Cansat 2013 PDR Outline

Team # : 1300

Team Frequency

Presentation Outline

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Team Organization

2012 Texas Annual CanSat Competition

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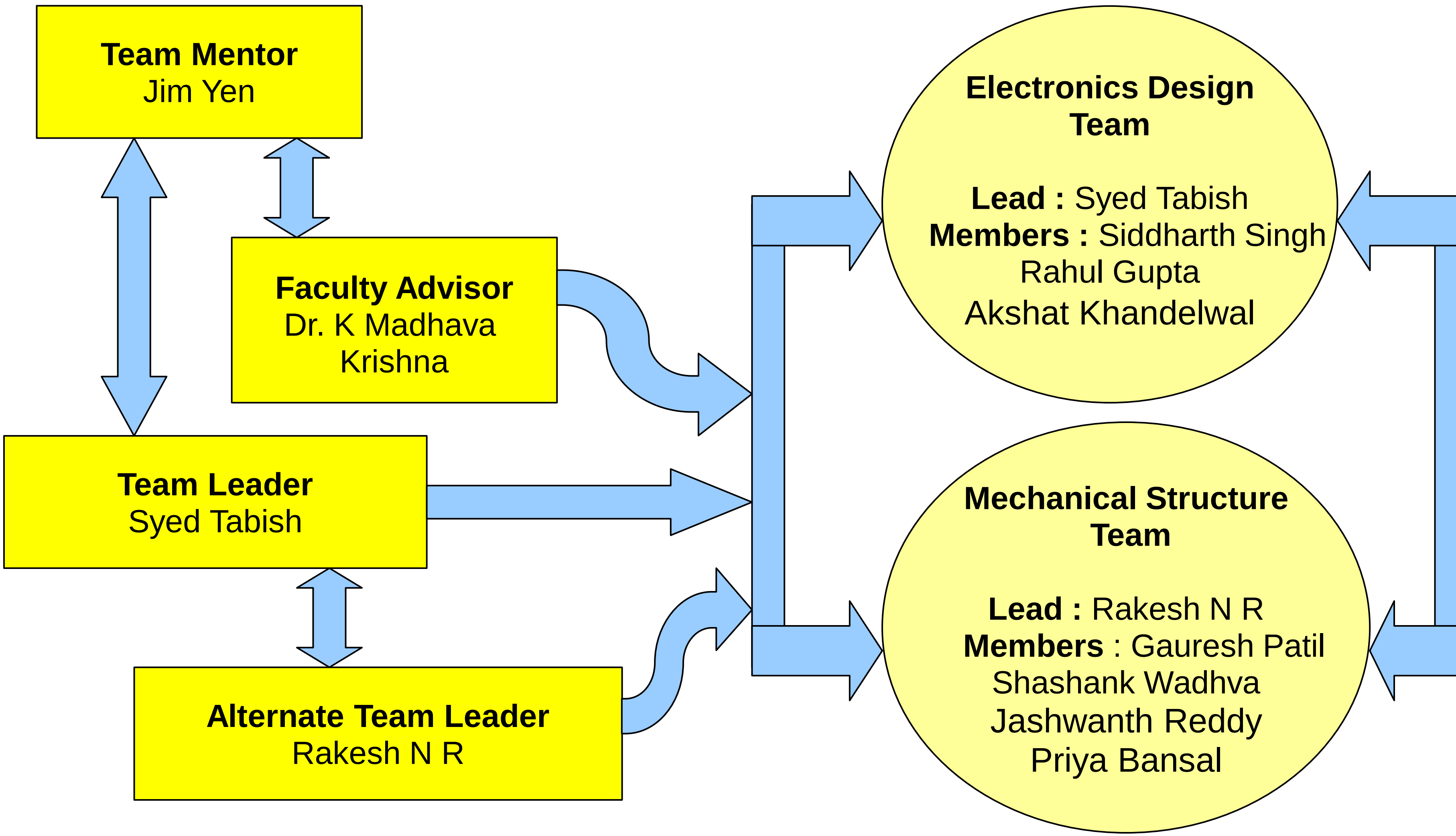
Internal Organization



Acronyms

➢ **M**	Mission
➢ **S**	Sensor
➢ **MS**	Mechanical System
➢ **DCS**	Descent Control System
➢ **CDH**	Command and Data Handling
➢ **EPS**	Electrical and Power system
➢ **FSW**	Flight Software
➢ GCS	Ground control station

❖ A/D	Analog or Digital
❖ ADC	Analog digital converter
❖ CLK	Clock
❖ CPU	Central processing unit
❖ EEPROM	Electrically Erasable Programmable Read-Only Memory
❖ FCC	Federal communications commission
❖ g	Acceleration due to gravity
❖ GHz	Giga hertz
❖ GPS	Global positioning system
❖ Hz	Hertz
❖ ISM	Industrial, scientific and medical
❖ Kbps	Kilobytes per second
❖ Km	Kilometer
❖ MHz	Mega hertz
❖ NiMH	Nickel metal hydride
❖ RF	Radio frequency
❖ SPI	Serial peripheral interface
❖ SRAM	Static random access memory
❖ USART	Universal synchronous asynchronous receiver/transmitter
❖ USD	US Dollar
❖ INR	Indian Rupees

Systems Overview

Presenter : Syed Tabish Abbas

Mission Summary

Mission:

- The mission of 2013 Cansat competition is Sensor Delivery System.

Objectives:

- To carry the hen's egg intact for the entire duration from launch to landing.
- To control the descent of the Container and maintain its speed to less than 20 m/s.
- The Container should hold the Cansat till deployment and after the Container reaches 400m after deployment, it should deploy the Cansat containing the egg.
- To control the descent of the Cansat after its deployment from the Container at the descend speed of 20 +/- 1 m/s.
- To send the telemetry data to a central ground station.

Optional Objective:

- To measure the force of impact of the Cansat with the ground and store the data on-board which can later be downloaded.

System Requirements

ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
SYS-01	Total mass of the Entire system will be 700 +/- 10gms excluding the egg	There is always a finite limit of the mass that can be put into space	HIGH		MS01 DCS02		X	X	
SYS-02	Container will fit in a cylindrical envelope of 130mm diameter and 250 mm in length	Payload structure dimensions are influenced by launch vehicle characteristics	HIGH		MS02,03 DCS 04		X		
SYS-03	There will be no protrusions until Container deployment from rocket payload	Payload structure dimensions are influenced by launch vehicle characteristics	HIGH		DCS-01,02,03		X		
SYS-04	Container will descent with rate of less than 20m/s and Cansat at rate of 20 +/- 1m/s	So that does not get drifted away by wind safe landing speed	HIGH		DCS-01,02,03,04	X		X	X

System Requirements

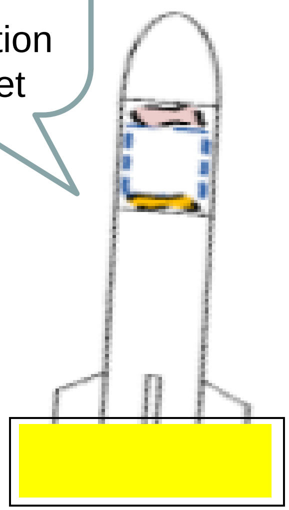
ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
SYS-05	GCS will have external power control with confirmation from Cansat power state	To avoid Battery consumption when idle and to not to tamper the Cansat while operating.	LOW				X		X
SYS-06	Total cost of the Cansat will not exceed $1000	Every well managed systems has constraint, to have uniformity	MEDIUM				X		
SYS-07	During descent Cansat will send its position along with house keeping telemetry	To track the health of the Cansat	HIGH		S01 MS05 CDH 01,02			X	X

System Requirements

ID	Requirement	Rationale	Priority	Parent(s)	Children	VM			
						A	I	T	D
SYS-08	Cansat will stop transmitting telemeter upon landing and it will calculate the impact force with the ground as requirement of additional objective.	To measure the impact force on the Cansat so as to estimate the amount of maximum force that the Lander can sustain in order to save the egg.	LOW		S01 MS05 CDH05			X	X
SYS-09	Container and Cansat should be recovered safely.	To avoid damage to cansat structure and components so that it functions properly after landing.	HIGH						X
SYS-10	Team will provide all saved telemetered data transmitted by the Cansat.	As a part of Post Flight Review so as to analyze the telemetered data.	MEDIUM		CDH06,07,08				X

System Concept of Operations

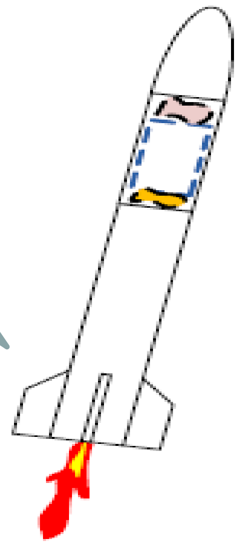
Cansat rests inside the container placed in payload section of the rocket



Team developed Ground Control Station

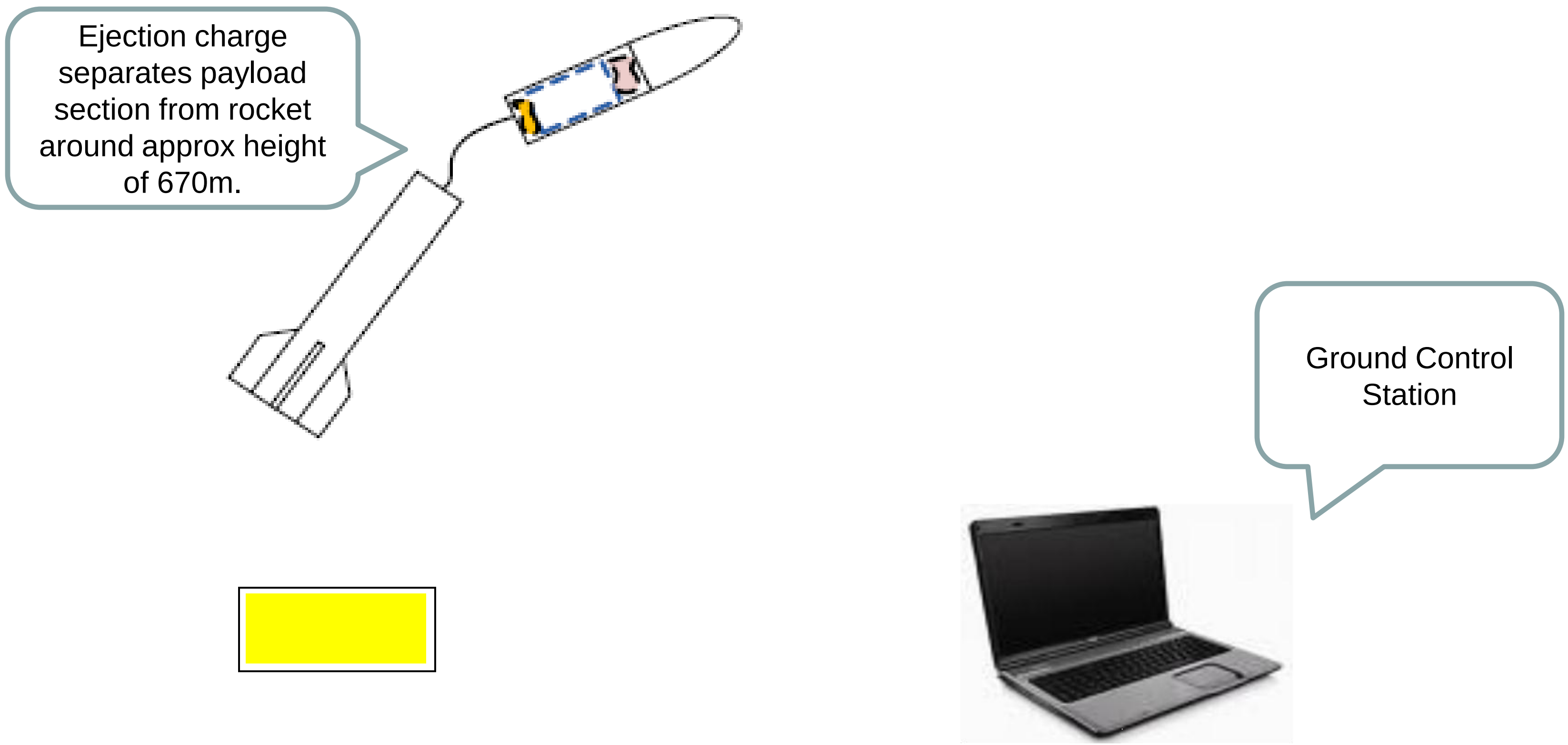
System Concept of Operations

Container rests on its parachute still inside the parachute. Wings are folded and sitting inside the container.



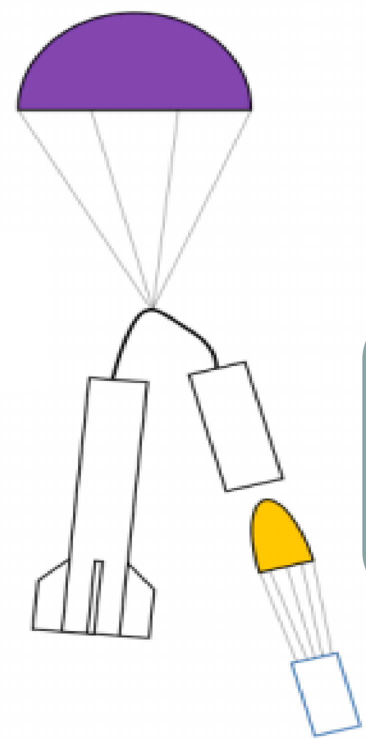
Ground Control Station

System Concept of Operations



System Concept of Operations

Front section tips over and the container falls out of the payload section. The Container parachute inflates and slows it down.

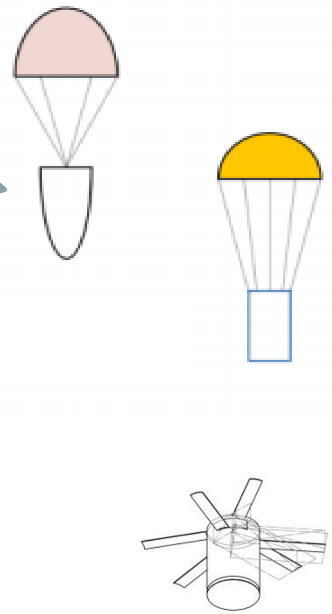


Container starts sending Descent Data Packets as soon as the parachute inflates.

Ground Control Station receives and visualizes Descent Data Packets

System Concept of Operations

The Container, Nose cone and rocket descend under parachutes. The carrier and lander separate at 400m above ground.



Cansat will detach from the Container at 400m above the ground.

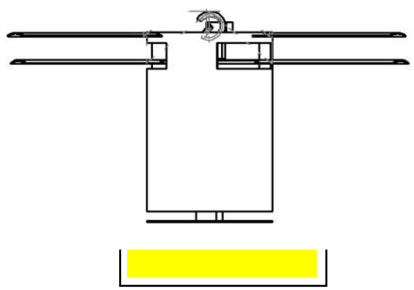
Ground Control Station receives and visualizes Descent Data Packets

Cansat carrier will communicate with the GCS

System Concept of Operations

Ground Control Station receives and visualizes Descent Data Packets

Cansat will measure the ground impact force after landing.

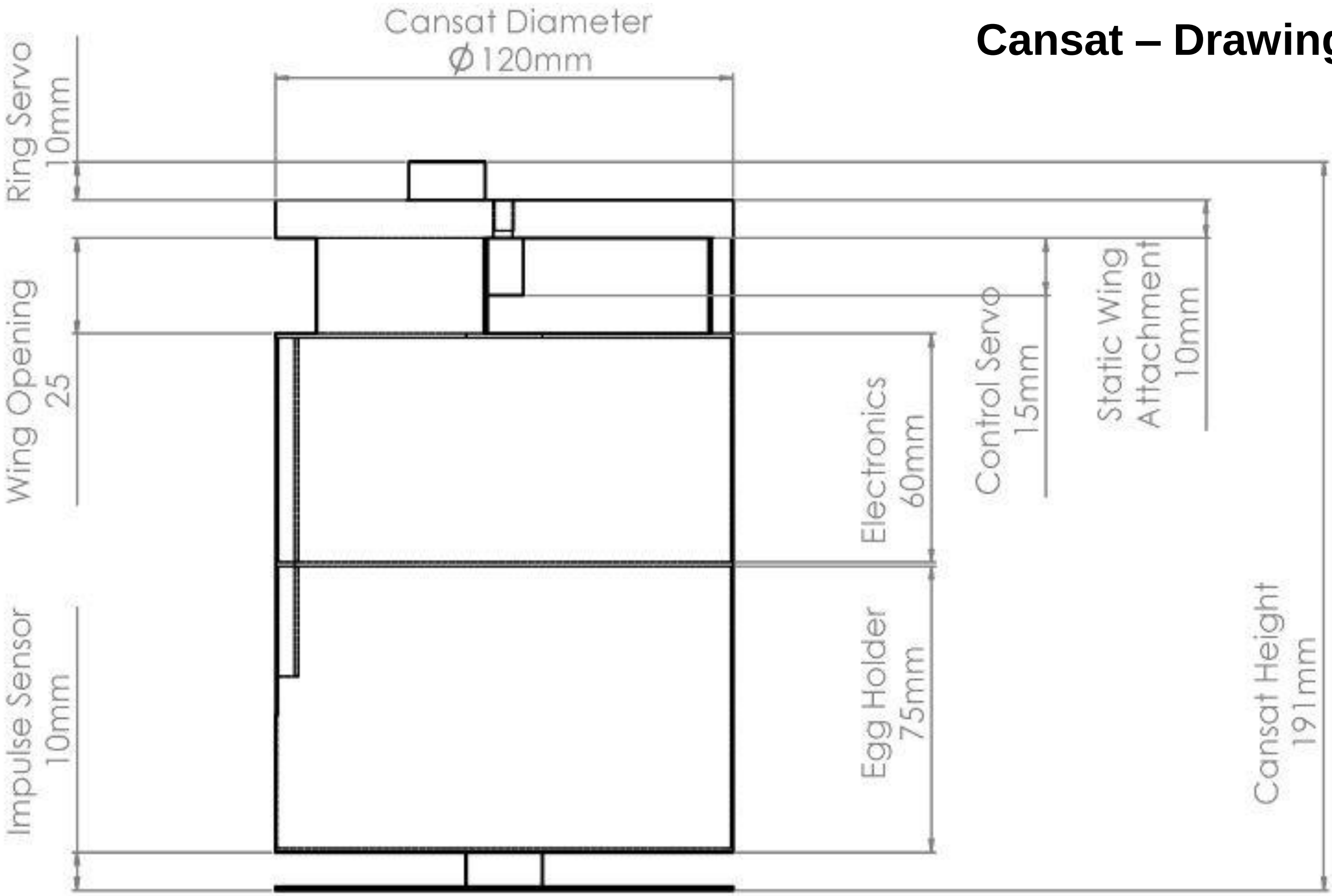


Physical Layout

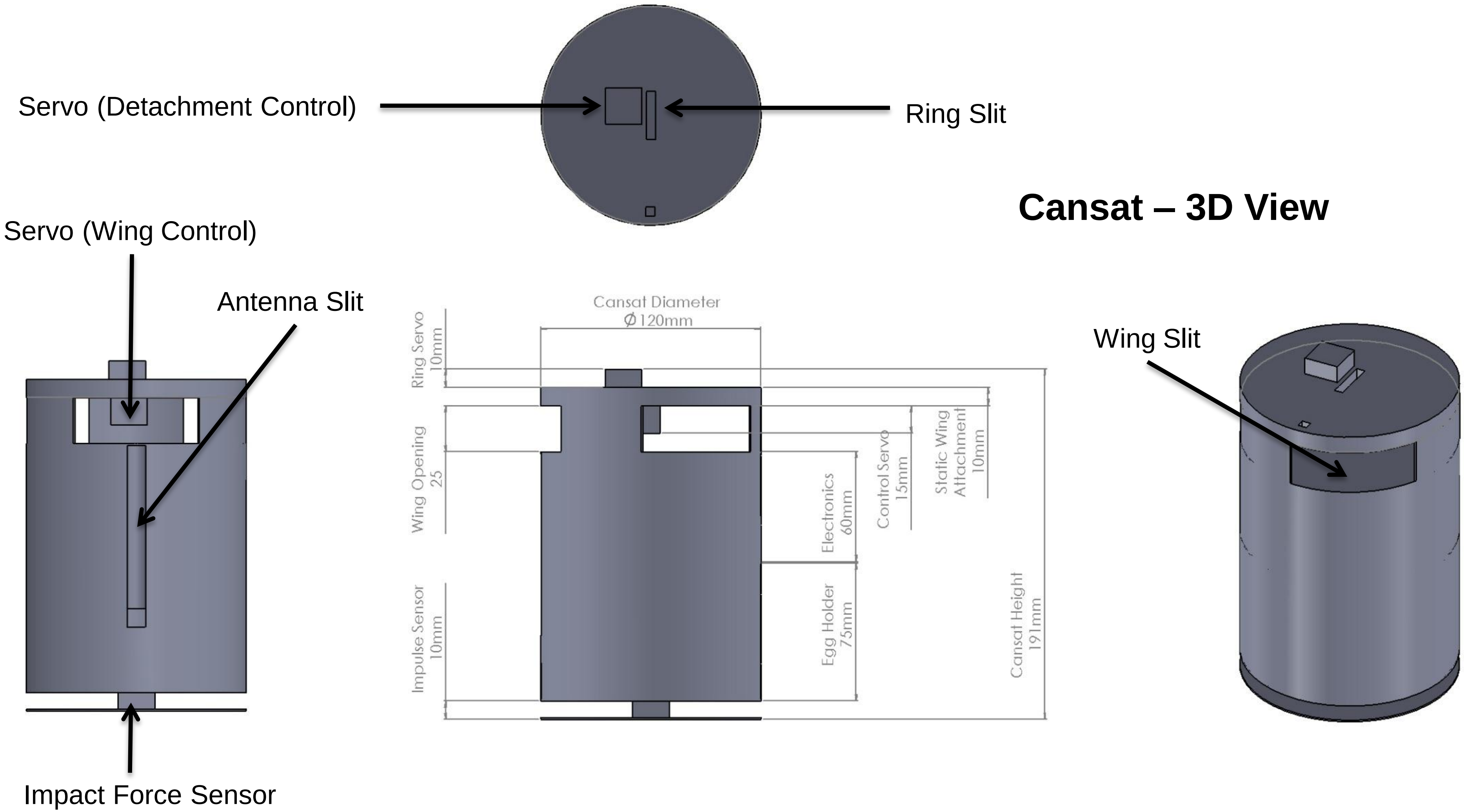
Presenter : Rakesh N R

Physical Layout

Cansat – Drawing

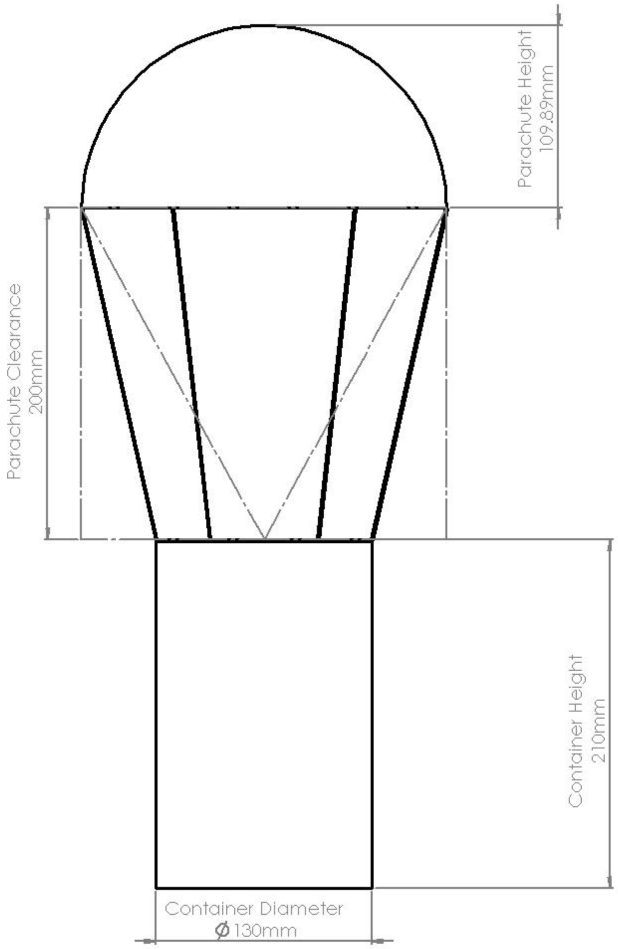


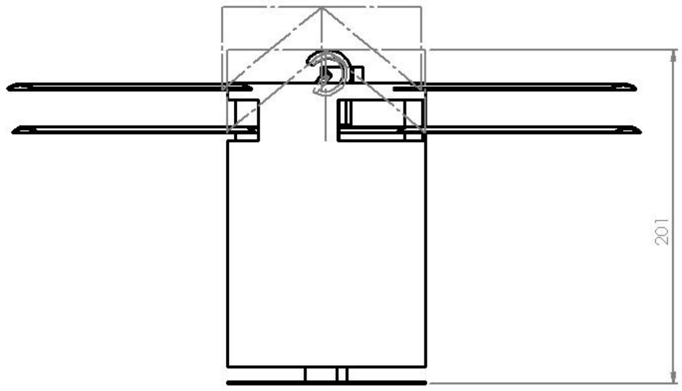
Physical Layout



Physical Layout

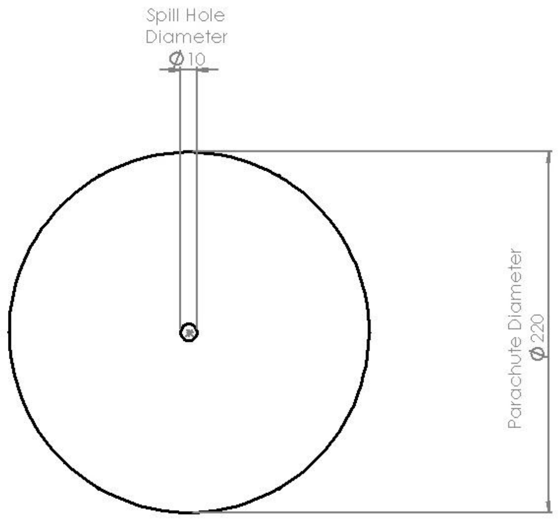
Design – Front View

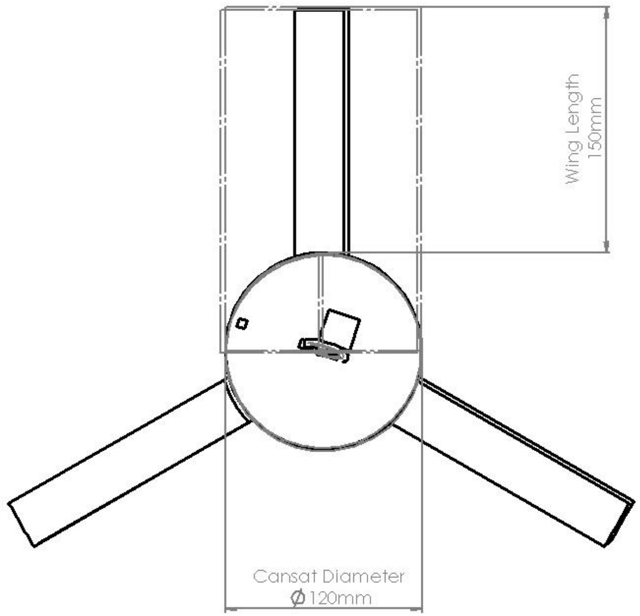




Physical Layout

Design – Top View

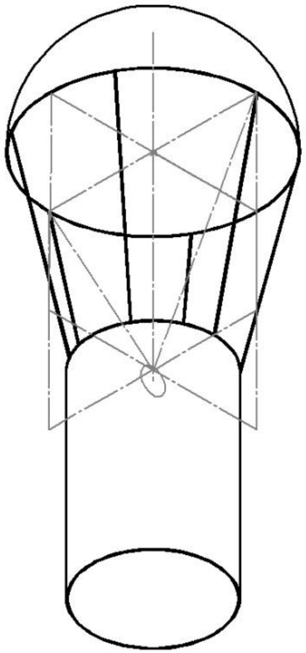


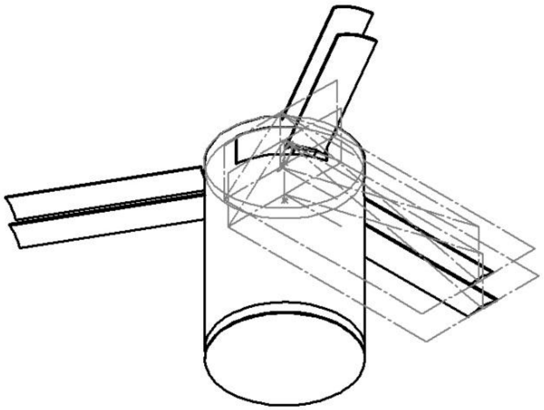


Wings Overlapping

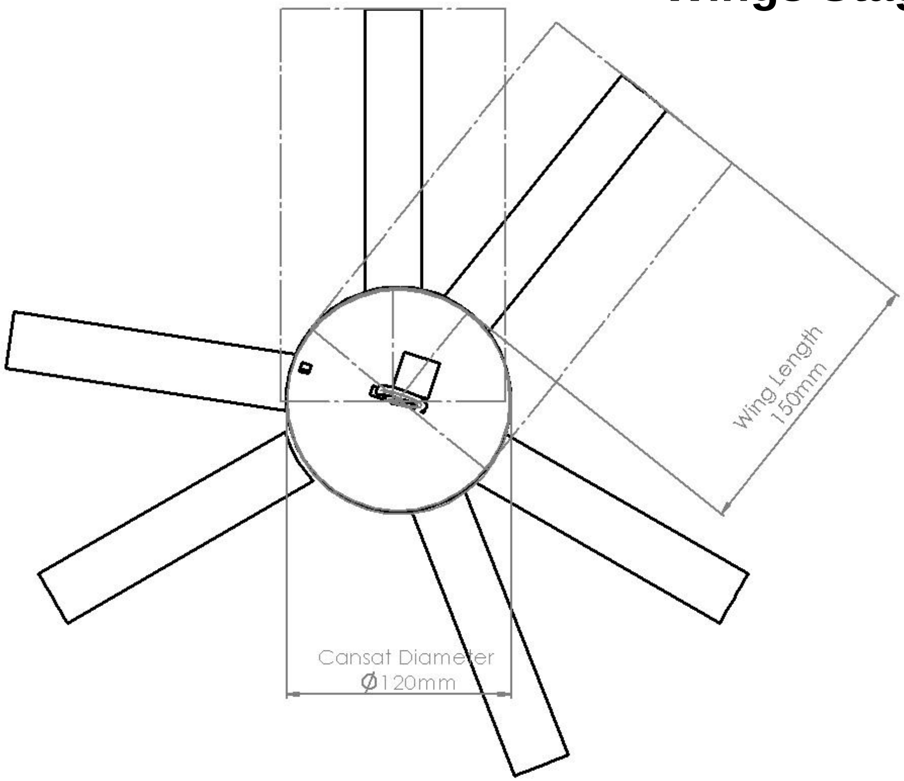
Physical Layout

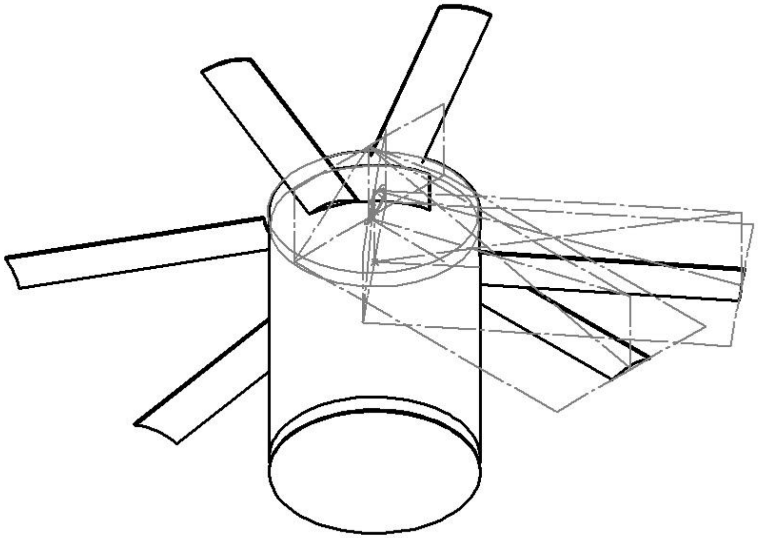
Design – Isometric View





Wings Staggered





1. **Choice of aluminum over steel:** Aluminum was chosen over steel keeping in mind the mass constraints.

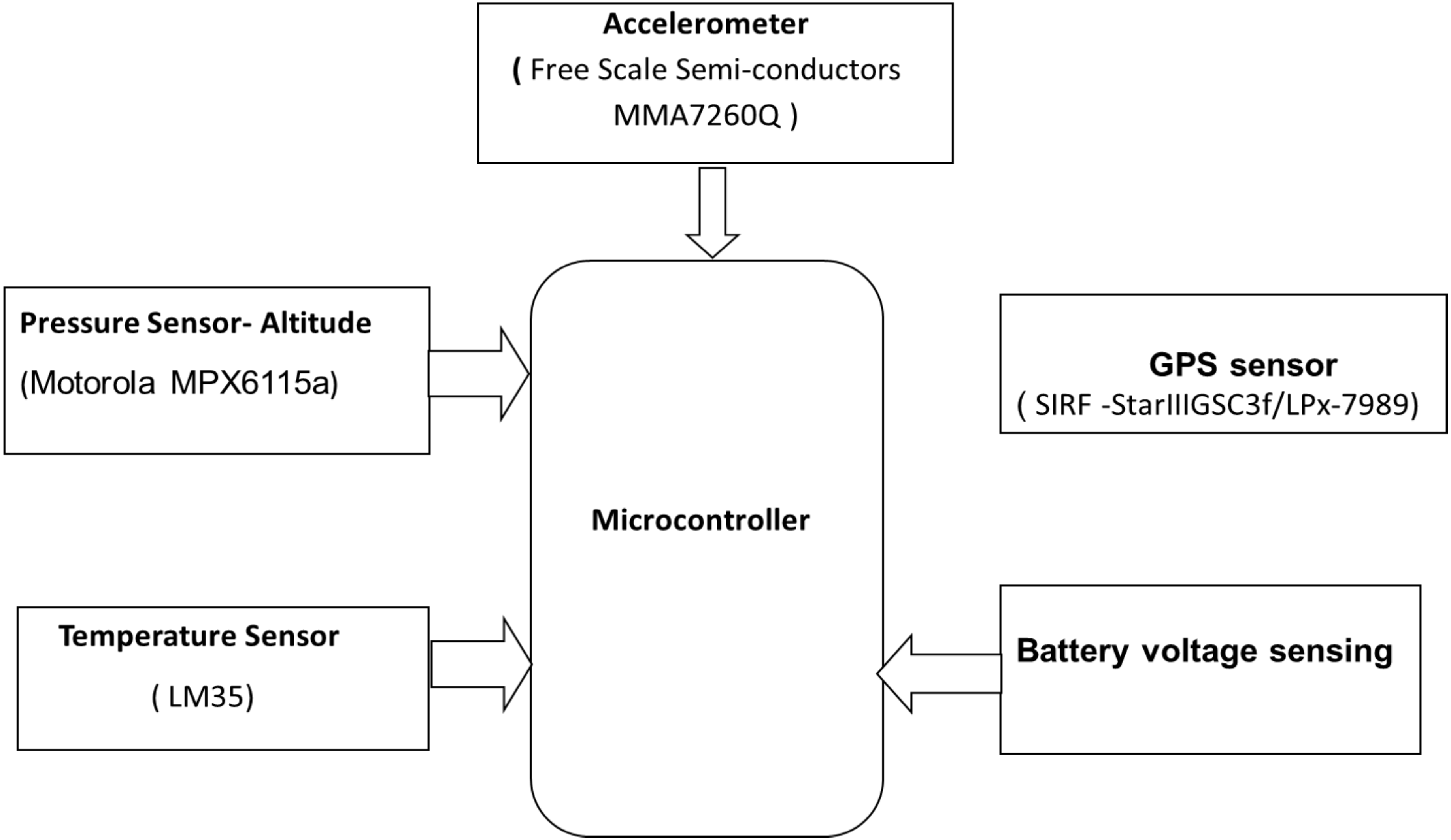
2. **The container containing the egg is kept at the bottom of the lander** and the electronics is in the middle as we want the center of mass to be as low as possible to improve the stability of the cansat.

3. Wings were earlier thought to be made of aluminum, but later to have higher strength, lower mass and accurate geometry, we are thinking of using plastic/fiber material.

Sensor Subsystem Design

Presenter : Rahul Gupta

Sensor Subsystem Overview



Sensor Subsystem Requirements

2012 Texas Annual CanSat Competition

ID	Requirement	Rationale	Parent	Children	Priority	VM			
						A	I	T	D
S01	Measurement of barometric altitude	It is a requirement for descent telemetry	SYS - 08,09		HIGH	X		x	x
S02	Measurement of air temperature.	It is a requirement for descent telemetry	SYS - 08,09	-	HIGH			X	x
S03	Measurement of Battery Voltage.	Requirement for Descent Telemetry and Housekeeping Data	SYS-08,09	-	HIGH			X	
S04	GPS Location data	Descent Telemetry and determination of Landing	SYS-08,09	-	HIGH	X		X	x
S05	Acceleration Sensor	Various events such as ejecting, mapping of motion and operational objective of landing data.	SYS – 08,09	-	MEDIUM	X		x	X
S06	Audio Beacon	It is required to retrieve the Cansat after it has landed.		-	MEDIUM				

GPS Trade & Selection

Manufacturer	Model	Dimensions	Accuracy	Mass	Power/voltage
SIRF	**StarIII GSC3f/LPx-7989**	**Length:27mm, Width: 23mm**	**5m**	**10g**	**75mw/3.3v**
Garmin	OEM GPS 15H-W	Length:30mm, Width: 30mm	4m	15g	85mw/8-40v
Global Sat	EM-406	Length:30mm, Width: 30mm	3m	23g	70mw/4.5v

SiRF GSC3f GPS Sensor

GSC3f/LPx-7989 sensor is selected because it has much more accuracy than other sensors, also it weighs less and uses less power which are other critical parameters for the selection of GPS sensor.

Non-GPS Altitude Sensor Trade & Selection

Manufacturer	Model	Accuracy	Mass	Current/voltage	Dimensions	A/D
Freescale	**MPX6115a**	**+-1.5%**	**25g**	**0.5ma/5v**	**16.6 * 7.2mm**	**A**
Freescale	MPXH6101A	+-1.72%	31g	97ma/10v	28.6 * 81.7mm	A
Vaisala	PTB210	+-0.25hpa	110g	55ma/6v	120mm * 30mm	D

MPX6115a Non-GPS Altitude Sensor

MPX6115a Non-GPS Altitude Sensor is selected because it weighs less, consumes less power and is smaller than other two sensors in race.

Non-GPS Altitude Sensor Trade & Selection

MPX6115a will act as lander pressure sensor.

Barometric pressure changes with respect to altitude and temperature

The relation between analog pressure and voltage in analog sensors is almost linear and is most of the times provided by the manufacturer

MPX6115a Pressure Sensor

Pressure from Voltage :

P = 22.222 * V + 10.556 – (22.222*EF)

Height from Pressure :

$$h(feet) = 1.4544 \times 10^{5} \times \left(1 - \left(\frac{P(\text{kPa})}{101.325\text{kPa}}\right)^{0.1902}\right)$$

Air Temperature Trade & Selection

Product	Type	Operates in region	Accuracy
FM 75	Digital	0 – 100 degrees	+-1degree Celsius
LM 35	**Analog**	**0 – 100 degrees**	**+- 0.5 degree Celsius**

LM 35

- This temperature sensor is selected to fulfill the need of our mission because of it's more accuracy than FM75, low cost and easy availability.

- Other fact about using this sensor is that it is very simple to use it rather than using a digital temperature sensor which on other hand is expensive and not easily available.

Lander Impact Force Sensor Trade & Selection

Model	Dimensions	Voltage/current Normal mode	Current Power saving mode	Range	Accuracy	Sensitivity Due to temp	A/D
Analog devices ADXL345	**15mm*25mm**	**3.3V/145uA**	**0.1uA**	**±16g**	**±1%**	**±0.01%/° C**	**D**
Free Scale Semi-conductors MMA7260Q	25mm*25mm	3.3V/500uA	3uA	± 6g	±5%	±0.03%/° C	A

The ADXL345 is digital, low weight, higher accuracy, better range and low power consumption.

Lander Impact Force Sensor Trade & Selection

Model	Dimensions	Voltage/current Normal mode	Current Power saving mode	Range	Weight	Sensitivity Due to temp	A/D
Kistler 9712B250	16mm* 16mm* 13mm	24V/4mA	1uA	+1kN	19g	- 0.009%/° F	A

Since we are worried that the cansat may rotate (due to winged structure), the accelerometer may not provide accurate results. Hence we are going for a physical sensor.

But due to requirement of extra space and very high voltage, decision has not yet been made. Decision will be taken once Accelerometer is purchased and tests are performed.

XBEE

Model	Dimensions	Voltage/current Normal mode	Indoor/ Urbun Range	Outdoor/ RF-Line of Sight Range	Transmit Power	A/D
XBEE PRO® 802.15.4(Series1)	33mm*24 mm	3.3V/100mA	90 m	3200 m	63mW	D
XBee-PRO® ZB SMT	**21.99mm x 34mm**	**3.3V/100mA**	**100m**	**3200m**	**60mW**	**D**

Descent Control Design

Presenter : Siddharth Singh

Descent Control Overview

- The Descent control system will be achieved through the use of parachutes of appropriate size 22cm for Container and wings for Cansat and design keeping in mind the aerodynamics of the fall.
- Proper design and right choice of materials will be the backbone of the Descent Control System. Extreme care and precision needs to be involved in design taking care of all possibilities.
- Both Container and Cansat sections will have separate mechanisms to achieve the required constant descent speeds of 20(+/- 1)m/s.
- While the Cansat is in the payload section , the parachutes will be closed such as to occupy an allotted space.
- After deployment from the rocket airflow will cause the parachute of the carrier to inflate and the rate of descent will be controlled by the parachute.
- At the time of separation(at 400m), spring system will cause the wings of the Cansat to open.
- The spill hole at the top (1cm radius) will ensure continuous air flow through the parachute, thereby stabilizing it and ensuring descent at required speeds.

Descent Control Requirements

ID	Requirement	Rationale	Parent	Children	Priority	VM			
						A	I	T	D
DCS01	Container chutes occupy their allotted space, whatever be the orientation of the payload.	to ensure a tangle free separation, and proper fitting while in payload.	SYS – 04		HIGH				
DCS02	container chute size such that descent rate ~20m/s	Competition requirement	SYS- 01,04		HIGH				
DCS03	Cansat descent rate ~20m/s	Competition requirement	SYS- 04		HIGH			X	
DCS04	Materials used to be light and flexible.	To minimize mass and volume requirements.	SYS- 02		MEDIUM				
DCS05	The descent control system shall not use any flammable or pyrotechnic device.	Safety.			MEDIUM				

Container Descent Control Strategy Trade and Selection

Strategy selection

Strategy	Pros	Cons
Use of Wings	Orientation can be easily controlled using servo motors.	Controlling drift will not be possible using the mechanism
Use of parachute	Easy to design and attain required speed, low space requirement.	Drift(can be countered by a spill hole, affects area)

Material selection for parachute design

1. Silk- thin, light and easy to fold but expensive and not as elastic as nylon
2. **Rip stop Nylon cloth - Due to property to block air , easy availability and good elasticity.**

Strings to control shape : **Nylon strings – High strength , easy to use and light.**

Material selection for Wing design

The Possible materials for the design of the wing are

- **Aluminum**
- **Plastic/Fiber**

The material selection is based on the fact that the materials should be light weight and have high enough tensile strength to support the weight of the Cansat .

We have chosen to use plastic wings keeping in mind the weight constraints of the Cansat as well as the torque requirements for wing rotation.

Descent Rate Estimates

The size of the parachutes is fixed by calculation from the following relation.

$$r = \text{sqrt}(\ (2\ m\ g) / (\boldsymbol{\pi}\ p\ \ C_d\ v^2)\ )$$

where,

π = 3.14159265359

ρ = 1.146 kg/m^3 (density of air at 35 °C)

C_d = 1.5 (drag coefficient of the chute for a hemisphere chute)

v = Terminal velocity achieved (from mission required)

r = radius of the chute

g = acceleration due to gravity

Descent Rate Estimates

The area of the wing is calculated from the following relation.

$$A = (2\ m\ g) / (p\ \ C_d\ v^2)$$

where,

π = 3.14159265359

ρ = 1.146 kg/m³ (density of air at 35 °C)

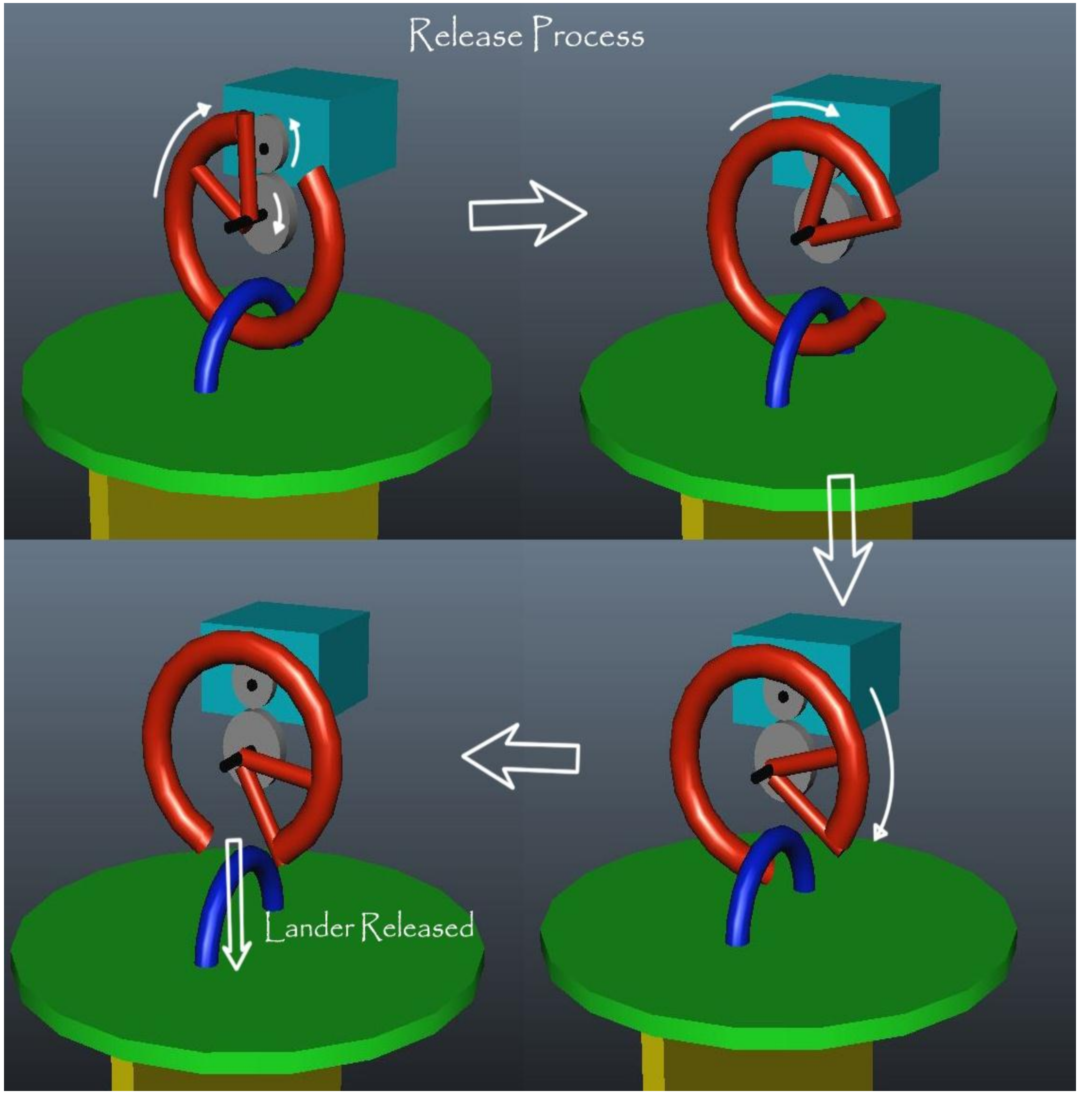
C_d = 2.32 (AS MEASURED FROM EXPERIMENT)

v **=terminal velocity achieved (from mission required)**

A = area of the plate

g = acceleration due to gravity

Cansat detachment strategy



Mechanical Subsystem Design

Presenter: Jaswanth Reddy

Mechanical Subsystem Overview

- The major components of the cansat are the egg carrier , the carrier circuit , the wing system and the sensor arrangement.
- Top layer is the wing system. The position of the wings are controlled by a servo attached underneath the cansat top cap.
- After that there is space for PCB, sensor and batteries.
- Then comes the egg container. It has a small slit for connecting the impact force sensor.
- Impact force sensor is attached to the bottom of the cansat and provided with a metal sheet for larger area of impact measurement.
- The entire body skeleton is made of **aluminium**.
- Container and Cansat are interfaced using a motor-hook system. The servo controlling this lies to the top of cansat top cap.

Mechanical System Requirements

ID	Requirement	Rationale	Parent	Priority	VM			
					A	I	T	D
MS01	Total mass of the Cansat will be 700+/-10gms excluding egg	Control system relies heavily on accurate mass estimation .	SYS -01	HIGH		x	x	
MS02	Cansat will fit in a cylindrical envelope of 120mm diameter and 210 mm in length	Payload structure dimensions are influenced by launch vehicle characteristics	SYS -02	HIGH		x		
MS03	There will be no protrusions until Cansat deployment from rocket payload	Payload structure dimensions are influenced by launch vehicle characteristics	SYS -02	HIGH		x		
MS04	Cansat and egg placed inside should be recovered safely.	Structure should be able to withstand vibration shocks and protect the egg from breaking.		HIGH			x	x
MS05	Placement of GPS Antenna , Transceiver Antenna	Placement of Sensors and Antennas have to be appropriate for proper Transmission and Reception	SYS-08,09	MEDIUM			x	x
MS06	Ensure smooth detachment of the container and the cansat at a height of 400m.	The wing system shouldn't be harmed.		HIGH		x	x	

Egg Protection Trade and Selection

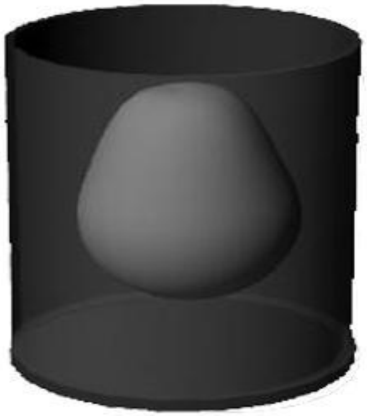
Egg is best protected in the following conditions -

- An ***Aluminum container*** is used for carrying the egg. The rationale of using aluminum is as follows:

Material	Density (gms/cc)	Tensile strength (GPa)	Cost per square meter	Availability
Aluminum	**2.7**	**90**	**59.74 $**	**Easily available**
Carbon Fiber	1.75	3.5	651 $	Facility not yet identified
Steel	7.9	1.3	52.31 $	Difficult

- The container is stuffed with ***polystyrene balls*** with egg in the middle.
- Sponge and paper cushions were also considered but rejected based on test observations (Refer : Egg drop test In Integrated test section).
- Polystyrene balls provide the required cushioning to protect the egg. Polystyrene balls are inexpensive, light weight and easily available

Egg Protection Trade and selection



Images showing the egg container region of the structure

Image shows the egg surrounded by Polystyrene balls

Mechanical Layout of Components Trade & Selection

- The Battery and the rest of the electronics have been placed on opposite sides to ensure that center of mass remains near the center of the structure for proper balance.
- The motor-hook arrangement is placed at the center of the CanSat cross-section for smooth release.

Estimated Mass Budget

Item	Weight (g)
Mass of Skeleton (Container)	225
Mass of Skeleton (Cansat)	190
Mass of Wings	30
Mass of PCB (including microcontroller, temp. Sensor)	30
Servo Motor*2 + Antenna + Buzzer + Others	85
Battery*2	105
Parachute	20
Egg Cushioning	20
TOTAL	**705**

Communication and Data Handling Subsystem Design

Presenter : Gauresh Patil

CDH Overview-1

- **Cansat**
  - Processor: AtMega 128 (As Central Processing Unit of the Carrier; sensing, processing, transmitting, storing telemetry data)
  - Memory: Atmel0736 (For storing telemetry data onboard for backup in case of communication failure)
  - Radio Transceiver: XBee-PRO® ZB SMT Transceiver (For transmitting data to ground station once every 2 seconds)
  - Antenna : A24-HASM-450 (2.1dBI)

CDH Overview-2

- **Ground Station**
  - Radio Transceiver: XBee-PRO® ZB SMT Transceiver (For receiving data from the carrier once every 2 seconds)
  - Xbee USB Explorer
  - Antenna : A24-HASM-450 (2.1dBI)
  - Intel Core i3 Processor Laptop.

CDH Requirements-1 (Container)

ID	Requirement	Rationale	Parent	Priority	VM			
					A	I	T	D
CDH01	Transmit GPS Data Stream	Descent Telemetry packet (transmitted every 2 seconds)	SYS -08 CD-01	HIGH			x	x
CDH02	Transmit Altitude in meters	Descent Telemetry packet (transmitted every 2 seconds)	SYS-08 CD-01	HIGH			x	x
CDH03	Transmit Air Temperature in Celsius	Descent Telemetry packet (transmitted every 2 seconds)	SYS-08 CD-01	HIGH			x	X
CDH04	Transmit Battery Voltage in Volts	Descent Telemetry packet (transmitted every 2 seconds)	SYS-08 CD-01	HIGH	x		x	x
CDH05	Terminate Telemetry	Terminate Telemetry within 5 minutes of landing.	SYS-08,09 CD-01	HIGH	x		x	x
CDH06	Store Telemetry Data	For Post Processing in case of Communication Failure	SYS-11	LOW				

CDH Requirements-2 (Cansat)

ID	Requirement	Rationale	Parent	Priority	VM			
					A	I	T	D
CDH06	Store/Transmit Cansat Altitude Measured	Descent Telemetry packet (stored every 2 seconds)	SYS-11	HIGH			x	x
CDH07	Store/Transmit Cansat Battery Voltage	Descent Telemetry packet (stored every 2 seconds)	SYS-11	HIGH			x	x
CDH08	Storing the Impact Force	Impact Force (Stored when cansat hits the ground)	BONUS	HIGH				
CDH09	Send stored descent telemetry to Ground Control	For post-processing following retrieval of Lander	SYS-11	HIGH			x	X

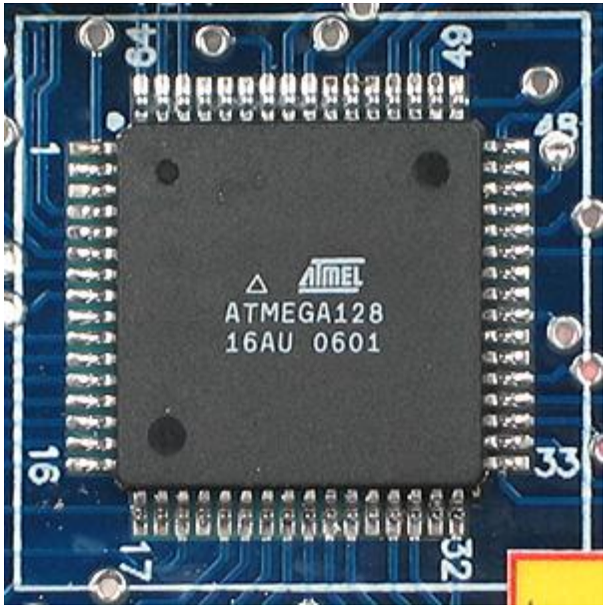
CDH Requirements-3 (GROUND STATION)

ID	Requirement	Rationale	Parent	Priority	VM			
					A	I	T	D
CDH09	Receive GPS Data Stream	Descent Telemetry packet Receive every 2S	CD01	HIGH			x	x
CDH10	Receive Altitude in meters	Descent Telemetry packet (received every 2 seconds)	CD01	HIGH			x	x
CDH11	Receive Air Temperature in Celsius	Descent Telemetry packet (received every 2 seconds)	CD01	HIGH			x	X
CDH12	Receive Battery Voltage in Volts	Descent Telemetry packet (received every 2 seconds)	CD01	HIGH	x		x	x
CDH13	Plot telemetry data In real time	Ret real time feel for what is happening.	CD01	HIGH	x		x	x

Processor : Trade & Selection

Cansat: AtMega128

- **Maximum Clock Frequency 16 MHz (external)**
- **Data Interfaces:**
  - USART: 2 (One for Transceiver and one for GPS)
  - SPI: 1(For memory)
  - ADC PORTS: 8 channels(one each for battery voltage, temperature sensor and pressure Sensor, impact force sensor)



- **On chip Flash Memory: 128 Kb**
- **SRAM / EEPROM: 4 Kb**
- **Supply Voltage: 4.5V – 5V**

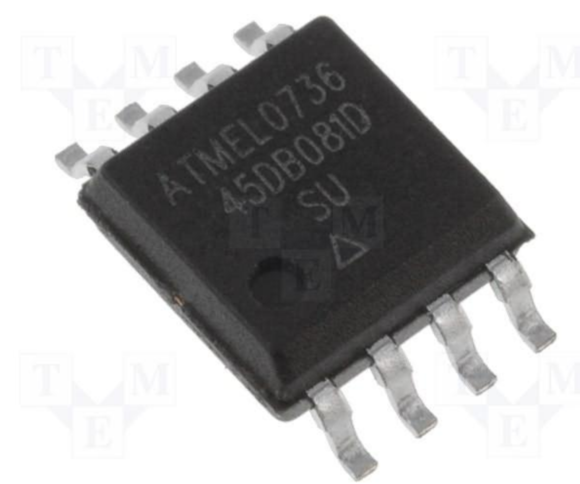
Memory : Trade & Selection

- **If 1 minutes of Descent Telemetry(carrier) sampled at 2 seconds**
  60 * (50 bytes) ~= 3 kB

- **If Acceleration Data is calculated with 100 samples per second :**
  3*100*10 bits ~= 0.4 kB

- **Totally it adds up to around 4 kB.**

- **Atmel Memory chip**
  - 8 MB, SPI Mode, Chip Select Available
  - Its cheap and readily available.



Carrier Antenna Trade & Selection

- The Antenna had to be matching for the range of 2.4 GHz.
- Have preferably an MMCX connector against SMA,BNC or TNC .
- High Decibel Gain
- VWSR less than 2.0 : 1
- Half Wave Dipole and Omni Directional
- Antenna Chosen: A24-HASM-450 (2.1dBI)

Communications Configuration

Transceiver programmed for API control Mode

Fixed baud rate of 57600 bps , channel 0 in Receive mode for query wait

Transmit when asked for a query, through UDR buffer

The system in API mode set at fixed baud rate and channel transmits and receives through a 3 byte MAC address which can either be hard coded on the EEPROM or sent dynamically.

Carrier Telemetry Format

Characters	Definition
cc.	State
hhmmss	Data time tag in hours , minutes and seconds
Hhmmss	Mission Time
N	Start of latitude data
AA.aaaa	Cansat latitude
W	Start of longitude data
BB.bbbb	Cansat Longitude
hh.hh..	Cansat GPS altitude
Ab	Number of satellites tracked in decimal
vv.	Pressure Sensor Sampled Data
tt.	Air temperature (1 degree resolution)
vv.	Battery voltage

States
BOOT
TEST_MODE
LAUNCH_PAD
ASCENT
PARA
CANSAT
IMPACT
BUZZER

- Data sent every 2 seconds with baud rate of 57600 bps.
- Data Format: Data Format will be finalized in CDR

Autonomous Termination of Transmissions

- **To terminate telemetry:**
  - This will be done via a check in the loop which compares the altitude from GPS data to altitude from several previous data packets, accelerometer output and impact force sensor. If the altitude remains same for a certain amount of time and accelerometer gives a very high value and impact force sensor records impact, we conclude that the cansat has landed and that its time to stop sending the telemetry.
  - The GCS will recognize the end of telemetry by the special custom occurrence of special character.

Locator Device Selection

- We are going to use a buzzer to locate the cansat after impact.
- The buzzer selected is pro-Signal ABI-001-RC.
- It is Rated at greater than 80dB at 10cm distance.
- Power consumed is 84mW.

Electrical Power Subsystem Design

Presenter : Shashank Wadhwa

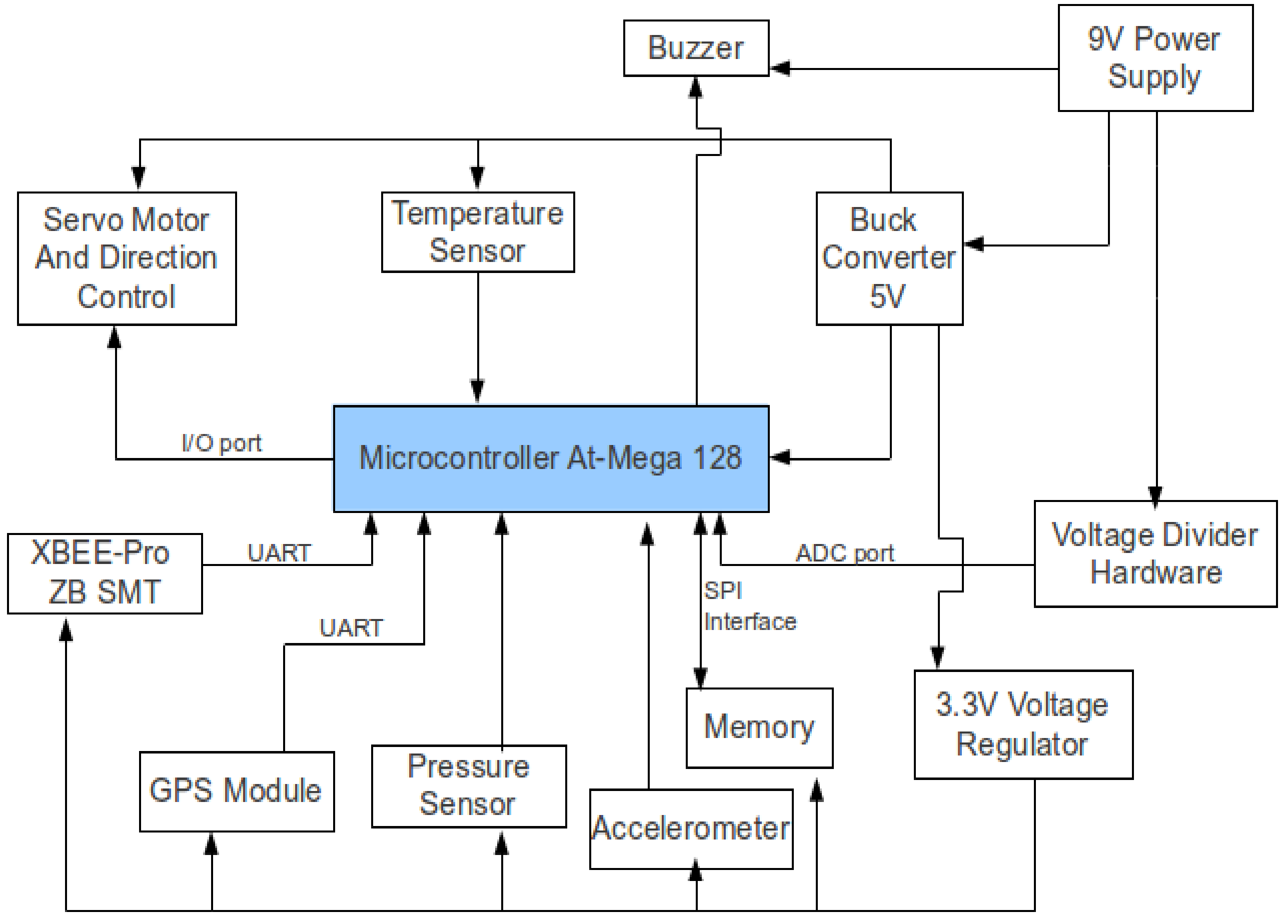
EPS Overview

Design Considerations	• All the power and electrical requirements are met.
Voltage Regulation	• Level-shifting and voltage regulations for using two different voltage regulators each corresponding to 5v and 3.3v.
Power Monitoring	• Done by additional hardware

EPS Requirements For Cansat System

ID	Requirement	Rationale	Parent	Priority	VM			
					A	I	T	D
EP01	Voltage Requirement (5V, 3.3V)	• 5V required for MicroController, Temperature Sensor and Servo. • 3.3V for Memory, Pressure sensor, Accelerometer, Transceiver and GPS.	EP02	MEDIUM			x	x
EP02	Battery Requirement (9V)	To be able to provide adequate power for the whole period of flight.	-----	MEDIUM		x		

Cansat Electrical Block Diagram

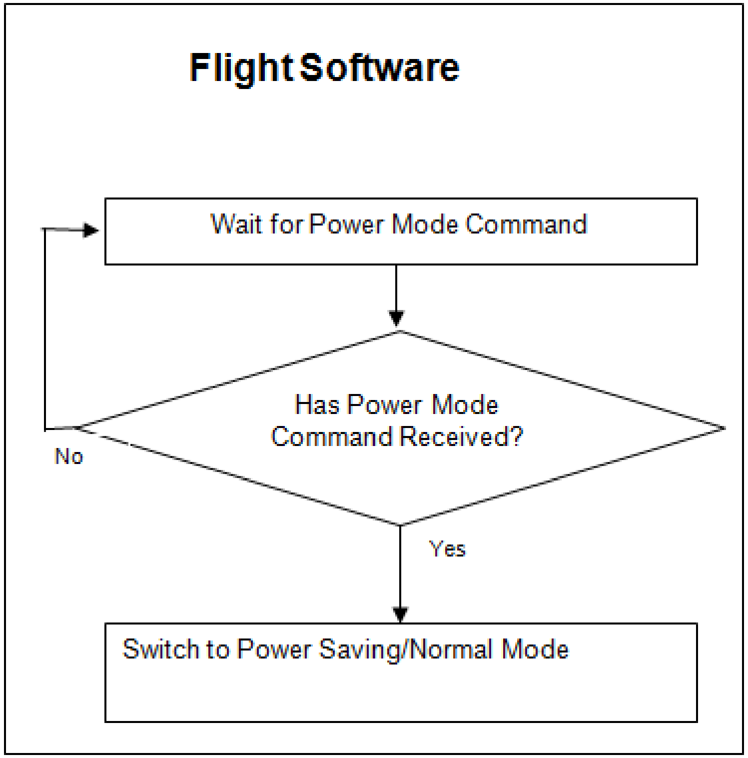


External Power Switch will be present to control the power flow in the system.

Battery Voltage will be read using microcontroller-ADC.

Power Control without disassembling the Cansat

Idle Mode: In this mode, the processor would disable the CPU



Also there will be an external switch to enable battery.

Power Budget

2012 Texas Annual CanSat Competition

Device	Average Power consumption (mWatts)	Voltage	Average Current	Usage
GPS	75 mW	3.3V	23 mA	3 hrs
Pressure Sensor	1.65 mW	3.3V	0.5mA	3 hrs
Temperature Sensor	75 mW	3.3V	23mA	3 hrs
XBEE-Pro ZB SMT	376 mW	3.3V	100mA	3 hrs
Microcontroller	110 mW	5V	28mA	3 hrs
Flash memory	16.5 mW	3.3V	5mA	3 hrs
Buck Convertor 5v			**92% eff**	
Buck converter 3.3v			**90% eff**	
Voltage divider H			**Negligible**	
Servo Motor	2*1W	5v		(Descent time)
Buzzer	63 mW	9 V	7mA	1 hr

Total Power Budget

Total Power used by main components is 718.15 mWh.

Voltage conversion of 90% efficiency in 3.3v and 92% in 5v for Buck Convertors.

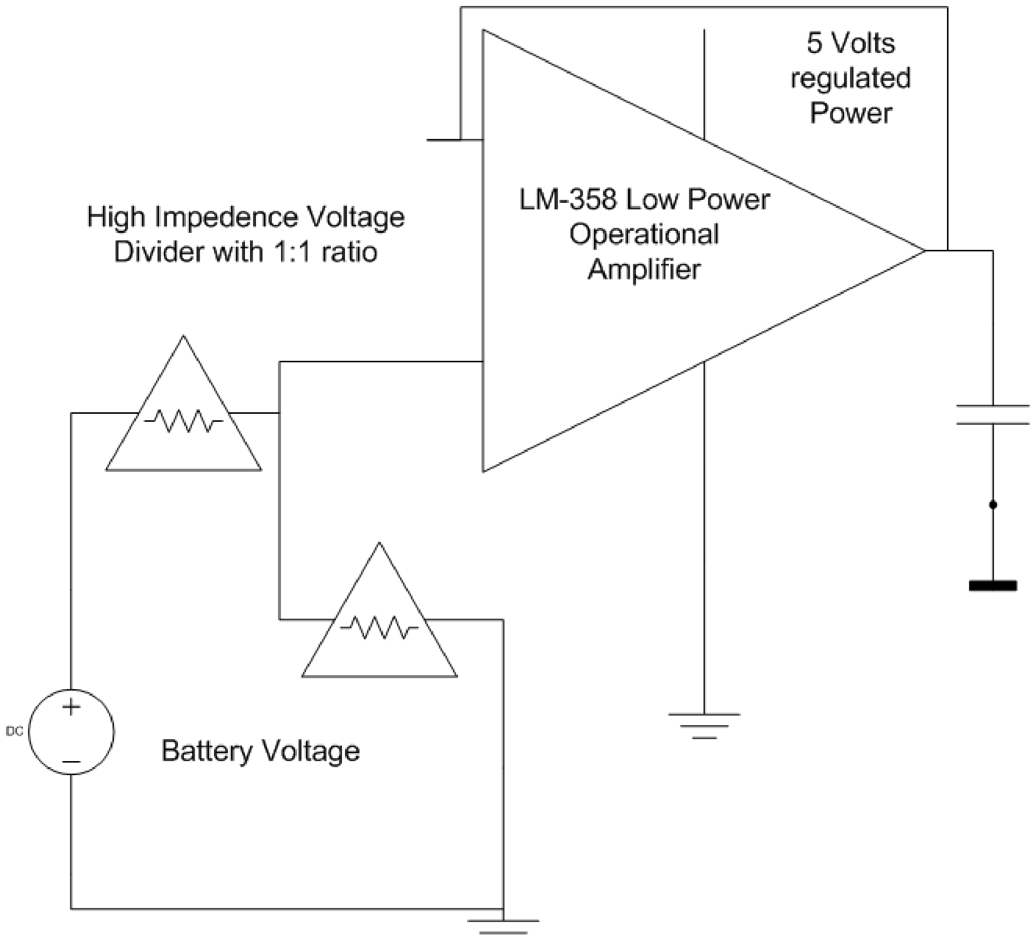
Life of each Battery: 2.15 hours (approx)

Power Source Trade & Selection

Name	Voltage/Power	Type	Mass
6F22 Heavy duty	9v / 500mah	Alkaline	45g
UBP 001	3.7v/1800mah	Lithium Ion	41g
Dura Cell	**9.6v/ 170mah**	**Ni Mh**	**47g**

We are using Dura Cell as it is most easily available and highly efficient for the purposes required.

Battery Voltage Measurement Trade & Selection



- Battery Voltage is measured by giving a high impedance voltage divider with outsourcing and then interfaced to the ADC port.

EPS Testing Overviews

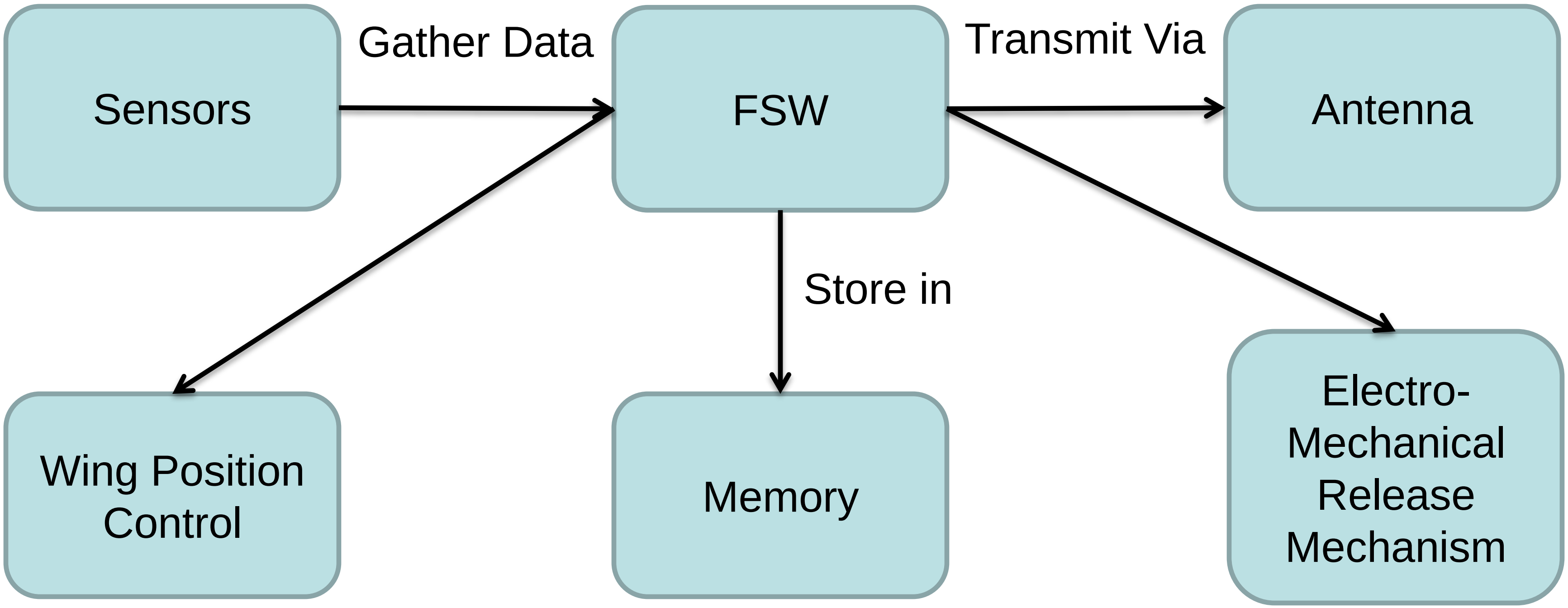
Power Regulation	• Testing of Buck Converter based Regulators 1 week post PDR
Lab Power Testing	• 1 week prior to CDR
On Field Power Testing	• Post CDR

Flight Software Design

Presenter : Rakesh N R

FSW Overview

- The FSW will work in a Microcontroller(Atmega128). Its basic structure will be as follows:



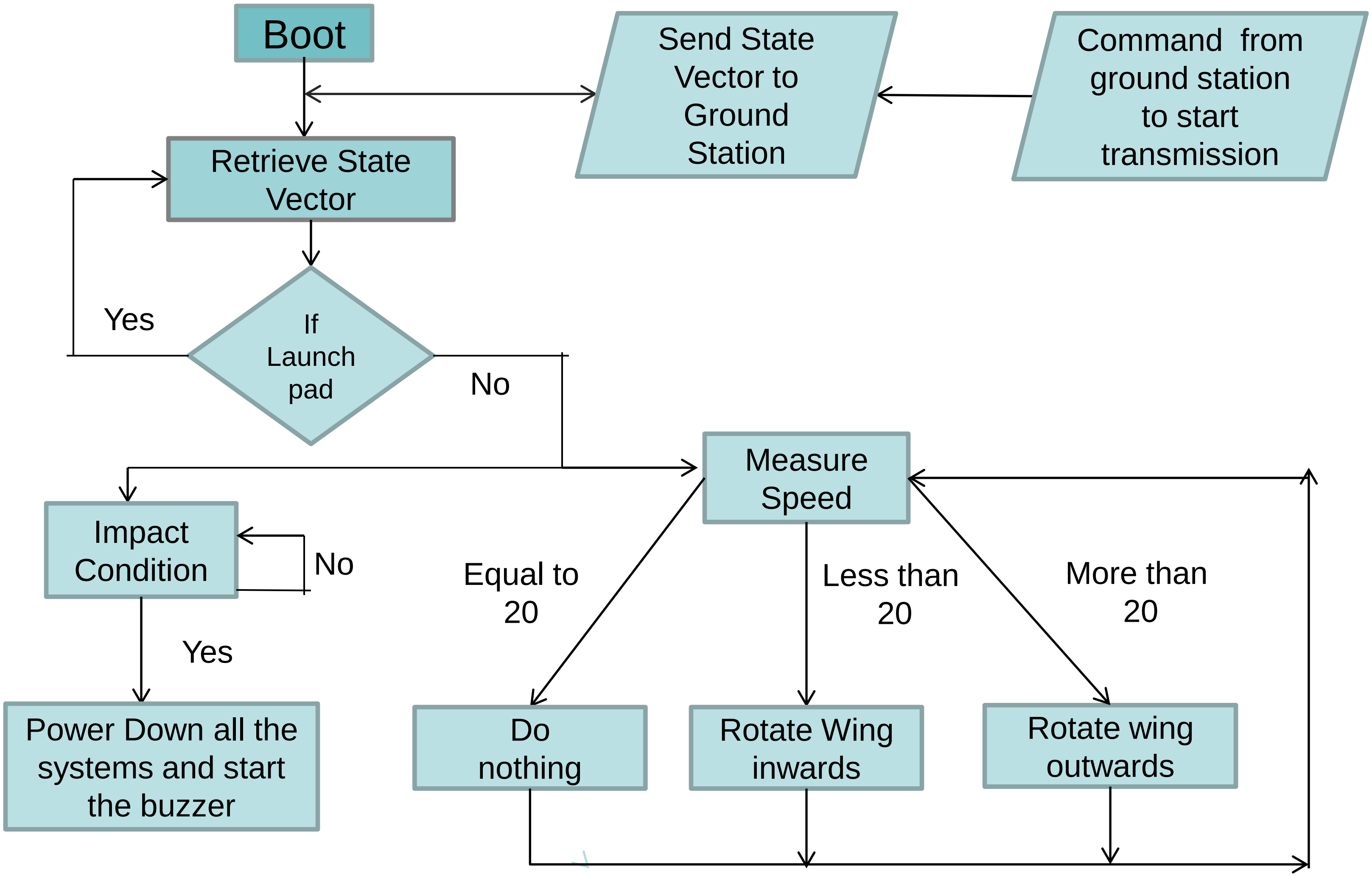
FSW Overview

- The FSW will collect data from all the sensors and store it onto the onboard memory. It will also transmit the collected data via XBEE.
- It will also initialize the Electromechanical Mechanism used to release the Cansat from the container at the height of 400 meters.
- The FSW for the Cansat will collect data from the altitude sensor and the impact sensor and store it onto the onboard memory so as to be analyzed later.
- Complete FSW will be developed in C with an AVR GCC environment. All C programs are compiled and dumped as HEX codes in ATMEL microcontrollers which forms the embedded platform of our Cansat. We have chosen this platform because we are familiar with it as it is a part of our curriculum.

FSW (Cansat) Requirements

ID	Requirement	Rationale	Parent	Priority	VM			
					A	I	T	D
FSC01	Collection of Sensor data in processor and formation of packet	Reception of data values from sensors and analysis in firmware to produce data packets	CD01	HIGH	x		x	x
FSC02	Data packet to be sent to RF Transceiver via USART.	Packet sent for Transmission to Relay	CD01	HIGH			x	x
FSC03	Packets sent also stored as Data backup.	Packet also sent to memory for Data-packet backup.	CD01 CD04 CD06	LOW				x
FSC04	Control the Release mechanism of the lander	So that the lander can be released at height of 400 meters	CD03	LOW	x		x	x

Software (Cansat) flow diagram(High Level)



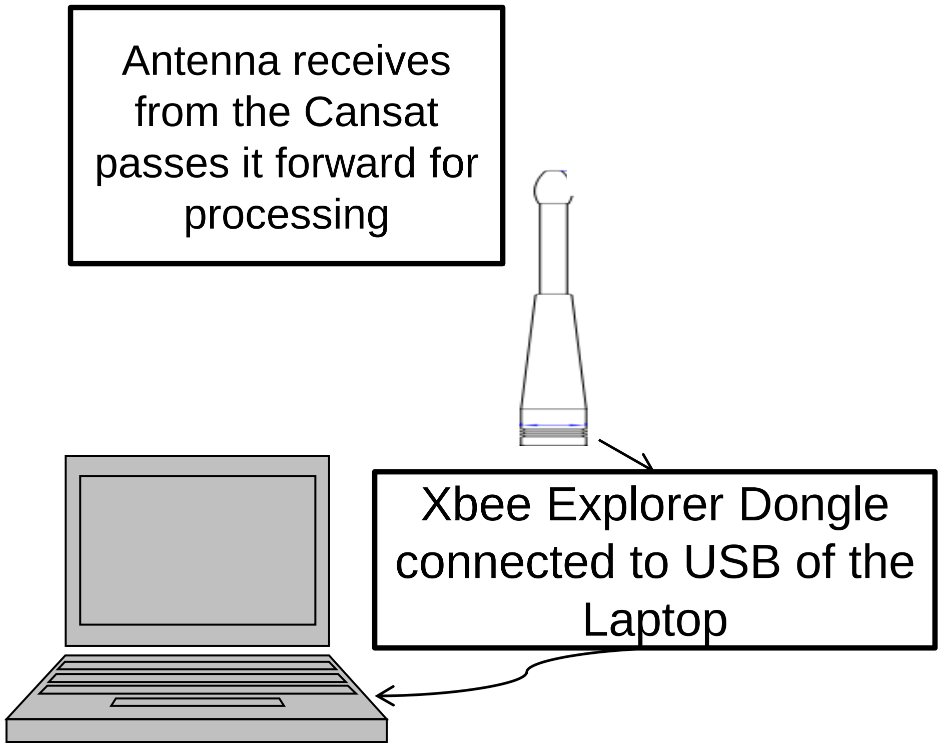
Sensors

- **Pressure Sensor:**
  - » Interfaced via ADC
  - » sampled at 10kHz
- **Battery Voltage Sensor:**
  - » Interfaced via ADC
  - » sampled at 10kHz.
- **Accelerometer X,Y and Z:**
  - » Interfaced via ADC(3 ADC ports)
  - » sampled at 100Hz.
- **Memory :** Memory chip is interfaced via SPI

Ground Control System Design

Presenter : Rakesh N R

GCS Overview



GCS uses the data received to populate various tables and plot graphs. The software clearly indicates the phases of flight, i.e. pre-launch, moving upwards, deployment, coming down, landed etc..

GCS Requirements

ID	Requirement	Rationale	Priority	Parent	Children	VM A	VM I	VM T	VM D
GCS01	Antenna placement : Antenna must point upward, towards the Cansat	For better signal reception.	Medium	None	GCS02 GCS03			X	
GCS02	Computational requirements : Data is received at 0.5 Hz.	Computational speed is not a big issue. (Assuming GCS laptop has a reasonably fast processor)	Low	GCS01	None			X	
GCS03	Power Requirement : Should be able to receive and display data for about 3 hrs.	GCS has to be ready always for the communication. Not a big issue as ample power is available.	Medium	GCS01	GCS05			X	
GCS04	Analysis Software requirements : Should support Java, C/C++.	To be able to run analysis software.	High	None	None		X	X	
GCS05	Mission operations : Includes the detection of various phases by the GCS	To be able to distinguish between various states of flight.	Medium	GCS03	None			X	

GCS Antenna Trade & Selection

Name	Range	Gain	Radiation Direction	Mass
Antenova B58124	1 Km	1.8dB	Omni	2g
A24-HASM-450	**3.2 Km**	**2.1dB**	**Omni**	**25g**

The first one is small easy to accommodate and light weight, but lacks in providing the required range hence communication fails, which is an extremely important objective of the Cansat mission. Thus we select the one which gives us the required range.

Cansat Integration and Test

Presenter : Syed Tabish Abbas

Integration of Cansat subsystems

- **Integration of Container and Cansat**
  - We used a servo motor to control a hook that holds the Container and the Cansat.
- **Integrations in Container**
  - EPS, DC
    - There will be a servo motor for the hook release of Cansat.
- **Integrations in Cansat**
  - EPS , SS , CDHS and SS
    - There will be two stacks of PCB's one on top of each other .
    - There will be two batteries . One of the batteries is going to serve as a backup in case the other one fails .

Tests Performed

- **Sensor Testing**
  - The sensor will be tested after procurement .

    The sensors selected so far are :-

    - GPS sensor(SIRF GSC3f/LPX7989)
    - Temperature Sensor (LM35)
    - Pressure Sensor (MPX6115A)
    - Accelerometer (MMA7260Q)

Tests Performed

Mechanical Testing

- Egg drop tests to decide the cushioning material .
- *Test conditions include free fall and windy conditions .*

Trial	Outer case	Inner filling	Drop Height (feets)	Velocity at Ground Level (metres/second) V = √(2gh)	Results
1	Aluminum container	Sponge + Paper Cushion	40	15.5	FAIL
2	Aluminum container	Sponge + thermacol balls	20	11	PASS
3	Aluminum container	Sponge + polystyrene balls	40	15.5	Pass
4	**Aluminum container**	**Sponge + polystyrene balls**	**60**	**19**	**Pass**

➢ Descent Control Testing

- The test was performed using a prototype of the proposed Cansat control system using Simple wings made from cardboard .

- The test shows that the prototype achieves Terminal Velocity after some distance .

Tests to be Performed

1) Communication Testing
2) Flight Software Testing
3) Detachment Testing during Flight
4) Cansat Position Estimation Testing
5) Final Structure Testing
6) Electronics Testing

Mission Operations & Analysis

Presenter: Siddharth Singh

Overview of Mission Sequence of Events

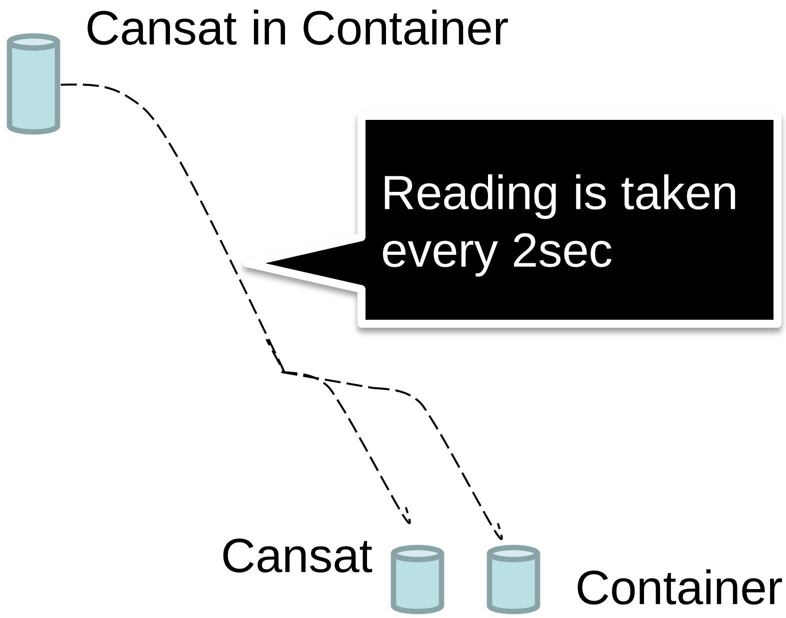
2012 TEXAS ANNUAL CANSAT COMPETITION

Preliminary launch-day sequence of events

- –Arrive at the Launch site well in-time
- –Locate a workspace for the team
- –Layout the team's equipment and put up the team's banner
- –Collect the launch time schedule
- –Assemble the Cansat and carrier for final check
- –Setup GCS
- –Verify communication between Cansat and GCS
- –Collect and place the Egg in its container
- –Proceed to place the Cansat in the payload section of the rocket
- –Post Launch – run all the GCS operations
- –On successful landing of Cansat, proceed for recovery
- –Pack up and leave the Launch site

Cansat Landing Coordinate Prediction

- DCS will keep track of GPS readings during descent.
- The sensor data will be taken after each 2 seconds. This timing is done by the onboard controller.
- After detachment the co-ordinates of Cansat will be predicted on the basis of GPS readings at the carrier.
- After some Readings Trajectory of the Cansat can be estimated.
- The DCS will be enabled as soon as Cansat will come out of Rocket.
- It keeps track of height using Altitude Sensor.
- At 400 Meter height Cansat and Container detach with DCS on Container tracking co-ordinates of Cansat.
- Further Trajectory can be estimated by extrapolation.



Cansat Location and Recover

- **Cansat Recovery**

  - The co-ordinates of Cansat will be estimated by FSW that will help us to find the exact location of Cansat on the ground. This is a heuristic approach based upon GPS data as follows we store the position of Cansat before separation of container and Cansat in the memory at every 2 sec interval. This will depict the trajectory of the Cansat as it falls. This can be extrapolated taking into consideration local wind effect as altitude decreases to predict the trajectory and final position of Cansat.

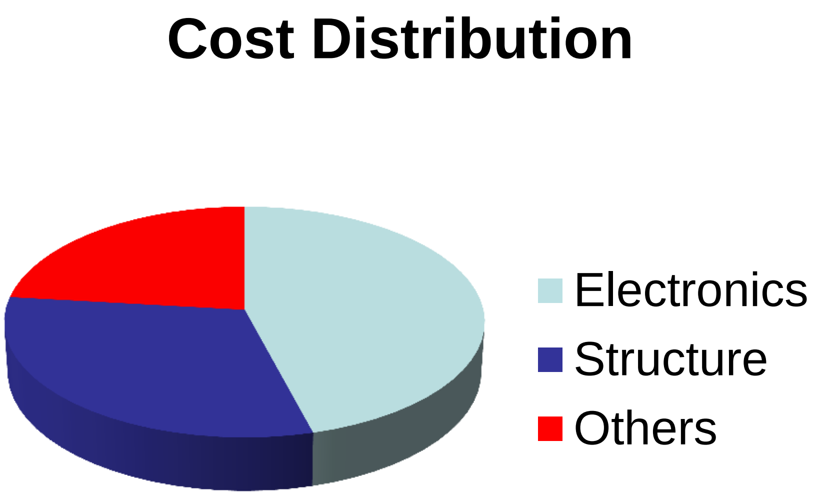
  - The Cansat will have a shiny body after detachment from the container which will help in easy detection of the Cansat. There would also be a Buzzer that would keep on sounding for one hour thus helping in easy tracking of the Cansat .

Management

- **Presenter : Siddharth Singh**

Cansat Budget – Hardware

Component	Quantity	Unit Price (in USD)	Cost (in USD)
Atmega128 microcontroller	1	6.8	6.8
Temperature Sensor	1	16	16
Accelerometer	1	7	7
Battery	2	22	44
Servo Motor	2	5	10(mini)
Circuit Fabrication	2	10	20
GPS Equipment	1	108	108
Electronics system			71.3
Xbee Explorer Dongle	1	25	25
Structure material and Fabrication		200	200
Rip-Stop Nylon	3	18	54
Miscellaneous		20	20
Margin	15%	41.3	66.1
Total			646.5



Program Schedule

Electronics Team					
Task	Scheduled Dates (dd/mm/yy)		Actual Dates (dd/mm/yy)		Reasons for not completing
1. Recognition of Tasks	1/1/13	4/1/13	1/1/13	7/1/13	
2. Allocation and Division of Tasks	5/1/13	10/1/13	8/1/13	14/1/13	
3. Identification of Systems and System Architecture	11/1/13	15/1/13	14/1/13	17/1/13	
4. Testing of Available components from previous year	15/1/13	27/1/13	17/1/13	18/1/13	
5. PDR Report and Presentation	27/1/13	31/1/13	27/1/13	5/2/13	Mid-sem exams and R&D showcase organized in our college
6. Hardware Procurement Begins	10/2/13	17/2/13			
7. Basic System Integration	17/2/13	15/3/13			
8. Work on Image Sensing and Orientation	15/3/13	25/3/13			

Program Schedule(contd.)

Electronics Team					
Task	Scheduled Dates		Actual Dates		Reasons for not completing
9. CDR PPT and PDF	25/3/13	29/3/13			
10. Accelerometer Interfacing	1/4/13	10/4/13			
11. Flight Software Development	11/4/13	25/4/13			
12. Testing of Prototype	25/4/13	5/5/13			
13. Fabrication of Final PCB	6/5/13	15/5/13			
14. Field Testing of Hardware with System	16/5/13	5/6/13			
15. Flight Operations Preparation	6/6/13	11/6/13			

Mechanical Team Schedule

Mechanical and Descent Control Team					
Task	Scheduled Dates		Actual Dates		Reasons
1. Recognition of Tasks	1/1/13	15/1/13	1/1/13	15/1/13	
2. Descent Mechanism Design	16/1/13	20/1/13	16/1/13	24/1/13	
3. Egg Landing Test on Materials	20/1/13	25/1/13	23/1/13	25/1/13	
4. Mechanical Structure Design	25/1/13	27/1/13	25/1/13	27/1/13	
5. PDR report and presentation	27/1/13	31/1/13	27/1/13	3/1/13	

Mechanical Team Schedule(contd.)

2012 Texas Annual CanSat Competition

Mechanical and Descent Control Team					
Task	Scheduled Dates		Actual Dates		Reasons
6. Descent Control Hardware	1/2/13	15/2/13			
7. Designing Descent Control	16/2/13	25/2/13			
8. Integrating Descent Control with Egg Canopy	25/2/13	5/3/13			
9. Testing of Structure for operation	5/3/13	15/3/13			
10. Make necessary changes in descent or Egg mechanism	15/3/13	15/4/13			
11. Testing with Changes	15/4/13	1/5/13			
12. Fabrication of Final Structure	1/5/13	10/5/13			
13. Testing with integrated Hardware	10/5/13	25/5/13			

Conclusions

- **Accomplishments :**
  - Detachment mechanism finalized.
  - Physical structure layout finalized.
  - Sensors and components are decided.
  - Descent mechanism decided.
  - Preliminary Testing of Descent mechanism done.
  - Sensors tested.
- **Yet to be done :**
  - PCB design is yet to be finalized.
  - Physical structure needs to be prepared.
  - FSW code has to be written.
  - GCS code has to be written.

We are ready for the next stage which is - Implementation of the subsystems according to the conclusions we've reached upon.

THANK YOU