CanSat 2014
Preliminary Design Review (PDR)
Outline

#5524

ARISAT

(ISTANBUL TECNICAL UNIVERSITY)

Presentation Outline

Team ARISAT

Name	Year	Department
Hasbi Sevinc	Junior	Electronic and Communication Engineering
Ali Canpolat	Senior	Electronic and Communication Engineering
Eren Durkaya	Freshman	Astronautical Engineering
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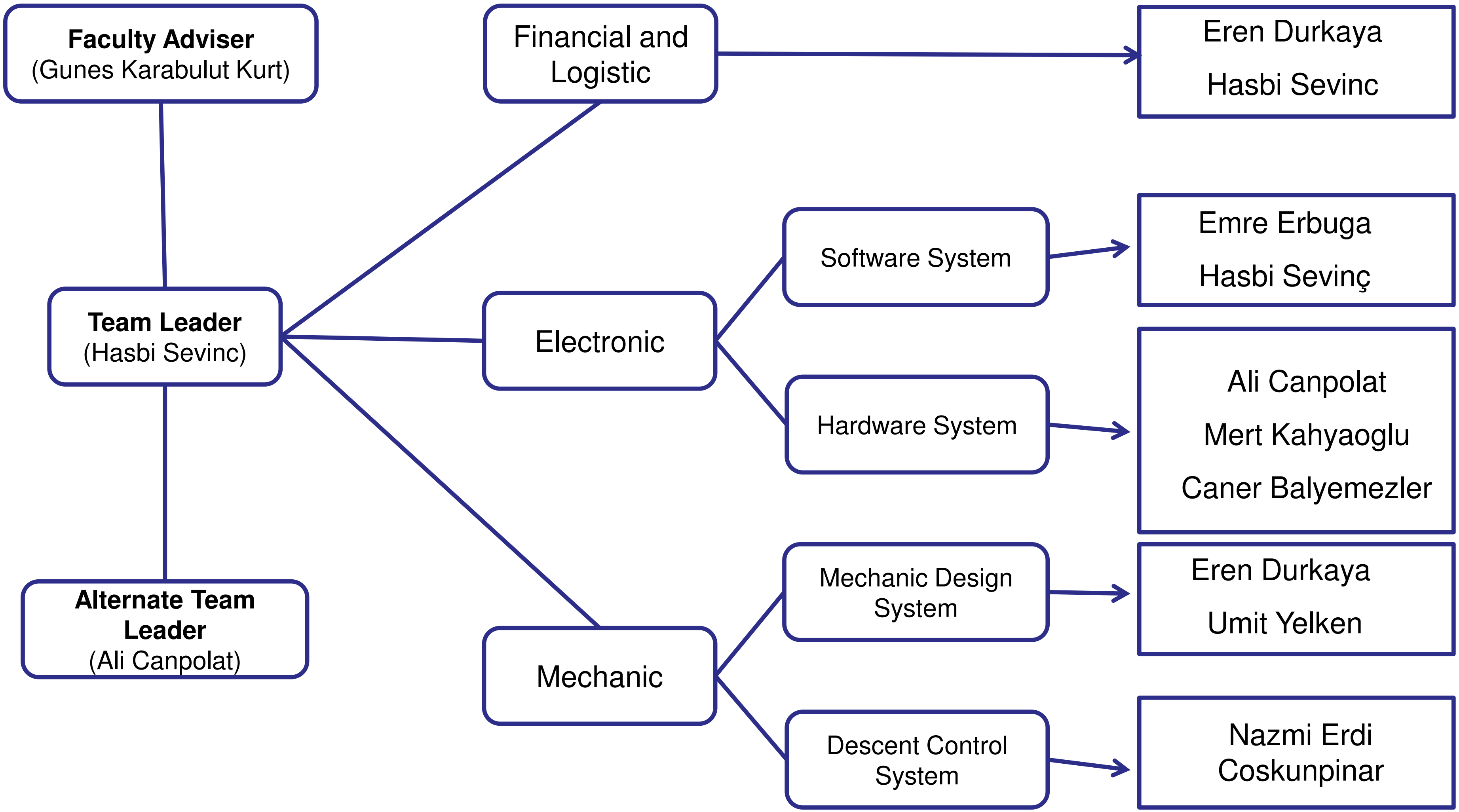
Umit Yelken	Junior	Mechanical Engineering
Mert Kahyaoglu	Junior	Electronic and Communication Engineering
Nazmi Erdi Coskunpinar	Junior	Astronautical Engineering

Team Organization



Acronyms

A – Analysis

ADC – Analog-to-Digital Converter

ADR – Average Descent Rate

ALT - Altitude

CDH – Communication & Data Handling

D – Demonstrate

DCD – Descent Control Design

DCS – Descent Control System

DS – Datasheet

EEPROM – Electrically Erasable Programmable Read-Only Memory

EPS – Electric Power System

F- Figure

FSW – Flight Software

GCS – Ground Control System

GPS – Global Positioning System

I – Inspect

I2C – Inter-Integrated Circuit

MSR- Mechanica System Requirements

SR-System Requirements

SSR – Sensor Subsystem Requirements

T – Test

TEM – Temperature

UART– Universal synchronous asynchronous receiver/transmitter

VM – Verification Matrix

Systems Overview

Hasbi Sevinç

Mission Summary

The Main object:

- The 2014 mission simulates a sensor payload traveling through a planetary atmosphere sampling the atmospheric composition during descent.

Other Objectives:

- Cansat shall collect data using sensors. (pressure, temperature, altitude…)
- Cansat shall transmit telemetry data's to ground station.
- Protecting the egg.
- The descent rate of the CanSat shall be 12 m/s above 500 meters.
- Container shall release the payload at 500 meters.
- After releasing, the payload shall have a descent rate of less than 10 m/s.
- Payload must control descent rate without using parachute

Bonus Objective:

- Use a three-axis accelerometer to measure the stability and angle of descent of the payload during descent. Sample at appropriate rate and store data for later retrieval.
- We decided to choose first bonus because measuring light intensity requires new subsystem. Our system already capable of measuring stability and angle of descent

System Requirement Summary

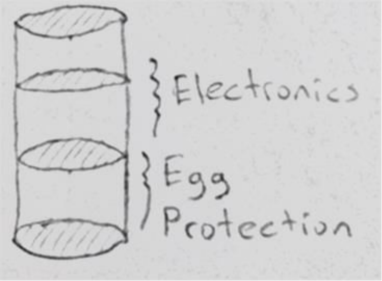
ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
SRS-01	Total mass of the CanSat shall not exceed 600 grams without the egg.	Competition Rule	HIGH		MSR-01		X		
SRS-02	Cansat will be suited into cylindrical envelope at 125 mm diameter and 310 mm in length.	Competition Rule	HIGH		MSR-04		X		
SRS-03	Payload suppose to harvest energy and also control descent rate without using parachute	Competition Requirement	HIGH		EPS-01	X	X		
SRS-04	CanSat shall not use any flammable or pyrotechnic devices	Mission requirement to display real-time data.	HIGH		DSC-02		X		
SRS-05	Cansat system and egg shall be recovered safely	Competition Rule	HIGH		MSR-02			X	

System Requirement Summary

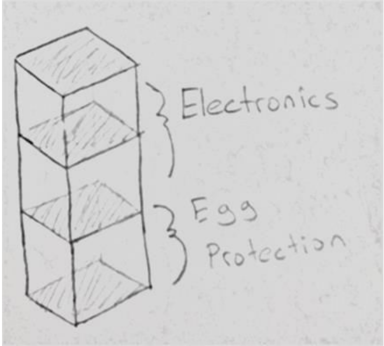
ID	Requirement	Rationale	Priority	Parent	Children	VM			
						A	I	T	D
SRS-06	Cansat communication radio shall be the XBEE radio model and shall not use the broadcast mode	Competition Rule	HIGH		CDH-01	X	X		
SRS-07	Each team must use their own ground station	Competition Requirement	HIGH		GCS -01		X		
SRS-08	All descent control systems must be capable of handling a 30G shock force	Competition Rule	HIGH		DSC-06 DSC-07		X		
SRS-09	The cost of the Cansat shall not exceed $1000 USD.	Competition Rule	HIGH			X	X		
SRS-10	Use a three-axis accelerometer to measure the stability and angle of descent of the payload during descent	Bonus mission	MEDIUM		SSD-04			X	

System Level CanSat Configuration Trade & Selection

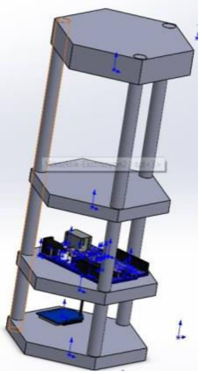
- **Round Design:** First we consider a round design for payload, but this design ended up having area problem with energy harvesting system. We need to use flexiable solar panel which is unadaptable for energy harvesting system.



- **Square Design:** Solar panels can be integrated easly, however this design could cause separation problem between payload and container.



- **Hexagon Design (selected):** This design provides enough area for electronic systems. Edge of hexagon has enough field to stick energy harvesting system. We think this is the best way for this years competition concept because harvesting energy is a big deal for structure type.



System Level CanSat Configuration Trade & Selection

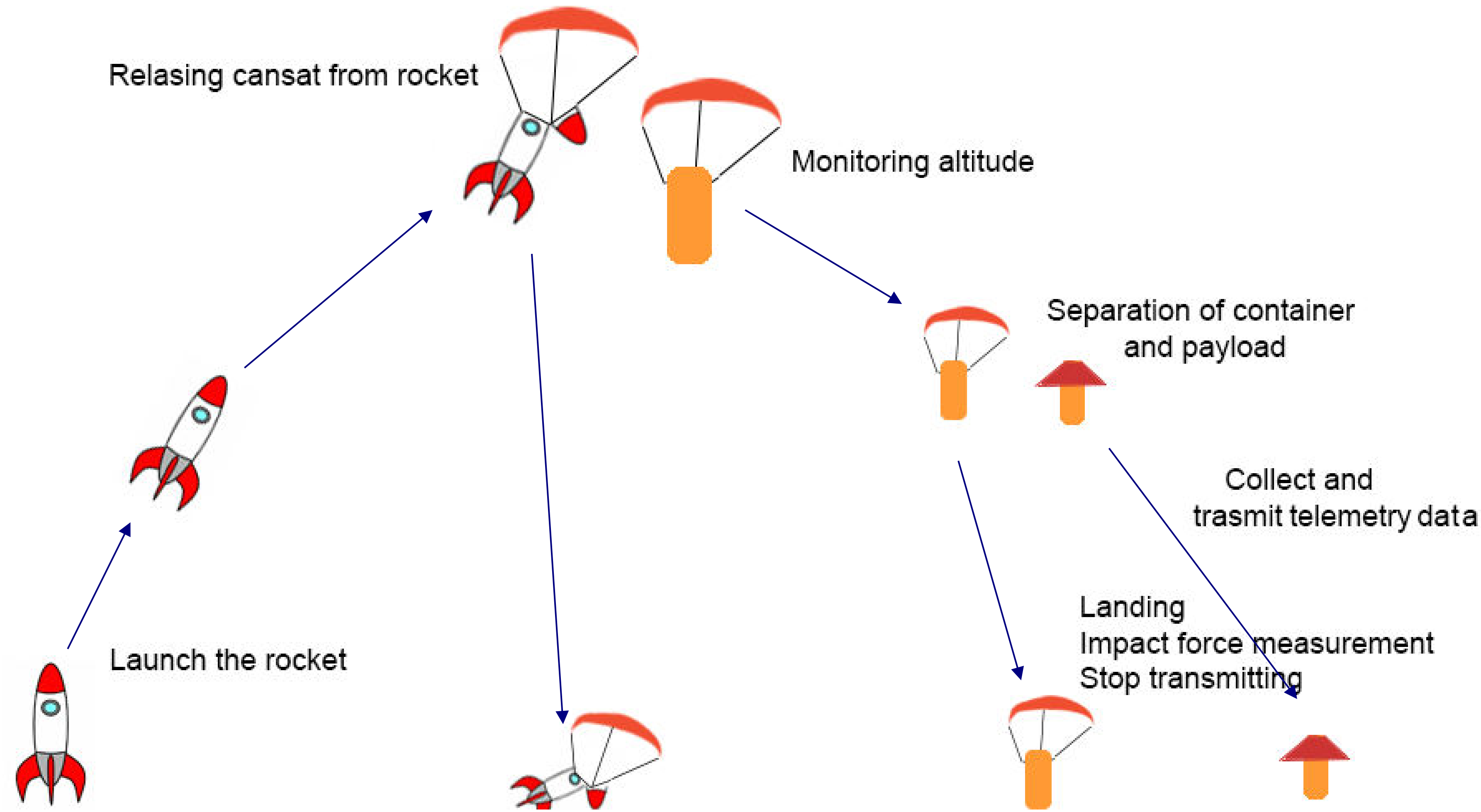
- We decided to use **carbon fiber** as a material of lateral cover and base cover, because its light and sturdy against damages.
- **For Egg Protection:** We have so many options for egg protection hence, we had narrow the options down. There was two 2 different material left for the tests: rubber and polyethylen-C70 composite sandwich structure foam. When we try to use rubber system we saw that rubber system is heavier than polyethylen-C70 composite sandwich structure foam system. Finally our egg protection system is ready.
- **Separation :** When we discussing about our separation system some thoughts came up for instance using a cap system, using a rail system, using a prestressed spring but they did not satisfied us we should not make any mistake finally we compromise then we designed ring-clevis system.

System Concept of Operations

Pre-launch	• Prelaunch Briefing • Insert egg into lander • Last Mechanics and electronics checks • Integrate the payload and container • Locate the cansat into the rocket payload section
Launch	• Rocket launch • Cansat deployment • Separation of container and payload at 500 meters • Collect and Send telemetry data to ground station
Post-Launch	• Finding cansat (container and payload) • Telemetry data is retrieved from SD Card • Prepare and Presentation of PFR

System Concept of Operations

Launch and Descent Operations



System Concept of Operations

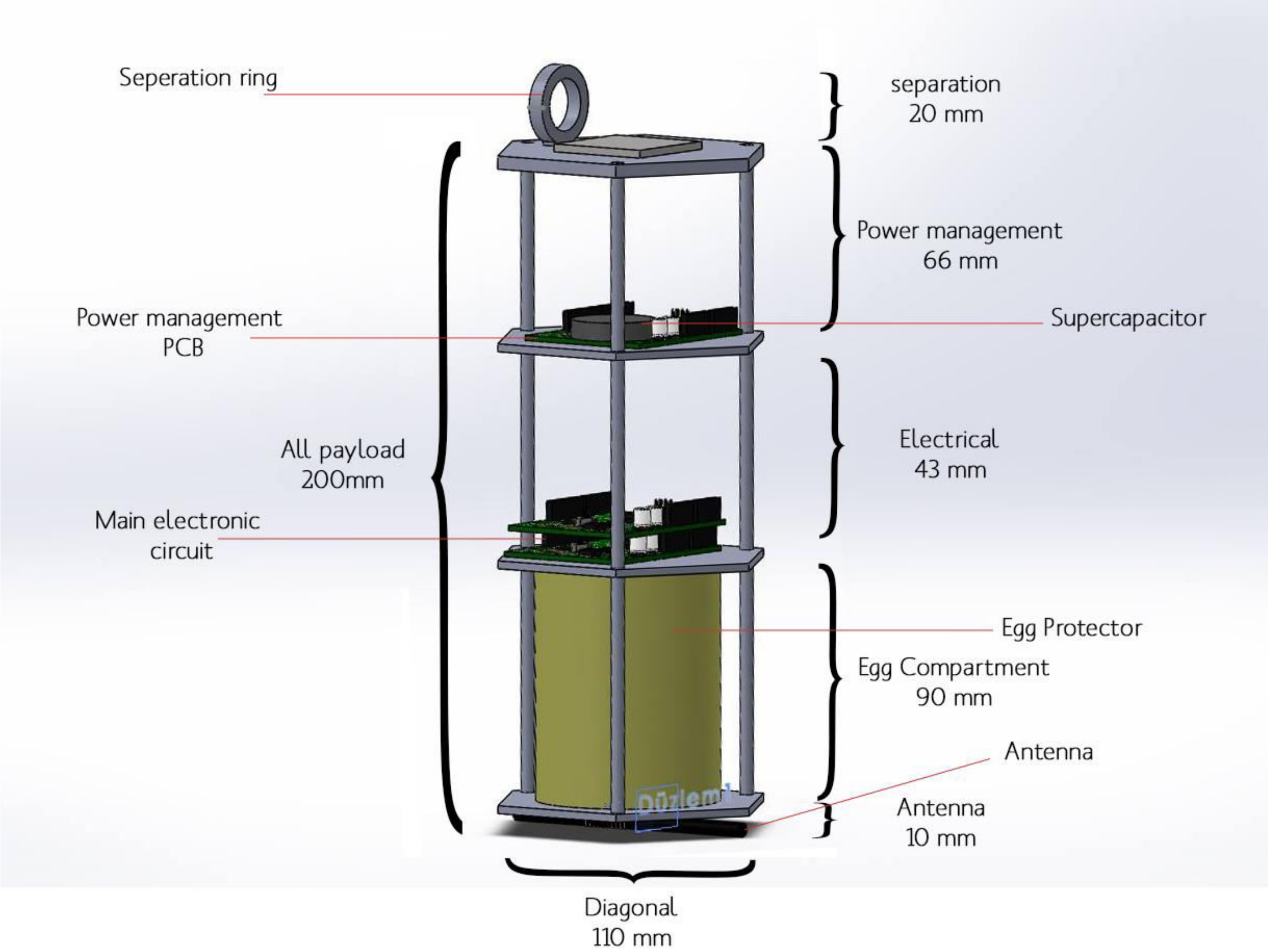
Post-launch recovery

- Find to landing location
- Come back to ground station
- Looking data which stored by payload via SD Card

Post-launch data reduction

- Infiltrate unpaired datas
- Taking acceleration values
- Compare ground station data with payload's for detect any differences

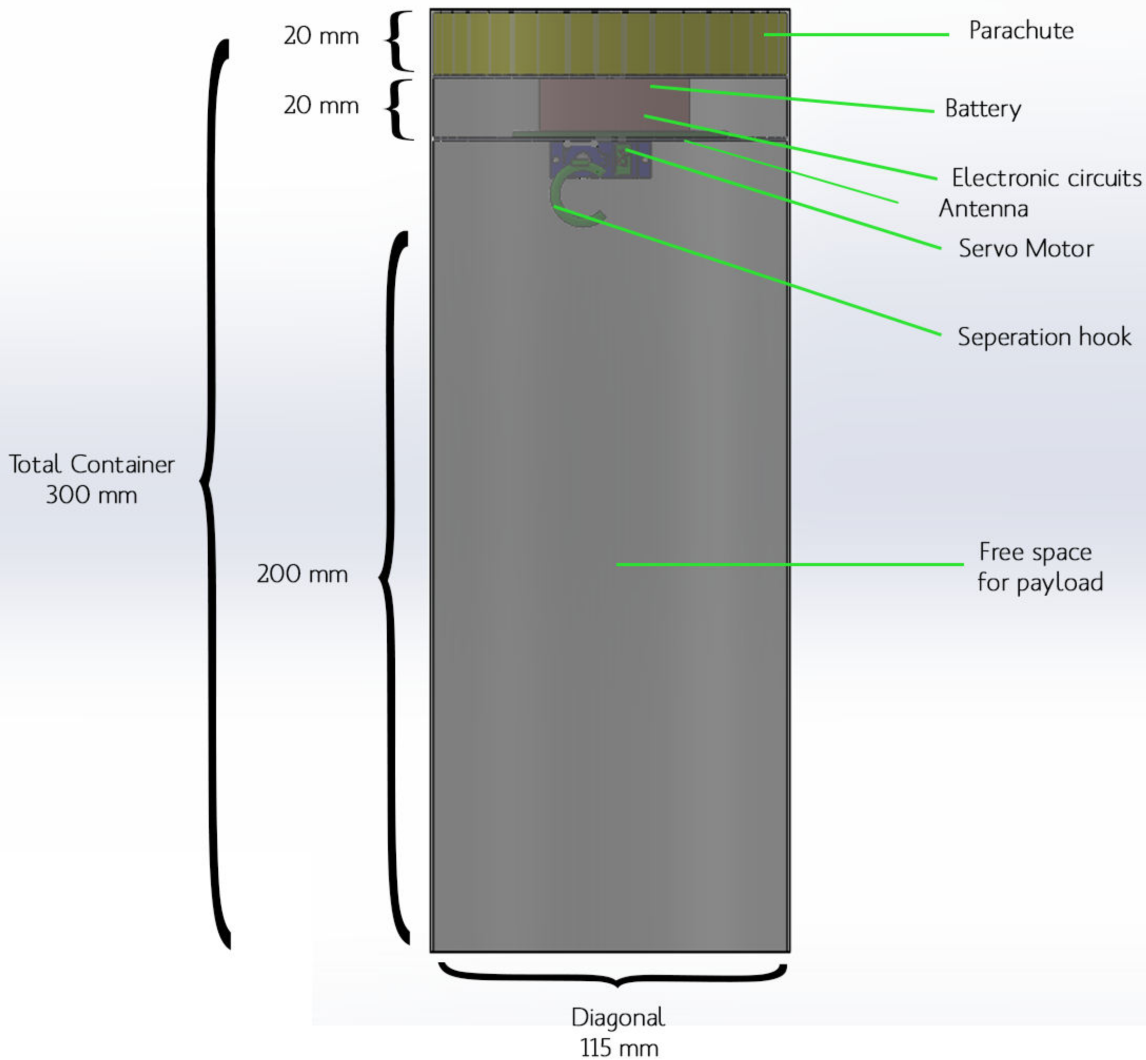
Physical Layout (Payload)



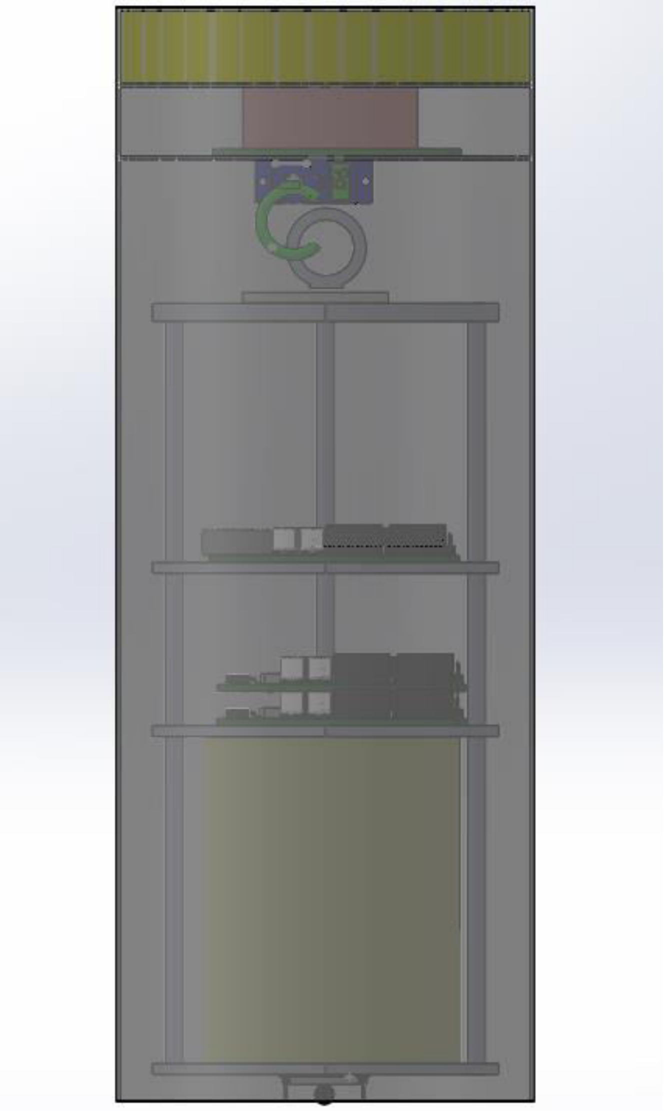
Physical Layout (Payload)

Payload with solar panels and descent system

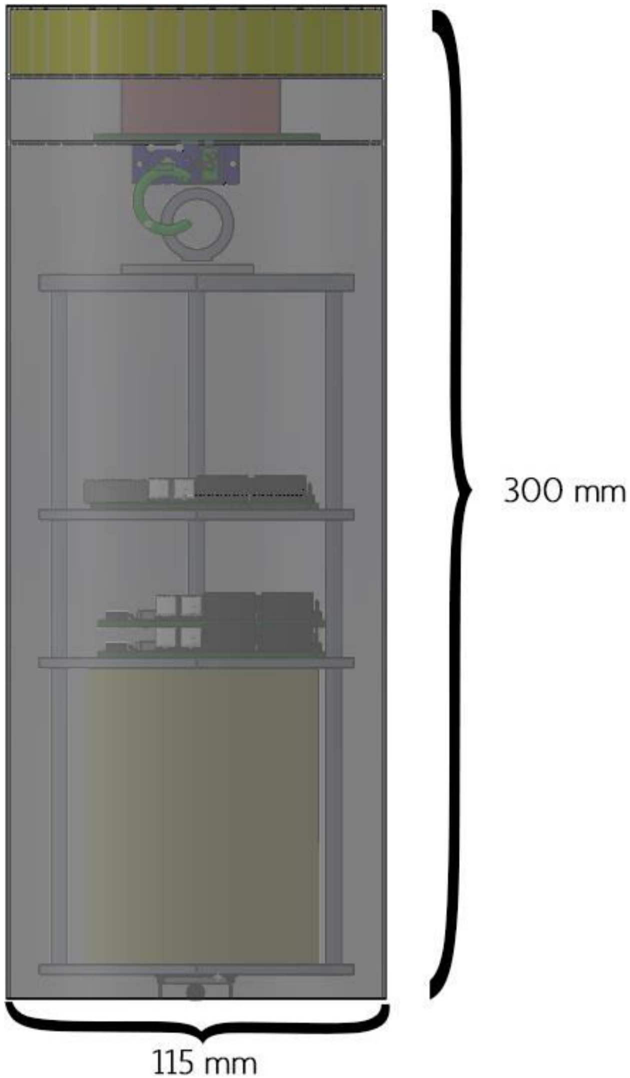
Physical Layout (Container)



Physical Layout (Payload + Container)



Launch Vehicle Compatibility



- **Rocket payload dimensions:**
  - 125 mm x 310 mm
- **Cansat dimensions:**
  - Height: 300 mm
  - Diameter: 115 mm
- **For a safety separation from rocket:**
  - leaving 5 mm of space on the top and bottom.
  - leaving 5 mm of space on the left and right.
- **Cansat has a simple cylinder ic shape which disallowing any protrusions to hinder ejection.**
- **Before launch, cansat will test with a pre-built rocket payload model for verification**
- **CanSat will be placed upside-down in rocket payload forDeployment from rocket correctly**

Sensor Subsystem Design

Mert Kahyaoğlu

Sensor Subsystem Overview

Payload

- Pressure Sensor – Altitude
- Temperature Sensor
- Accelerometer
- Power source voltage sensing

Container

- Pressure Sensor – Altitude
- Power source voltage sensing
- GPS

Sensor Subsystem Overview

Sensor Type	Manufacture	Model	Purpose	CanSat use	Power Consumptioın
Pressure	Bosch	BMP-085	Non-GPS Altitude measurement	Payload Container	3.3v/5uA
Temperature	Bosch	BMP-085	Temperature	Payload	3.3v/5uA
Accelerometer	Analog Devices	ADXL345	3-Axis, ±2 g/±4 g/±8 g/±16 g Digital Accelerometer	Payload	3.3v/40uA
Volt-meter	Atmel	Atmega2560	Measurement of power source voltage	Payload Container	-
GPS	LOCOSYS Technology Inc	LS20031	Descent Telemetry and determination of Landing	Container	3.3v/41mA

Sensor Subsystem Requirements

ID	Requirement	Rationale	Priority	Parent	Children	VM			
						A	I	T	D
SSD-01	Sensors must operate at 5V or less.	Our power system provide 5V or less	Medium		EPS-05 EPS-04	x			
SSD-02	All sensors must be able to sample data at a rate of at least 1 Hz	Base mission requirement	High		FSW-01	x	x		
SSD-03	Pressure sensor shall measure altitude with accuracy of at least 0.5 hPa	Base mission requirement	High			x		x	
SSD-04	Accelerometer shall measure impact force at rate of at least 100 Hz	Base mission requirement	High			X			
SSD-05	Sensors shall use the following protocols: I$_2$C, SPI, or Analog	Interface to Microcontroller	High			x		X	

Sensor Subsystem Requirements

ID	Requirement	Rationale	Parent	Children	Priority	VM			
						A	I	T	D
SSD-06	Temperature sensor must have a range of at least 0ºC-50ºC	Air conditions of launch locatioın	High			x			
SSD-07	GPS Location data	Descent Telemetry and determination of Landing	High			x		x	

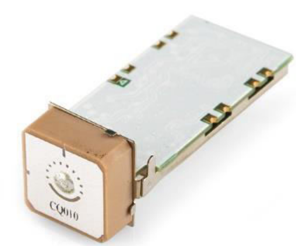
Container GPS Trade & Selection

Model	Voltage/Current	Channel	Accuracy	Price	Weight
LS20031 GPS 5Hz Receiver	**3.3v/41mA**	**66**	**3**	**$59.95**	**14g**
EM-408	3.3v/75mA	20	10	$60.00	16
MTK3339 10Hz	3.3v/25mA	20	2	$39.95	8.5

LS20031 is selected, because;

- Extremely compact
- Internal antenna
- High update rate
- Low power consumption
- Fast TTFF at low signal level
- Widely used, tested and examples.

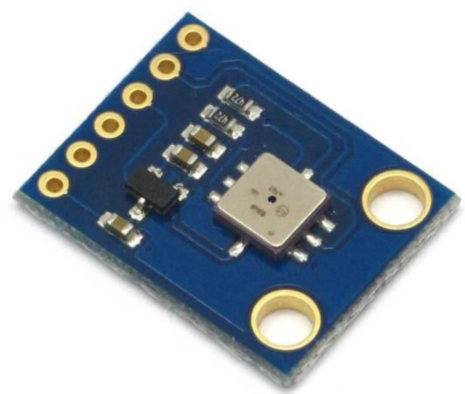
- We use GPS therefore determination of container location after the landing.



Altitude Sensor Trade & Selection

Model	Voltage/ Current	Range	Sample Rate(Hz)	Interface	Price	Weight
BMP085	**3.3v/5uA**	**30kPA-110kPa**	**1**	**I2C**	**$19.95**	**11g**
SCP1000	3.3v/25uA	30kPA-120kPa	9	SPI	$34.95	1.7g
MPL115A1	3.3v/10uA	50kPa-115kPa	1	SPI	$11.95	2g

BMP085 is selected for both payload and container.



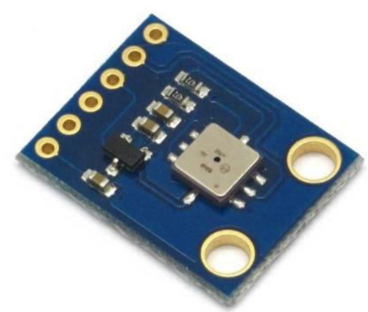
- Temperature measurement included
- I2C interface
- Fully calibrated
- Pb-free, halogen-free and RoHS compliant,
- Ultra low power consumpiton
- Altimeter accuracy of 0.25 [m]
- Pressure Accuracy to ±0.2 [hPa]

Air Temperature Sensor Trade & Selection

Model	Voltage/ Current	Range	Sample Rate(Hz)	Interface	Price	Weight
BMP085	**3.3v/5uA**	**-40º to +85ºC**	**1**	**I2C**	**$9.95**	**11g**
SCP1000	3.3v/25uA	-20 to 70°C	9	SPI	$34.95	1.7g
MPL115A1	3.3v/10uA	-40°C to +105°C	1	SPI	$11.95	2g
DHT11	3.3v/200uA	0-50'C	1	Single Bus	$5.00	1.8g

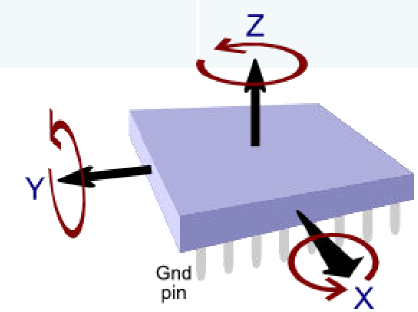
BMP085 is selected because:

- Temperature measurement included
- I2C interface
- Fully calibrated
- Pb-free, halogen-free and RoHS compliant,
- Ultra low power consumpiton
- Temperature Accuracy to ±0.5 [ºC]



3-Axis Accelerometer Sensor Trade & Selection

Model	Voltage/ Current	Range	Sample Rate(Hz)	Interface	Price	Weight
L3G4200D	3.3v/6.7 mA	User Selectable ±250, ±500, ±2000 [dps]	800Hz	I2C	$29.99	0.7 g
ADXL345	**3.3v/40uA**	**±1.5, ±16 [g]**	**3200Hz**	**I2C/SPI**	**$27.95**	**5g**
ADXL320	3.3v/450 uA	±5 [g]	500Hz	Analog	$40.85	3g



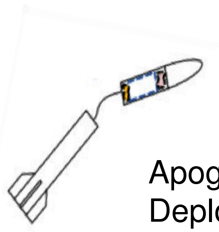
ADXL345 is selected because:

- 2.0-3.6VDC Supply Voltage
- Ultra Low Power: 40uA in measurement mode, 0.1uA in standby@ 2.5V
- Tap/Double Tap Detection
- Free-Fall Detection
- SPI and I2C interfaces

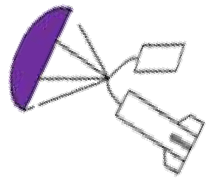
Descent Control Design

Presenter: Nazmi Erdi COŞKUNPINAR

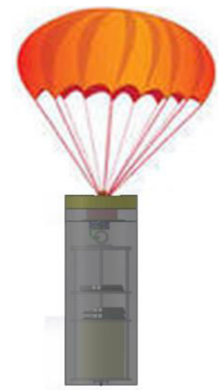
Descent Control Overview



Apogee at 670 m. Deployment of the container with payload.

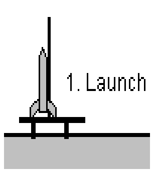


670 meters to 500 meters contaier will descent with parachute at 12 m/s rate of velocity.



2. Boost and Coast Phase of Rocket

At 500 meters altitude payload will deploy from container. From 500 meters to ground the descent rate must be 10 m/s .At this point the solar panels will open with angle of 46.10 degree. Solar panels are attached to shells. Shells are attached to each other with parachute fabrics.



The descent systems have two phases;

Container phase: Container phase has two critical point.

a) 670 meters to 500 meters altitude descent rate.

b)500 meters to ground drift range

According to these phases, the descent device and its properties must chosen compatible for both two critical point.

Payload Phase: Payload should have 10 m/s descent rate. Passive descent device is not permit to. Because of this situation a hybrid design of Aerobrake umbrella design were considered.

Descent Control Requirements

Number	Requirement	Rational	Priority	Parent	Children	A	I	T	D
DSC - 01	The CanSat (container and payload) shall deploy from the rocket fairing section.	Base Requirement	High			X	X		
DSC-02	The descent control systems shall not use any flammable or pyrotechnic devices.	Base Requirement	High	SRS-04		X	X		
DSC-03	The descent rate of the CanSat shall be 12 m/s above 500 meters.	Base Requirement	Medium				X	X	
DSC-04	When the CanSat reaches 500 meters, the payload shall be released from the container.	Base Requirement	High		FSW-04		X		
DSC-05	When released, the payload shall have a descent rate of less than 10 m/s with a combined aerobrake and umbrella design.	Base Requirement	High			X	X		
DSC-06	All descent control device attachments shall survive 30 Gs of shock.	Base Requirement	High	SRS-08			X		
DSC -07	All descent control devices shall survive 30 Gs of shock.	Base Requirement	High	SRS-08			X		

Container Descent Control Strategy Selection and Trade

Color selection : Orange

Shock Survivability: The staged parachute system can survive with 30g shock force. It can be tested in wind tunnel.

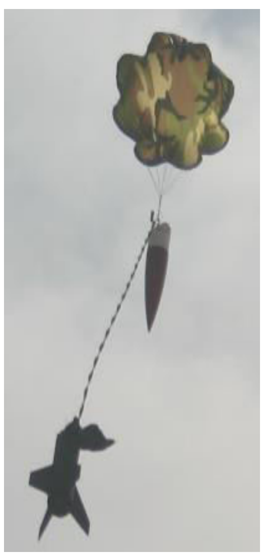
DCS connections: The parachute lines attached to top of the container.

Preflight review testability:

1)Shock force survivability of passive descent system will test behind of a car which has 20 m/s velocity.

2)The prototype of the system can be tested in wind tunnel.

3)Deploy from high buildings and plane or quadrotors.



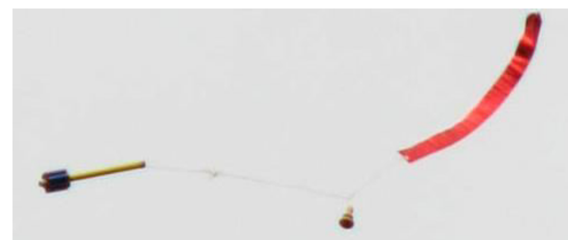
Option 1: Staged Parachute **(Chosen)**

Advantages:

- ✓ Drag coefficient 1.5
- ✓ High stability,
- ✓ Compact
- ✓ Contrable

Disadvadvantages:

- ✓ High wind drift potential



Option 2: Streamer

Advantages:

- ✓ Low Wind Drift Potential and simple

Disadvantages:

- ✓ Drag Coefficient 0.14 – 0.4

System Concept

- ✓ The parachute will open after deployment
- ✓ The first diameter has a fix value from 670 meters to 500 meters.
- ✓ After deployment of the payload from container at altitude of 500 meters, the weight of the container to reduce 234 grams.
- ✓ Because of this situation the Radius of the sphere should reduce to 5 cantimeters. The length of the scope is constant. Thus, we can change the angle between the scope and axis.
- ✓ To change the angle we can make some changings in line lengths.
- ✓ The all lines attached to each other with a point. This point atttached to a motor. When this motor turns around its axis of mil. Thus the lines will close to each other and their lengths will reduce. Finally the value of the angle will reduce to considered value.
- ✓ With this system we keep the descent rate of the container after separation for minmum drift.

Payload Descent Control Strategy Selection and Trade

Passive systems are prohibited. The system is a combined hybrid system. Umbrella aerobrake combined system. We use aerobrake panels for loacation of the solar panels. The umbrella section is used between the panels.

Color Selection:

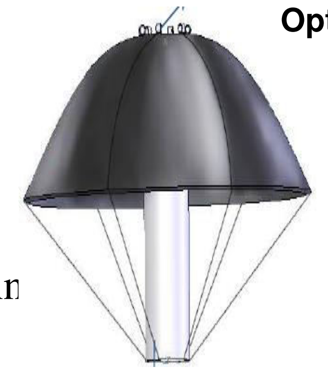
a)Panels: The solar panels color

b)Umbrella: Bright Orange

Preflight review testability:

1)The prototype of the system can be tested in wind tunn

2)Deploy from high buildings and plane or quadrotors.



Option 1: Umbrella Design

Advantage:

Basic opening mechanism

Fixed drag coefficent

Disadvantages:

Not competitible for solar panels.

Option 2: Rotor Design

Advantages:

- ✓ Controllable

Disadvantages:

- ✓ Complex
- ✓ Not compettible for low energy
- ✓ Heavy

Option 3 : Combined System of Umbrella and Aerobrake Design (Chosen)

Advantages:

- ✓ Competitible for solar panels
- ✓ Low energy requirement
- ✓ Loe place requirement

Disadvantages:

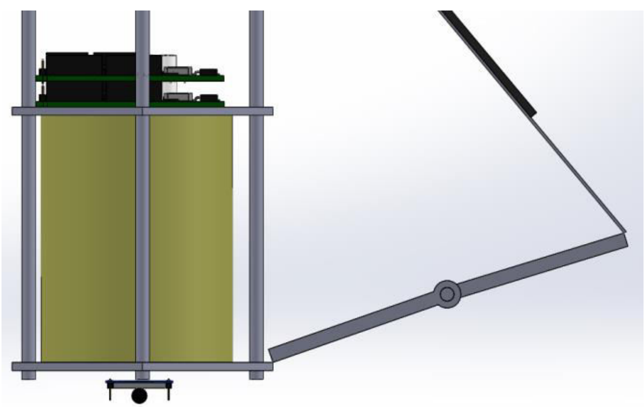
- ✓ Complex drag coefficent
- ✓ Mid- diffuculty opening mechanism

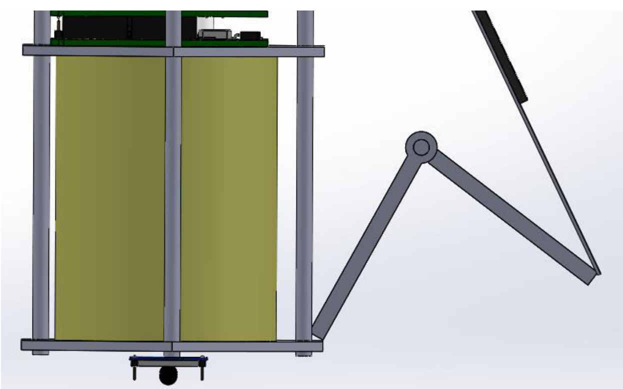
ARISAT

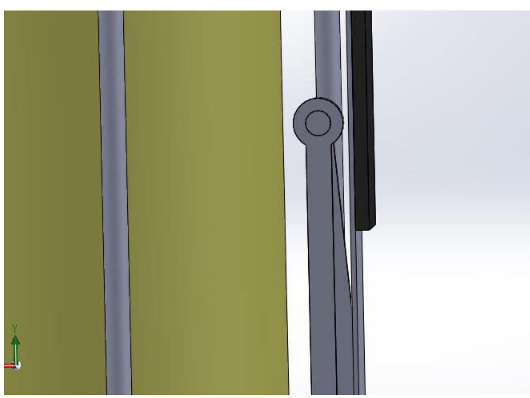
System Concept

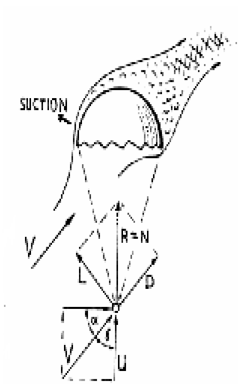
ANNUAL CANSAT COMPETITION

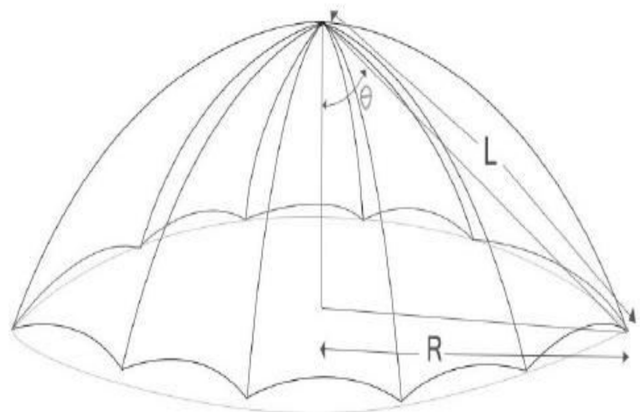
- The panels are closed in container
- The panels attached to cansats top lpate with high strong spring.
- The panels attached to cansats bottom plate with foldable sticks.
- When cansat separates from the container, the compressed string push the panels. The foldable sticks keep the angle between the cansat and panels.
- Thus requiement will be accomplished with zero electric energy and basic mechanic system.











R= Radius of sphere
L=length of scopes
θ = angle between s copes and axis

$\rho = 1.143\ kg/m^3$

$C_d = 1.5$

$u_\infty = 12\ m/s$

$m = 0.667\ kg$

$\theta = 45°$

$$D = \frac{1}{2} \times C_d \times \rho \times \Delta A \times u_\infty^2$$

$$\Delta A = \pi \times R^2$$

$$G = m \times g$$

Base rule:

$D = G$ so;

$$u_\infty = \sqrt{\frac{2 \times m \times g}{C_d \times \Delta A \times \rho}}$$

Before Separation;

$R = 12{,}6cm$

$R = L \times \sin\theta$

$L = 17.8cm$

Constant

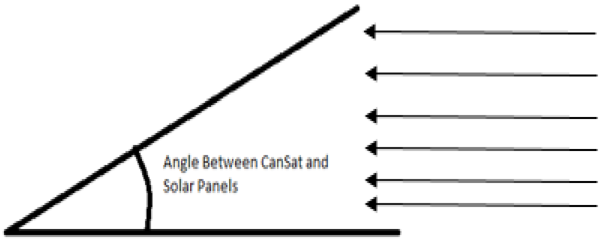
After Separation;

$R = 7.7cm$

$\theta = \sin^{-1}\frac{R}{L}$

$\theta = 26°$

Payload Descent Rate Estimates



$$u_\infty = 10\ m/s$$

$$\Delta A_a = a \times b \times n$$

$$\Delta A_{a\alpha} = a \times b \times n \times \cos\alpha$$

$$G = m \times g$$

$$D = \frac{1}{2} \times C_d \times \rho \times \Delta A_{a\alpha} \times u_\infty^2$$

Base rule:

$D = G$ so;

$$\alpha = \cos^{-1} \frac{2 \times m \times g}{C_d \times \rho \times \Delta A_a \times u_\infty^2}$$

If we calculate according to only aerobrake system, we can find angle between panels and cansat. We know the infinite velocity. It is $10\ m/s$. Thus the angle is;

$$\alpha = 65.80°$$

Now we know the angle between panels and cansat. According to this, we add the area of umbrella section.

$$\Delta A_{u\alpha} = a \times h \times n \times \cos\alpha$$

$$\Delta A_{a\alpha} = 0.095\ m^2$$

The velocity equation is;

$$u_\infty = \sqrt{\frac{2 \times m \times g}{C_d \times A_t \times \rho \times \cos\alpha}}$$

Payload Descent Rate Estimates

Total Area of the Umbrella Section: $A_{tua} = 0.095m^2$

Total Area of the Aerobrake Section: $A_{taa} = 0{,}0825\ m^2$ thus;

$$\Delta A_{ta} = \Delta A_{taa} + \Delta A_{tua}$$

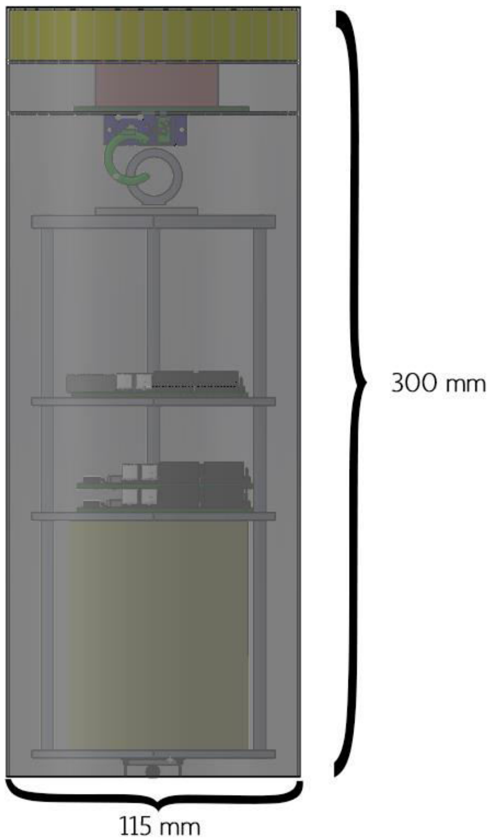
$$\Delta A_{ta} = 0,1775m^2$$

$$u_\infty = 7.33\ m/s$$

Mechanical Subsystem Design

Ümit Yelken

Mechanical Subsystem Overview



Egg Protection:

- Polyethylen and C70 Composite

Sandwich Structure foam combined..

- **Container Structure:**
- **Cylinder PVC**
- **Bright Orange Color**
- **Basic Rail System to keep edge plates of the cansat closed.**
- **Container Electronic:**
- Battery and circuitry allocated in top of the container.
- **Separation System:**
- Ring-Clevis System
- **Payload Structure:**
- Aliminium Screw Stick to attached the plates.
- Carbon Fiber & Epoxy ⇨ Carbon Fiber Plates
- Glue
- **Payload Electronic:**
- Circuitry allocated in the mid in the payload and solar panels allocated on the edge of the payload.

Mechanical Sub-System Requirements

ID	Requirement	Rationale	Priority	Parent	Children				
						A	I	T	D
MSR-01	Total mass of the CanSat (container and payload) shall be 600 grams +/- 10 grams without the egg.	Mission Requirement	High	SRS-01			X		
MSR-02	The payload shall contain and protect the egg from cracking or breaking during flight through landing. The egg will weigh not more than 67 grams.	Payload section of the Rocket is limited	High	SRS-05			X	X	
MSR-03	The payload shall be completely contained in the container. No part of the payload may extend beyond the container.	Mission Requirements	Low				X		
MSR-04	Container shall fit in the envelope of 125 mm x 310 mm including the container passive descent control system.	Mission Requirements	High	SRS-02			X		

Mechanical Sub-System Requirements

ID	Requirement	Rationale	Priority	Parent	Children	A	I	T	D
MSR-05	The container shall not have any sharp edges to cause it to get stuck in the rocket fairing section.	Mission Requirement	High			X	X		
MSR-06	The container shall be a florescent color, pink or orange.	Mission Requirements	High				X		
MSR-07	The rocket airframe shall not be used to restrain any deployable parts of the CanSat	Mission Requirements	High						
MSR-08	The rocket airframe shall not be used as part of the CanSat operations	Mission Requirements	High				X		

Egg Protection Trade & Selection

We have so many options for egg protection hence, we had narrow the options down. There was 2 different material left for the tests: rubber and C-70 Composite sandwich structure & polyethylen foam. When we try to use rubber system we saw that rubber system is heavier than polyethylen combined foam system. Finally our egg protection system is ready.



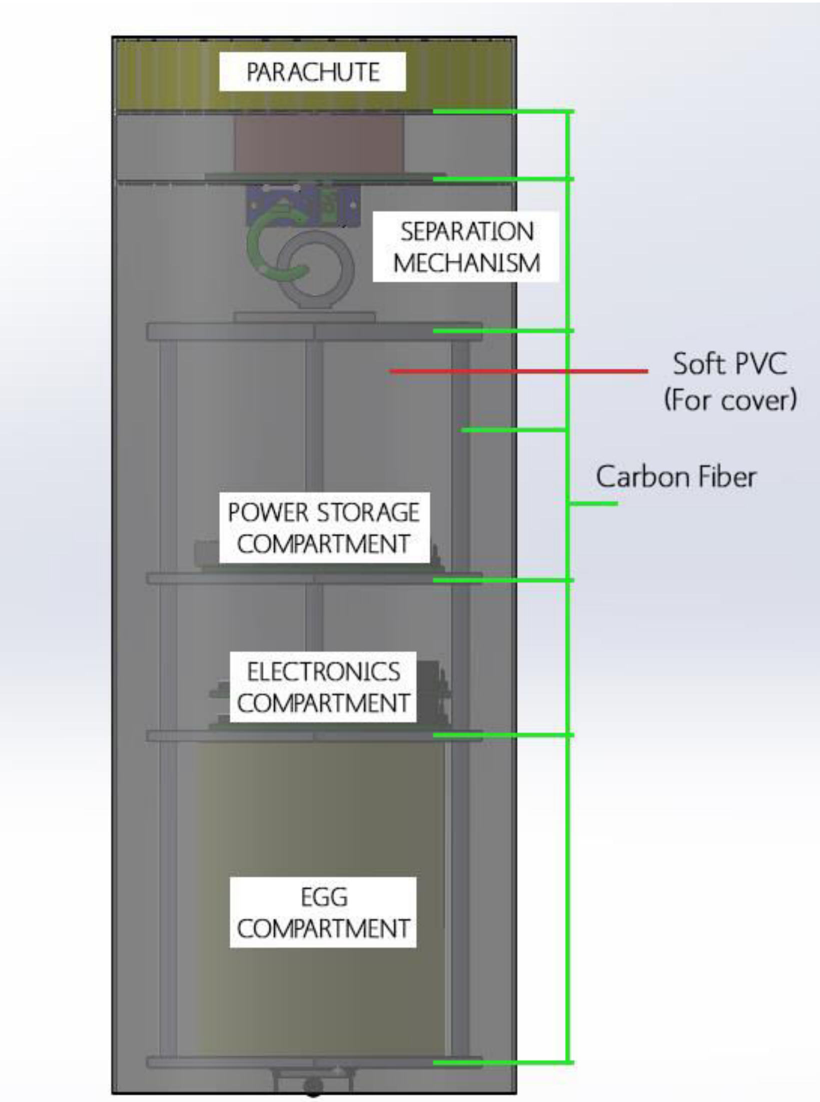

Egg Protection Trade & Selection

Material	Density	Cost	Details	Pros	Cons
Memory Foam	48-80 kg/m^3	$20-150/ mattress topper	Rectangular foam 1.5 in thick	Soft, light	Susceptible to heat
Dough	unknown	$2-10	Organic material with air pockets	cheap	Difficult to obtain consistent properties
Polyethylen	0.910–0.940 g/cm^3	$1-$2/Kg	Thermoplastic	Cheap, light	May get loose in container
Rubber	1.1 kg/m^3	243.10 Cents/kg	petroleum by product	Easy for shaping	Heavy

Chosen one Polyethylen:

- Resistant
- Inexpensive.
- Best performance in experiment.
- Energy absorbing capacity

Mechanical Layout of Components Trade & Selection



- Solar panels placed on the edge descent aerobrake plates of the cansat .
- Egg protection system placed on the bottom for wise payload integration.
- Ring-Clevis separation mechanism placed on top of payload in order to accomplish succesful separating.
- Servo Motor will be placed on the top of container to realize the separation.
- CanSats every single compartments material have chosen with rigor.

Mechanical Layout of Components Trade & Selection

Material	Cost ($/m^2)	Tensile Strength (MPa)	Density (kg/m^3)	Pros	Cons
Polyethylene	12.20-47.94	41.2	1040	light, cheap, easily molded	weaker then other options
Fiber Glass	10-40	42.3	1120	Light Strong	Low Tensile Strength
Carbon Fiber	50-200	350	1330	light, strong	expensive
Aluminum	69-144	152-310	2700	strong, relatively cheap	heavier then other choices,

Material Chosen: Carbon Fiber

- Light
- Strong Enough
- Expensive but work it

Material Selections

- **Aliminium Screw Stick choosen:**

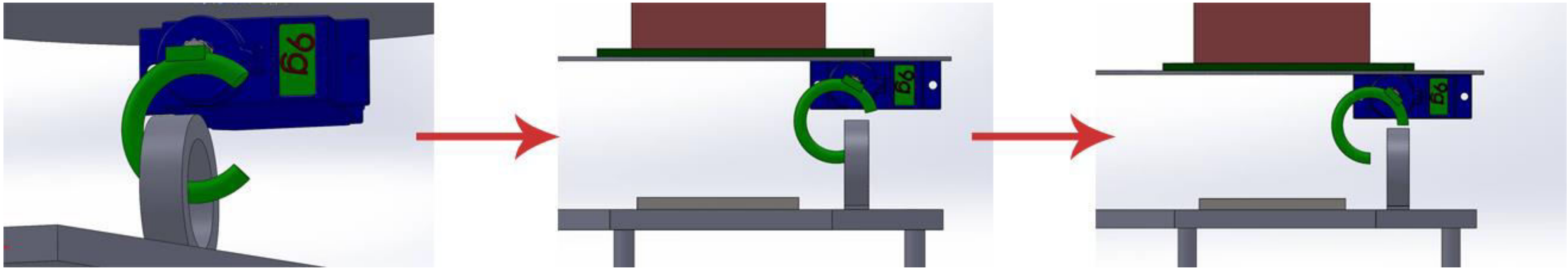
- First we consider a carbon fiber stick.Because this type of sticks are most capable to shock force. But their production process has some problems, moreover ; their prices are high. The last one is aliminium screw stick.This meterial is used for building a cansat that is more stable and capable to shock force.

- **Carbon fiber and Epoxy:**
  - high strength
  - high flexibility
  - hard to machinability for carbon fiber but easy to machinability for epoxy
  - very low weight
  - we already have in our laboratory
- **Glue and pin bolt for assemble the parts**
- **Polyethhylene & C70 Foam Combined system for egg protection.**

Container - Payload Interface

- **Ring-Clevis System Designed for Separation:**

- This system is used for separation of payload and container at 500 m altitude. According to this system; the ring attached to servo motor. When the servo motor turned, the ring will release the payload which has a clevis on top. Thus; at 500 m altitude the payload and container will separate.



Servo motor is Turning

payload and container separated

Structure Survivability Trades

- **For both Container and Payload ;**
- We use printed circuit board for electronic component mounting method.In addition PCB to be mounted on hexagon carbon fiber plate.
- We cover our cansat with **PVC Plates** for prevent to particules spreading.
- **Acceleration and shock force requirements and testing:** For these requirements and testing we have some laborities. For instence; we can test our structure shock force capacibility tests our composite laboratory.
- Morover, we can test the our parachute and aerobrake systems in our Trisonic Laboratory wind tunnels.
- We use tape for securing of electrical materials.
- We have decided to connect our payload's solar-wings with carbon plastic rod from the tip of the wing.

ARISAT

Mass Budget

ANNUAL CANSAT COMPETITION

Component	Mass(g)	Source
Frame	50	Estimate
RF Module	11	Datasheet
Microcontroller & PCB	10	Datasheet
Buzzer	7	Datasheet
Accelerometer	1	Datasheet
Super Capacitor	12	Estimate
Solar Panels x 6	180	Datasheet
Temperature & Pressure (Altitude) Sensor	2	Datasheet
Egg Protection Material	25	Estimate
Egg	67	Given Information
Exterior Shell	10	Estimate
Other Mechanical Parts	20	Estimate
Payload Total	**395**	**(With egg)**

Component	Mass(g)	Source
Frame	25	Estimate
Parachute	80	Estimate
Battery	46	Datasheet
RF Module	11	Datasheet
Microcontroller & PCB	10	Datasheet
GPS	14	Datasheet
Pressure (Altitude) Sensor	2	Datasheet
Exterior Shell	10	Estimate
Other Mechanical Parts	20	Estimate
Buzzer	7	Datasheet
Micro Servo Motor	9	Datasheet
Container Total	**234**	

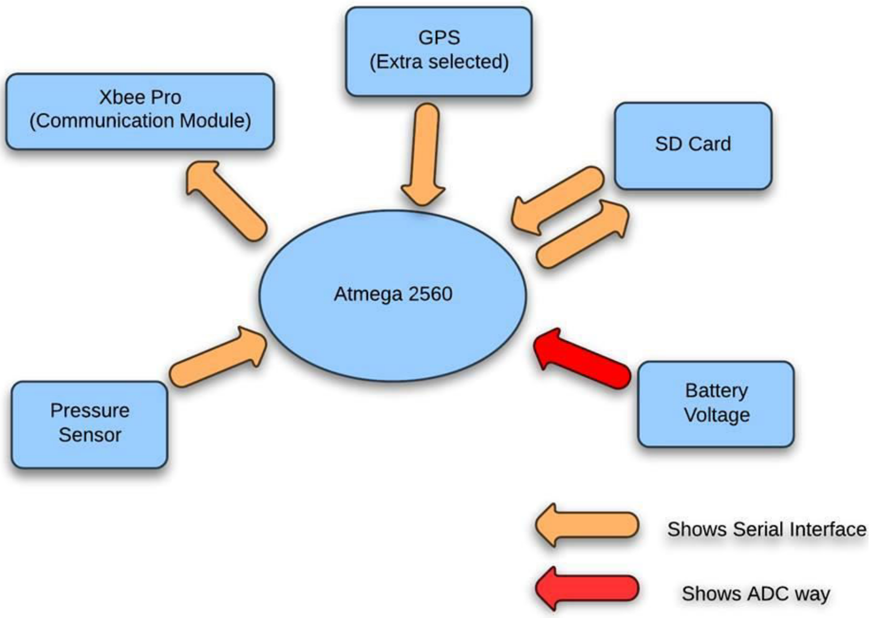
Total Cansat Mass with egg (g)	Total Cansat Mass without egg (g)
629 gram	**562 gram**

Communication and Data Handling (CDH) Subsystem Design

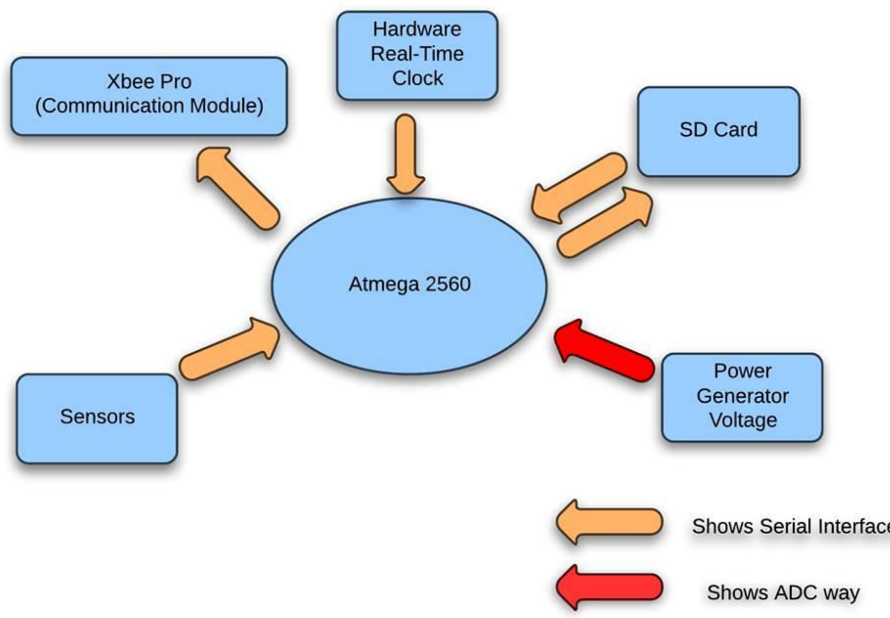
Presenter Name: Caner BALYEMEZLER

CDH Overview

Communication and Data Handling (CDH) sub-system is responsible for communication between cansat and ground station. It's main purpose is transmitting required information in stated format from CanSat to ground station at 1Hz. Communications between the CanSat and the base station will be carried out via Xbee transceivers.



Container



Payload

CDH Requirements

ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
CDH-01	XBEE radios shall not use broadcast mode	Competition Rule	HIGH	SRS-06			X		
CDH-02	XBEE radios shall have their NETID/PANID set to their team number	Competition Rule	HIGH	SRS-07			X		
CDH-03	Organizing Sensor Data	Data must be suitable for Transmission	HIGH	SSD-02				X	
CDH-04	Telemetry packets shall transmit to GCS every second	Competition Rule	HIGH		FSW-02		X		
CHD-05	Xbee Radio Shall have minimum range of at least 1km	Radio must stay in contact during the flight	HIGH			X		X	
CDH-06	Communications shall terminate after CanSat landing	Competition Rule	HIGH	GCS -03			X		

Processor & Memory Trade & Selection

SPECIFICATION	16f877	18f4550	PIC18F46J50	ATmega2560
Memory	14 Kb	32 KB	64 KB	644 KB
CPU Speed	20MHZ	48MHZ	48MHZ	16MHZ
RAM	368 Byte	2048 Byte	3800 Byte	8 Kbyte
ADC	8 x 10 bit ADC	13 x 10 Bit ADC	13 x 10 Bit ADC	6 x 10 Bit ADC
Operating Voltage	2 – 5.5 V	2 – 5.5 V	2 – 3.6 V	2.7-5.5 V
Price	2.95 $	6.50 $	6 $	16 $
Advantage	Low Price	Low Operating Voltage	Low Operating Voltage	Low Power Consumption

Processor & Memory Trade & Selection

CHOSEN DEVICE: ATmega2560

Atmega2560 Advantages

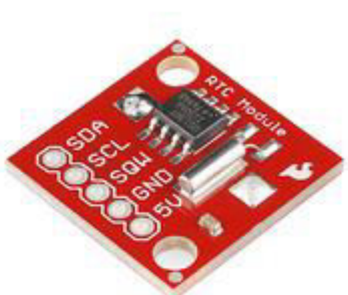
High flash program memory
High internal SRAM
High EPPROM capacity
Easy to use
More reliable

Atmega2560 Disadvantages

More expensive

Real-Time Clock

- Hardware real-time clock will be used for both payload and container.
- Because, if the system has no power to run (or reset), software clock could not show the real-time correctly. So that a hardware real-time clock will be used.
- İf the system will be reset, microcontroller check the real-time using with hardware clock.



($14.95)

Features of Real Time Clock Module:

- Two wire I2C interface
- Hour : Minutes : Seconds AM/PM
- Battery backup included
- 1Hz output pin
- 56 Bytes of Non-volatile memory available to user

Antenna Trade & Selection

SPECIFICATION	XBEE	XBEE-PRO
Indoor/Urban Range	30m	90m
Outdoor RF line-of-sight	90m	1600m
Transmit Power Output	1mW	63mW
RF Data Rate	250000bps	250000bps
Supply Voltage	2.8V – 3.4V	2.8V – 3.4V
Transmit Current (typical)	45mA (@ 3.3 V)	250mA (@3.3 V)
Operating Frequency	2.4GHz	2.4GHz

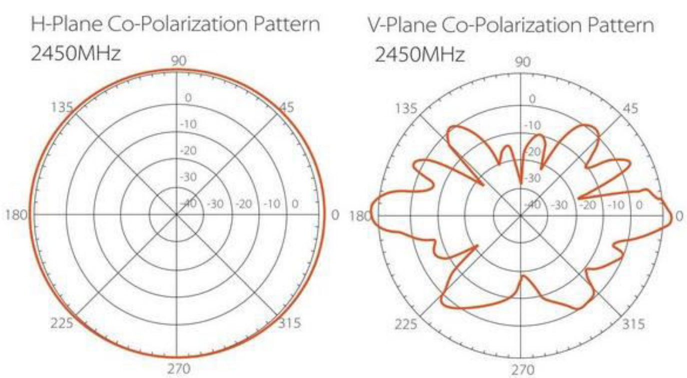
- **CHOSEN MODUL**: Xbee Pro

XbeePro Advantages

- Long Distance
- Easy to communicate

Antenna Trade & Selection

SPECIFICATION	Tp-link TL-ANT2408CL	Tp-Link TL-ANT2405CL	2.1dB Stock Xbee Antenna
Gain	8 dB	5 dB	2.1 dB
Type	Omnidirectional	Omnidirectional	Omnidirectional
Size	1.3x25 cm	1.3x19 cm	1.3x10 cm
Price	5.3 $	2.9 $	2 $



Radiation pattern of Stock Xbee Antenna

CHOOSEN ANTENNA: stock xbee antenna

We choose stock Xbee antenna because;

- it is a small antenna in size
- comes free with xbee pro

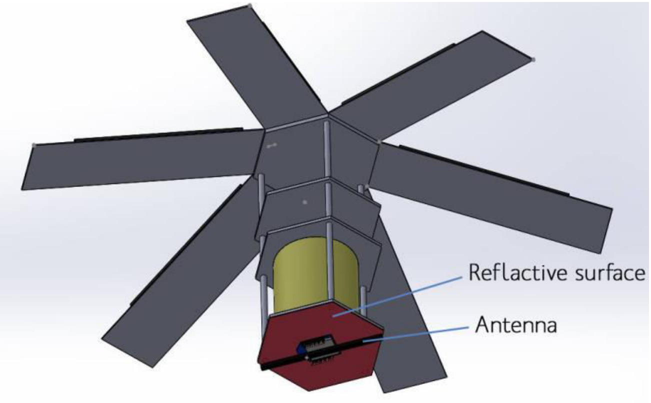
2.4 GHz wireless coverage **range:** 600-900 m
(depending on the output power)

Radio Configuration

XBP24-ZB RF Modules are configured by using X-CTU Configuration Tool. Steps of radio configuration are explained in a below

- XBEE Adapter is connected to PC USB port for radio configuration, after X-CTU Configuration Tool is run.
- Radios mission is selected by using program. Radio of GCS is configured as COORDINATOR AT and radio of CanSat is configured as ENDPOINT AT.
- Team number is entered PAN ID of COORDINATOR and ENDPOINT.
- Serial number is written SH and SL of ENDPOINT Device to Destination Adress DH and DL of coordinator.
- Serial number is written SH and SL of COORDINATOR Device to Destination Adress DH and DL of coordinator.
- XBP24-ZB RF Modules are ready to communications between them.

We placed xbee antenna under the payload so we can get a clear view of ground station antenna. We also use reflactive surface behind the antenna to reflect all the signals in one direction and achieve maximum range.



Telemetry Format

Included Data

–<TEAM_ID>
_<PACKET COUNT> - calculated by microcontroller
–<MISSION_TIME> -Time as maintained by the MCU
–<ALT_SENSOR> -Altitude as returned by non
–<TEMP> -Air temperature
–< VOLTAGE > -Battery voltage
–< BONUS > -Current flight software state

Data Format

–Each field is comma separated, packet terminated with carriage return
–Baud rate of 9600

<TEAM ID>,<PACKET COUNT>,<MISSION_TIME>,<ALT SENSOR>,<TEMP>,<VOLTAGE>,[<BONUS>]

Ex : <4934>,<0004>,<000102.1234>,<0600.25>,<30.123>,<05.234>,[<BONUS>]

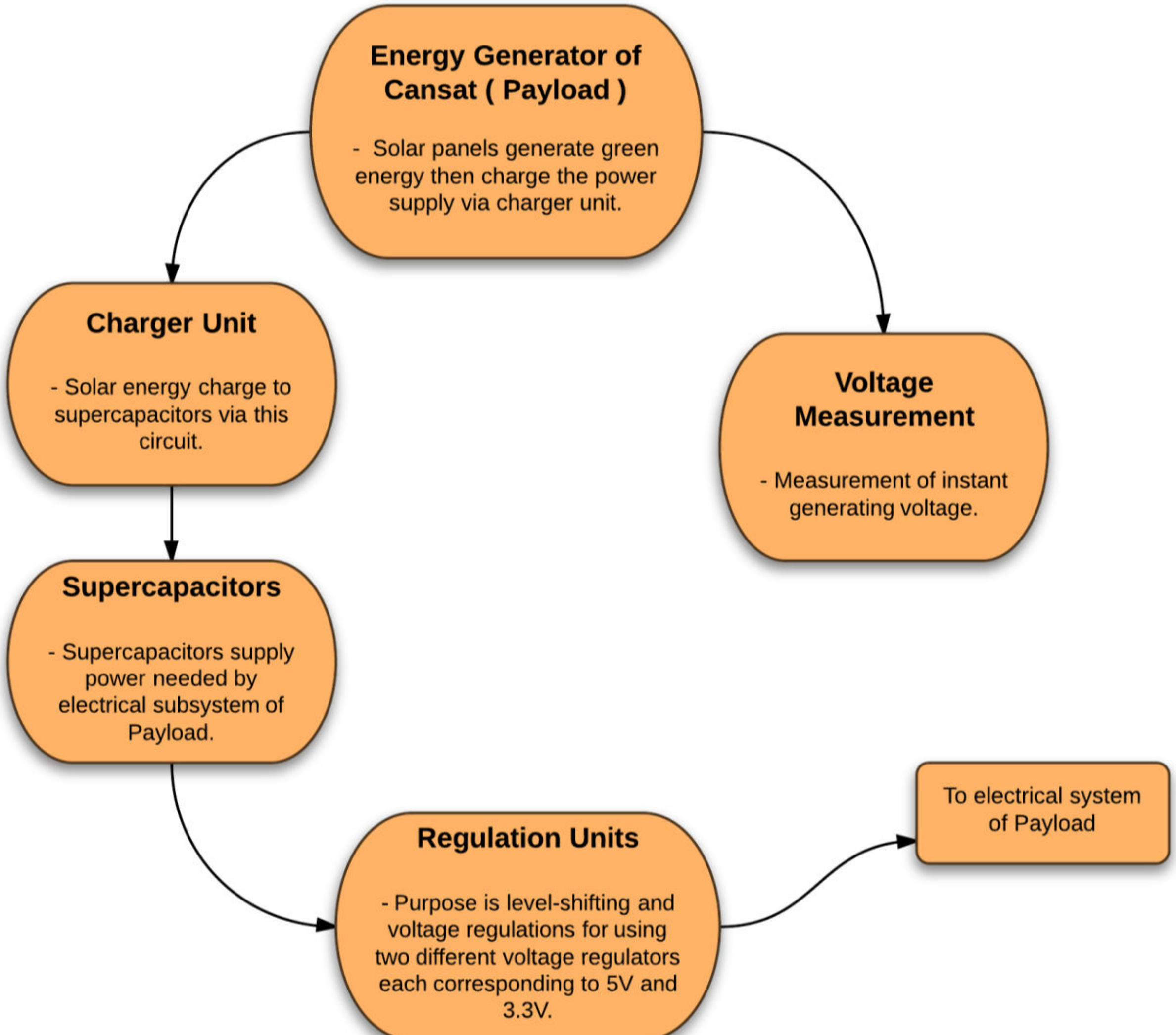
Telemetry Format

DEFINITION	CHARACTERS	EXPRESSION OF CHARACTERS
UTC Time	HHMMSS.SfSf	H -Hour, M-Minute, S-Second , Sf-Fraction of second
Latitude of CanSat	DDMM.MMM	D –Degree , M- Minute
Longitude of CanSat	DDDMMM.MMM	D –Degree , M- Minute
Mean Sea Level Altitude of CanSat	HHHH.HH	H-Height (Meter)
Battery Voltage	VV.VVV	V -Volt
Air Temperature	T T .T T T	T -Temperature (Celcius)
Tracked Satellites	ZZ	Z-Number of satellites
Pressure	PPPPPP	P-Pressure (Pascal)
Altitude of CanSat via non GPS Sensor	HHHH.HH	H-Height (Meter)

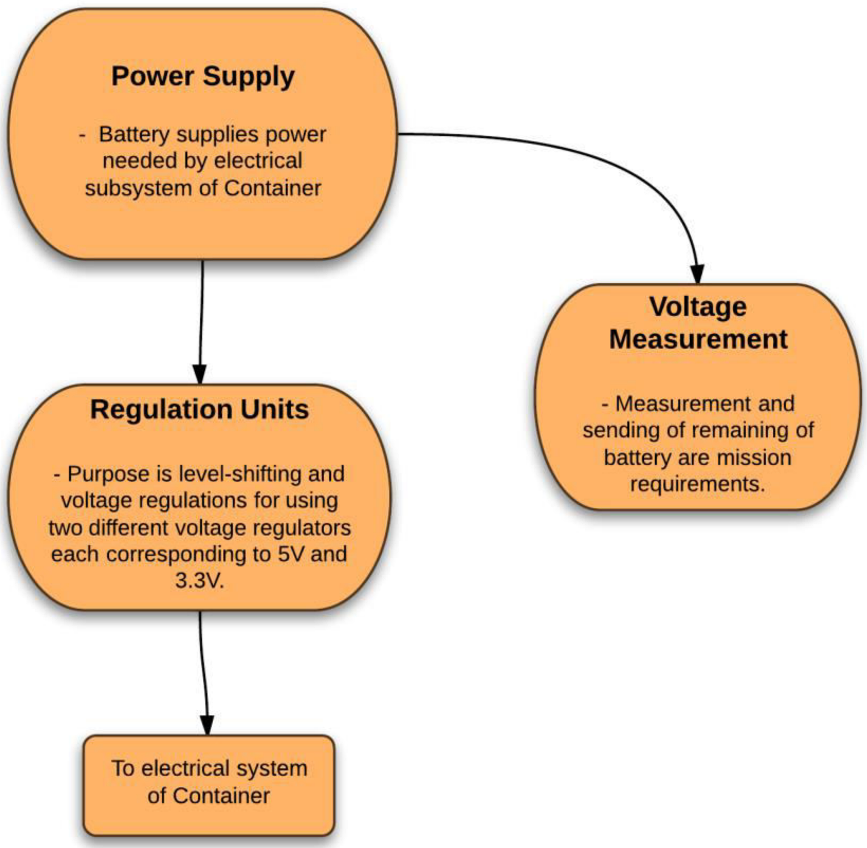
Electrical Power Subsystem (EPS) Design

Emre Erbuğa

EPS Overview of Payload



EPS Overview of Container



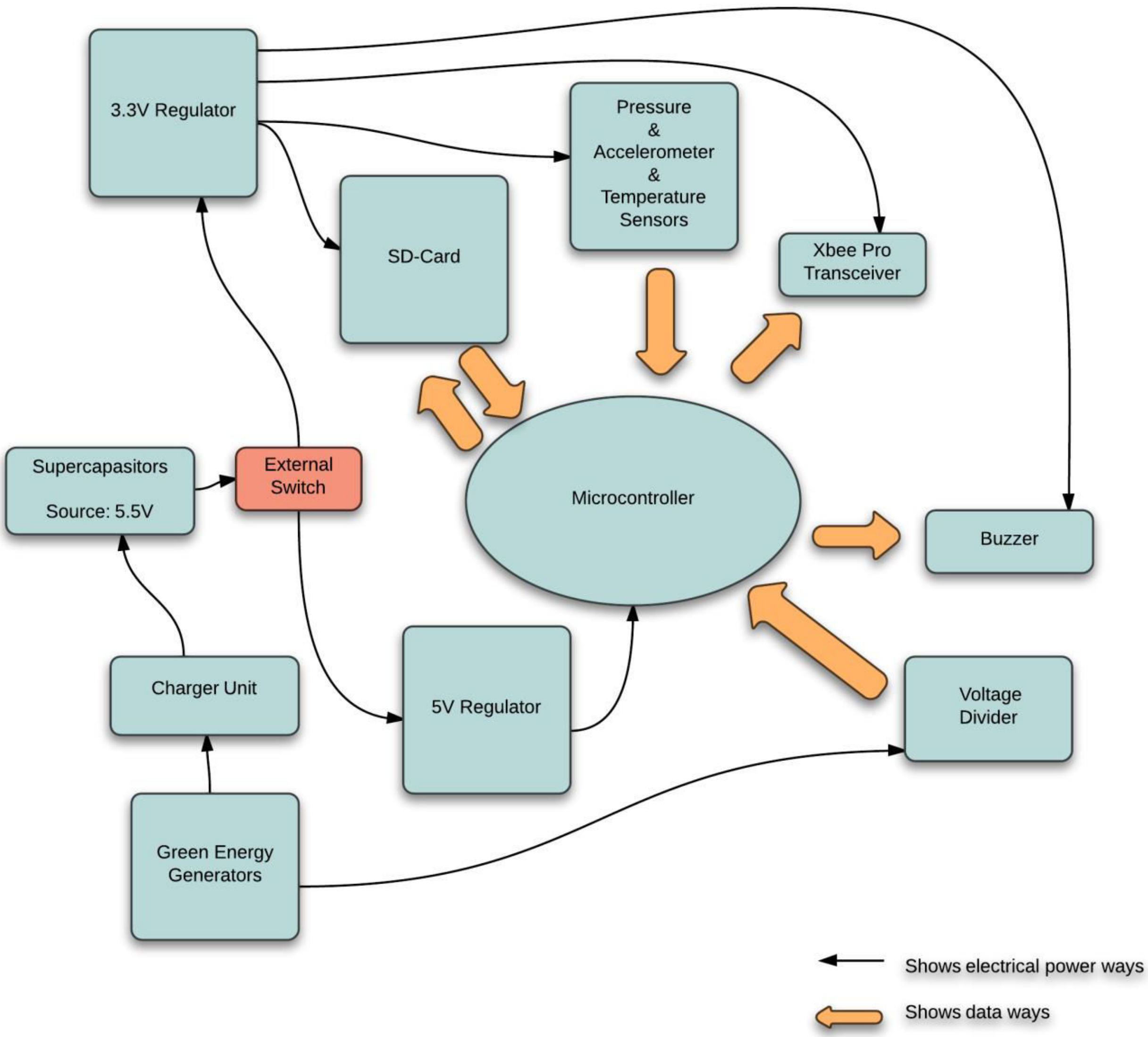
EPS Requirements

ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
EPS-01	Energy harvesting with using solar panel (Payload).	Payload has no battery thus it needs energy generator.	HIGH	SRS-03		X	X		
EPS-02	Entire components should be supplied with supercapasitors (Payload).	There is only one energy storage.	HIGH		EPS-07		X	X	
EPS-03	Entire components should be supplied with an only battery (Container).	There is only one voltage supply, battery.	HIGH				X		
EPS-04	A 3.3v regulator must be used in Payload and Container.	Entire sensors use 3.3V	HIGH	SSD-01			X		

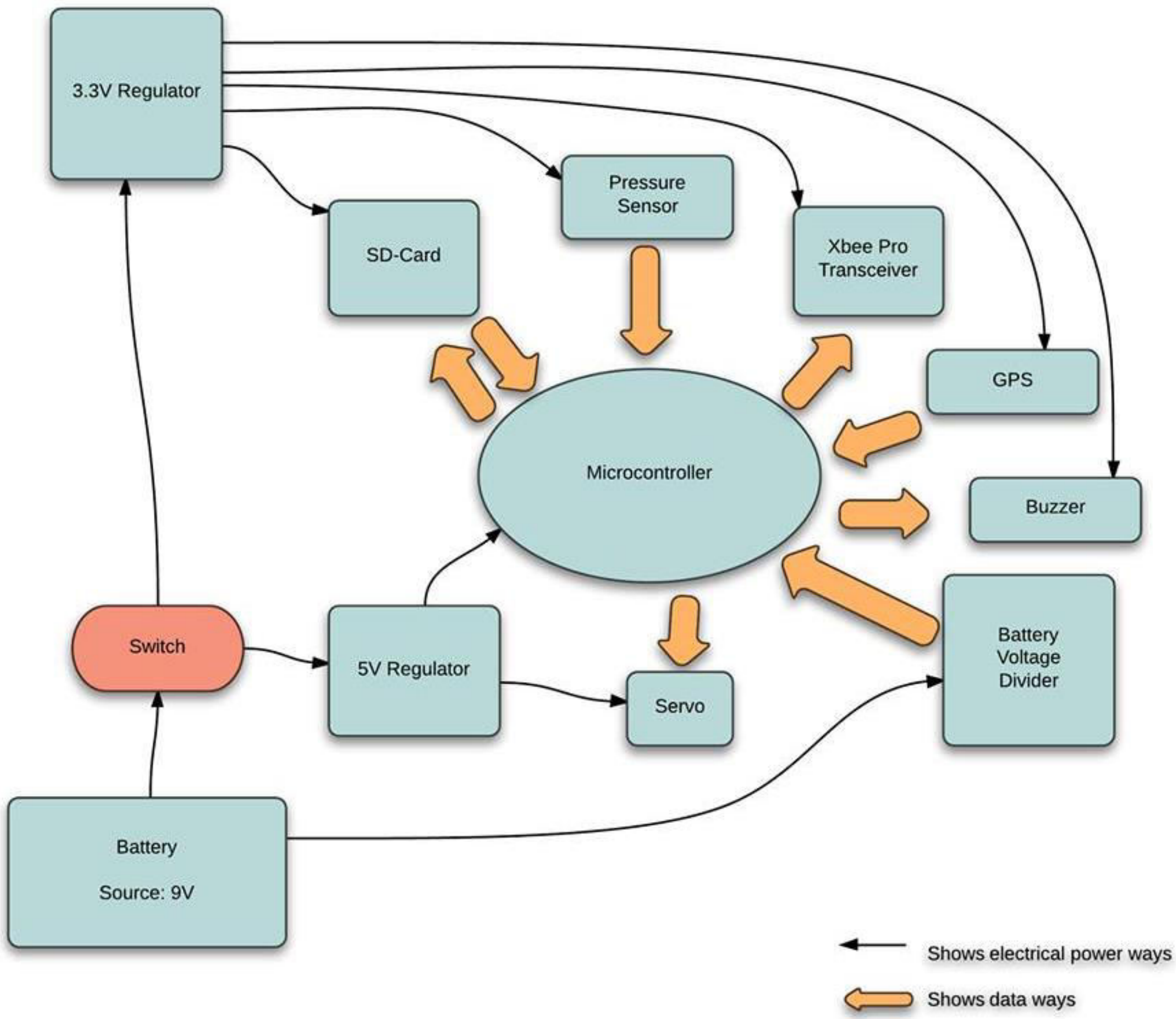
EPS Requirements

ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
EPS-05	A 5v regulator must be used in Payload and Container.	Microcontrollers use 5v	High	SSD-01			X		
EPS-06	Measure voltage with using microcontroller's ADC. Resolution is 10 bits.(Payload,Container)	Base Mission Requirement	Medium				X		
EPS-07	A charger unit (Payload)	Harvesting energy shall be charge to supercapacitors via this unit.	High	EPS-02		X	X		
EPS-08	Payload and Container shall have an accessible external switch.	Base Mission Requirement	Medium				X		

Payload Electrical Block Diagram

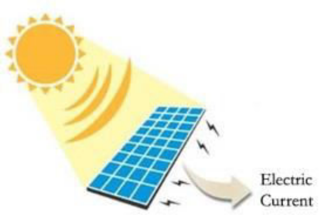


Container Electrical Block Diagram



Payload Energy Harvesting Strategy Trade Study

Power source	Rationale	Voltage	Current	Energy Stroge	Weight	Source
Solar Panels	**Solar panels are main power source of Payload.**	**~6V**	**~480mA**	**Supercapacitors will be charge via charger unit.**	**30g X 6(pieces)= 180g**	**Estimation**
Thermoelectric Generator *This datas will be occur at 100 Celcius differences.	Will NOT use	~5.5V	~500mA	Will NOT use	~22g x 5(pieces)= 110g	Estimation
Wind power	Will NOT use	~5V	~100mA	Will NOT use	~180g	Estimation



We chose solar energy for Payload's main energy source, because;

- High proportion of Current/Weight
- Sufficient voltage
- Convenient environment for harvesting energy with this strategy

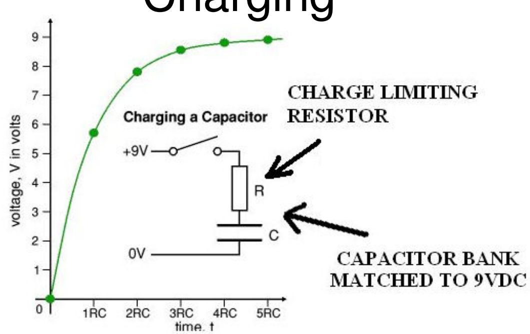
Payload Power Budget

Component	Voltage	Current	Power	Expected Duty Cycle(Time on in min.)	Uncertainty(±%)	total energy consumed	Source
Microcontroller	5V	10ma	50mW	60	20	50mWh	Datasheet
Pressure & Temperature Sensor	3.3V	5µA	0.0165mW	5	10	0.001mWh	Datasheet
Accelerometer Sensor	3.3V	40 µA	0.132mW	5	10	0.011mWh	Datasheet
SD-Card	3.3V	45mA	148.5mW	5	10	12.375mWh	Datasheet
Xbee Transceiver	3.3V	205mA	676.5mW	5	10	56.375mWh	Datasheet
Buzzer	3.3V	9mA	29.7mW	60	15	29.7mWh	Datasheet
Voltage Divider	-	-	Negligible	-	-	Negligible	Estimation

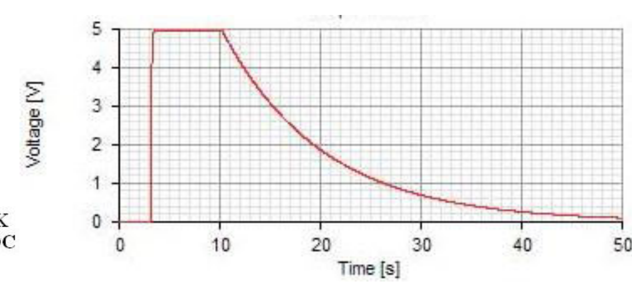
Total power consumed	**~269mAh(3.3v-5v)**
Power sources	Solar Panels (6v)
Total power available	~480mAh
Margins	~211mAh

**Budget tables show total power consumption for an hour.*

Charging



Discharging

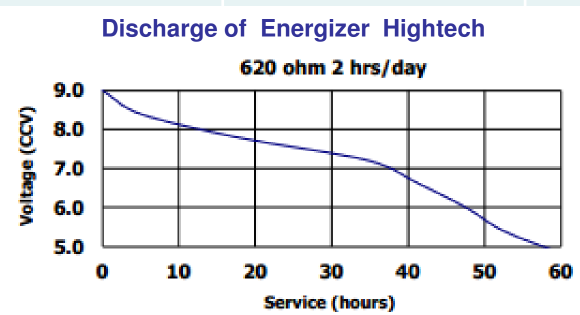


Container Power Budget

Component	Voltage	Current	Power	Expected Duty Cycle(Time on in min.)	Uncertainty(±%)	total energy consumed	Source
Microcontroller	5V	10mA	50mW	60	20	50mWh	Datasheet
Pressure Sensor	3.3V	5µA	0.0165mW	5	10	0.001mWh	Datasheet
SD-Card	3.3V	45mA	148.5mW	5	10	12.375mWh	Datasheet
Xbee Transceiver	3.3V	205mA	676.5mW	5	10	56.375mWh	Datasheet
Buzzer	3.3V	9mA	29.7mW	60	15	29.7mWh	Datasheet
GPS	3.3V	41mA	135.3mW	5	10	11.275mWh	Datasheet
Voltage Divider	-	-	negligible	-	-	negligible	Estimation

Total power consumed	~310mAh(3.3v-5v)
Power sources	Alkaline Battery (9V)
Total power available	615mAh
Margins	~305mAh

Budget tables show total power consumption for an hour.



Power Source Trade & Selection (Payload)

Solar Panel Trade & Selection

Brand	Voltage	Current	Max Power	Weight	Size(mm)	Price	Source
TEN	6 V	320 mA	1.92W	120g	150x90x4	$15.2	Datasheet
OEM	5.5V	180 mA	1w	52g	95x95x3	$2.6	Datasheet
Solar Pocket Factory	**6V**	**165mA**	**1w**	**30g**	**145x55x2.75**	**$10**	**Datasheet**

We chose **Solar Pocket Factory's** solar panels for Payload;

- Extremly light weight
- Sufficient voltage and current for system
- Suitable size for payload mechanism

Power Source Trade & Selection (Container)

Container Battery Trade & Selection

Brand	Type	Capacity	Weight	Voltage	Size(mm)	Price
Duracell duralock	Alkaline	230mAh	45 g	9v	17.5x26.5x48.5	$4
U9VL-FP	Alkaline	360mAh	44.0g	9v	17.5 x 26.5 x 48.5	$4.48
Energizer HighTech	**Alkaline**	**615mAh**	**46g**	**9v**	**17x26.2x48**	**$3**

We chose **Energizer HighTech** for Container;

- Low price
- Easily accesible battery
- High capacity
- Stabil at high current drain
- Suitable size

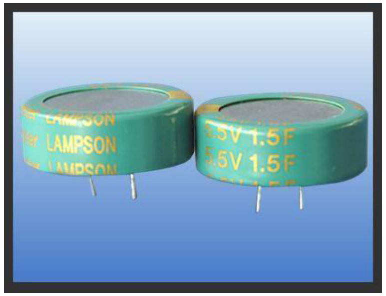
SuperCapacitor Trade & Selection

Brand	Nominal capacitance	MAX operating voltage	Weight	Price
KAMCAP	0.50 F	5.5V	9g	$1.8
LAMPSON	**1.5F**	**5.5V**	**8.87g**	**$4**

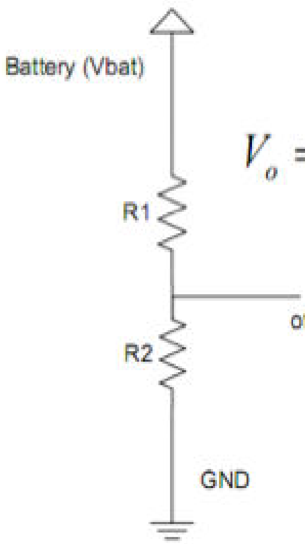
While we choosing our payloads power source we all accept that we should use supercapasitors because they are non chemical components and also they have small weight. We have some experiments on them.

We chose **Lampson's supercapasitors** for Payload ;

- High capacitance
- Low weight
- Quick charge and discharge



Power Bus Voltage Measurement Trade & Selection



$$V_o = V_{bat} \cdot \frac{R_2}{R_1 + R_2}$$

We will be using the microcontroller's ADC to measure the voltage, which has a resolution of 10 bits. Will use high valued resistors (for low current drain and power consumption) to make a simple voltage divider and bring the voltage down from 9V max to 5V max. Because our microcontrollers can take maximum 5Volts as ADC input. Resistor values will be 250k(R2) and 200 k(R1).

We chose this way, because;

- Easy way to divided voltage
- Resistors were chose high because of low current drain
- Compact and no extra weight(neiglieble)

Flight Software (FSW) Design

Emre Erbuğa

FSW Overview

- **Basic FSW architecture:** Software in microcontroller monitors altitude and there is a timer code to send data's to ground station and store in SD CARD. Two Atmega 2560 microcontrollers are used in container and payload. Microcontroller of container will generate GPS, pressure for altitude, RF and SD card. Microcontroller of payload will generate temperature, acceleration, pressure sensors for altitude, RF and SD card.
- **Brief summary FSW tasks:**

✓ Container collect altitude datas and transmit around the flight.
✓ Container shall release the payload the height of 500 meters.
✓ Read all sensors and prepare the data packet.
✓ The packets would be stored in SD card and trasmitted to ground station.
✓ If microcontroller restart , fsw will recover data and continue the mission requirements.

- **Programming languages:** C/C++
- **Development environments:** Arduino IDE

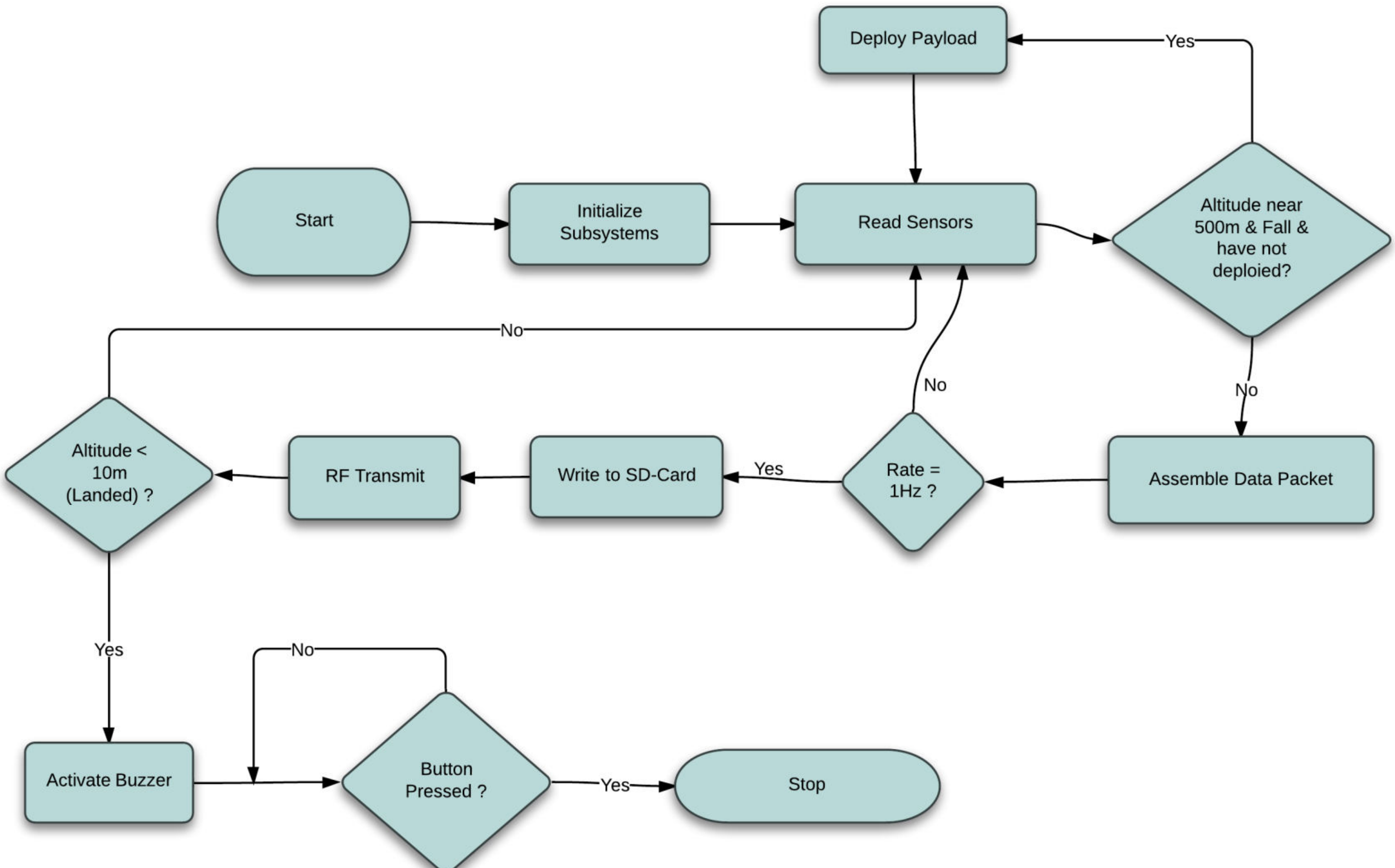
FSW Requirements

ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
FSW-01	Collection of sensors' data in processor and formation of packet (Payload)	Reception of data values from sensors and analysis in firmware to generate data packets	High	SSD-02				X	
FSW-02	FSW shall transmit datapackets at a rate of 1Hz at least(Payload,Container)	At least 1 Hz telemetry shall be received from ground station.	High	CDH-04			X		
FSW-03	Packets sent also stored as Data backup.(container,payload)	Packet also sent to SD-Card for Data backup	Medium				X		
FSW-04	Control the release of Cansat at 500m (container)	So that the payload can be released at height of 500 meters	High	DSC-04		X	X		

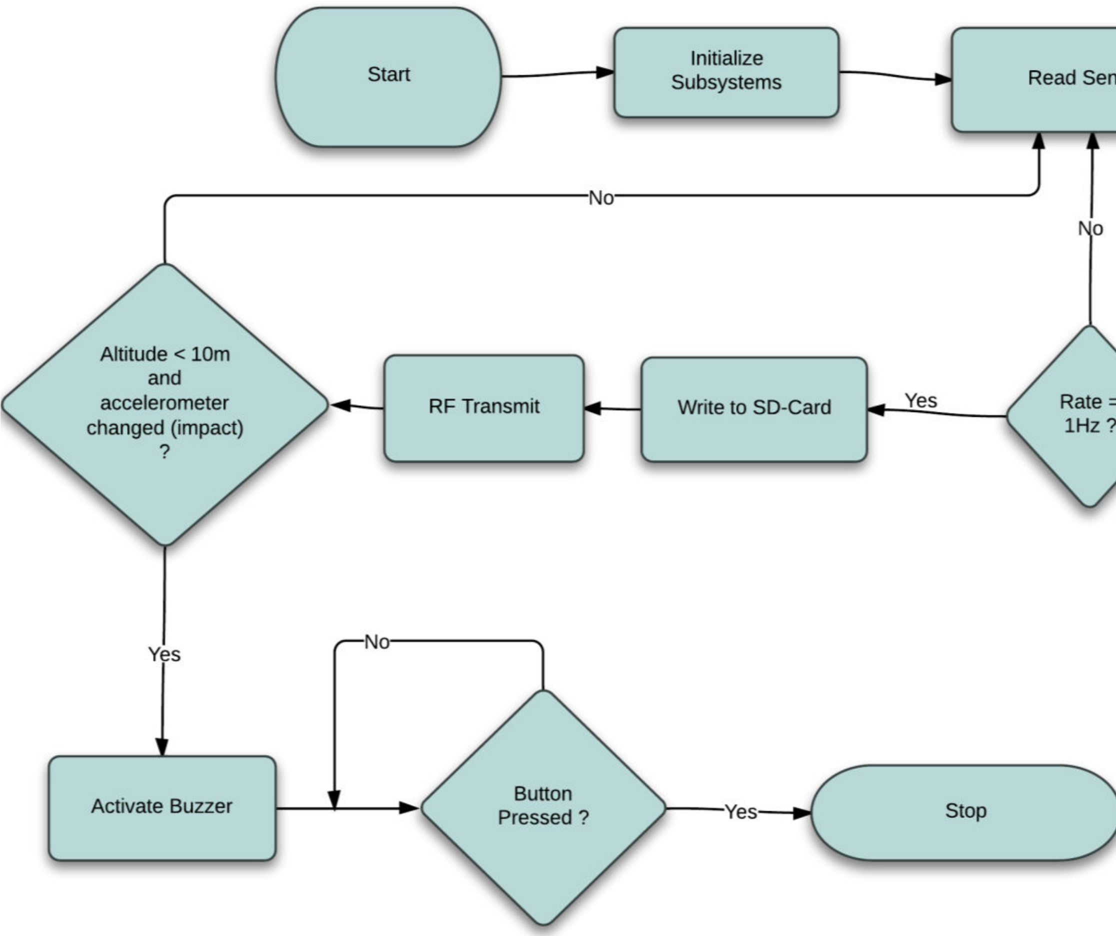
FSW Requirements

ID	Requirement	Rationale	Priority	Parent(s)	Children	VM A	VM I	VM T	VM D
FSW-05	Collection of sensor data in processor and formation of packet (container, payload)	Reception of data values from sensor and analysis in firmware to generate data packets	High	CDH-04			X		
FSW-06	Baud rate of 9600 bps (container,payload)	To be able to send data's regularly	Medium			X	X		

CanSat FSW State Diagram (Container)



CanSat FSW State Diagram (Payload)



During the operation, FSW will check the hardware Real-Time Clock if the microcontroller's mission time will not match the hardware Real-Time Clock. Microcontroller will check its mission time via hardware Real-Time Clock and read last saved data in the SD-Card (payload and container)

ARISAT

Software Development Plan

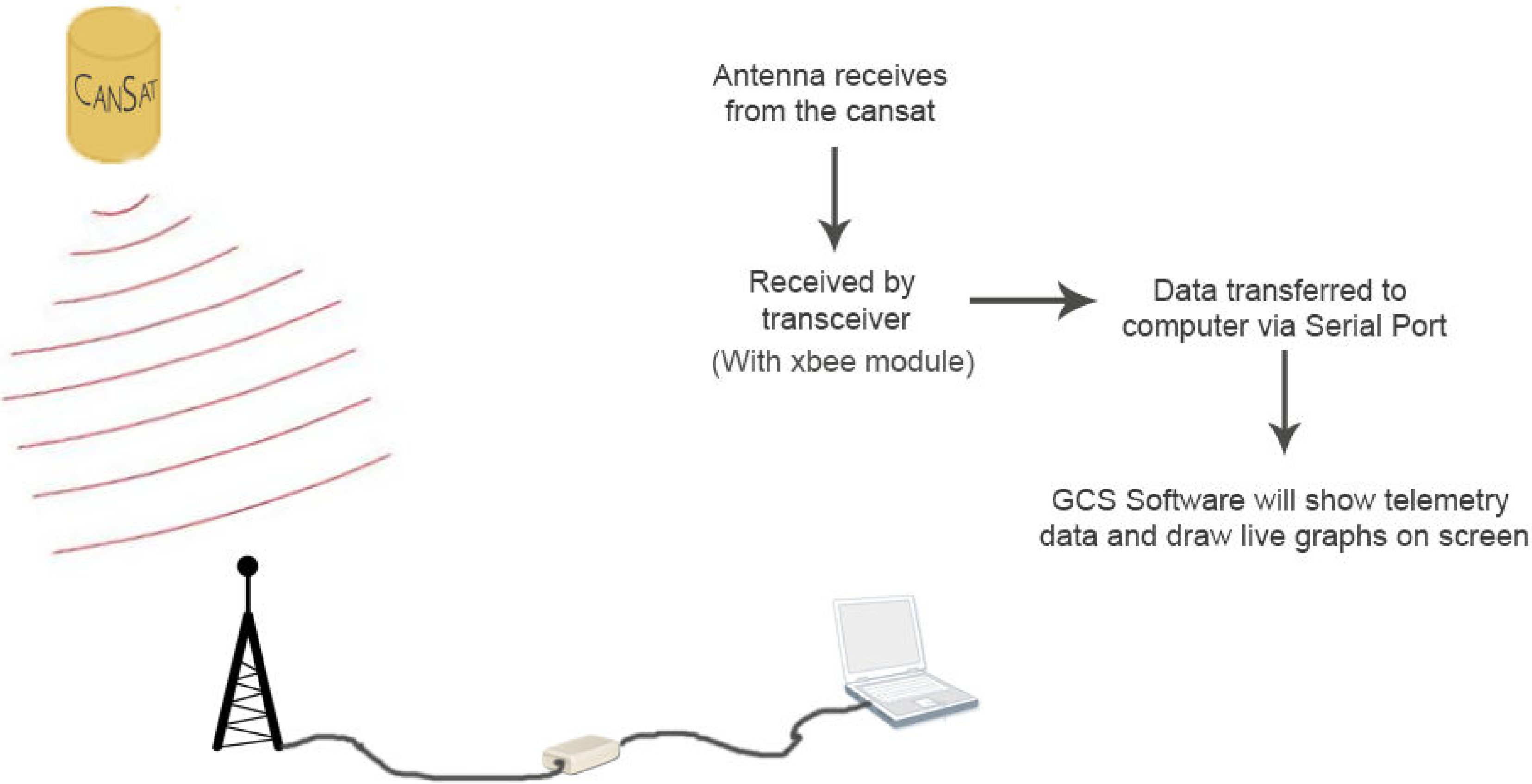
ANNUAL CANSAT COMPETITION

- Flight software prototypes have been coded using the Arduino IDE .
- Support for the radio transceivers will be coded first so that the microcontroller can communicate, sensors will be coded for and integrated into the system as they are received.
- Our software developers have their own projects on their area besides they knowledge of c/c++, php, matlab programming languages.
- The code will be tested as each sensor is integrated into the program.Then integrated software will test.
- Simulations will be run to approximate the conditions of the flight and possible problems to ensure the software will run properly under all conditions.

Ground Control System (GCS) Design

Ali Canpolat

GCS Overview



GCS Requirements

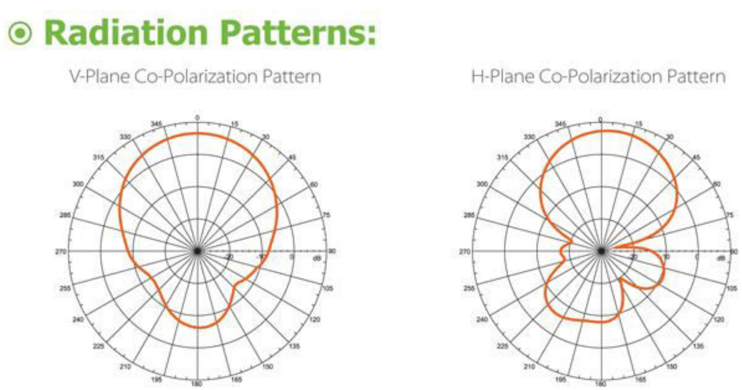
ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
GCS -01	Our team have to have own GCS	Competition Rule	HIGH	SRS-07			X		
GCS -02	GCS antenna shall be elevated a minimum of 3.5 m	Allows for clearer signal transmission	HIGH				X		
GCS -03	GCS shall receive telemetry from the CanSat during flight	Competition Requirement	HIGH		CDH-06		X		
GCS -04	GCS shall display and graph telemetry in real time	Mission requirement to display real-time data.	HIGH			X	X		
GCS -05	GCS shall store telemetry data in a .csv file	Competition Rule	HIGH			X	X		

GCS Requirements

ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
GCS - 06	Antenna of GCS must be towards CanSat for reduce to signal loss	Signal is affected by path loss and lose some power	HIGH				X		
GCS - 07	Antenna shall not have any interference	prevent signal loss	HIGH				X		
GCS - 08	All telemetry shall be displayed in engineering units	Competition Rule	HIGH			X	X		

GCS Antenna Trade & Selection

SPECIFICATION	Tp-link TL-ANT2409A	Tp-Link TL-ANT2405CL	2.1dB Stock Xbee Antenna
Gain	**9 dB**	5 dB	2.1 dB
Type	**Directional**	Omnidirectional	Omnidirectional
Size	**12cmx12cm**	1.3x19 cm	1.3x10 cm
Price	**22 $**	2.9 $	2 $



CHOOSEN ANTENNA:

Tp-link TL-ANT2409A

GCS Antenna Trade & Selection

CHOOSEN ANTENNA: Tp-link TL-ANT2409A

Whe choose this antenna because;

- High gain
- 9 dBi gain is enough for communications range

between CanSat and GCS.

Antenna mast height and mounting strategy

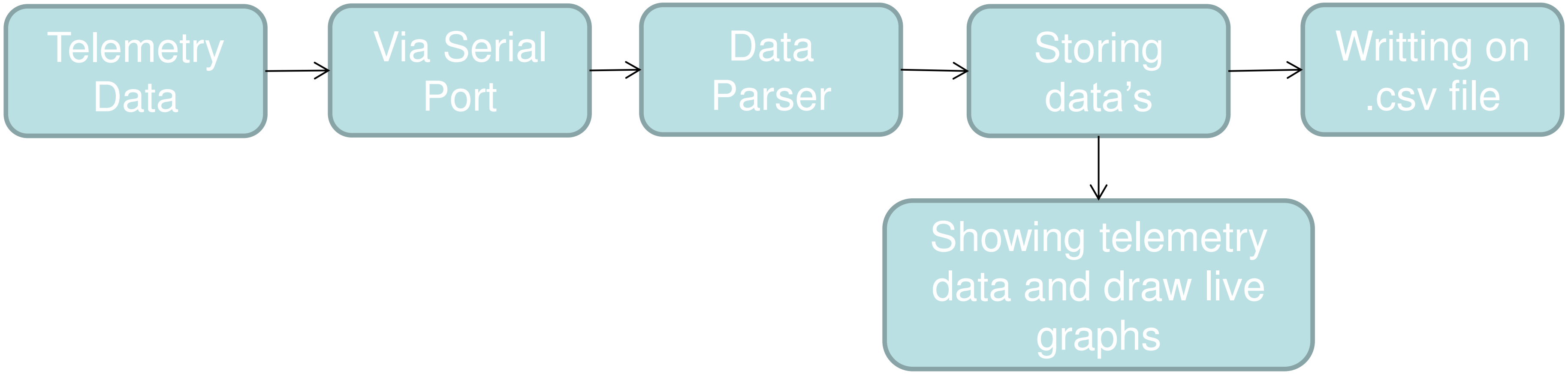
- Setup the ground control systems in suitable competition
- Set antenna with extendable tripod
- Using tape measure, we will verify length of system

Distance link predictions and margins

- Approximate range 1500 meters

GCS Software

- GCS software will show telemetry data and draw live graphs on screen
- GCS software will be designed by team members helping with open-source projects. Thus we can optimize the program according to our design requirements
- After parsing telemetry data, data will be stored in a txt file. These parsed data will be plotted on screen and will be written on .csv telemetry file



CanSat Integration and Test

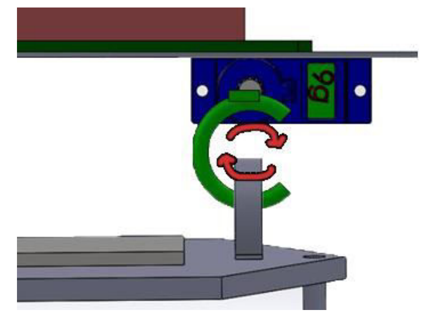
Ümit Yelken

CanSat Integration and Test Overview

- **Mechanical**

Separation Mechanism:

- We all aggreed that ring-clevis separation system is more safe than any other one.
- We will test under unexpected conditions (forces and acceleration)
- This tests will be made as soon as the mechanical workouts are done



Egg Drop Test:

- We covered the egg (as in the picture) and we threw it on to ground from different altitudes.
- Depends on several test results we find the best way for egg protection with using polyethylen.
- After finis all cansat mechanism, egg protection will be integrated cansat and we will re-test egg protection on different altitudes.

CanSat Integration and Test Overview

Descent Control:

Container:

- For parachute opening and impact tests we have some options such as release from a quadrocopter, wind tunnel, opening behind a car. We will try all of these options repeatly

Payload:

- Firstly, we will test with only panels without solar panels for opening of the plate.
- Then we will make these tests with for solar panels and we will optimize them with changing sunlight angle depends on energy they havest.
- Finally, we will add the fabrics between the plates to check rate of descent.

After all integrations of cansat subsystems are done, we will check again the descent rate of the CanSat.

CanSat Integration and Test Overview

- **Power / Electrical**
  - All electronic components are located on a printed circuit board.
  - Energy harvest: Solar panels will be tested before integration. According to test results, energy harvest system will be integrated with electrical systems.
  - First of all, electrical subsystems will be tested separately. After all subsystems work successfully, electrical subsystems will be integrated with each other and the energy harvest system.
  - After integration, electronic system will be tested by using low altitude tests.
- **Sensors**
  - Pressure: The altitude of cansat will be calculated with the pressure sensor. Pressure sensor will be tested on a location, the altitude of which we exactly know.
  - Accelerometer: Sensor system will be tested, when the cansat mechanism is ready.
  - Memory: Sample data will be tested and stored in SD Card. After storing, data needs to be read from the SD Card correctly.
  - Voltage monitor: Battery on the container and energy harvest system of payload will be monitered in microcontroller. To do this, voltage divider circuit will be used and will send the voltage data microcontroller via ADC.

CanSat Integration and Test Overview

- **Communication**

 - Sample data will be sent for test of communication range. Communication tests will be repeated upon completion of the ground station.

 - Sample data needs to be transferred correctly and completely to the ground station.

- **Ground Control:**
  - The data sent from cansat should be accurately received and saved by the ground station. When communication part is ready, ground station will be tested
- **Flight Software:**
  - Will be tested when all electrical subsystems are integrated

- **List of major electrical tests:**
  - Energy harvest test
  - Sensor test
  - Long distance Communication test
  - Monitoring data from ground station test
  - Flight software test

Mission Operations & Analysis

Eren Durkaya

Overview of Mission Sequence of Events

Before Launch Checks	• Testing CanSat's Electrical Subsystems by External Power (Hasbi S.) • Setting up Ground Control Station and Checking (Ali C.) • Testing CanSat's Mechanical Subsystems (Ümit Y.) • Integration CanSat into Rocket (Eren D.)
Deploying from the rocket	• Pressure Sensor Begin Working • Container Begin Calculating Altitude • Container Controls Descent Rate • Container Separates from Payload When Altitude is 500m
After Separation Of Container and Payload	• Payload Begin Harvesting Energy • Payload Subsystems Begin Working • Payload Controls Descent Rate • All Data Send to GCS
Landing	• Impact Force Recorded by Container • Recovering Container by Containers Colour • Recovering Payload Using the Buzzer

Overview of Mission Sequence of Events

After Landing	•Checking Egg for Damage (Emre E.) •Checking for being Sure Nothing Left in the Field (Team)
Analysing	•Analysing Data that GCS Recieved from Payload (Team) •Analysing Data in Container via USB Connection (Team)
Post Flight Review	•Using Informations about Flight Preparing a Presentation •Presenting the Post Flight Presentation to Participants

Mission Operations Manual Development Plan

On Mission Operation Manuel Developement Plan

- Team manual of cansat
- Mission controller list
- Station set-up instructions

Operation Manual Developement Plan

- Documentation of cansat design being revised now
- Program schedule of competition
- Operation instruction

CanSat Location and Recovery

- **Container Recovery:**

- We will use the sensor and GPS values transmitted between the launch and the deployment of the Container to estimate the horizontal speed of the Cansat.
- Container will have a horizontal speed with variable direction depends on wind.
- We will write our analysis software for this.
- Container will have Orange colour to find it easily

- **Payload Recovery:**

- We will make estimations about the location of Payload using the transmitted GPS data from container, the direction of its horizontal speed calculated using transmitted data.
- Payload will have loud buzzers activated after landing thus finding them should not be hard.
- Payload will have Orange colour to find it easily

Requirements Compliance

Eren Durkaya

Requirements Compliance Overview

- In general, content of the detailed slides that follow includes base requirements which are about structure properties, mechanical subsystems, communication and data handling, electrical power systems, flight software design, ground station system design, mission operation and management.
- All subsystem designs were finished, sensors were tested, flight software algorithms were created, structural and mechanical subsystems were completed and descent and ground station systems were designed. To sum up, many base requirements are satisfied.
- The ground station will be completed soon so all base requirements will be satisfied in little time.

Requirements Compliance

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
1	Total mass of CanSat, container, and payload shall be 600 grams +/-10 grams without the egg	Partial	x, y, z	Using materials are specified. Essential arrengements are going to be done when cansat is prepared.
2	The payload shall contain and protect the egg . The egg will weigh not more than 67 grams.	Comply	Covering egg	Everything is comply
3	The payload shall be completely contained in the container. No part of the payload may extend beyond the container.	Comply	Structure	Payload is designed conveniently to container.
4	Container shall fit in the envelope of 125 mm x 310 mm including the container passive descent control system. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Comply	Structure	Container is designed according to the rocket and it will be produced.
5	The container shall use a passive descent control system. It cannot free fall.	Comply	Descent Control	The container has a passive descent control system.
6	The container must be a florescent color, pink or orange.	Comply	Locating	Orange color is selected

Requirements Compliance

Rqmt. Num.	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
7	The container shall not have any sharp edges to cause it to get stuck in the rocket fairing section.	Comply	Deploying	The container have not any sharp edges.
8	The rocket airframe shall not be used as part of the CanSat operations or to restrain any deployable parts of the CanSat.	Comply	Structure	Any parts of CanSat are not restrained by rocket airframe.
9	The CanSat (container and payload) shall deploy from the rocket fairing section.	Comply	Structure	Everything is comply
10	The descent control systems shall not use any flammable or pyrotechnic devices.	Comply	Security	Everything is comply
11	The descent rate of the CanSat shall be 12 m/s above 500 meters.	Comply	Descent Control	The descent system was designed according to these datas.
12	When the CanSat reaches 500 meters, the payload shall be released from the container.	Comply	Ring-clevis design	Design is completed, it is ready for production and tests.

Requirements Compliance

Rqmt. Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
13	When released, the payload shall have a descent rate of less than 10 m/s.	Comply	Descent control	Payload descent system is completed and it will be tested when CanSat will be finished.
14	All descent control device attachments shall survive 30 Gs of shock.	**Partial**	**Durability**	it will be tested when CanSat will be finished.
15	All descent control devices shall survive 30 Gs of shock.	**Partial**	**Durability**	it will be tested when CanSat will be finished.
16	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Comply	Structure	Everything is comply.
17	All structures shall be built to survive 15 Gs acceleration.	**Partial**	**Durability**	it will be tested when CanSat will be finished.
18	All structures shall be built to survive 30 Gs of shock.	**Partial**	**Durability**	it will be tested when CanSat will be finished.

Requirements Compliance

Rqmt. Num.	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
19	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	Structure	
20	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Comply	Structure	All mechanisms are durable under all forces.
21	Mechanisms shall not use pyrotechnics or chemicals.	Comply	Security	
22	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	Security	
23	No batteries shall be allowed in the payload. Batteries are allowed only in the container to support releasing the payload.	Comply	Concept	The energy harvesting system was finished for payload.

ARISAT

Requirements Compliance

ANNUAL CANSAT COMPETITION

Rqmt. Num.	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
24	The container shall only use alkaline type batteries.	Comply	Security	The battery is selected.
25	The container shall collect and store altitude data at a 1 Hz rate from launch to the moment of landing.	**Partial**	**Electrical**	All of sensors was tested and ready for combination.
26	The container shall transmit its altitude data at a 1 Hz rate during from launch time to landing.	Comply	Electrical	The distance tests is continuing.
27	The payload shall harvest energy from the environment during descent.	Comply	Electrical	The energy harvesting system was finished for payload.
28	During descent, the payload shall collect air pressure, air temperature and power source voltage once per second.	Comply	Electrical	All of sensors was tested and ready for combination.

Requirements Compliance

Rqmt. Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
29	During descent, the payload shall transmit all telemetry. The number of telemetry data transmitted shall be scored. The payload shall not generate telemetry at greater than 1 Hz rate.	Comply	Electrical	
30	Telemetry shall include payload mission time with one second or better resolution, which begins when the payload is powered on. Mission time shall be maintained in the event of a processor reset during the launch and mission.	**Partial**	**Electrical**	We have wrote our software accomplish this requirement
31	XBEE radios shall be used for telemetry. 2.4 GHz Series 1 and 2 radios are allowed. 900 MHz XBEE Pro radios are also allowed.	Comply	Electrical	
32	XBEE radios shall have their NETID/PANID set to their team number.	Comply	Electrical	

Requirements Compliance

Rqmt. Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
33	XBEE radios shall not use broadcast mode.	Comply	Electrical	
34	Both the container radio and payload radio shall use the same NETID/PANID.	Comply	Electrical	
35	The payload shall include an external umbilical power connection to allow for testing and safety checks when not harvesting energy.	Comply	Electrical	external umbilical power connection system was finished.
36	The external power connection shall be a sturdy connector that is easily accessible when the payload is stowed in the container. Loose wires are not allowed.	Comply	Mechanical	
37	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Comply	Management	

Requirements Compliance

Rqmt. Num.	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
38	Each team shall develop their own ground station.	Partial	Mechanical	It is decided to how the ground station will be made and it will be finished soon.
39	All telemetry shall be displayed in real time during descent.	No Comply	Electrical	İt will be tested after the ground station will be completed.
40	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Comply	Electrical	All telemetry will be display in engineering units.
41	Teams shall plot data in real time during flight.	No Comply	Electrical	İt will be made after the ground station will be completed.
42	The ground station shall include an antenna mast of 3.5 meters height, which is to be measured from the ground to the tip of the antenna structure.	Comply	Mechanical	

ARISAT

Requirements Compliance

ANNUAL CANSAT COMPETITION

Rqmt. Num.	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
43	The ground station mast shall be free standing. The antenna mast cannot be attached to provided tent or other structures.	Comply	Mechanical	
44	The ground station mast shall be properly secured as to not fall over under any conditions with surface winds up to 30 mph.	Comply	Mechanical	
45	If guy wires are used to support the ground station antenna mast, the guy wires shall be made visible for safety.	Comply	Security	
46	Both the container and payload shall be labeled with team contact information including email address.	Comply	Recovery	

Requirements Compliance

Rqmt. Num.	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
47	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Partial	Electrical	It is thought that how it will be made and it will be completed after the electronic system of CanSat will be finished.
48	The container and payload shall maintain a mission time which is the number of seconds since each vehicle is powered on. The mission time shall be maintained in the event of a power loss or processor reset. The time may be maintained by software or by hardware real-time clock. If a hardware real-time clock is used, a separate, dedicated power source may be used to power the clock; however, this power source may not be used to power any other vehicle functions.	Comply	Electrical	A hardware real-time clock will be used

Management

Hasbi Sevinç

CanSat Budget – Hardware

	Components	Model	Quantity	Unit Price	Price Definition
Electronic	Pressure and Temperature Sensor (Container and Payload)	BMP-085	2	**$19.95**	Actual
	Accelerometer (Payload)	ADXL345	1	**$27.95**	Actual
	GPS (Container)	LS20031	1	**$59.95**	Actual
	Microcontroller (Container and Payload)	ATmega2560	2	**$16**	Actual
	Buzzer (Container and Payload)	ADL	2	**$5**	Actual
	SuperCapacitor (Payload)	Lampson	2	**$4**	Actual
	Solar Panel (Payload)	Solar Pocket Factory	6	**$10**	Actual
	Battery (Container)	Energizer HighTech	1	**$3**	Actual
	XBEE Module (Container and Payload)	Xbee pro 2.4 ghz	2	**$40**	Actual
	Custom PCB (Container and Payload)	-	2	**$100**	Estimate
MECHANIC	Servo (Container)	Tower Pro SG92R	1	**$3**	Actual
	Descent Control System (Payload)	-	-	**$35**	Estimate
	Parachute (Container)	-	1	**$25**	Estimate
	Structure Materals (Container and Payload)	-	-	**$50**	Estimate
	Egg Protection (Payload)	-	-	**$5**	Estimate
	SUBTOTAL				**$638.8**

ARISAT

CanSat Budget – Other Costs

ANNUAL CANSAT COMPETITION

Ground System Costs

Components	Model	Quantity	Unit Cost	Price Definition
Antenna Cable	Tp-link TL-ANT2409A	1	**$22**	Actual
XBEE Module	Xbee pro 2.4 ghz	1	**$40**	Actual
Mounting hardware	-	1	**$25**	Estimate
SUBTOTAL				**$87**

Other Costs

Category	Quantity	Unit Price	Price Definition
Prototyping & Testing	-	**$250**	Estimated
Travel	7 person	$900	Estimated
Hotel	3 days	$150	Estimated
Food	7 person	$75	Estimated
SUBTOTAL			**$7525**

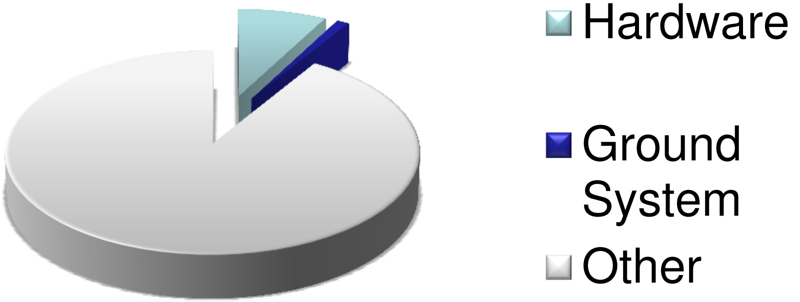
CanSat Budget – Total Costs

Total Costs

Description	Price($)
Hardware	**$638.8**
Ground System Costs	**$87**
Other Costs	**$7525**
Total Cost	**$8250.8**

The total funding we receive from the University is $7000.

We are currently in search of new sponsors.



ARISAT Program Schedule

<table>
<tr><th>DATE</th><th>Mechanics</th><th>Electronics</th><th>Managements</th><th>Academic Schedule</th><th>High Level Task</th></tr>
<tr><td>September (1-15 days)</td><td>-</td><td>-</td><td>Finding team members</td><td rowspan="2">Beginning of first term</td><td rowspan="2">Team comes together</td></tr>
<tr><td>September (15-31 days)</td><td>-</td><td>-</td><td>Finding team members</td></tr>
<tr><td>October (1-15 days)</td><td>Gathering and reviewing information about competition</td><td>Gathering and reviewing information about competition</td><td>Gathering and reviewing information about competition</td><td rowspan="2">Quizes Homeworks</td><td rowspan="2">Gathering and reviewing information about competition tasks and Cansat systems</td></tr>
<tr><td>October (15-31 days)</td><td>Reviewing mechanic structures of previous CanSats</td><td>Reviewing electronic structures of previous CanSats</td><td rowspan="4">Searching for Sponsorship</td></tr>
<tr><td>November (1-15 days)</td><td>Designing mechanic systems</td><td>Designing electronic systems & purchase of components</td><td rowspan="2">Midterms</td><td>Subsystems design</td></tr>
<tr><td>November (15-30 days)</td><td>Purchasing materials</td><td rowspan="2">Testing sensors, RF and GPS systems</td><td rowspan="2">Testing subsystems</td></tr>
<tr><td>December (1-15 days)</td><td>Testing egg protection system</td><td rowspan="2">Quizes Homeworks</td></tr>
<tr><td>December (15-31 days)</td><td>Brainstorm for energy harvest system</td><td>Brainstorm for energy harvest system</td><td>Gathering information for PDR</td><td>Designing energy harvest system</td></tr>
</table>

Program Schedule

<table>
<tr><th>DATE</th><th>Mechanics</th><th>Electronics</th><th>Managements</th><th>Academic Schedule</th><th>High Level Task</th></tr>
<tr><td>January
(1-15 days)</td><td>Preparing PDR</td><td>Preparing PDR</td><td>Preparing PDR</td><td>Final Exams</td><td rowspan="2">Preparing PDR</td></tr>
<tr><td>January
(15-31 days)</td><td>Preparing PDR</td><td>Preparing PDR</td><td>Preparing PDR</td><td rowspan="2">Winter Break</td></tr>
<tr><td>February
(1-15 days)</td><td>Lookink for Sponsorship</td><td>Lookink for Sponsorship</td><td>Searching for test area</td><td>Lookink for Sponsorship</td></tr>
<tr><td>February
(15-28 days)</td><td>Testing descent systems</td><td>Preparation of ground system and software</td><td>Buying flight tickets</td><td>Beginning of second term</td><td rowspan="3">Producing the cansat prototype</td></tr>
<tr><td>March
(1-15 days)</td><td>Putting together subsystems</td><td>Testing energy harvest</td><td>Preparing CDR</td><td rowspan="2">Quizes
Homeworks</td></tr>
<tr><td>March
(15-31 days)</td><td>Testing cansat mechanics</td><td>Putting together subsystems</td><td>Preparing CDR</td></tr>
<tr><td>April
(1-15 days)</td><td>Putting together Cansat mechanics and electronics</td><td>Putting together Cansat mechanics and electronics</td><td rowspan="2">Hotel reservations and
Visa applications</td><td rowspan="2">Exams</td><td rowspan="2">Testing Subsystems and all cansat systems</td></tr>
<tr><td>April
(15-30 days)</td><td>Testing Cansat</td><td>Testing Cansat</td></tr>
</table>

Program Schedule

DATE	Mechanics	Electronics	Managements	Academic Schedule	High Level Task
May (1-15 days)	Evaluation of tests	Evaluation of tests	-	Quizes Homeworks	Evaluation of tests for the final check
May (15-31 days)	Final checks	Final checks	Final checks	Final Exams	
June	Cansat Competition	Cansat Competition	Cansat Competition	-	Participating in the Cansat Competition

{ MILESTONES }

Conclusions

Major accomplishments

- Team is built up
- A good understanding of the mission requirements acquired
- Subsystems are designed
- Materials and components are selected
- Sensors and RF systems are tested
- Descent and energy harvest systems are designed

Major unfinished work

- PCB design will be produced
- Software will be improved
- Cansat protype will be produced
- Cansat will be tested

Electronic and mechanic subsystems are ready for production and integration. Therefore, the next stage involves the production and integration of all subsystems.