CanSat 2019
Preliminary Design Review (PDR)
Version 1.0

Team # 6160
grizu-263

Presentation Outline (1 of 8)

3. Sensor Subsystem Design - 38

4. Descent Control Design - 52

5. Mechanical Subsystem Design - 76

6. Communication and Data Handling (CDH) Subsystem Design - 105

Presentation Outline (5 of 8)

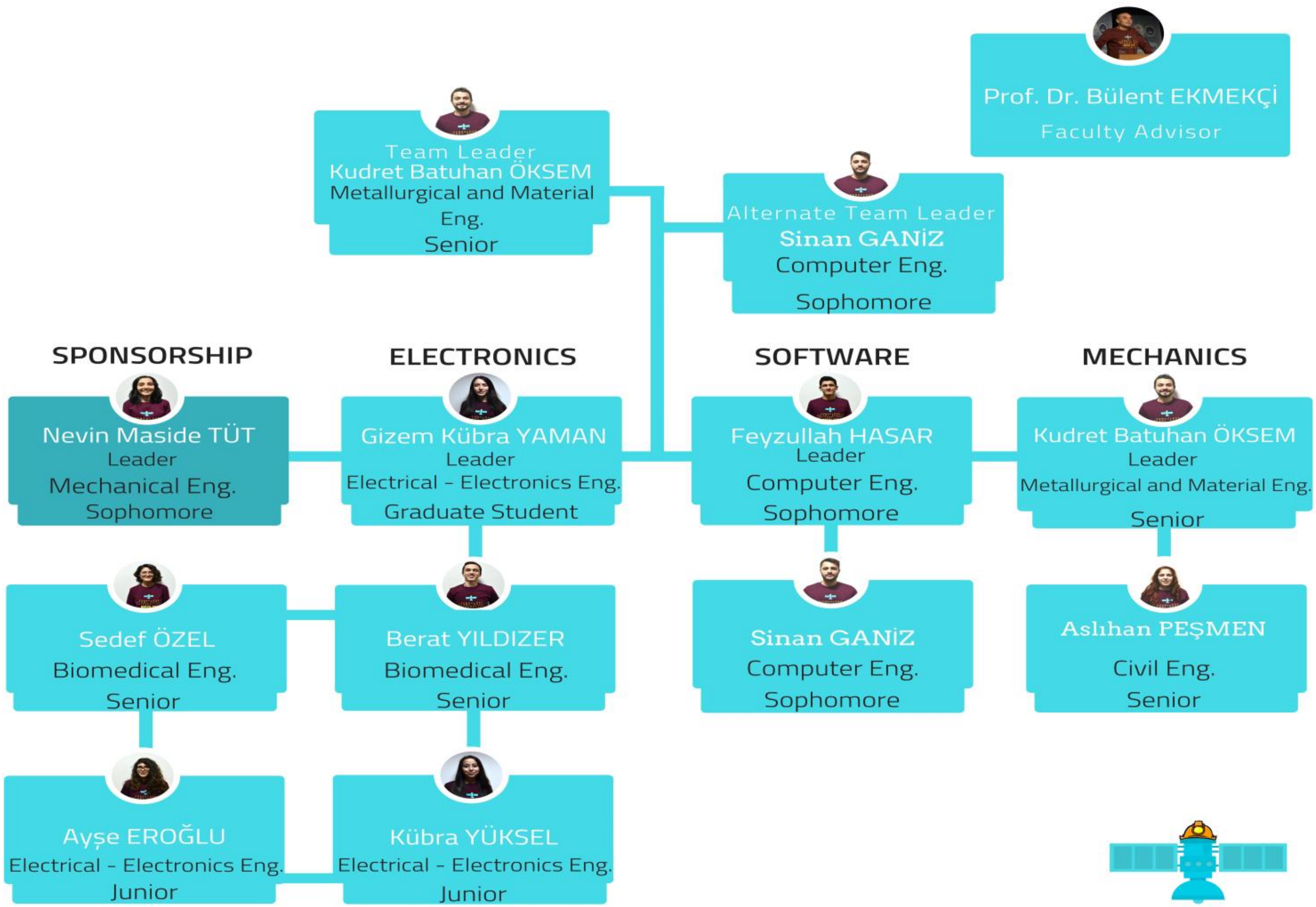
Presentation Outline (6 of 8)

Presentation Outline (7 of 8)

Presentation Outline (8 of 8)

- **Systems Overview –** Gizem Kübra YAMAN
- **Sensor Subsystem Design –** Sedef ÖZEL
- **Descent Control Design –**Aslıhan PEŞMEN
- **Mechanical Subsystem Design –**Kudret Batuhan ÖKSEM
- **CDH Subsystem Design –** Ayşe EROĞLU
- **Electrical Power Subsystem Design –** Ayşe EROĞLU
- **Flight Software Design –** Feyzullah HASAR
- **Ground Control System Design –** Sinan GANİZ
- **CanSat Integration and Test –** Kübra YÜKSEL
- **Mission Operations and Analysis –** Berat YILDIZER
- **Requirements Compliance –** Berat YILDIZER
- **Management –** Nevin Maside TÜT

Team Organization



Acronyms (1 of 2)

- **A** – Analysis
- **ABS -** Acrylonitrile-Butadiene-Styrene
- **AC** – Alternate Current
- **ANT** – Antenna
- **CAD**- Computer Aided Design
- **CC** – Cansat Crew
- **CDH** – Communication and Data Handling
- **COM** – Communication
- **D** – Demonstration
- **dB** – Decibel
- **dBi** – Decibel isotropic
- **dBm** – Decibel milliwatt
- **DC** – Direct Current
- **DS-** Data Sheet
- **EEPROM** – Electrically Erasable Programmable Read Only Memory
- **E-** Estimate
- **etc** – et cetera
- **FSW** – Flight Software
- **G** – Gravitational Force
- **g** – Gram
- **GB** – GigaByte
- **GCS** – Ground Control System
- **GHz** – GigaHertz
- **GND** – Ground
- **GPIO** – General Purpose Input Output
- **GPS** – Global Positioning System
- **GSC** – Ground Station Crew
- **hPa-** HectoPascal
- **hr** – Hours
- **Hz** – Hertz
- **I** – Inspection
- **I2C** – Inter-Integrated Circuit
- **ID** – Identification
- **IDE** – Integrated Development Environment
- **IMU** – Inertial Measurement Unit
- **kB** – KiloByte
- **km** – Kilometers
- **MPa-** MegaPascal
- **M-** Measurement
- **m** – Meter
- **mA**- Milliampere
- **mAh**- Milliampere hour
- **max** – Maximum
- **Mb** – Megabit
- **MCO** – Mission Control Officer
- **MCU** – Microprocessor Control Unit

Acronyms (2 of 2)

- **MHz** – MegaHertz
- **min**- Minute
- **mm** – Millimeter
- **ms** – Millisecond
- **mV** – millivolt
- **mW**- MilliWatt
- **nA** – Nanoampere
- **Pa** – Pascal
- **PCB** - Printed Circuit Board
- **PDIP** – Plastic Dual In-Line Package
- **PDR** – Preliminary Design Review
- **PFR-** Post Flight Review
- **Prev** – Previous
- **Pro** – Professional
- **PVC-** Polyvinyl Chloride
- **PWM** – Pulse Width Modulation
- **Rad** – Radian
- **RAM** – Random Access Memory
- **RC** – Recovery Crew
- **RN** – Requirement Number
- **RPM** – Revolution per minute
- **RP-SMA** – Reverse Polarity SubMiniature Version A
- **RTC** – Real Time Clock
- **s** – Second
- **SD** – Secure Digital
- **SOIC**-Small Outline Integrated Circuit
- **SPI-** Serial Peripheral Interface
- **SSD-** Sensor Subsystem Design
- **SSR –** Sensor Subsystem Requirement
- **T** – Test
- **Temp** - Temperature
- **UART** – Universal Asynchronous Receiver/ Transmitter
- **V** – Voltage
- **VM** – Verification Method
- **Wh** – Watt Hour
- **XAML** – Extensible Application Markup Language
- **XCTU** – Next Generation Configuration Platform for Xbee/RF Solutions
- **% -** percent
- **.csv** - Comma-Seperated Values
- **°C –** Centigrade Degree
- **°-** Degree
- **µA** – microampere

Systems Overview

Gizem Kübra Yaman

Mission

CanSat is an auto-gyro controlled container that protects the electronic part and protects the payload.

Mission Objectives

- CanSat consists of 2 parts: payload and container.
- Container protects the payload that will perform the desired mission.
- The launched CanSat will leave the rocket at a height of 670 to 725 m.
- CanSat will go down to 450 m with a speed of 20 m/s via the parachute .
- The container will be separated from the auto-gyro controlled payload after 450 m.
- The container will descent via parachute after separation.
- Auto-gyro's descent speed will be 10 to 15 m/s.
- The auto-gyro rotates passively during descent.
- When going under the control of payload auto-gyro, the payload will transmit telemetry, which will include air pressure, outside temperature, battery voltage, GPS position, pitch and roll, auto-gyro blade spin rate.
- After the landing, the payload will be stopped telemetry transmission and starts to give warning sound and light.

Mission Summary (2 of 3)

Bonus Objective

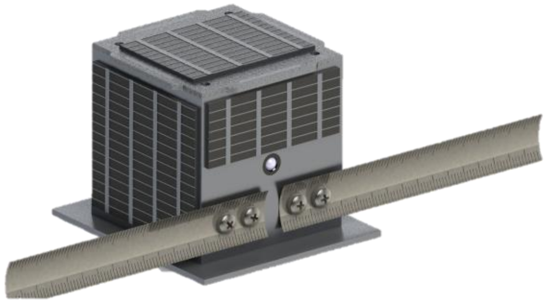
- The camera will be integrated into the payload. After released payload from the container (450 meters), the camera will start to record video.
- The camera shall point downward 45 degrees from nadir. It shall be spin stabilized and point in one direction relative to the earth’s magnetic field with a stability of +/- 10 degrees.
- The video camera resolution will be at least 640x480 and will be colored to 30 frames per second.

External Objective

- Our goal is to be among of the top three in CanSat 2019.
- We have gained an acceptable experience with CanSat Competition and started a new national project to design and produce Turkey's first PocketQube satellite.
- PocketQube will be dimensions of the 5x5x5 cm.
- It will be placed in orbit at an altitude of about 500 km .
- The camera system is developing at now .
- PocketQube and CanSat internet address:

  https://x.grizu-263.space/

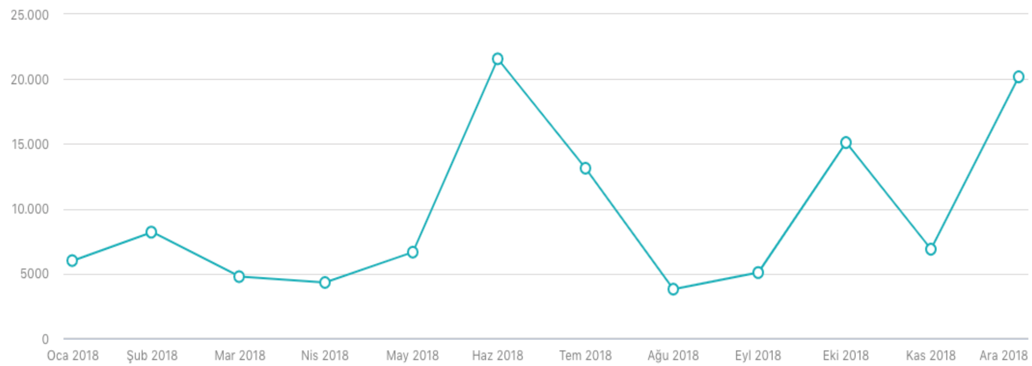
  https://grizu-263.space/cansat/



Mission Summary (3 of 3)

External Objective

- CanSat Competition being introduced in Turkey.
- After the second place we won, we took part in the national press and we made the promotion of the CanSat Competition.
- We reached hundreds of thousands of people on social media.
- Below you can see the various statistics.



LinkedIn Page Statics for 12 Months

Twitter Account Jun 2018 Statics

Our news (CanSat Competition 2018 results) on the most popular national channel CNN Türk.

System Requirement Summary (1 of 5)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#1	Total mass of the CanSat (science payload and container) shall be 500 grams +/- 10 grams.	Competition Requirement	HIGH		√		
RN#2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Competition Requirement	HIGH		√		
RN#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.	Competition Requirement	HIGH	√	√		
RN#4	The container shall be a fluorescent color; pink, red or orange.	Competition Requirement	MEDIUM	√			
RN#5	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition Requirement	LOW	√	√		
RN#6	The rocket airframe shall not be used as part of the CanSat operations.	Competition Requirement	HIGH	√	√		
RN#7	The CanSat shall deploy from the rocket payload section and immediately deploy the container parachute.	Competition Requirement	HIGH	√	√		
RN#8	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Competition Requirement	HIGH	√	√		

System Requirement Summary (2 of 5)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#9	The container shall release the payload at 450 meters +/- 10 meters.	Competition Requirement	HIGH		√	√	
RN#10	The science payload shall descend using an auto-gyro descent control system.	Competition Requirement	HIGH	√		√	√
RN#11	The descent rate of the science payload after being released from the container shall be 10 to 15 meters/second.	Competition Requirement	HIGH	√	√		
RN#16	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Competition Requirement	MEDIUM	√		√	√
RN#17	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Competition Requirement	MEDIUM	√			
RN#19	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Competition Requirement	HIGH	√	√		
RN#20	The science payload shall measure altitude using an air pressure sensor.	Competition Requirement	HIGH			√	√
RN#21	The science payload shall provide position using GPS.	Competition Requirement	HIGH			√	√
RN#22	The science payload shall measure its battery voltage.	Competition Requirement	HIGH			√	√

System Requirement Summary (3 of 5)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#23	The science payload shall measure outside temperature.	Competition Requirement	HIGH			√	√
RN#24	The science payload shall measure the spin rate of the auto-gyro blades relative to the science vehicle.	Competition Requirement	HIGH			√	√
RN#25	The science payload shall measure pitch and roll.	Competition Requirement	HIGH			√	√
RN#26	The probe shall transmit all sensor data in the telemetry.	Competition Requirement	HIGH			√	√
RN#27	The Parachute shall be fluorescent Pink or Orange.	Competition Requirement	MEDIUM	√	√		
RN#34	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Competition Requirement	LOW	√	√		
RN#35	Each team shall develop their own ground station.	Competition Requirement	HIGH	√	√		
RN#36	All telemetry shall be displayed in real time during descent.	Competition Requirement	MEDIUM			√	√
RN#37	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Competition Requirement	HIGH	√	√		

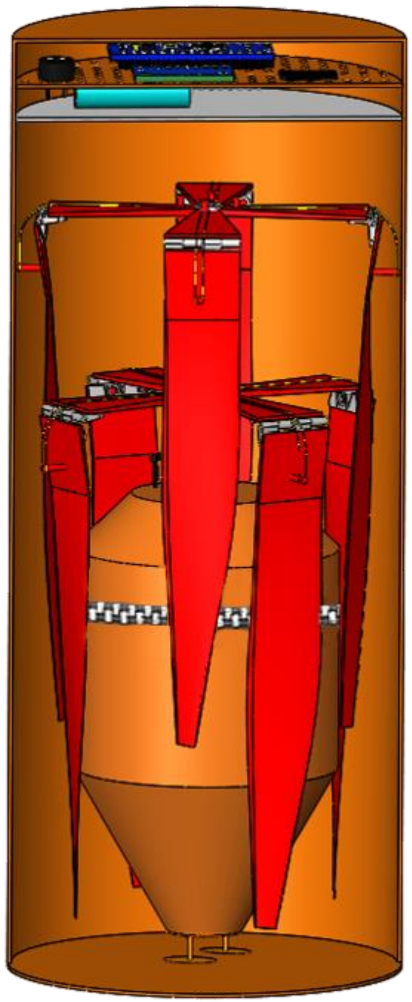
System Requirement Summary (4 of 5)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#39	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Competition Requirement	HIGH	✓		✓	
RN#41	Both the container and probe shall be labeled with team contact information including email address.	Competition Requirement	MEDIUM	✓	✓		
RN#44	No lasers allowed.	Competition Requirement	LOW	✓			
RN#45	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.	Competition Requirement	MEDIUM	✓	✓		
RN#46	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.	Competition Requirement	MEDIUM	✓	✓		
RN#47	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	Competition Requirement	HIGH	✓		✓	✓
RN#48	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	Competition Requirement	HIGH	✓		✓	✓
RN#49	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells.	Competition Requirement	HIGH	✓	✓		

System Requirement Summary (5 of 5)

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#50	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.	Competition Requirement	HIGH	✓	✓		
RN#51	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Competition Requirement	MEDIUM	✓			
RN#52	The auto-gyro descent control shall not be motorized. It must passively rotate during descent.	Competition Requirement	HIGH	✓		✓	✓
RN#55	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Competition Requirement	HIGH	✓	✓		
BONUS	A video camera shall be integrated into the science payload to record the descent after being released from the container. The camera shall point downward 45 degrees from nadir of the science payload. It shall point in one direction relative to the earth's magnetic field with a stability of +/- 10 degrees in all directions during descent. Direction does not matter as long as it is in one direction. The payload can pick the direction. Video shall be in color with a minimum resolution of 640x480 pixels and 30 frames per second. The direction the camera is pointed relative to earth's magnetic north shall be included in the telemetry.	To fulfill bonus objective	HIGH	✓		✓	✓

Configuration 1



Configuration 1	
General Description	The payload will be separated from the container with the burn of wire method. The propellers will be opened by stretched fabric elastic. The nose is designed as to reduce the friction and to improve the stability of the payload.The propellers will rotate passively during inclination due to air resistance. A camera system is placed at the bottom of the payload. The orientation of the camera will be controlled with the use of a servo motor to ensure stable positioning. (against the risk of rotation). The servo motor will rotate in the opposite direction of the payload to obtain fixed camera view orientation. The easy access to the circuit component will be achieved by zipper construction of the payload.
Pros	The center of mass of the payload will be designed as to be placed at the nose section that will provide a more balanced passive descent. The payload diameter is small. The useful area of the propellers is big. The proposed design has high stability.
Cons	The risk of turbulence is high. The payload is heavy because it has more in number of propellers.

System Level CanSat Configuration Trade & Selection (2 of 5)

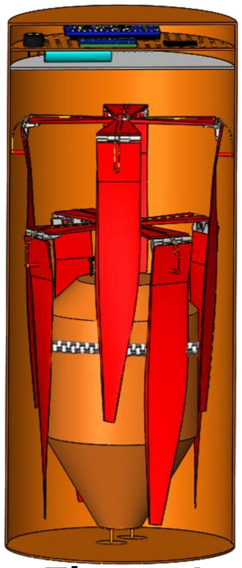


Figure 1

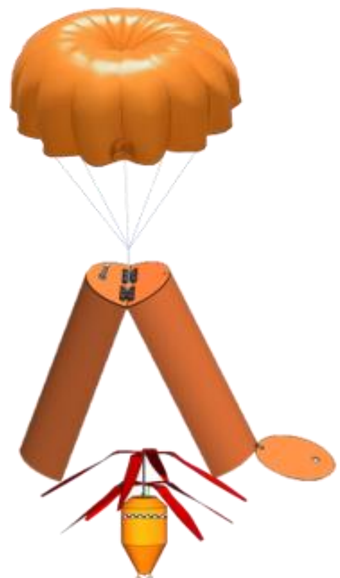


Figure 2

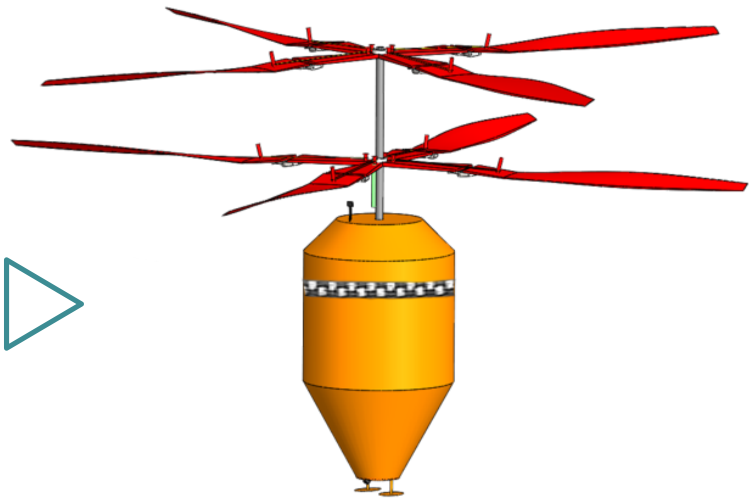


Figure 3

Position 1

Assemblied container and payload (Figure1). The payload will be separated from the container with the use of burn of wire method.

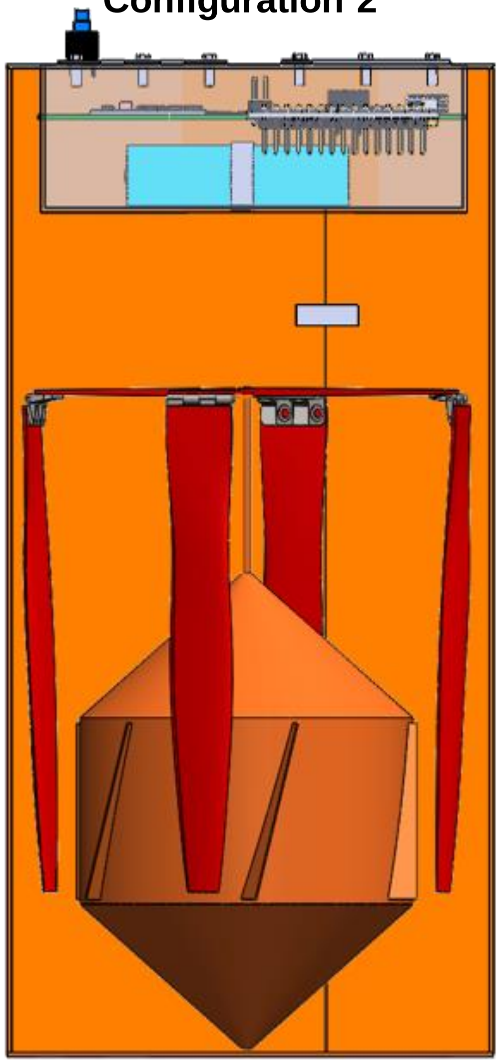
Position 2

Payload’s propellers will be opened by stretched fabric elastic after separation from the container (Figure 2).

Position 3

The payload will be descent passively. Payload’s propellers are shown in open position in figure 3.

Configuration 2



Configuration 2	
General Description	The payload will be separated from the container with the burn of wire method. The propellers will be opened by stretched fabric elastic. Payload has an inclined flaps that direct air in a counterclockwise rotation while the propellers rotate clockwise. In this way, the payload will decrease passively.
Pros	The risk of turbulence is lower. The opposite rotation direction of the flaps and the propellers provides stable descent.
Cons	Payload body is difficult to produce due to flaps. The momentum balanced's mainted is harder than configuration 1.

System Level CanSat Configuration Trade & Selection (4 of 5)

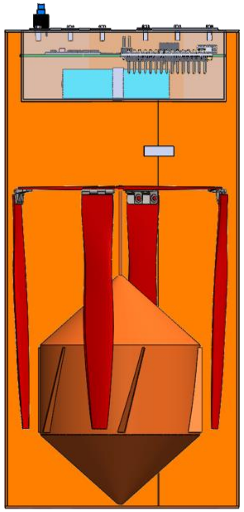


Figure 1

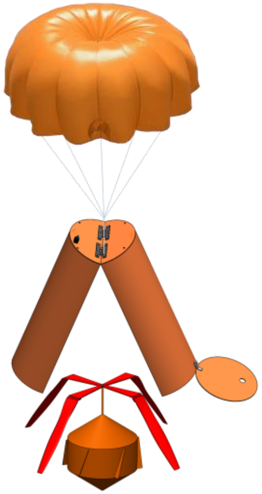


Figure 2

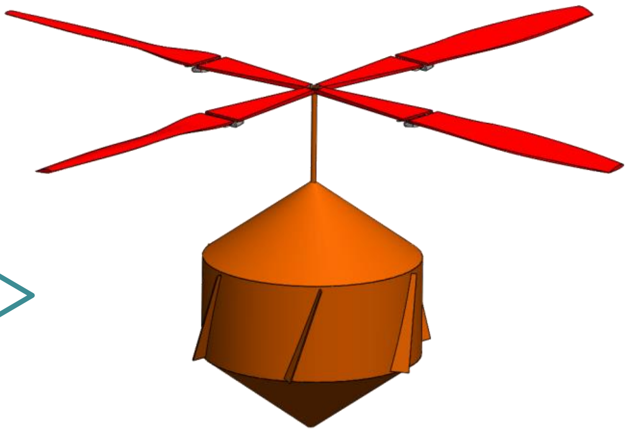


Figure 3

Position 1

The payload will be separated from the container at an altitude of 450 m. The burn of wire method will be used in the separation mechanism (Figure 1).

Position 2

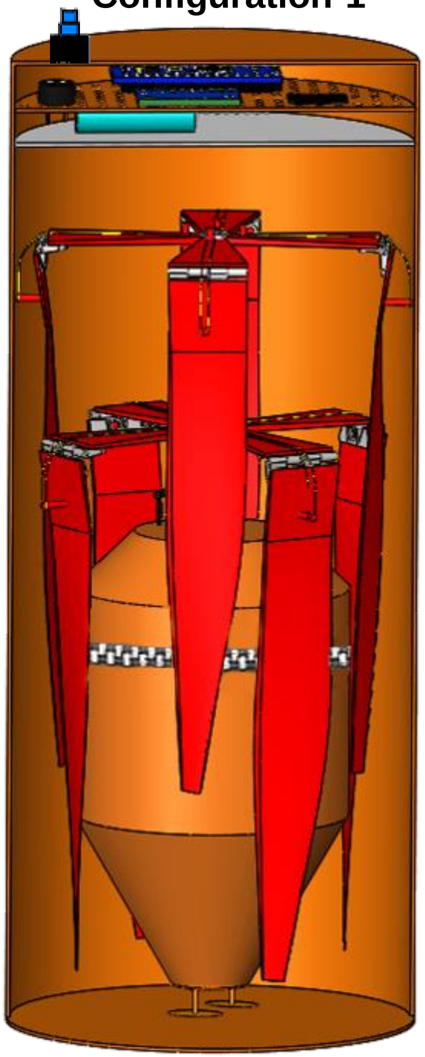
The container opens, and the payload will be separated. The payload propellers than opened by the use of stretched fabric elastic (Figure 2).

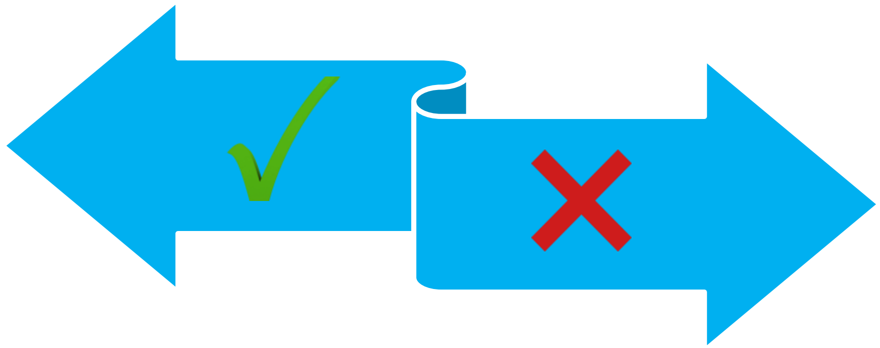
Position 3

The propellers and the flaps will begin to rotate in the opposite direction via air resistance and payload will decrease passively (Figure 3).

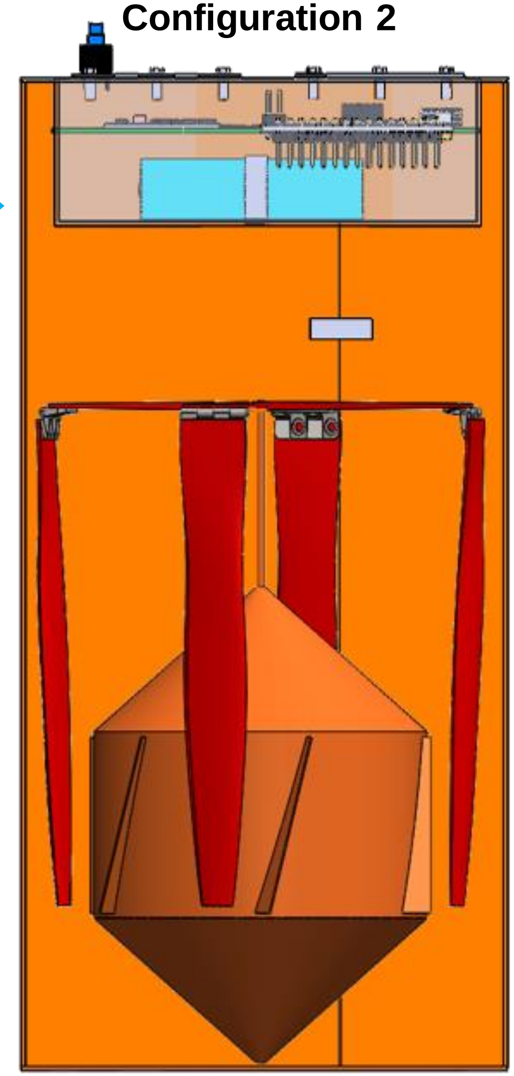
System Level CanSat Configuration Trade & Selection (5 of 5)

Configuration 1





Configuration 2

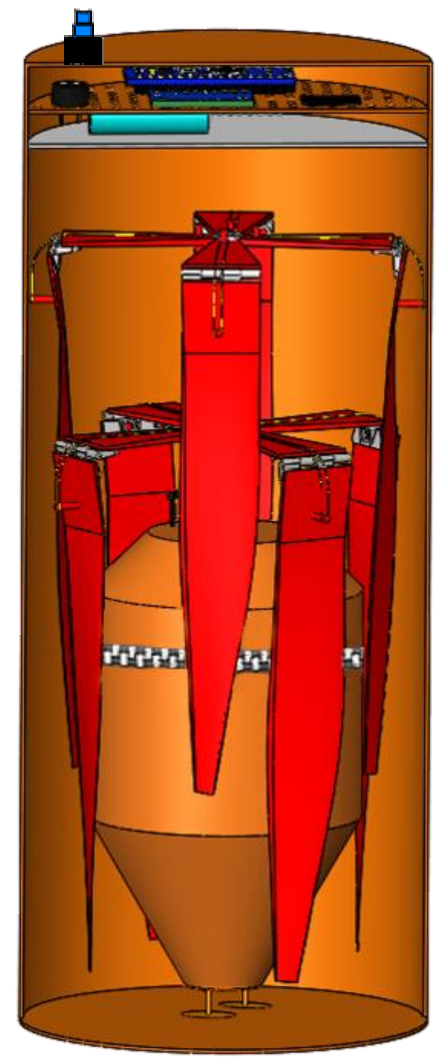


Both designs comply with the requirements. Both designs decrease passively but configuration 1 has two propellers so payload more stable descent than the other configuration 2. Configuration 1 has a diameter small than the other. Therefore, we have selected Configuration 1.

System Level Configuration Selection

Definition of Choose

- The payload will be separated from the container with the burn of wire method.
- The propellers will be opened by stretched fabric elastic.
- At the bottom of the payload is a camera system with a servo motor. The servo motor will rotate in the opposite direction as the payload rotates around its axis and bonus mission will be provided.
- Balanced passive descent control will be provided by positioning the center of mass at the bottom section of the payload.
- Payload dimensions: 70 mm diameter and 187 mm long.
- Payload has two propellers.

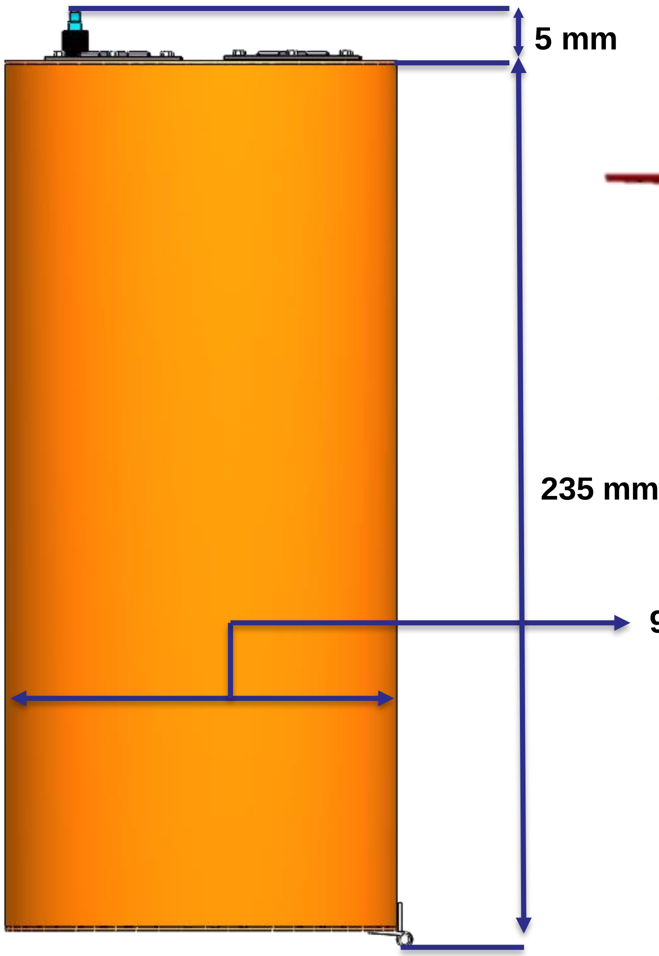


Reasons to Choose

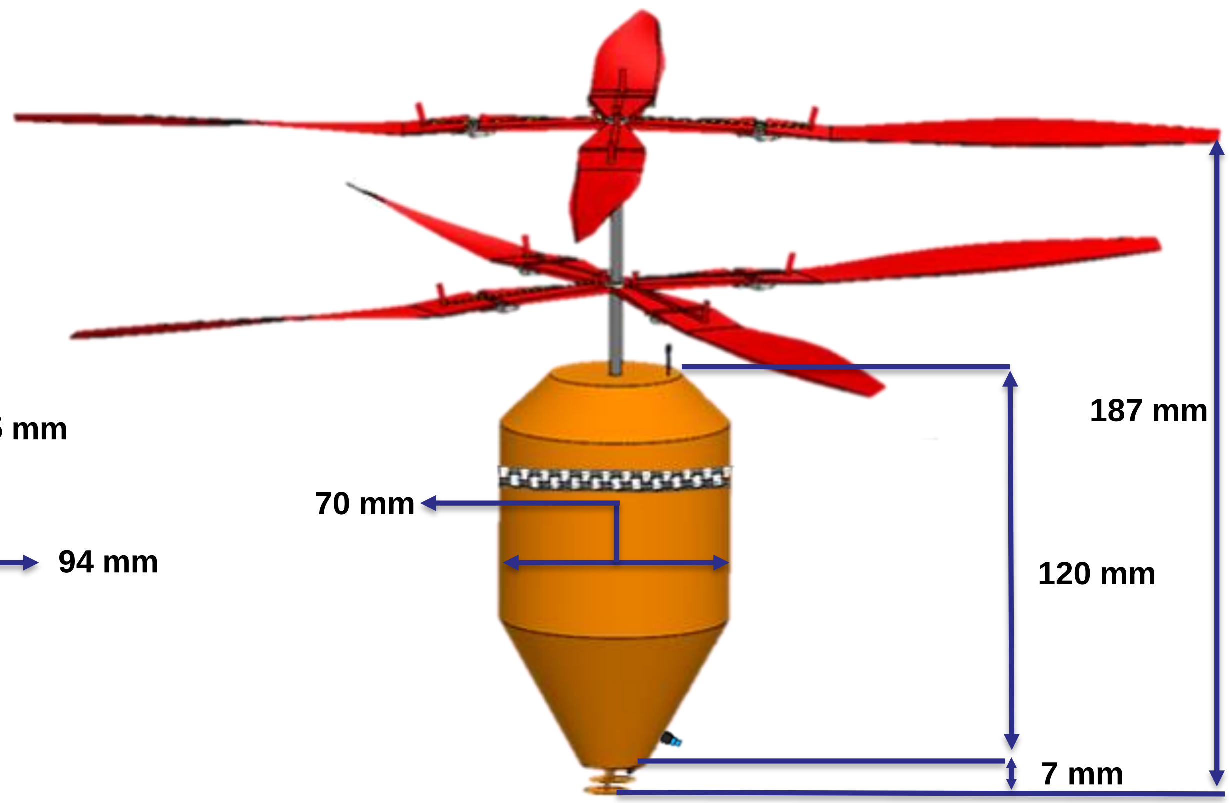
- The useful area of the propellers is bigger than the alternative design.
- It has higher stability during inclination.
- Easy to production.

Physical Layout (1 of 6)

Container Dimensions

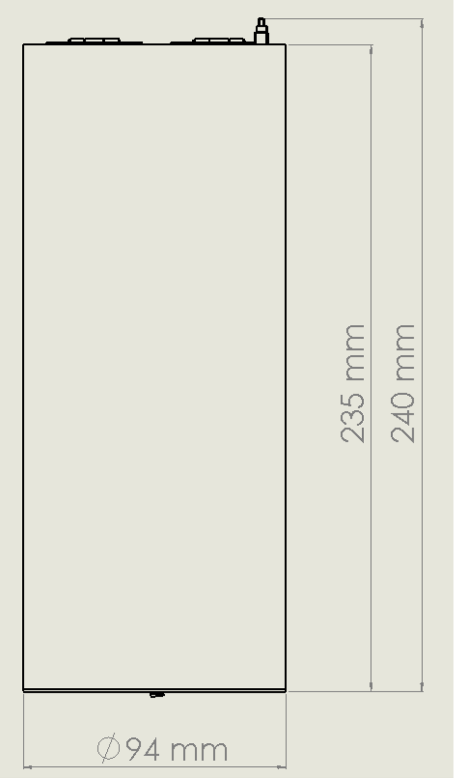


Payload Dimensions

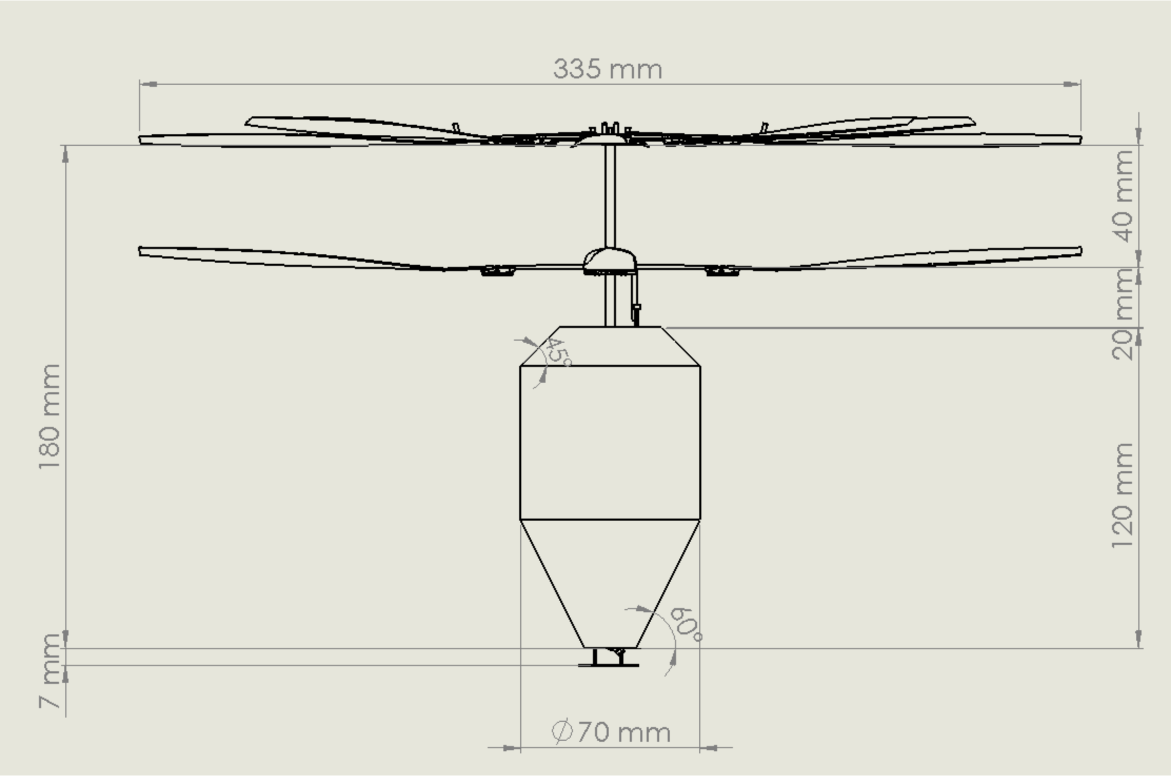


Physical Layout (2 of 6)

Container Dimensions

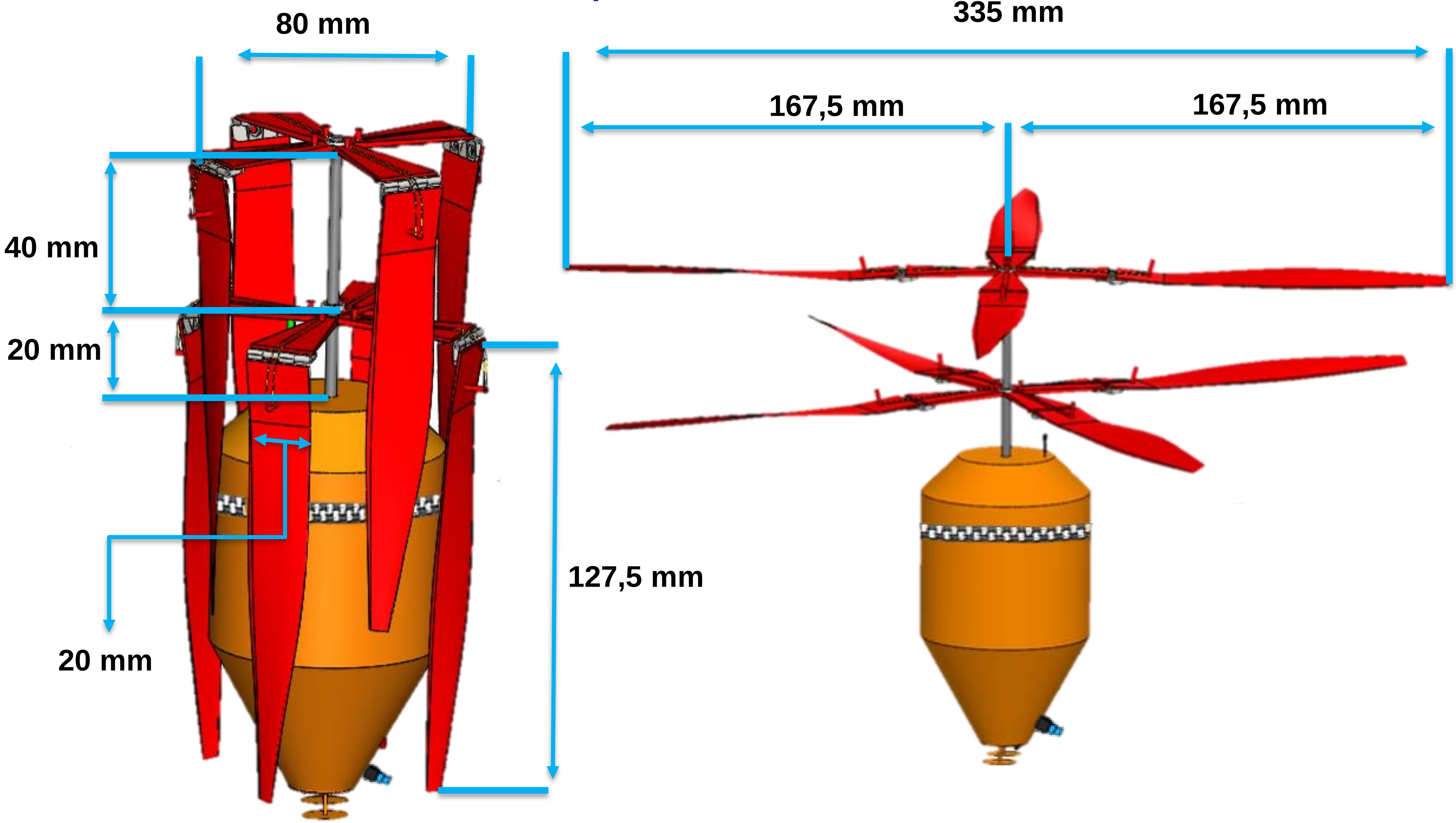


Payload Dimensions

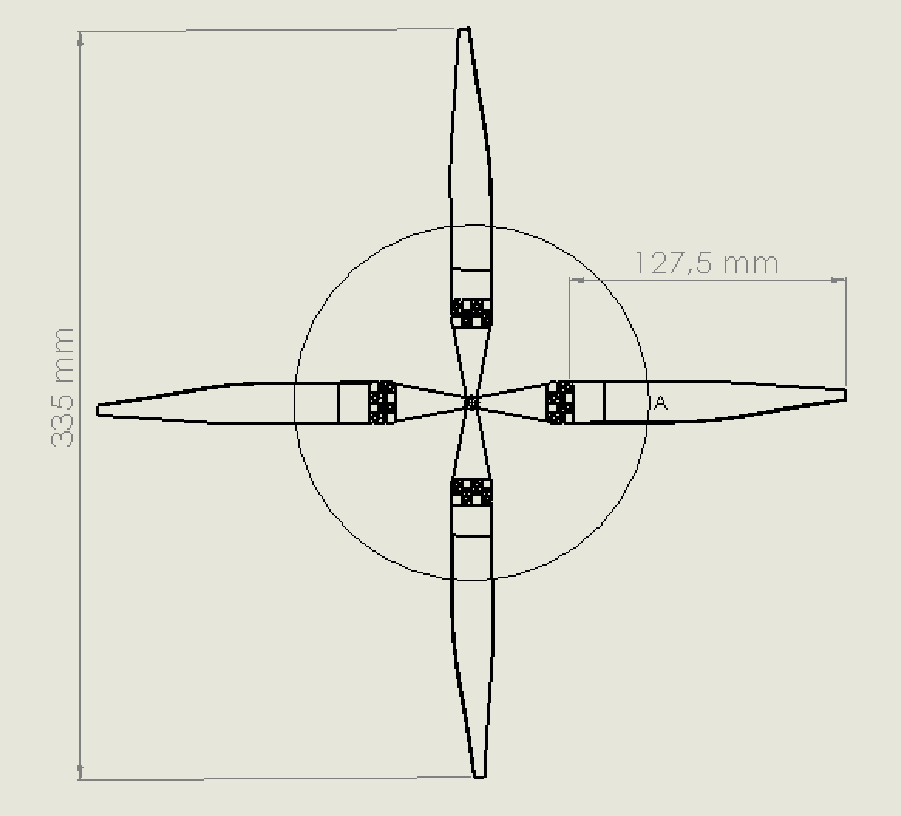


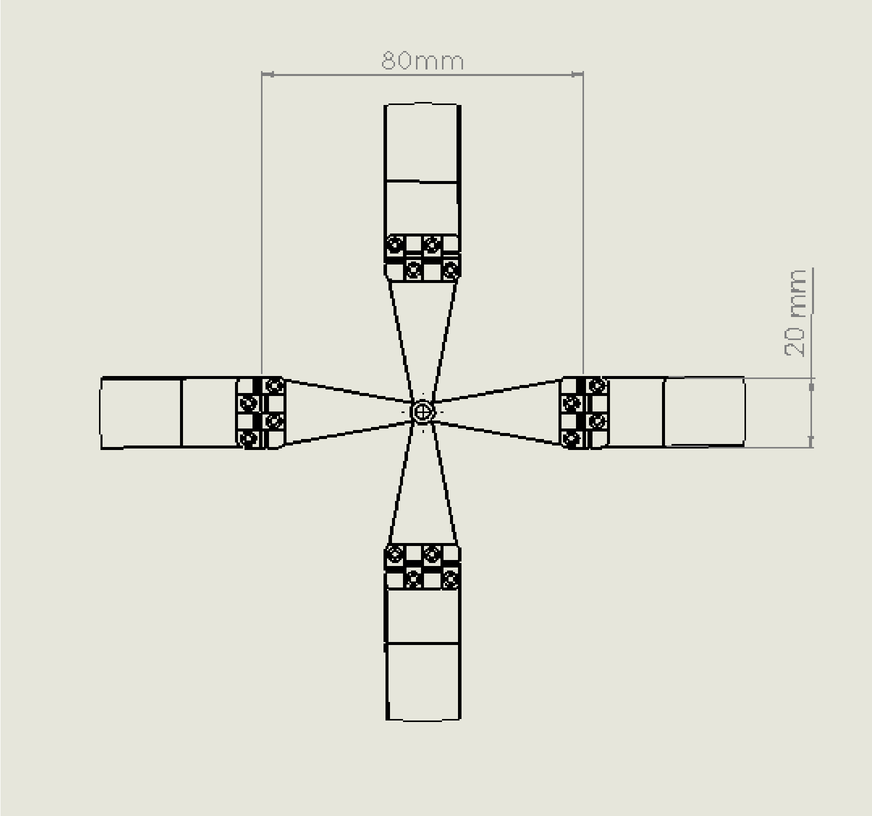
- Container and payload technical drawings.
- Pictures were drawn with CAD program.
- All measurements are in mm.

Propellers Dimensions



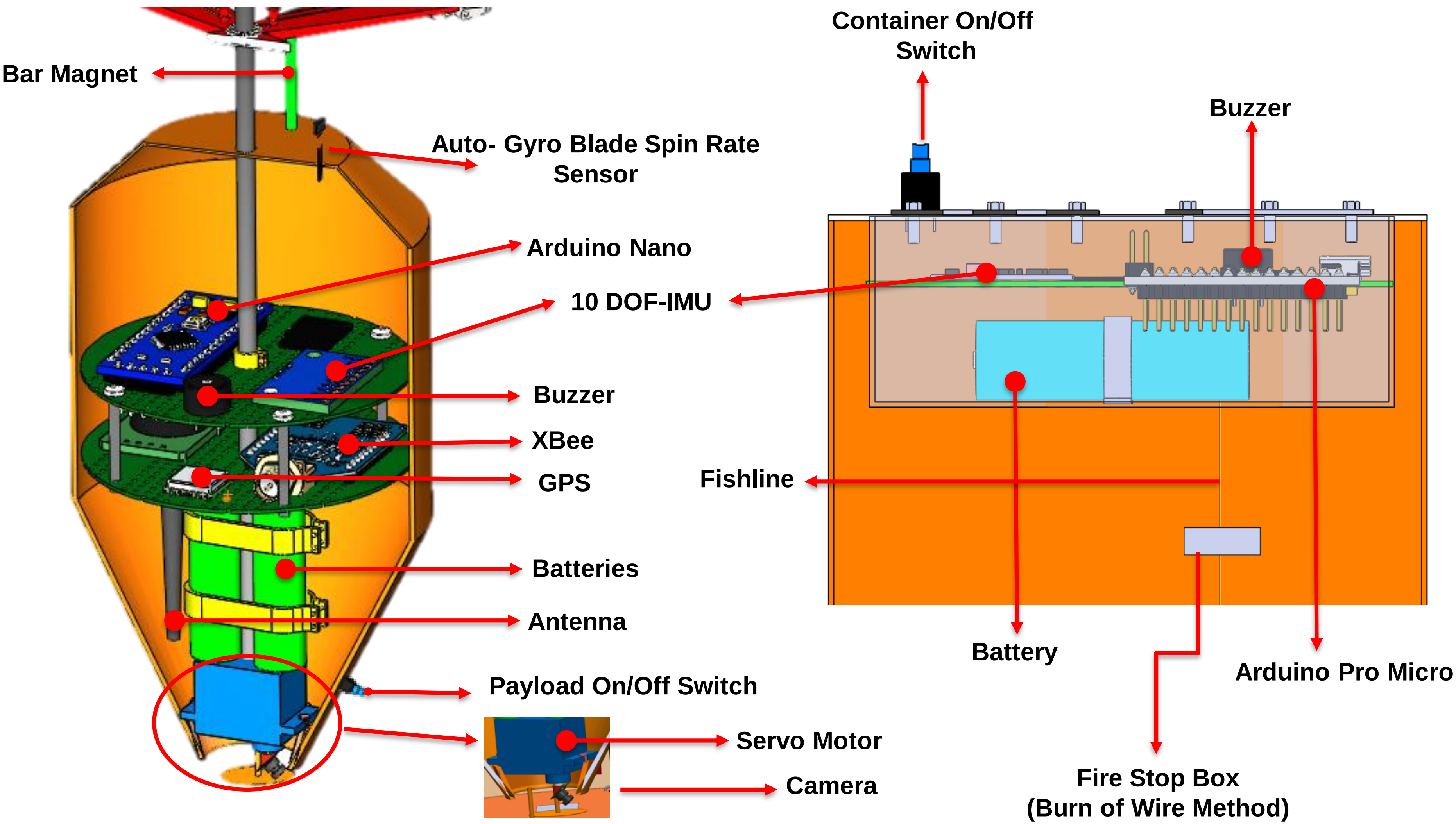
- **Propellers Dimensions**





- **Propellers technical drawings.**
- **Payload has two propellers.**
- **The propellers will be folded with the hinges.**
- **The propellers will be opened by stretched fabric elastic.**

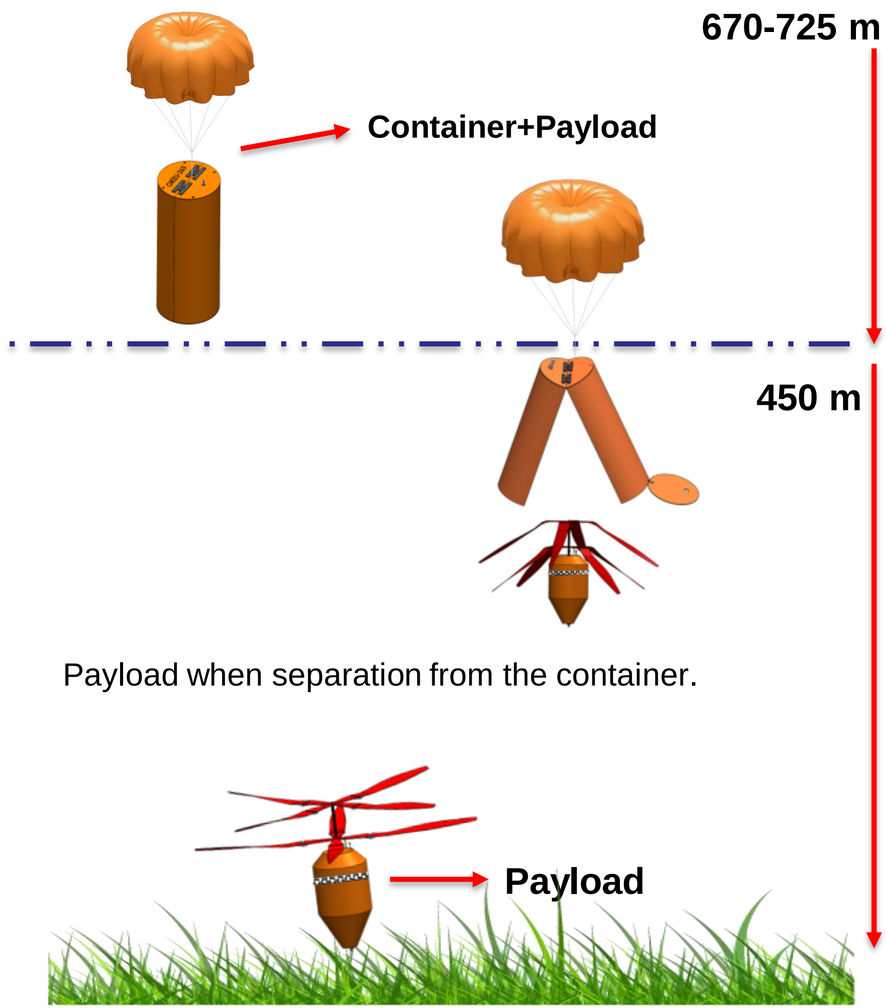
Placement of Major Components (Payload and Container)

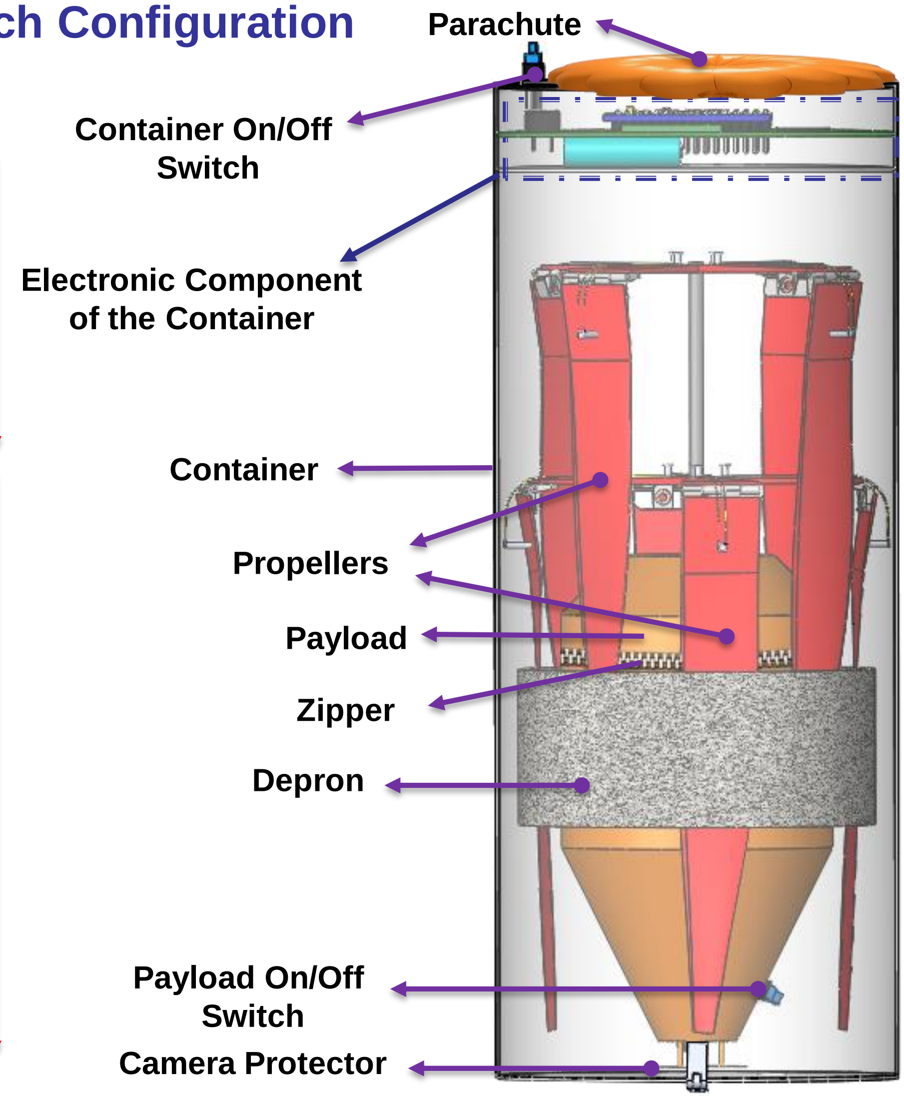


Physical Layout (6 of 6)

Deployed and Launch Configuration

Immediately after the CanSat separation from the rocket.





System Concept of Operations (1 of 2)

System Concept of Operations (2 of 2)

Pre-Launch

- Set-up ground station system.
- We will have a power bank for a cooling fan.
- The system will be calibrated with the command sent from the ground station.
- Communication tests.
- Check of mechanical systems.
- We will use an umbrella in the area.

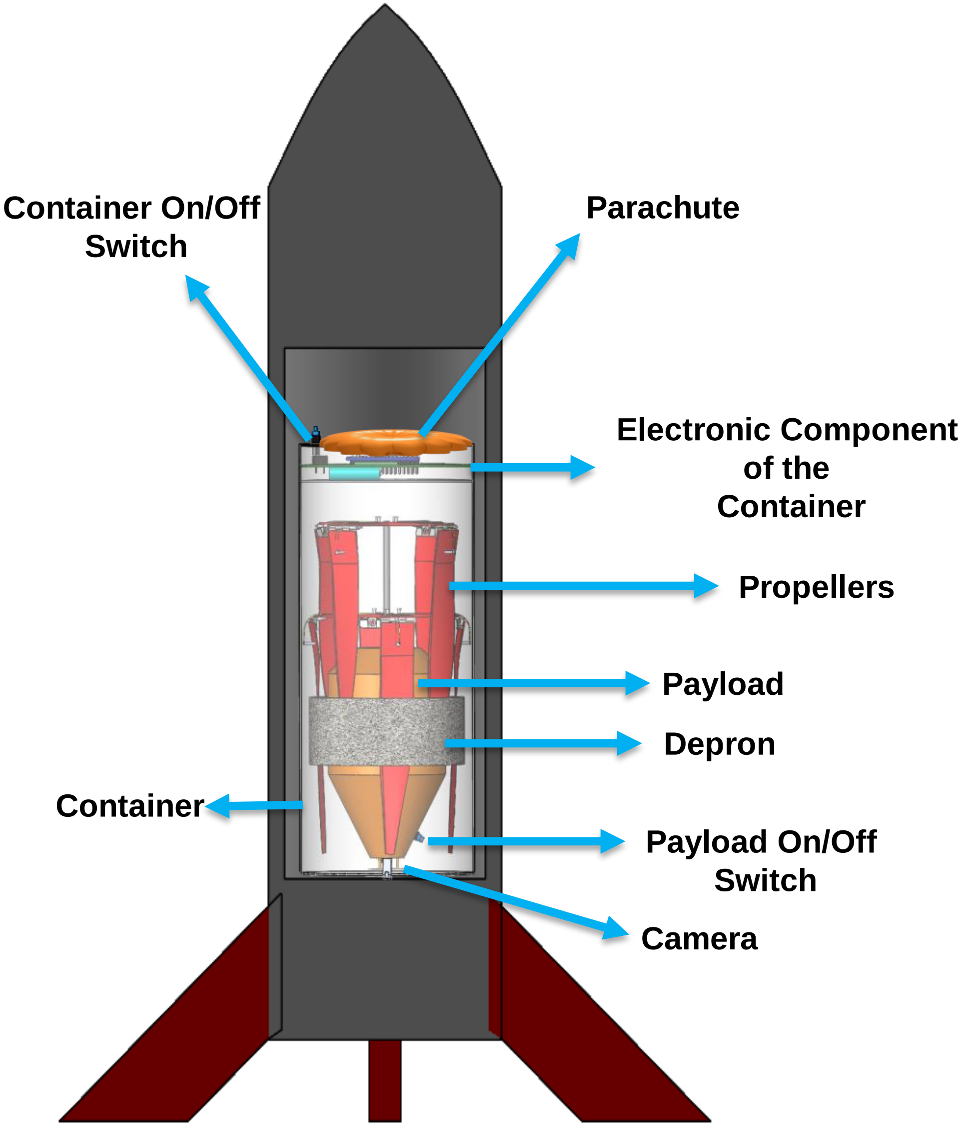
Launch

- CanSat placed into the rocket.
- Rocket launch.
- The electronic system will start sending data.
- CanSat separated from the rocket (between 670-725 meters).
- The parachute will be opened.
- The speed up to 450 m is 20 m/s.
- The release of the payload at 450 m.
- The payload will descent passively with the propellers.
- The payload speed will be between 10 to 15 m/s.
- The camera starts to record video at 450 meters.
- The buzzer will be activated in 5 meters.
- Telemetry transmission will stop when buzzer starting.

Post-Launch

- The location of the payload is via GPS and buzzer.
- The location of the container is via buzzer.
- We will take the SD card from the payload and container.
- Take video recording.
- To analyze the data.
- Delivery of received data to the jury.
- Preparation for PFR.

Launch Vehicle Compatibility (1 of 2)

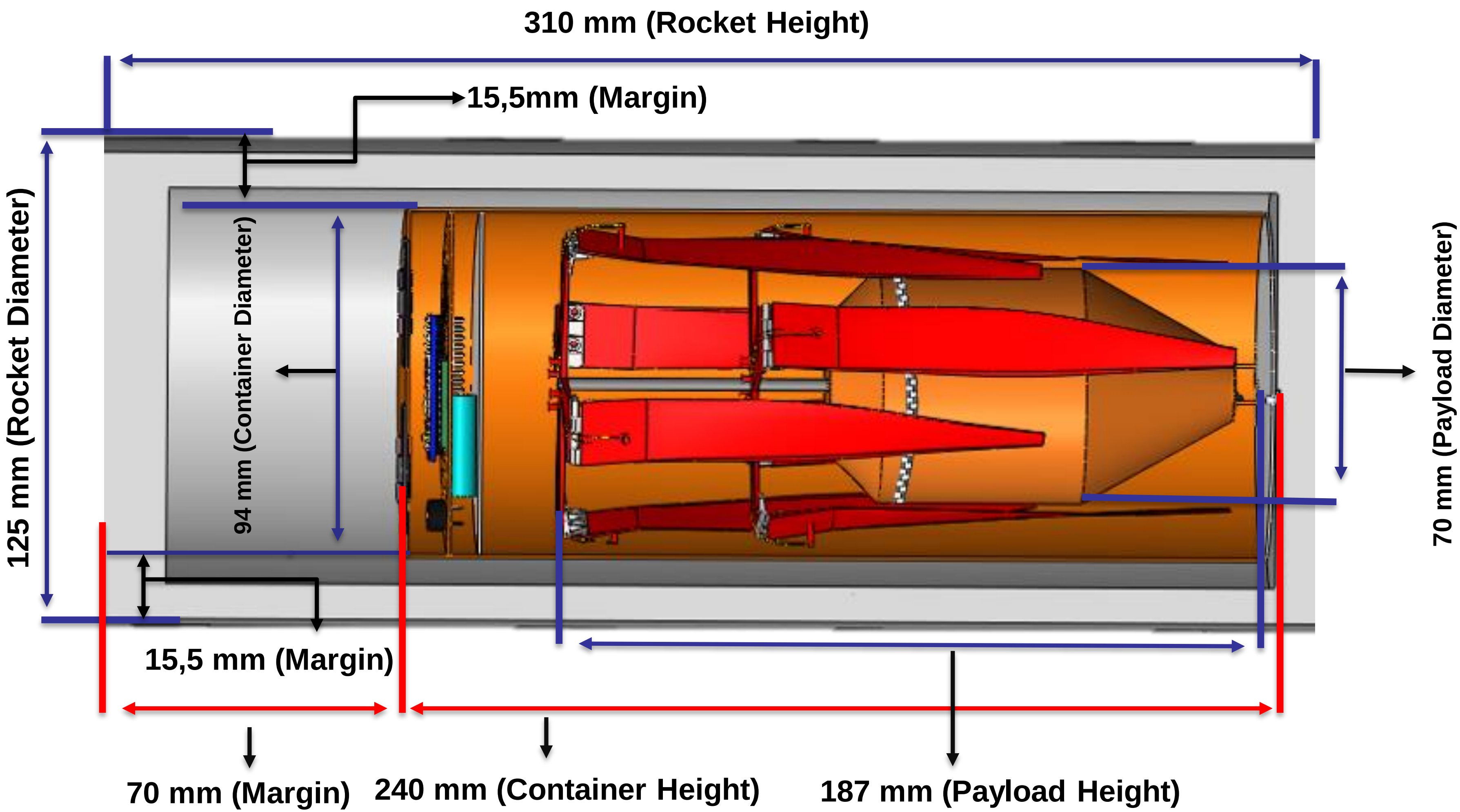


Dimensions (mm) Section	Height (mm)	Diameter (mm)
Rocket (Requirement Dimensions)	310	125
CanSat	240	94
Payload	187	70

- The CanSat consists of 2 parts:The payload and the container.
- Margins of 70 mm are given for height and 31 mm for width.

Launch Vehicle Compatibility (2 of 2)

Margins of 70 mm are given for height and 31 mm for width.



Sensor Subsystem Design

SEDEF ÖZEL

Sensor Subsystem Overview

NO	SENSOR TYPE	MODEL	PURPOSE	FUNCTION
1	Inertial Measurement Unit Sensor	BMP280 + MPU-9255	We will use this sensor because there are many sensors in it. BMP280 sensor will measure the temperature, air pressure. MPU-9255 will be used as gyroscope, accelerometer and magnetometer.	To measure air pressure, air temperature, altitude and tilt.
2	GPS	NEO-7M	We will use NEO-7M to measure the longitude, latitude and altitude. The update rate of NEO-7M is higher and its power consumption is much less than other GPS sensors.	To measure location, altitude and satellite count data.
3	Voltage Measure	Arduino Nano Analog Pin	Instead of using a sensor, we used Arduino nano to provide the voltage divider function. Because it is easy to use and more lucrative.	To measure of battery voltage.
4	Auto-gyro Blade Spin Rate	US1881 Hall Effect	The US1881 Hall Effect sensor will be used to qualify the blade spin rate of the propellers due to the magnetic field between the bar magnet and the hall effect sensor.	To measure of Auto-gyro blade spin rate.
5	Camera	SQ11	We will use this camera because it has a wide angle lens.	To record video.
6	Air Pressure Sensor (Container)	BMP280	We will use the BMP280 sensor inside the container to measure the air pressure.	To measure of air pressure.

Sensor Subsystem Requirements (1 of 2)

Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#13	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Competition requirement	HIGH	✔	✔		
RN#14	All structures shall be built to survive 15 Gs of launch acceleration.	Competition requirement	MEDIUM	✔		✔	
RN#15	All structures shall be built to survive 30 Gs of shock.	Competition requirement	HIGH	✔		✔	
RN#16	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Competition requirement	HIGH	✔		✔	✔
RN#20	The science payload shall measure altitude using an air pressure sensor.	Competition requirement	HIGH			✔	✔
RN#21	The science payload shall provide position using GPS.	Competition requirement	HIGH			✔	✔

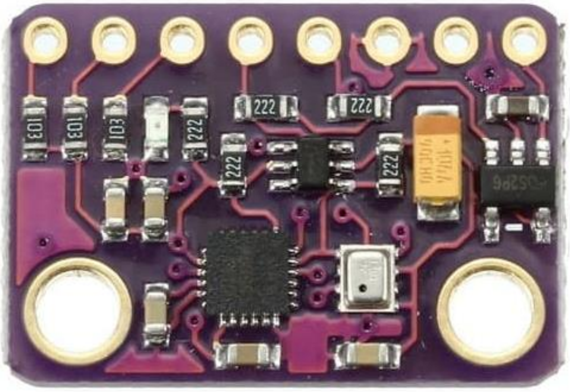
Sensor Subsystem Requirements (2 of 2)

Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#22	The science payload shall measure its battery voltage.	Competition requirement	HIGH			✔	✔
RN#23	The science payload shall measure outside temperature.	Competition requirement	HIGH			✔	✔
RN#24	The science payload shall measure the spin rate of the auto-gyro blades relative to the science vehicle.	Competition requirement	HIGH			✔	✔
RN#25	The science payload shall measure pitch and roll.	Competition requirement	HIGH			✔	✔
SSR#1	Use of 10-DOF IMU	Less space on the PCB	MEDIUM	✔		✔	✔
SSR#2	When selecting a servo motor for the bonus mission, the servo motor must rotate continuous.	To stabilisation of camera	MEDIUM			✔	✔

Payload Air Pressure Sensor Trade & Selection

Payload Air Pressure Sensor	Size (mm)	Weight (g)	Operating Voltage (V)	Operating Current (µA)	Pressure Range (hPa)	Resolution (Pa)	Interface	Price ($)
BMP280	2x2.5x0.9	2	1.71 – 5.5	325	300 - 1100	0.16	I2C, SPI	3.48
BME280	2.5x2.5x0.9	3	1.71 – 4.25	300	300 - 1100	0.18	I2C, SPI	7.60
MPL3115A2	5x3x1.1	1.2	1.95 – 3.6	325	500 - 1100	1.5	I2C	14.98

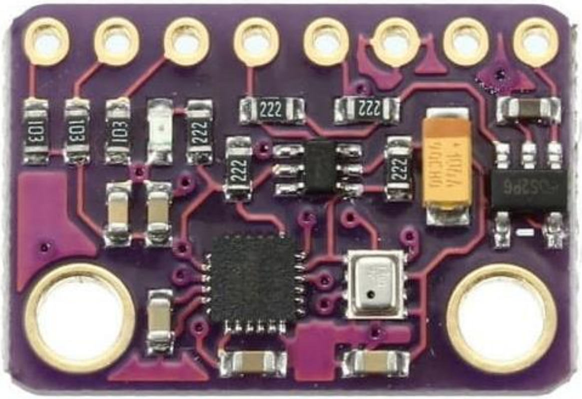
SELECTED SENSOR: BMP280	
Reasons	• Small size • Low price • Included on the 10-DOF IMU board



Payload Air Temperature Sensor Trade & Selection

Payload Air Temperature Sensor	Size (mm)	Weight (g)	Operating Voltage (V)	Operating Current (μA)	Operating Temperature (°C)	Resolution (°C)	Interface	Price ($)
BMP280	2x2.5x0.9	2	1.71 – 5.5	325	-40 ~ +85	0.01	I2C, SPI	3.48
MCP9808	3x3x0.9	9	2.7 – 5.5	200	-40 ~ +125	0.125	I2C	4.82
MPL3115A2	5x3x1.1	1.2	1.6 - 3.6	325	-40 ~ +85	1	I2C	14.98

SELECTED SENSOR: BMP280	
Reasons	• Small size • Cheaper than the others • Included on the 10-DOF IMU board



GPS Sensor Trade & Selection

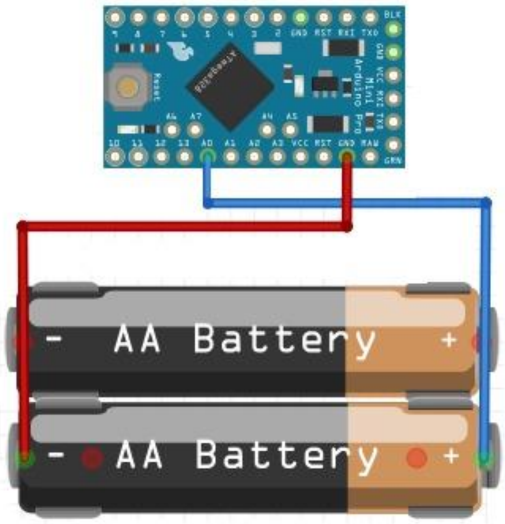
GPS Sensor	Size (mm)	Weight (g)	Operating Voltage (V)	Operating Current (mA)	Max Update Rate (Hz)	Resolution (m)	Interface	Price ($)
MT3329	16x16x6	8	3.2 - 5	53	10	2.5	UART	30
NEO-7M	16x12x3	16	3.3 - 5	40	10	2.5	UART	17.4
Adafruit Ultimate	25x35x6	8.5	3.5 - 5.5	20	10	3	I2C	39.95

SELECTED SENSOR: NEO-7M GPS	
Reasons	• Used the GPS sensor before • Ideal working current • Small size than the others • It has better resolution than the others • Low price

Payload Power Voltage Sensor Trade & Selection

Payload Power Voltage Sensor	Size(mm)	Weight (g)	Measurement Voltage (V)	Resolution (V)	Interface	Price ($)
Arduino Nano Analog Pin	No extra space needed	Negligible	0 - 25	0.01	Analog	Free
LTC2990	2x2x1	2	2.6 - 5.8	0.1	I2C	5.58

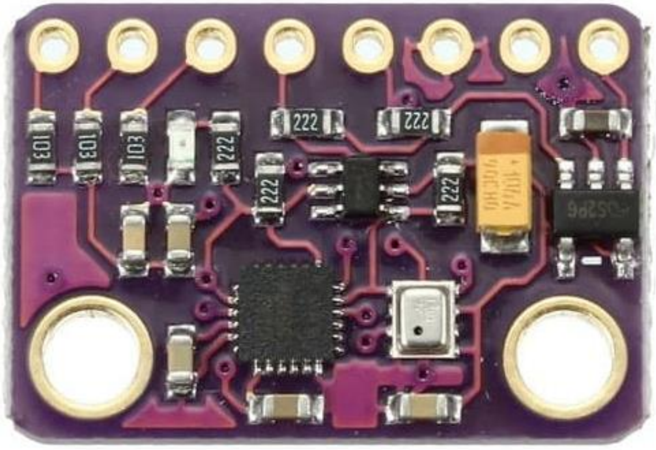
SELECTED SENSOR: Arduino Nano Analog Pin	
Reasons	• This method is simpler, lighter and smaller than other • Instead of using a sensor, the analog pin of the Arduino nano will be used



Pitch and Roll Sensor Trade & Selection

Pitch and Roll Sensor	Size (mm)	Weight (g)	Operating Voltage (V)	Working Current (mA)	Accel Full Scale Range (G)	Resolution (bit)	Interface	Price ($)
MPU-6050	21.2x16.4x3.3	2.1	3.0 – 5.0	3.6	±16	16	I2C	2.96
MPU-9255	25x15x3	2	3.3 – 5.5	3.2	±16	16	I2C, SPI	3.48

SELECTED SENSOR: MPU-9255	
Reasons	• Low working current • Included on the 10-DOF IMU board



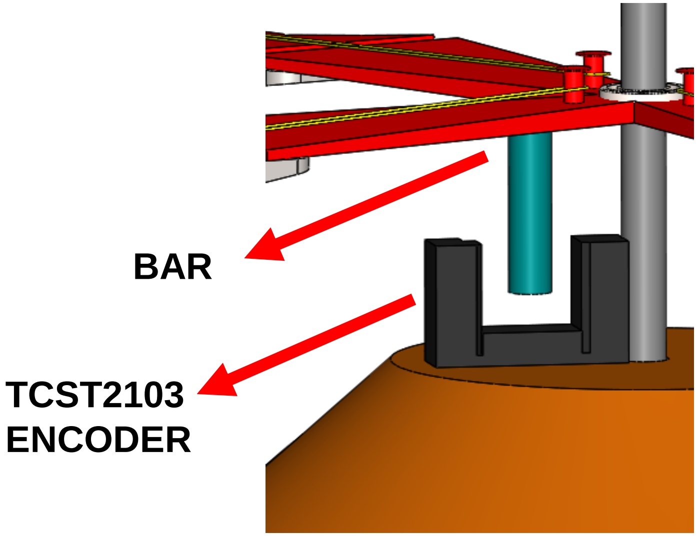
Auto-gyro Blade Spin Rate Sensor Trade & Selection (1 of 2)

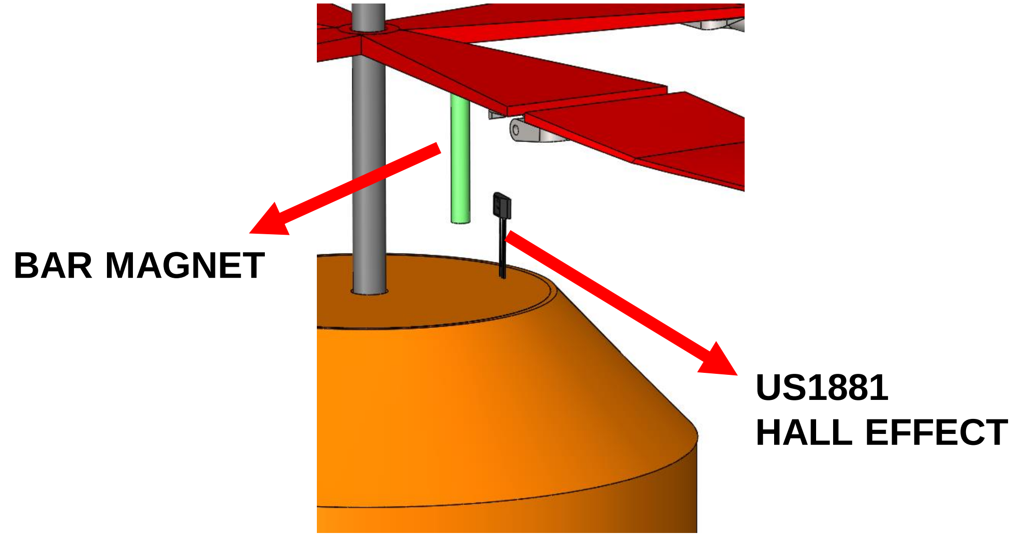
Auto-gyro Blade Spin Rate Sensor	Size(mm)	Weight (g)	Operating Voltage (V)	Typical Output Current (mA)	Resolution	Interface	Price ($)
TCST2103	24.5x6.3x10.8	1.1	1.25 – 6	4	0.6 mm	Digital	1.11
US1881 Hall Effect	4.1x3x1.5	<1	2.7 – 5	5	2.5 mV/G	Analog	0.54

TCST2103 ENCODER

US1881 HALL EFFECT

Auto-gyro Blade Spin Rate Sensor Trade & Selection (2 of 2)





- The bar is assemblied below the propeller for determine the speed.
- Data is received depending on whether the infrared light is cut.
- It can’t be used because the bar may hit the sensor.

- The bar magnet is assemblied below the propeller for determine the speed.
- The bar magnet is passed in front of the magnetic field sensor and the analog data is received depending on the distance.

SELECTED SENSOR: US1881 Hall Effect	
Reasons	• Small size and lighter than the other • High stabilisation • Cheaper than other

Bonus Camera Trade & Selection (1 of 2)

Camera	Size (mm)	Weight (g)	Operating Voltage (V)	Range of Vision (◦)	Video Resolution (pixel)	Interface	Price ($)
Y2000	35x30x30	10	5	25	640x480	Digital	5.84
SQ11	22x22x22	4	5	50	640x480	Digital	3.41
OV7670	35x34x26	12	3	25	640x480	I2C	5.50

SELECTED CAMERA: SQ11	
Reasons	• Light and small size • Wide angle lens • Low price

Bonus Camera Trade & Selection (2 of 2)

We choose the servo motor for bonus camera stabilisation.

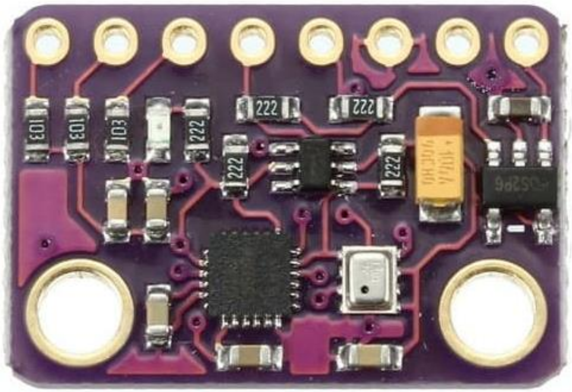
Servo Motor	Size(mm)	Weight (g)	Operating Voltage (V)	Spin Rate (RPM)	Work Angle (°)	Price ($)
Feetech FS5106R	40.8x20.1x38	39	6	95	Continuous	17.70
Tower Pro SG90	23.1x12.2x29	9	6	10	180	1.5

SELECTED SERVO: Feetech FS5106R	
Reasons	• High spin rate the RPM • High work angle than the other

Container Air Pressure Sensor Trade & Selection

Container Air Pressure Sensor	Size (mm)	Weight (g)	Operating Voltage (V)	Operating Current (μA)	Pressure Range (hPa)	Resolution (Pa)	Interface	Price ($)
BMP280	2x2.5x0.9	2	1.71 – 5.5	325	300 - 1100	0.16	I2C, SPI	3.48
BME280	2.5x2.5x0.9	3	1.71 – 4.25	300	300 - 1100	0.18	I2C, SPI	7.60
MPL3115A2	5x3x1.1	1.2	1.6 – 3.6	325	500 - 1100	1.5	I2C	14.98

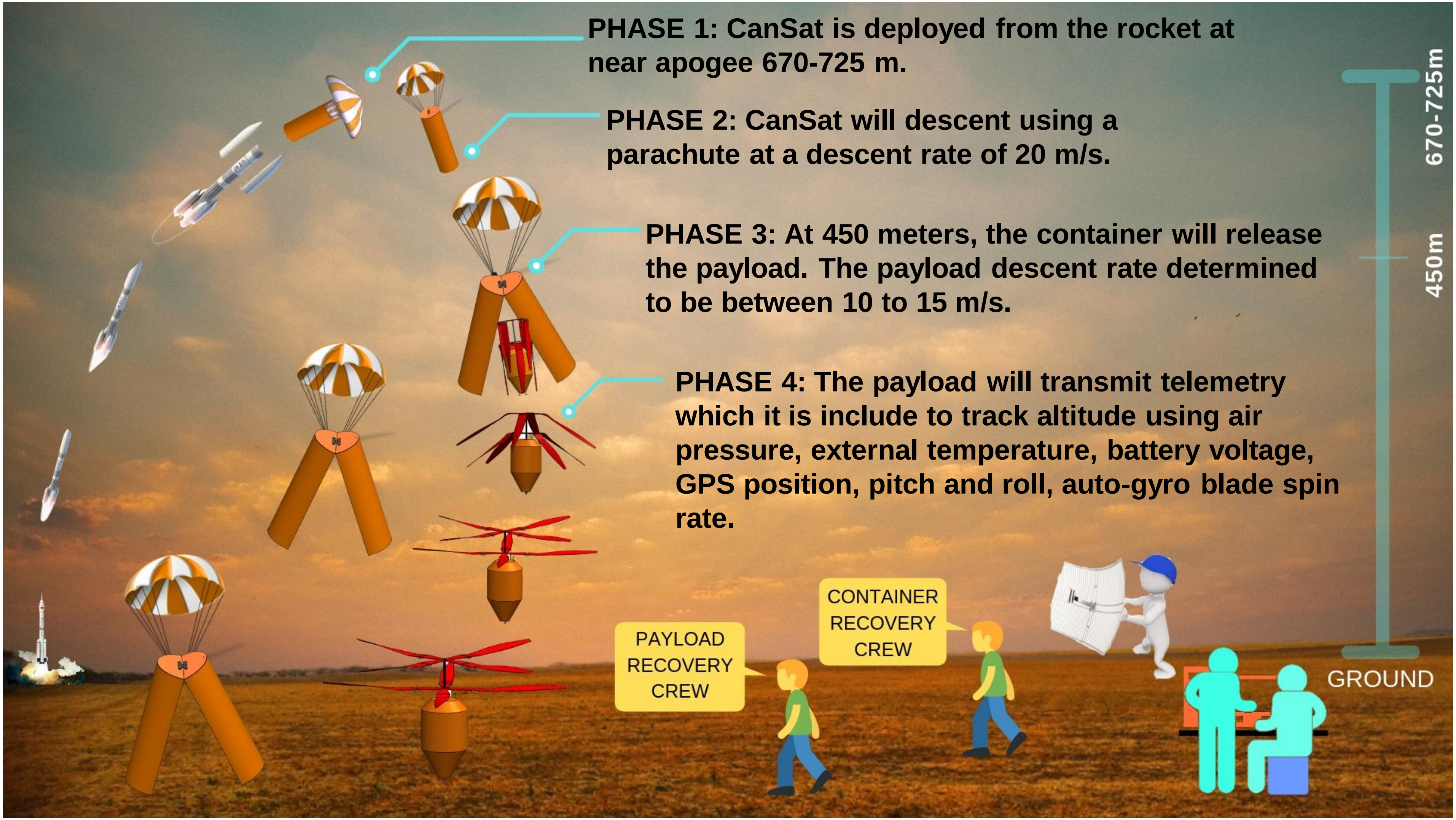
SELECTED SENSOR: BMP280	
Reasons	• Small size • Low price • Included on the 10-DOF IMU board (Accelerometer, Gyroscope, Magnetometer)



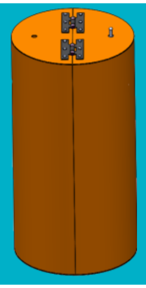
Descent Control Design

Aslıhan PESMEN

Descent Control Overview (1 of 2)



Descent Control Overview (2 of 2)

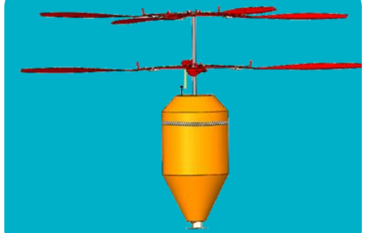


Container :

The separation of the Rocket from the container is determined to occur at an altitude around of the 670 meters to 725 meters. The container has 240 mm in length and 94 mm in diameter. CanSat will descent using a parachute at a descent rate of 20 m/s. At 450 meters, payload will separated from the container. Container has made from fiberglass.

Parachute:

It has 130 mm diameter. It includes a spill hole diameter of 29 mm to stabilize parachute container. Parachute has made from Silnylon 30D Nylon 66.



Auto-gyro:

Passive control is provided by the auto gyro system and the center of the mass. Auto-gyro includes 8 wings for adjusting drag and lift force. Auto-gyro propellers materials are carbon fiber and axle material is carbon fiber stick.

Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN#1	Total mass of the CanSat (science payload and container) shall be 500 grams +/- 10 grams	Competition requirement	HIGH		✓		
RN#2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Competition requirement	HIGH		✓		
RN#4	The container shall be a fluorescent color; pink, red or orange.	Competition requirement	MEDIUM	✓			
RN#5	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition requirement	LOW	✓	✓		
RN#6	The rocket airframe shall not be used as part of the CanSat operations	Competition requirement	HIGH	✓	✓		
RN#7	The CanSat shall deploy from the rocket payload section and immediately deploy the container parachute.	Competition requirement	HIGH	✓	✓		
RN#8	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Competition requirement	HIGH	✓	✓		

Descent Control Requirements (2 of 2)

Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN#10	The science payload shall descend using an auto-gyro/ passive helicopter recovery descent control system.	Competition requirement	HIGH	✓		✓	✓
RN#11	The descent rate of the science payload after being released from the container shall be 10 to 15 meters/second.	Competition requirement	HIGH	✓	✓		
RN#12	All descent control device attachment components shall survive 30 Gs of shock.	Competition requirement	HIGH	✓		✓	
RN#24	The science payload shall measure the spin rate of the auto-gyro blades relative to the science vehicle.	Competition requirement	HIGH			✓	✓
RN#27	The Parachute shall be fluorescent Pink or Orange.	Competition requirement	LOW	✓	✓		
RN#34	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Competition requirement	MEDIUM	✓	✓		
RN#52	The auto-gyro descent control shall not be motorized. It must passively rotate during descent.	Competition requirement	HIGH	✓		✓	✓

Payload Descent Control Strategy Selection and Trade (1 of 6)

Parachute Selection (1 of 2)

Design 1

Round Parachute

TYPE	PROS	CONS
Design 1	➢ High durability in opening ➢ Opening time short ➢ More durability	➢ Balanced load adjustment is more disadvantageous than squared parachute.
Design 2	➢ Balanced load distribution	➢ High probability of drift in the air ➢ Faster landing

Design 2

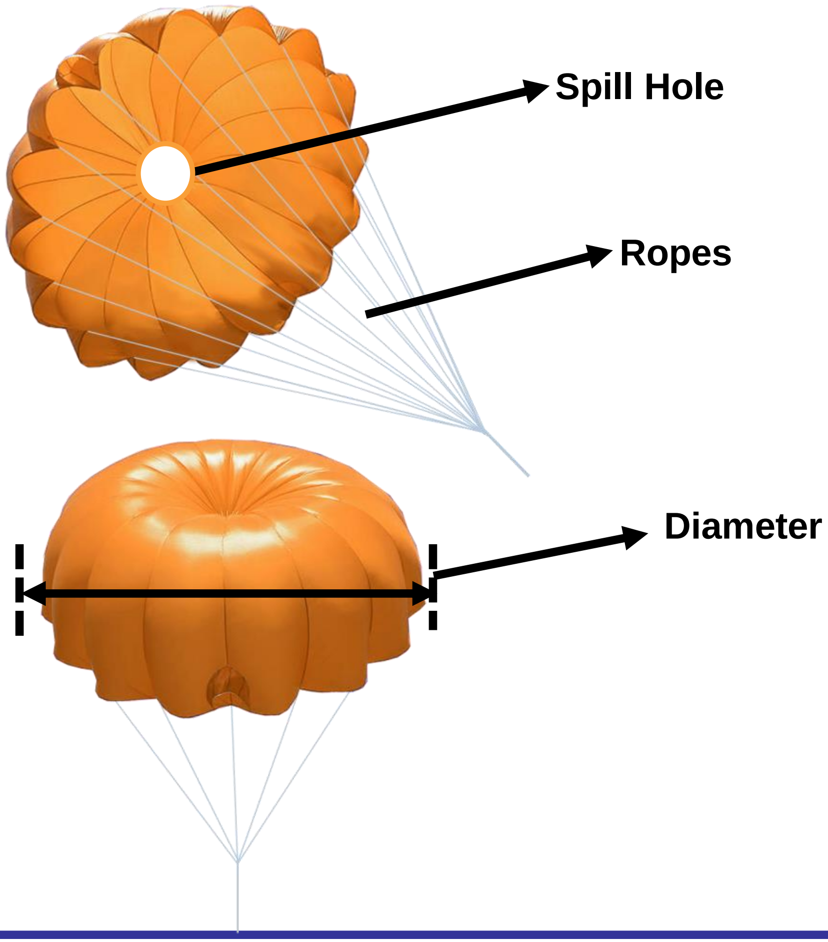
Square Parachute

We choose Design 1 Round Parachute	➢ **Aerodynamically more stable than square type.** ➢ **Lighter than square type.** ➢ **Faster deployment than design 2.**

Payload Descent Control Strategy Selection and Trade (2 of 6)

Parachute Selection (2 of 2)

Current Design Round Parachute



Current Parachute Design

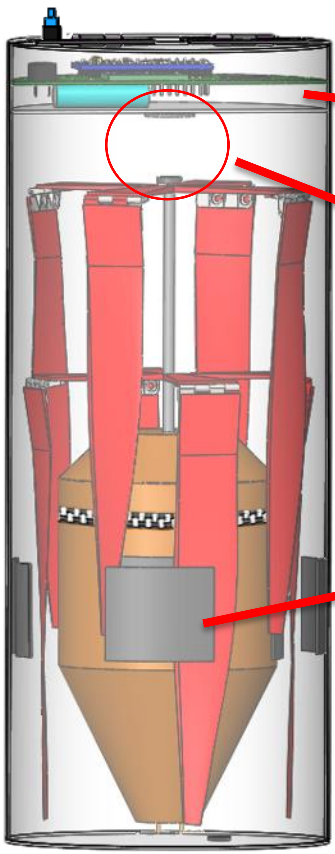
Made of Silnylon 30D Nylon 66.

Parachute diameter is 130 mm.

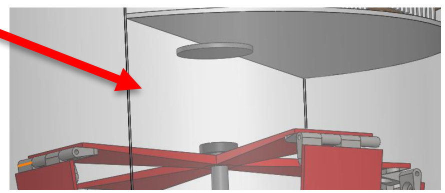
Spill hole diameter is 29 mm.

Payload Descent Control Strategy Selection and Trade (3 of 6)

Stowed Descent Rate Control (1 of 2)
(Pre payload deployment)

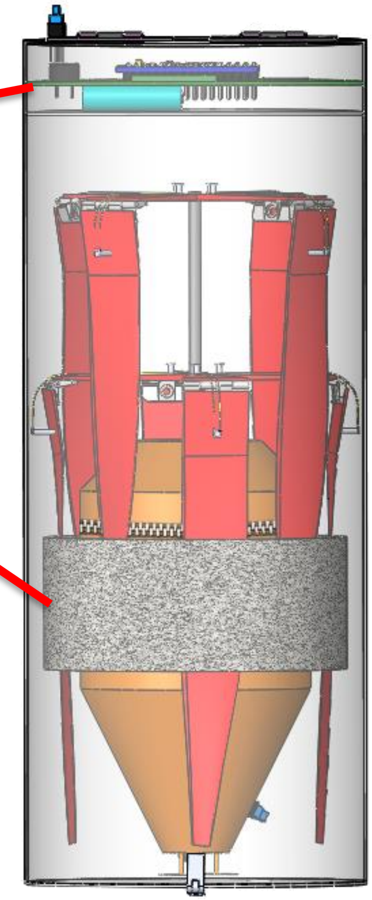


Container Electronic Circuit



The same polar magnets are fixed to the outer surface of the payload and to the inner surface of the container. So, the payload is placed in the container.

Payload is placed by depron in container. Depron prevents vibration of payload.



Inside container, wings are folded by the hinges in both design.

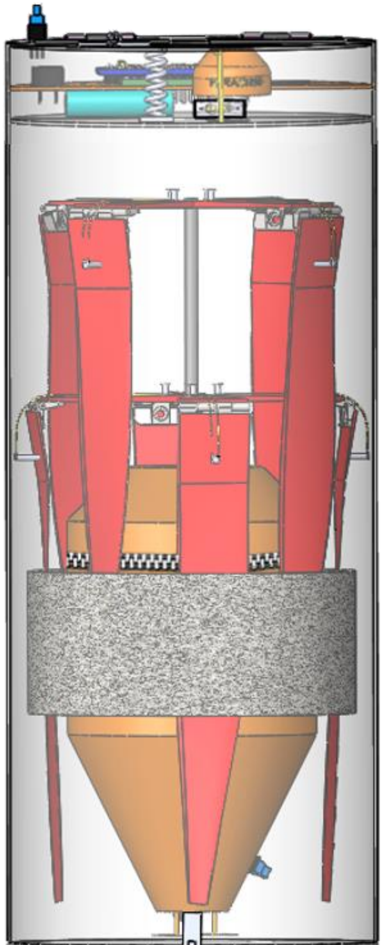
We choose design 2 because it's cheaper and lighter than design 1.

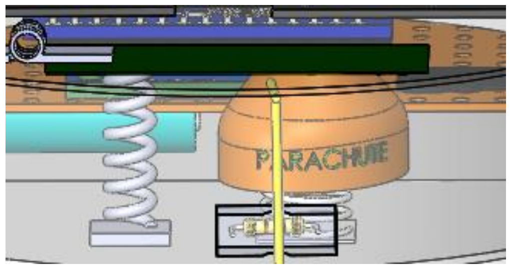
Design 1

Design 2

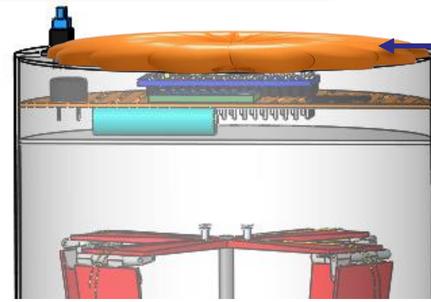
Payload Descent Control Strategy Selection and Trade (4 of 6)

Stowed Descent Rate Control (2 of 2)
(Pre Payload Deployment for Parachute)



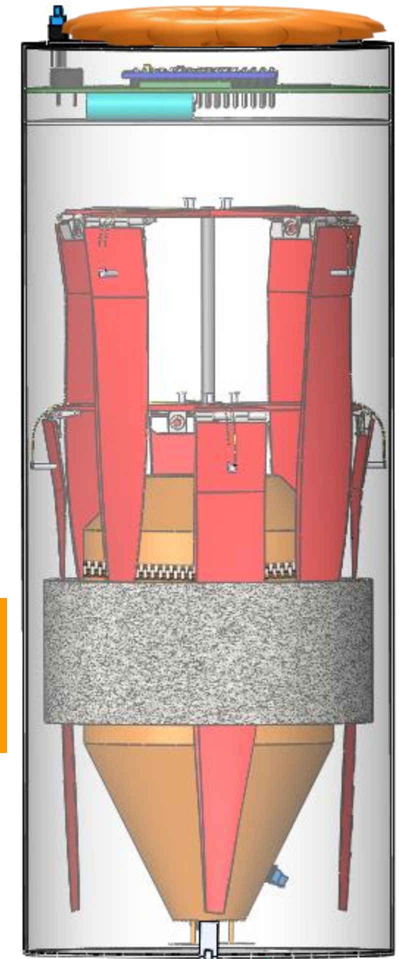


The parachute is under the cover. After breaking the fishline with the burn of wire method the cover opened with the spring force and the parachute is released.



PARACHUTE

The parachute is on the top of the container and opens with air resistance.



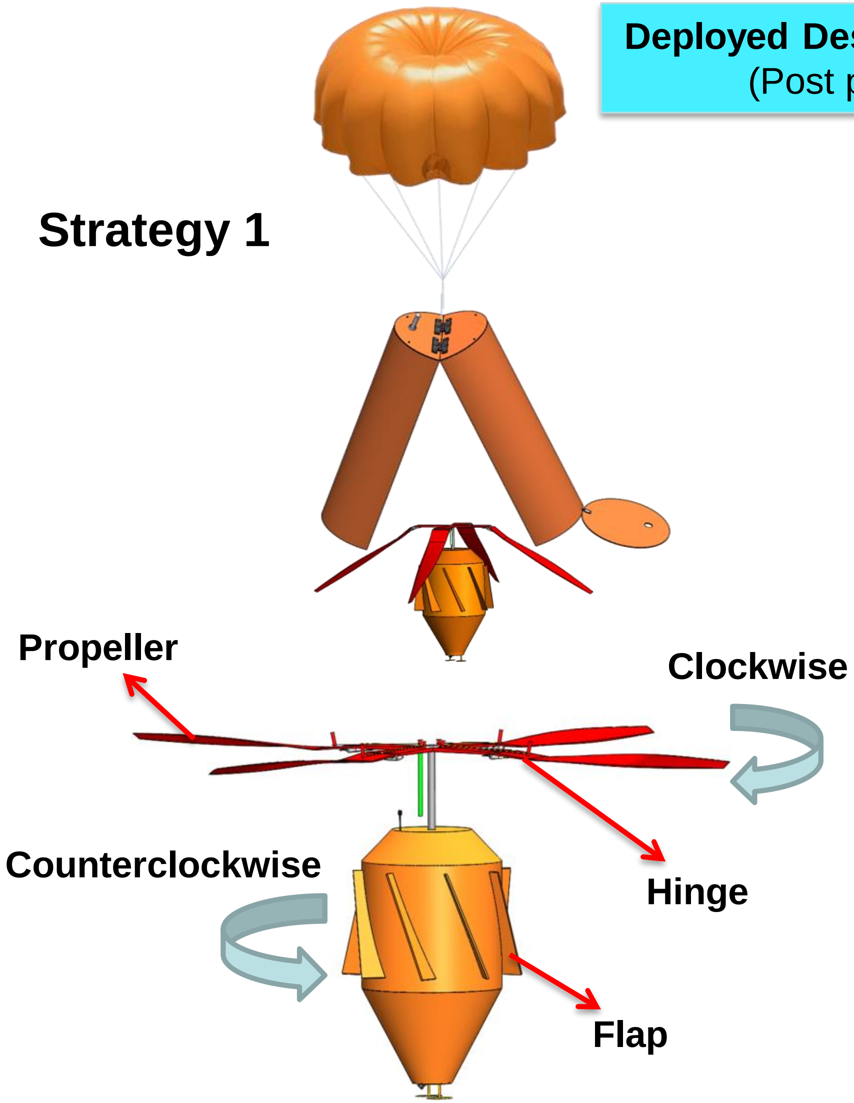
We choose design 2 because design 1 has heavy materials (hinges,springs,fire stopping box etc.) and design 2's simpler to use.

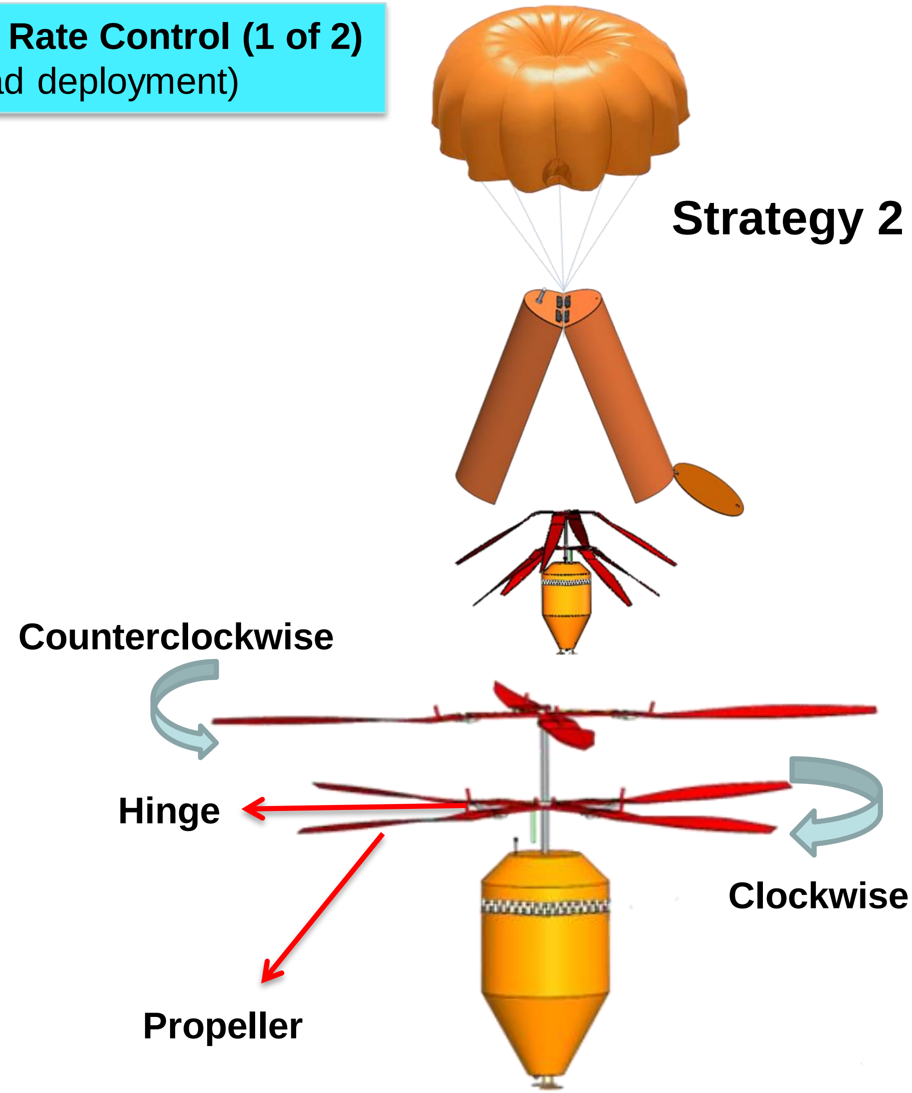
Design 1

Design 2

Payload Descent Control Strategy Selection and Trade (5 of 6)

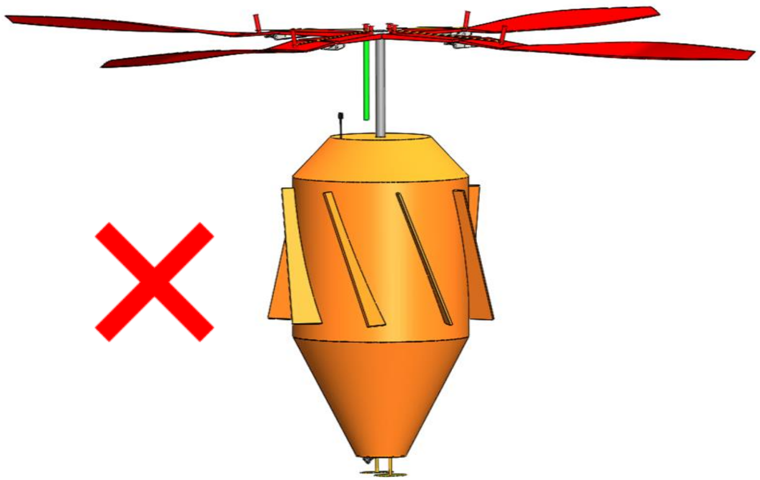
Deployed Descent Rate Control (1 of 2)
(Post payload deployment)

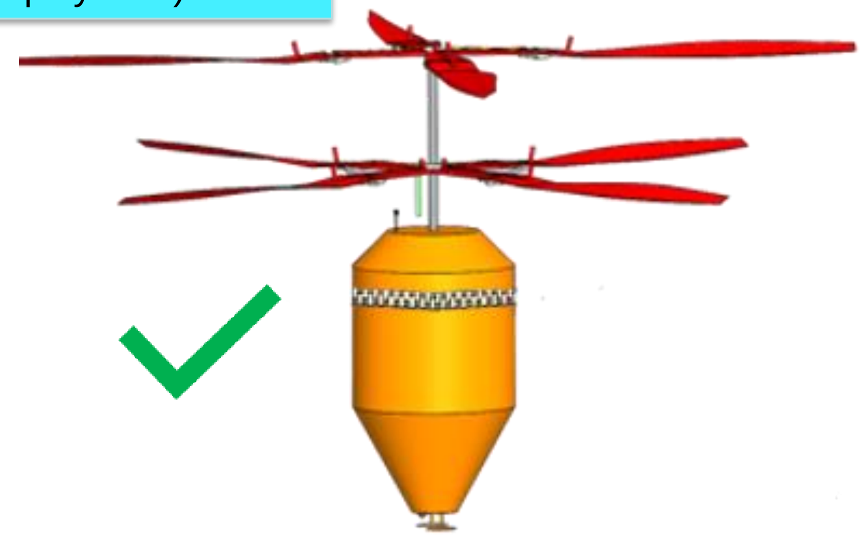




Payload Descent Control Strategy Selection and Trade (6 of 6)

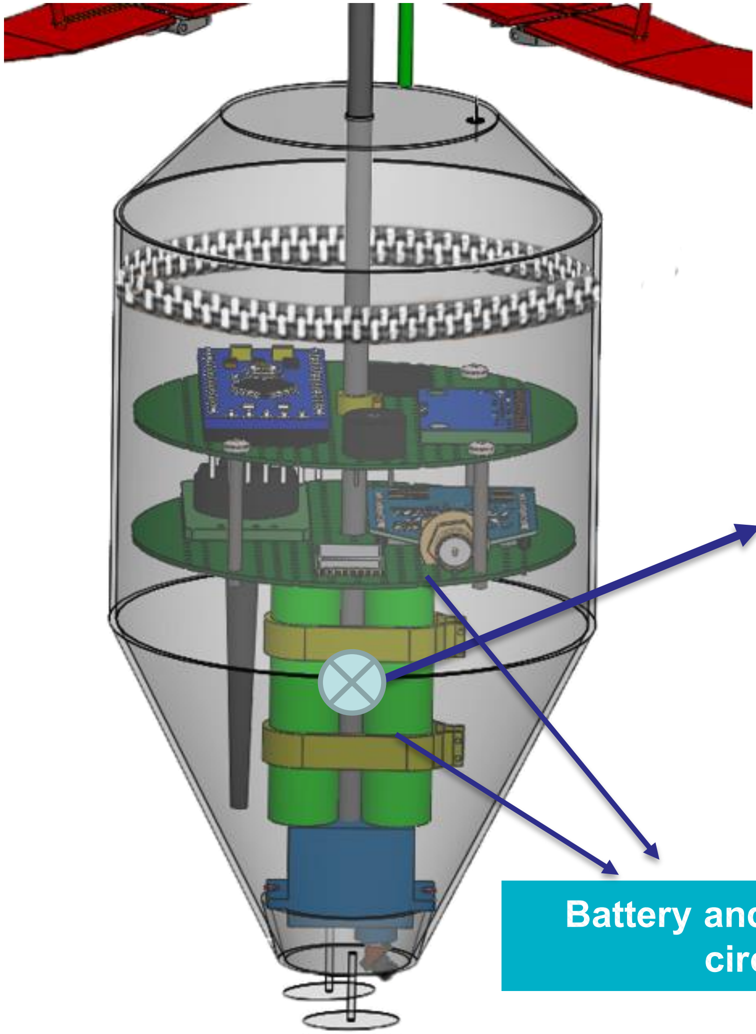
Deployed Descent Rate Control (2 of 2)
(Post payload deployment)





Strategy 1	Strategy 2
➢ Balancing flaps ➢ Single propeller ➢ Large diameters	➢ Double propeller ➢ Small diameters

We choose Strategy 2, Larger wings area provides easier to required descent control in two propellers system. Also strategy 1's production more difficult.



Type of Stability Control

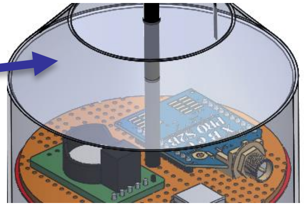
- **It will be controlled passively (Not any motorized system used).**
- The moment balance is obtained by reversely rotating propellers.
- The use of two propellers are reduces the velocity of descent

Center of mass position

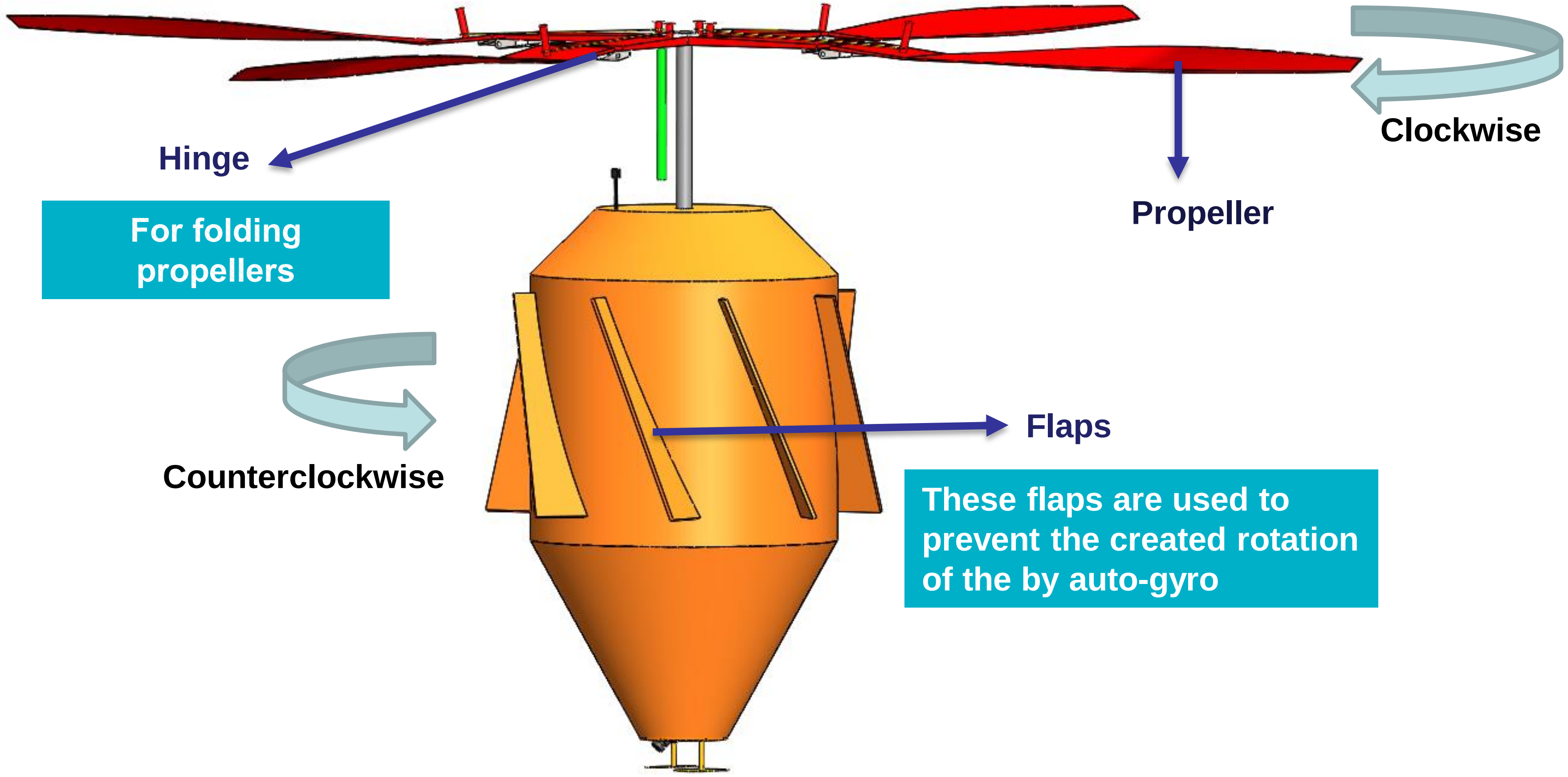
- Passive control is provided via the position of the center of mass.
- Heavy parts such as battery were mounted as close to the bottom of payload as possible to pull the center of gravity. Nadir direction is provided like that.

Battery and electronic circuit

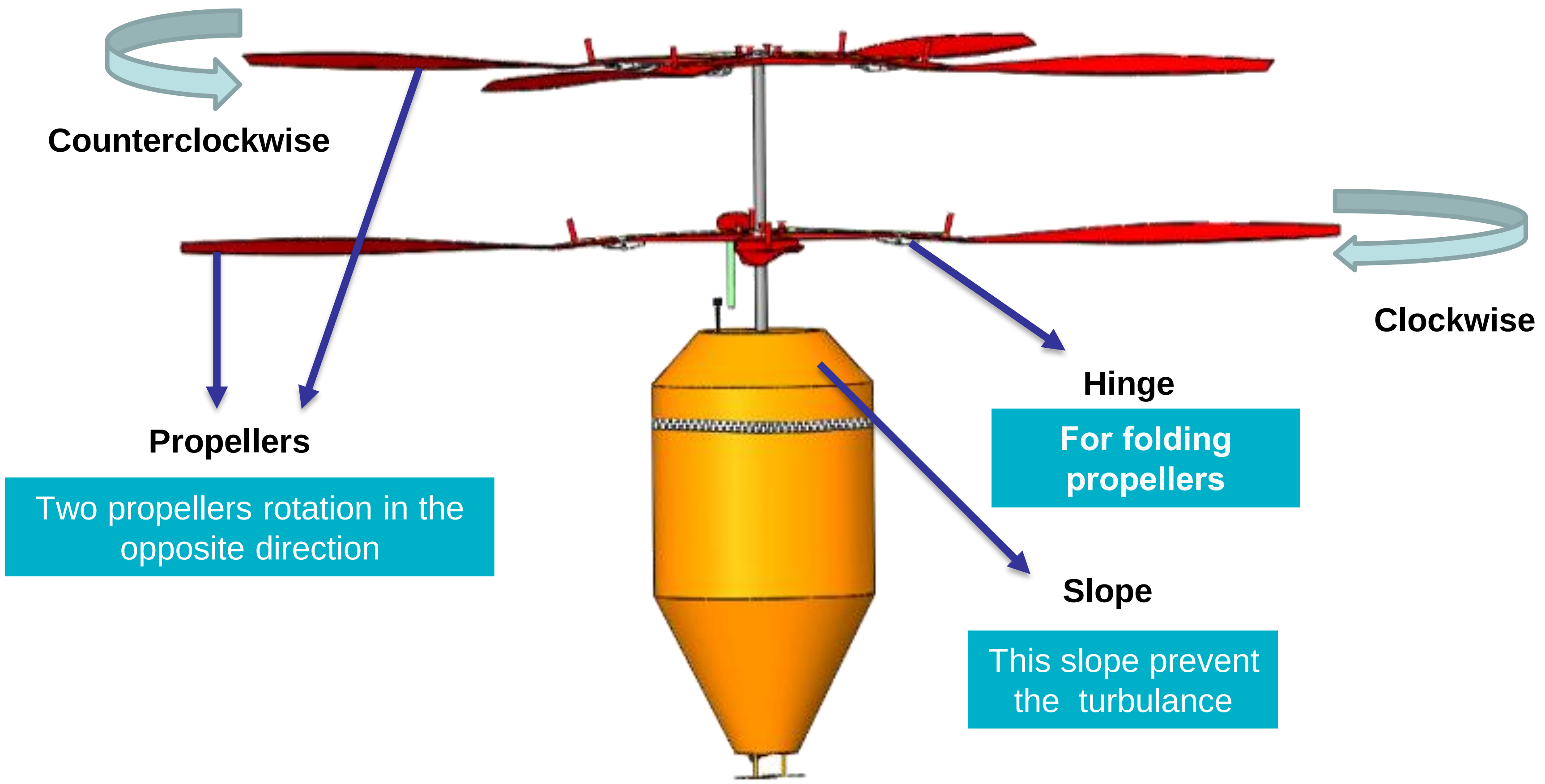
The payload has slope to prevent the turbulence.



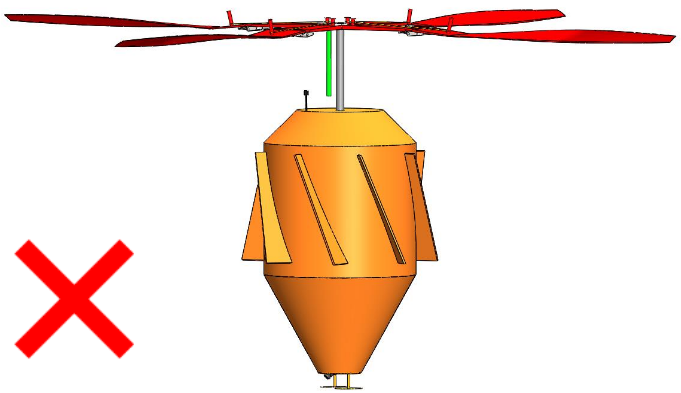
STABILITY DESIGN 1

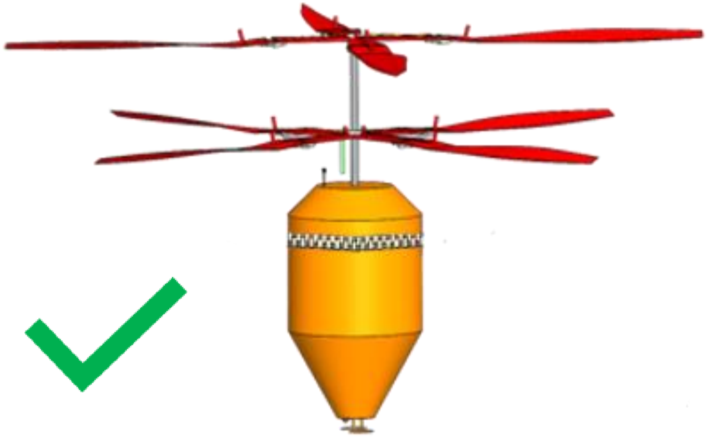


STABILITY DESIGN 2



Payload Descent Stability Control Strategy Selection and Trade (4 of 4)





Design 1	Design 2
• **First Method:** Payload's balance is ensured by single propellers and flaps.	• **Second Method:** Two propellers rotate in the opposite direction will be used that prevent rolling and provide descent stability control.

We choose Design 2

The rotation speeds of the propeller in Design 2 are closer to each other. So the moment balancing is more easily maintained and a more stable descent is achieved.

Container + Payload post rocket-separation

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

$$S_p = \frac{2 \times (0.5\ kg) \times (9.81\ m/s^2)}{(1.225 kg/m^3) \times (20 m/s)^2 \times (1.5)}$$

$$S_p = 0.01334\ m^2$$

S_p = Area of the parachute with a spill hole (m^2)
D = The diameter of the parachute (mm)
V = Descent speed (m/s)
π = 3.14159265359
C_D = 1.5 (Drift coefficient of parachute)
ρ = 1.225 kg/m^3 (Air density at +15°C from sea level)
$m = 500\ g$ (Container+Payload)
$g = 9.81\ m/s^2$
S_{s_h} = Spill hole area

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

$$D = \sqrt{\frac{4 \times Sp}{\pi}}$$

- **Area of the spill hole is chosen to be 5% of the total parachute projected area.**
- **Project area of spill hole:**

$$\boldsymbol{S_{s_h} = Sp \times 5\% \rightarrow 0.01334\ m^2 \times 0.05 = 0.0006555\ m^2}$$

Spill hole radius $= \sqrt{\frac{S_{Sh}}{\pi}} = \sqrt{\frac{0.0006555\ m^2}{\pi}} = \boldsymbol{0.0145\ m = 14.5 mm}$

$$D = \sqrt{\frac{4 \times 0.01334\ m^2}{\pi}} \Rightarrow D = 0.1303\ m \cong 130\ mm$$

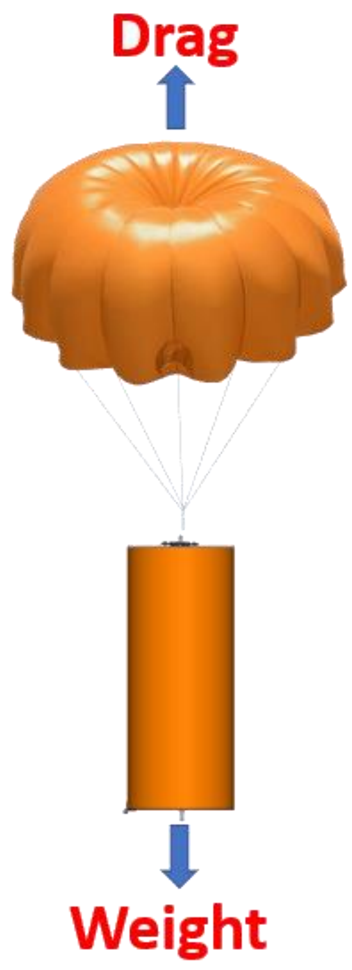
Container+Payload post rocket separated calculation

Landing velocity of container with parachute.

$$V = \sqrt{\frac{2 \times F_{Drag}}{\rho \times S_p \times C_D}} \Longrightarrow F_{Drag} = m \times g$$

$$V = \sqrt{\frac{2 \times (0.5\ kg) \times (9.81 m/s^2)}{(1.225 kg/m^3) \times (0.01334\ m^2) \times (1.5)}}$$

$$\boxed{V = 20.005\ \text{m/s} \cong 20\ \text{m/s}}$$



Descent Rate Estimates (3 of 9)

Container after being released

$$S_p = \frac{2 \times m \times g}{\rho \times V^2 \times C_{D_p}} \Rightarrow V = \sqrt{\frac{2 \times m \times g}{\rho \times S_p \times c_{D_p}}}$$

S_p = Area of the parachute with a spill hole (m^2)

V = Descent speed (m/s)

C_{D_p} = 1.5 (Drift coefficient of parachute)

ρ = 1.225 kg/m^3 (Air density at +15°C from sea level)

$m = 145\ g$ (Container)

$g = 9.81\ m/s^2$

$$V = \sqrt{\frac{2 \times (0.145\ kg) \times (9.81\ m/s^2)}{(1.225 kg/m^3) \times 0.01334\ m^2 \times (1.5)}}$$

$$\boxed{V = 10.77\ m/s}$$

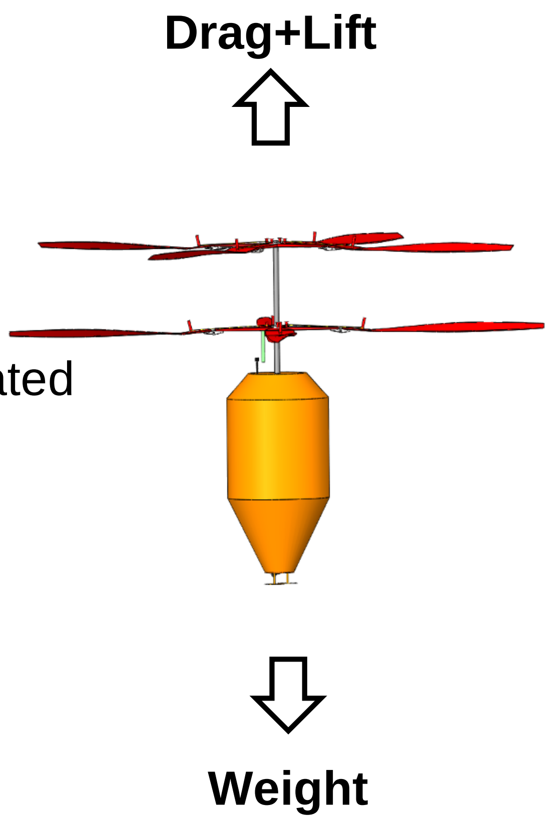
Container descent speed after released

Payload following separation from the Container

The **Lifting** force acting on a body in a air flow can be calculated

$$F_L = \frac{1}{2} \times C_L \times \rho \times V^2 \times A$$

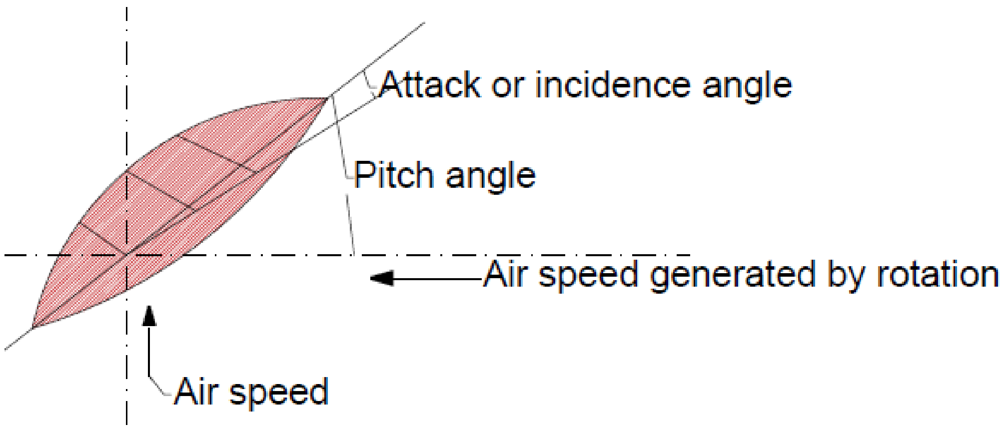
F_L = *Lifting force (N)*
C_L= *Lifting coefficient*
ρ = *Density of air (kg/m³)*
V= *Air flow velocity (m/s)*
A = *Body area (m²)*

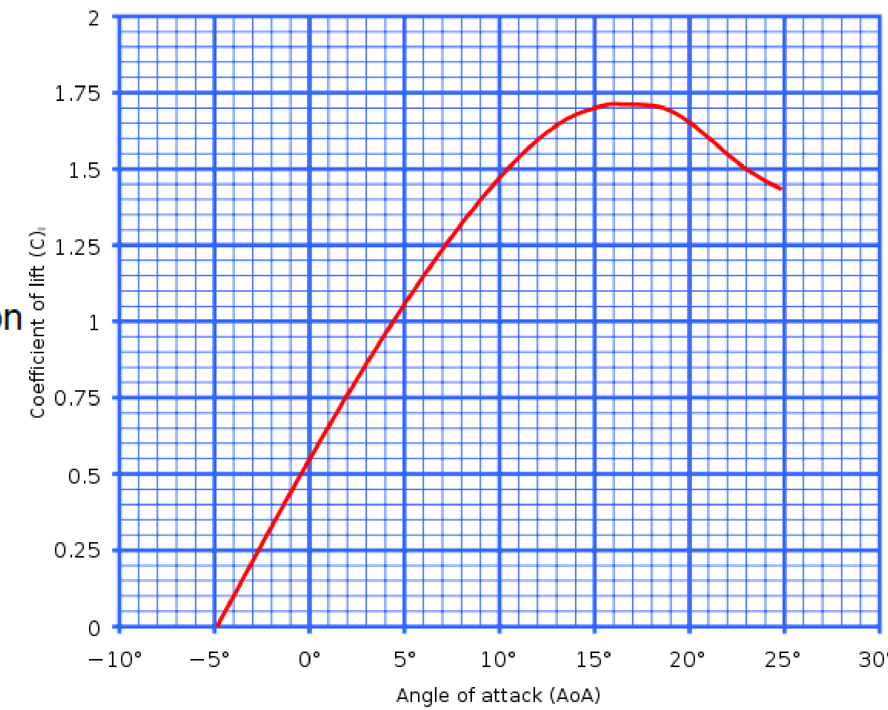


The **Drag** force acting on a body in air flow can be calculated

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

F_D = *Drag force (N)*
C_D= *Drag coefficient*
ρ = *Density of air (kg/m³)*
V= *Air flow velocity (m/s)*
A = *Body area (m²)*





Source: www.wikiwand.com

- Pitch's angular change in rotation speed.
  As long as we keep the angle wide we can get the maximum rotation speed.
- Coefficient C_L(Lift coefficient) contains all the complex dependicies and is usually determined experimentally.

So we choose efficient pitch angle and lift coefficient.

Pitch angle $\cong 15°$

$C_L \cong 1.7$

Descent Rate Estimates (6 of 9)

$$F_L + F_d - F_w = 0 \Longrightarrow F_L + F_d = F_w$$

$$\frac{1}{2}(C_D + C_L)\rho A V^2 = mg$$

$F_w = mg$
$m = 355\ g$ (Mass of payload)
$C_D = 0.045$ (for airfoil)
$C_L = 1.7$
$\rho = 1.225\ kg/m^3$ (Air density at +15 °C from sea level)
$g = 9.81\ m/s^2$
A = Area (Total wings area)

$$A = \frac{2 \times m \times g}{\rho \times V^2 \times (C_D + C_L)}$$

$$\mathrm{A} = \frac{2 \times (0.355\ \mathrm{kg}) \times (9.81 m/s^2)}{(1.225 \mathrm{kg/m^3}) \times (10 m/s\ )^2 \times (0.045 + 1.7)}$$

Total Wings Area
$A = 0.032583\ m^2 = 32583\ mm^2$

Payload descent velocity (V)

$$V = \sqrt{\frac{2 \times m \times g}{\rho \times A \times (C_D + C_L)}}$$

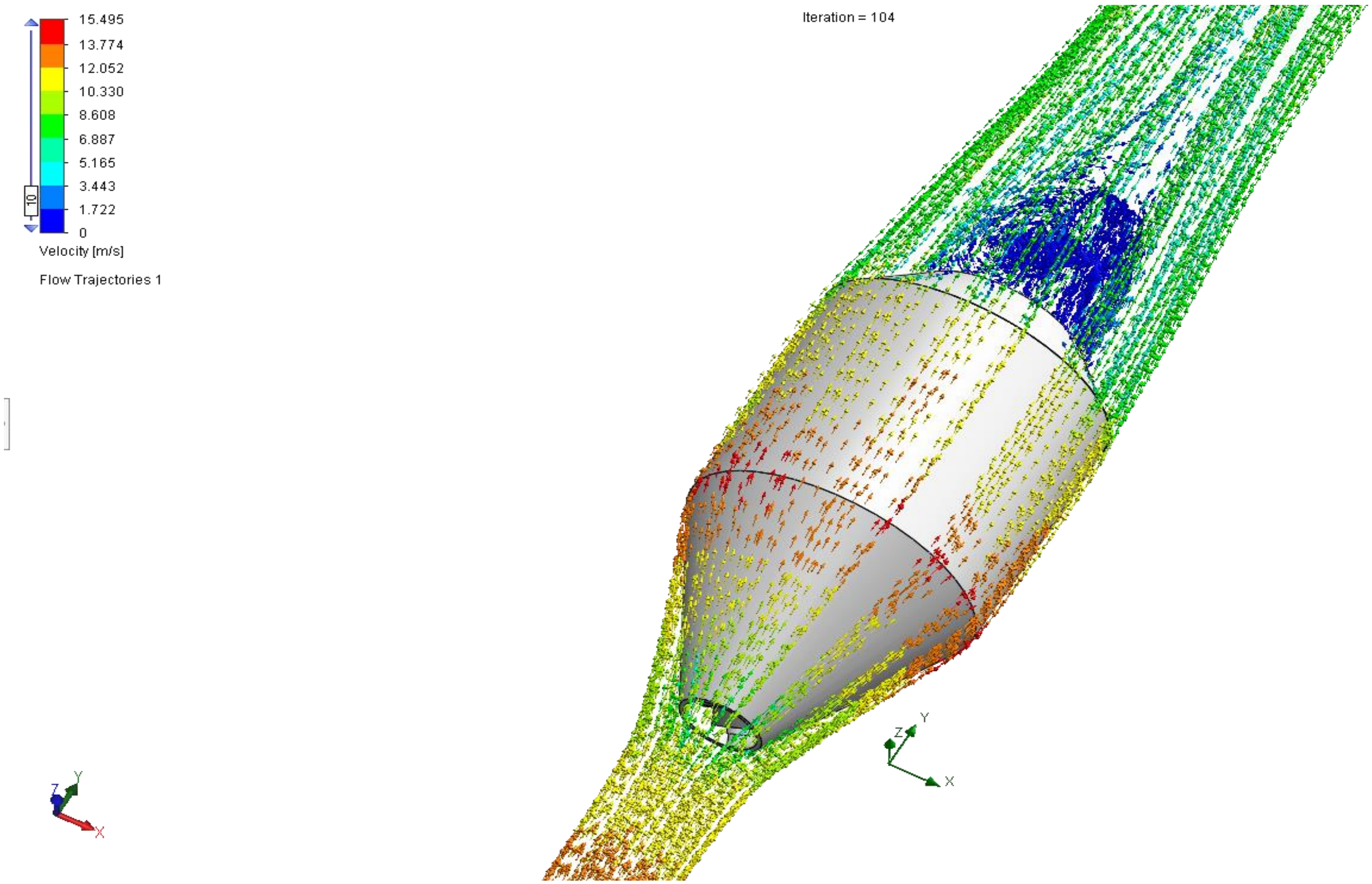
$m = 355\ g$ (payload)
$A = 0.032583\ m^2$
$g = 9.81\ m/s^2$
$C_D = 0.045$ (for airfoil)
$C_L = 1.7$

$$\mathrm{V} = \sqrt{\frac{2 \times (0.355\ kg) \times (9.81 m/s^2)}{(1.225\ kg/m^3) \times (0.032583\ m^2) \times (0.045 + 1.7)}}$$

$$\boldsymbol{V = 10.00\ m/s}$$

We reached our the speed limit based on the calculated wing area.

Flow Simulation



Payload body flow simulation in fall time. The wind speed is shown in the simulation according to the colors.

Final Results

As a result of physical and mathematical operations:

Container + Payload post rocket-separation

- ✓ Spill hole diameter: 29 mm
- ✓ The diameter of the parachute:130 mm
- ✓ Descent speed: $20\ m/s$

Container after being released

- ✓ Container descent speed after released : 10.77 m/s

Payload following separation from the Container

- ✓ Pitch angle : 15º
- ✓ Area of wing :$32583\ mm^2$
- ✓ Payload descent speed : $10.00\ m/s$

Mechanical Subsystem Design

Kudret Batuhan OKSEM

Mechanical Subsystem Overview

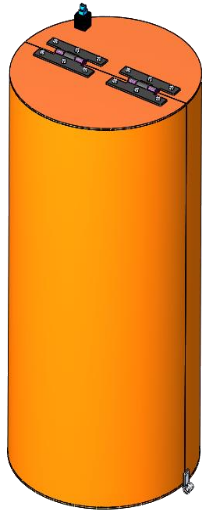
All component mass is 500 g (Payload, container, auto-gyro system and all electrical components).

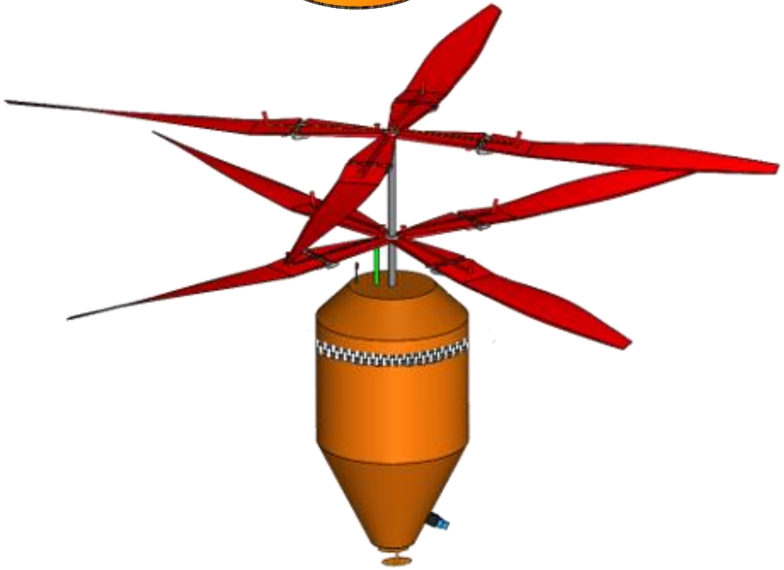
Container

- Container material is fiberglass.
- Container dimension is 240 mm lenght and 94 mm diameter.
- Container's pre payload release descent rate is 20 m/s , container velocity after being released is 10 m/s. This velocity provide via the parachute.
- Consists of a round parachute of diameter 130 mm with a spill hole of diameter 29 mm.

Payload

- Payload material is fiberglass.
- Payload dimension is 70 mm diameter x 187 mm length.
- The Payload descent rate is between 10 to 15 m/s .
- Passive control is provided by the auto-gyro system and the center of the mass .
- Auto-gyro propeller material is carbon fiber and axle material is carbon fiber stick.
- We use fabric elastics for all the propeller deployed.
- Batteries and electronic components are easily reached by means of zipper.





Mechanical Sub-System Requirements (1 of 3)

Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN#1	Total mass of the CanSat (science payload and container) shall be 500 grams +/- 10 grams	Competition requirement	HIGH		✓		
RN#2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Competition requirement	HIGH		✓		
RN#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.	Competition requirement	HIGH	✓	✓		
RN#4	The container shall be a fluorescent color; pink, red or orange.	Competition requirement	MEDIUM	✓			
RN#5	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition requirement	MEDIUM	✓	✓		
RN#6	The rocket airframe shall not be used as part of the CanSat operations.	Competition requirement	MEDIUM	✓	✓		
RN#7	The CanSat shall deploy from the rocket payload section and immediately deploy the container parachute.	Competition requirement	HIGH	✓	✓		

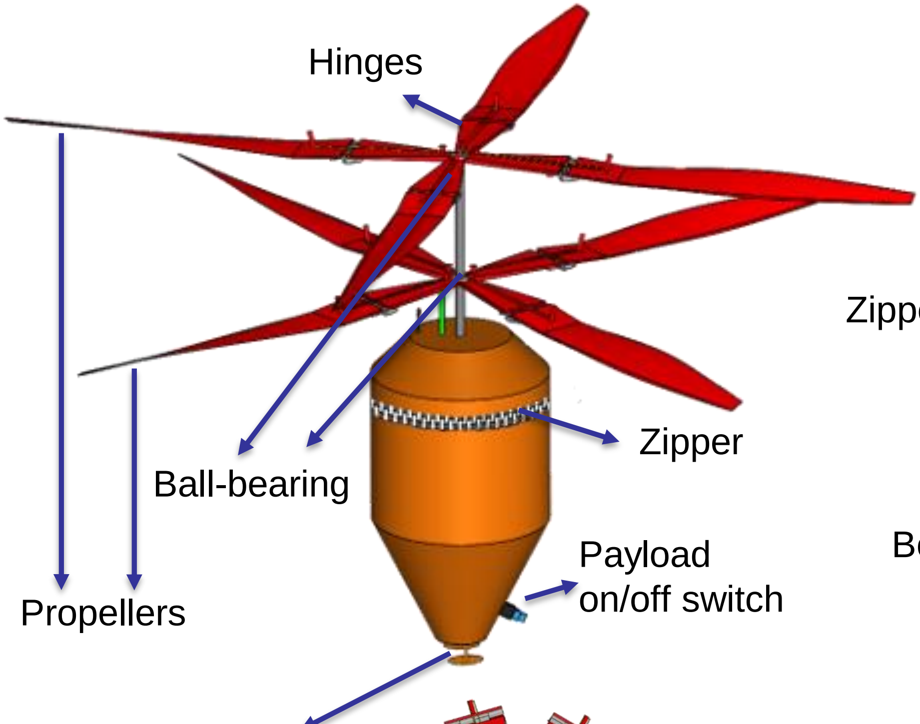
Mechanical Sub-System Requirements (2 of 3)

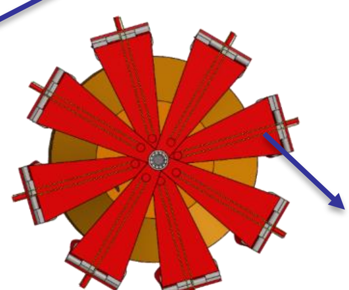
Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN#9	The container shall release the payload at 450 meters +/- 10 meters.	Competition requirement	HIGH		✓	✓	
RN#12	All descent control device attachment components shall survive 30 Gs of shock.	Competition requirement	HIGH	✓		✓	
RN#13	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Competition requirement	HIGH	✓	✓		
RN#14	All structures shall be built to survive 15 Gs of launch acceleration.	Competition requirement	HIGH	✓		✓	
RN#15	All structures shall be built to survive 30 Gs of shock.	Competition requirement	HIGH	✓		✓	
RN#16	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Competition requirement	HIGH	✓		✓	✓
RN#17	All mechanisms shall be capable of maintaining their configuration or states 8 under all forces.	Competition requirement	HIGH	✓			

Mechanical Sub-System Requirements (3 of 3)

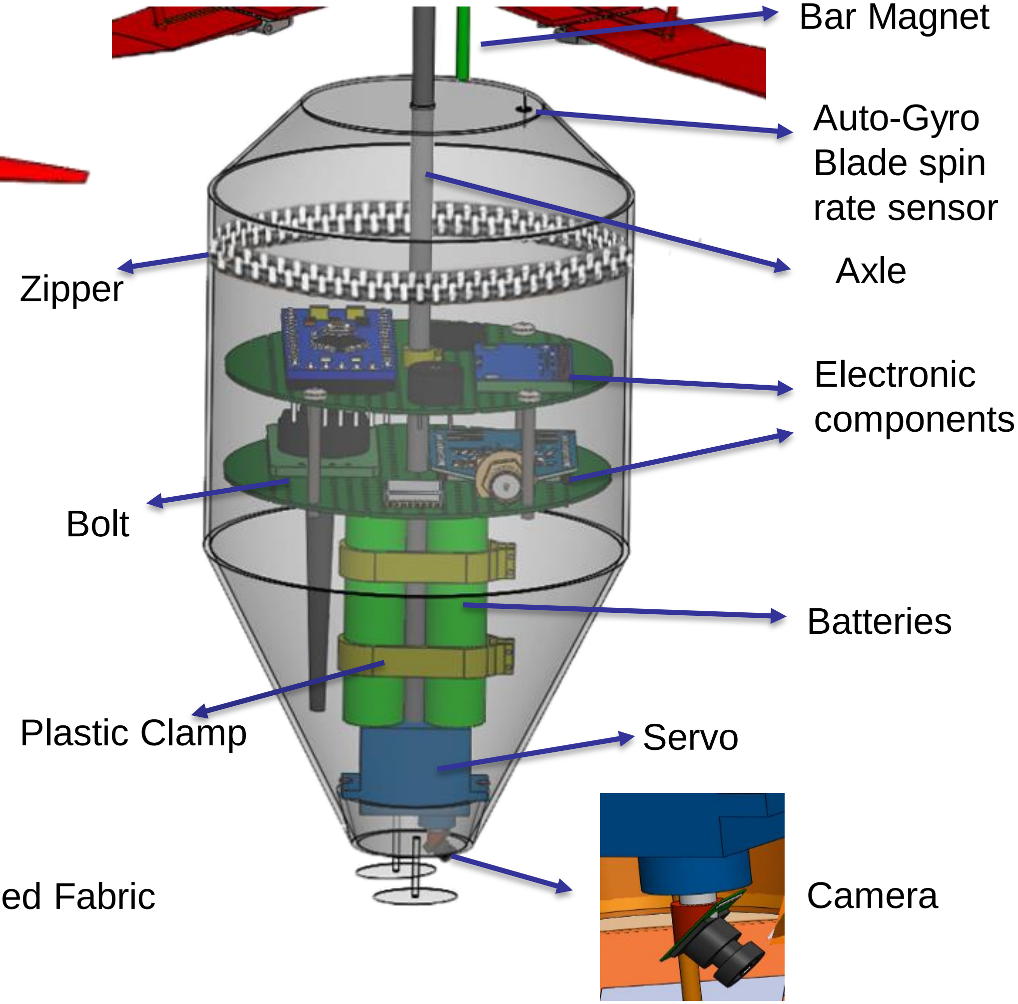
Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN#18	Mechanisms shall not use pyrotechnics or chemicals.	Competition requirement	HIGH	✓			
RN#19	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	Competition requirement	MEDIUM	✓	✓		
RN#34	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Competition requirement	MEDIUM	✓	✓		
RN#50	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.	Competition requirement	HIGH	✓	✓		
RN#54	The CANSAT must operate during the environmental tests laid out in Section 3.5.	Competition requirement	HIGH	✓	✓		

Payload Mechanical Layout Design 1



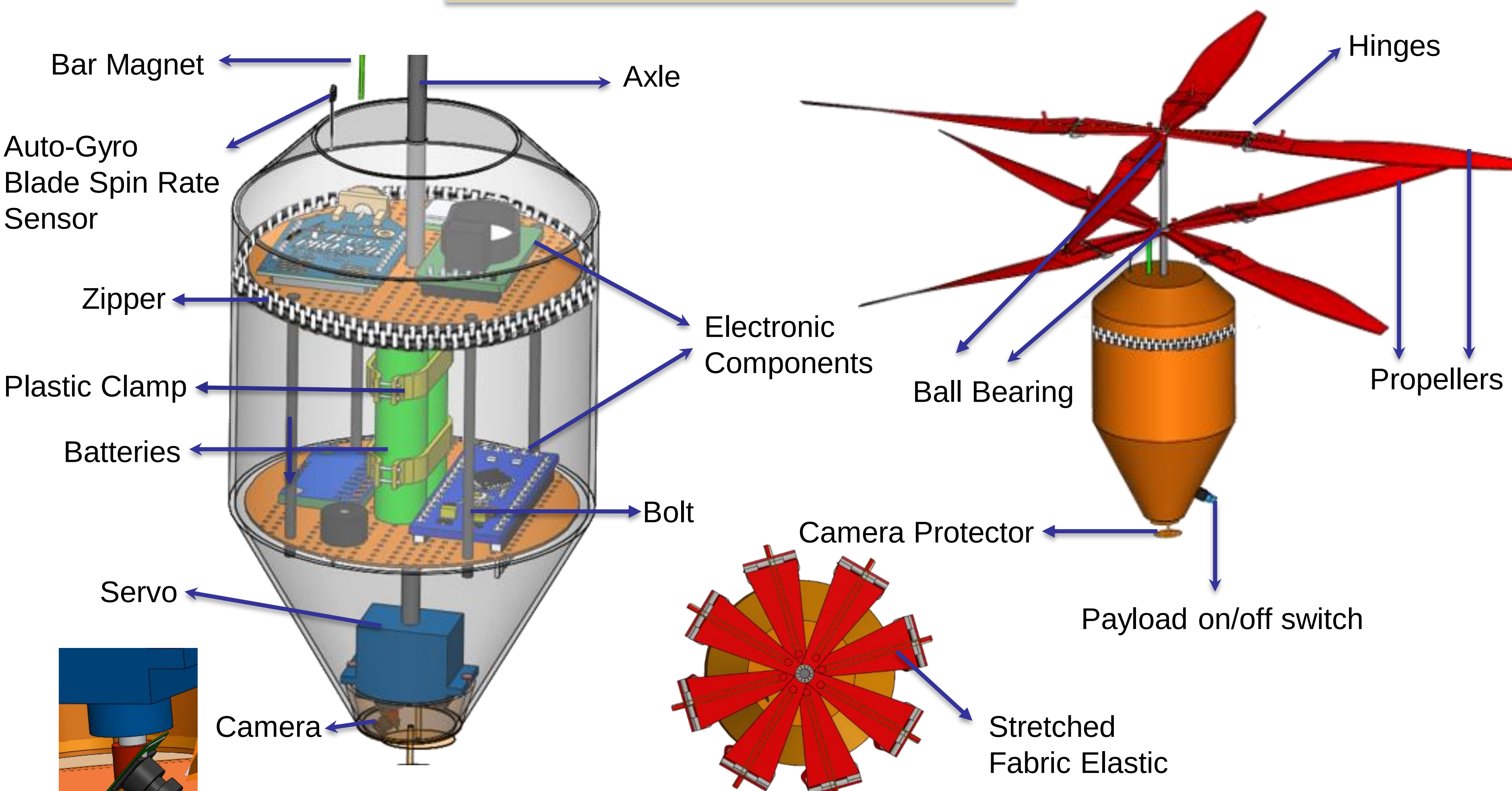


- Top view of payload

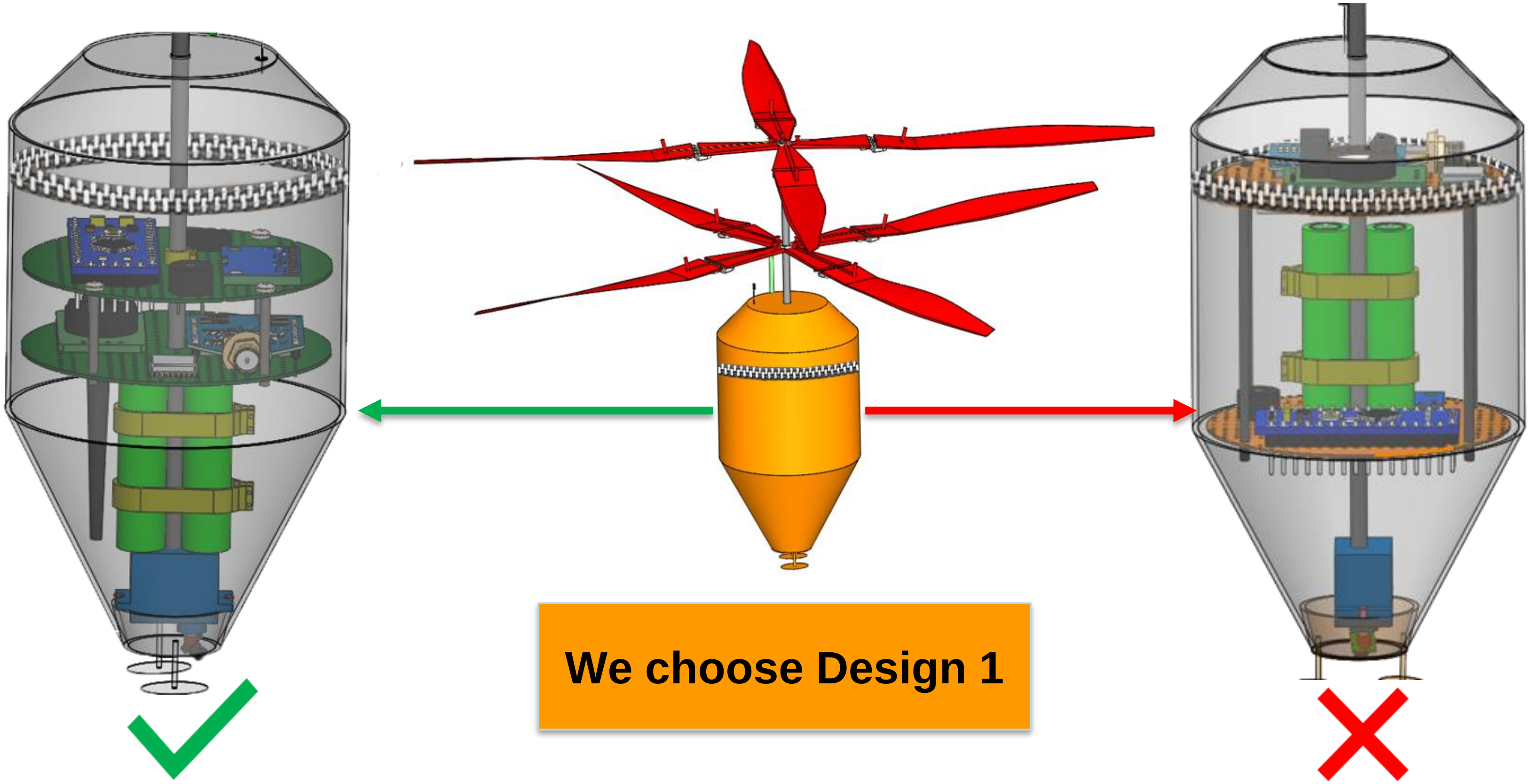


Payload Mechanical Layout of Components Trade & Selection (2 of 6)

Payload Mechanical Layout Design 2



- Top view of payload



We choose Design 1

Design 1

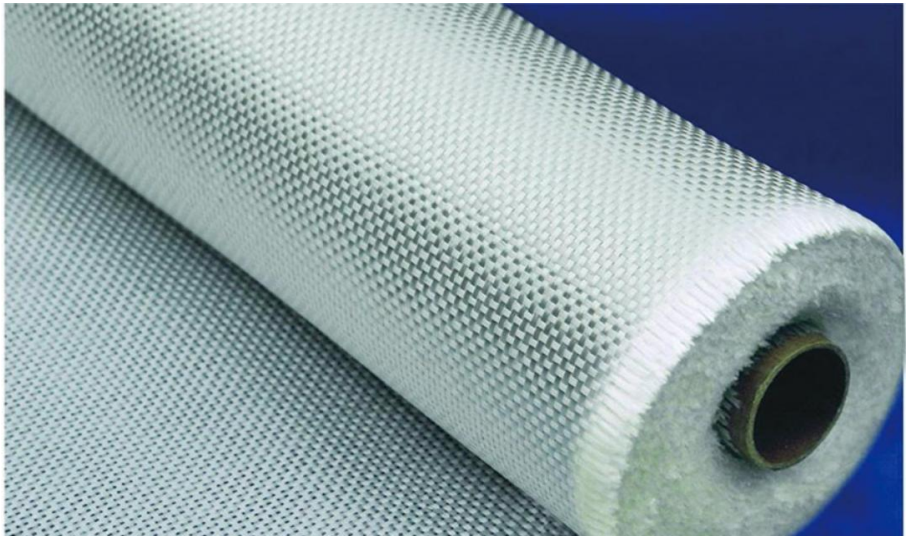
Design 2

- Design 1 more stable descent than design 2 because center of mass is below.
- Electronic circuits are easier to access in design 1.
- The connection with wire between the two circuits are difficult in design 2. So we choose design 1.

Payload Mechanical Layout of Components Trade & Selection (4 of 6)

PAYLOAD					
Part	Material	Density(g/cm^3)	Durability(MPa)	Weight (g)	Price ($\$/m^2$)
Payload Body	Fiberglass	2.5	1103	138	9.33
	Carbon Fiber	1.8	1500	100	25
	ABS	1.04	73	70	20

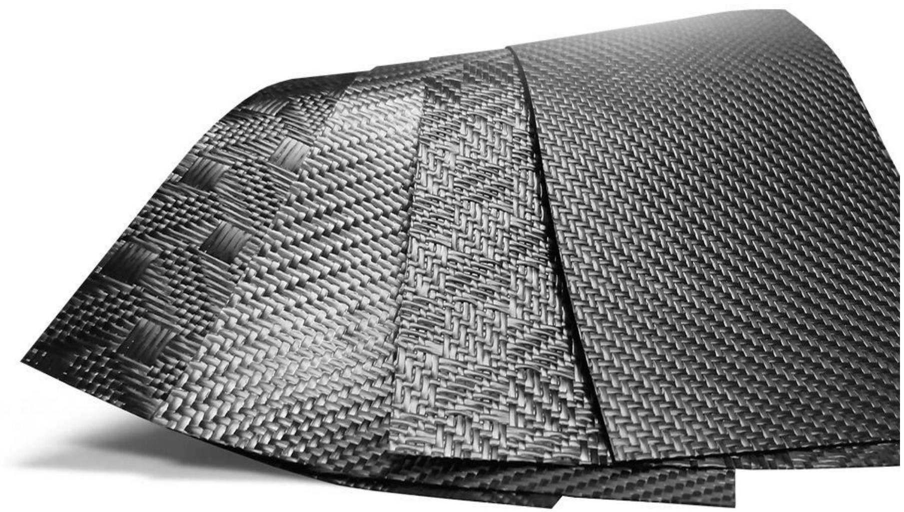
Selected Material	Reasons
Fiberglass	Very cheap
	It doesn’t prevent data transmission.
	Easy to shape



Payload Mechanical Layout of Components Trade & Selection (5 of 6)

PAYLOAD					
Part	Material	Density(g/cm^3)	Durability (MPa)	Unit Weight (g)	Price ($)
Wing	Carbon Fiber	1.8	1500	6	3.92
	PVC	1.4	100-350	4.6	3
	Polycarbonate	1.2	90	4	2.5

Selected Material	Reasons
Carbon Fiber	Easy to shape
	Very durable
	Impact resistance higher



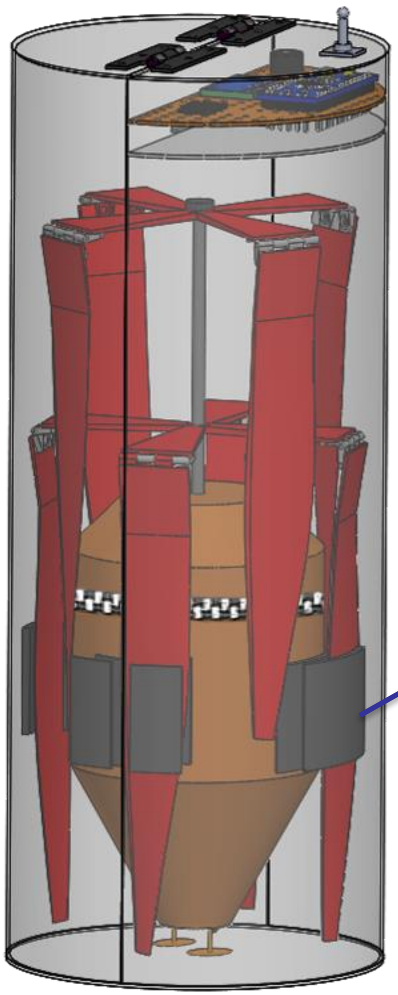
Payload Mechanical Layout of Components Trade & Selection (6 of 6)

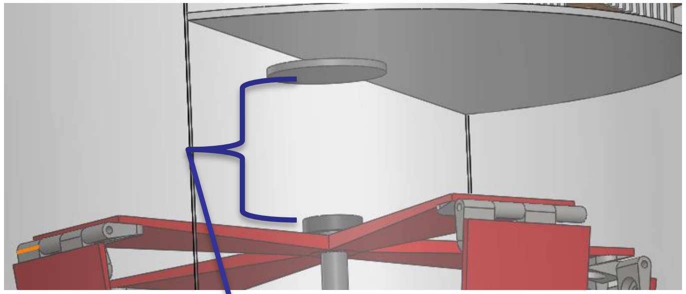
PAYLOAD					
Part	Material	Density(g/cm^3)	Durability (MPa)	Weight (g)	Price ($) (3mm x 200mm)
Axle	Carbon Fiber	1.8	1500	3	2
	Fiberglass	2.5	1103	4.1	3
	Aluminium	2.7	1000	4.5	4

Selected Material	Reasons
Carbon Fiber	Cheaper than others
	Light Material
	Sufficient Durability

Payload Pre Deployment Configuration Trade & Selection (1 of 3)

Payload Pre Deployment (Magnets) Design 1

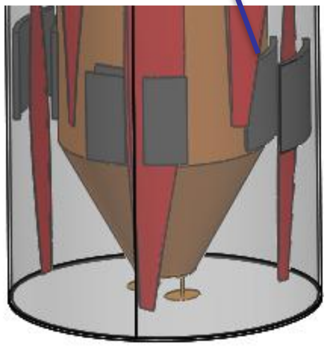


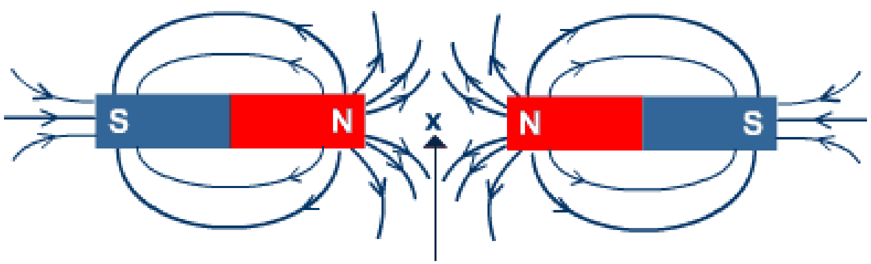


We keep the payload in the container by magnets.

Magnetic forces of magnets facing each other in the same pole, so the payload is placed in the container, it is easy to separate from the container due to magnetic force.

Magnets

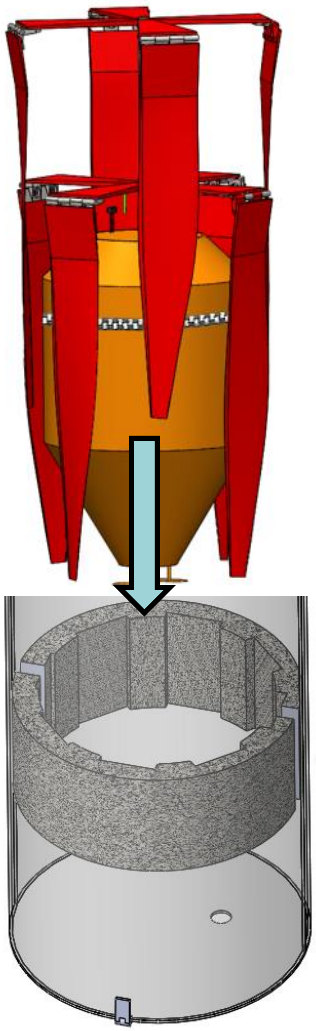




Source:www.s-cool.co.uk

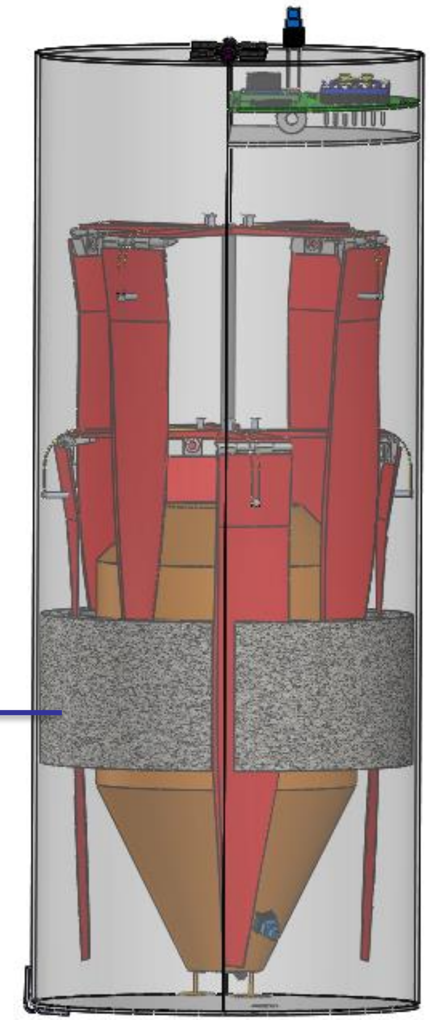
Payload Pre Deployment Configuration Trade & Selection (2 of 3)

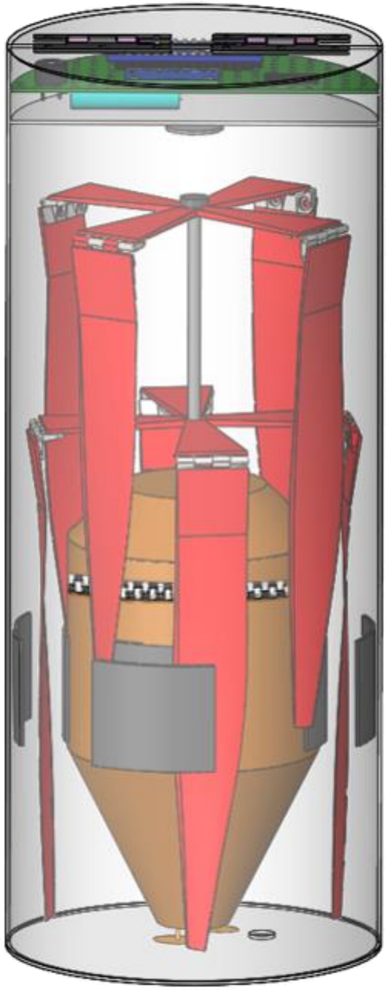
Payload Pre Deployment (Deprons) Design 2



Payload is placed with two half disk in the container. Disk material is depron. Deprons are prevent vibration and protects the payload when in the rocket.

Deprons

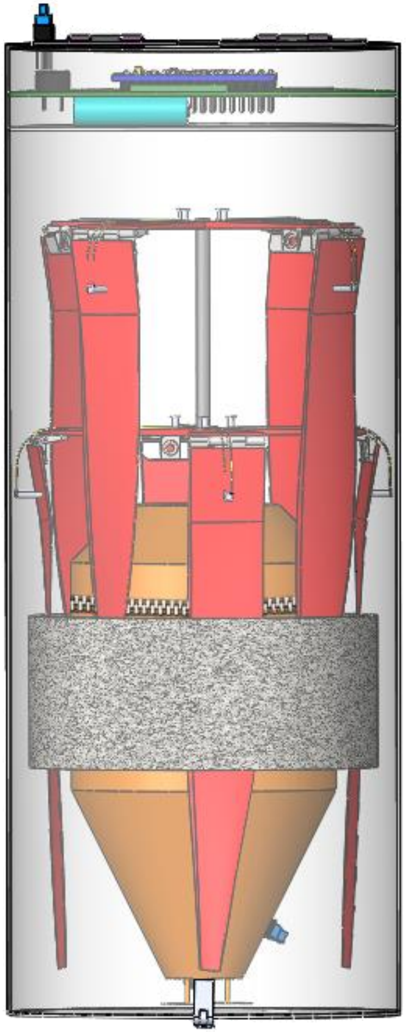




Design 1

We choose Design 2

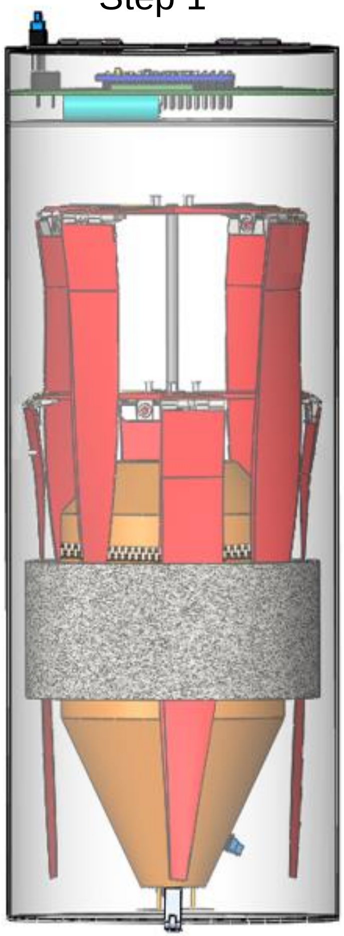
Because depron is lighter than the magnet. The magnets form the magnetic field so that the electronic system may not work stably.



Design 2

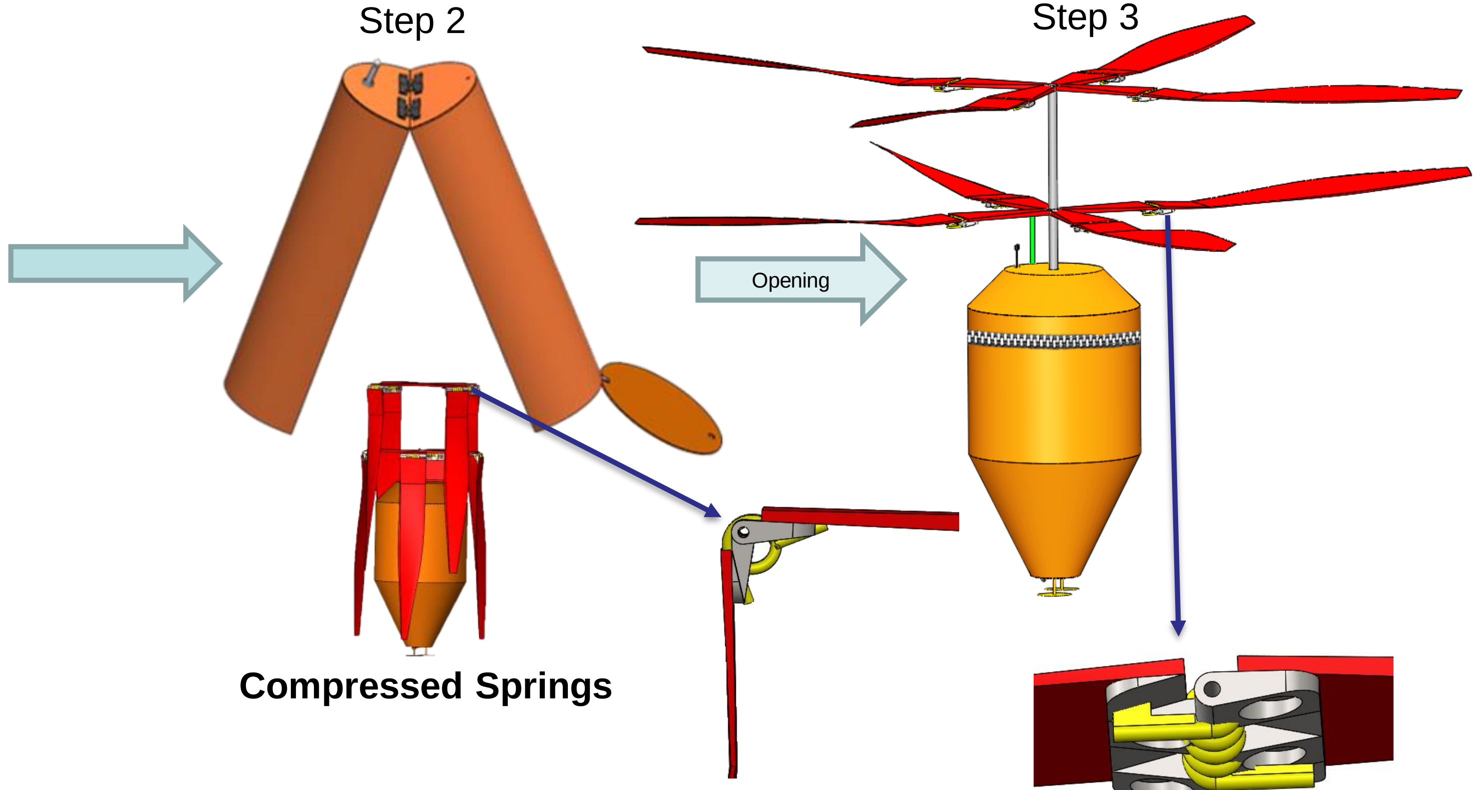
Payload Deployment Configuration (Spring Hinge) Design 1

Step 1



Step 2

Step 3

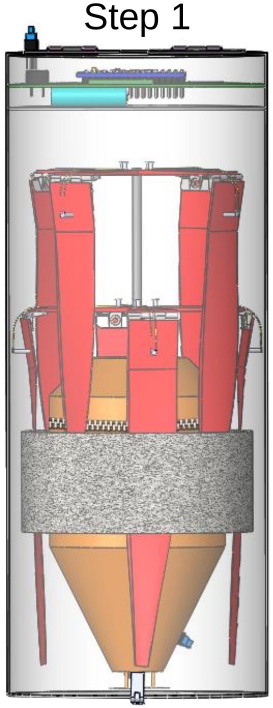


Compressed Springs

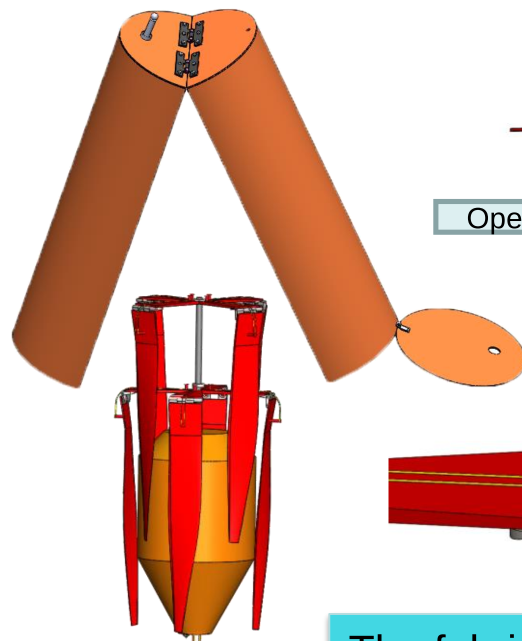
Spring hinge and placed in the propeller hinge. The auto-gyro system will be opened with the spring force of the spring hinge.

Payload Deployment Configuration (Fabric Elastic) Design 2

Step 1

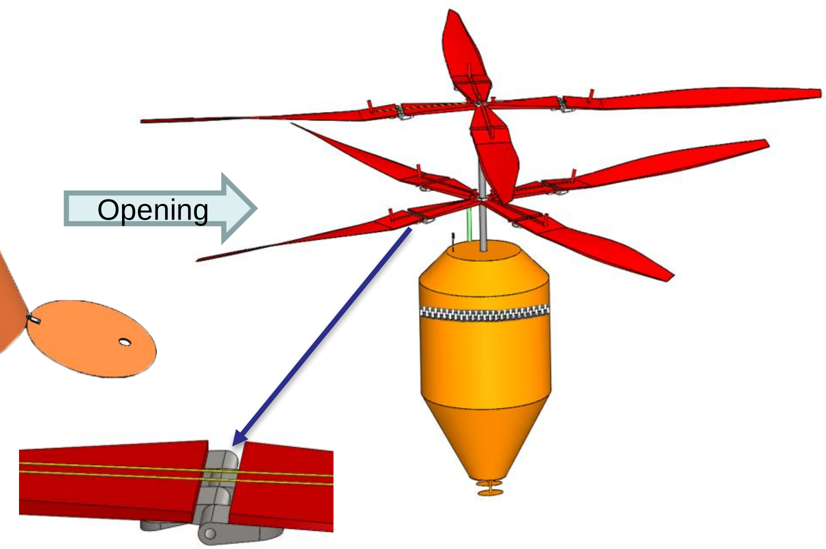


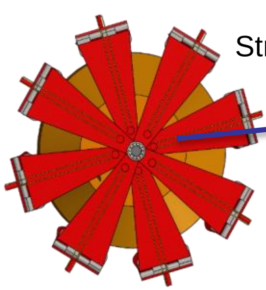
Step 2



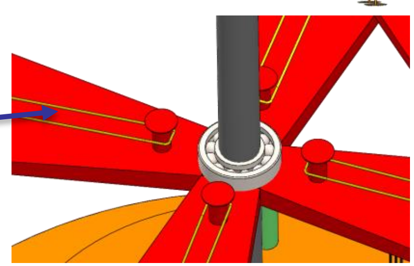
Step 3

Opening



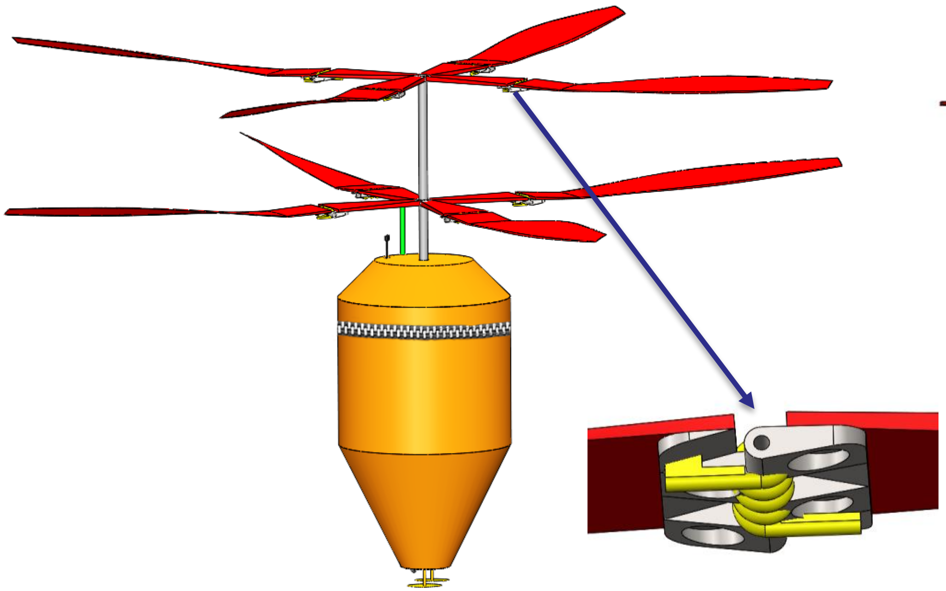


Stretched Fabric Elastic

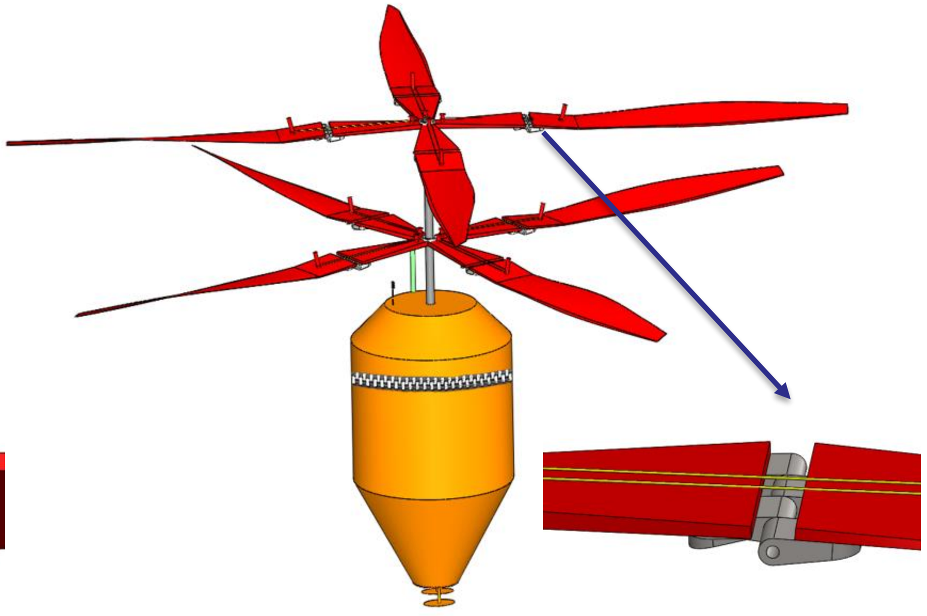


The fabric elastics stretched and placed in the container. The auto-gyro system will be opened with the tensile force of the fabric elastics.

Payload Deployment Configuration Trade & Selection (3 of 3)



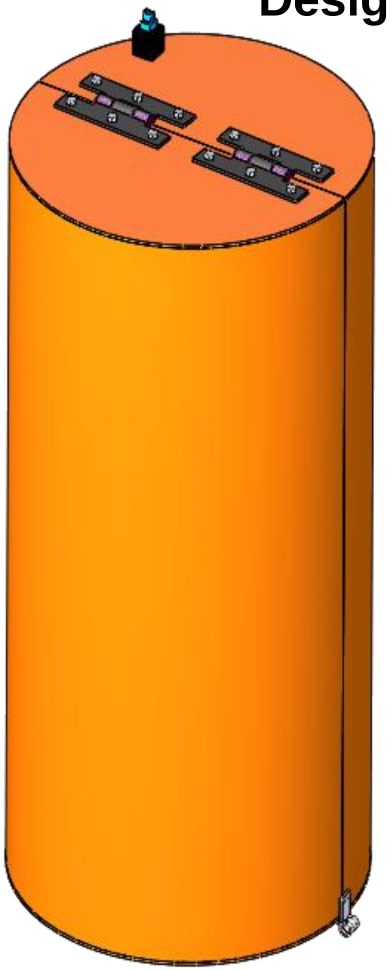
Design 1

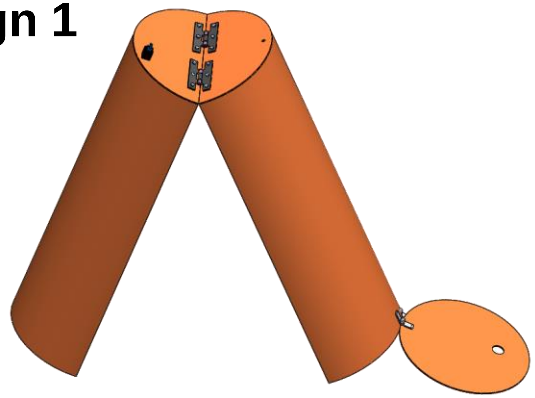


Design 2

We choose Design 2: Because fabric elastics are lighter than spring hinge. Application will be easy with fabric elastic.

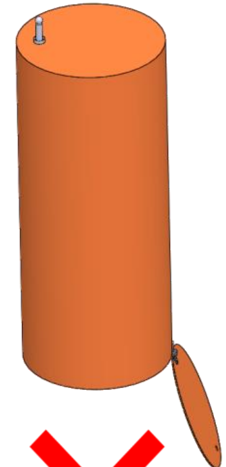
Design 1

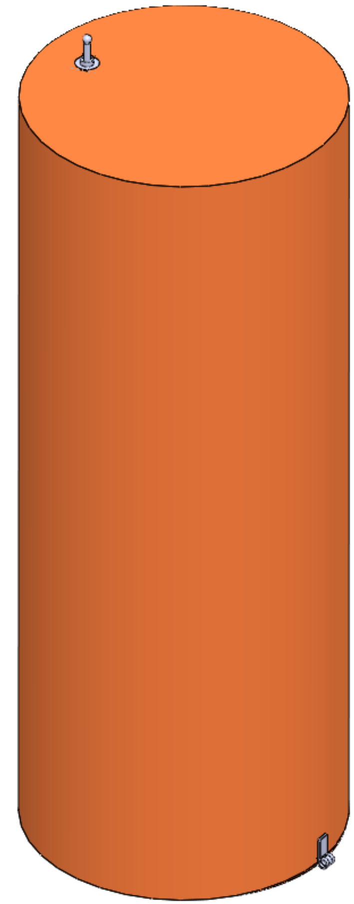




Bottom cover and container body are opened simultaneously.

Design 2





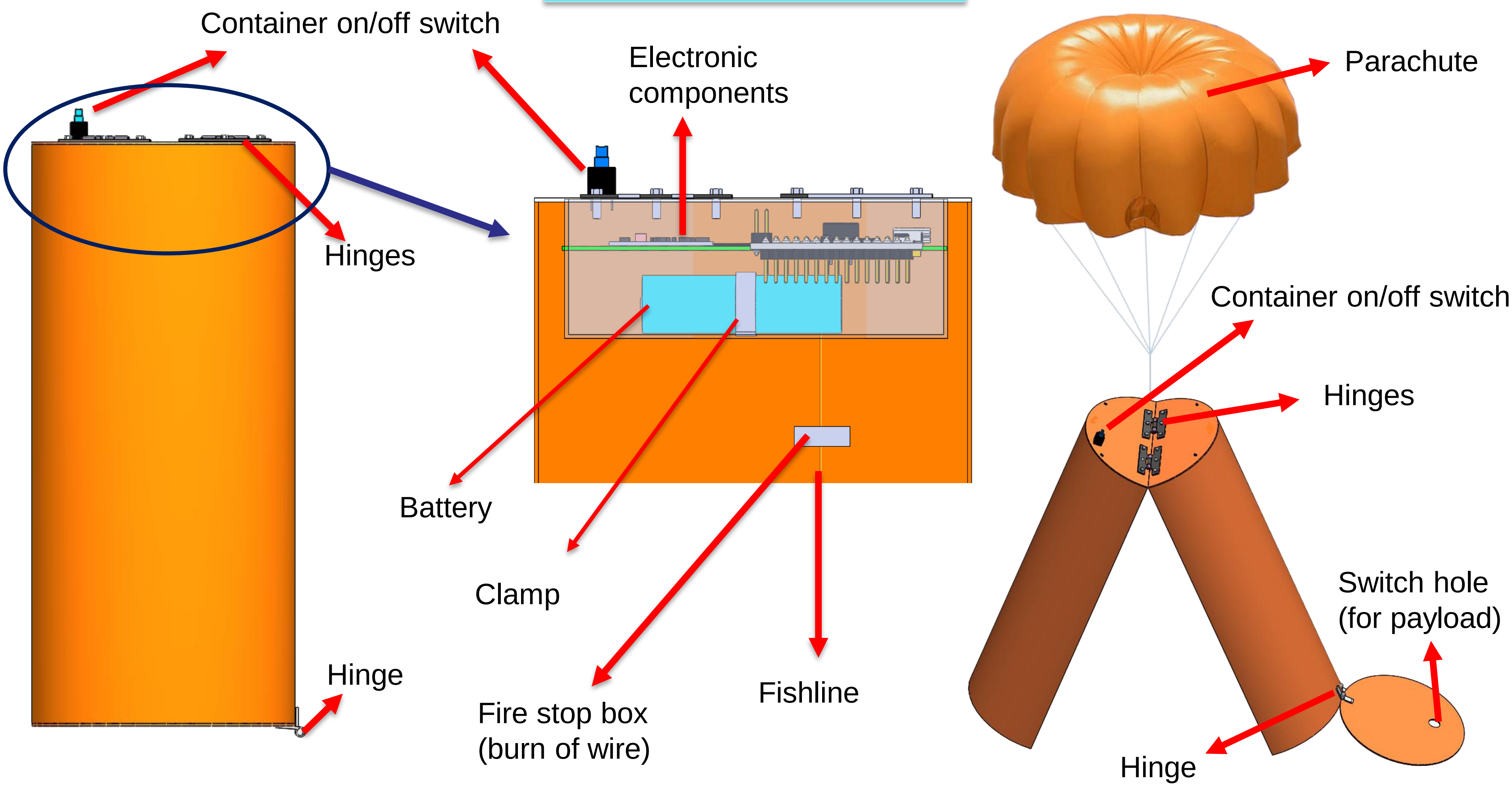
Only the bottom cover opens.

We choose Design 1

- Easy opening due to air resistance.
- Provides more space area.
- Container will not blocking the payload during separation.

Container Mechanical Layout of Components Trade & Selection (2 of 4)

Selected Design 1



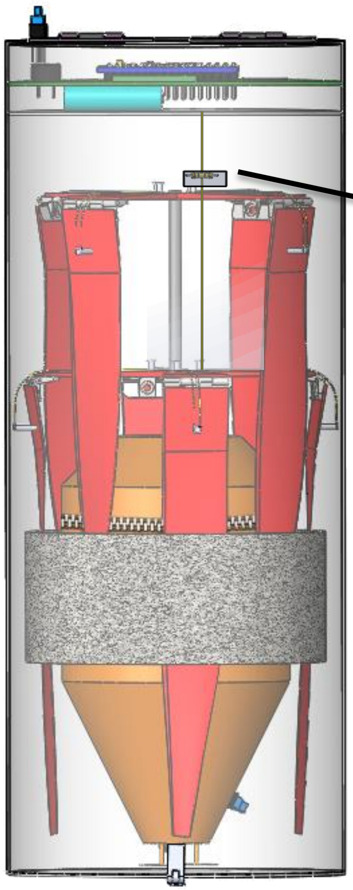
CONTAINER					
Part	Material	Density(g/cm^3)	Durability(MPa)	Weight (g)	Price ($\$/m^2$)
Container Body	Fiberglass	2.5	1103	138	9.33
	Carbon Fiber	1.8	1500	100	25
	ABS	1.04	73	70	20

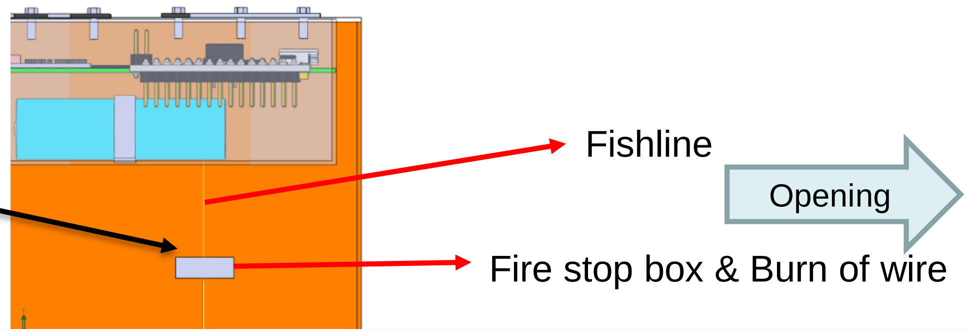
Selected Material	Reasons
Fiberglass	Very cheap
	It doesn't prevent data transmission.
	Easy to shape

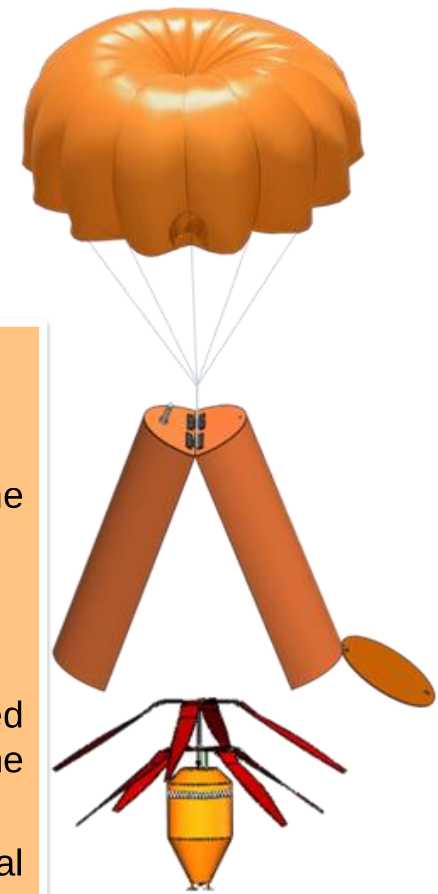
Container Mechanical Layout of Components Trade & Selection (4 of 4)

CONTAINER				
Part	**Material**	**Air Permeability**	**Durability**	**Price ($)**
Parachute	Nylon	High	Low	12.4
	Parachute Fabric	Medium	Low	7.1
	Silnylon 30D Nylon 66	High	High	12.5

Selected Material	Reasons
Silnylon 30D Nylon 66	Easy to supply
	It has high air resistance
	It is the strongest, more abrasion resistant fabric







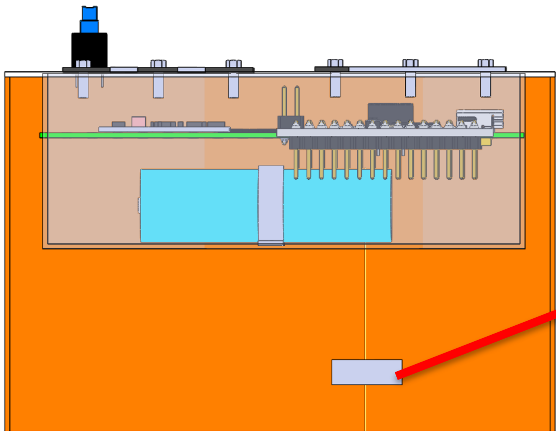
CONNECTION METHOD

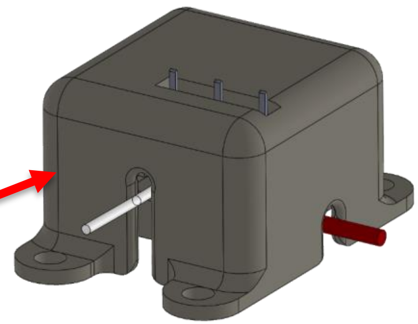
- The container bottom cover will be opened.
- The payload propellers folded and the payload pushed into the container.
- The bottom cover is closed.

RELEASE METHOD

- When the CanSat reaches 450 m the container will be opened by the burn of wire method. The payload release under the influence of gravity.
- The burn of wire is protected in a box to avoid enviromental damage (not be exposed to the outside).
- The burn of wire pulls a current of 1.4 A.
- The fishline breaks under a second.

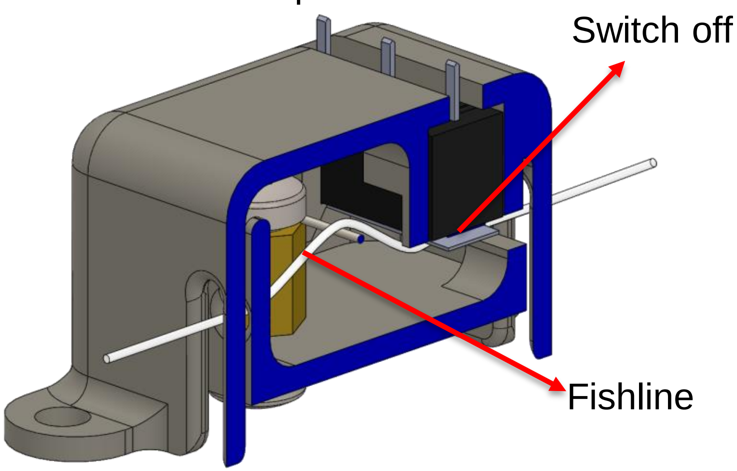
Payload Release Mechanism (2 of 2)



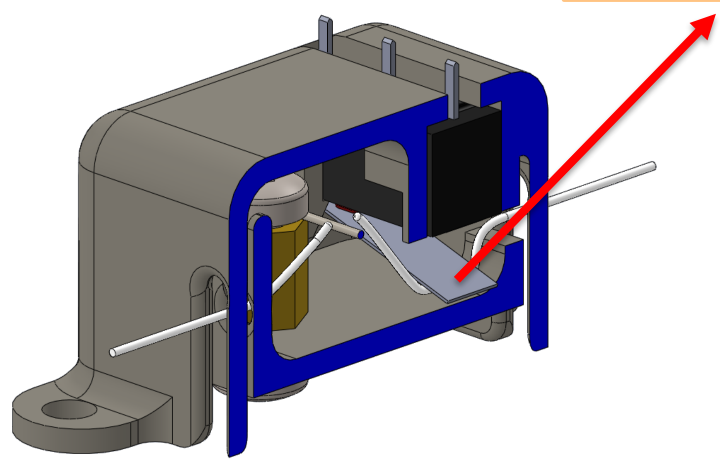


We use burn of wire method because of the reusability. When fishline breaks, switch activates and sends data to Arduino. Then current flow to the wire will be stopped. We will use fire stop box for safety.

Step 1



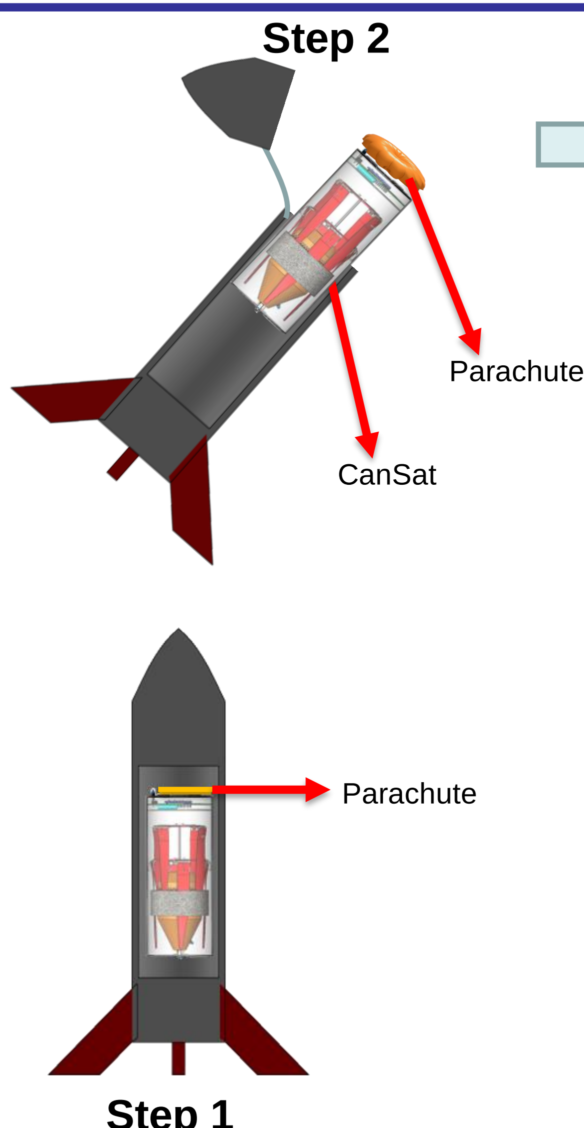
Step 2

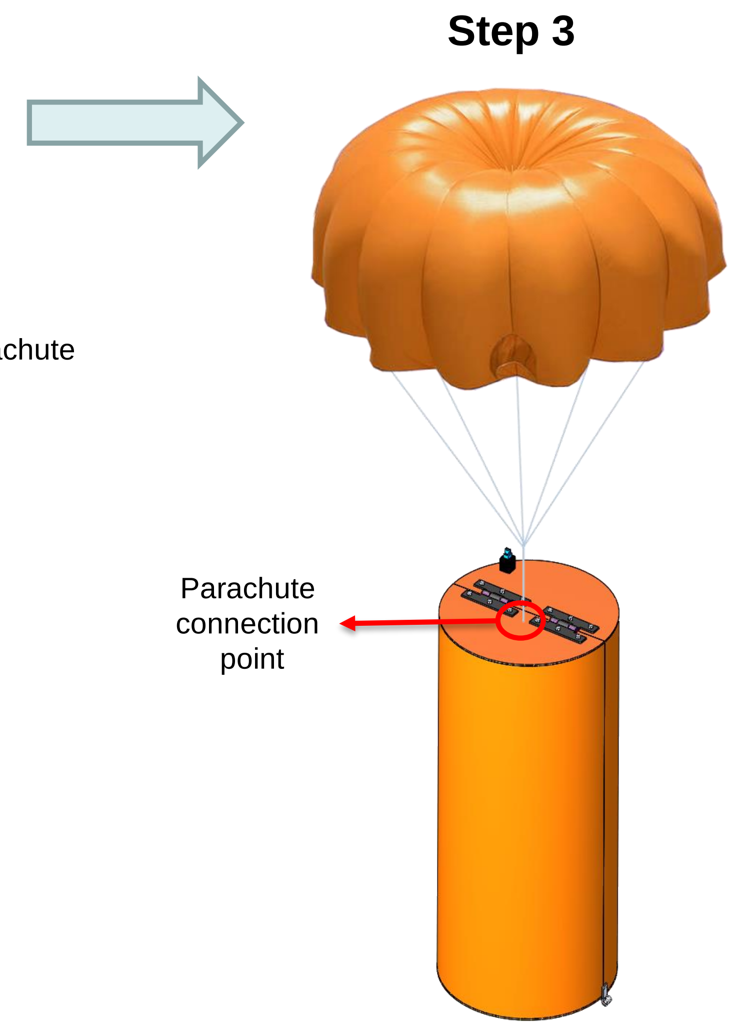


Fishline breaks and switch active (Sending data to Arduino).

Container Parachute Release Mechanism

Step 1 (Ground Station) The payload is placed in the container, parachute is attached to the container by ropes, folded over and placed on the container.
Step 2 (at 670-725 m) **1.**Rocket arrived to 670-725m. **2.**Container separate from the rocket (670-725m).
Step 3 (at 670-725 m) The parachute on the top of the container is opened by air resistance.





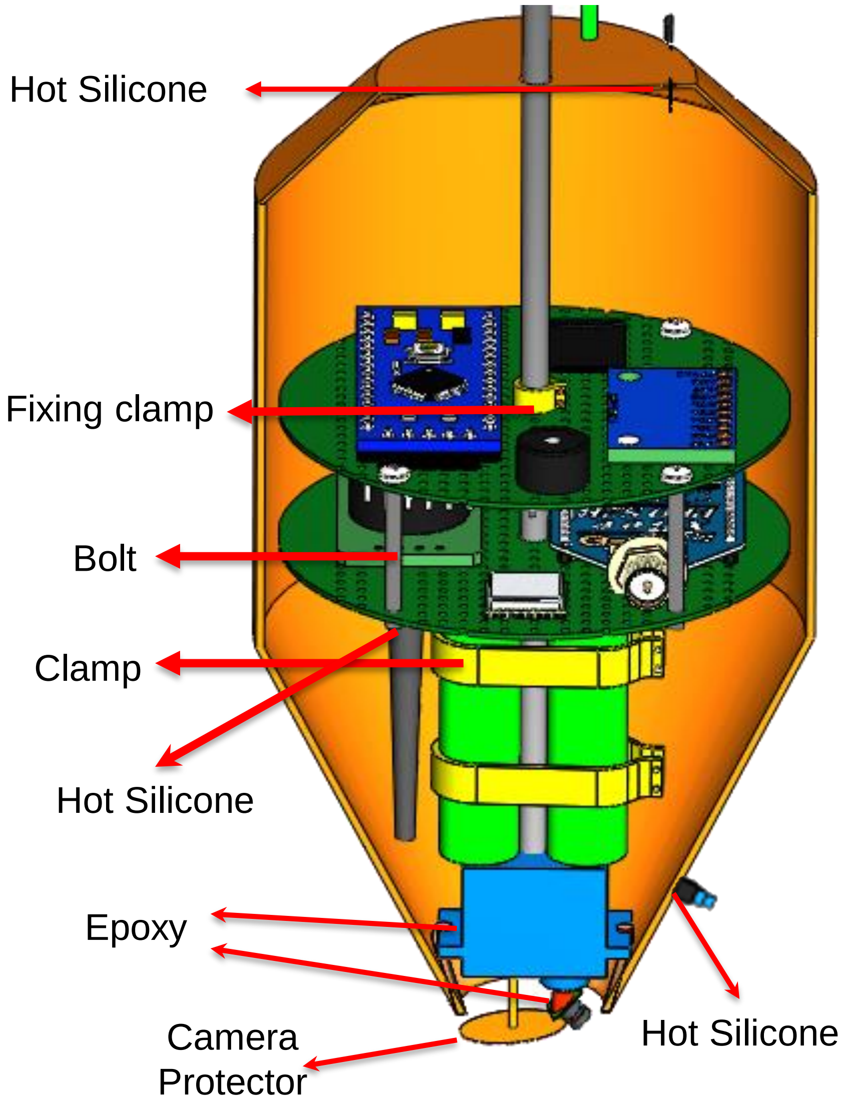
Electronics Structural Integrity

Connection
- Electronic components are successfully fixed by solder on the PCB.

Enclosure
- Bolts and plastic clamps were used to fix the PCB.
- Batteries fixed with plastic clamp on the axle.

Mounting
- The servo mounted to the payload with epoxy. The camera is placed on the servo motor.
- Blade spin rate sensor mounted with hot silicone.
- Payload on/off switch mounted with hot silicone.
- Antenna mounted to PCB with hot silicone

Descent Control Attachments
- We will use a parachute for container landing control
- We will use auto-gyro system for payload.



Mass Budget (1 of 4)

ELECTRONIC COMPONENTS

	Part Name	Quantity:	Unit Weight(g):	Weight (g) :	Determination:
PAYLOAD	SD Card Module	1	6	6	DS
	SD Card(SanDisk Ultra)	2	1	2	M
	Arduino Nano	1	5	5	DS
	Battery (SonyVTC6)	2	48.5	97	DS
	PCB	2	15	30	E
	DC-DC Converter (MP23070N)	2	2	4	M
	10-DOF IMU (MPU-9255 + BMP280)	1	2	2	M
	GPS (NEO-7M)	1	13	13	M
	RTC (DS1307)	1	10	10	DS
	Coin Cell(CR2032 3V)	1	1.2	1.2	DS
	Telemetry Module(Xbee Pro S1 & Antenna)	1	13	13	DS
	Hall Effect (US1881)	1	<1	<1	DS
	Camera(SQ11)	1	4	4	M
	Servo Motor (Feetech FS5106R)	1	39	39	DS
	Switch (KTS102)	1	2	2	DS
	Reset Button	1	<1	<1	M
	Buzzer	1	5	5	DS

CE: CAD Estimate M: Measurement
DS: Data Sheet E: Estimate

TOTAL	**235.2 g**

Mass Budget (2 of 4)

STRUCTURAL ELEMENTS

	Part Name	Quantity:	Unit Weight(g):	Weight (g) :	Determination:
PAYLOAD	Payload Body	1	28	28	CE
	Zipper	1	6	6	M
	Wings	8	6	48	CE
	Axle	1	3	3	M
	Plastic Hinge	8	1	8	M
	Plastic Clamp	4	1	4	M
	Bolt	4	3	12	M
	Ball Bearing	2	4	8	DS

Measurement (Mainstays Digital Glass Kitchen Food Scale):
Capacity: 5 kg
Sensivity: 1 g

TOTAL	117 g

CE: CAD Estimate
M: Measurement
DS: Data Sheet
E: Estimate

PAYLOAD ELECTRONIC + PAYLOAD STRUCTURAL = PAYLOAD MASS
235.2 g + 117 g = 352.2 g

Mass Budget (3 of 4)

ELECTRONIC ELEMENTS

	Part Name:	Quantity:	Unit Weight(g):	Weight (g) :	Determination:
CONTAINER	SD Card Module	1	6	6	DS
	SD Card(SanDisk Ultra)	1	1	1	M
	Arduino Pro Micro	1	7	7	DS
	Battery(ORION 14500 AA)	1	19,5	19,5	DS
	PCB	1	7.5	7.5	E
	DC-DC Converter (MP23070N)	1	2	2	M
	10-DOF IMU(MPU-9255+BMP280)	1	2	2	M
	Switch(KTS102)	1	2	2	DS
	Buzzer	1	5	5	DS

TOTAL	52 g

STRUCTURAL ELEMENTS

CONTAINER	Container Body	1	58	58	M
	Parachute	1	10	10	DS
	Depron	0.04 m^3	209	8	E
	Hinge	3	2	6	M
	Fire Stop Box	1	5	5	CE

TOTAL	87 g

CONTAINER ELECTRONIC + CONTAINER STRUCTURAL = CONTAINER MASS

52 g + 87 g = 139 g

Mass Budget (4 of 4)

Electronic Components	287.2 g
Structural Components	204 g
Total Mass	491.2 g
Margins	8.8 g

Uncertaines:
The weights of materials such as screws, epoxy electronic cables are not visible. When we consider these materials, margin is calculated as 8.8 g.
RN#1: Total mass of the CanSat (science payload and container) shall be 500 grams +/- 10 grams.

MARGIN	
Mass Requirement - Total Mass = Margin	**500 g - 491.2 g = 8.8 g**

Total Payload Mass= 352.2 g + 2.8 g (Margin) = 355 g **Total Container Mass = 139 g + 6 g (Margin) = 145 g**

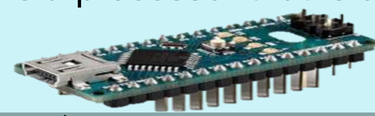
Correction Methods	
If weight of Cansat < 490 g	Container with thicker wall will be use. (For example wall thickness 25 mm) If systems are heavy, we will assembly sinker in container
If weight of CanSat > 510 g	Container with thicker wall will be use. (For example wall thickness 10 mm)

Communication and Data Handling (CDH) Subsystem Design

Ayse EROGLU

Payload CDH Overview

Arduino Nano This is a processor that is used to control all components

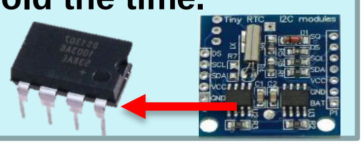


SQ11 This is a camera module that is used for bonus mission (camera has an internal SD card module).

XBee Pro S1 This is a RF Module that is used for communcation to ground station.

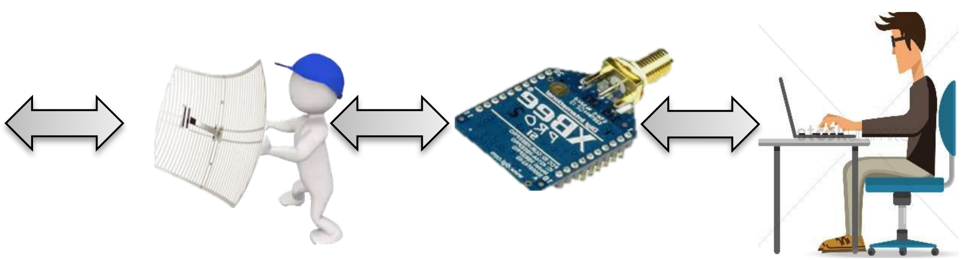
SanDisk Ultra 4 GB memory card is used to record telemetry data.

DS1307 RTC are crystal oscillators located on top of them and the integrators that produce **their own clock pulses and hold the time.**



SanDisk Ultra 4 GB This is a memory card that is used to record the video for bonus mission. It is located in the camera.

A24-HASM-450 We use an external antenna to increase the gain of the RF module



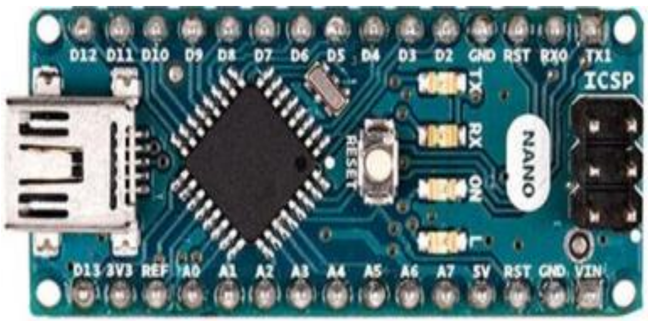
Payload CDH Requirements

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#30	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Competition Requirement	HIGH	√			
RN#31	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Competition Requirement	HIGH	√		√	
RN#32	XBEE radios shall have their NETID/PANID set to their team number.	Competition Requirement	MEDIUM	√	√	√	
RN#33	XBEE radios shall not use broadcast mode.	Competition Requirement	MEDIUM	√			
RN#36	All telemetry shall be displayed in real time during descent.	Competition Requirement	HIGH			√	√
RN#37	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Competition Requirement	HIGH	√	√		
RN#38	Teams shall plot each telemetry data field in real time during flight.	Competition Requirement	HIGH			√	√

Payload Processor & Memory Trade & Selection (1 of 2)

Processor	Boot Time (Second)	Processor Speed (MHz)	RAM (Byte)	Flash Memory (kB)	Operating Voltage (V)	Data Interface	Price ($)
ATTiny85	5	16	512	8	4.5 - 5.5	-4 Analog Pins -6 Digital Pins -3 PWM Pins	3.5
Arduino Nano	7-9	16	2048	3	5	- 14 Digital Pins - 6 PWM Pins - 2 Serial Pins - 4 SPI Pins - 2 I2C Pins	27
Arduino Lilypad	12	8	1024	16	2.7-5.5	-14 Digital Pins -6 PWM Pins -6 Analog Pins	6

SELECTED MODEL	REASON FOR SELECTION
Arduino Nano	Suitable processor speed
	More pin count
	High RAM



Boot Time = **The program is determined by the time it takes to open the program after loading it to the microprocessor.**

Payload Processor & Memory Trade & Selection (2 of 2)

Model	Memory (GB)	Interface	Speed (Mb/s)		Price ($)
			Write	Read	
SanDisk Ultra	4	SPI	75	80	5
Link Tech	4	SPI	30 - 45	30 - 45	6
Team Class6	8	SPI	30	40	8

SELECTED MODEL	REASON FOR SELECTION
SanDisk Ultra	Cheaper than others
	Faster than others
	Suitable storage capacity

SD card is used with **Arduino SD card Module (Connector Type SPI)**

Payload Real-Time Clock

HARDWARE

Hardware **The RTC has a built-in power detection circuit that detects power failures and automatically switches to a backup source.** So we can protect the data so that it doesn't reset. RTC is powered by the coin cell battery, the system continues to operate even if there is power loss.

HARDWARE

SOFTWARE

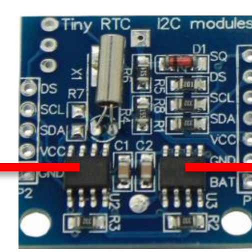
SOFTWARE

Delta is an easy way to calculate time and there is no support to localize time zones. Time comparison (for alarms) requires more MCU cycles because many building members require only a long integer comparison.

So we choose HARDWARE

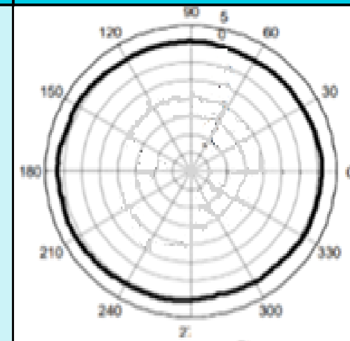
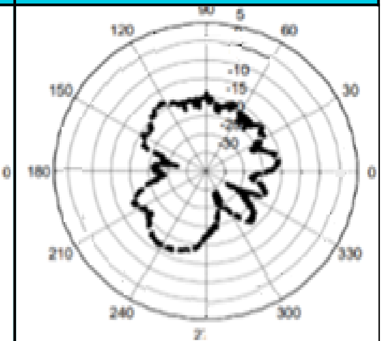
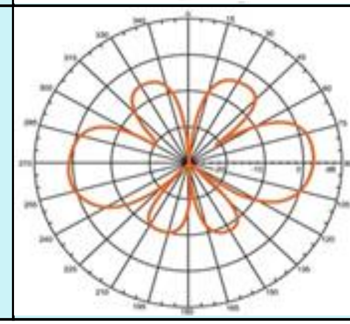
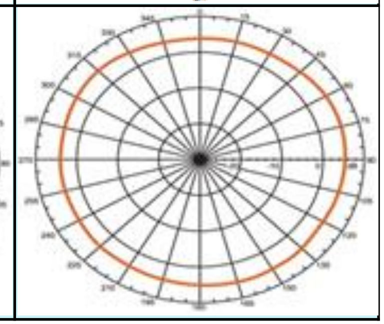
Model	Memory Type	Operating Voltage(V)	Interface	Current (nA)	Package/ Pins	Price ($)
DS1307	NV SRAM	5	I2C	300	SOIC/8 PDIP/8	1.50
DS3231	NONE	2.3 - 5.5	I2C	840	SOIC/16	3.85

SELECTED MODEL	REASON FOR SELECTION
DS1307	Cheaper than other
	It has an internal memory
	Low Current
	Its module has a EEPROM



The RTC module has a EEPROM. We use this to save telemetry data against power failure.

Payload Antenna Trade & Selection

Payload Antenna	Range (km)	Frequency (GHz)	Gain (dBi)	Connector Type	Price ($)	Patterns	
						Vertical	Horizontal
A24-HASM-450	1.75	2.4	2.14	RP-SMA	9.2		
TL-ANT2405CL	1	2.4	5	RP-SMA	14.6		

SELECTED MODEL	REASON FOR SELECTION
A24-HASM-450	Acceptable size
	Cheaper than other
	High range

It is advantageous that the antenna is non-directional during mission time, we cannot control the direction of the antenna in the payload, therefore, we selected a non-directional antenna.

Payload Radio Configuration (1 of 2)

Model	Sensitivity(dBm)	Current (mA)	Transmit Power Output (mW)	Operating Frequency (GHz)	Price ($)
XBee Pro S2B	-102	295	63	2.4	40
XBee Pro S1	-100	215	63	2.4	36
XBee Pro 900 Hp	-110	230	250	0.9	178

SELECTED MODEL	REASON FOR SELECTION
XBee Pro S1	Low current working
	Suitable sensitivity
	Cheaper than others

Payload Radio Configuration (2 of 2)

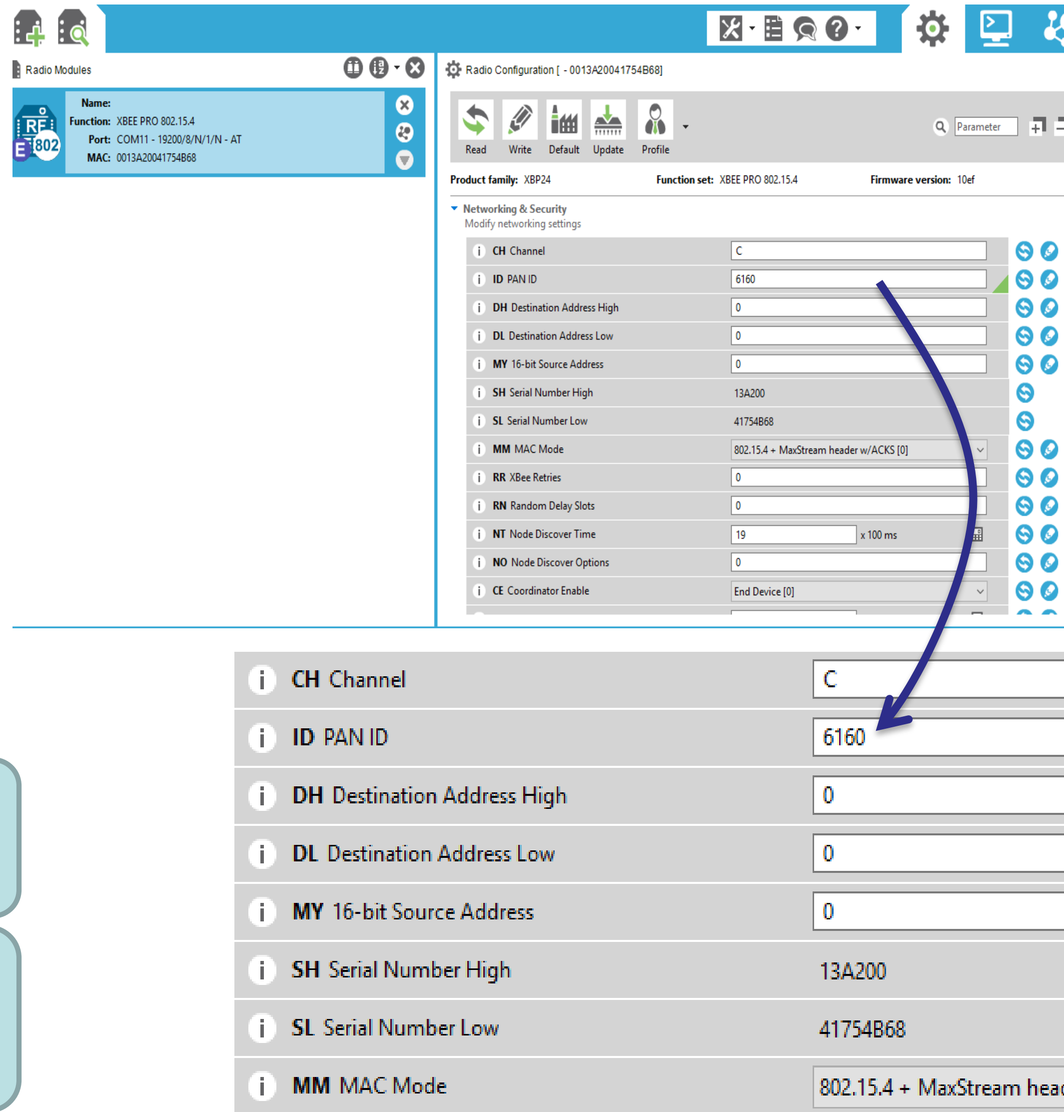
Transmission Control

The selected model is XBee Pro S1. <u>The calibration command</u> is transmitted from the ground station to the Payload via Xbee Pro S1, explorer module, antenna. Payload, every second during the entire flight (1 Hz) will send the telemetry package to the ground station. Data will be simultaneously saved to SD card. **When Payload is into the rocket, XBee on CanSat will send the data to XBee on the Ground Station and data transmission continues for the duration of the mission**

Other tests related to communication are detailed in the "CanSat Integration and Test" section.

NETID: 6160

CAST MODE: Unicast



Payload Telemetry Format (1 of 4)

Data Format

<TEAM ID>, <MISSION TIME>, <PACKET COUNT>, <ALTITUDE>, <PRESSURE>, <TEMP>, <VOLTAGE>, <GPS TIME>, <GPS LATITUDE>, <GPS LONGITUDE>, <GPS ALTITUDE>, <GPS SATS>, <PITCH>, <ROLL>, <BLADE SPIN RATE>, <SOFTWARE STATE>, <BONUS DIRECTION>

Example Data Format

<6160>,<15>,<60>,<550.6>, <1079.4>, <40> , <12.67>,<12:10:01>,<42.1526>, <73.8061>,<102.5>,<22>,<75>,<82>,<35>,<6>,<7>

Data will be transmitted at a rate of 1 Hz in bursts.

The telemetry data file shall be named as follows:
Flight_<6160>.csv

The presented telemetry format match the Competition Guide requirements

Payload Telemetry Format (2 of 4)

<TEAM ID>	is the assigned team identification
<MISSION TIME>	is the time since initial power up in seconds.
<PACKET COUNT>	is the count of transmitted packets, which is to be maintained through processor reset.
<ALTITUDE>	is the altitude in units of meters and must be relative to ground level. The resolution must be 0.1 meters.
<PRESSURE>	is the measurement of atmospheric pressure in units of pascals. The resolution must be 0.1 pascals.
<TEMP>	is the sensed temperature in degrees C with one tenth of a degree resolution.
<VOLTAGE>	is the voltage of the CanSat power bus. The resolution must be 0.01 volts.
<GPS TIME>	is the time generated by the GPS receiver. The time must be reported in UTC and have a resolution of a second.
<GPS LATITUDE>	is the latitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees

Payload Telemetry Format (3 of 4)

<GPS LONGITUDE>	is the longitude generated by the GPS receiver in decimal degrees with a resolution of 0.0001 degrees.
<GPS ALTITUDE>	is the altitude generated by the GPS receiver in meters above mean sea level with a resolution of 0.1 meters
<GPS SATS>	is the number of GPS satellites being tracked by the GPS receiver. This must be an integer number.
<PITCH>	is the tilt angle in the pitch axis in degrees. The resolution must be 1 degree.
<ROLL>	is the tilt angle of the roll axis in degrees. The resolution must be 1 degree.
<BLADE SPIN RATE>	is the rate the auto-gyro blades spin relative to the science payload. The units must be in revolutions per minute (rpm). The resolution must be 1 rpm.
<SOFTWARE STATE>	is the operating state of the software. (boot, idle, launch detect, deploy, etc.)
<BONUS DIRECTION>	is the direction the camera is pointed relative to earth's magnetic north specified in degrees.

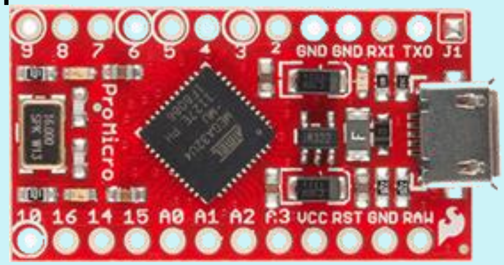
Payload Telemetry Format (4 of 4)

INCOMING DATA TO GROUND STATION

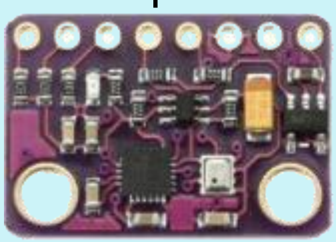
REAL-TIME PLOTTING	JUST SHOWN	OTHER
ALTITUDE	TEAM ID	GPS LATITUDE (SHOW ON MAP)
PRESSURE	MISSION TIME	GPS ALTITUDE (SHOW ON MAP)
TEMP	PACKET COUNT	GPS LONGITUDE (SHOW ON MAP)
VOLTAGE	SOFTWARE STATE	PITCH (SHOW IN 3D)
BLADE SPIN RATE	GPS TIME	ROLL (SHOW IN 3D)
BONUS DIRECTION	GPS SATS	

Container CDH Overview

ARDUINO PRO MICRO : Required for release mechanism,calculate altitude and buzzer operation



ELECTRONIC COMPONENTS : IMU-10DOF is required to measure pressure and temperature.



**SD CARD : ** It will be used to save taken data from IMU-10DOF

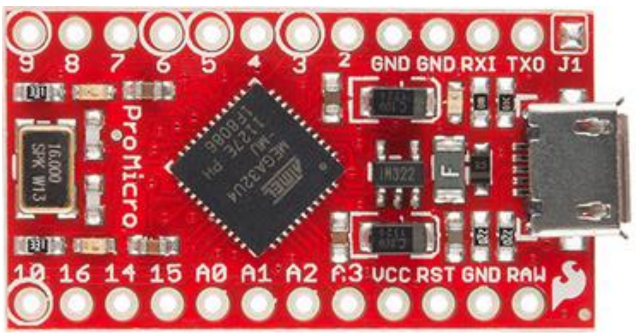
Container CDH Requirements

Requirement Number	Requirement	Rationale	Priority	VM			
				A	I	T	D
RN#7	The CanSat shall deploy from the rocket payload section and immediately deploy the container parachute.	Competition Requirement	HIGH	√	√		
RN#8	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	Competition Requirement	HIGH	√	√		
RN#9	The container shall release the payload at 450 meters +/- 10 meters.	Competition Requirement	HIGH			√	√
RN#11	The descent rate of the science payload after being released from the container shall be 10 to 15 meters/second.	Competition Requirement	HIGH	√	√		
RN#55	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Competition Requirement	HIGH	√	√		

Container Processor & Memory Trade & Selection (1 of 2)

Processor	Boot Time (Seconds)	Processor Speed (MHz)	RAM (Byte)	Flash Memory (kB)	Operating Voltage (V)	Data Interface	Price ($)
ATTiny85	5	16	512	8	4.5 - 5.5	-4 Analog Pins -6 Digital Pins -3 PWM Pins	3.5
Arduino Pro Micro	7-9	16	2048	32	5	-4 Analog Pins -12 Digital Pins -5 PWM Pins	19.95

SELECTED MODEL	REASON FOR SELECTION
Arduino Pro Micro	High flash memory
	More pin count
	High RAM capacity



Container Processor & Memory Trade & Selection (2 of 2)

Model	Memory (GB)	Interface	Speed (Mb/s)		Price ($)
			Write	Read	
SanDisk Ultra	4	SPI	75	80	5
Link Tech	4	SPI	30 - 45	30 - 45	6
Team Class6	8	SPI	30	40	8

SELECTED MODEL	REASON FOR SELECTION
SanDisk Ultra	Cheaper than others
	Faster than others
	Suitable storage capacity

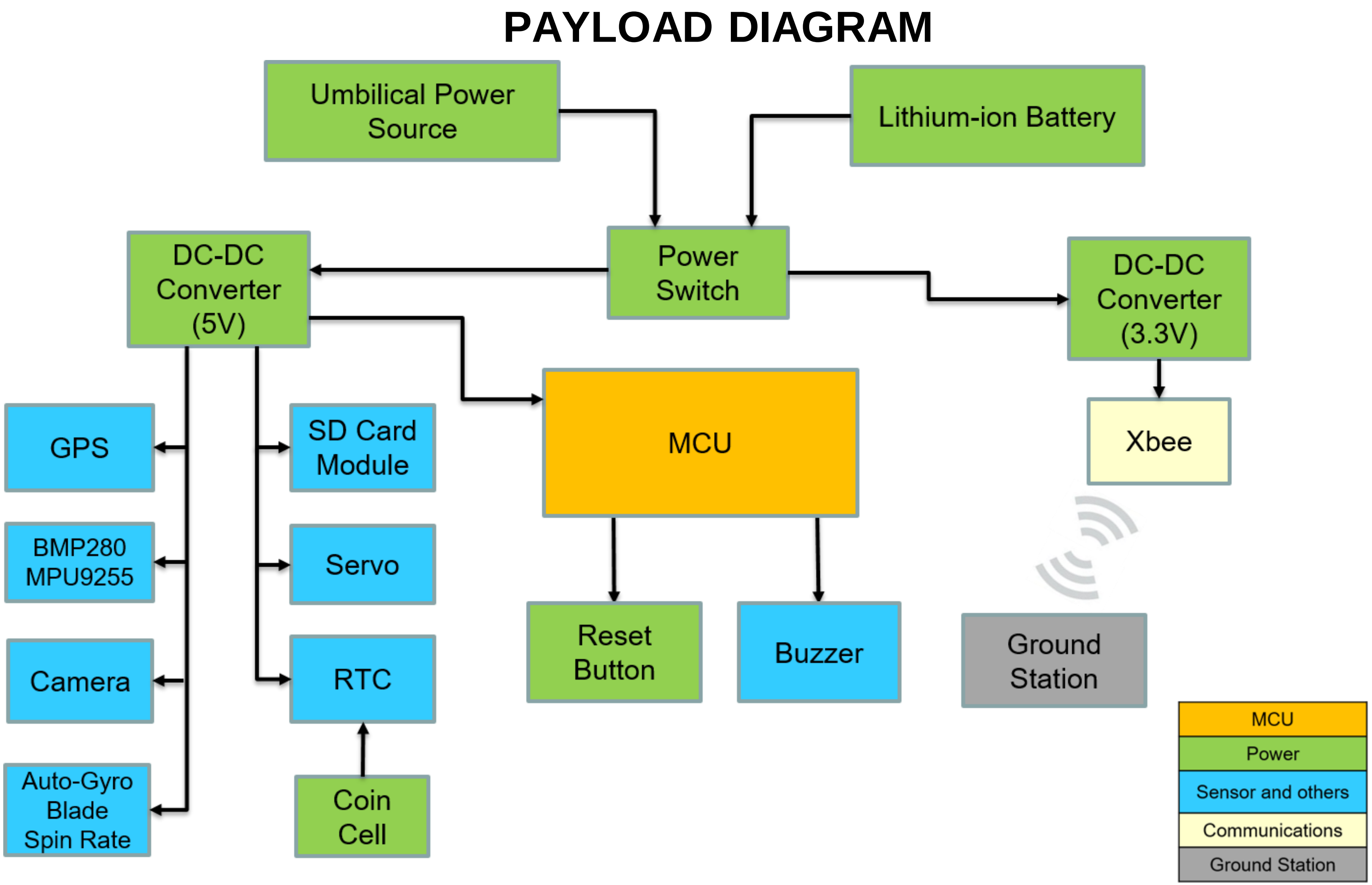
SD card is used with **Arduino Micro SD card Module (SPI)**

Electrical Power Subsystem (EPS) Design

Ayşe EROGLU

PAYLOAD COMPONENTS

- All sensors in the payload will be connected to the MCU with powered by a lithium-ion battery.
- A 3V battery will also be used for the RTC.
- An external on/off switch is used to control system power for payload.
- We will be obtained to 3.3V via voltage regulator and Xbee will be supplied with this voltage value.
- The battery voltage is measured by the Arduino Nano analog pin.
- We will use reset button for payload reset.
- The voltage regulator is used to arrange voltage arriving from the battery.
- Temperature, air pressure, altitude and tilt will be taken from the IMU sensor powered by 5V line.
- We will use a servo motor with powered by 5V line for camera stabilization.
- The blade spin rate of the propeller will be measured with a hall effect sensor.
- The umbilical power source is used for the external supply.
- 92 dB buzzer will be used for Payload recovery.
- We will use GPS with powered by 5V line to find the location of the payload.


PAYLOAD DIAGRAM
Umbilical Power Source
Lithium-ion Battery
DC-DC Converter (5V)
Power Switch
DC-DC Converter (3.3V)
GPS
SD Card Module
MCU
Xbee
BMP280 MPU9255
Servo
Camera
RTC
Reset Button
Buzzer
Ground Station
Auto-Gyro Blade Spin Rate
Coin Cell
MCU
Power
Sensor and others
Communications
Ground Station

CONTAINER COMPONENTS

All sensors in the container will be connected to the Arduino Pro Micro with powered by a lithium-ion battery.

The umbilical power source is used for the external supply.

An external on/off switch is used to control system power for container.

The burn of wire method will be used for separation payload from the container

The battery voltage is measured by the Arduino Pro Micro analog pin.

We will use reset button for container reset.

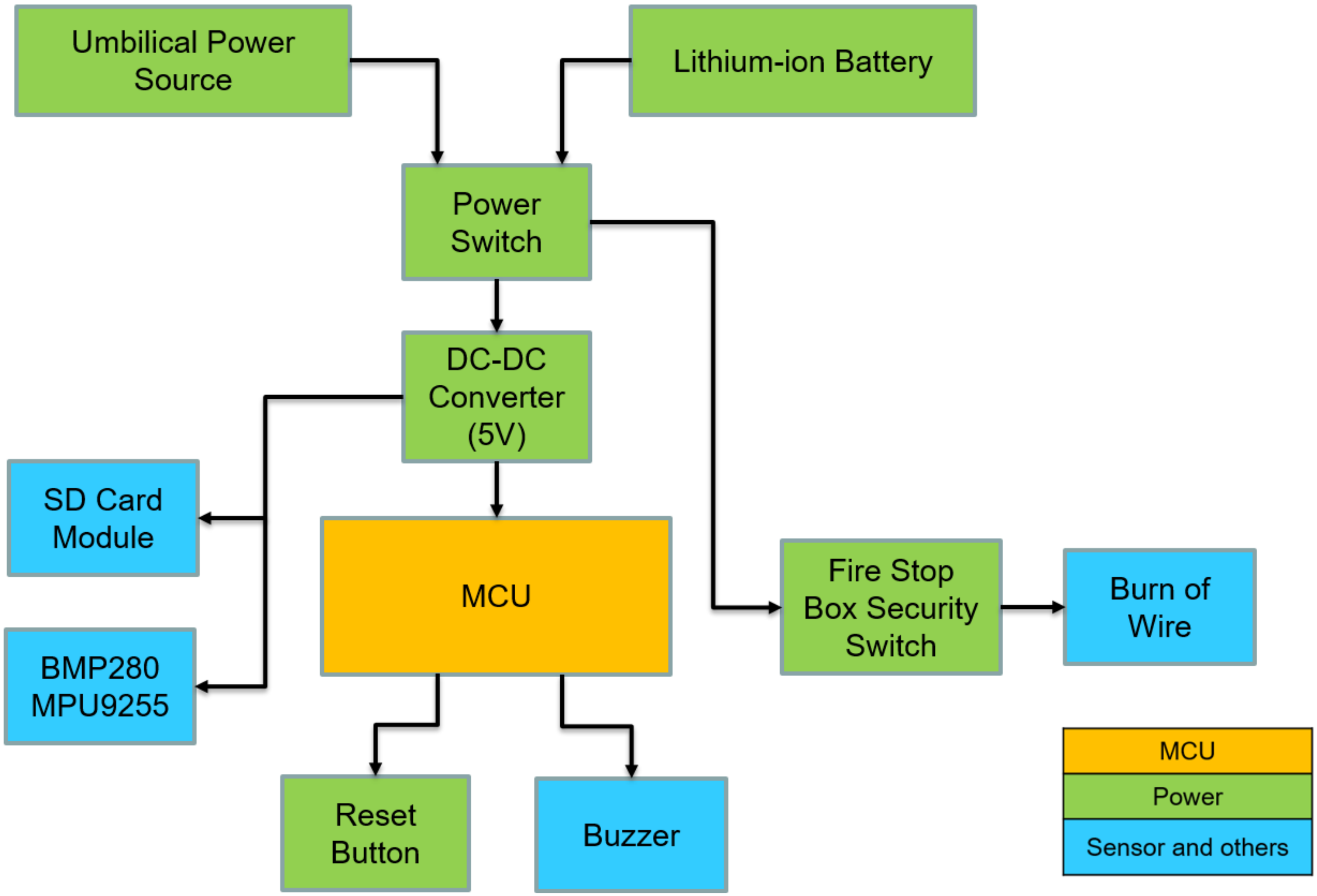
The voltage regulator is used to arrange voltage arriving from the battery.

92 dB buzzer will be used for container recovery.

We will be used IMU with powered by 5V line for separation system control.

EPS Overview (4 of 4)

CONTAINER DIAGRAM



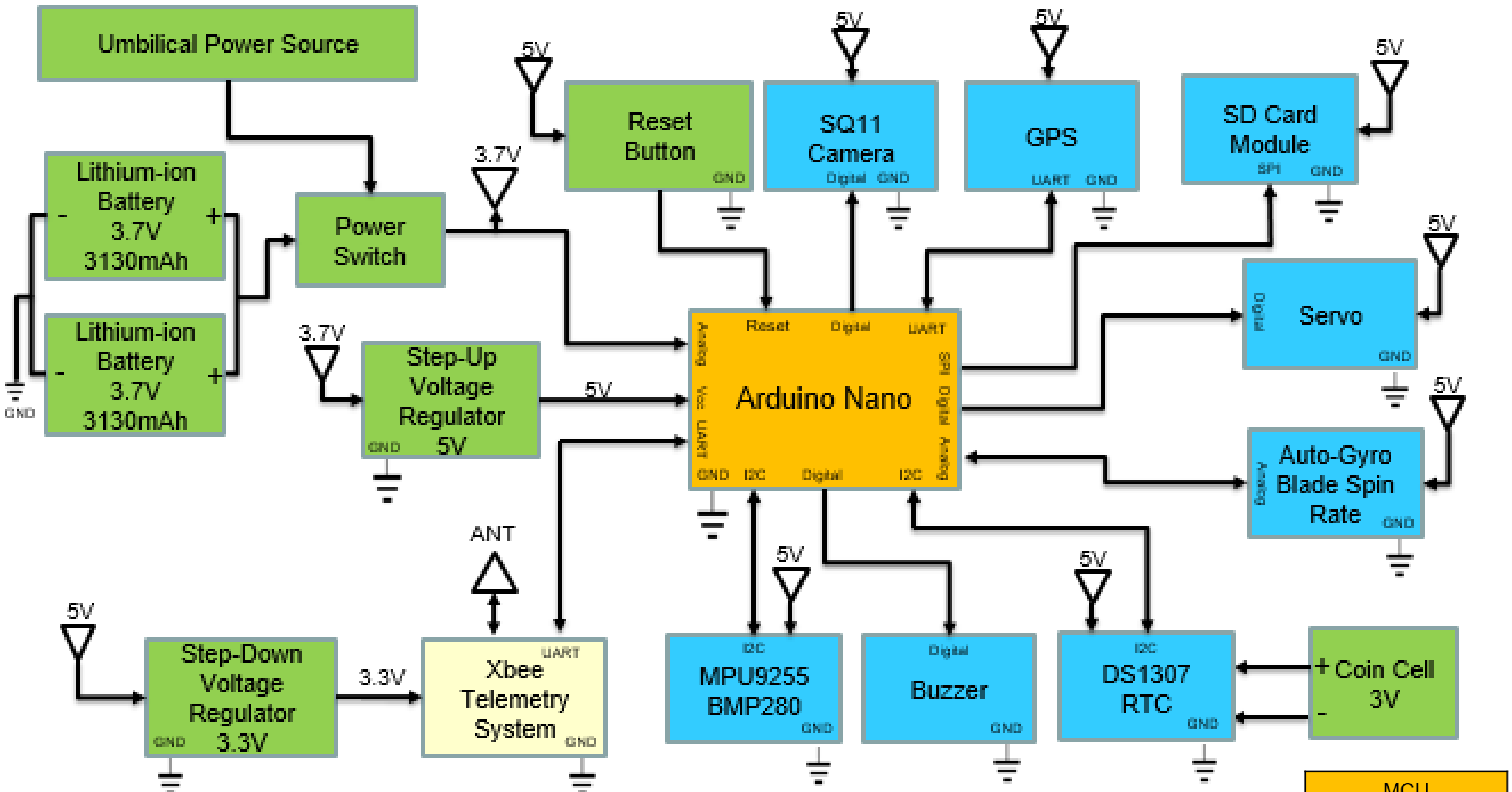
EPS Requirements (1 of 2)

Requirements Number	Requirement	RATIONALE	Priority	VM			
				A	I	T	D
RN#20	The science payload shall measure altitude using an air pressure sensor.	Competition Requirement	HIGH			√	√
RN#22	The science payload shall measure its battery voltage.	Competition Requirement	HIGH			√	√
RN#45	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.	Competition Requirement	MEDIUM	√	√		
RN#46	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	Competition Requirement	MEDIUM	√	√		
RN#47	An audio beacon is required for the probe. It may be powered after landing or operate continuously.	Competition Requirement	HIGH	√		√	√

EPS Requirements (2 of 2)

Requirements Number	Requirement	RATIONALE	Priority	VM			
				A	I	T	D
RN#49	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells.	Competition requirement	HIGH	√	√		
RN#51	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Competition requirement	MEDIUM	√			
RN#52	The auto-gyro descent control shall not be motorized. It must passively rotate during descent.	Competition requirement	HIGH	√		√	√
RN#55	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Competition requirement	HIGH	√	√		

Payload Electrical Block Diagram



- Electronic system will be on/off by a switch.
- When the system is powered on, the led turn light.
- Buzzer will be activated for 1 second.

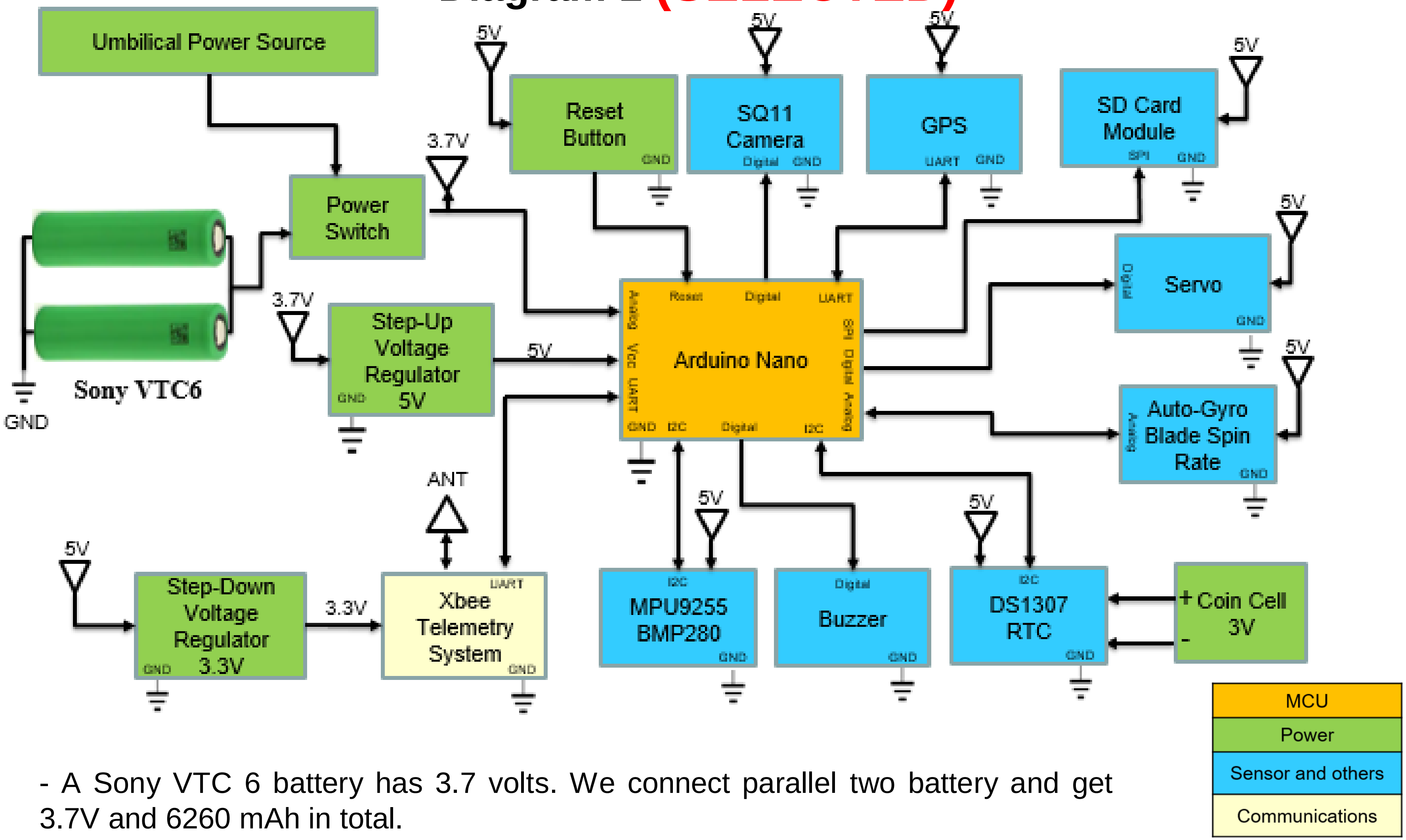
MCU
Power
Sensor and others
Communications

Payload Power Trade & Selection (1 of 3)

Battery	Voltage(V)	Current (mAh)	Weight (g)	Dimension (mm)	Price ($)	Battery Chemistry
Sony VTC6	3.7	3130	48.50	18.25 x 65.00	6.70	Lithium-ion
GP ReCyko+	1.2	800	42.5	48.8 x 26	4.8	Nickel-Metal-Hyride (Ni-MH)

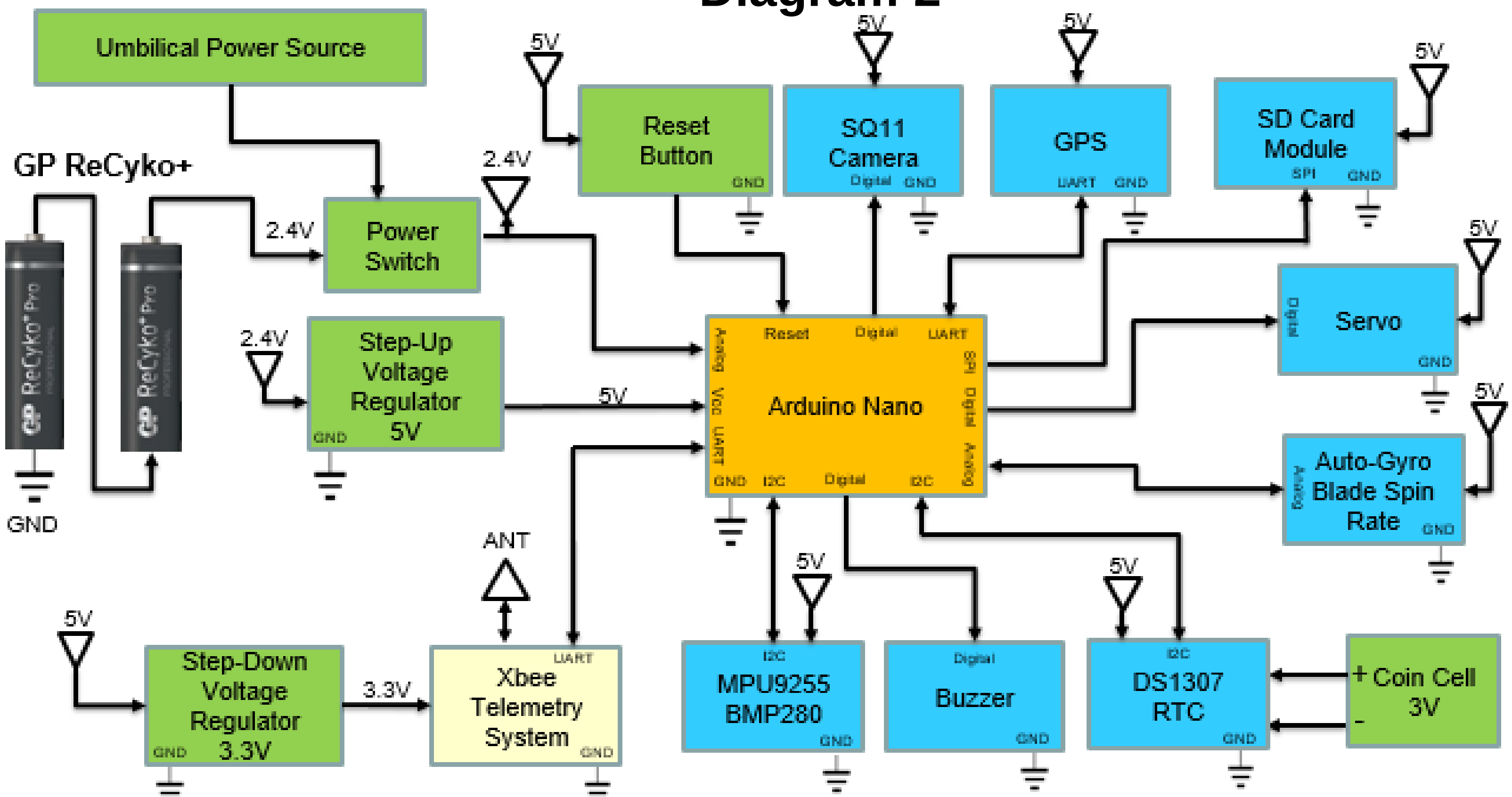
Selected Battery	Why
SONY VTC 6	Very high capacity.
	Better price/performance ratio.
	High power density than other.
	Suitable power/weight ratio.

Diagram 1 (SELECTED)



- A Sony VTC 6 battery has 3.7 volts. We connect parallel two battery and get 3.7V and 6260 mAh in total.

Diagram 2



- GP ReCyko+ battery has 1.2 volts. We connect series two battery and get 2.4V and 800 mAh in total.

- We select battery in Diagram 1 . Because in the second option, the current is low. We get more current and more operating time Diagram 1.

MCU
Power
Sensor and others
Communications

Payload Power Budget (1 of 3)

Components	Power Consumption (Wh)	Current (mA)	Voltage (V)	Duty Cycles (hr:min:sec)	Source
Microcontroller	0.19	19	5	02:00:00	Data sheet
DS 1307 RTC	0.000003	0.0003	5	02:00:00	Data sheet
Buzzer	0.1	80	5	00:15:00	Data sheet
SQ11-Camera	0.033	200	5	00:02:00	Measurement
10-DOF IMU (BMP280, MPU9255)	0.0442	4.42	5	02:00:00	Data sheet
Telemetry Module	2.244	340	3.3	02:00:00	Data sheet
Neo 7M GPS	0.4	40	5	02:00:00	Data sheet
SD Card Module	0.00016	0.016	5	02:00:00	Measurement
Servo	0.165	1000	5	00:02:00	Data sheet
Auto-Gyro Blade Spin Rate	0.05	5	5	02:00:00	Data sheet

Payload Power Budget (2 of 3)

Avaible Power(Max)	23.162Wh
Total Power Consumption	3.226Wh
Margins	19.93Wh

Avaible Power(Max) - Total Power Consumption = Margins

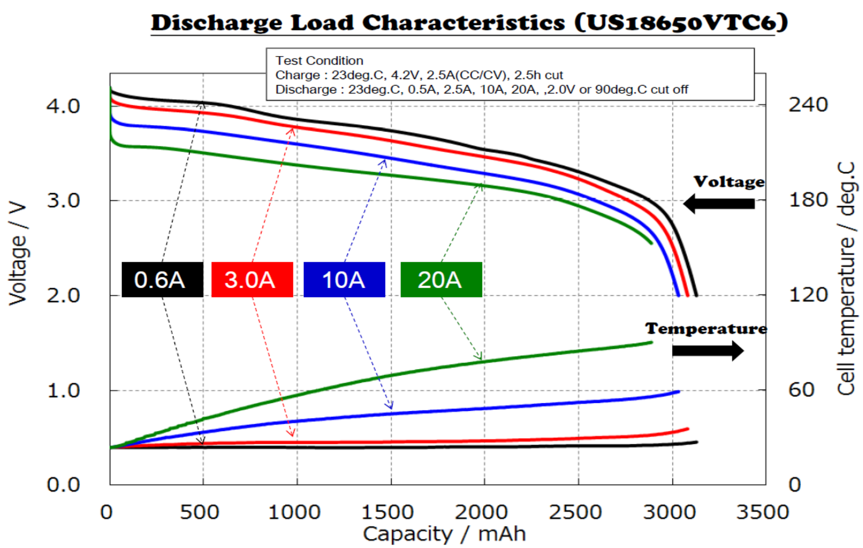
- **The margin is changing showed according to the current consumption by sensors at different work temperature.**

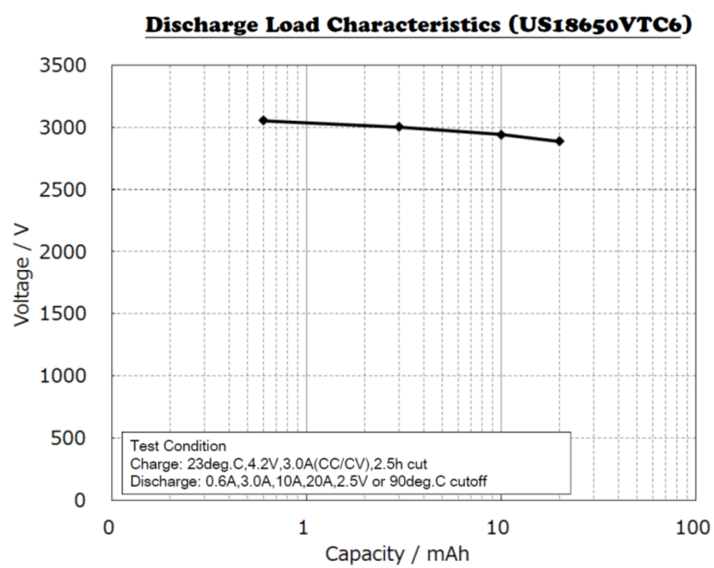
Payload Power Strategy:

(Battery Capacity(Max) / Current Consumption) * 0.707 = Battery operating time

((6260mAh) / (1688.439mA))*0.707 = 2.62h

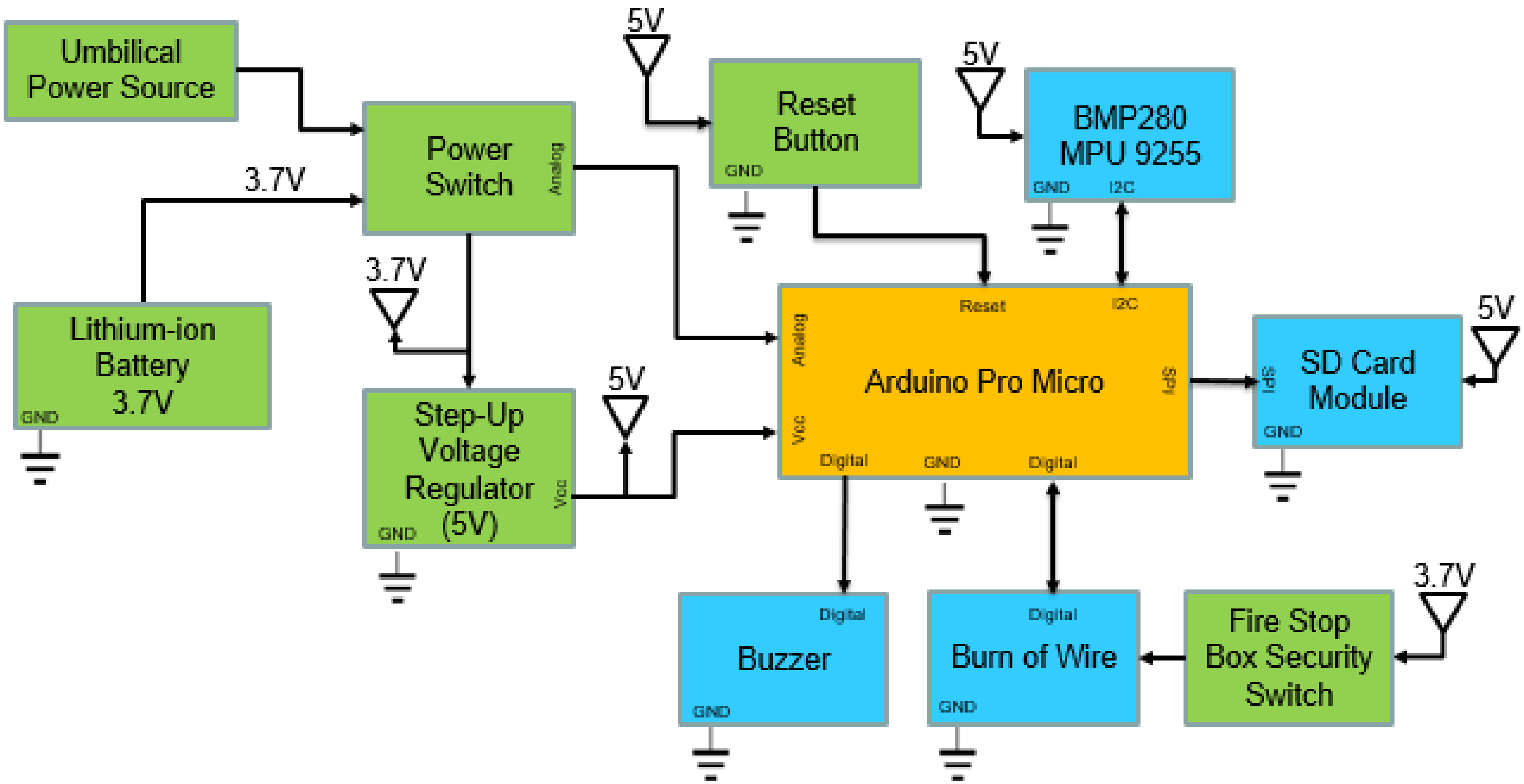
- **The system will be powered directly with a battery.**
- **The system will work for more than two hours.**





Source: Sony VTC 6 Data sheet

Container Electrical Block Diagram



- Electronic system will be on/off by a switch.
- When the system is powered on, the led turn light.
- Buzzer will be activated for 1 second.

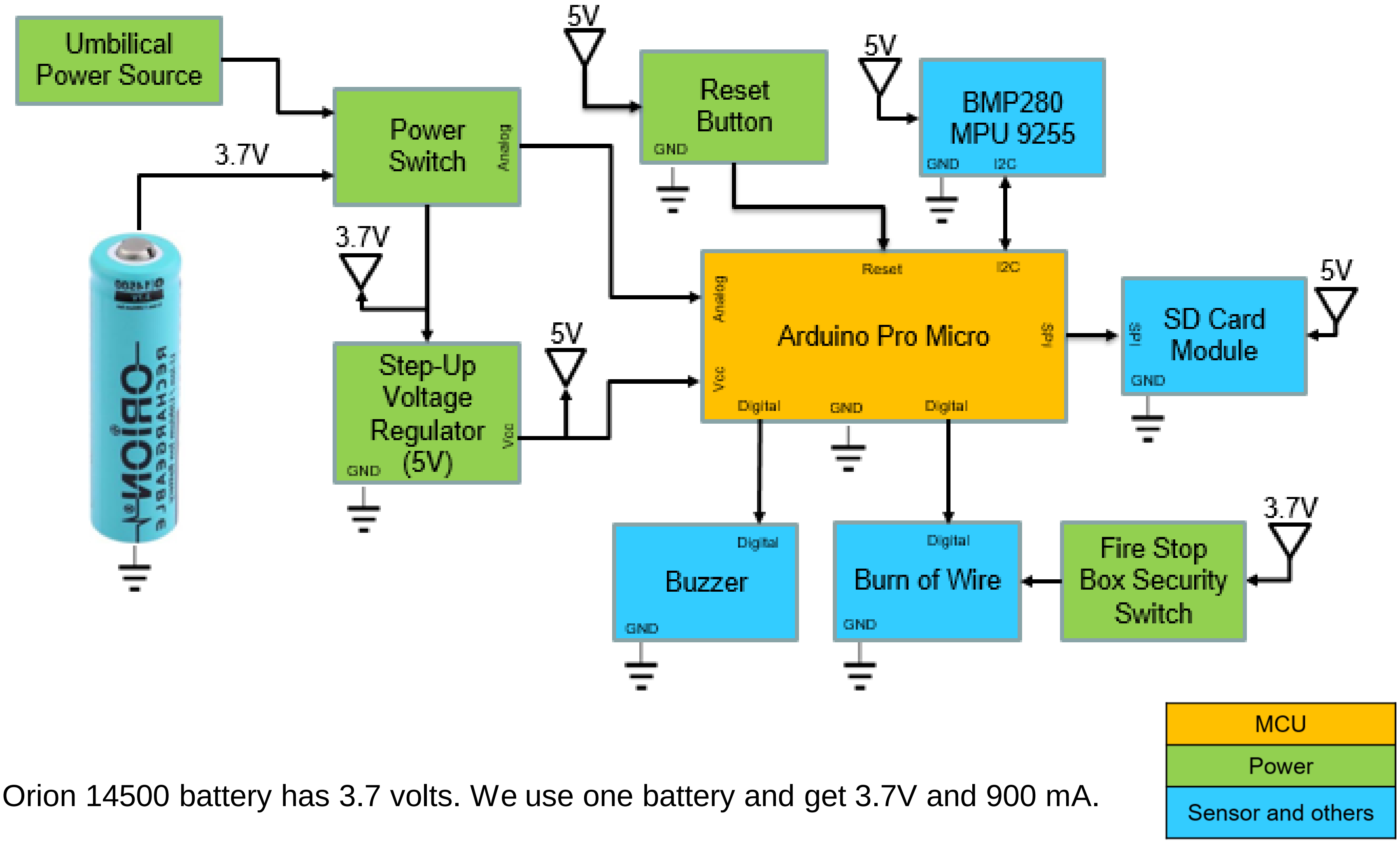
MCU
Power
Sensor and others

Container Power Trade & Selection (1 of 3)

Battery	Voltage (V)	Current (mAh)	Weight (g)	Dimension (mm)	Price ($)	Battery Chemistry
ORION 14500 AA	3.7	900	19.5	14.5 x 50.0	3.76	Lithium-ion
Duracell DL223	6	1400	38	36 x 35	7.05	Lithium

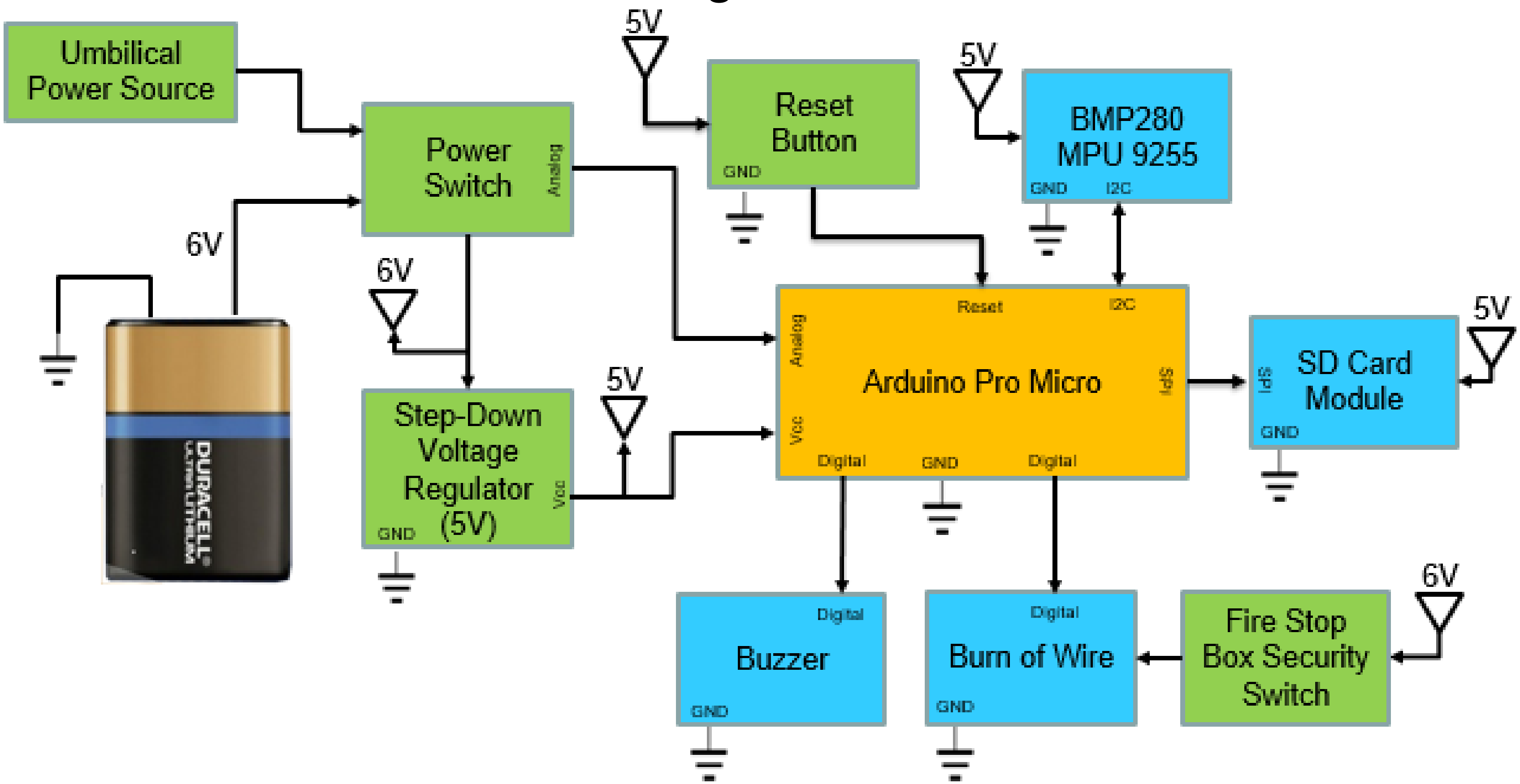
Selected Battery	Why
ORION 14500 AA	Low weight.
	Suitable capacity.
	Better price/performance ratio.
	Suitable voltage

Diagram 1 (SELECTED)



- A Orion 14500 battery has 3.7 volts. We use one battery and get 3.7V and 900 mA.

Diagram 2



MCU
Power
Sensor and others

- A Duracell DL223 battery has 6 volts. We use one battery and get 6V and 1400 mA.
- **We select battery in Diagram 1 because sufficient current and sufficient voltage values are provided.**

Container Power Budget

Components	Power Consumption (Wh)	Current (mA)	Voltage (V)	Duty Cycles (hr:min:sec)	Source
Microcontroller	0.19	19	5	02:00:00	Data sheet
10-DOF IMU (BMP280, MPU9255)	0.0442	4.42	5	02:00:00	Data sheet
Burn of Wire	0.001946	1400	3.7	00:00:01	Measurement
Buzzer	0.1	80	5	00:15:00	Data sheet
SD Card Module	0.00016	0.016	5	02:00:00	Measurement

Avaible Power(Max)	3.33 Wh
Total Power Consumption	0.34 Wh
Margins	2.99Wh

Avaible Power(Max) - Total Power Consumption = Margins

- The margin is changing showed according to the current consumption by sensors at different work temperature.

Payload Power Strategy:

(Battery Capacity(Max) / Current Consumption)*0.707 = Battery operating time

(900mAh / 54.43mA)*0.707=11.69h

- The system will be powered directly with a battery.
- The system will work for more than two hours.
- The Burn of wire method draw current less than one second so this current is not calculated.

Flight Software (FSW) Design

Feyzullah HASAR

FSW Overview (1 of 4)

- **Overview of the CanSat FSW design**

The necessary data from the sensors will be transmitted to the MCU. The data will be stored on the SD-card and transmitted to the ground station via XBee.

- **Programming languages**

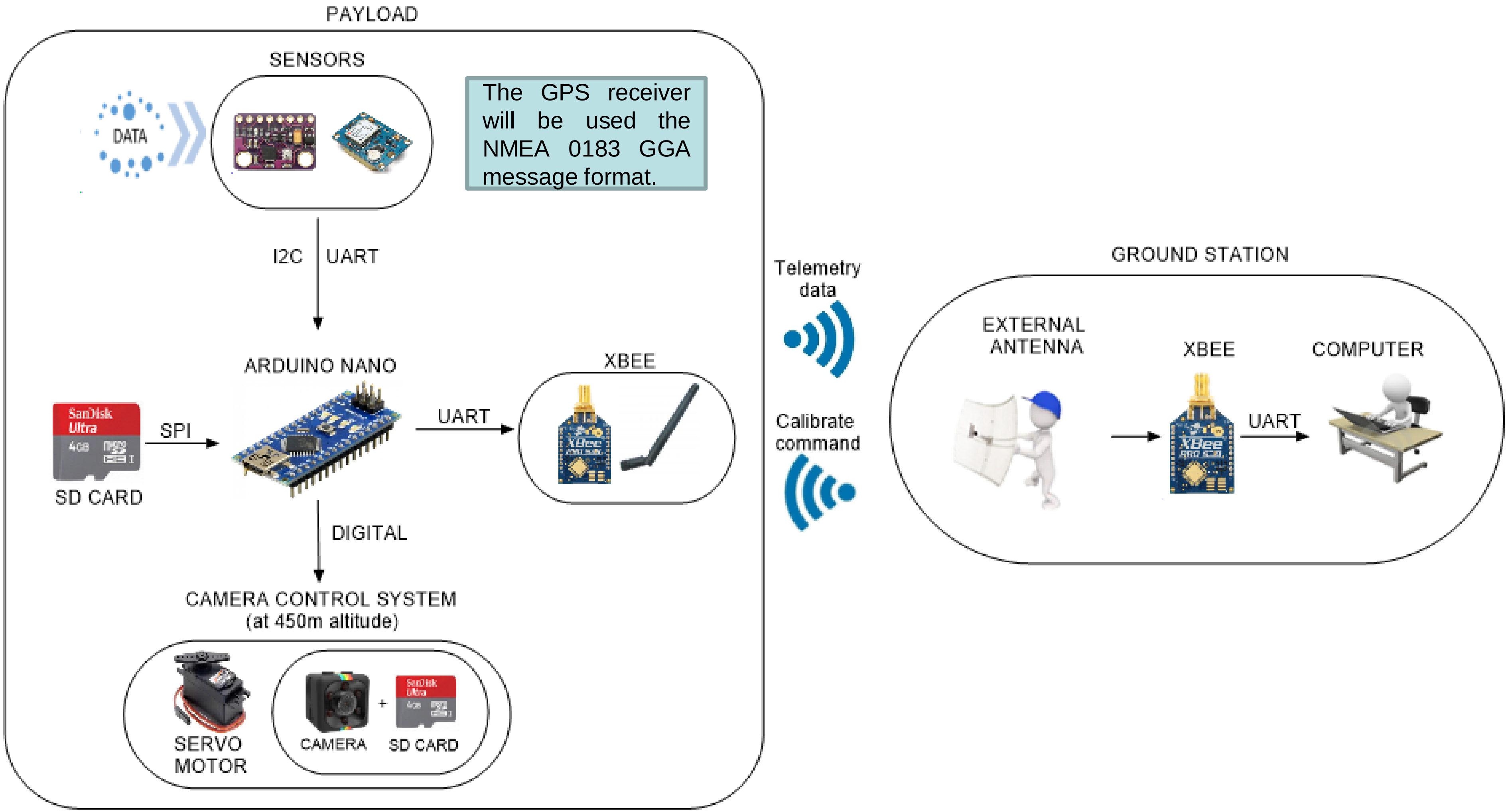
C/C++ programming languages

- **Development environments**

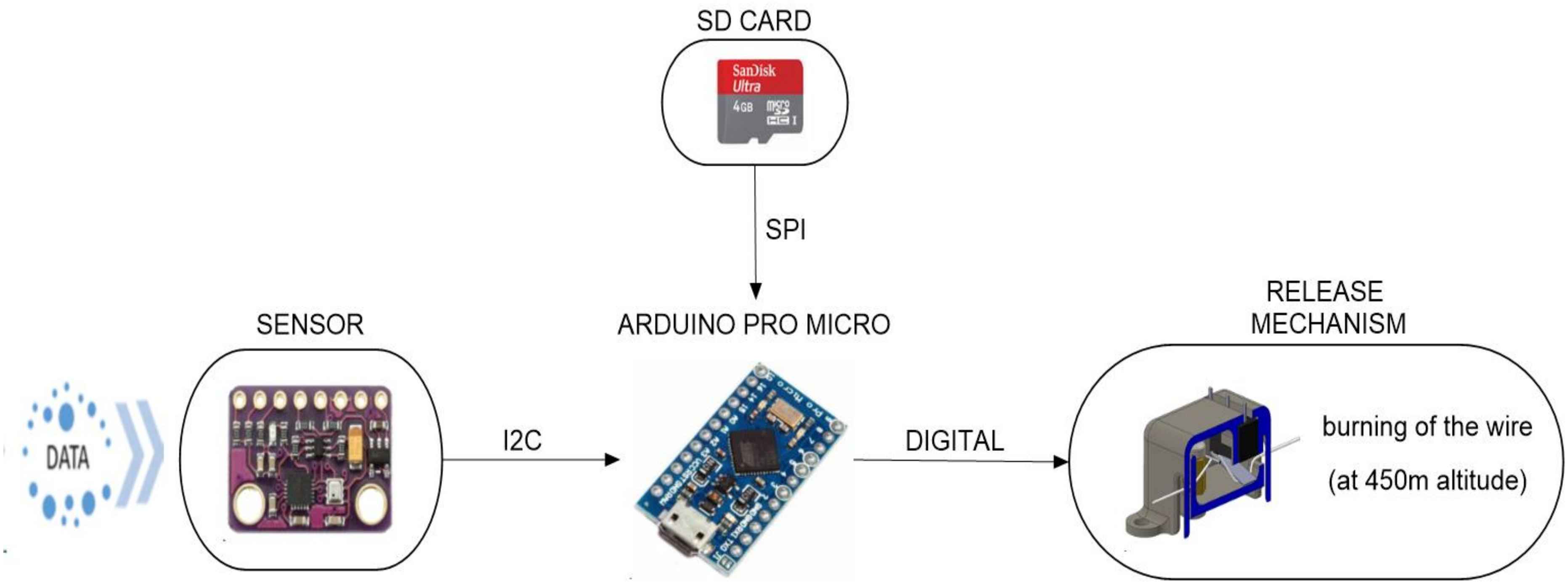
Arduino IDE

ClickCharts by NCH software

- **FSW Design of Basic Flow Chart for Payload**



- **FSW Design of Basic Flow Chart for Container**



FSW Overview (4 of 4)

- **Brief summary FSW tasks**

- ✓ The electronic system is activated by the power (on / off) button.
- ✓ If "System calibrate" command is received from ground station, EEPROM will be reset, the reference altitude will be determined, roll and pitch angles to zero and system will be calibrated.
- ✓ The data will be gathered from sensors in the container. Those will be saved to the SD card in the container.
- ✓ All necessary data gathered from the sensors will be sent to the ground station in real time via XBee. All necessary data simultaneously will be saved in the on SD card that place in the payload.
- ✓ CanSat will launch with the rocket and will release from the rocket after completing the rocket rise and then the parachute will be opened.
- ✓ The payload will be released from container via burning of wire at 450 meters (+/-10 meters). Then it will start record video in payload.
- ✓ The buzzer will become activated when the altitude drop below 5 m. Data transmission will be stopped. The buzzer will continue to be heard until the electronic system is turned off by the power (on / off) button.
- ✓ The mission will be completed.

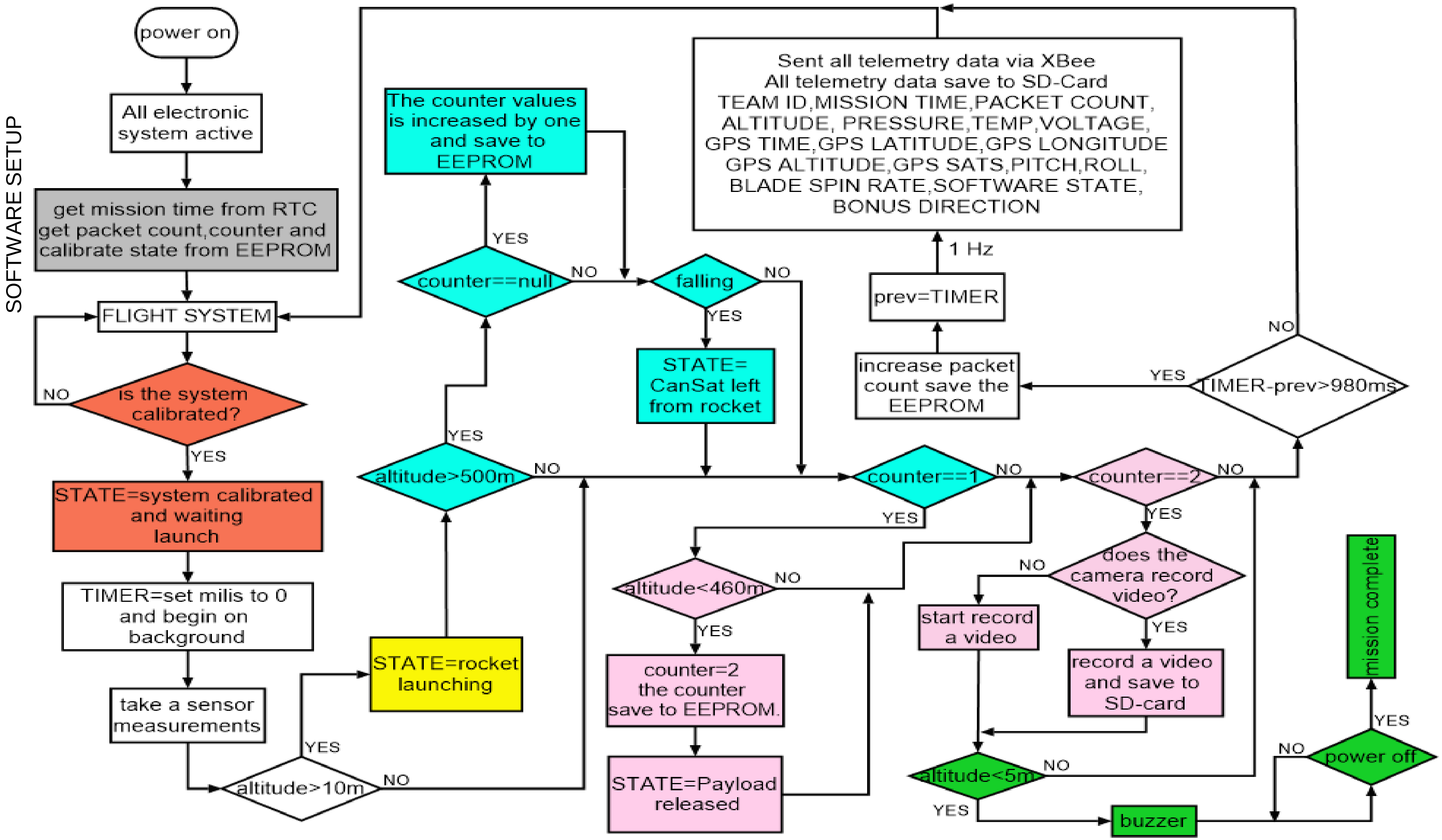
FSW Requirements (1 of 2)

Number	Desciption	Rationale	Priority	VM			
				A	I	T	D
RN#9	The container shall release the payload at 450 meters +/- 10 meters.	Competition Requirement.	HIGH		✓	✓	
RN#20	The science payload shall measure altitude using an air pressure sensor	Competition Requirement	HIGH			✓	✓
RN#21	The science payload shall provide position using GPS.	Competition Requirement	HIGH			✓	✓
RN#22	The science payload shall measure its battery voltage.	Competition Requirement	HIGH			✓	✓
RN#23	The science payload shall measure outside temperature.	Competition Requirement	HIGH			✓	✓
RN#24	The science payload shall measure the spin rate of the auto-gyro blades relative to the science vehicle.	Competition Requirement	HIGH			✓	✓
RN#25	The science payload shall measure pitch and roll	Competition Requirement	HIGH			✓	✓
RN#26	The probe shall transmit all sensor data in the telemetry	Competition Requirement	HIGH			✓	✓

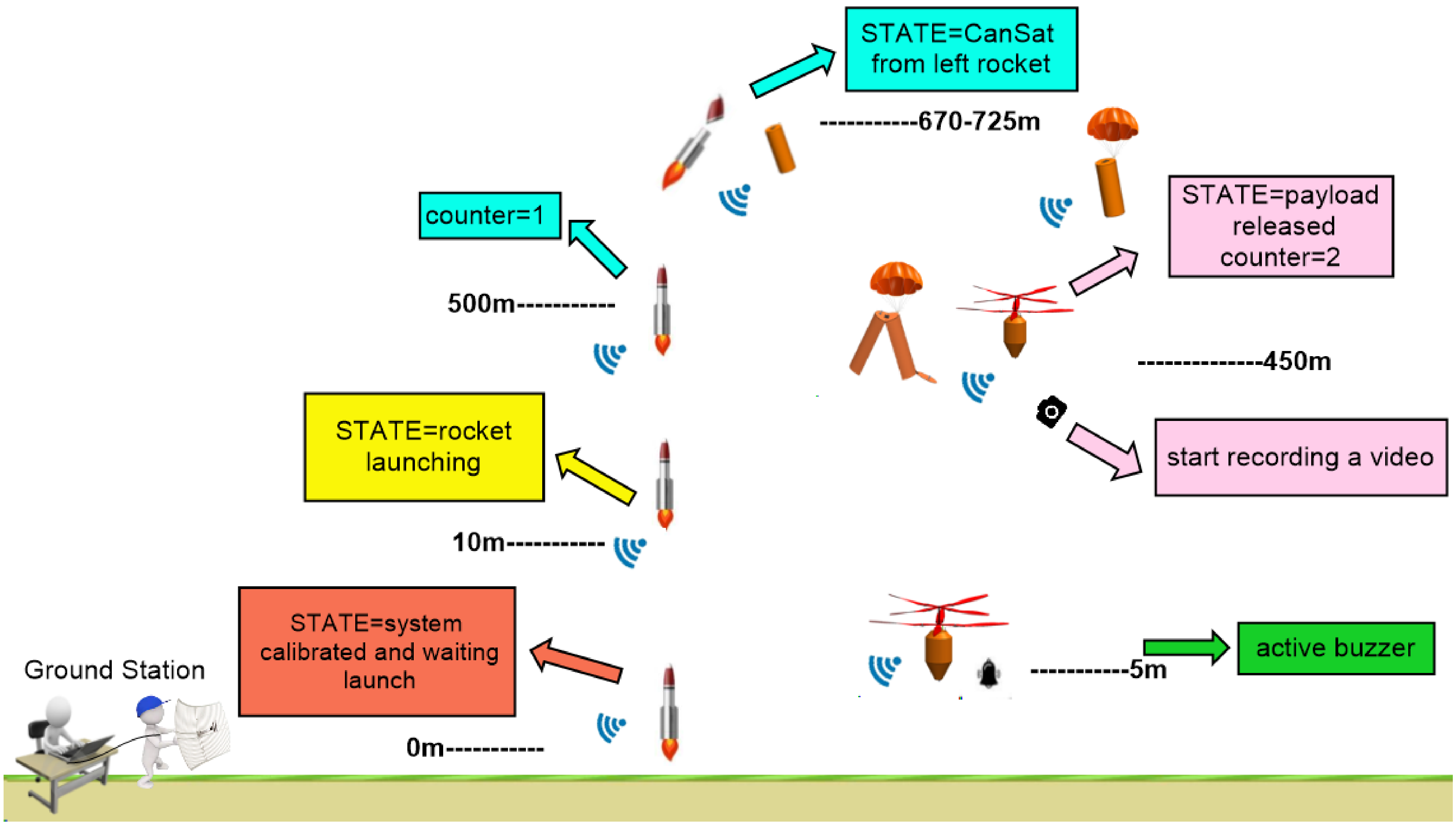
FSW Requirements (2 of 2)

Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN#28	The ground station shall be able to command the science vehicle to calibrate barometric altitude, and roll and pitch angles to zero as the payload sits on the launch pad.	Competition Requirement	HIGH	✓		✓	
RN#30	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission	Competition Requirement	HIGH	✓			
RN#36	All telemetry shall be displayed in real time during descent.	Competition Requirement	HIGH			✓	✓
RN#37	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Competition requirement.	MEDIUM	✓	✓		
RN#42	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Competition requirement.	HIGH	✓		✓	
RN#53	The GPS receiver must use the NMEA 0183 GGA message format.	Competition requirement.	MEDIUM	✓		✓	✓

Payload FSW State Diagram (1 of 3)



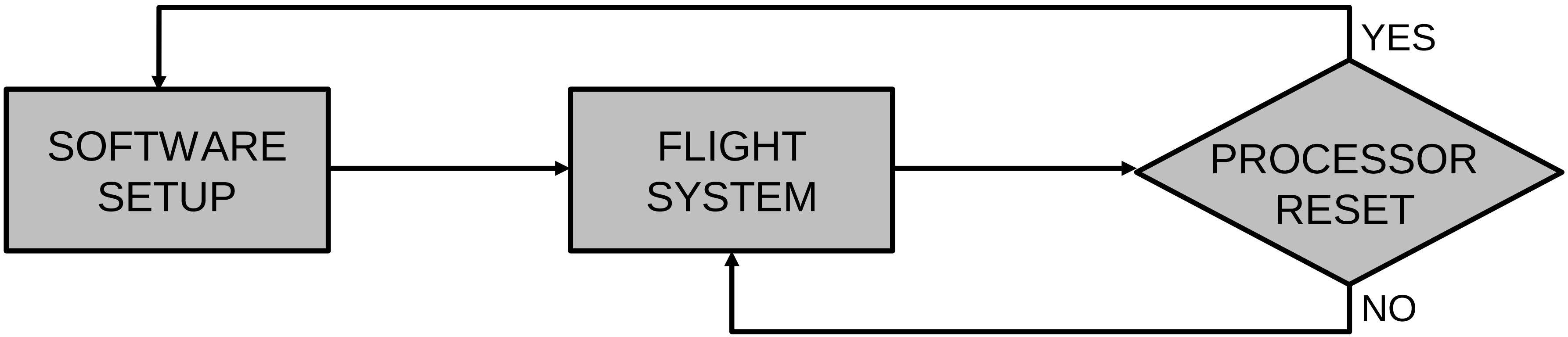
Display of FSW sub functions running during flight according to colors in payload flow chart.



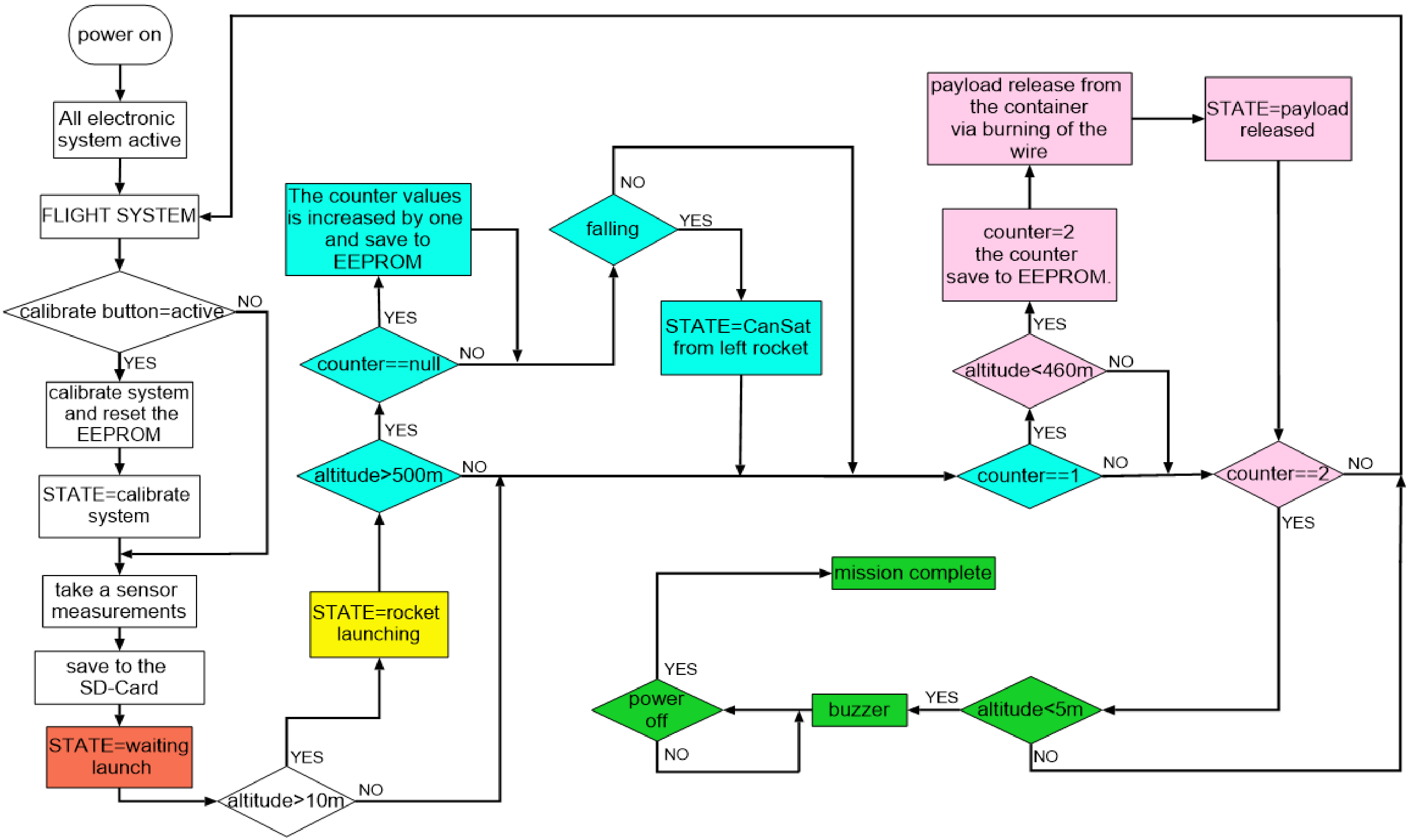
Payload FSW State Diagram (3 of 3)

Processor Reset Control for Payload

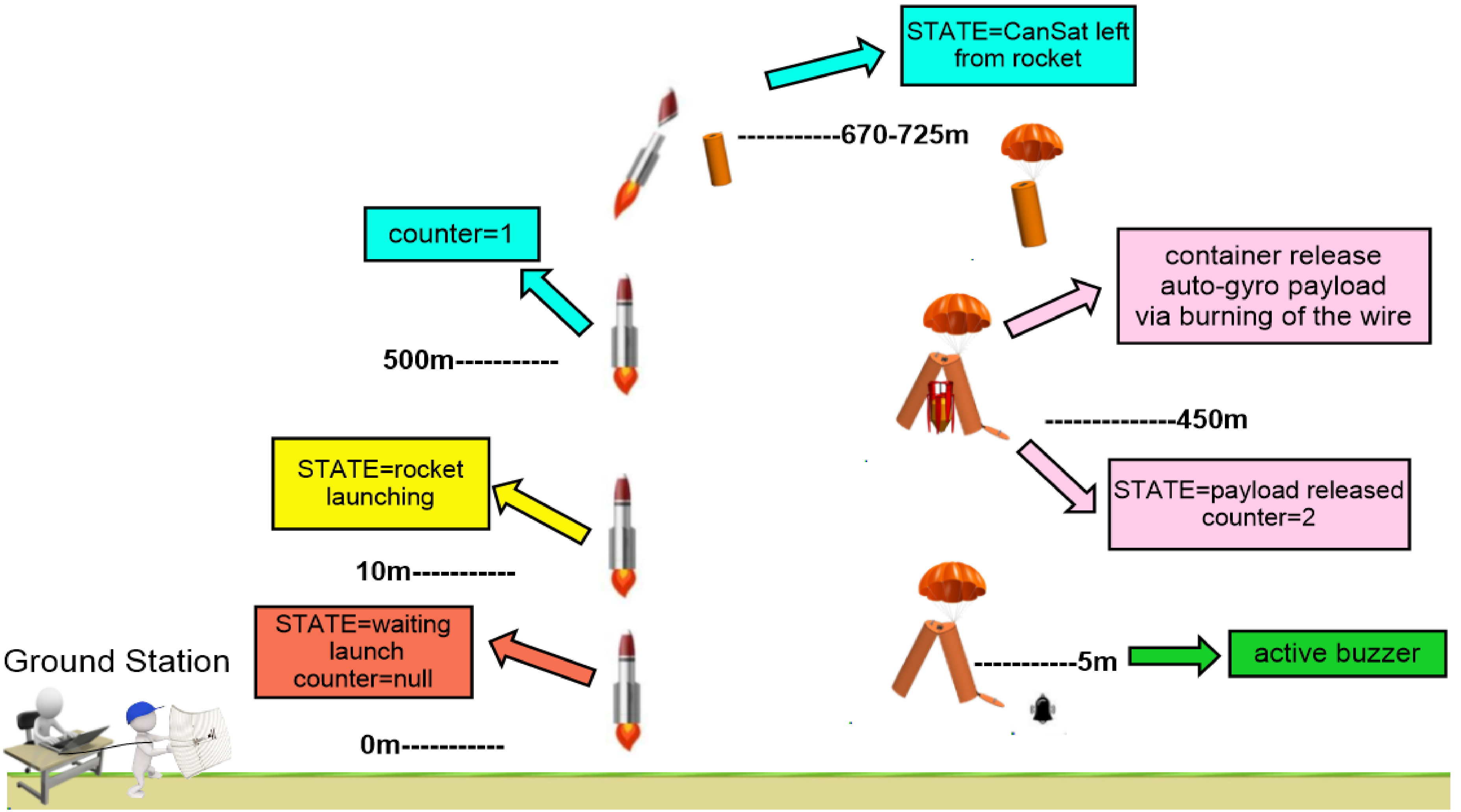
- The processor is reset when there is a temporary power failure.
- The processor save necessary data on its EEPROM, in this way data loss will be prevented.
- The RTC data will be stored in the internal EEPROM of the RTC module. The RTC data will be protected when there is a momentary power failure.
- Mission time, calibrate state, packet count and counter data will be saved in EEPROM.
- If the processor is reset, data recovered in the software installation section.



Container FSW State Diagram (1 of 3)



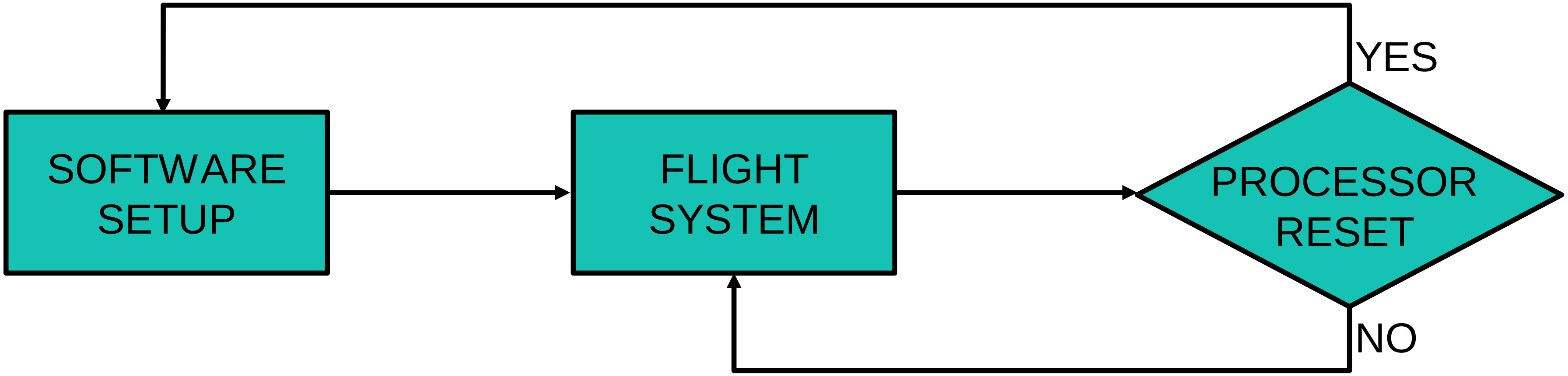
Display of FSW sub functions running during flight according to colors in container flow chart.



Container FSW State Diagram (3 of 3)

Processor Reset Control for Container

- The processor is reset when there is a temporary power failure.
- The processor save necessary data on its internal EEPROM, in this way data loss will be prevented.
- Mission time, packet count and counter data will be saved to EEPROM.



Software Development Plan (1 of 2)

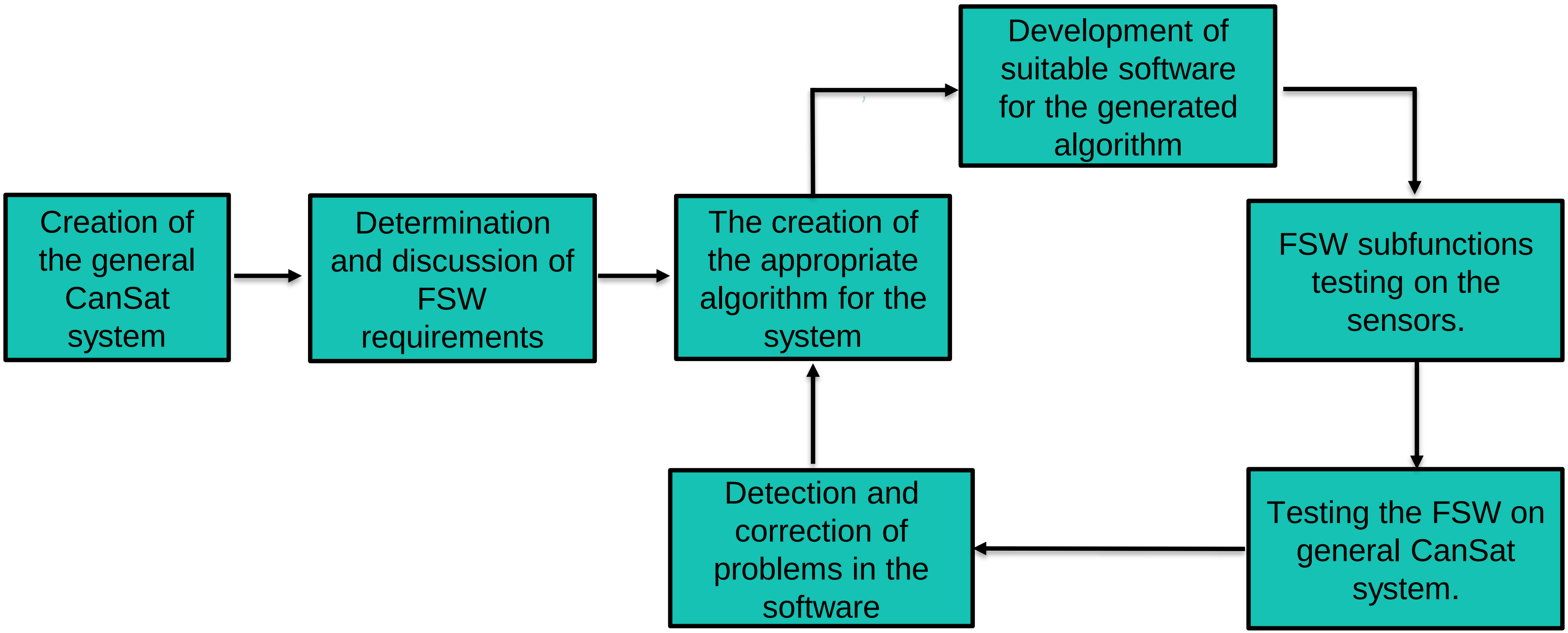
Prototyping and Prototyping Environments

1. The required software is installed in Arduino.
2. Each sensor is tested separately on breadboard.
3. The data stream is checked from the Arduino Serial monitor.

Test Methodology

1. Testing the sensors to be used in the system.
2. Installation of necessary software in Arduino.
3. Checking the accuracy of the data coming from the sensors.
4. Checking whether the FSW meets the CanSat competition requirements.
5. Testing the FSW on the general CanSat system.

Software Subsystem Development Sequence



Development Team

-Sinan GANİZ

-Feyzullah HASAR

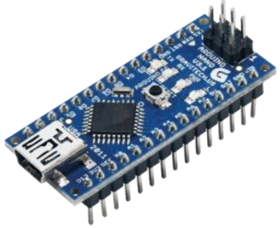
Ground Control System (GCS) Design

Sinan GANİZ

GCS Overview

PAYLOAD

Arduino NANO



XBee Pro S1

Antenna

Data transmission from the payload to the ground station

- XBee Pro S1 in payload transfers data with antenna from arduino nano to the XBee Pro S1 in the ground station.
- Then data are transferred to the computer using the explorer module.

Data transmission from the ground station to the payload

- The calibration command is transmitted from the ground station to the Payload via XBee Pro S1, explorer module and antenna.

Ground Station Antenna

GROUND STATION

Computer

Explorer Module

XBee Pro S1

GCS Requirements (1 of 2)

Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN#28	The ground station shall be able to command the science vehicle to calibrate barometric altitude, and roll and pitch angles to zero as the payload sits on the launch pad.	Competition Requirement	HIGH	✓		✓	
RN#29	The ground station shall generate a csv file of all sensor data as specified in the telemetry section.	Competition Requirement	HIGH	✓		✓	
RN#30	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Competition Requirement	MEDIUM	✓			
RN#31	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Competition Requirement	MEDIUM	✓		✓	
RN#32	XBEE radios shall have their NETID/PANID set to their team number.	Competition Requirement	MEDIUM	✓	✓	✓	
RN#33	XBEE radios shall not use broadcast mode.	Competition Requirement	MEDIUM	✓			
RN#35	Each team shall develop their own ground station.	Competition Requirement	HIGH	✓	✓		

GCS Requirements (2 of 2)

Number	Description	Rationale	Priority	VM			
				A	I	T	D
RN#36	All telemetry shall be displayed in real time during descent.	Competition Requirement	HIGH			✓	✓
RN#37	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Competition Requirement	HIGH	✓	✓		
RN#38	Teams shall plot each telemetry data field in real time during flight.	Competition Requirement	HIGH			✓	✓
RN#39	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Competition Requirement	HIGH	✓		✓	
RN#40	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.	Competition Requirement	HIGH	✓			
RN#42	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Competition Requirement	MEDIUM	✓		✓	
GCS#1	The link budget must be calculated. According to this calculation, antenna selection should be made.	To select the appropriate antenna	HIGH	✓	✓		

GCS Design

SMA Connector

2 mm Header

Hand-Held Antenna

XBee Module

Explorer Module

USB Wire

Computer

Specifications

★ The computer has got at least 2 hours battery power.

- Fan and umbrella will be used to protect the computer from high temperature.
- Power bank using for a fan. (For not to consume the computer battery)
- Updates will be disabled and the computer will be disconnected from the internet.

GCS Antenna Trade & Selection (1 of 3)

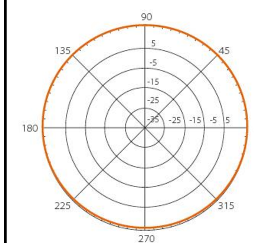
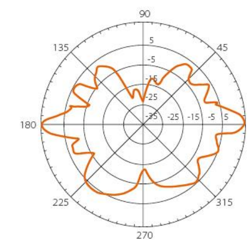
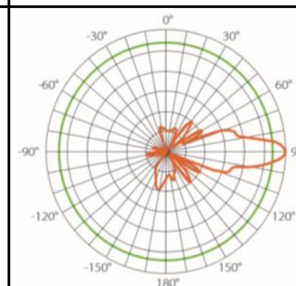
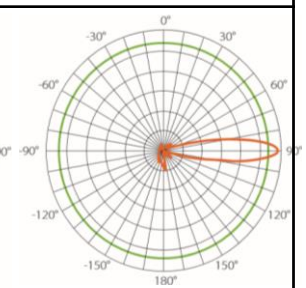
Design for Mounting Antenna

Hand-Held Antenna

Table Top Antenna

Our chosen is hand-held antenna

- Setting angle is important for us because for the signal source (Payload) is moving.

Antenna Image	Model	Spread	Frequency Range (GHz)	Gain (dBi)	Polarization	Antenna Patterns
	TL-ANT2415D	Non Directional	2.4	15	Vertical Horizontal	 Vertical  Horizontal
	TL-ANT2424B	Directional	2.4	24	Vertical Horizontal	 Vertical  Horizontal

Our Chosen Antenna

TL-ANT2424B

Reasons

- Provided the better gain than other antenna.
- We got better results in our tests.
- We used last year, we have experience in this antenna.
- **It is directional antenna.** ★

Simple Link Budget Equation

$$P_{RX} = P_{TX} + G_{TX} + G_{RX} - L_{FS}$$

P_{RX} = Received Power (dBm)
P_{TX} = Transmitter Power Output (dBm)
G_{TX} = Transmitter Antenna Gain (dBi)
G_{RX} = Receiver Antenna Gain (dBi)
L_{FS} = Free Space Loss (dB) = 20 x log(f) + 20 x log(d) + 32.44 dB = 100.04
Fade Margin = L_{FS} (dB) - P_{RX} (dBm) = 44(dB)

Xbee Transmit Power = 18 dBm
Xbee Receiver sensitivity = -100 dBm

f = Frequency (MHz)
d = Distance (km)

$$P_{RX} + \text{Fade Margin} = 18\ dBm + 24\ dBi + 2.1\ dBi + 44\ dB - 100.04\ dB = -\mathbf{11.94\ dBm}$$

Calculated P_{RX} + Fade Margin is -11.94 dBm > -100 dBm, which gives us reliable margin

Telemetry display prototypes

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

Commercial off the shelf software packages used

- Visual Studio (Community Version)
- XCTU (Xbee Program Software (Free))

Real time plotting software design

- With C#, we draw the data we read from the serial port in real time using the graphical structures in XAML.

Calibration command and verify

- The payload will be **calibrated from the ground station.** For this added a button to the GCS interface.
- The calibration verification will be performed according to the telemetry data sent from the barometric sensor and row/pitch angles in the payload to the ground station.

Telemetry data recording and media presentation to judges

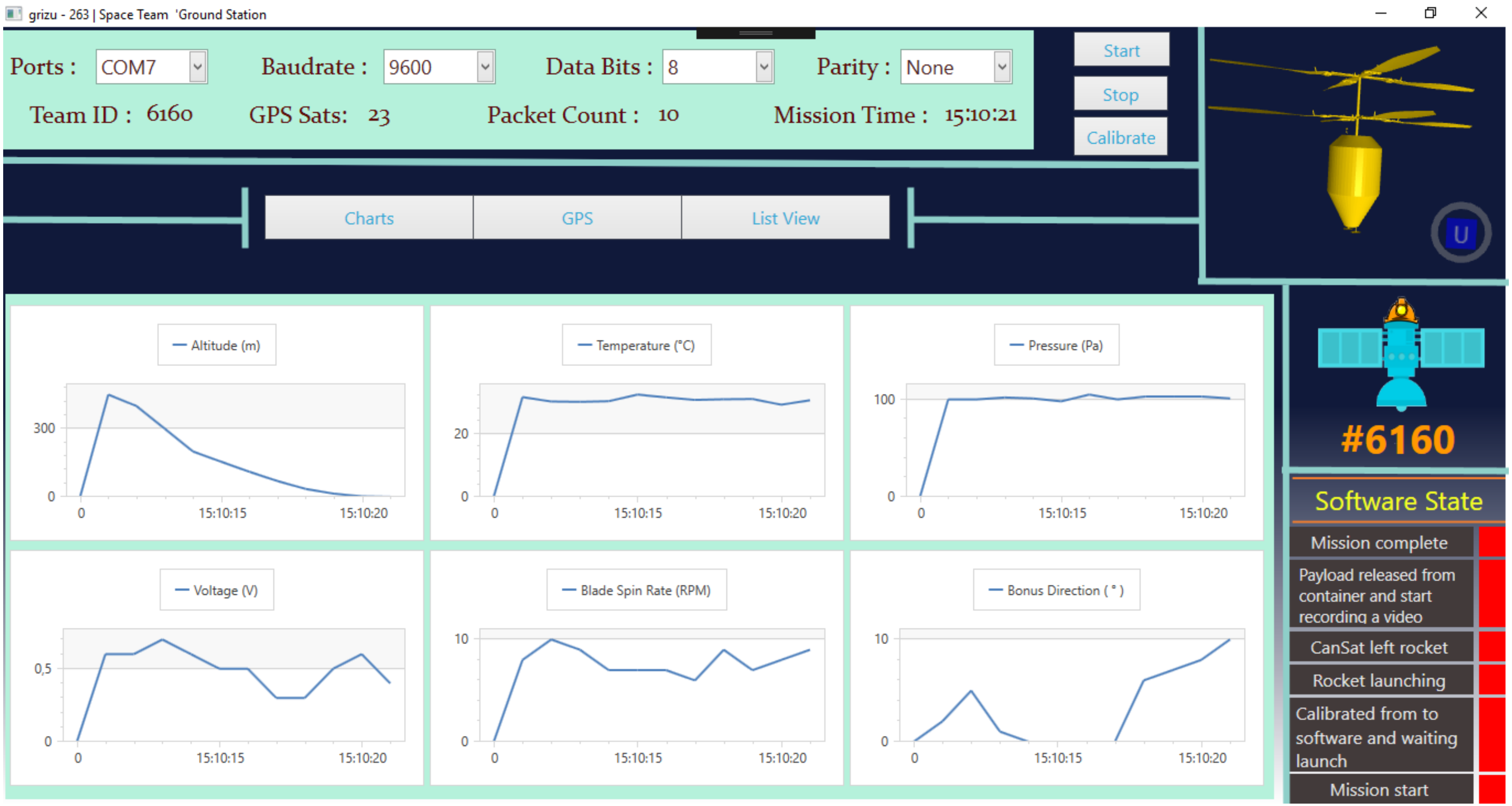
- Telemetry data as a .csv file, the screenshot of the interface, media data recorded on the SD card on the camera will be presented to the jury in the USB memory at the end of the mission.

.csv telemetry file creation for judges

- The data "," between them transferred to Ground Station will be saved as a .csv file at the end of the mission by adding.

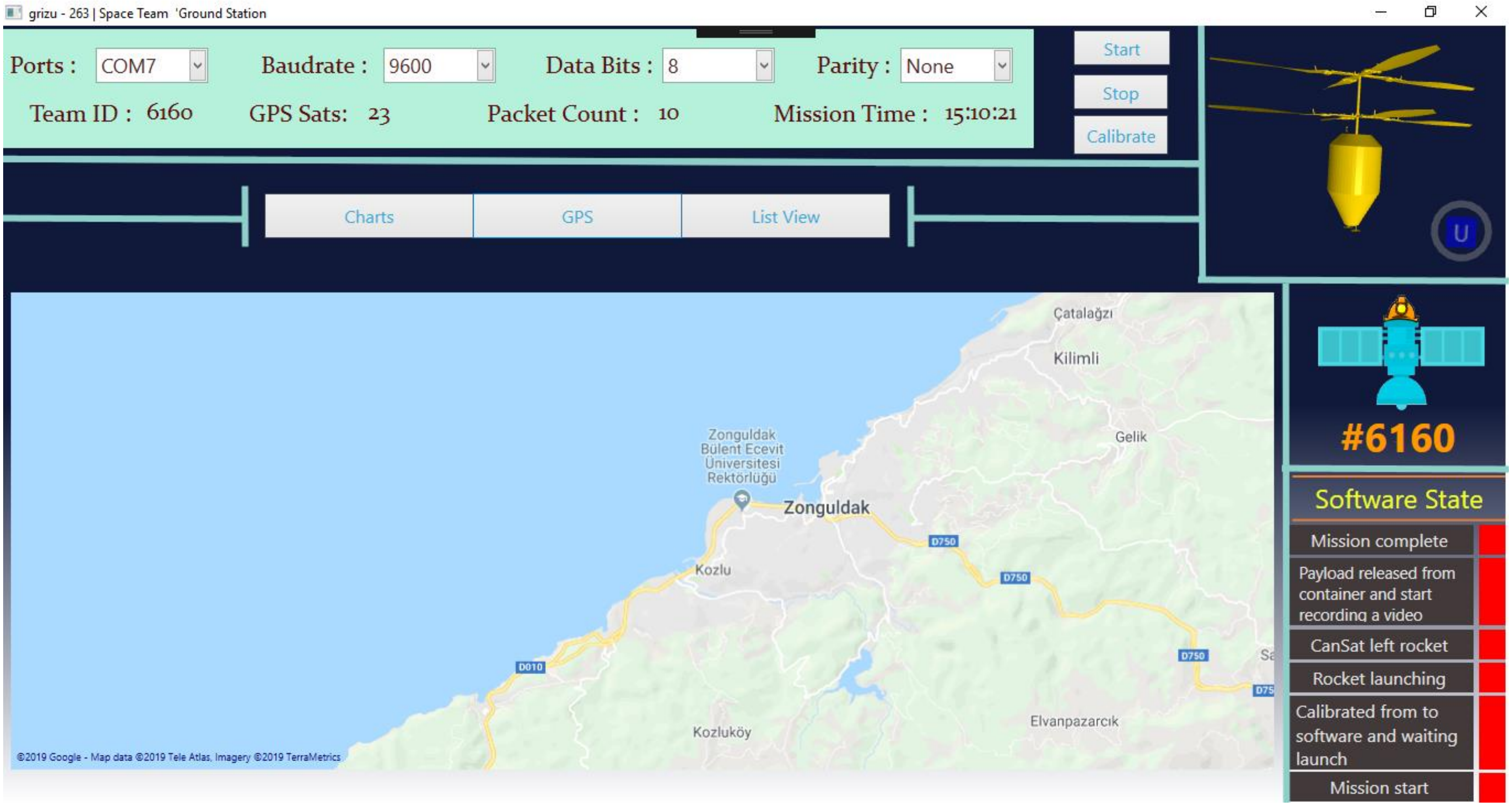
GCS Software (2 of 4)

Real-time plotting display prototypes



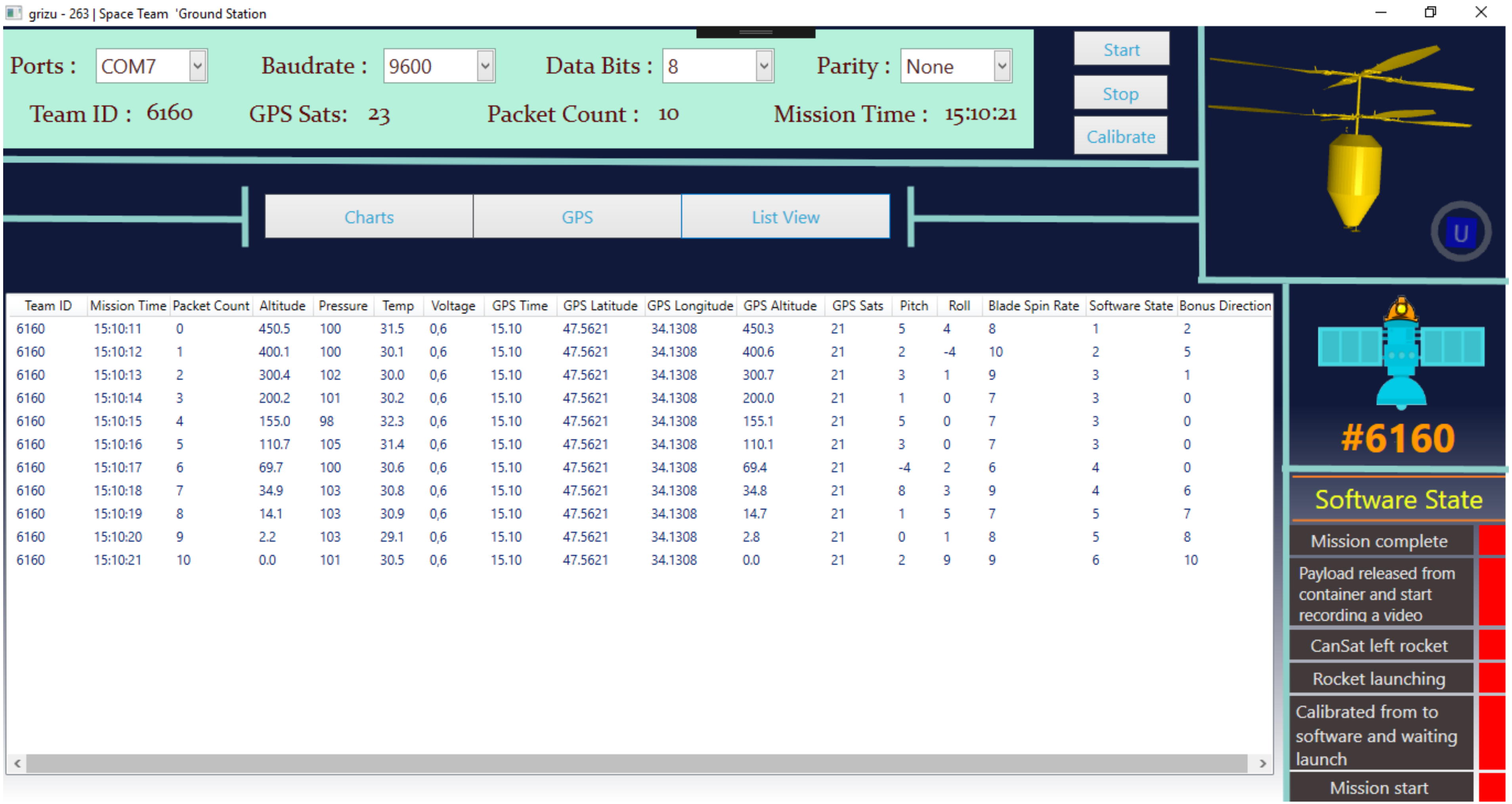
GCS Software (3 of 4)

GPS display prototypes



GCS Software (4 of 4)

All telemetry display prototypes



Team ID	Mission Time	Packet Count	Altitude	Pressure	Temp	Voltage	GPS Time	GPS Latitude	GPS Longitude	GPS Altitude	GPS Sats	Pitch	Roll	Blade Spin Rate	Software State	Bonus Direction
6160	15:10:11	0	450.5	100	31.5	0,6	15.10	47.5621	34.1308	450.3	21	5	4	8	1	2
6160	15:10:12	1	400.1	100	30.1	0,6	15.10	47.5621	34.1308	400.6	21	2	-4	10	2	5
6160	15:10:13	2	300.4	102	30.0	0,6	15.10	47.5621	34.1308	300.7	21	3	1	9	3	1
6160	15:10:14	3	200.2	101	30.2	0,6	15.10	47.5621	34.1308	200.0	21	1	0	7	3	0
6160	15:10:15	4	155.0	98	32.3	0,6	15.10	47.5621	34.1308	155.1	21	5	0	7	3	0
6160	15:10:16	5	110.7	105	31.4	0,6	15.10	47.5621	34.1308	110.1	21	3	0	7	3	0
6160	15:10:17	6	69.7	100	30.6	0,6	15.10	47.5621	34.1308	69.4	21	-4	2	6	4	0
6160	15:10:18	7	34.9	103	30.8	0,6	15.10	47.5621	34.1308	34.8	21	8	3	9	4	6
6160	15:10:19	8	14.1	103	30.9	0,6	15.10	47.5621	34.1308	14.7	21	1	5	7	5	7
6160	15:10:20	9	2.2	103	29.1	0,6	15.10	47.5621	34.1308	2.8	21	0	1	8	5	8
6160	15:10:21	10	0.0	101	30.5	0,6	15.10	47.5621	34.1308	0.0	21	2	9	9	6	10

CanSat Integration and Test

Kübra YÜKSEL

CanSat Integration and Test Overview (1 of 4)

- **Cansat Integration and Test Overview**
  - **Subsystem Level Testing Plan**
    - ❑ Sensors
    - ❑ CDH
    - ❑ EPS
    - ❑ Radio Communications
    - ❑ FSW
    - ❑ Mechanical
    - ❑ Descent Control
  - **Integrated Level Functional Test Plan**
    - ❑ Descent Testing
    - ❑ Communications
    - ❑ Mechanisms
    - ❑ Deployment
  - **Environmental Test Plan**
    - ❑ Drop Test
    - ❑ Thermal Test
    - ❑ Vibration Test
    - ❑ Fit Check

CanSat Integration and Test Overview (2 of 4)

Subsystem level testing

Testing of Sensors	Testing of CDH	Testing of EPS	Testing of FSW
❑ Checking whether the sensors are working. ❑ Calibration sensors.	❑ Configuration Xbees ❑ Antenna test	❑ Making the necessary measurements(voltage, current, power etc.) for circuit.	❑ Sensor Communication Test ❑ Algorithm test ❑ Separation mechanism Test

Testing of Radio Communications	Testing of Mechanical	Testing of Descent Control
❑ Sufficiency of antenna ❑ Distance dependent accuracy of Xbees	❑ Weight control of Cansat ❑ Control of subsystems	❑ Sufficiency test of propeller and parachute system.

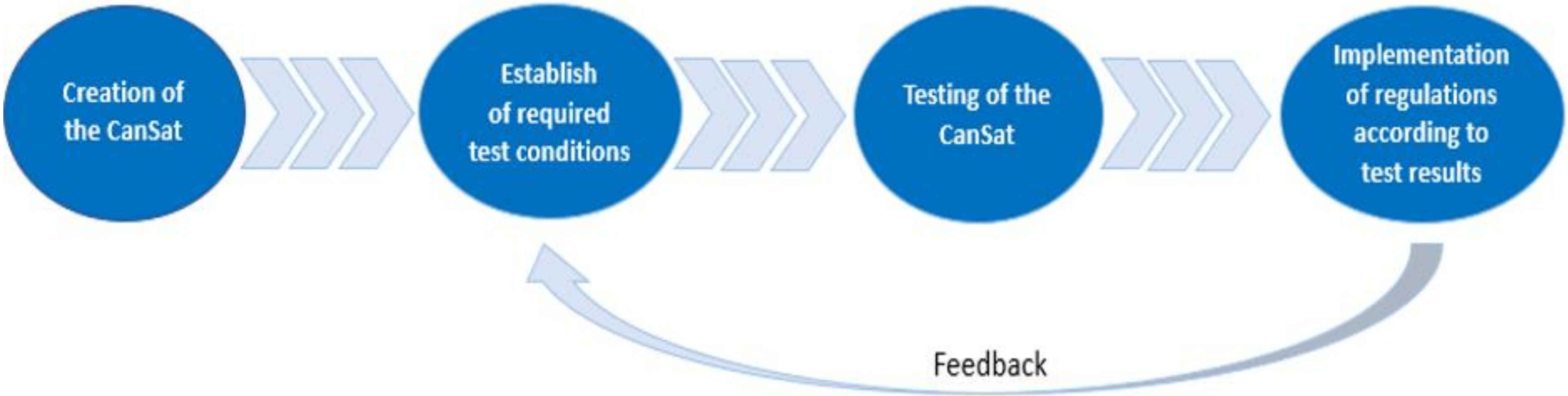
CanSat Integration and Test Overview (3 of 4)

Integrated Functional Level Testing

Descent Testing	Communications	Mechanisms	Deployment
❑ Separation of payload from container will be tested with the burn of wire.	❑ Communications of Xbee (distance, reflections, different environmental conditions, etc.)	❑ CanSat's suitability to the given dimensions (125 mm diameter x 310 mm length). ❑ Control of separation mechanism	❑ Increasing CanSat to a height of 400 meters and testing the parachute. ❑ Separation of payload from the container at 300 meters and testing of falling with propellers.

Environmental Testing

Drop Test	Thermal Test	Vibration Test	Fit Check
❑ 30Gs shock durability of the system.	❑ CanSat's temperature durability to 60°C for 2 hours.	❑ Endurance test of the assembly integrity of system components by the orbit sander with an amount of 20-29 Gs of shaking generated.	❑ It is checked whether CanSat is the desired diameter (125 mm diameter x 310 mm length).



Analyzing the mission guide and identifying the important requirements

Mechanical System:

- Different types of propeller prototypes are designed and controlled to ensure that the load falls to the desired speed.
- Parachute test is performed with the help of drone at high altitudes.
- Environmental test are planned to be done at our engineering faculty laboratories.

Electronic System:

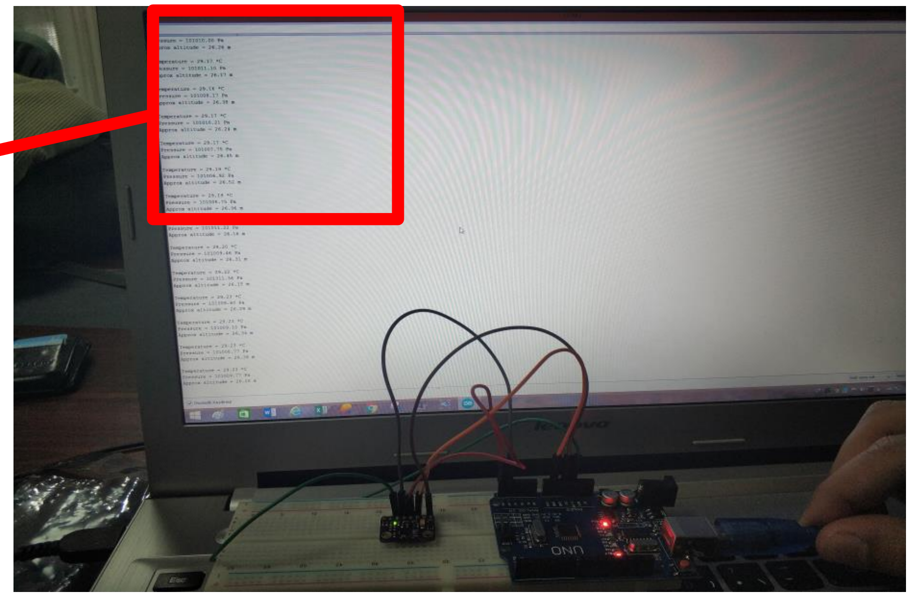
- Electronic system are set on the breadboard.
- Data transfer test was performed at a distance of 1.2 km via Xbee modules.
- During the data transmission ground control system interfaces are tested.

Subsystem Level Testing Plan (1 of 9)

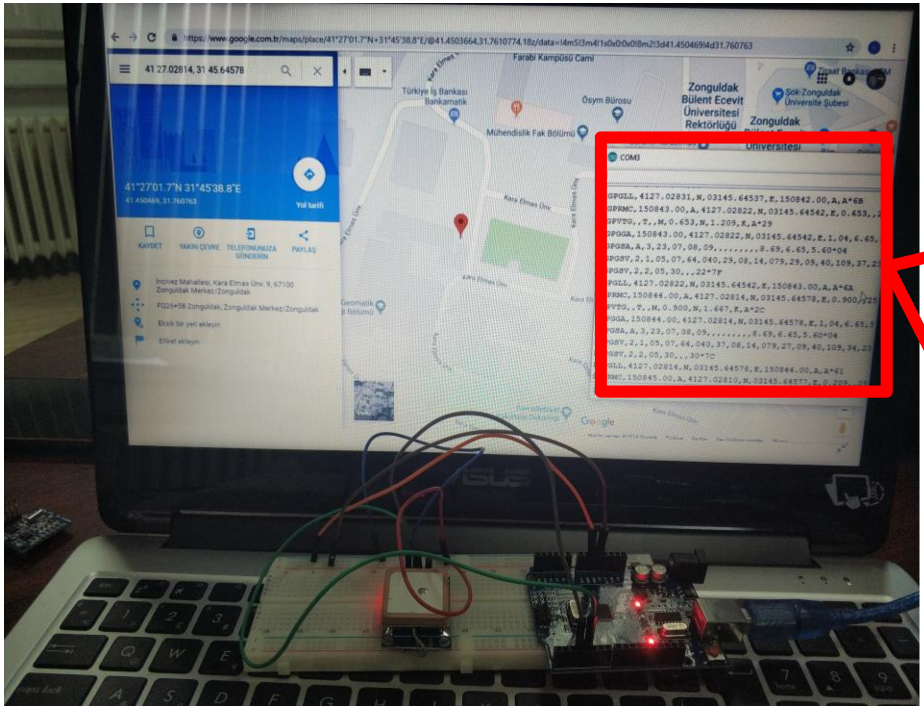
Testing of Sensors

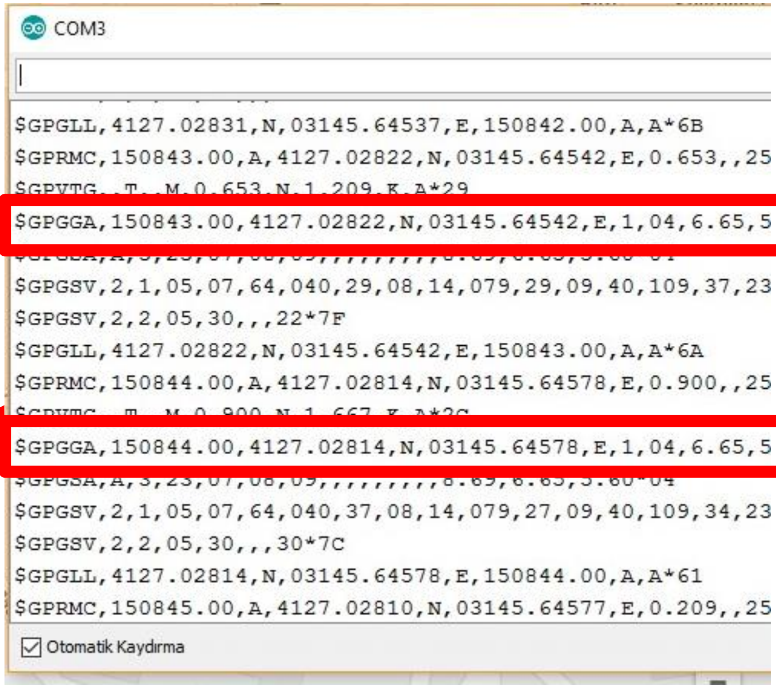
- Firstly all electronic circuit set on the breadboard.
- The robustness of all sensors will be tested.
- Sensors and telemetry data collection will be tested.
- All sensors will be calibrated with the appropriate test codes.

```
Temperature = 29.26 *C
Pressure = 101010.36 Pa
Approx altitude = 26.23 m

Temperature = 29.26 *C
Pressure = 101009.17 Pa
Approx altitude = 26.33 m

Temperature = 29.26 *C
Pressure = 101010.17 Pa
Approx altitude = 26.25 m

Temperature = 29.26 *C
Pressure = 101007.51 Pa
Approx altitude = 26.47 m

Temperature = 29.26 *C
Pressure = 101008.52 Pa
Approx altitude = 26.38 m
```

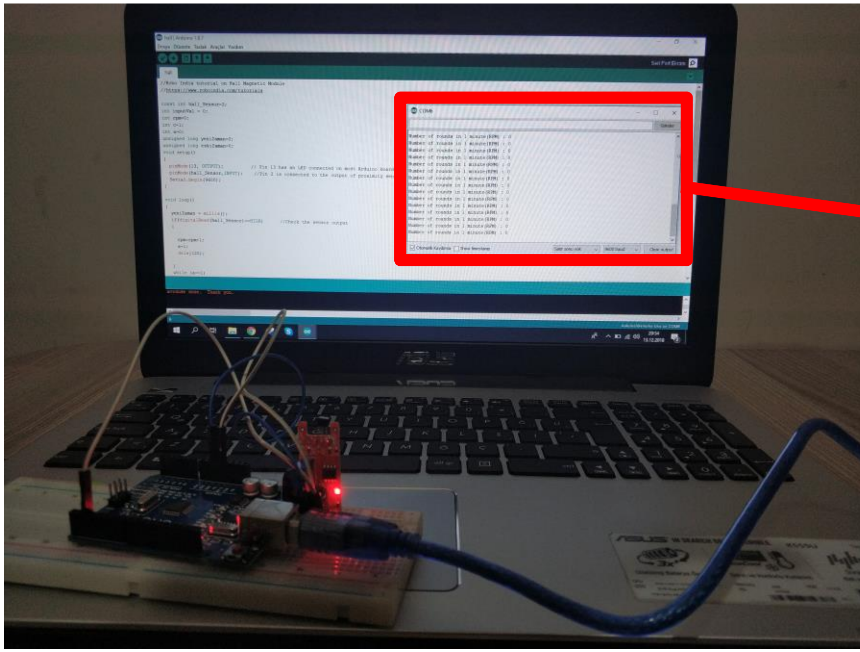


We calibrated the 10 DOF IMU (BMP280, MPU9255) sensor and then got the data from the sensor.



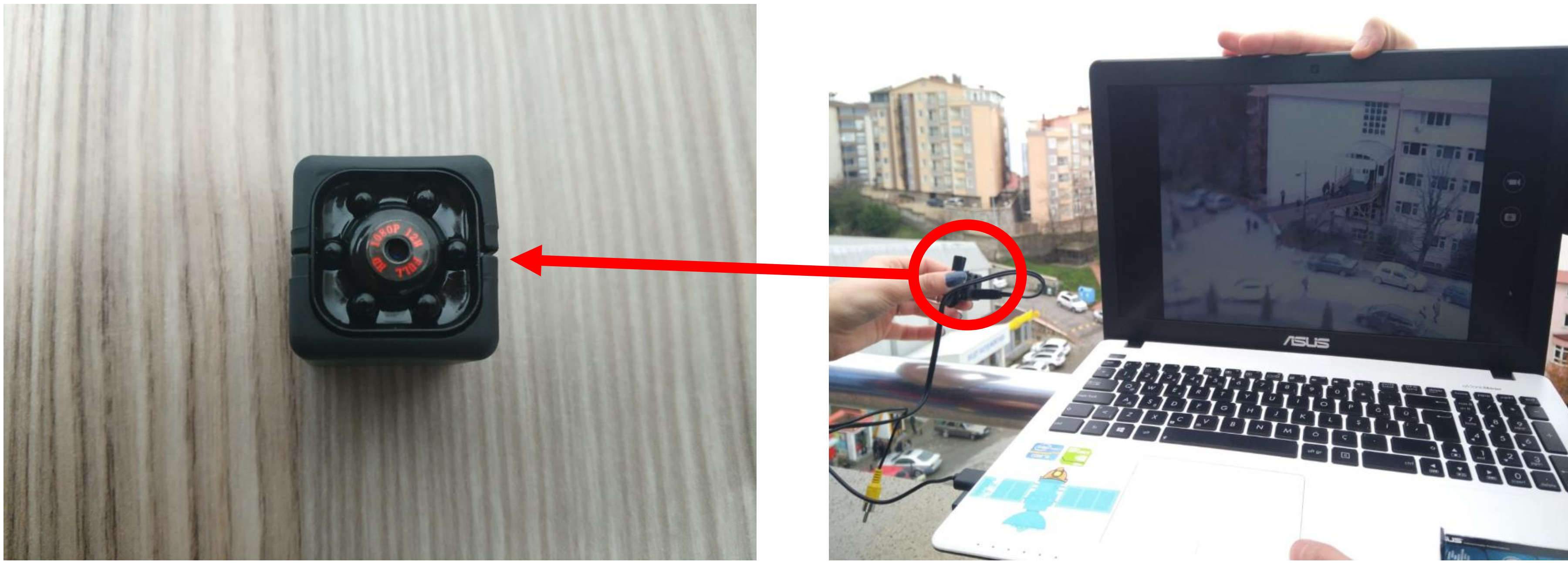


A sample of data received according to NMEA 0183 GGA message format is given in the image.



```
Number of rounds in 1 minute(RPM) : 59
Number of rounds in 1 minute(RPM) : 40
Number of rounds in 1 minute(RPM) : 40
Number of rounds in 1 minute(RPM) : 27
Number of rounds in 1 minute(RPM) : 28
Number of rounds in 1 minute(RPM) : 34
Number of rounds in 1 minute(RPM) : 34
Number of rounds in 1 minute(RPM) : 63
Number of rounds in 1 minute(RPM) : 53
Number of rounds in 1 minute(RPM) : 49
Number of rounds in 1 minute(RPM) : 4
Number of rounds in 1 minute(RPM) : 0
```

We calibrated the Blade Spin Rate sensor (Hall Effect Encoder) and then got the data from the sensor.



We check the camera (SQ11) and shot some images from the roof of the faculty building.

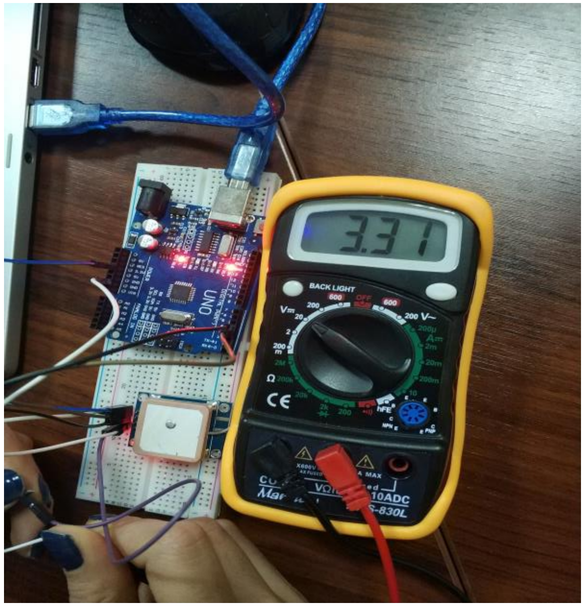
Testing of CDH

- The communication between the receiver and transmitter XBee will be tested in the XCTU program.
- The accuracy of the data sent to the ground station will be checked.
- The speed of sending data will be checked.
- The data transmission at high distances will be checked.
- The gain test of the antenna was tested with the XCTU program.

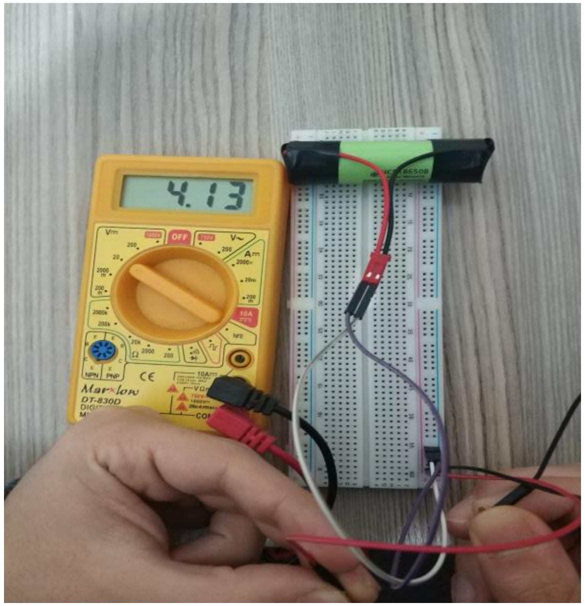
Ground Station

Testing of EPS

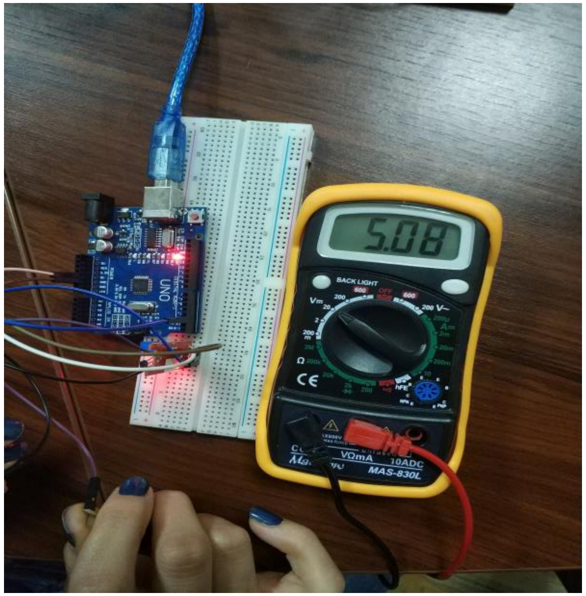
- The voltage and current values of GPS and all sensors used in CanSat will be measured with multimeter.
- 3.7V battery will be connected in series as discussed in previous slides.
- The battery voltage decrease rate will be measured under 1.68 A current load for 2 hours with the use of a multimeter.



GPS



Battery



Sensor

Testing of FSW

- The accuracy of taken the data from the sensors will be checked. (GPS location, temperature, pressure, etc.)

- The calibration command will be transmitted from the ground station to the payload and tested whether or calibrate of the system.

- Sub-systems will be tested. (Separation, communication, etc.)

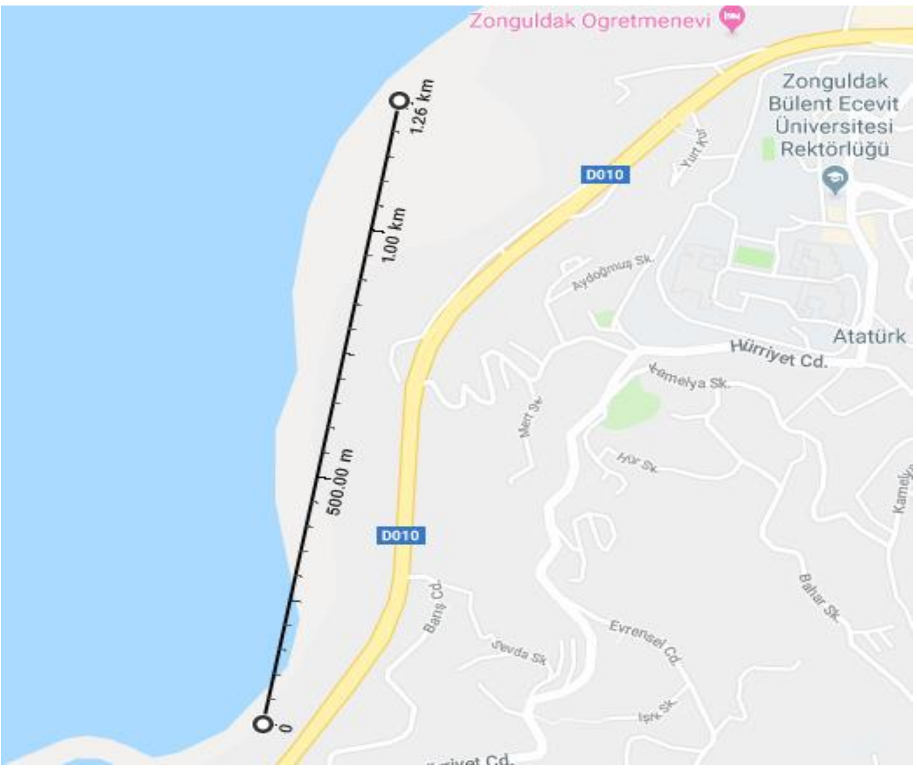
- The sending of the data in the appropriate order to the ground station will be tested.

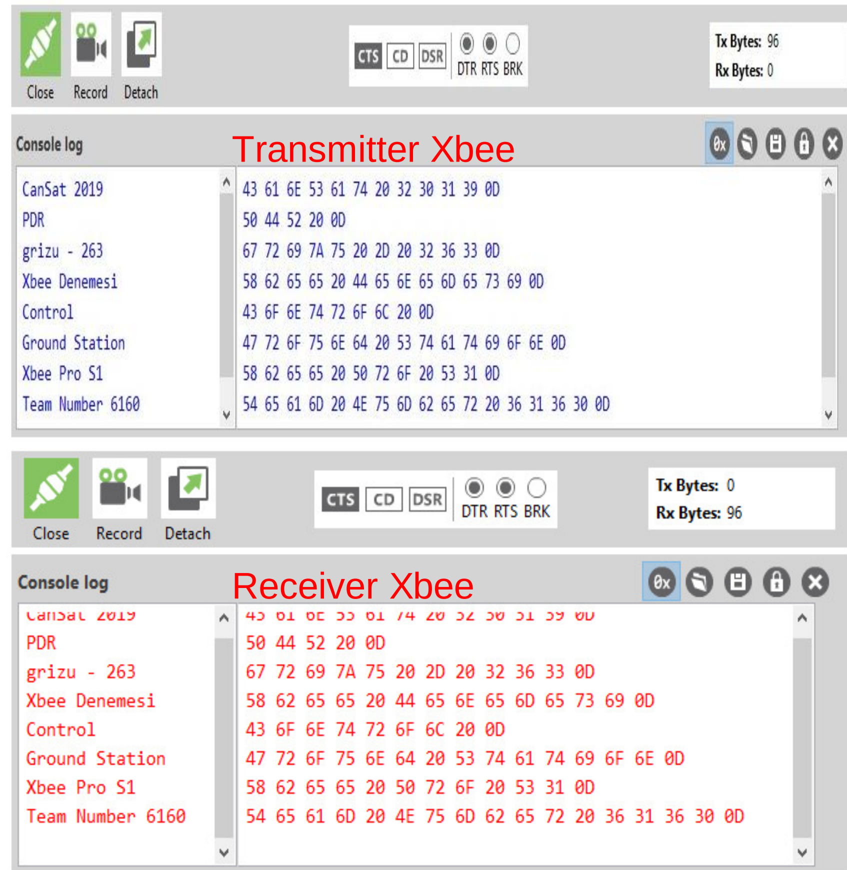
- If the microcontroller is reset, data recovery algorithms will be tested.

- General The CanSat system will be released from an altitude of 400 meters to test the stability of the system.

Testing of Radio Communications

After the set of the electronic circuit on breadboard, the data transmission of XBees against various distance and environmental conditions will be tested.





Data are taken from 1.2 km via Xbee.

Testing of Mechanical System

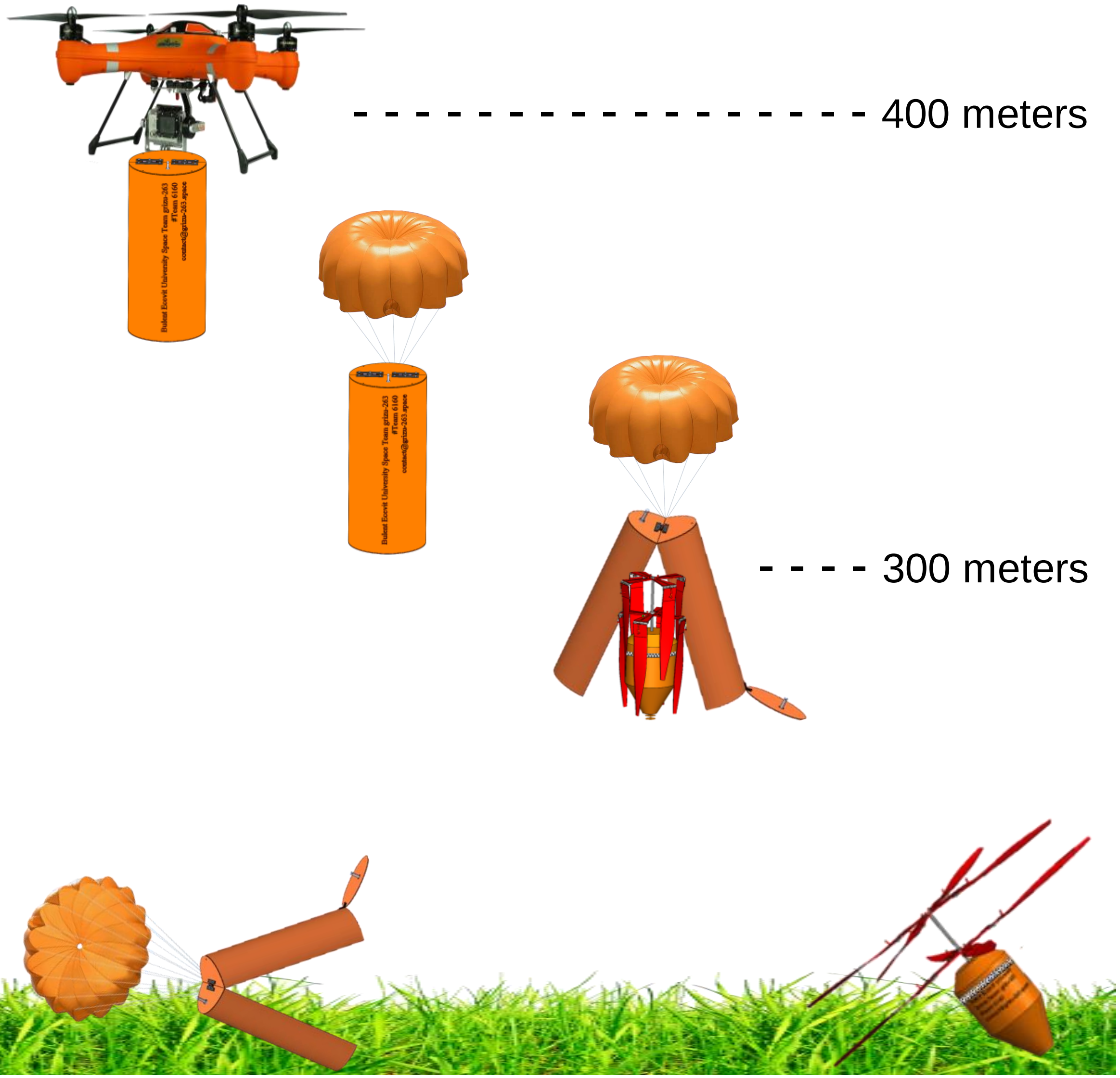
- It will be checked whether the total mass is 500 g determined in the competition requirements.
- CanSat's ability to pass mechanical tests will be checked. (Separation, drop, etc.)
- It is planned to test CanSat's ability to pass environmental tests.
- All electrical subsystems before and after the test flights will be checked.

Testing of Descent Control System

- Payload integrated with propellers, will be separated at 400 meters with the drone without any electronic circuit on it.
- Then the electronic circuit installation will be placed on the payload and will be separated at 400 meters with the drone.
- The propeller's tests will be completed with the via these free falls and sensors.
- Parachute system will be tested like the propellers system and its aerodynamic suitability will be checked.

DEPLOYMENT TESTING

CanSat will be carried an altitude to 400 meters via a drone. The container will be descent from 400 meters to 300 meters with the parachute. After 300 meters the payload will release from the container and descent with the propellers.



Communications

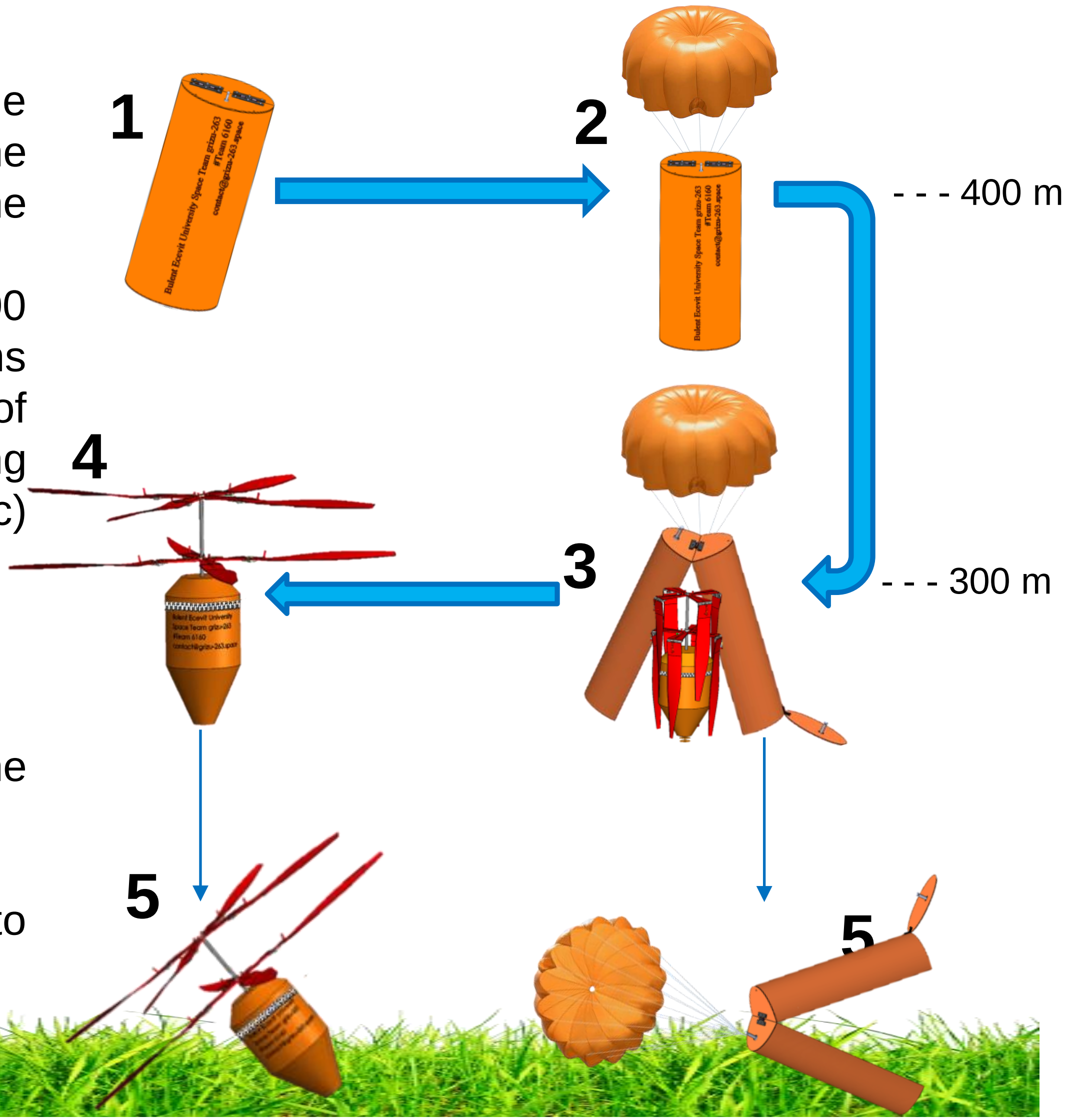
- The entire system implemented will be taken to a certain altitude using the drone and a communication test will be performed.
- Transmission with XBees will be tested when drone reaches the required altitude.

CanSat

Integrated Level Functional Test Plan (3 of 6)

Mechanisms

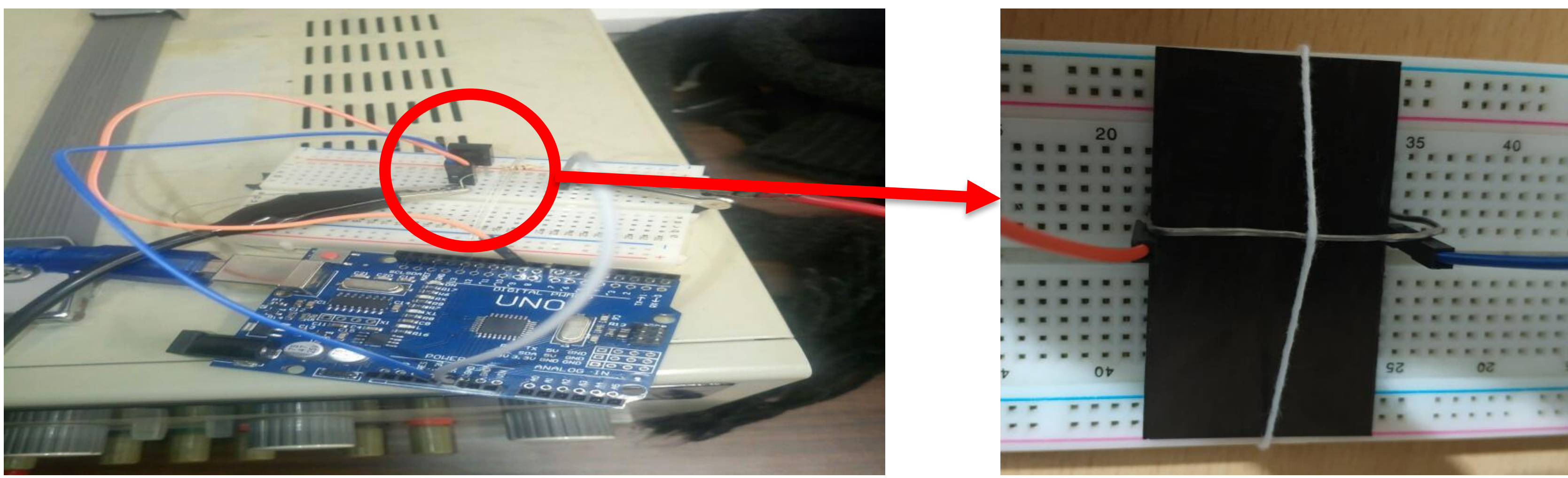
- Measuring the dimensions of the system that we have created (Does the container fits into the rocket, Does the payload fit into the container?).
- The container will be released for 400 meters and our opening mechanisms (opening of the container, separation of the payload from the container, opening of propellers stretched fabric elastic) will be checked.



1-Container
2-Parachute opened
3-Payload separated from the container
4-Propellers opened
5-Payload and container landing to ground

Release Mechanism Testing

- CanSat's opening mechanism is performed with the burn of wire.
- Sufficient power will be given to the wire for this process.
- The wire will be placed in a fire stop box inside the CanSat.
- As soon as the opening occurs, the power of the wire will be cut off automatically by the switch.
- The wire will be operated for a very short period of time and will not be heated at full power.



We tested the release mechanism. The test method is the burn of wire .

Descent Test (Container)

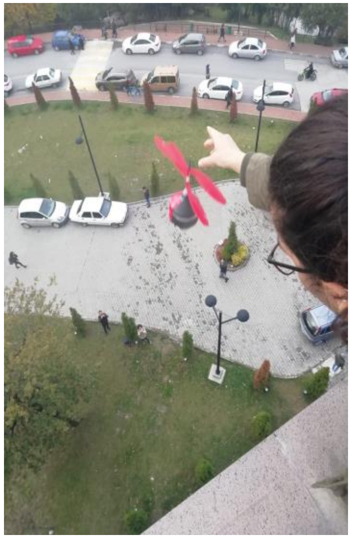
- Firstly, the diameter of the parachute is calculated according to the desired descent rate (20 m/s).
- The parachute was then lowered from an altitude of 25 meters and checked for falling at the desired speed.
- If the desired speed could not be achieved in the fall, the parachute diameter calculation would be done again.

Parachute

We tried the parachute drop test. We released the pre-prepared parachute system from 25 meters.

Descent Test (Payload)

- We mounted different types of propellers respectively on the payload.
- This test was performed to check that the payload fell at the desired speed.
- After finishing all of the payload mechanism, propeller will be integrated to the payload and we will re-test propeller mechanism on different altitudes.



We tried the payload drop test. We released the pre-prepared payload system from 25 meters.

Environmental Test Plan (1 of 4)

Drop Test

- CanSat was raised to a height of 2 meters and tied to 61 cm rope.
- The CanSat is powered and released from a height of 2 meters.
- It will be checked whether CanSat is still operational.
- CanSat will be checked for any damage.
- It will be confirmed that CanSat is still receiving telemetry.

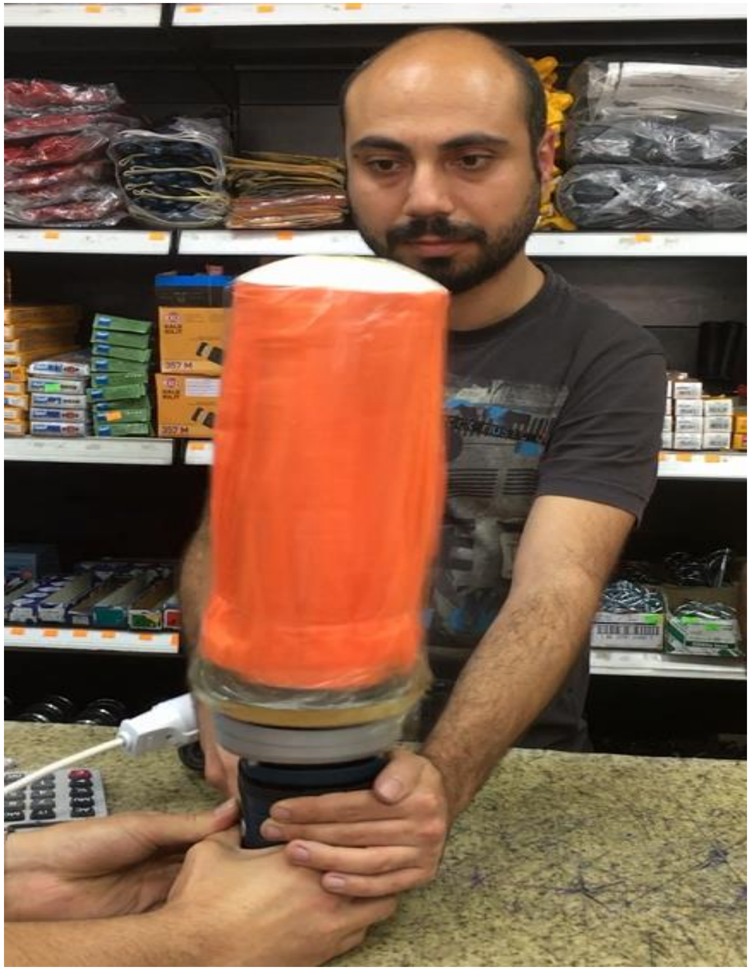
Drop test image from last year

Thermal Test

- CanSat will be powered and then placed in the thermal chamber.
- The temperature of the thermal chamber will be adjusted to 60°C.
- The thermal test will continue for 2 hours.
- At the end of the test, it will be checked that the entire mechanism is still operational.

Vibration Test

- Before starting the test, it will be checked that the accelerometer data is collected from CanSat.
- CanSat will be placed on the orbital sander and the vibration test will be done with 20-29 Gs shaking rate for 5 minutes.
- At the end of the vibration test, it will be checked whether there is any damage to CanSat and the accelerometer data is still being received.



Vibration test image from last year

Fit Check

- In order to control CanSat's dimensions, a 125 mm diameter hole is cut from a steel plate.
- The accuracy of the diameter of the generated circle will be controlled by a micrometer calliper.
- The accuracy of CanSat's diameter will be tested with the formed hole.

Mission Operations & Analysis

Berat YILDIZER

Overview of Mission Sequence of Events (1 of 3)

ARRİVAL

- Check launch and CanSat.(Whole team)
- Arrival at the launch location.
- Set up of ground station system.(GSC)

PRE- LAUNCH

- Software calibration command will send by ground station (GSC).
- Checking size and weight of CanSat(MCO).
- Check communication (GSC).
- Camera calibration according to the magnetic field of the north earth.
- Check propeller(CC).
- Check separation mechanism (CC-GSC).
- Drop test(MCO-GSC-CC).
- Check safety (MCO).

Set up ground station system

- Our battery will work for at least 2 hours.
- We will have a power bank for cooling fan.
- We have umbrella and water.

Check antenna (GSC)

- Antenna connected with XBee
- We will have the antenna to receive the data.

Assembly (CC)

- Payload will be stowed into container. Then parachute will be folded and placed top of the container.

LAUNCH

- Rocket liftoff.
- The electronic system will be started sending data.
- CanSat will be separated from the rocket(between 670-725 meters).
- The parachute will open.
- The speed up to 450 m is 20m/s.
- The release of the payload at 450 meters.
- The payload will be descent passively with the propellers.
- Payload speed should be between 10-15 m/s.
- The camera will be started to record video at 450 meters.
- The buzzer will be started to ring before falling.
- Telemetry transmission will stop when buzzer starting.

Overview of Mission Sequence of Events (2 of 3)

FLIGHT RECOVERY

- Payload we'll take the SD card and back up video on GSC.
- Get backed up telemetry data from SD card (GSC).
- Delivery of received data to the jury (MCO).

DATA ANALYSIS

- Check camera data (GSC-MCO).
- Checking and backing up telemetry data plot outliers (GSC-MCO).
- Check of real-time graphics (GSC-MCO).

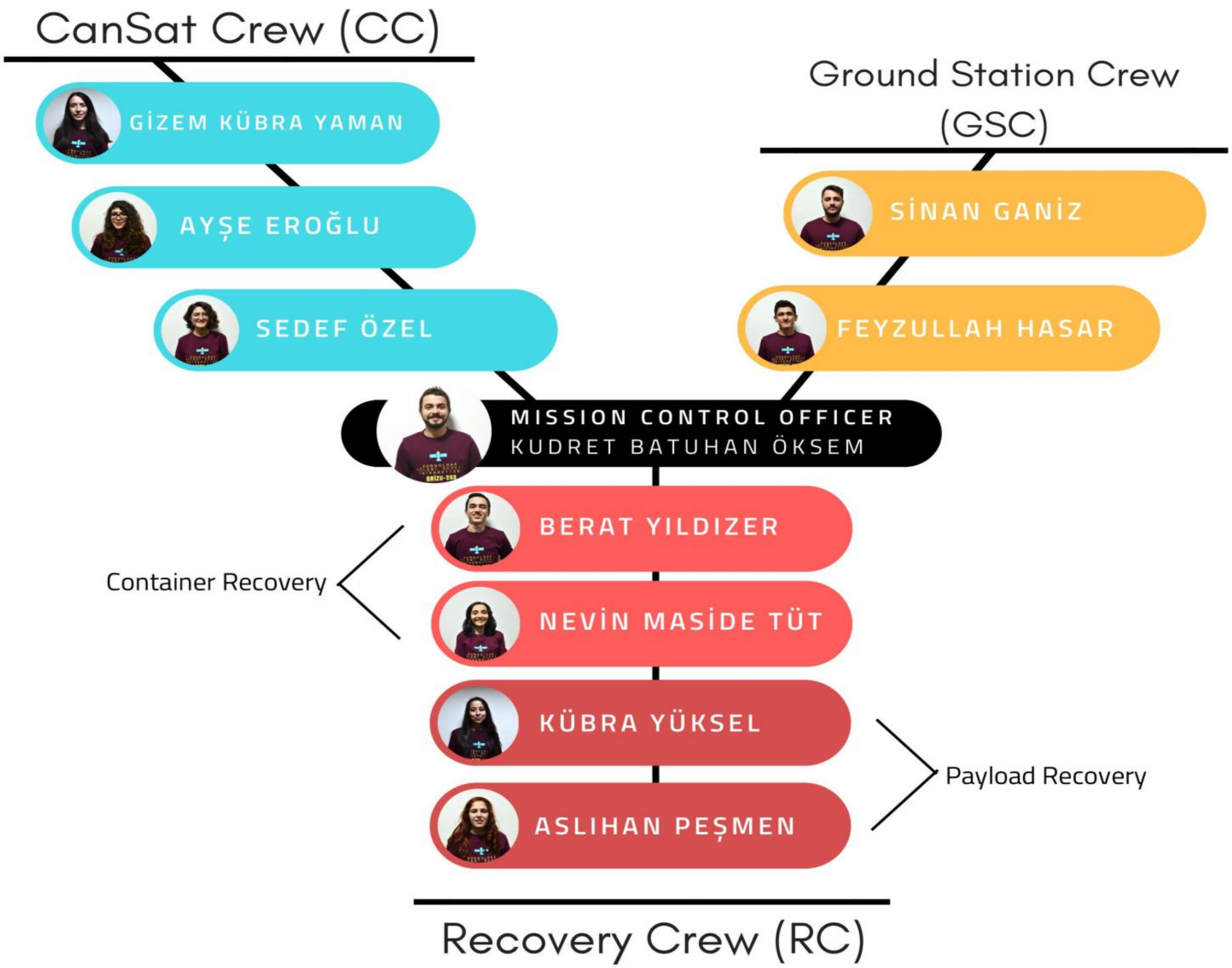
POST FLIGHT REVIEW

- Preparation of post-flight review presentation file (Whole team).

Preliminary at PDR;

- Organization chart prepared.
- All team members reviewed competition requirements and accomplished their parts.

Overview of Mission Sequence of Events (3 of 3)



Mission Operations Manual Development Plan (1 of 2)

CONFIGURE GROUND STATION	PREPARING CANSAT	INTEGRATING CANSAT
• Control of necessary equipment (antenna, laptop etc.) by GSC. • Communication systems testing and installation.	• Calibration of sensors and CanSat's final check will be done by CC. • CanSat deliver for launch by MCO.	• The people in this section will make the CanSat fully assembled and ready for launch. • Care should be taken to ensure that all parts are properly mounted when this is done. • After we have done all the tests, person will deliver the CanSat to the launcher.

Mission Operations Manual Development Plan (2 of 2)

Mission Operations Manual Checklist

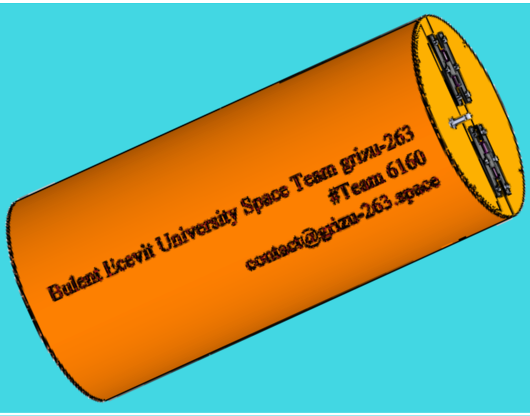
- Configuring the ground station
  - Communication test
  - Antenna Check
  - Safety tests
- Preparing the CanSat
  - CanSat assemble
  - Separation mechanism control
  - Weight and size control
  - Drop test
  - Safety tests
- Integrating the CanSat into the rocket
  - Fit check
  - Check stowed parachute
- The launch preparation procedures
  - Launch procedure
  - Removal procedure

How can find container?

We will use buzzer and this buzzer will started reaches 5 meters.

Which fluorescent color container?

We choose fluorescent orange color for container .



Container return address

The necessary contact information will be written on the container.

Zonguldak Bülent Ecevit University Space Team
grizu-263 #Team 6160
contact@grizu-263.space

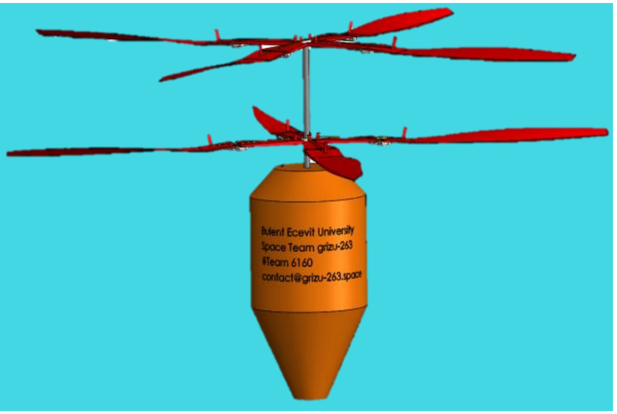
CanSat Location and Recovery (2 of 2)

How can find payload?

- We will use buzzer and this buzzer will start reaches 5 meters. When the buzzer started, data transfer stop between payload and ground station.
- Second method , we will use Global Positioning System(GPS) for find payload.

Which fluorescent color payload?

- We choose fluorescent orange color for payload.



Payload return address

The necessary contact information will be written on the payload.

Zonguldak Bülent Ecevit University Space Team

grizu-263 #Team 6160

contact@grizu-263.space

Requirements Compliance

Berat YILDIZER

Requirements Compliance Overview

The design was prepared according to the CanSat 2019 mission. The compatibility of the design with the requirements have been successfully tested.

Mechanical Team

- The CanSat descent test completed.
- The payload separation from the container was successfully tested.
- Passive descent of the payload was completed.
- The CanSat size and weight were checked.
- Prohibited substances were not used.

Electrical and Software Team

- The data in a few seconds have been completed with the selected sensor.
- The buzzer was tested to find the payload.
- Tests were made to run the batteries for at least 2 hours.
- The necessary software tests have been success performed against the resetting of the microprocessor.
- Appropriate camera tests were performed for the bonus mission.

Requirements Compliance (1 of 9)

RN	Requirement	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 500 grams +/- 10 grams.	Comply	77,104	OK
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Comply	27,28,29,36,37,191	OK
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	33,88,89,191	OK
4	The container shall be a fluorescent color; pink, red or orange.	Comply	198	OK
5	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Comply	88,89	OK
6	The rocket airframe shall not be used as part of the CanSat operations.	Comply	36	OK

Requirements Compliance (2 of 9)

RN	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
7	The CanSat shall deploy from the rocket payload section and immediately deploy the container parachute.	**Comply**	34,53,99	OK
8	The descent rate of the CanSat (container and science payload) shall be 20 meters/second +/- 5m/s.	**Comply**	68,77	OK
9	The container shall release the payload at 450 meters +/- 10 meters.	**Comply**	73	OK
10	The science payload shall descend using an auto-gyro descent control system.	**Comply**	54,64	OK
11	The descent rate of the science payload after being released from the container shall be 10 to 15 meters/second	**Comply**	77	OK
12	All descent control device attachment components shall survive 30 Gs of shock.	**Partial Comply**	**190**	Tested with prototypes. Need actual design test.

Requirements Compliance (3 of 9)

RN	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
13	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	**Comply**	33,36	OK
14	All structures shall be built to survive 15 Gs of launch acceleration.	**Partial Comply**	**190**	Tested with prototypes. Need actual design test
15	All structures shall be built to survive 30 Gs of shock.	**Partial Comply**	**190**	Tested with prototypes. Need actual design test
16	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	**Comply**	100	OK
17	All mechanisms shall be capable of maintaining their configuration or states under all forces.	**Comply**	100,190	OK
18	Mechanisms shall not use pyrotechnics or chemicals.	**Comply**	101,102,103	OK

RN	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
19	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire	**Comply**	32,94	OK
20	The science payload shall measure altitude using an air pressure sensor.	**Comply**	42	OK
21	The science payload shall provide position using GPS.	**Comply**	44	OK
22	The science payload shall measure its battery voltage.	**Comply**	45	OK
23	The science payload shall measure outside temperature.	**Comply**	43	OK
24	The science payload shall measure the spin rate of the auto-gyro blades relative to the science vehicle.	**Comply**	47,48	OK

RN	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
25	The science payload shall measure pitch and roll.	Comply	46	OK
26	The probe shall transmit all sensor data in the telemetry	Comply	142,143,157	OK
27	The Parachute shall be fluorescent Pink or Orange.	Comply	54,57,58	OK
28	The ground station shall be able to command the science vehicle to calibrate barometric altitude, and roll and pitch angles to zero as the payload sits on the launch pad.	Comply	35,145,157,164	OK
29	The ground station shall generate a csv file of all sensor data as specified in the telemetry section.	Comply	114,164	OK
30	Telemetry shall include mission time with one second or better resolution. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Comply	148,150	OK

Requirements Compliance (6 of 9)

RN	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
31	XBEE radios shall be used for telemetry. 2.4 GHz Series radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Comply	157,160	OK
32	XBEE radios shall have their NETID/PANID set to their team number.	Comply	113	OK
33	XBEE radios shall not use broadcast mode.	Comply	106,157	OK
34	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Comply	212,213,214	OK
35	Each team shall develop their own ground station.	Comply	161,193	OK
36	All telemetry shall be displayed in real time during descent.	Comply	145,165	OK

Requirements Compliance (7 of 9)

RN	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
37	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Comply	165	OK
38	Teams shall plot each telemetry data field in real time during flight.	Comply	145,165	OK
39	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	Comply	157,160	OK
40	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	35,160,193	OK
41	Both the container and probe shall be labeled with team contact information including email address.	Comply	198,199	OK
42	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Comply	150,153	OK

Requirements Compliance (8 of 9)

RN	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
44	No lasers allowed.	**Comply**	36	OK
45	The probe must include an easily accessible power switch that can be accessed without disassembling the cansat and in the stowed configuration.	**Comply**	32,33,36	OK
46	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**	32,33	OK
47	An audio beacon is required for the probe. It may be powered after landing or operate continuously..	**Comply**	198,199	OK
48	The audio beacon must have a minimum sound pressure level of 92 dB, unobstructed.	**Comply**	123	OK
49	Battery source may be alkaline, Ni-Cad, Ni-MH or Lithium. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells.	**Comply**	123,130	OK

Requirements Compliance (9 of 9)

RN	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
50	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	22,32,81	OK
51	Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.	Comply	129,131,136,138	OK
52	The auto-gyro descent control shall not be motorized. It must passively rotate during descent.	Comply	22,23,35,61,64	OK
53	The GPS receiver must use the NMEA 0183 GGA message format.	Comply	143	OK
54	The CANSAT must operate during the environmental tests laid out in Section 3.5	Comply	188,189,190,191	OK
55	Payload/Container shall operate for a minimum of two hours when integrated into rocket.	Comply	135	OK

Management

Nevin Maside TÜT

Electronics Hardware

Electronics Components	Quantitiy	Unit Price	Price (Total)	Considerations
Arduino Nano (Payload)	1	$27,00	$27,00	Actual
Arduino Pro Micro (Container)	1	$19,95	$19,95	Actual
10-DOF IMU (MPU-9255+BMP280)	2	$3,48	$6,96	Actual
US1881 (Hall Effect Sensor)	1	$0,54	$0,54	Actual
SQ11 (Camera)	1	$3,41	$3,41	Actual
Feetech FS5106R (Servo Motor)	1	$17,70	$17,70	Actual
NEO-7M (GPS Sensor)	1	$17,40	$17,40	Actual
Buzzer	2	$1,70	$3,40	Actual
A24 - HASM - 450 (Payload)	1	$9,20	$9,20	Actual
XBee Pro S1 (Payload)	1	$36,00	$36,00	Actual
Sony VTC6 (Payload Battery)	2	$6,70	$13,40	Actual
ORION 14500 AA (Container Battery)	1	$3,76	$3,76	Actual
DS1307 (RTC)	1	$1,50	$1,50	Actual
CR2032 3V (Coin Cell)	1	$0,54	$0,54	Actual
KTS102 (Switch)	2	$0,48	$0,96	Actual
DC-DC Converter	3	$1,90	$5,70	Actual
Sandisk Ultra 4 gb	3	$5,00	$15,00	Actual
SD Card Module	2	$0,71	$1,42	Actual
Total			**$183,84**	

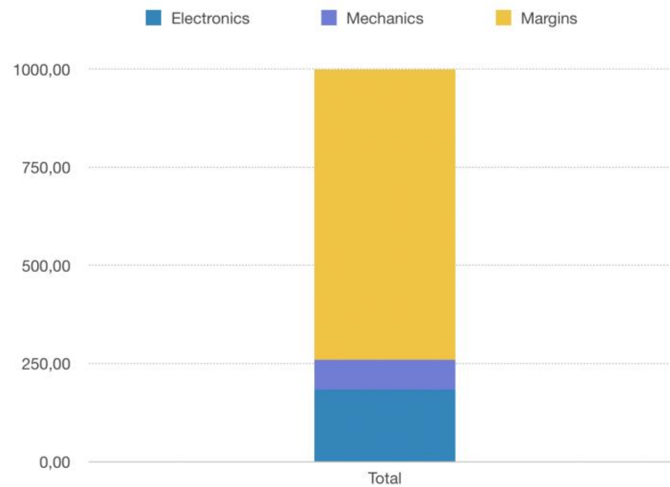
Mechanics Components

Mechanical Components	Quantity	Unit Price	Price (Total)	Considerations
Fiberglass	1 m²	$9,33	$6,00	Estimate
Silnylon 30D Nylon 66	1 m²	$12,50	$12,50	Actual
Steel Hinge x3	30mm*10mm	$1,50	$4,50	Actual
Science Payload Components				
Wing x8	335mm*20mm*1mm	$3,92	$31,36	Actual
Ball Bearing x2	3mm*6mm*2,5mm	$3,00	$6,00	Actual
Carbon Fiber Axle	1000mm*3mm	$10,00	$2,00	Estimate
Fiberglass	1 m²	$9,33	$3,60	Estimate
Plastic Hinge x8	20mm*10mm	$1,00	$8,00	Actual
Bar Magnet	3mm*10mm	$1,50	$1,50	Actual
Total			**$75,46**	

CanSat Budget – Hardware (3 of 3)

Electronics / Mechanical Components

Electronics	$183,84
Mechanical	75,46
Exact Total	**$259,30**
Margin	$740,70



CanSat Requirement Cost – Exact Total = Margin

$1000 - $259.30 = $740.70

CanSat Budget – Other Costs

GROUND STATION

Part	Model	Quantitiy	Price	Price (Total)	Considerations
Computer	-	1	Our Own Computer	-	Actual
XBEE	Pro S1	1	$36,00	$36,00	Actual
ANTENNA	TL-ANT2424B	1	$98,76	$98,76	Actual
Total				$134,76	

OTHER

	Quantity	Price (Total)	Considerations
Prototyping		$150,00	Estimate
Test facilities and equipment		University Budget	
Rental	Car x 2	$800,00	Estimate
Computers		Our Own Computers	
Travel (Flight Ticket)	8 person	$4.000,00	Estimate
VISA (USA)	8 person	$1.280,00	Estimate
Hotel	8 person	$2.250,00	Estimate
CanSat Competition Fee		$100,00	Actual
Total		$8.580,00	

INCOME

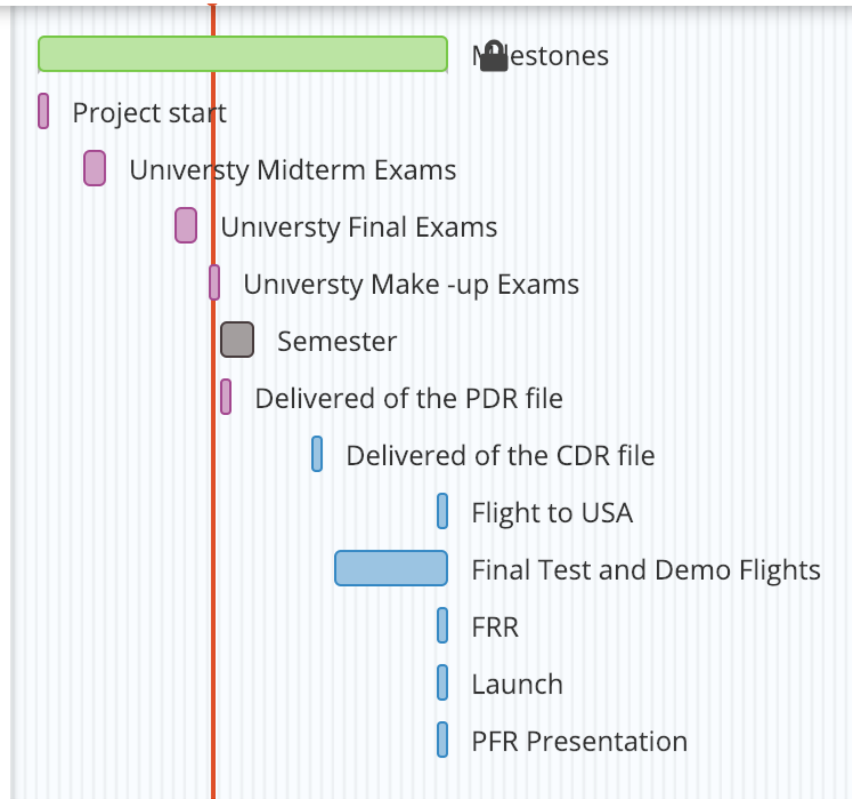
		Price (Total)
Sponsors	Turkish Airlines	Flight Ticket
	ERDEMİR	$4.000,00
Grants	Zonguldak Bulent Ecevit University	$2.750,00
Total		$6.750,00

The money needed for CanSat to produce grizu-263 was met by Zonguldak Bulent Ecevit University. We have completed sponsorship negotiations for travel and all other necessary expenses. All agreements will be approved for acceptance into the competition. **Turkish Airlines agrees to be our transportation sponsor .** We will not have a problem this year in terms of the budget.

Program Schedule Overview

Milestones

Milestones	08/Oct	16/Jun
Project start	08/Oct	08/Oct
Universty Midterm Exams	07/Nov	16/Nov
Universty Final Exams	31/Dec	11/Jan
Universty Make -up Exams	21/Jan	25/Jan
Semester	28/Jan	11/Feb
Delivered of the PDR file	31/Jan	31/Jan
Delivered of the CDR file	29/Mar	29/Mar
Flight to USA	11/Jun	11/Jun
Final Test and Demo Flights	12/Apr	15/Jun
FRR	14/Jun	14/Jun
Launch	15/Jun	15/Jun
PFR Presentation	16/Jun	16/Jun



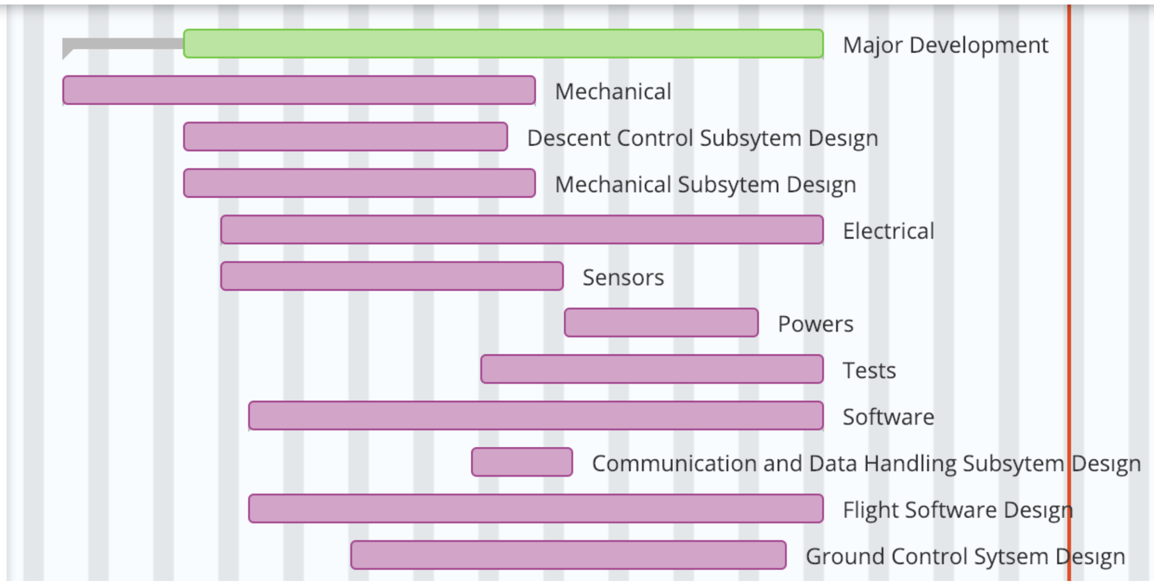
Completed Tasks

Incomplete Tasks

Holiday

Major Development

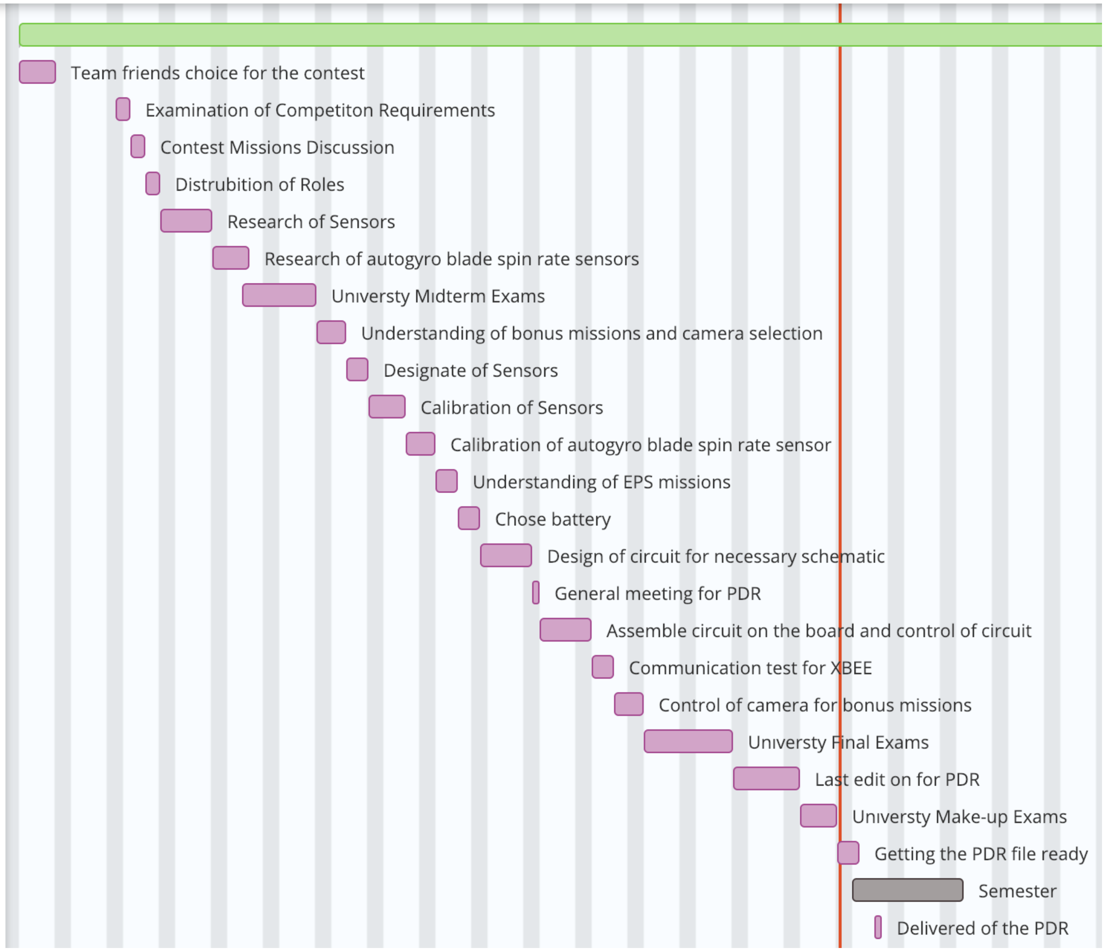
Major Development	10/Oct	30/Dec
Mechanical	10/Oct	29/Nov
Descent Control Subsytem Des...	23/Oct	26/Nov
Mechanical Subsytem Design	23/Oct	29/Nov
Electrical	27/Oct	30/Dec
Sensors	27/Oct	02/Dec
Powers	03/Dec	23/Dec
Tests	24/Nov	30/Dec
Software	30/Oct	30/Dec
Communication and Data Han...	23/Nov	03/Dec
Flight Software Design	30/Oct	30/Dec
Ground Control Sytsem Design	10/Nov	26/Dec



Completed Tasks

Electrical and Electronics

Electrical and Electronics	08/Oct	16/Jun
Team friends choice for the contest	08/Oct	12/Oct
Examination of Competiton Requir...	21/Oct	22/Oct
Contest Missions Discussion	23/Oct	24/Oct
Distrubition of Roles	25/Oct	26/Oct
Research of Sensors	27/Oct	02/Nov
Research of autogyro blade spin ra...	03/Nov	07/Nov
Unıversty Mıdterm Exams	07/Nov	16/Nov
Understanding of bonus missions ...	17/Nov	20/Nov
Designate of Sensors	21/Nov	23/Nov
Calibration of Sensors	24/Nov	28/Nov
Calibration of autogyro blade spin ...	29/Nov	02/Dec
Understanding of EPS missions	03/Dec	05/Dec
Chose battery	06/Dec	08/Dec
Design of circuit for necessary sche...	09/Dec	15/Dec
General meeting for PDR	16/Dec	16/Dec
Assemble circuit on the board and ...	17/Dec	23/Dec
Communication test for XBEE	24/Dec	26/Dec
Control of camera for bonus missio...	27/Dec	30/Dec
Unıversty Final Exams	31/Dec	11/Jan
Last edit on for PDR	12/Jan	20/Jan
Unıversty Make-up Exams	21/Jan	25/Jan
Getting the PDR file ready	26/Jan	28/Jan
Semester	28/Jan	11/Feb
Delivered of the PDR	31/Jan	31/Jan



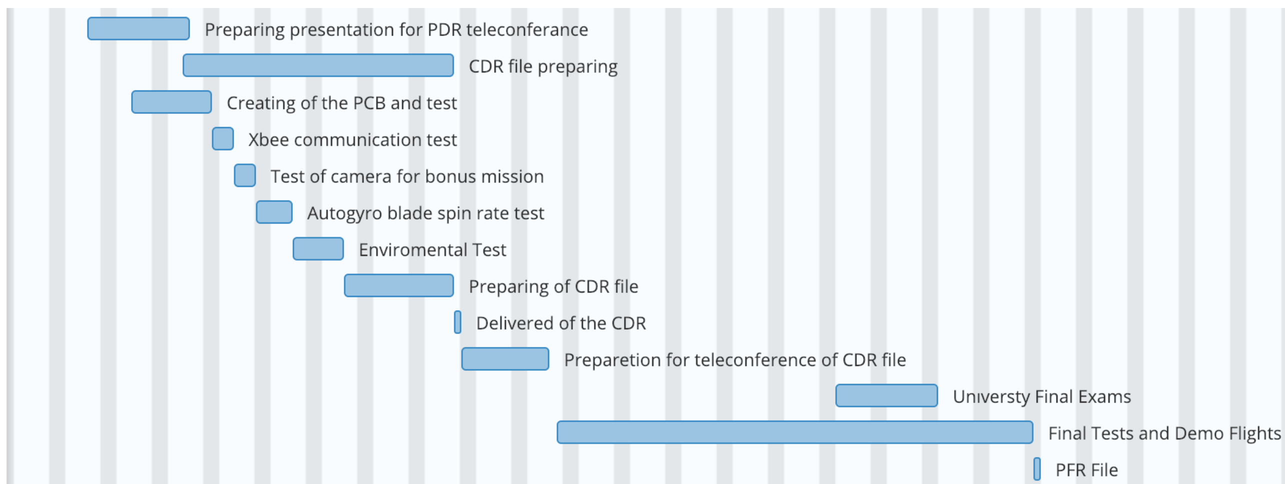
Completed Tasks

Holiday

Detailed Program Schedule (3 of 9)

Electrical and Electronics

	Task	Start	End
☐	Preparing presentation for PDR tel...	07/Feb	20/Feb
☐	CDR file preparing	20/Feb	28/Mar
☐	Creating of the PCB and test	13/Feb	23/Feb
☐	Xbee communication test	24/Feb	26/Feb
☐	Test of camera for bonus mission	27/Feb	01/Mar
☐	Autogyro blade spin rate test	02/Mar	06/Mar
☐	Enviromental Test	07/Mar	13/Mar
☐	Preparing of CDR file	14/Mar	28/Mar
☐	Delivered of the CDR	29/Mar	29/Mar
☐	Preparetion for teleconference of C...	30/Mar	10/Apr
☐	Unıversty Final Exams	20/May	02/Jun
☐	Final Tests and Demo Flights	12/Apr	15/Jun
☐	PFR File	16/Jun	16/Jun

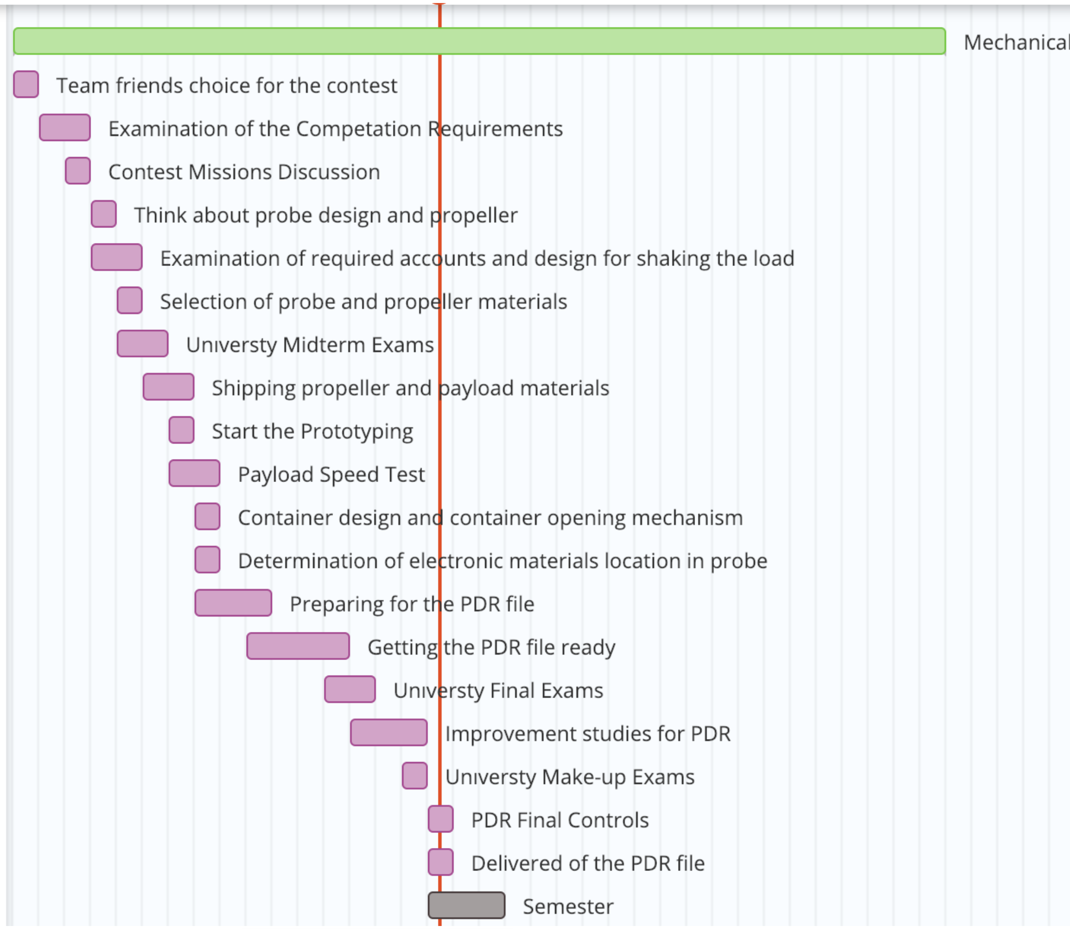


Incompleted Tasks

Detailed Program Schedule (4 of 9)

Mechanical

Task	Start	End
Mechanical	08/Oct	16/Jun
Team friends choice for the contest	08/Oct	12/Oct
Examination of the Competation R...	21/Oct	22/Oct
Contest Missions Discussion	23/Oct	24/Oct
Think about probe design and pro...	30/Oct	01/Nov
Examination of required accounts ...	01/Nov	05/Nov
Selection of probe and propeller m...	05/Nov	07/Nov
Universty Midterm Exams	07/Nov	16/Nov
Shipping propeller and payload ma...	17/Nov	23/Nov
Start the Prototyping	23/Nov	25/Nov
Payload Speed Test	25/Nov	26/Nov
Container design and container op...	26/Nov	28/Nov
Determination of electronic materi...	28/Nov	30/Nov
Preparing for the PDR file	30/Nov	11/Dec
Getting the PDR file ready	11/Dec	31/Dec
Universty Final Exams	31/Dec	11/Jan
Improvement studies for PDR	11/Jan	21/Jan
Universty Make-up Exams	21/Jan	25/Jan
PDR Final Controls	30/Jan	30/Jan
Delivered of the PDR file	31/Jan	31/Jan
Semester	28/Jan	11/Feb

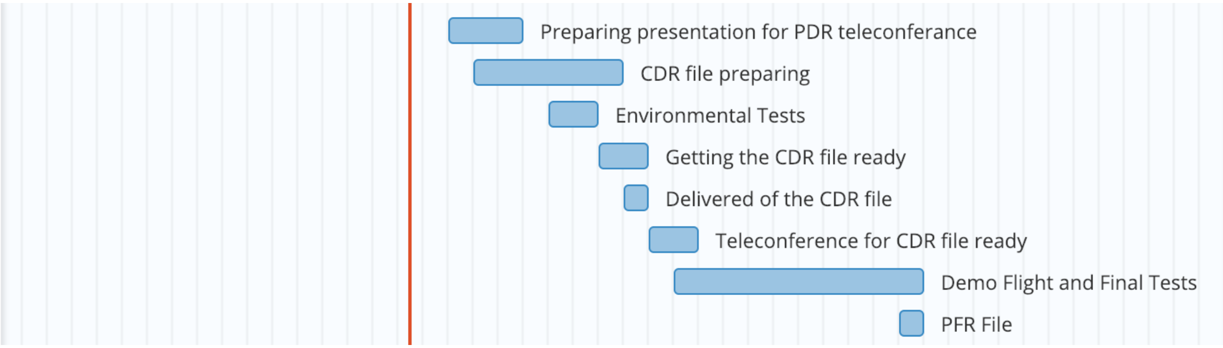


Completed Tasks

Holiday

Mechanical

☐	Preparing presentation for PDR tel...	07/Feb	20/Feb
☐	CDR file preparing	11/Feb	20/Mar
☐	Environmental Tests	07/Mar	14/Mar
☐	Getting the CDR file ready	20/Mar	28/Mar
☐	Delivered of the CDR file	29/Mar	29/Mar
☐	Teleconference for CDR file ready	01/Apr	12/Apr
☐	Demo Flight and Final Tests	12/Apr	15/Jun
☐	PFR File	16/Jun	16/Jun

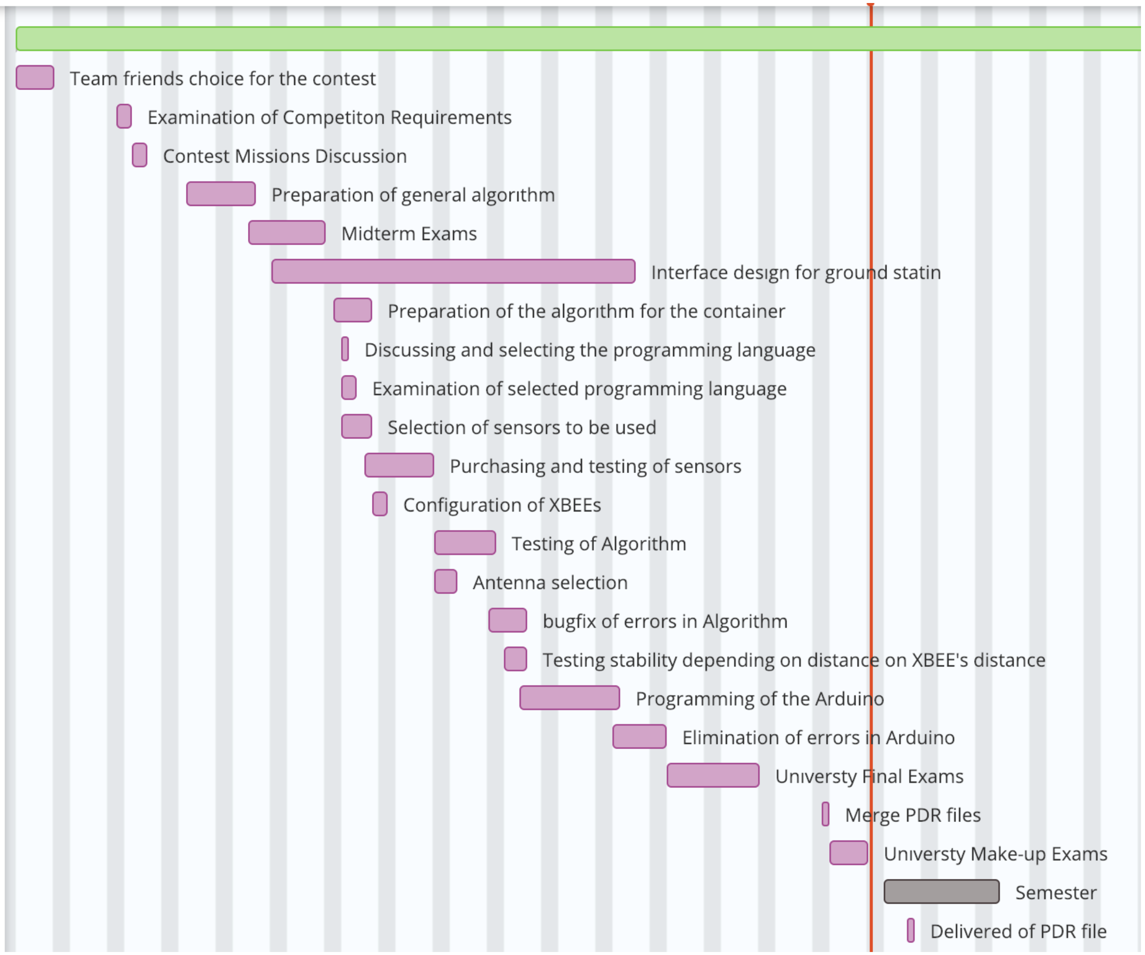


Incompleted Tasks

Detailed Program Schedule (6 of 9)

Software

Task	Start	End
Software	08/Oct	16/Jun
Team friends choice for the contest	08/Oct	12/Oct
Examination of Competiton Requir...	21/Oct	22/Oct
Contest Missions Discussion	23/Oct	24/Oct
Preparation of general algorıthm	30/Oct	07/Nov
Midterm Exams	07/Nov	16/Nov
Interface desıgn for ground statin	10/Nov	26/Dec
Preparation of the algorıthm for th...	18/Nov	22/Nov
Discussing and selecting the progr...	19/Nov	19/Nov
Examination of selected programm...	19/Nov	20/Nov
Selection of sensors to be used	19/Nov	22/Nov
Purchasing and testing of sensors	22/Nov	30/Nov
Configuration of XBEEs	23/Nov	24/Nov
Testing of Algorithm	01/Dec	08/Dec
Antenna selection	01/Dec	03/Dec
bugfix of errors in Algorithm	08/Dec	12/Dec
Testing stability depending on dist...	10/Dec	12/Dec
Programming of the Arduino	12/Dec	24/Dec
Elimination of errors in Arduino	24/Dec	30/Dec
Unıversty Final Exams	31/Dec	11/Jan
Merge PDR files	20/Jan	20/Jan
Unıversty Make-up Exams	21/Jan	25/Jan
Semester	28/Jan	11/Feb
Delivered of PDR file	31/Jan	31/Jan



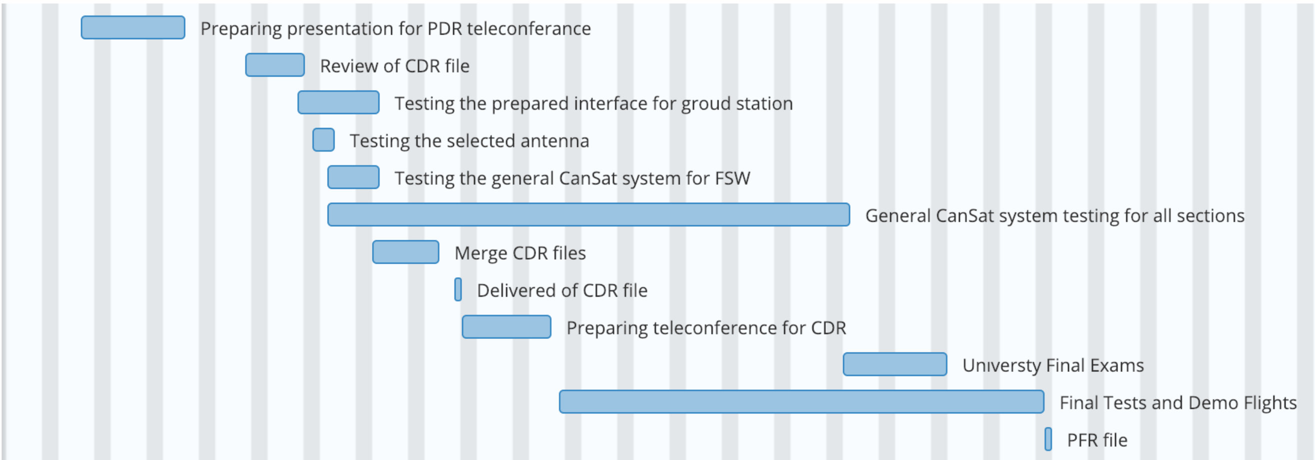
Completed Tasks

Holiday

Detailed Program Schedule (7 of 9)

Software

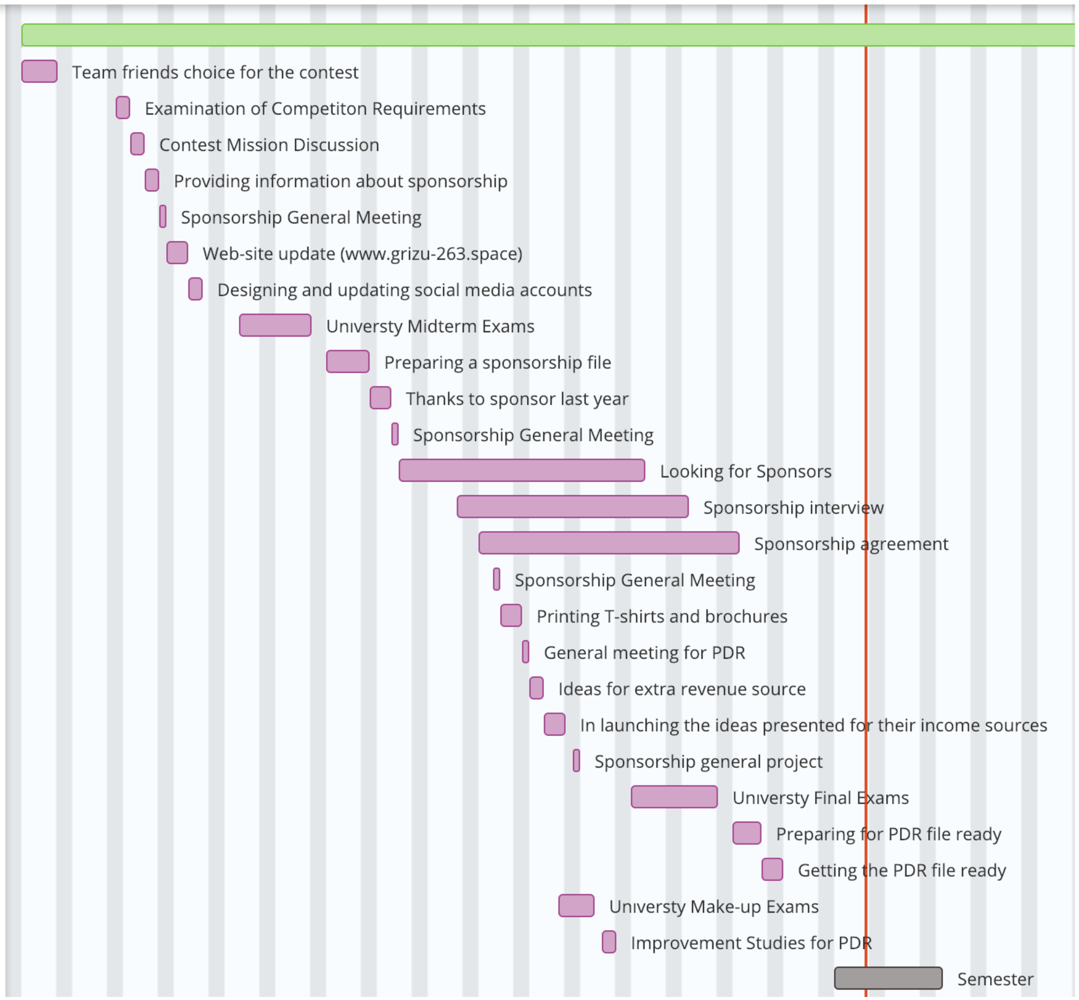
☐	Preparing presentation for PDR tel...	07/Feb	20/Feb
☐	Review of CDR file	01/Mar	08/Mar
☐	Testing the prepared interface for ...	08/Mar	18/Mar
☐	Testing the selected antenna	10/Mar	12/Mar
☐	Testing the general CanSat system ...	12/Mar	18/Mar
☐	General CanSat system testing for ...	12/Mar	20/May
☐	Merge CDR files	18/Mar	26/Mar
☐	Delivered of CDR file	29/Mar	29/Mar
☐	Preparing teleconference for CDR	30/Mar	10/Apr
☐	Unıversty Final Exams	20/May	02/Jun
☐	Final Tests and Demo Flights	12/Apr	15/Jun
☐	PFR file	16/Jun	16/Jun



Incompleted Tasks

Sponsorship

Task	Start	End
Sponsorship	08/Oct	16/Jun
Team friends choice for the contest	08/Oct	12/Oct
Examination of Competiton Requir...	21/Oct	22/Oct
Contest Mission Discussion	23/Oct	24/Oct
Providing information about spons...	25/Oct	26/Oct
Sponsorship General Meeting	27/Oct	27/Oct
Web-site update (www.grizu-263.s...	28/Oct	30/Oct
Designing and updating social med...	31/Oct	01/Nov
Universty Midterm Exams	07/Nov	16/Nov
Preparing a sponsorship file	19/Nov	24/Nov
Thanks to sponsor last year	25/Nov	27/Nov
Sponsorship General Meeting	28/Nov	28/Nov
Looking for Sponsors	29/Nov	01/Jan
Sponsorship interview	07/Dec	07/Jan
Sponsorship agreement	10/Dec	14/Jan
Sponsorship General Meeting	12/Dec	12/Dec
Printing T-shirts and brochures	13/Dec	15/Dec
General meeting for PDR	16/Dec	16/Dec
Ideas for extra revenue source	17/Dec	18/Dec
In launching the ideas presented fo...	19/Dec	21/Dec
Sponsorship general project	23/Dec	23/Dec
Universty Final Exams	31/Dec	11/Jan
Preparing for PDR file ready	14/Jan	17/Jan
Getting the PDR file ready	18/Jan	20/Jan
Universty Make-up Exams	21/Dec	25/Dec
Improvement Studies for PDR	27/Dec	28/Dec
Semester	28/Jan	11/Feb



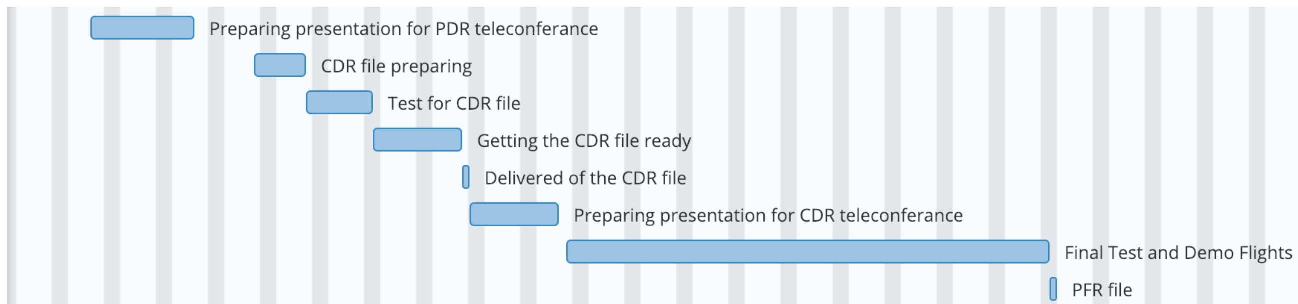
Completed Tasks

Holiday

Detailed Program Schedule (9 of 9)

Sponsorship

☐	Preparing presentation for PDR tel...	07/Feb	20/Feb
☐	CDR file preparing	01/Mar	07/Mar
☐	Test for CDR file	08/Mar	16/Mar
☐	Getting the CDR file ready	17/Mar	28/Mar
☐	Delivered of the CDR file	29/Mar	29/Mar
☐	Preparing presentation for CDR tel...	30/Mar	10/Apr
☐	Final Test and Demo Flights	12/Apr	15/Jun
☐	PFR file	16/Jun	16/Jun



Incompleted Tasks

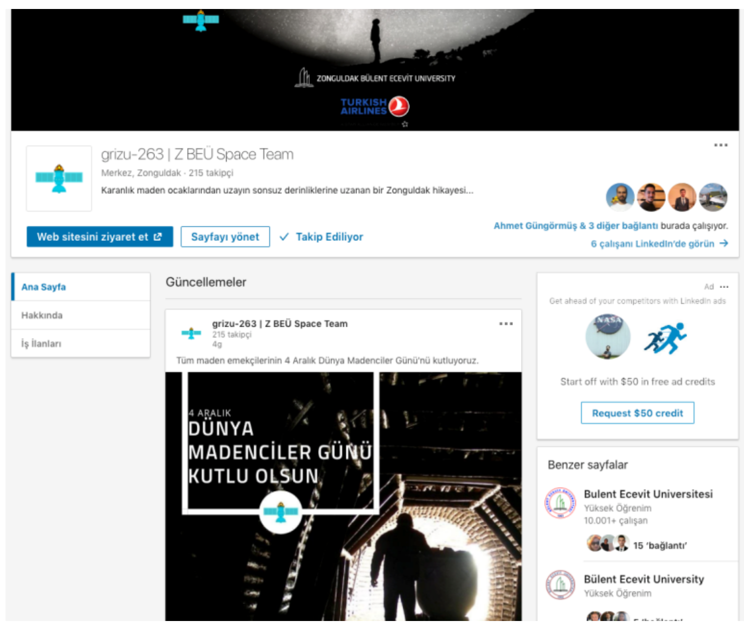
Social Media and Publicity (1 of 5)

grizu-263.space

Our website has been active since September 2016.
Average number of unique visitors per day 21.

Linkedin

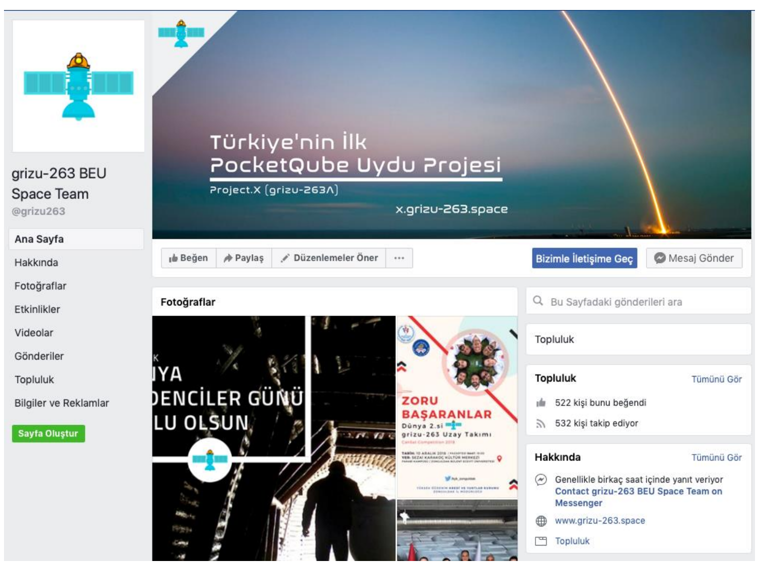
We have about 284 followers.
Our followers are mostly academicans and universty students.



Twitter

Our Twitter page opened in October 2016. Approximately 360 posts were shared in the team, Cansat Competiton, space ,engineering and science fields .

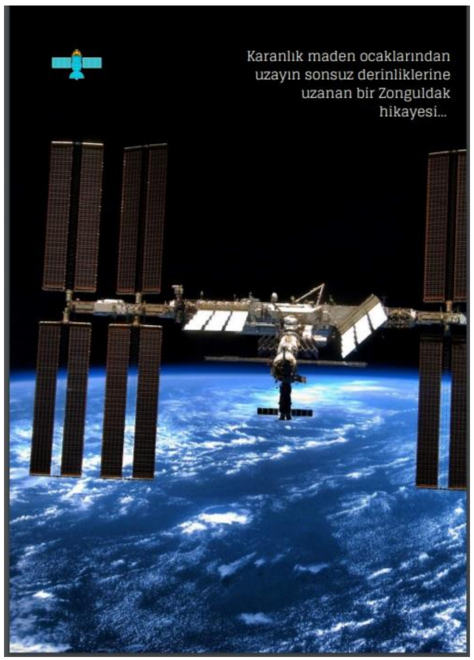
We have about 1.246 followers



Facebook

Our Facebook page has been active since September 2016 . We have about 525 followers. We are sharing more in teams , competition , science , space and enginnering .

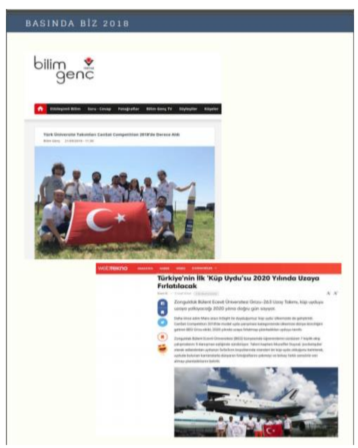
- **Other Presentation and Information Tools**



Our slogan's :
It is a story of Zonguldak which
reaches from the dark mines
to the infinite depths of the space !

- **Other Presentation and Information Tools**

News, our team, some images and sponsorship packages in the sponsorship file.



Other Presentation and Information Tools

Some of our sponsors and supporters…

Thank you for not leaving us alone on this way.

Conclusions (1 of 3)

Accomplishments:

- Mechanical Design was made.
- Material selection has been made.
- Auto-Gyro stability and descent test were done. It was seen not tumble down over.
- All sensors determined, procured and tested.
- Circuit design devised according to power budget.
- The interface design for the ground station was done.
- The XBees' communications test.
- Flight software algorithm created.
- Selection of electronic components required to receive telemetry data and transmit to the ground station is completed.

Unfinished work:

- Container and payload was not doing to separation mechanical test.
- The devised circuit in breadboard will install to PCB.
- Testing the selected antenna.
- Testing the prepared interface for ground station.
- Testing the general CanSat system for FSW.

Conclusions (2 of 3)

Why you are ready to proceed to next stage of development

- We understood auto-gyro system and accomplished auto-gyro prototypes test with successfully.
- The Preliminary Design Phase is complete for mechanical, software, electronic systems.
- We have planning to environmental tests.
- We have planning to test whole CanSat system.
- We have carried out our work in a planned way according to the requirements of the competition.
- CanSat's production, our transportation and accommodation expenses are ready to be covered by the sponsors. (Such as Turkish Airlines and ERDEMİR)
- With the experience we gained from the past years, we are confident in transforming the prototype into a product.

Conclusions (3 of 3)