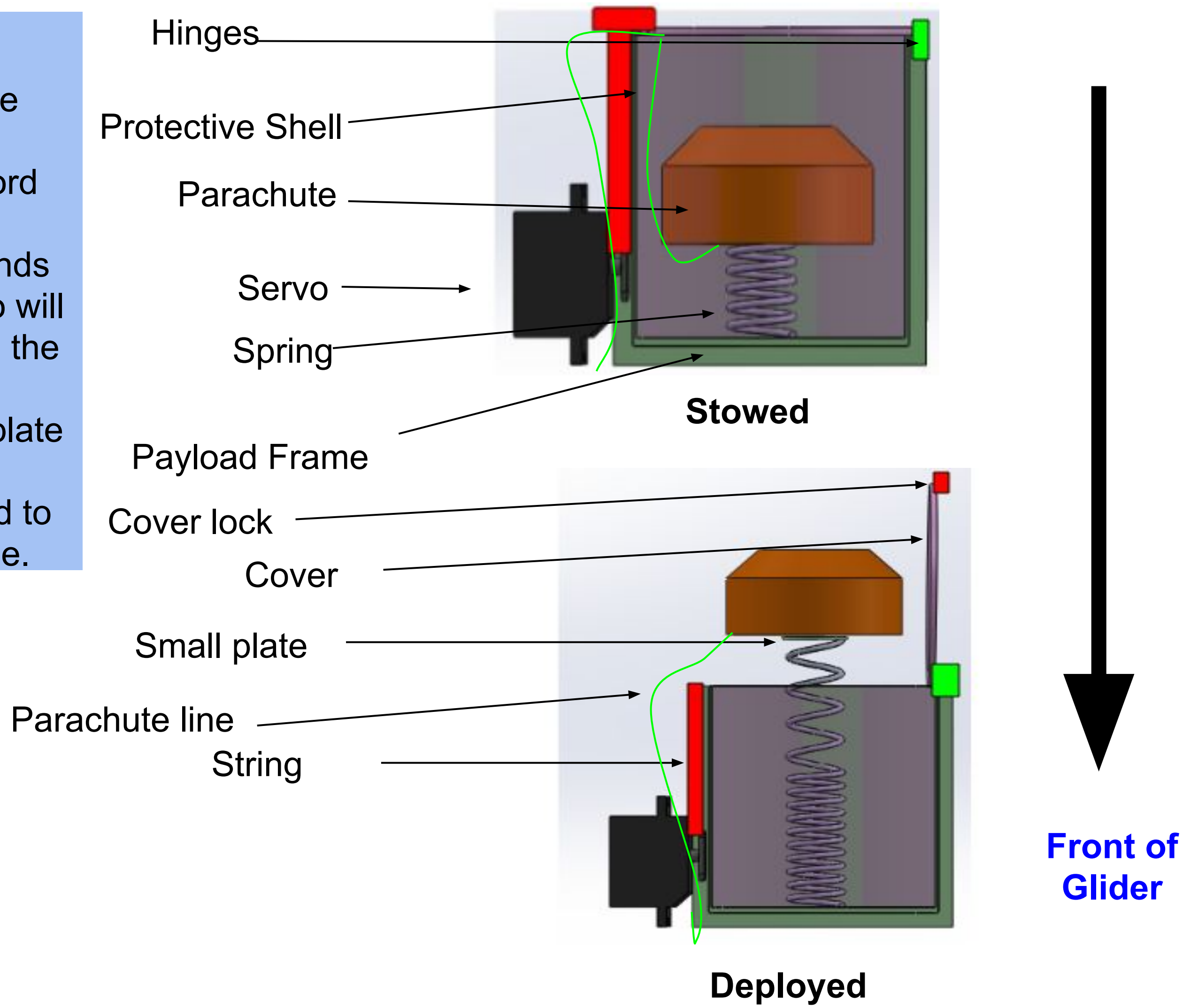


Payload Parachute Release Mechanism

Description:

- The spring and small plate will be held inside the cylinder using a Kevlar cord to avoid littering
- When the payload descends to ~100 meters, the servo will be activated which opens the lid. The parachute will be pushed out by the small plate and spring.
- The parachute is attached to the payload with a tail hole.





Structure Survivability

Electronic Component Mounting Methods
● Electronic components is organized and soldered into a PCB. The PCB will be mounted using double sided foam tape and zip ties ● The PCBs will have breakouts to other subsystems. The breakouts will be headers with Molex connectors hot glued together to avoid disconnect ● Sensors that cannot be mounted on a PCB board such as outside temp sensor, air speed sensor and particulate sensor will be mounted using double sided foam tape, zip ties or pre-designed 3d printed mounting
Electronic Component Enclosures
● The fuselage will be 3d printed using PETG material. All the electronics and sensors will be enclosed inside the fuselage ● The release mechanism enclosure will be 3D printed on the outside with fireproof fiberglass on the inside.

Structure Survivability

Securing Electrical Connections

- Each battery will have a screw terminal block on the PCB to allow battery charging and easy swap.
- Electrical connections to breakout subsystems will have a header and Molex connector hot glued together to avoid disconnect

Descent Control Attachments

- The elevon will be attached using nylon horns, steel push rods and linkage stopper to the servo
- The servo will be screwed on and hot glued to the wing
- The container parachute is connected by nylon shroud line to an eyebolt on the CanSat.
- The payload parachute is connected by a nylon shroud line to a reinforced tail hole on the payload
- The wings is connected together using nylon hinges hot glued and bolted on.
- The wing openers are anchored with micro bolts and washers
- All materials will be tested to ensure that it will survive 30Gs of shock

Mass Budget

Payload Components	Weight (g)	PCB Location	Source	Margin(g)
Microcontrollers	14	Main Board	Measured	
PETG Payload Structure	120		Estimate	5
Temp Sensor	1	Breakout	Measured	
Air Speed Sensor	8.5	Breakout	Measured	
GPS	8.5	XBEE and GPS	Measured	
BME280	1.3	Main Board	Measured	
Payload release	.5	Breakout	Estimate	5
MOSFET	1	Main Board	Measured	
Camera	2.8	Breakout	Measured	
Batteries	50	Breakout	Measured	
Audio Beacon	1	Main Board	Measured	
Xbee	4	XBEE and GPS	Measured	
Particle Sensor	26	Breakout	Measured	

Mass Budget

Payload Components	Weight (g)	Location	Source	Margin(g)
Parachute	9	Breakout	Measured	
Hinges	.3	Mechanical	Measured	
Nylon Bolts and Nuts	.1	Mechanical	Estimate	3
High Temp Elastic Band	.05	Mechanical	Measured	

Mass Budget

Payload Components	Weight (g)	Source	Margin (g)
Main Board	60	Measured	
SD Card Module	20	Measured	
XBEE and GPS module	22	Measured	
Air Speed Sensor	7	Measured	
MPU6050	5	Measured	
Payload Structure	130	Estimate	20
Parachute Deployment	22	Measured	
Battery	75	Measured	
Eletrical Connectors	20	Estimate	16

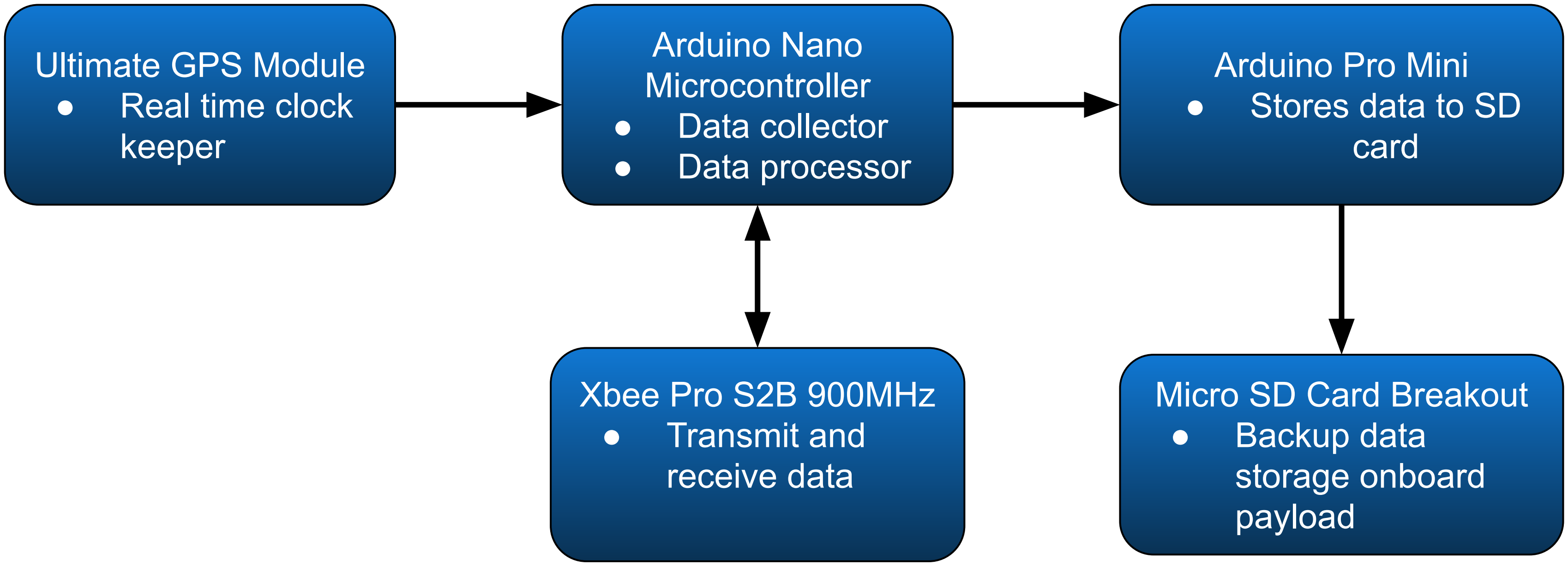
Total Weight of Payload		
341 (+36g) = 377g		
Container Components	**Weight (g)**	**Source**
Container	175	Measured
Payload Deployment Parts	38	Measured
Parachute	9	Measured
Total Mass of CanSat (g)		
599		
Mass Margin		
600g - 599g = 1 gram		
Mass Margin is within 600g +/- 10g		

Overweight - We will change our eyebolt washer to fender washer. We will also have a standby container that is 3D printed with reduced infill. Current infill is 45 percent.
Underweight - We will add fender or metal washer to our eyebolt.

Communication and Data Handling (CDH) Subsystem Design

Tim Marcello

CDH Overview



CDH Changes Since PDR

Changes	Reason
Added a microcontroller Arduino Pro mini to connect to main controller via i2c to process backup data to SD card	- Our sketch space is at 92% in our main controller and adding SD card library will cause programming space overflow.

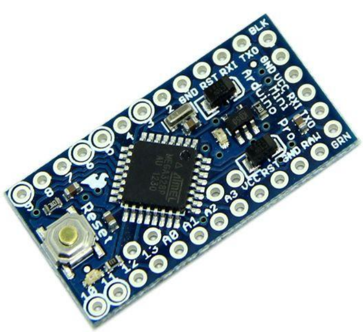
CDH Requirements

Requirements	Description
29	Telemetry shall be updated once per second.
33	Telemetry shall include mission time with one second or better solution. Mission time shall be maintained in the event of processor reset during the launch and mission.
35	XBEE radios shall be used for telemetry. 2.5 GHz Series radios are allowed. 900 MHz XBEE Pro radios also allowed.
36	XBEE radios shall have their NETIP/PANID set to their team number.
37	XBEE radios shall not use broadcast mode.
38	Cost of CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.
41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)

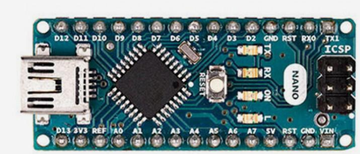
Payload Processor & Memory Selection

Processor	Boot time (s)	Speed (MHz)	Memory (KB)	Weight (g)	Dimension (mm)	Voltage Input (V)	Ports
Arduino Nano	8-10	16	32	7	18 x 45	7-12	Analog Input - 8 PWM Output - 6 I2C I/O - 1 SPI - 1 DAC Output - 0
Arduino Pro mini	<1	16	32	2	18 x 33	5	Analog Input - 8 PWM Output - 6 I2C I/O 1 SPI - 1 DAC Output - 0

SD Card Controller

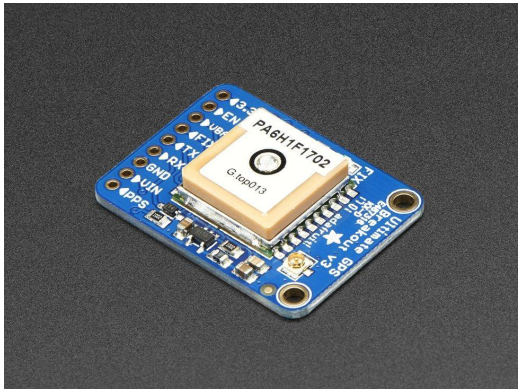


Main Controller



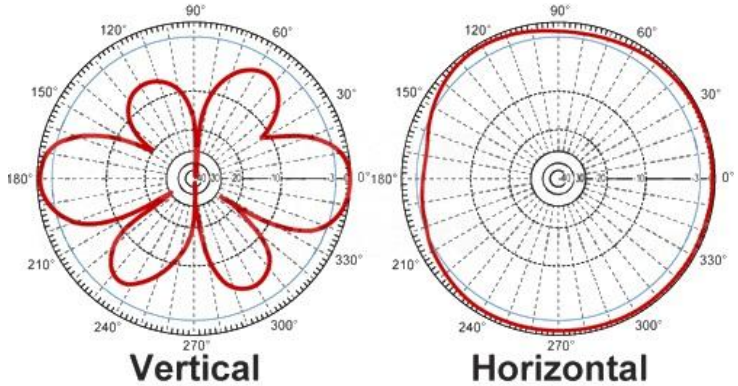
Payload Real-Time Clock

Real-Time Clock Keeper	Type	Reset Method
Ultimate GPS Board	Hardware	Battery backup RTC



Payload Antenna Selection

Name	Frequency Range	Length	Gain	Connection Type	Calculated Range
Noyito Antenna	900 MHz - 915 MHz	195 mm (unbended)	5 dBi	SMA	9 miles



Payload Radio Configuration

Radio	Frequency	Transmit Power
Xbee 900HP Pro	900 Mhz	250mW 24dBm Software Selectable

Radio Configuration
• NET ID - 1360 (Team ID) • Configuration Mode - Point to Point Unicast • Transmission Control -- Data will be sent continuously at 1Hz during all phases • Will stop data transmission after landing. Altitude sensor will be used to detect landing

Payload Telemetry Format

Data Format	Sample Data	Description
<TEAM ID>	1360	The assigned team identification number
<MISSION TIME>	1615	Time since initial power up in seconds
<PACKET COUNT>	1571	The count of transmitted packets
<ALTITUDE>	73.1	The altitude in meters relative to ground level. The resolution is 0.1 meters
<PRESSURE>	100674	The measurement of atmospheric pressure in unit of pascals. The resolution is 1 pascal.
<TEMP>	27.0	The sensed temperature in degrees C with 0.1 of a degree resolution
<VOLTAGE>	7.93	The voltage of the CanSat power bus. Resolution must be 0.01 volts
<GPS TIME>	04:38:34	The time generated by the GPS receiver. Time must report in UTC and have a resolution of a second
<GPS LATITUDE>	20.9079	The latitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees
<GPS LONGITUDE>	-156.4987	The longitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001
<GPS ALTITUDE>	51.2	The altitude generated by the GPS receiver in meters above mean sea level with a resolution of 0.1 meters

Payload Telemetry Format

Data Format	Sample Data	Description
<GPS SATS>	7	The number of GPS satellites being tracked by the GPS receiver. This must be in an integer number.
<AIR SPEED>	17.00	The air speed relative to the payload in meters/second
<SOFTWARE STATE>	1	The operating state of the software
<PARTICLE COUNT>	73.1	Decimal value representing the measured particle count in mg/m^3

- Data from payload shall transmit continuously at 1Hz sample rate
- Data format:
  <TEAM ID>,<MISSION TIME>,<PACKET COUNT>,<ALTITUDE>, <PRESSURE>, <TEMP>,<VOLTAGE>,<GPS TIME>,<GPS LATITUDE>,<GPS LONGITUDE>,<GPS ALTITUDE>,<GPS SATS>,<AIR SPEED>,<SOFTWARE STATE>, <PARTICLE COUNT> \newline
- Telemetry data file name: Flight_1360.csv

Container Processor & Memory Selection

This slide does not pertain to our team's design.

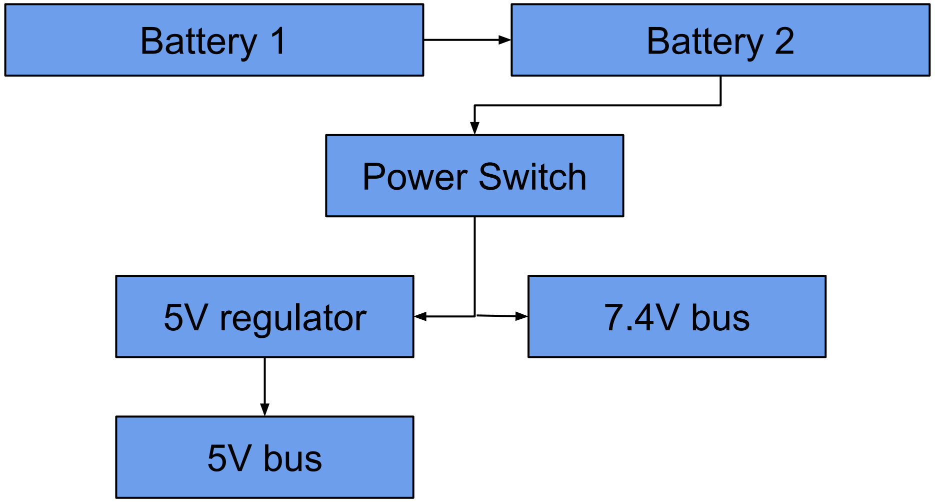
Our team's container does not have components relating to this slide.

Electrical Power Subsystem Design

Guillermo Martin

EPS Overview

Component	Purpose
3.7V 18650 Batteries	Power source
5V step down regulator	Provides clean 5 volts supply to sensors
Power switch	Mechanism that cuts out main power to the payload
5V bus	Power bus for sensors
7.4V bus	Power bus for controller and nichrome wire



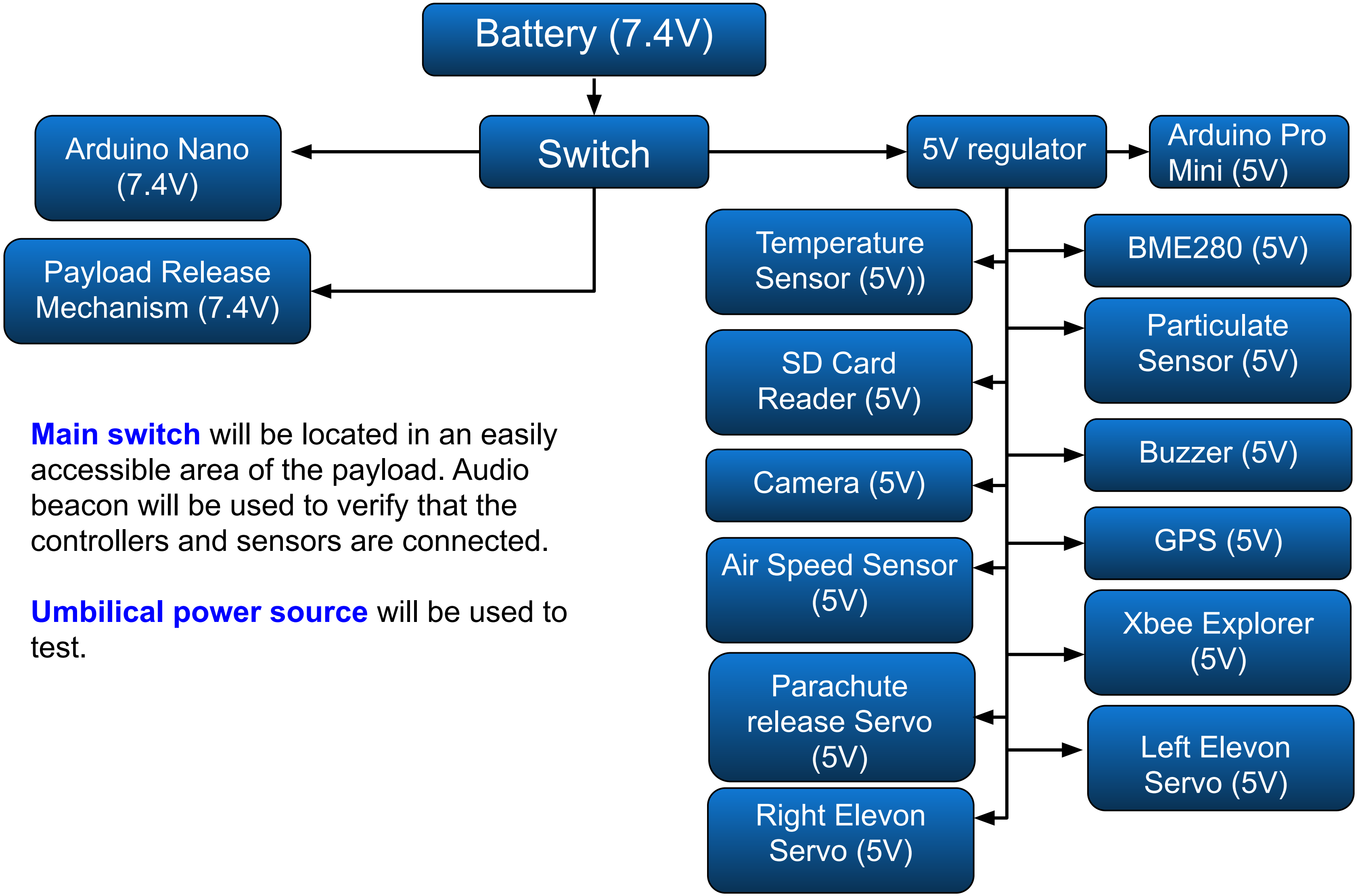
EPS Changes Since PDR

Changes	Reason
Added Arduino Pro Mini to electrical budget and diagram	To process backup data to SD card

EPS Requirements

Requirements	Description
15	All electronics components shall be enclosed and shielded from the environment with the exception of sensors.
49	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.
50	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the cansat and in the stowed state.
53	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells.
54	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.
55	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.
57	Payload/Container shall operate for a minimum of two hours when integrated into rocket.

Payload Electrical Block Diagram



Main switch will be located in an easily accessible area of the payload. Audio beacon will be used to verify that the controllers and sensors are connected.

Umbilical power source will be used to test.

Payload Power Source

Type	Battery	Voltage	Capacity	Weight	Qty. Needed	Total Voltage	Total Weight
Lithium-Ion	18650	3.7V	3000mAh	18.5g	2	7.4V	50g

Battery Configuration
Two 18650 batteries in series to provide ~8.2V @ 3A

Payload Power Budget

Component	Voltage (V)	Power(W)	Duty Cycle(%)	Power Consumption(Wh)	Source
Arduino Nano	7.4V	.1406	100	.1406	Datasheet
Adafruit Ultimate GPS	5V	.1	100	.1	Datasheet
Tem Sensor	5V	.0003	100	.0003	Datasheet
BME280	5V	0.000025	100	0.000025	Datasheet
SD Card Reader	5V	.75	100	.75	Estimate
Xbee Explorer	5V	1	100	1	Estimate
Particulate Sensor	5V	.3	100	.3	Datasheet
Camera	5V	.55	100	.55	Datasheet
Buzzer	5V	.4	1	.4	Estimate

Payload Power Budget

Component	Voltage (V)	Power (W)	Duty Cycle(%)	Power Consumption(Wh)	Source
Airspeed Sensor	5V	.05	100	.05	Datasheet
Servo x2	5V	2*2.5	20	2*2.5	Estimate
Arduino Pro Mini	5V	1	100	1	Datasheet

Total Power (W)	Total Power Consumption(Wh) (2 hrs)
9.3	**18.6**

Available total power (Wh) (2 hrs)	Power consumption margin (Wh) (2 hrs)
22.2	**3.6**

Container Electrical Block Diagram

This slide does not pertain to our team's design.

Our team's container does not have components relating to this slide.

Container Power Source

This slide does not pertain to our team's design.

Our team's container does not have components relating to this slide.

Container Power Budget

This slide does not pertain to our team's design.

Our team's container does not have components relating to this slide.

Flight Software (FSW) Design

Arthur S Agdeppa Jr

FSW Overview

Programming Languages:

- C/C++

Development environments:

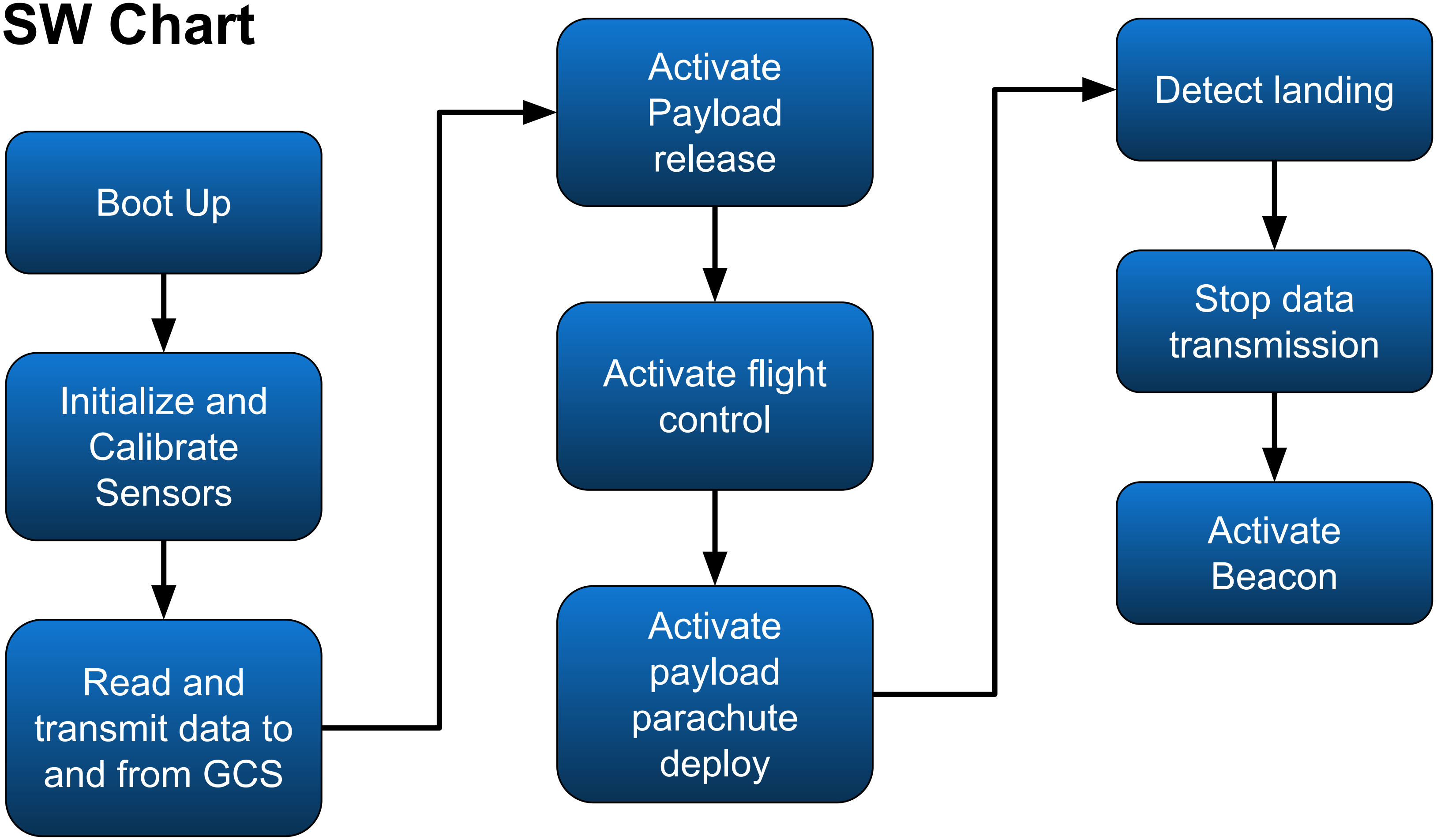
- Arduino IDE

Summary of FSW tasks:

- To collect sensors data and convert it to a value that complies with CanSat requirements
- To format sensors data in correct sequence according to CanSat requirements. Send it to Ground control station and store it to an onboard backup SD card.
- Monitor altitude changes to trigger payload release
- Engage flight control system
- Monitor altitude during gliding flight to trigger payload parachute release
- Activate audio beacon after landing
- Erase EEPROM and reboot controller upon GCS command
- Generate an audio beacon to indicate that payload is turned on

FSW Overview

FSW Chart



FSW Changes Since PDR

- **Overview of the CanSat FSW changes since the PDR. Details of the changes should be discussed in subsequent slides.**

Changes	Reason
Added data used to recover: 1. Gyro calibration values 2. Airspeed calibration values 3. Initial altitude	- We need gyro calibration and air speed calibration values to recover from mid air reset. - We need initial altitude to calculate actual height travelled.
Added a function that will erase EEPROM and reboot controller upon GCS command	It will enable us to reset our controller without reprogramming via USB cable

FSW Requirements

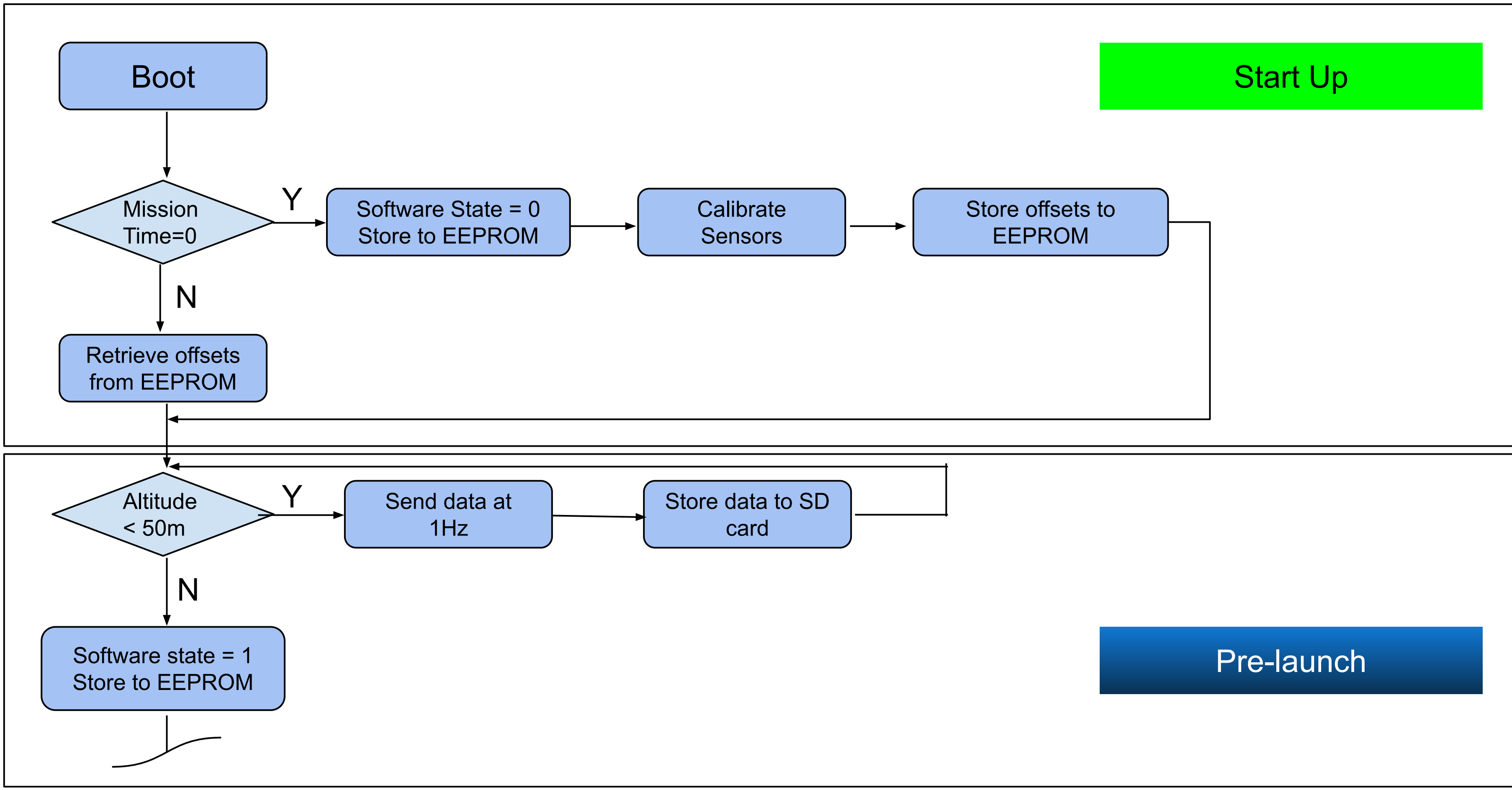
Requirements	Description
10	The container shall release the payload at 450 meters +/- 10 meters.
13	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5m/s
22	The science payload shall measure altitude using an air pressure sensor.
23	The science payload shall provide position using GPS.
24	The science payload shall measure its battery voltage.
25	The science payload shall measure outside temperature.
26	The science payload shall measure particulates in the air as it glides.
27	The science payload shall measure airspeed.

FSW Requirements

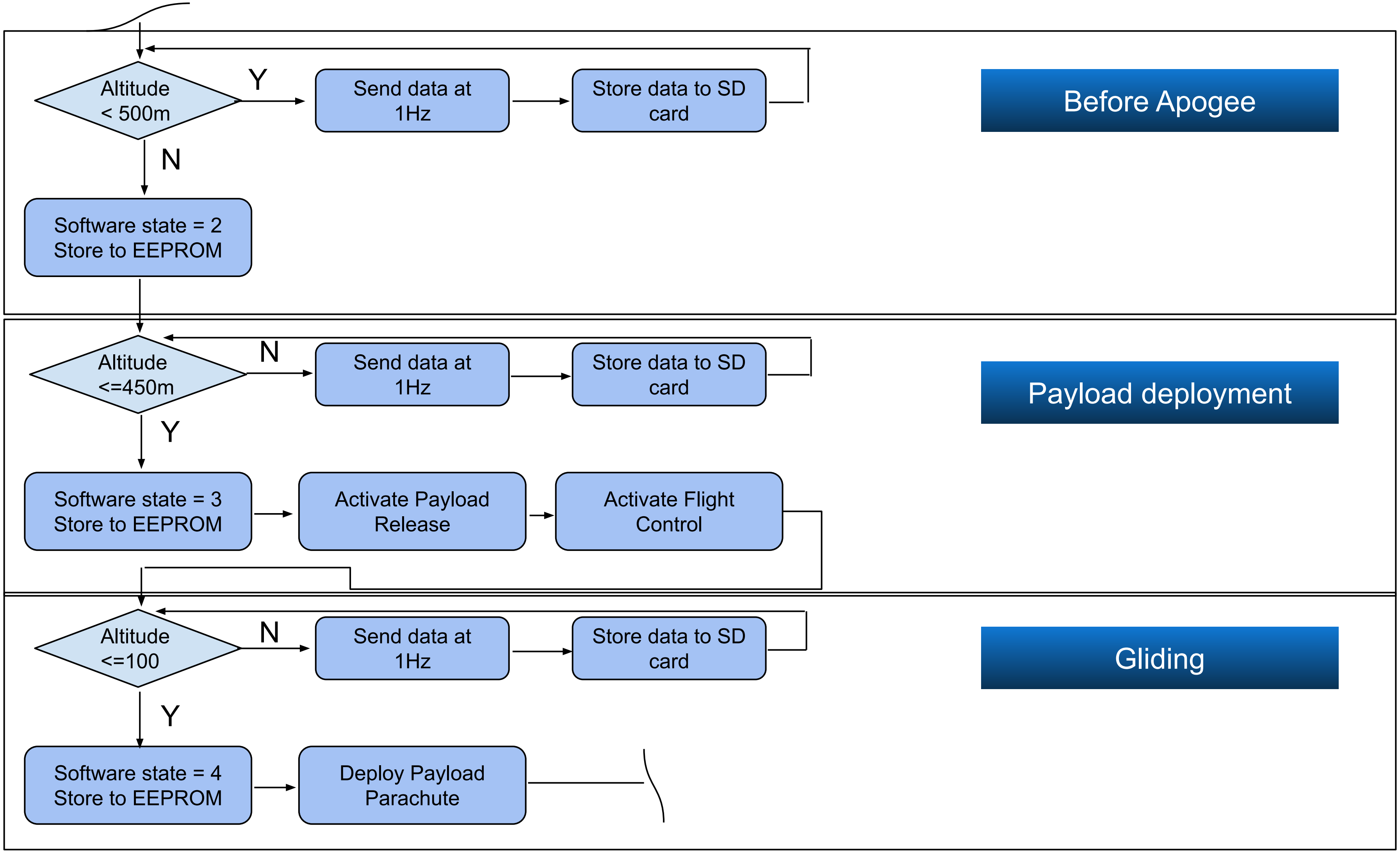
Requirements	Description
28	The science payload shall transmit all sensors data in the telemetry.
29	Telemetry shall be updated once per second.
33	Telemetry shall include mission time with one second or better solution. Mission time shall be maintained in the event of processor reset during the launch and mission.
34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.
47	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 process resets.

Payload CanSat FSW State Diagram

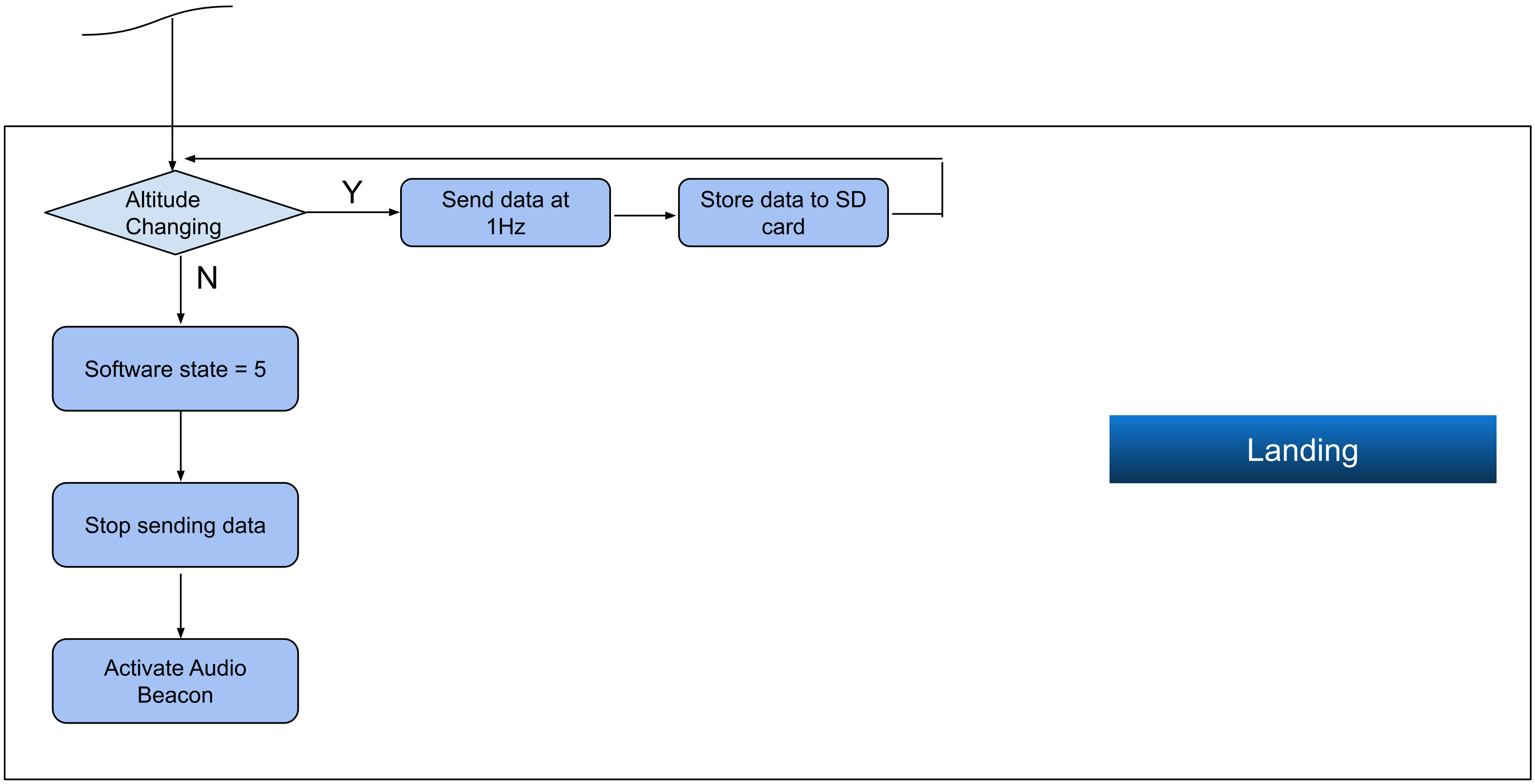
FSW Chart



Payload CanSat FSW State Diagram



Payload CanSat FSW State Diagram



Payload CanSat FSW State Diagram

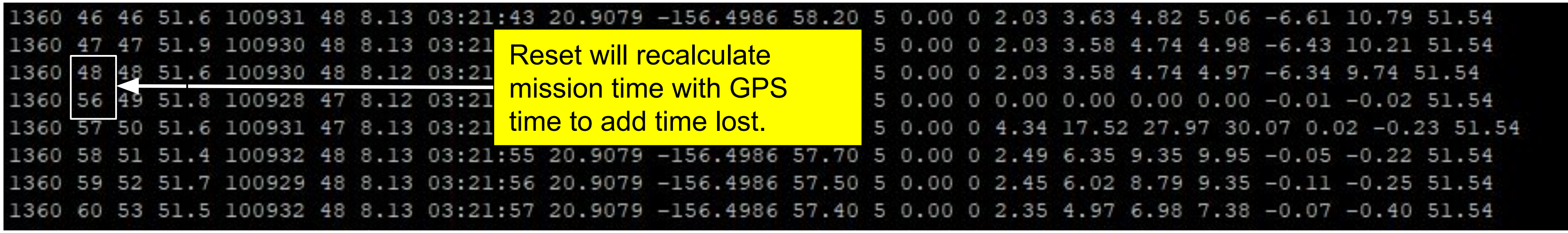
FSW Reset Recovery:

Data used to recover (will store in EEPROM at a rate of 1Hz):

1. Mission Time
2. Packet Count
3. Software State
4. Initial altitude
5. Previous Altitude
6. GPS Time
7. Gyro calibration values
8. AirSpeed calibration values

Reasons for reset:

1. Payload loss of power supply reset. Method of recovery will be data retrieval from EEPROM.
2. Software hang reset. Method of recovery will be data retrieval from EEPROM.



Container CanSat FSW State Diagram

This slide does not pertain to our team's design.

Our team's container does not have components relating to this slide.

Software Development Plan

Prototyping and prototyping environments

- Breadboard components
- Prototype board components

Development Team

- Arthur Agdeppa
- Tim Marcello
- Guillermo Martin

Test Methodology

- Classroom lab test
- Outdoor free fall test
- Drone flight test sensors

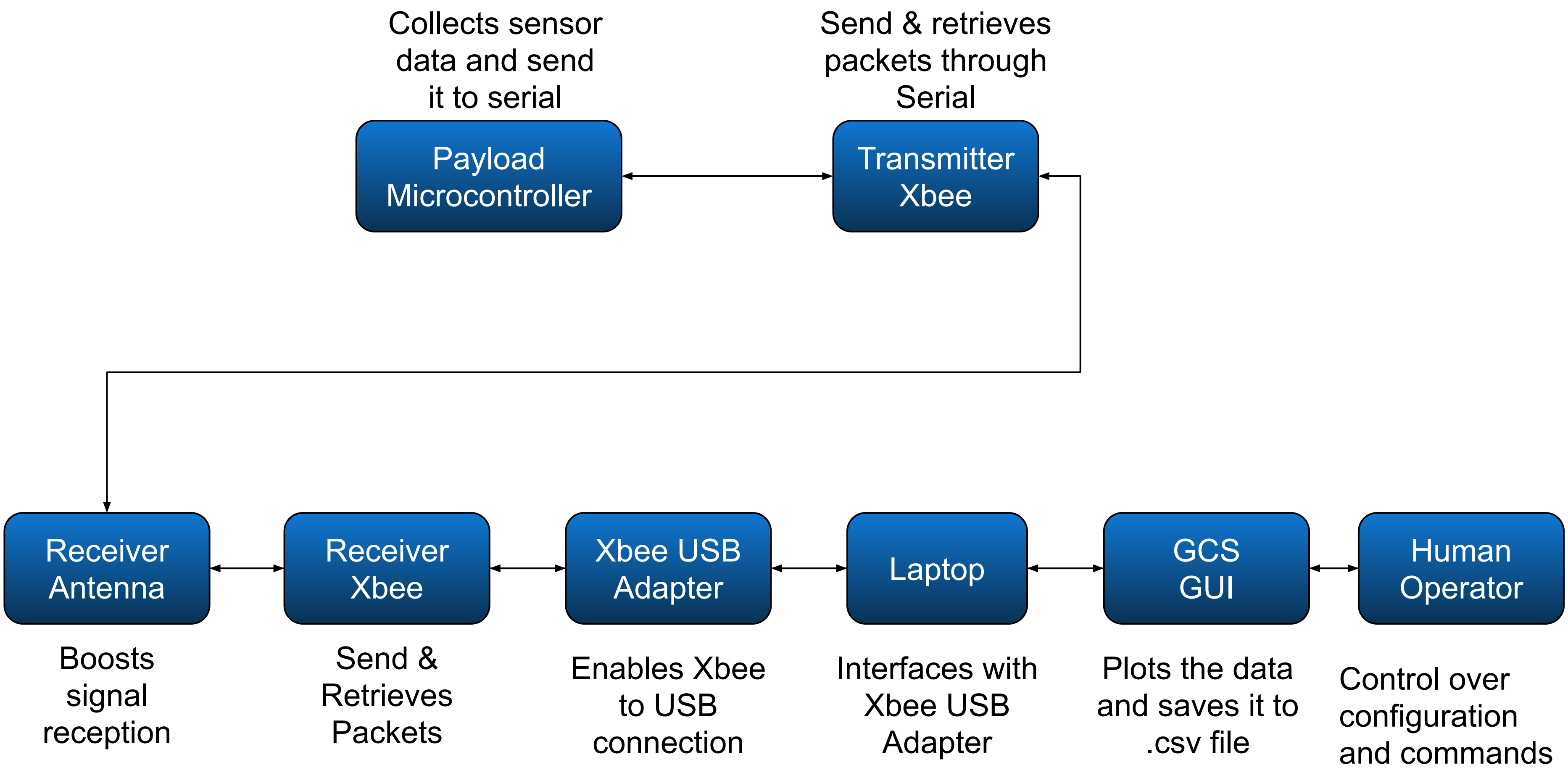
Software Development Plan

Subsystem	Development Sequence
Sensors	1. Sensor trade and selection - select the best sensors for our application 2. Individual sensor programming - program each sensor with arduino to avoid confusion 3. Integrate all sensor programming into one program and test all sensors are working
Xbee Radio	1. Configure and test point to point communication fo the radio using controller and GCS serial port 2. Integrate sensors with Xbee to ensure data transmission at 1Hz
Flight Control	1. Program closed feedback control system with servos connected to elevon
Release mechanisms	1. Program release mechanisms such as nichrome wire and servos
Software state	1. Program software state logic using altitude sensor as data
Audio Beacon	1. Program locator audio beacon
Integrate all	Integrate all software subsystem and ensure that data transmits at 1Hz and all events at the software state is executed.

Ground Control System (GCS) Design

Arthur S Agdeppa Jr

GCS Overview



GCS Changes Since PDR

Changes	Reason
Added a button that will send a command to FSW to erase EEPROM and reboot controller	To reset our FSW without reprogramming via USB cable

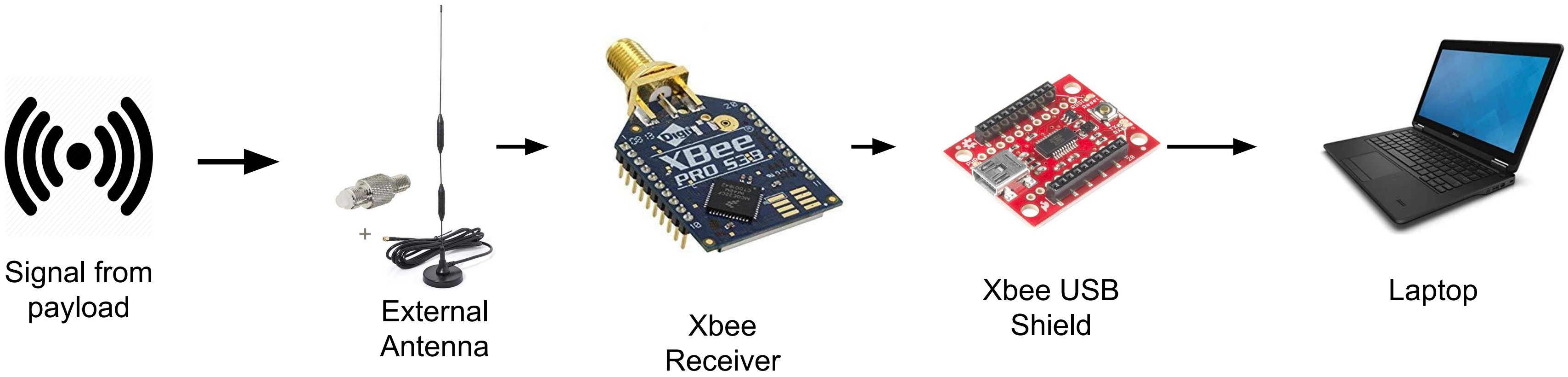
GCS Requirements

Requirements	Description
29	Telemetry shall be updated once per second.
31	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.
32	The ground station shall generate a csv file of all sensor data as specified in the telemetry section.
33	Telemetry shall include mission time with one second or better solution. Mission time shall be maintained in the event of processor reset during the launch and mission.
34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.
35	XBEE radios shall be used for telemetry. 2.5 GHz Series radios are allowed. 900 MHz XBEE Pro radios also allowed.
36	XBEE radios shall have their NETIP/PANID set to their team number.
37	XBEE radios shall not use broadcast mode.
38	Cost of CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.
39	Each team shall develop their own ground station.

GCS Requirements

Requirements	Description
41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)
42	Team shall plot each telemetry data field in real time during flight.
44	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.
45	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.

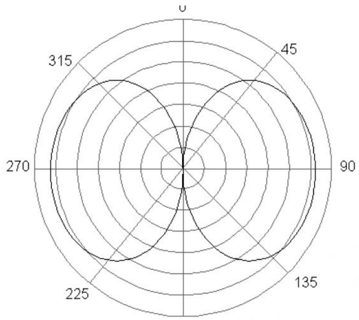
GCS Design

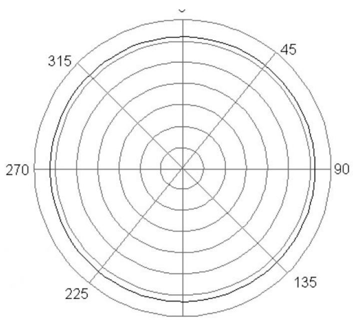


Specification	Description
Laptop battery life	4 hours
Auto-Update mitigation	Windows 10 OS update will be disabled
Overheating mitigation	Umbrella will be used to block off sunlight
	Laptop fan with own battery
Contingency Plan	External portable battery pack will be used in case laptop power is not enough

GCS Antenna

Name	Connection Type	Frequency	Range	Direction	Gain
WLANIOT	RP - SMA	900 - 1900 MHz	14km	Omni-directional	9dBi



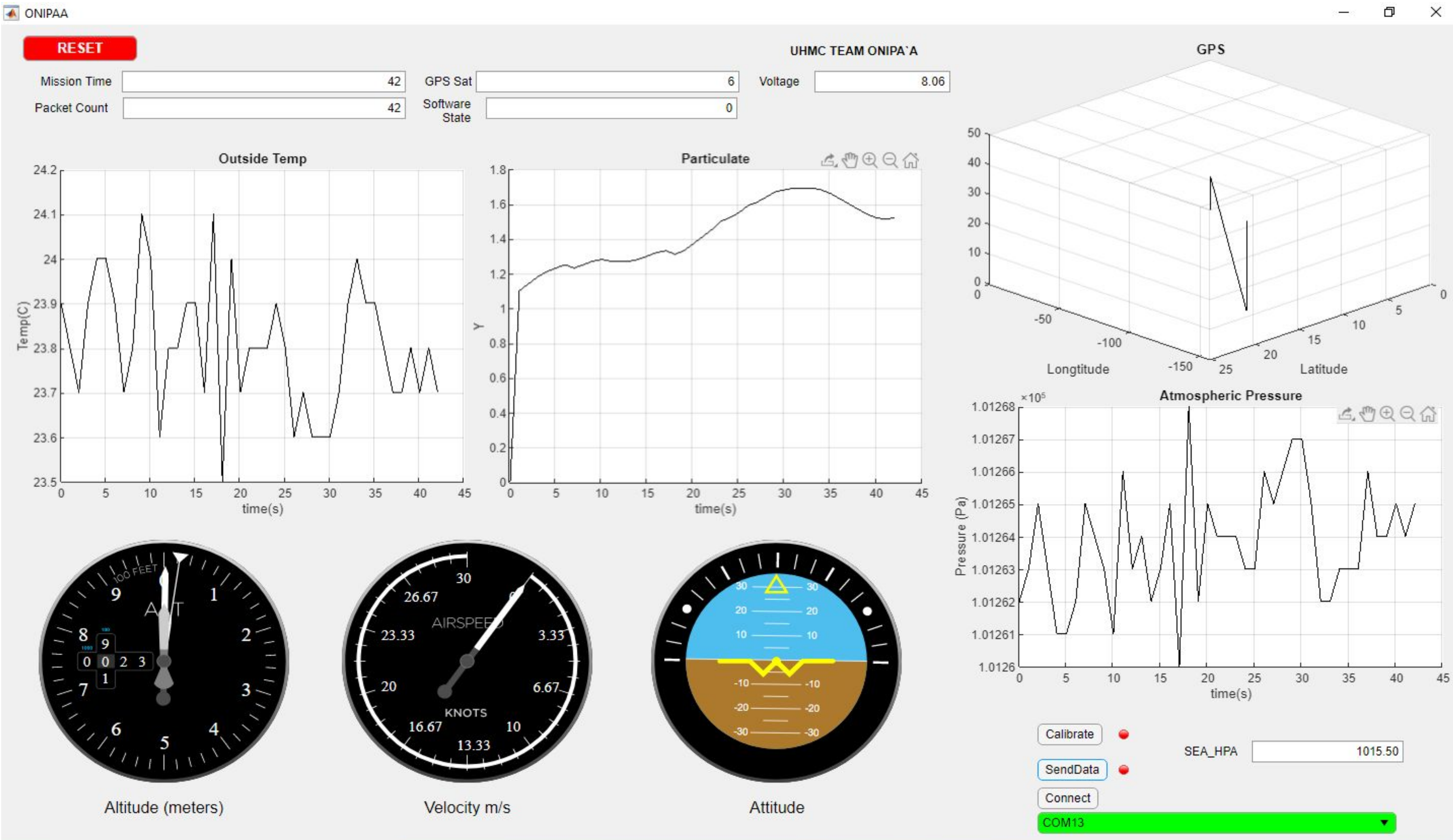


GCS Software (1/3)

Software Used	**MATLAB Student Version** **Rationale:** 1. Availability 2. Student's familiarity with the software
Software Design	1. Parse data when serial data available 2. Save data to CSV file 3. Plot data to GUI 4. Back to step 1
Calibration command	1. Payload will start calibration upon receiving specific data from GCS 2. Payload will send calibration OK to GCS when done 3. Start sending data
CSV file creation	1. File will be comma delimited and formatted according to CANSAT requirements

GCS Software (2/3)

Team Onipa’a updated GCS GUI interface



GCS Software (3/3)

Sample CSV file from GCS

myflightdata

File Edit View Insert Format Data Tools Add-ons Help All changes saved in Drive

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
38	1360	704	711	41.2	101057	46	8.06	5:33:22	20.908	-156.4986	79.6	6	0	0	4.8	7.19	8.91	9.25	-0.69	0.37	51.54	
39	1360	705	712	41.1	101057	45	8.05	5:33:23	20.908	-156.4986	79.6	6	0	0	4.78	7.18	8.9	9.24	-0.72	0.35	51.54	
40	1360	706	713	41.3	101054	46	8.08	5:33:24	20.908	-156.4986	79.6	6	0	0	4.74	7.04	8.69	9.02	-0.71	0.33	51.54	
41	1360	707	714	41.3	101054	46	8.12	5:33:25	20.908	-156.4986	79.6	6	0	0	4.73	7.04	8.69	9.02	-0.73	0.36	51.54	
42	1360	708	715	41.3	101054	45	8.1	5:33:26	20.908	-156.4986	79.6	6	0	0	4.71	7.03	8.7	9.03	-0.75	0.34	51.54	
43	1360	709	716	41.3	101057	46	8.09	5:33:27	20.908	-156.4986	79.6	6	0	0	4.68	7.01	8.68	9.02	-0.75	0.29	51.54	
44	1360	710	717	41.3	101054	45	8.09	5:33:28	20.908	-156.4986	79.7	6	0	0	4.63	6.89	8.51	8.84	-0.76	0.29	51.54	
45	1360	711	718	41.4	101053	45	8.07	5:33:29	20.908	-156.4986	79.7	6	0	0	4.59	6.86	8.48	8.81	-0.75	0.3	51.54	
46	1360	712	719	41.2	101055	45	8.12	5:33:30	20.908	-156.4986	79.7	6	0	0	4.54	6.76	8.34	8.66	-0.75	0.3	51.54	
47	1360	713	720	41.4	101053	45	8.04	5:33:31	20.908	-156.4986	79.7	6	0	0	4.51	6.76	8.36	8.69	-0.76	0.33	51.54	
48	1360	714	721	41.3	101054	45	8.11	5:33:32	20.908	-156.4986	79.7	6	0	0	4.48	6.77	8.42	8.75	-0.78	0.34	51.54	
49	1360	715	722	41.3	101054	46	8.12	5:33:33	20.908	-156.4986	79.7	6	0	0	4.43	6.73	8.38	8.71	-0.82	0.36	51.54	
50	1360	716	723	41	101058	46	8.11	5:33:34	20.908	-156.4986	79.7	6	0	0	4.41	6.73	8.4	8.74	-0.85	0.35	51.54	
51	1360	717	724	41.3	101054	46	8.12	5:33:35	20.908	-156.4986	79.7	6	0	0	4.38	6.65	8.28	8.61	-0.88	0.35	51.54	
52	1360	718	725	41.2	101056	46	8.09	5:33:36	20.908	-156.4986	79.7	6	0	0	4.34	6.55	8.14	8.45	-0.87	0.36	51.54	
53	1360	719	726	41.4	101056	45	8.12	5:33:37	20.908	-156.4986	79.7	6	0	0	4.29	6.49	8.07	8.39	-0.91	0.36	51.54	
54	1360	720	727	41.2	101055	46	8.11	5:33:38	20.908	-156.4986	79.7	6	0	0	4.23	6.43	8.01	8.32	-0.9	0.33	51.54	
55	1360	721	728	41.1	101056	45	8.1	5:33:39	20.908	-156.4986	79.7	6	0	0	4.18	6.33	7.87	8.18	-0.92	0.33	51.54	
56	1360	722	729	41.1	101056	45	8.12	5:33:40	20.908	-156.4986	79.7	6	0	0	4.16	6.27	7.78	8.08	-0.93	0.36	51.54	
57	1360	723	730	41.4	101053	46	8.12	5:33:41	20.908	-156.4986	79.7	6	0	0	4.16	6.34	7.9	8.22	-0.94	0.35	51.54	
58	1360	724	731	41.5	101052	45	8.08	5:33:42	20.908	-156.4986	79.7	6	0	0	4.11	6.28	7.85	8.17	-0.95	0.38	51.54	
59	1360	725	732	41.3	101054	46	8.04	5:33:43	20.908	-156.4986	79.8	6	0	0	4.12	6.23	7.75	8.05	-0.95	0.4	51.54	
60	1360	726	733	41.2	101055	46	8.09	5:33:44	20.908	-156.4986	79.8	6	0	0	4.17	6.33	7.88	8.19	-0.95	0.37	51.54	
61	1360	727	734	41.3	101054	46	8.12	5:33:45	20.908	-156.4986	79.8	6	0	0	4.23	6.49	8.12	8.45	-0.98	0.37	51.54	
62	1360	728	735	41.4	101053	46	8.04	5:33:46	20.908	-156.4986	79.8	6	0	0	4.27	6.51	8.12	8.44	-0.99	0.38	51.54	
63	1360	729	736	41.3	101057	45	8.12	5:33:47	20.908	-156.4986	79.8	6	0	0	4.32	6.52	8.11	8.43	-1.02	0.41	51.54	
64	1360	730	737	41.2	101055	45	8.1	5:33:48	20.908	-156.4986	79.8	6	0	0	4.32	6.53	8.12	8.44	-1.03	0.38	51.54	
65	1360	731	738	41	101057	46	8.1	5:33:49	20.908	-156.4986	79.8	6	0	0	4.31	6.52	8.1	8.42	-1.03	0.38	51.54	

myflightdata

CanSat Integration and Test

Jhaymar Mendez

Team Logo Here (If You Want)

CanSat Integration and Test Overview

Sensor Subsystem Tests
- Operational test
- Controller integration test

Communication Data Handling Test
- SD Card storage test
- GPS Real time clock test
- Xbee radio communication test
- Antenna range test
- Sensors and controller interfaces test

EPS Subsystem Test
- All electronics current draw test
- Battery power capacity test

FSW Subsystem Test
- Payload release mechanism test
- Reset recovery test
- Software phases test
- Camera test
- Audio beacon test

Descent strategy tests
- Parachute descent speed test
- Payload release test
- Glider center of gravity test

Mechanical Subsystem Tests
- Servo and elevon tests
- Control System tests
- Payload parachute release test
- Folding wing deployment test
- Camera gimbal test
- Vibration test
- Heat test
- Drop test

Test Plan	
Subsystem Level	Every test listed in this page will be performed
Integrated Level	Integrated subsystems will be tested immediately and any errors or flaws will be swiftly corrected
Environmental Level	Heat test will be performed on the structure materials. Vibration and drop test will be done to integrated payload and container.

Subsystem Level Testing Plan

Sensors
- Sensors is connected to Arduino using a breadboard to test the interface.
- Sensor output value will be checked and calibrated.

CDH
- When all sensors are integrated to Arduino using a breadboard, all sensor values are outputted to serial console. Ensure the format is according to CANSAT guideline.
- The SD Card storage will be tested with the Arduino.
- CSV file write test to SD card will be performed.

EPS
- Current draw is measured when all electronics are integrated to ensure power source is enough to support it.
- Battery Watt hour capacity is measured to calculate margin.

Radio Communication
- Xbee is configured for point to point communication. Broadcast communication will be tested using a spare Xbee.
- Range test will be performed.

Mechanism
- Functions that engages mechanical subsystems -- payload release, active control, and payload parachute release -- will be tested by altering altitude values in our FSW.

Subsystem Level Testing Plan

Mechanical

- Unfolded wings is weight tested to ensure it is rigid for gliding.
- Folded payload will be fitted inside container then test payload release to ensure flawless separation
- Payload parachute deployment will be tested.
- Elevon will be visually inspected to ensure freedom of operation.
- Servo will be visually inspected to ensure freedom of operation.

Descent Control

- Parachute drop will be tested to calculate drag.
- Glider prototype will be launched to calculate lift and drag.
- Control system will be tested to fine tune PID controller.
- Air speed sensor will be calibrated with Drone.

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Integrated Level Functional Test Plan

Descent Testing	Communications Test
Parachute ● Descent rate - Will drop it from top of buildings to calculate drag ● Payload parachute deployment test **Glider** ● Glider will be launched on top of buildings to fine tune Center of Gravity and aerodynamics ● Glider will be subjected to abrupt changes to pitch and roll to test control system ● Air Speed sensor will be tested and calibrated using a known good drone air speed sensor **Prototypes** ● A prototype of the container and payload with similar weight to the real one will be dropped from top of buildings or from a drone to observe the drop rate and aerodynamics	**Xbee** ● Transmitter will be tested by placing it on top of building while receiver is 800 meters away line of sight to simulate range. ● Transmitter will be placed inside a cardboard to simulate the rocket cylinder wall

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Integrated Level Functional Test Plan

Mechanism Test	Deployment Test
Payload release ● Payload release will be tested by turning it on for 5 to 10 seconds to ensure the enclosure can withstand the heat ● Triggering will be tested by altering altitude value that simulates rocket launched. ● Communications will be tested while payload release is turned on to ensure sufficient power is available **Folding wings** ● Folding wings will be tested thoroughly to ensure the latex and anchors are able to pull the wings open **Glider support structure** ● The payload with its mechanical parts -- hinges, elevon linkages, servo -- will be subjected to calculated force to ensure operational integrity when airborne	**Payload release** ● The payload-container separation will be tested by stowing the payload into the container with all latex springs operational. ● Visually inspecting the inside of the container to ensure there are no sharp edges or obstructions that will prevent it from deployment **Payload parachute deployment** ● It will be tested by having the parachute in stowed position and deploying it. ● The BME280 altitude sensor will be tested for accuracy using a drone

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Integrated Level Functional Test Plan

Communications
Ground Station Software ● GCS is tested by connecting all required components then turn on payload and ensure that data will be received and graphed by GCS. CSV file will also be verified. The GCS GUI should be able to run for at least 2 hours without crashing. **Telemetry** ● When the GCS software is tested. All telemetry should be graphed and stored in a CSV file. The onboard backup SD card must also be verified to ensure the CSV file is uncorrupted. **Antennas** ● Antennas will be tested by comparing the GCS with and without the antenna. The range should improve significantly with the antenna installed

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Environmental Test Plan

Drop Test	Thermal Test
• A 61 cm non-stretching cord is attached to a rigid fixed point. The other end will be tied to the parachute. A harness will be placed on the bottom just in case the test fails. • The cansat is turned on and telemetry is working before being dropped. After being dropped, verify the CanSat did not lose power and telemetry is still being received.	• A hair dryer is placed inside an insulating cooler. A remote thermometer will allow reading the temperature inside. • The hair dryer won’t be blowing directly to CanSat • Turn on Cansat • Temperature will be from 55C to 60C for two hours • Visually inspect CanSat for operational integrity

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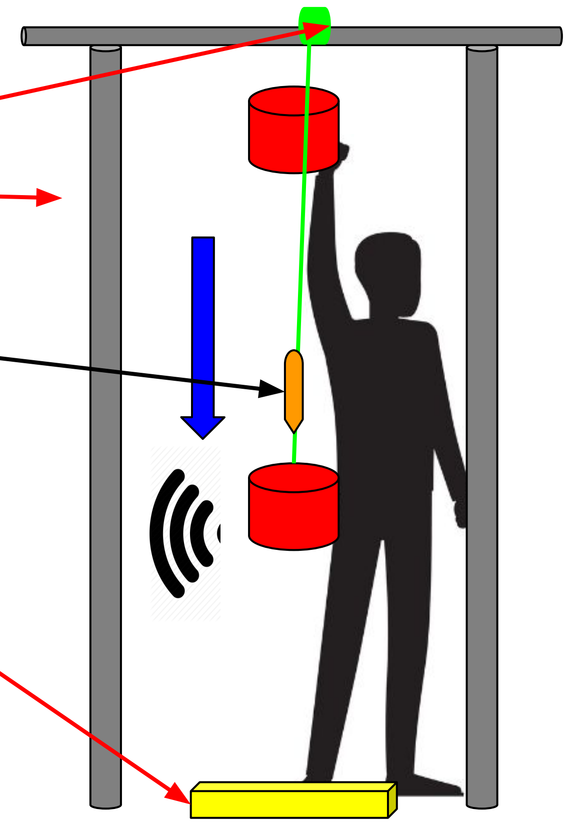
Environmental Test Plan

Drop Test: Test is designed to verify the container parachute and attachment point will survive 30 G's of shock

Materials:
- Kevlar Chord - 61 cm(2 ft) non-stretching cord
- High surface -ceiling or rigid structure
- Floor mat or pillow
- Parachute

Cansat



Ground Control Station

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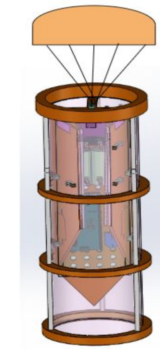
Environmental Test Plan

Thermal Test: test is to verify the CanSat and container can operate in a hot environment, temperatures up to the mid to upper 30C(86 F).

Objective:
heat the CanSat to 60C(140 F) for a period of 2 hours. Inspect compromised mechanical parts.

Material :
Cooler
Arduino controlled outlet
Hairdryer
thermometer

Heater won't be aimed directly to CanSat



BME280 Controller
Signal 0V @ 60 deg Celcius
Signal 5V @ <=55 deg Celcius

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Environmental Test Plan

Vibration Test	Fit Check
1. Power on CanSat. 2. Verify accelerometer data is being collected 3. Power up sander. 4. Wait 5 seconds after sander is up full speed 5. Power down sander. 6. Repeat steps 3 to 5 four more times. 7. Inspect the CanSat for Damage and functionality. 8. Verify accelerometer data is still being collected. 9. Power down CanSat.	• Prototype of the rocket cylinder wall will be built. • The container with stowed payload will be fitted inside and check for deployability.

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Environmental Test Plan

Vibration Test - test is designed to verify the mounting integrity of all components, mounting connections, structural integrity, and battery connections

Objective: *Orbit sanders operate orbits per minute (opm) ranging from 12,000 to 14,000 opm. That translates to 200 to 233 Hz*

- *Cycled over a one minute duration exposing the CanSat to vibrations from 0 Hz to 233 Hz. The amount of shaking generated by the sander is around 20 to 29 Gs. 3-4 times: verify accelerometer*

Material :
Orbit Sander

Test Procedures Descriptions

Drop Test			
Test Procedure	Test Description	Rqmts	Pass Fail Criteria
1	Power on Cansat		Pass if CanSat turns on. Otherwise fail.
2	Verify telemetry is being received	28,29	Pass if data is received on the GCS. Otherwise fail.
3	Raise CanSat by the attached cord, so that the attachment points of the cord, on the eye bolt and the parachute, are at the same height.		n/a
4	Release the CanSat.		n/a
5	Verify the CanSat did not lose power.	33,34	Pass if power is still on. Otherwise fail.
6	Inspect for any damage, or detached parts.	14,17,18,19	Pass if parts are still intact. Otherwise fail.
7	Verify telemetry is still being received.	47,56	Pass if data is still being received by GCS. Otherwise fail.

Test Procedures Descriptions

Thermal Test			
Test Procedure	**Test Description**	**Rqmts**	**Pass Fail Criteria**
1	Build a circuit with temperature sensor that turn on a hair dryer and turns it off when it reaches 60 degree Celcius. Turns on again when temperature goes down to 55 degree centrigrade.	57	n/a
2	Put powered on CanSat along with the test circuit inside a cooler and turn it on. Seal any leaks on the cooler and wait for two hours	15	Pass if Cansat powers on and sending data to GCS. Otherwise fail.
3	Inspect mechanical and structural to ensure everything is intact	19	Pass if everything is intact. Otherwise fail.
4	Verify that CanSat is still sending data to GCS	47	Pass if CanSat is sending data to GCS. Otherwise fail.

Test Procedures Descriptions

Vibration Test			
Test Procedure	**Test Description**	**Rqmts**	**Pass Fail Criteria**
1	Power on Cansat	14,16,17	Pass if CanSat turns on. Otherwise fail.
2	Verify accelerometer data is being collected	56	Pass if accelerometer data is received on the GCS. Otherwise fail.
3	Power up the sander		n/a
4	Once the sander is up to full speed, wait 5 seconds		n/a
5	Power down the sander to full stop		n/a
6	Repeat steps 3 to 5 four more times		n/a
7	Inspect CanSat for damage and functionality	14,17,18,19	Pass if CanSat is damage free and still functioning. Otherwise fail.
8	Verify accelerometer data is still being collected	27,28	Pass if accelerometer data is received on the GCS. Otherwise fail.
9	Power down CanSat		Pass if CanSat powers down. Otherwise fail.

Test Procedures Descriptions

Fit Check			
Test Procedure	**Test Description**	**Rqmts**	**Pass Fail Criteria**
1	Measure CanSat length	2	Pass if CanSat length is < 310mm. Otherwise fail.
2	Measure CanSat diameter	2	Pass if < 125mm. Otherwise fail.
3	Measure CanSat mass	1	Pass if 600 grams +/-10 grams. Otherwise fail.
4	Visually inspect for sharp edges that will prevent it from deploying out of the rocket	3,6	Pass if no sharp edges. Otherwise fail

Mission Operations & Analysis

Guillermo Martin

Overview of Mission Sequence of Events (1/2)

Launch Operations Crew Assignment	Team Member Assigned
Mission Control Officer	Tim Marcell
Ground Control Station Crew	Arthur S Agdeppa
Recovery Crew	Guillermo Martin
CanSat Crew	Jhaymar Mendez

Antenna Construction and Ground System Setup:

- The setup will be easy because the Xbee shield is USB plug and play
- The external antenna is desktop and will have the necessary adaptor to connect to the Xbee
- The laptop will be pre-loaded with the monitoring software

CanSat Assembly and Test:

- The payload and container are to be pre-assembled prior to arriving onsite
- Testing procedure will be turning on the master switch and wait for the audio beacon that indicates everything is OK.
- Container and payload will be labeled with team contact information including email addresses

Overview of Mission Sequence of Events (2/2)

Event	Duties and Responsibilities
1. Arrival	● Ground Control Station will be assembled and checked ● Payload and Container will be inspected and checked for full operation of system ● Check Xbee communications ● Integrate payload and container
2. Before Launch	● Turn in CanSat for weight and fit check
3. Rocket Integration	● GCS and crew will man assigned launch pad ● Collect CanSat, turn it on, integrate to rocket and ensure communication with GCS
4. Launch	● Team Mission Control Officer (Tim Marcell) will go to launch control table to execute launch procedure ● Ground station crew will perform all required flight operations
5. Recovery	● Recovery crew will head out to attempt recovery of payload and container ● GCS crew will clear out of the ground station area to allow the next batch of teams to set up.
6. Data Analysis	● Ground crew must turn in thumb drive with ground station data to the ground station judge

Field Safety Rules Compliance

Mission Operations Manual

GCS Configuration — CanSat Preparation — Rocket CanSat Integration — Launch Preparations Procedure — Launch Procedure — Removal Procedures

- Mission Operations Manual will include checklists for the each of the topics mentioned above.
- Each member will familiarize themselves with the manual before launch day. Safety of each person on launch day is paramount.
- A primary and a backup copy of the manual will be created.
- The document has been downloaded from CanSat competition website and had been modified to include our instructions. It will be updated as we encounter changes before launch day.

CanSat Location and Recovery

Container:

- Recovery crew will maintain visual contact with the container to ease recovery
- Pink color of the container will aid the recovery crew
- Parachute will be orange
- Team information will be written on the container

Payload:

- Recovery crew will maintain visual contact with the payload to ease recovery
- Payload frame will be orange in color
- Last GPS data and activated audio beacon will aid the recovery
- Team information will be written on the frame

Mission Rehearsal Activities

Ground system radio link check procedures

- Assembly of components, testing and troubleshooting

Powering on/off the CanSat

- Visual verification of loose electronic components before turning on

Launch configuration preparations (e.g., final assembly and stowing appendages)

- Visual verification of mechanical system
- Stowing payload into container and tying the fishing line
- Turning on the payload and wait for audio beacon to ensure electronics passed

Loading the CanSat in the launch vehicle

- Visual verification for sharp edges before loading
- Stowing the parachute on top of container to ensure deployment

Mission Rehearsal Activities

Telemetry processing, archiving, and analysis

- Reading graphs and indicators on GCS GUI
- Verification of CSV file

Recovery

- Audio beacon distinct sequence familiarization to locate our payload
- Container and payload color familiarization

Requirements Compliance

Tim Marcello

Requirements Compliance Overview

- Our current design complies with CanSat requirements
- Our payload and container complies with all 57 CanSat Guide requirements.

Requirements Compliance

Rqmt Num	Description	Comply/ No Comply / Partial	X-ref Slide(s) Demonstrating Compliance	Team Comments or Notes
1	Total mass of the CanSat (science payload and container) shall be 600 grams +/- 10 grams.	Comply	76	
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerance are to be included to facilitate container deployment from the rocket fairing.	Comply	22-23	
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.	Comply	67	
4	The Container shall be a fluorescent color ; pink, red, or orange	Comply	68	
5	The container shall be solid and fully enclose the science payload. Small holes to allow access to turn on the science payload is allowed. The end of the container where the payload deploys may be open.	Comply	70	

Requirements Compliance

Rqmt Num	Description	Comply/ No Comply / Partial	X-ref Slide(s) Demonstrating Compliance	Team Comments or Notes
6	The rocket airframe shall not be used to restrain any deployable parts of the CanSat	Comply	67	
7	The rocket airframe shall not be used as part of the CanSat operation	Comply	67	
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	Comply	70	
9	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Comply	49	~17.47m/s Calculated
10	The container shall release the payload at 450 meters +/- 10 meters.	Comply	106	
11	The science payload shall glide in a circular pattern with a 250 m radius for one minute and stay above 100 meters after release from the container.	Comply	52,54	

Requirements Compliance

Rqmt Num	Description	Comply/ No Comply / Partial	X-ref Slide(s) Demonstrating Compliance	Team Comments or Notes
12	The science payload shall be a delta wing glider.	Comply	16-19	
13	After one minute of gliding, the science payload shall release a parachute to drop the science payload to the ground at 10 meters/second, +/- 5m/s	Comply	55	~13.8m/s calculated
14	All descent control device attachment components shall survive 30 Gs of shock.	Comply	72-73	
15	All electronics components shall be enclosed and shielded from the environment with the exception of sensors.	Comply	48	
16	All structures shall be built to survive 15 Gs of launch acceleration.	Comply	72-73	
17	All structures shall be built to survive 30 Gs of shock.	Comply	72-73	
18	All Electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	72-73	

Requirements Compliance

Rqmt Num	Description	Comply/ No Comply / Partial	X-ref Slide(s) Demonstrating Compliance	Team Comments or Notes
19	All mechanism shall be capable of maintaining their configuration or states under all forces.	Comply	72-73	
20	Mechanism shall not use pyrotechnics or chemicals.	Comply	72-73	
21	Mechanism that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Comply	69	
22	The science payload shall measure altitude using an air pressure sensor.	Comply	28	
23	The science payload shall provide position using GPS.	Comply	30	
24	The science payload shall measure its battery voltage.	Comply	31	
25	The science payload shall measure outside temperature.	Comply	29	

Requirements Compliance

Rqmt Num	Description	Comply/ No Comply / Partial	X-ref Slide(s) Demonstrating Compliance	Team Comments or Notes
26	The science payload shall measure particulates in the air as it glides.	Comply	33	
27	The science payload shall measure airspeed.	Comply	32	
28	The science payload shall transmit all sensors data in the telemetry.	Comply	85-86,120-121	
29	Telemetry shall be updated once per second.	Comply	85-86,120-121	
30	The parachutes shall be fluorescent Pink or Orange	Comply	42,68	
31	The ground system shall command the science vehicle to start transmitting telemetry prior to launch.	Comply	120	
32	The ground station shall generate a csv file of all sensor data as specified in the telemetry section.	Comply	121	
33	Telemetry shall include mission time with one second or better solution. Mission time shall be maintained in the event of processor reset during the launch and mission.	Comply	120-121	

Requirements Compliance

Rqmt Num	Description	Comply/ No Comply / Partial	X-ref Slide(s) Demonstrating Compliance	Team Comments or Notes
34	Configuration states such as if commanded to transmit telemetry shall be maintained in the event of a processor reset during launch and mission.	Comply	85-86,120-121	
35	XBEE radios shall be used for telemetry. 2.5 GHz Series radios are allowed. 900 MHz XBEE Pro radios also allowed.	Comply	84	
36	XBEE radios shall have their NETIP/PANID set to their team number.	Comply	84	
37	XBEE radios shall not use broadcast mode.	Comply	84	
38	Cost of CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Comply	160	
39	Each team shall develop their own ground station.	Comply	119-120	
40	All telemetry shall be displayed in real time during descent.	Comply	120	
41	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Comply	120	

Requirements Compliance

Rqmt Num	Description	Comply/ No Comply / Partial	X-ref Slide(s) Demonstrating Compliance	Team Comments or Notes
42	Team shall plot each telemetry data field in real time during flight.	Comply	119-120	
44	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Comply	117	
45	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Comply	117	
46	Both the container and probe shall be labeled with team contact information including email addresses.	Comply	139	
47	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 process resets.	Comply	108	
48	No lasers allowed.	Comply	58	

Requirements Compliance

Rqmt Num	Description	Comply/ No Comply / Partial	X-ref Slide(s) Demonstrating Compliance	Team Comments or Notes
49	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.	Comply	65	
50	The probe must include a power indicator such as an LED or sound generating device that can be easily seen without disassembling the cansat and in the stowed state.	Comply	101	
51	Audio beacon is required for the probe. It may be powered after landing or operate continuously.	Comply	107	
52	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	Comply	157, 159	
53	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells.	Comply	93	
54	An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require a total disassembly of the CanSat.	Comply	66	

Requirements Compliance

Rqmt Num	Description	Comply/ No Comply / Partial	X-ref Slide(s) Demonstrating Compliance	Team Comments or Notes
55	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	66	
56	The CANSAT must operate during the environmental tests laid out in Section 3.5.	Partial	134-137	Awaiting the end of quarantine to do this as a team.
57	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Comply	95	

Management

Arthur S Agdeppa Jr.

Status of Procurements

Component	Status	Quantity	Date Ordered	Date Received
Arduino Nano	Received	2	September 9, 2019	September 18, 2019
BME280	In Stock	2	n/a	n/a
LM35DT	In Stock	2	n/a	n/a
GPS	Received	1	September 9, 2019	September 18, 2019
Xbee 900 Mhz Kit	Received	1	September 9, 2019	September 18, 2019
18650 Battery	Received	4	September 9, 2019	September 18, 2019
MPXV7002DP Air Speed Sensor	Received	2	September 9, 2019	September 18, 2019
Mini Spy Camera	In Stock	1	n/a	n/a
92 dB buzzer	In Stock	2	n/a	n/a
SD Card Breakout	In Stock	2	n/a	n/a
Micro SD Card 16GB	Received	2	September 9, 2019	September 18, 2019

Status of Procurements

Component	Status	Quantity	Date Ordered	Date Received
Arduino Pro Mini	Received	2	September 9, 2019	September 18, 2019
Linear Servo	Received	2	September 9, 2019	September 18, 2019
SPS30	Received	1	September 9, 2019	September 18, 2019
5V regulator	Received	2	September 9, 2019	September 18, 2019
Nylon Hinges (Pack of 16)	Received	2	September 9, 2019	September 18, 2019
M2 bolts and nuts (Kit)	Received	2	September 9, 2019	September 18, 2019
FoamBoard	In Stock	1	n/a	n/a
PETG Filament	In Stock	1	n/a	n/a
Laptop	In Stock	1	n/a	n/a
Matlab Software	In Stock	1	n/a	n/a
Xbee and GCS Antenna	Received	1	September 9, 2019	September 18, 2019

CanSat Budget – Hardware

Part	Status	Price	Quantity	Total Price	Type
Arduino Nano	New	$22.00	2	$44.00	Actual
Xbee 900 MHz	New	$40.00	2	$80.00	Actual
Xbee USB Adapter	New	$29.95	1	$29.95	Actual
18650 Battery	New	$5.00	2	$10.00	Actual
LM35DT	New	$4.00	1	$4.00	Actual
MPXV7002DP	New	$30.00	1	$30.00	Actual
Adafruit Ultimate GPS	New	$39.95	1	$39.95	Actual
BME280	New	$9.95	1	$9.95	Actual
Mini Spy Camera	New	$12.50	1	$12.50	Actual
92dB Buzzer	New	$1.73	1	$1.73	Actual
SD Card Breakout	New	$7.50	1	$7.50	Actual
Micro SD Card (16GB)	New	$4.50	2	$9.00	Actual

CanSat Budget – Hardware

Part	Status	Price	Quantity	Total Price	Type
Micro Servo	New	$5.95	3	$17.85	Actual
SPS30 (Particulate/Dust)	New	$46.95	1	$46.95	Actual
5V regulator D24V50F5	New	$14.95	1	$14.95	Actual
Xbee regulator adapter	New	$11.95	1	$11.95	Actual
Total Price				**$370.28**	

CanSat Budget – Other Costs

Part	Status	Price	Quantity	Total Price	Type
Prototype and testing	N/A	$100.00	1	$100.00	Estimate
Competition Fee	N/A	$200.00	1	$200.00	Actual
Airfare	N/A	$845.79/person	5	$4,228.95	Estimate
Hotel	N/A	$95/day	5	$475.00	Estimate
Food	N/A	$60/day/person	25	$1,500.00	Estimate
Car	N/A	$64/day	5	$320.00	Estimate
Gasoline	N/A	$200.00	1	$200.00	Estimate
Team uniform	New	$50.00/person	5	$250.00	Estimate
			Total Price	**$7,273.95**	

Team Logo
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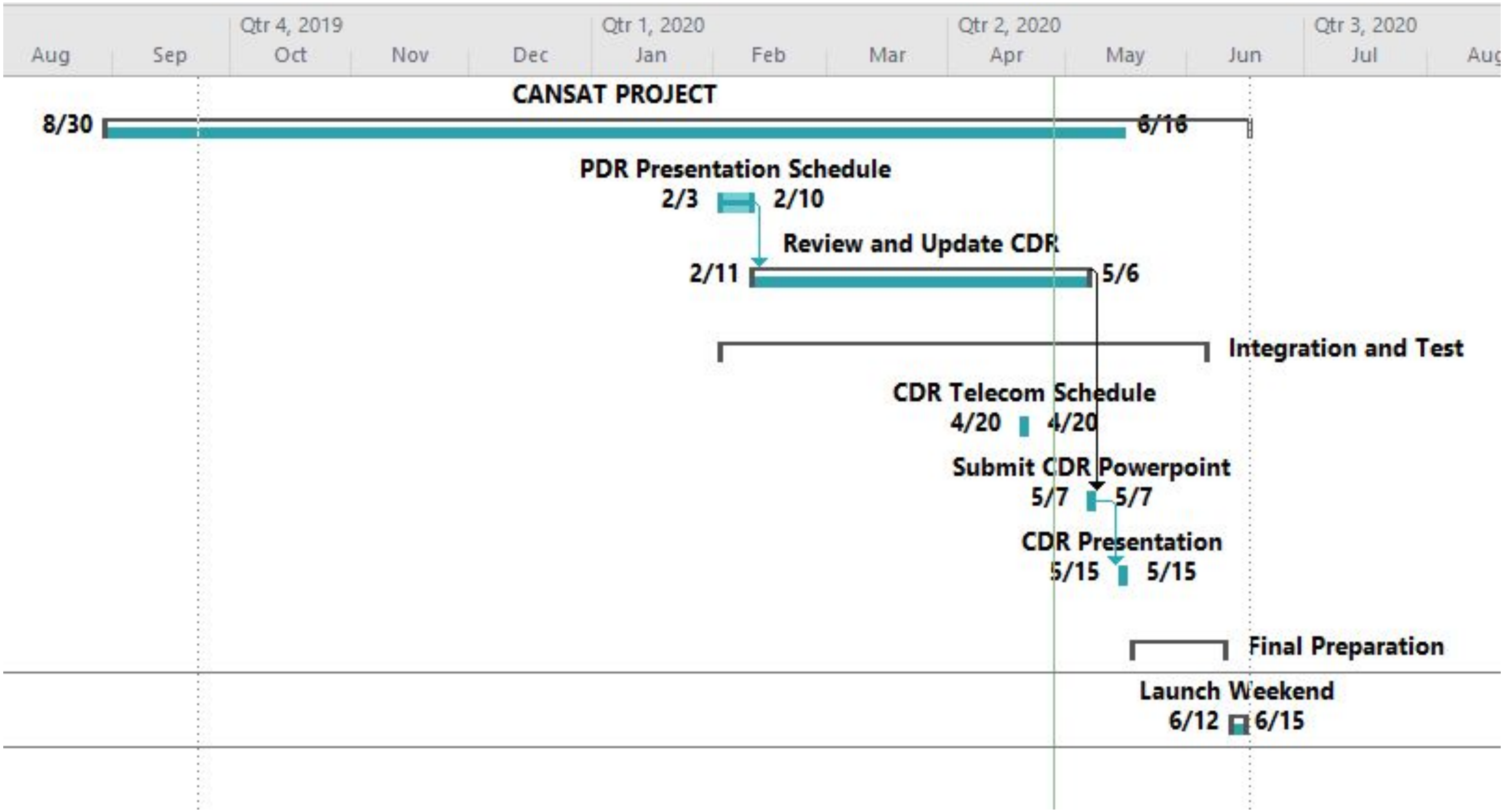
Program Schedule Overview



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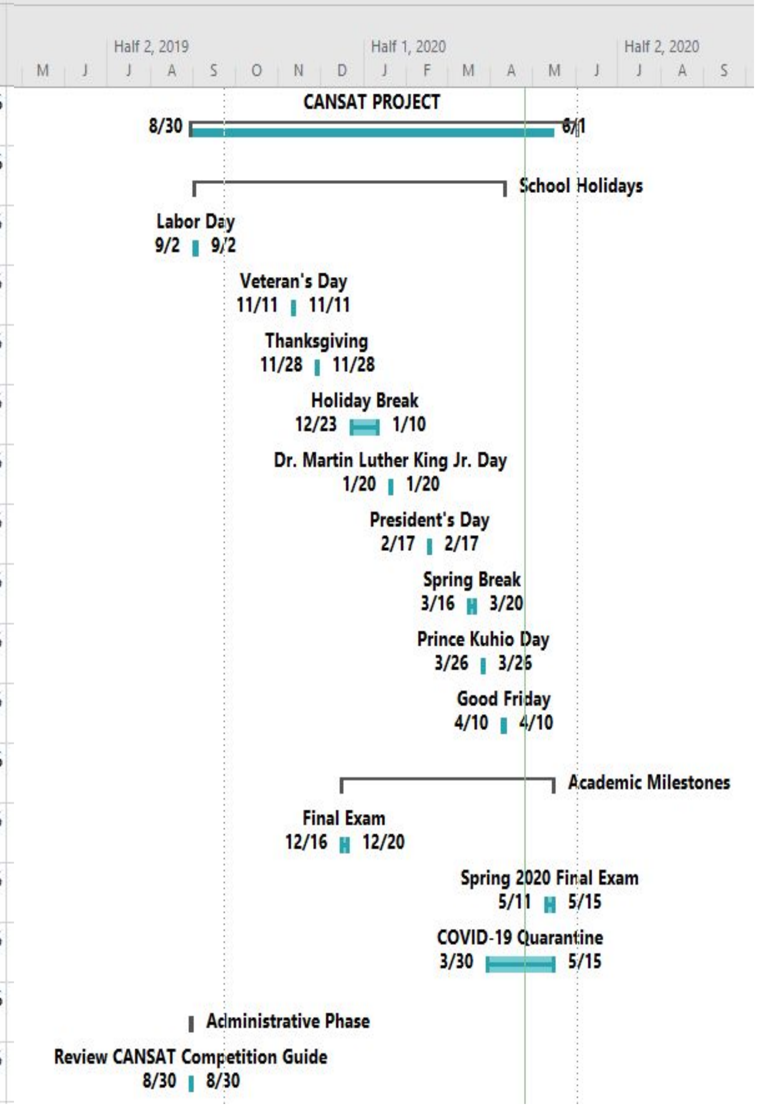
Detailed Program Schedule

GANTT CHART

	Task Name	Duration	Start	Finish	F	Resource Names	% Comp
1	**CANSAT PROJECT**	**197 days?**	**Fri 8/30/19**	**Mon 6/1/20**			**100%**
2	**School Holidays**	**160 days**	**Mon 9/2/19**	**Fri 4/10/20**			**100%**
3	Labor Day	1 day	Mon 9/2/19	Mon 9/2/19			100%
4	Veteran's Day	1 day	Mon 11/11/19	Mon 11/11/19			100%
5	Thanksgiving	1 day	Thu 11/28/19	Thu 11/28/19			100%
6	Holiday Break	15 days	Mon 12/23/19	Fri 1/10/20			100%
7	Dr. Martin Luther King Jr. Day	1 day	Mon 1/20/20	Mon 1/20/20			100%
8	President's Day	1 day	Mon 2/17/20	Mon 2/17/20			100%
9	Spring Break	5 days	Mon 3/16/20	Fri 3/20/20			100%
10	Prince Kuhio Day	1 day	Thu 3/26/20	Thu 3/26/20			100%
11	Good Friday	1 day	Fri 4/10/20	Fri 4/10/20			100%
12	**Academic Milestones**	**110 days**	**Mon 12/16/19**	**Fri 5/15/20**			**100%**
13	Final Exam	5 days	Mon 12/16/19	Fri 12/20/19			100%
14	Spring 2020 Final Exam	5 days	Mon 5/11/20	Fri 5/15/20			100%
15	COVID-19 Quarantine	35 days	Mon 3/30/20	Fri 5/15/20			100%
16	**Administrative Phase**	**1 day**	**Fri 8/30/19**	**Fri 8/30/19**		**ALL**	**100%**
17	Review CANSAT Competition Guide	1 day	Fri 8/30/19	Fri 8/30/19		ALL	100%



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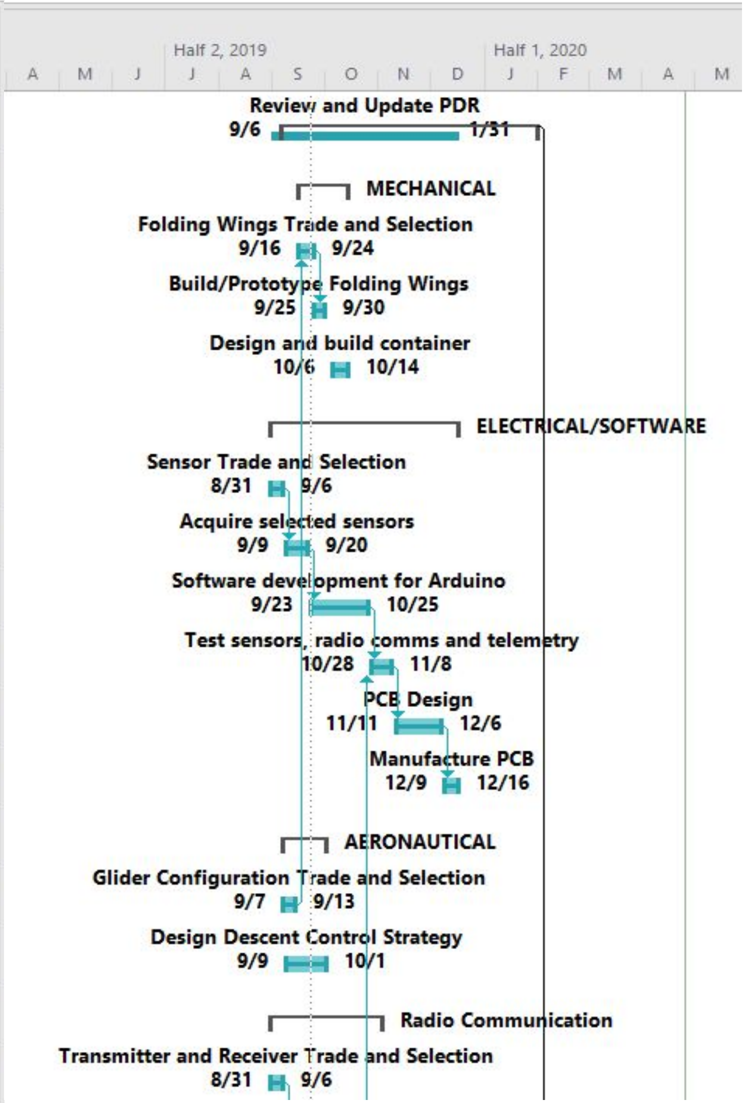
Detailed Program Schedule

GANTT CHART

	Task Name	Duration	Start	Finish	F	Resource Names	% Comp
19	**Review and Update PDR**	**106 days?**	**Fri 9/6/19**	**Fri 1/31/20**		**ALL**	**100%**
20	**MECHANICAL**	**21 days**	**Mon 9/16/19**	**Mon 10/14/19**			**100%**
21	Folding Wings Trade and Selection	7 days	Mon 9/16/19	Tue 9/24/19	32	Jhaymar M, Reece G	100%
22	Build/Prototype Folding Wings	4 days	Wed 9/25/19	Mon 9/30/19	21	Jhaymar M, Reece G	100%
23	Design and build container	7 days	Sun 10/6/19	Mon 10/14/19		Arthur S, Jhaymar M	100%
24	**ELECTRICAL/SOFTWARE**	**76 days**	**Sat 8/31/19**	**Mon 12/16/19**			**100%**
25	Sensor Trade and Selection	6 days	Sat 8/31/19	Fri 9/6/19		ALL	100%
26	Acquire selected sensors	10 days	Mon 9/9/19	Fri 9/20/19	25	Arthur S	100%
27	Software development for Arduino	25 days	Mon 9/23/19	Fri 10/25/19	26	Arthur S, Guillermo M	100%
28	Test sensors, radio comms and telemetry	10 days	Mon 10/28/19	Fri 11/8/19	27,:	Arthur S, Reece G	100%
29	PCB Design	20 days	Mon 11/11/19	Fri 12/6/19	28	Guillermo M	100%
30	Manufacture PCB	6 days	Mon 12/9/19	Mon 12/16/19	29	Arthur S, Guillermo M	100%
31	**AERONAUTICAL**	**17 days**	**Sat 9/7/19**	**Tue 10/1/19**			**100%**
32	Glider Configuration Trade and Selection	6 days	Sat 9/7/19	Fri 9/13/19		Tim M,Jeff C	100%
33	Design Descent Control Strategy	17 days	Mon 9/9/19	Tue 10/1/19		Jeff C,Tim M	100%
34	**Radio Communication**	**45 days**	**Sat 8/31/19**	**Sat 11/2/19**			**100%**
35	Transmitter and Receiver Trade and Selection	6 days	Sat 8/31/19	Fri 9/6/19		John C, Reece G	100%

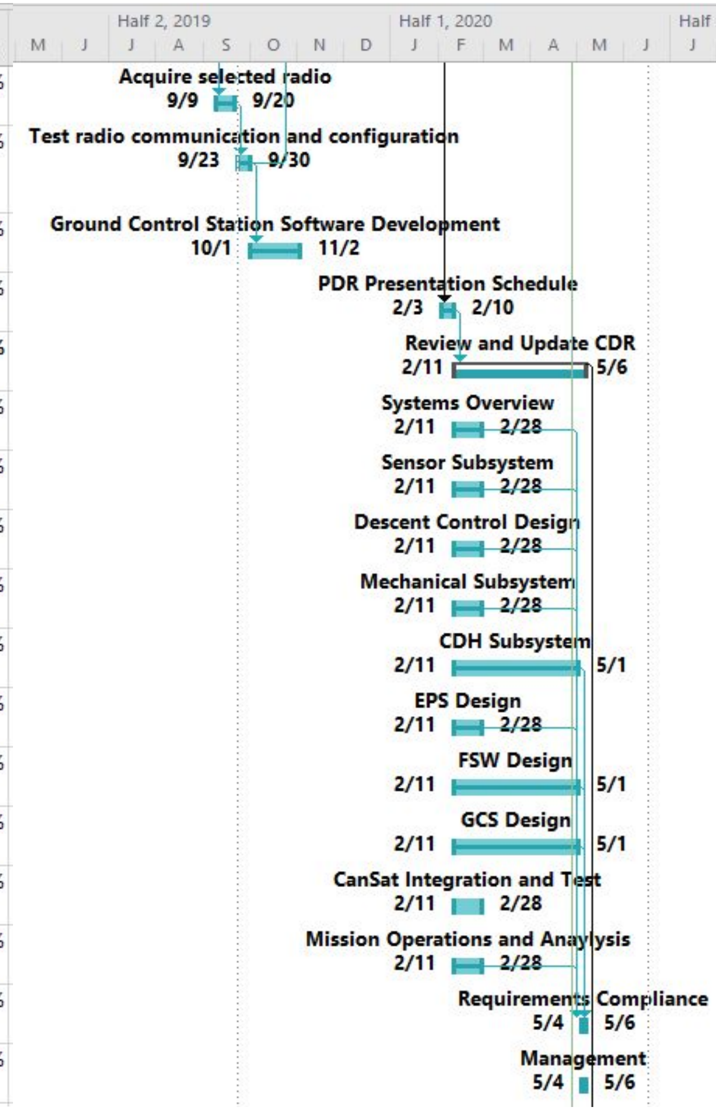


Team Logo Here (If You Want)

Detailed Program Schedule

GANTT CHART

	Task Name	Duration	Start	Finish	Pre	Resource Names	% Comp
36	Acquire selected radio	10 days	Mon 9/9/19	Fri 9/20/19	35	Arthur S	100%
37	Test radio communication and configuration	6 days	Mon 9/23/19	Mon 9/30/19	36	Arthur S, John C	100%
38	Ground Control Station Software Development	25 days	Tue 10/1/19	Sat 11/2/19	37	Arthur S, John C	100%
39	PDR Presentation Schedule	6 days	Mon 2/3/20	Mon 2/10/20	19		100%
40	**Review and Update CDR**	**62 days**	**Tue 2/11/20**	**Wed 5/6/20**	**39**		**96%**
41	Systems Overview	14 days	Tue 2/11/20	Fri 2/28/20		Jhaymar M	100%
42	Sensor Subsystem	14 days	Tue 2/11/20	Fri 2/28/20		Guillermo M	100%
43	Descent Control Design	14 days	Tue 2/11/20	Fri 2/28/20		Arthur S	100%
44	Mechanical Subsystem	14 days	Tue 2/11/20	Fri 2/28/20		Jhaymar M	100%
45	CDH Subsystem	59 days	Tue 2/11/20	Fri 5/1/20		Tim M	100%
46	EPS Design	14 days	Tue 2/11/20	Fri 2/28/20		Guillermo M	100%
47	FSW Design	59 days	Tue 2/11/20	Fri 5/1/20		Arthur S	100%
48	GCS Design	59 days	Tue 2/11/20	Fri 5/1/20		Arthur S	100%
49	CanSat Integration and Test	14 days	Tue 2/11/20	Fri 2/28/20		Arthur S, Jhaymar M	0%
50	Mission Operations and Anaylysis	14 days	Tue 2/11/20	Fri 2/28/20		Guillermo M	100%
51	Requirements Compliance	3 days	Mon 5/4/20	Wed 5/6/20	41,42,	Tim M	100%
52	Management	3 days	Mon 5/4/20	Wed 5/6/20		Arthur S	100%



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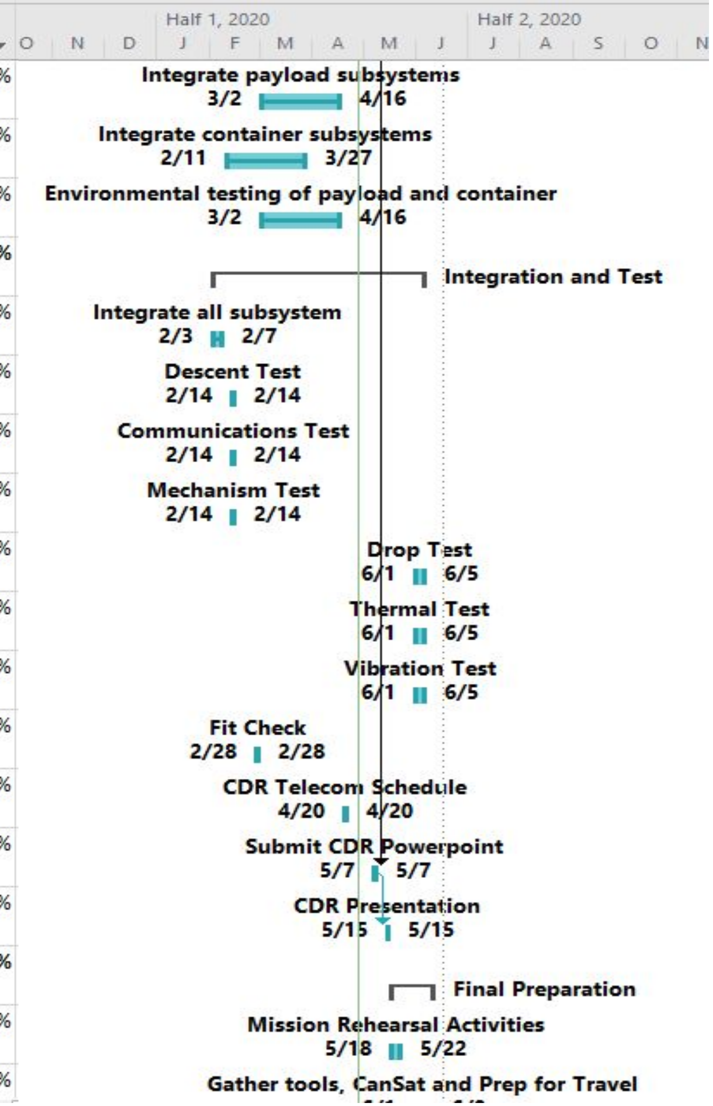
Detailed Program Schedule

GANTT CHART

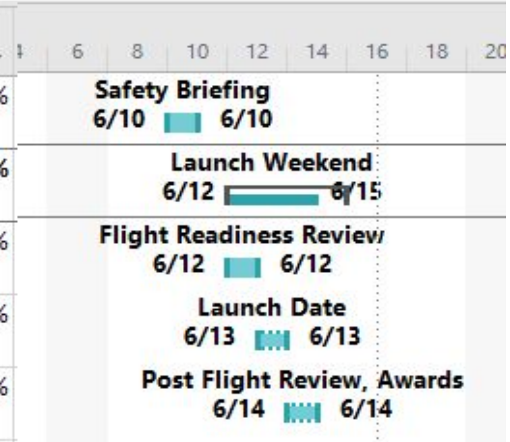
	Task Name	Duration	Start	Finish	Pre	Resource Names	% Comp
53	Integrate payload subsystems	34 days	Mon 3/2/20	Thu 4/16/20		ALL	100%
54	Integrate container subsystems	34 days	Tue 2/11/20	Fri 3/27/20		ALL	100%
55	Environmental testing of payload and container	34 days	Mon 3/2/20	Thu 4/16/20		ALL	100%
56	**Integration and Test**	**90 days**	**Mon 2/3/20**	**Fri 6/5/20**			**38%**
57	Integrate all subsystem	5 days	Mon 2/3/20	Fri 2/7/20		ALL	100%
58	Descent Test	1 day	Fri 2/14/20	Fri 2/14/20		Arthur S, Guillermo M,Jl	100%
59	Communications Test	1 day	Fri 2/14/20	Fri 2/14/20		Arthur S, Jhaymar M,Tin	100%
60	Mechanism Test	1 day	Fri 2/14/20	Fri 2/14/20		Arthur S, Jhaymar M	100%
61	Drop Test	5 days	Mon 6/1/20	Fri 6/5/20		ALL	0%
62	Thermal Test	5 days	Mon 6/1/20	Fri 6/5/20		ALL	0%
63	Vibration Test	5 days	Mon 6/1/20	Fri 6/5/20		ALL	0%
64	Fit Check	1 day	Fri 2/28/20	Fri 2/28/20		Arthur S	100%
65	CDR Telecom Schedule	1 day	Mon 4/20/20	Mon 4/20/20		Arthur S	100%
66	Submit CDR Powerpoint	1 day	Thu 5/7/20	Thu 5/7/20	40	Arthur S	0%
67	CDR Presentation	1 day	Fri 5/15/20	Fri 5/15/20	66	ALL	0%
68	**Final Preparation**	**18 days**	**Mon 5/18/20**	**Wed 6/10/20**			**0%**
69	Mission Rehearsal Activities	5 days	Mon 5/18/20	Fri 5/22/20			0%
70	Gather tools, CanSat and Prep	7 days	Mon 6/1/20	Tue 6/9/20			0%



Team Logo Here (If You Want)

Detailed Program Schedule

	Task Name	Duration	Start	Finish	Pre	Resource Names	% Comp
71	Safety Briefing	1 day	Wed 6/10/20	Wed 6/10/20			0%
72	**Launch Weekend**	**2 days**	**Fri 6/12/20**	**Mon 6/15/20**		**ALL**	**0%**
73	Flight Readiness Review	1 day	Fri 6/12/20	Fri 6/12/20		ALL	0%
74	Launch Date	1 day	Sat 6/13/20	Sat 6/13/20		ALL	0%
75	Post Flight Review, Awards	1 day	Sun 6/14/20	Sun 6/14/20		ALL	0%



Shipping and Transportation

- Pelican 1640 case
- Dimension 27.2” x 27.5” x 16.3
- There is a lot of room for our CanSat, payload, external antenna, and tools.
- The case came with “pick and pluck” foam so we can protect all of our devices
- Ground Control Station laptop will be carried on
- The case will be checked in

Conclusions

Major **accomplishments**

1. Control system software has been updated and verified telemetry is working
2. Integration of all electronics is finished
3. Integration and testing of container and payload mechanical are finished
4. Launched a prototype glider to recalculate drag and lift coefficient

Major **unfinished** work

1. Environmental testing

Testing to **complete**

1. Drop test
2. Thermal test
3. Vibration test

Flight software status

- Flight software programming is **finished**.