CanSat 2017
Preliminary Design Review (PDR)

TEAM 5851

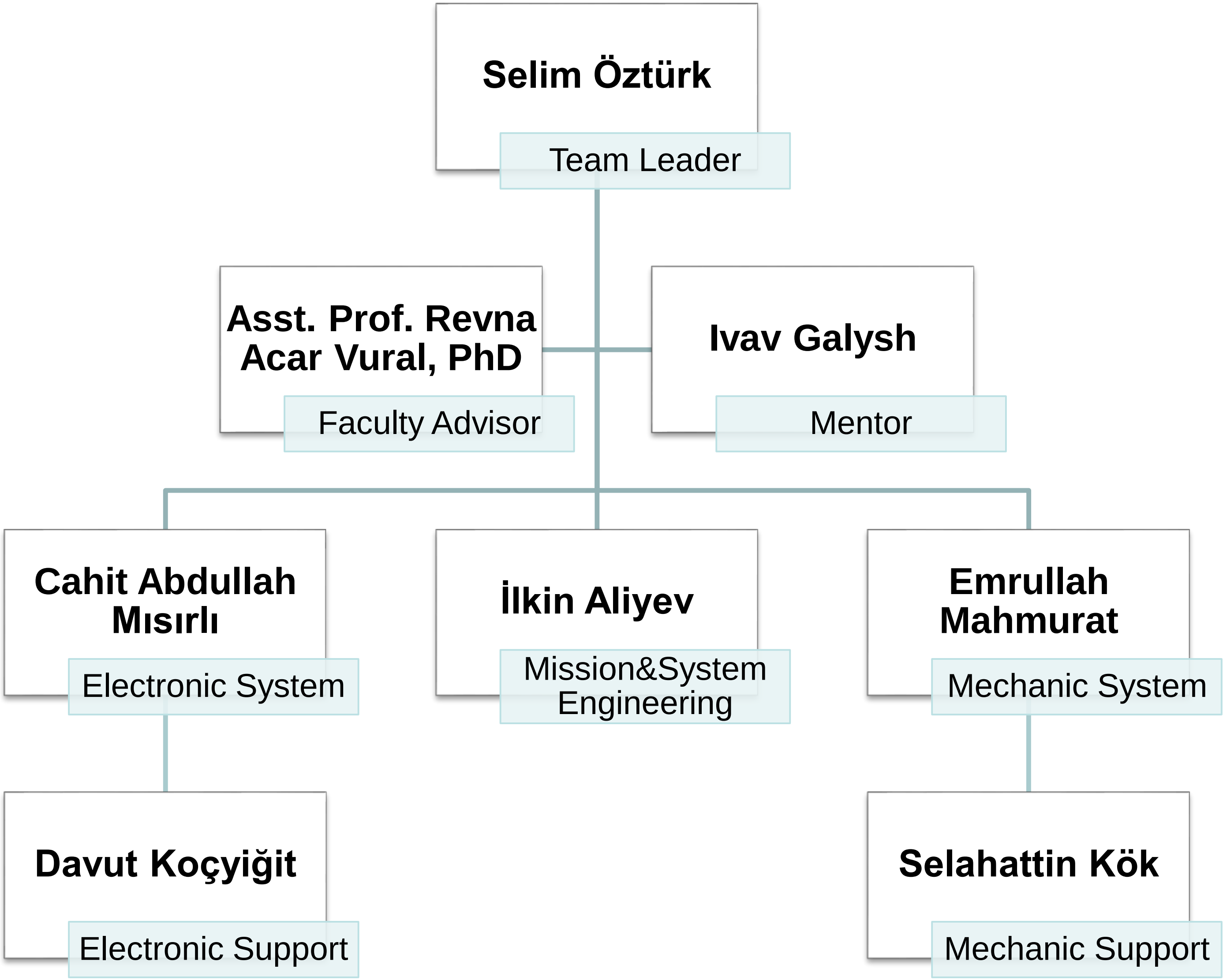
IQRASAT

Yildiz Technical University

Presentation Outline

- **System Overview:** İlkin Aliyev
- **Sensor Subsystem Design :** Selim Öztürk
- **Descent Control Design:** Emrullah Mahmurat
- **Mechanical Subsystem Design:** Selahattin Kök
- **Communication & Data Handling:** İlkin Aliyev
- **Electrical Power System:** Cahit Abdullah Mısırlı
- **Flight Software Design:** Cahit Abdullah Mısırlı
- **Ground Control System:** İlkin Aliyev
- **CanSat Integration & Testing:** Selim Öztürk
- **Mission Operations & Analysis:** Selim Öztürk
- **Requirement Compliance:** İlkin Aliyev
- **Management:** Selim Öztürk

Team Organization



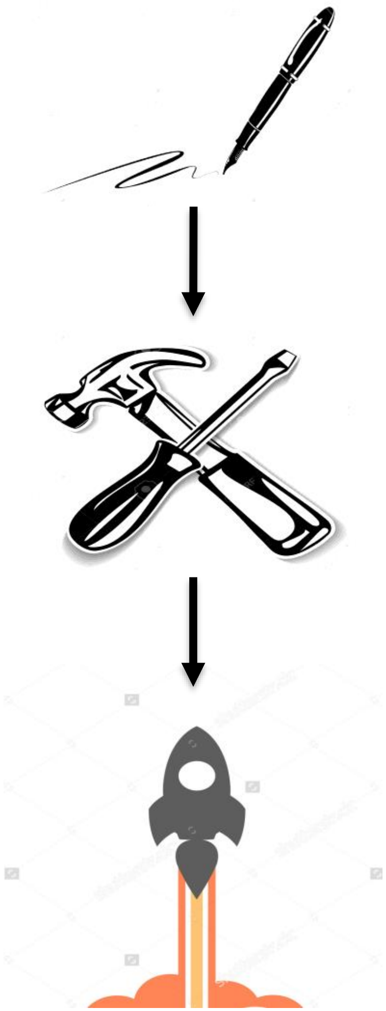
Acronyms

- VM → Verification Method
- SR → System Requirement
- SS → Sensor Subsystem
- RPS → Rocket Payload Section
- DCS → Descent Control System
- EPS → Electrical Power Subsystem
- CDH → Communication And Data Handling
- GCS → Ground Control System
- SV → Science Vehicle
- HD → High Definition
- RF → Radio Frequency
- RPS → Rocket Payload Section
- I^2C → Inter Integrated Circuit
- SPI → Serial Peripheral Interface
- UART → Universal Asynchronous Receive Transmitter
- ADC → Analog to Digital Converter
- PCB → Printed Circuit Board
- ABS → Acrylonitrile Butadiene Styrene
- MCU → Microcontroller
- LDR → Light Dependent Resistor
- RTC → Real Time Clock
- FSPL → Free Space Path Loss
- GS → Ground Station

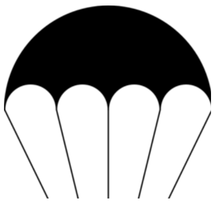
Systems Overview

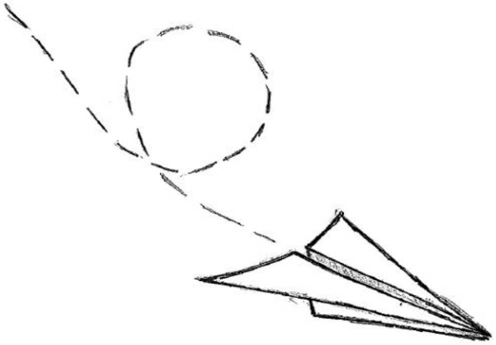
İLKİN ALİYEV

Mission Summary

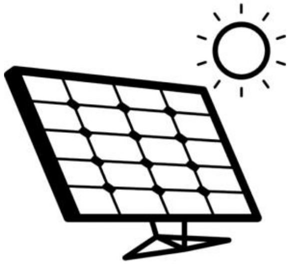


Design





Build



Launch

Mission

The 2017 mission simulates a solar powered sensor payload traveling through Venus atmosphere while sampling the atmospheric composition of the planet during flight.

Mission Objectives

- Design special elegant CanSat system and ensure system robustness.
- Payload will be protected in container during initial deployment from rocket.
- Container will use parachute for descent.
- Container will use mechanism for ejection of SV.
- Payload will glide in circular pattern.
- Payload will be fully powered by solar cells.
- Both container and glider will collect data from environment using sensors. (pressure, temperature, altitude etc.).
- Telemetry data will be transmitted to and monitored at a ground station in real time.

Bonus Objective

A color Camera located at the bottom of glider will be snapping HD pictures as fast as possible.

System Requirement Summary (1 of 4)

ID	Requirement	Rationale	Priority	Children
SR-01	Total mass of the CanSat shall be 500 grams +/- 10 grams.	Competition Requirement	High	DC-01 MS-01
SR-02	Glider shall be secured in container. And no part can extend beyond container.	Competition Requirement	High	DC-02 MS-02
SR-03	Container shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length including the container passive descent control system.	Competition Requirement	High	DC-03 MS-03
SR-04	The container shall use parachute as passive descent control system. Both container and parachute shall be orange colored. Container shall not have any sharp edge.	Orange color for tracking. No sharp edge for safe deployment	High	DC-04 MS-04 MS-06
SR-05	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition Requirement	High	DC-05 MS-05 MS-07 MS-09
SR-06	The glider must include an easily accessible power switch which does not require removal from the container for access. Access hole or panel in the container is allowed.	The glider can be powered off immediately in emergency situation	High	EPS-03
SR-07	The glider shall be released at 400+/-m and then start to glide at circular pattern passively.	Competition Challenge	High	FSW-01
SR-08	CanSat mechanical elements shall survive 30Gs of shock and 15Gs of acceleration.	Competition Requirement	High	DC-07 DC-08 MS-11 MS-12

System Requirement Summary (2 of 4)

ID	Requirement	Rationale	Priority	Children
SR-09	Electronics section shall be enclosed and shielded from environment with exception of sensors	Competition Requirement	High	SS-01 MS-10
SR-10	Mechanisms shall use neither pyrotechnics nor heat.	Safe Operation	High	MS-15 MS-16
SR-11	During descent, the glider shall collect air pressure, outside air temperature, compass direction, air speed and solar power voltage once per second and time tag the data with mission time.	Competition Requirement	High	SS-04,05,06,07,08 FSW-02 CDH-01
SR-12	Telemetry shall include mission time with one second or better resolution, which begins when the container and glider is powered on. Mission time shall be maintained in the event of a processor reset during the launch and mission	Competition Requirement	High	FSW-04 CDH-03
SR-13	XBee Pro radios shall be used for communication with ground station. 2.4Ghz and 900Mhz frequencies are allowed.	Competition Requirement	High	CDH-04
SR-14	Glider electronics shall be fully solar powered with exception of time keeping device.	Competition Requirement	Very High	EPS-01
SR-15	Cost of CanSat shall not exceed $1000	Competition Challenge	High	EPS-02 CDH-07
SR-16	Each team shall build their ground station	Competition Requirement	High	GCS-01

System Requirement Summary (3 of 4)

ID	Requirement	Rationale	Priority	Children
SR-17	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBee radio and a hand held antenna.	This data enables to analyse glider flight characteristic.	High	GCS-06
SR-18	All telemetry shall be displayed at ground staion in real time with engineering units (meters, meters/sec, Celsius, etc.)	Time reference for every collected packet	High	GCS-03
SR-19	Teams shall plot each telemetry data field in real time during flight. In addition, the ground system shall display a two dimensional map of estimated glider position based on speed and heading telemetry data.	Seeing those data in time spectrum enables to catch change more easily	High	GCS-04 GCS-05
SR-20	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.	Radio interference prevention	High	FSW-07
SR-21	No lasers allowed.	Broadcast mode is slower	High	FSW-12
SR-22	The container shall contain electronics and mechanisms to release the glider at the required altitude. The electronics shall be powered by only alkaline batteries.	Competition Challenge	High	EPS-04 MS-18

System Requirement Summary (4 of 4)

ID	Requirement	Rationale	Priority	Children
SR-23	The glide duration shall be as close to 2 minutes as possible.	Competition Requirement	High	DC-09
SR-24	Glider shall be a fixed wing glider and glide duration shall be approximately 2 minutes.	Competition Requirement	High	CDH-08
SR-25	The glider shall use a time keeping device to maintain mission time. The time keeping device can use a small coin cell battery.	Time reference for every collected packet	High	EPS-05
SR-26	The container shall transmit telemetry once per second from the time being turned on until 2 seconds after releasing the glider.	Competition Requirement	High	FSW-09
SR-27 (Bonus)	A color camera be added to take picture of ground as often as possible	Competition Requirement	Medium	SS-09 SS-10 FSW-13

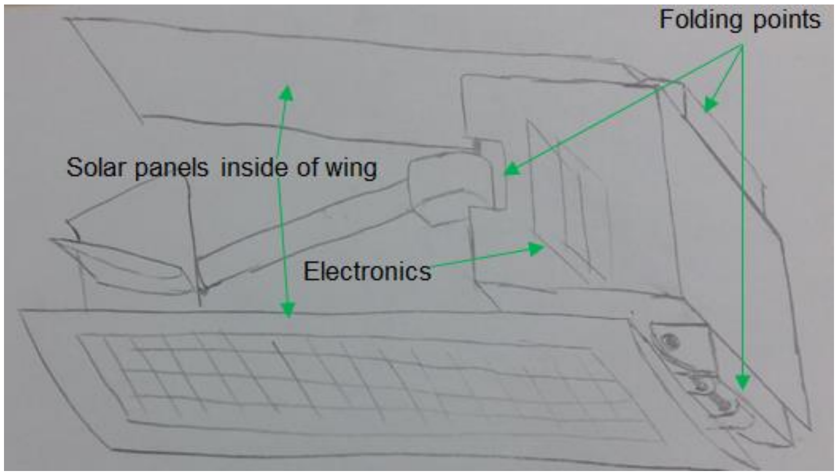
ANNUAL CANSAT COMPETITION

Configuration

Glider Shape

1

Stowed



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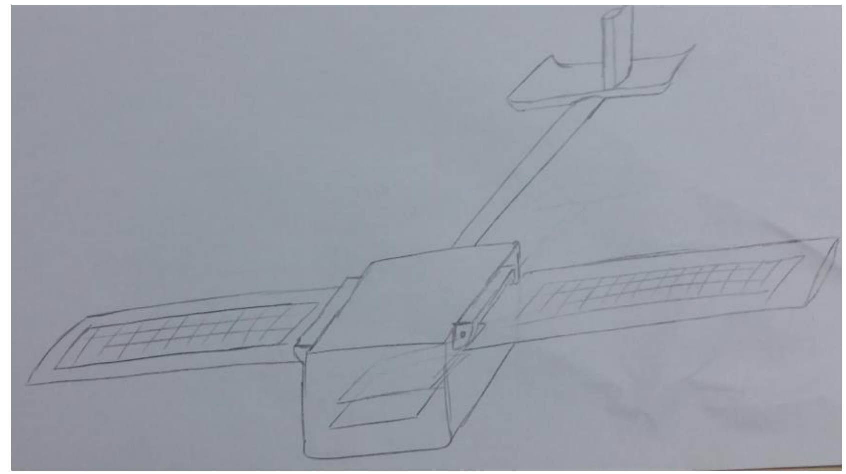

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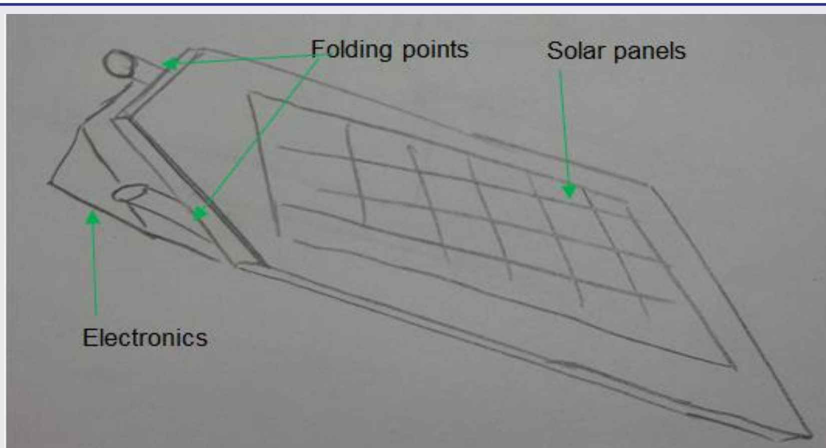
Stowed



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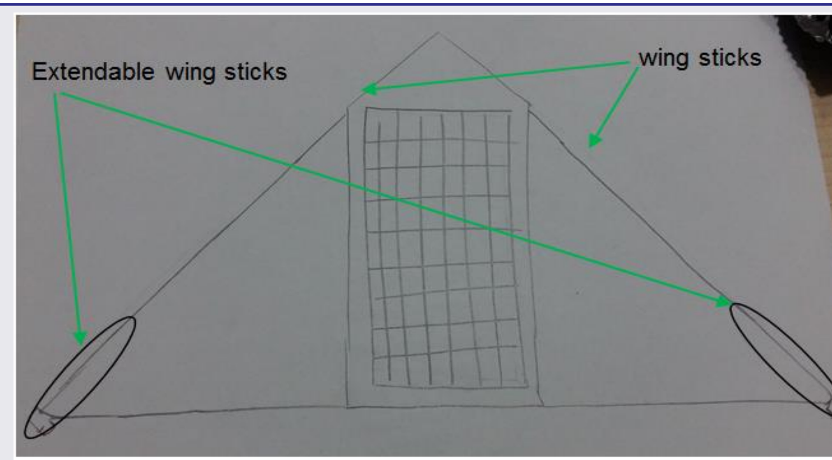
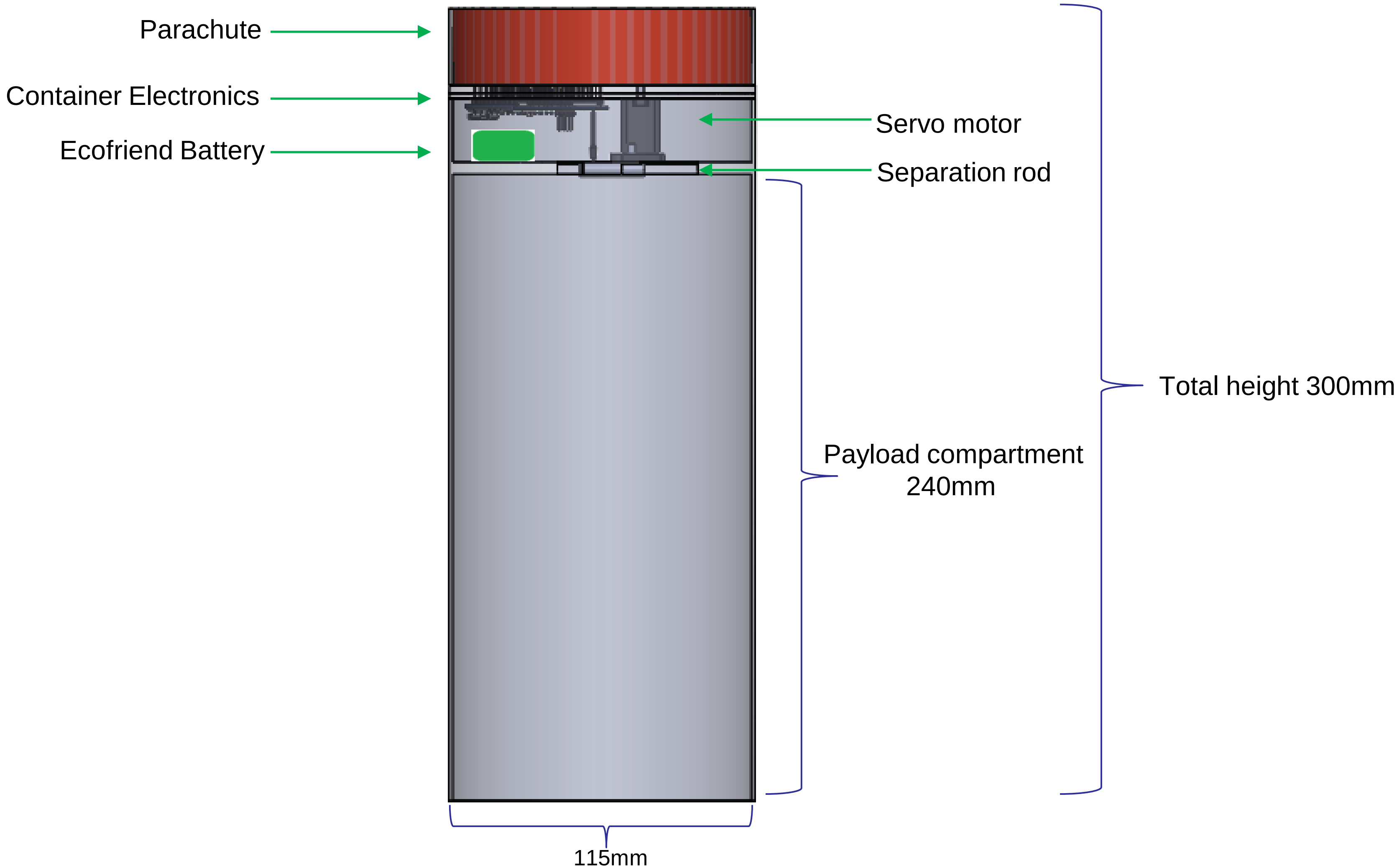


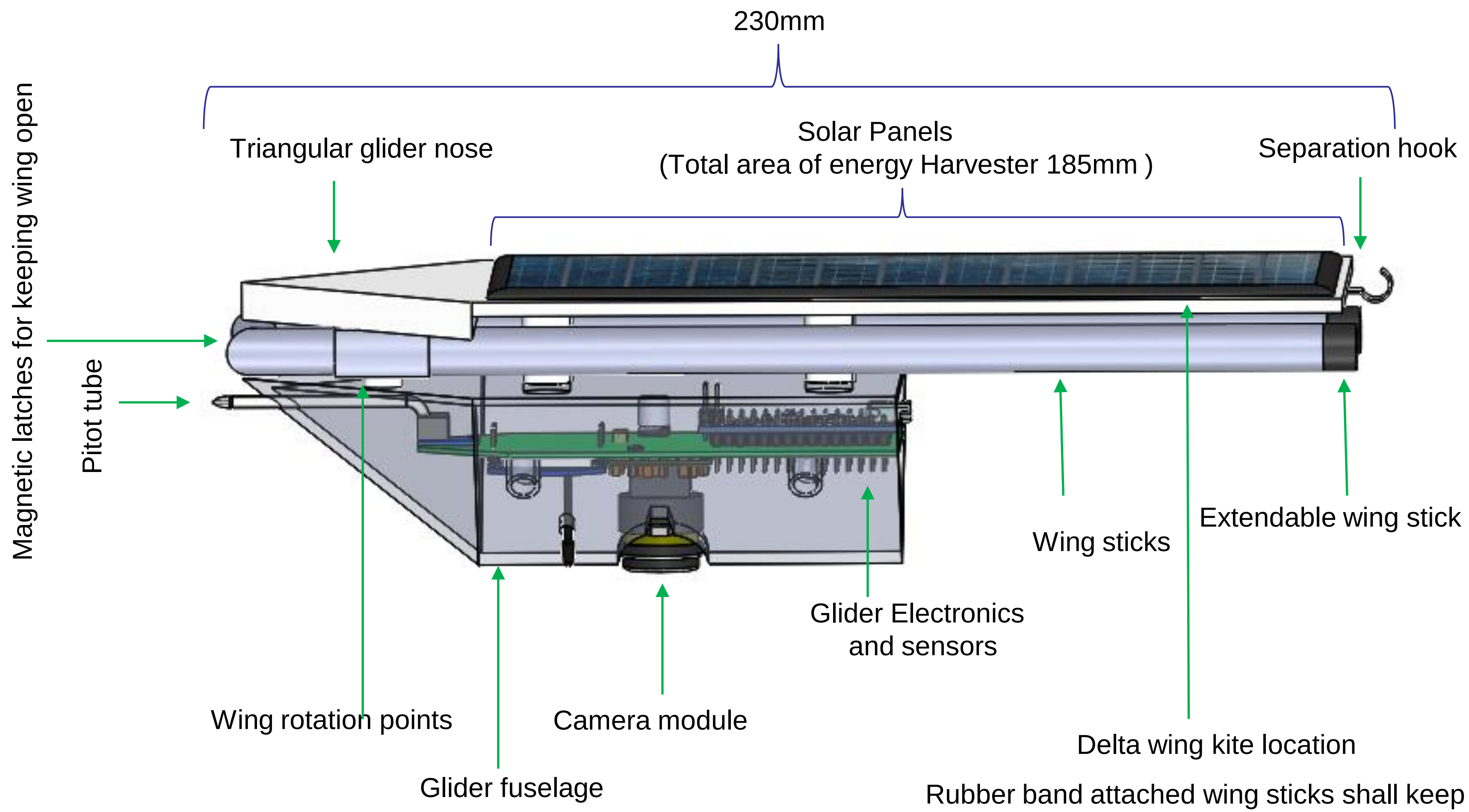
System Level CanSat Configuration Trade & Selection (2 of 2)

Discussion		Design	
		Conventional Glider Shape	Delta Wing Glider (**Selected**)
	Description	• Solar panels are located inside of aerodynamic wing. Electronics is located in the rectangular fuselage. Wing and stabilizers are folded down in ultra simple way. Spring apply pressure to folding points. This was the easiest design which nearly fulfils mission requirements among all. But we 3d printed the preliminary design. Then we saw the unstable flight. Details are discussed in mechanical subsystem part of presentation.	• Solar panels are located on surface of glider. Electronics is located in triangular fuselage. Delta wing sticks are folded and kite is kept between the sticks. Extendable sticks have impactful utility in system. One is forcing glider deployment and the other is providing bigger wing surface. In conclusion the design was constructed by our hands and tested with quadcopter. After several refinement we observed good flight.
	Pros	• Mechanically simple -Wing and stabilizers are folded in one axis • Smooth separation from container • Guarantee operative wing deployment	• Very large delta wing area for stable descent despite lightweight wing • Sufficient space for electronics • Extremely reliable panel implementation • Reduce potential threat of getting stuck in container
	Cons	• Heavier because of wing • Not enough space for electronics. Since the wing occupies most of the space inside container • Relatively bad aerodynamic structure. No stable flight	• A little more complex to design. • And difficult to fabricate. But we are dedicated to achieve this!

Physical Layout – Container



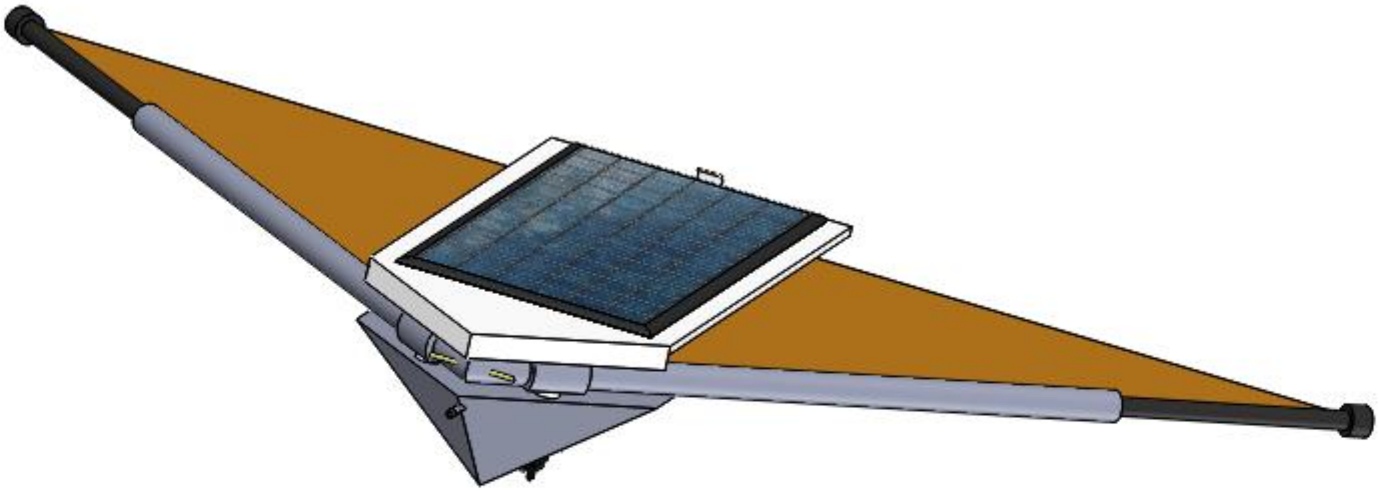
Physical Layout – Payload Stowed

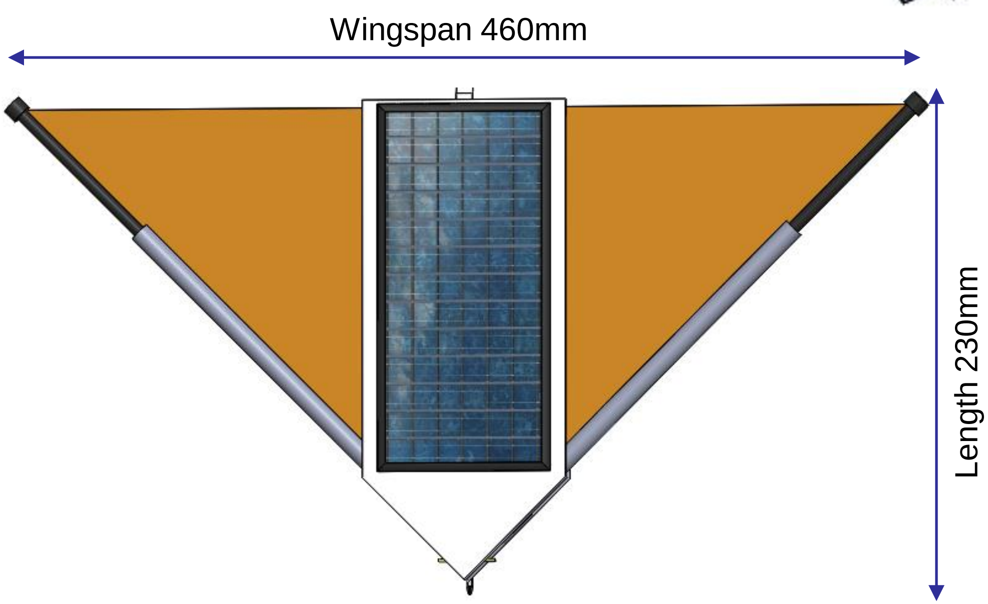


Rubber band attached wing sticks shall keep out glider in stowed configuration

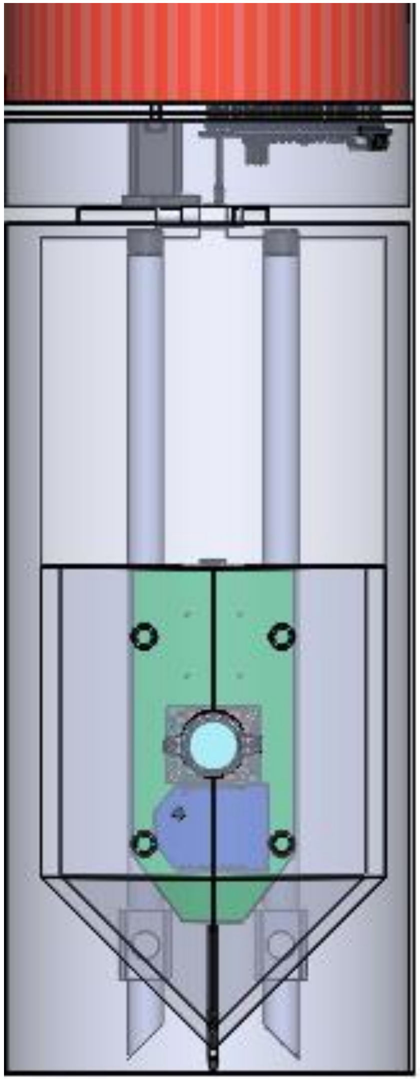
Rubber band attached to wing sticks shall force wing unfold.

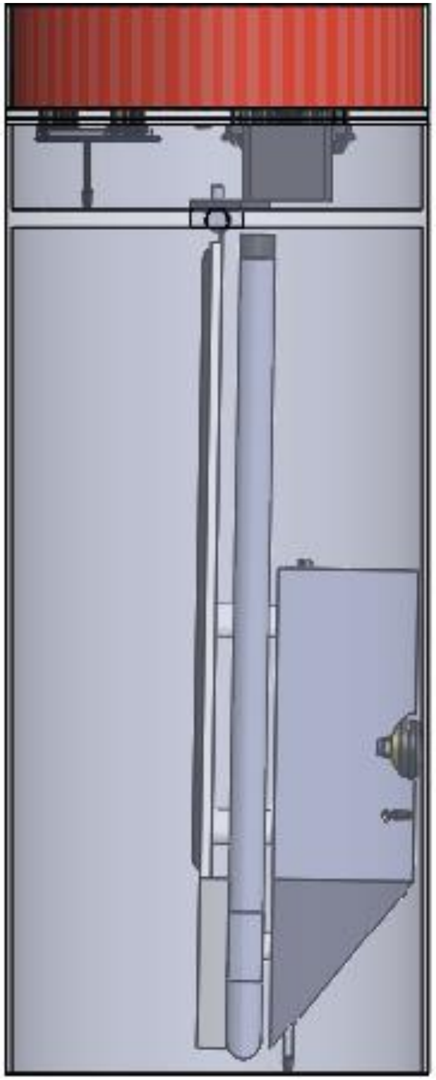
Physical Layout – Payload Deployed



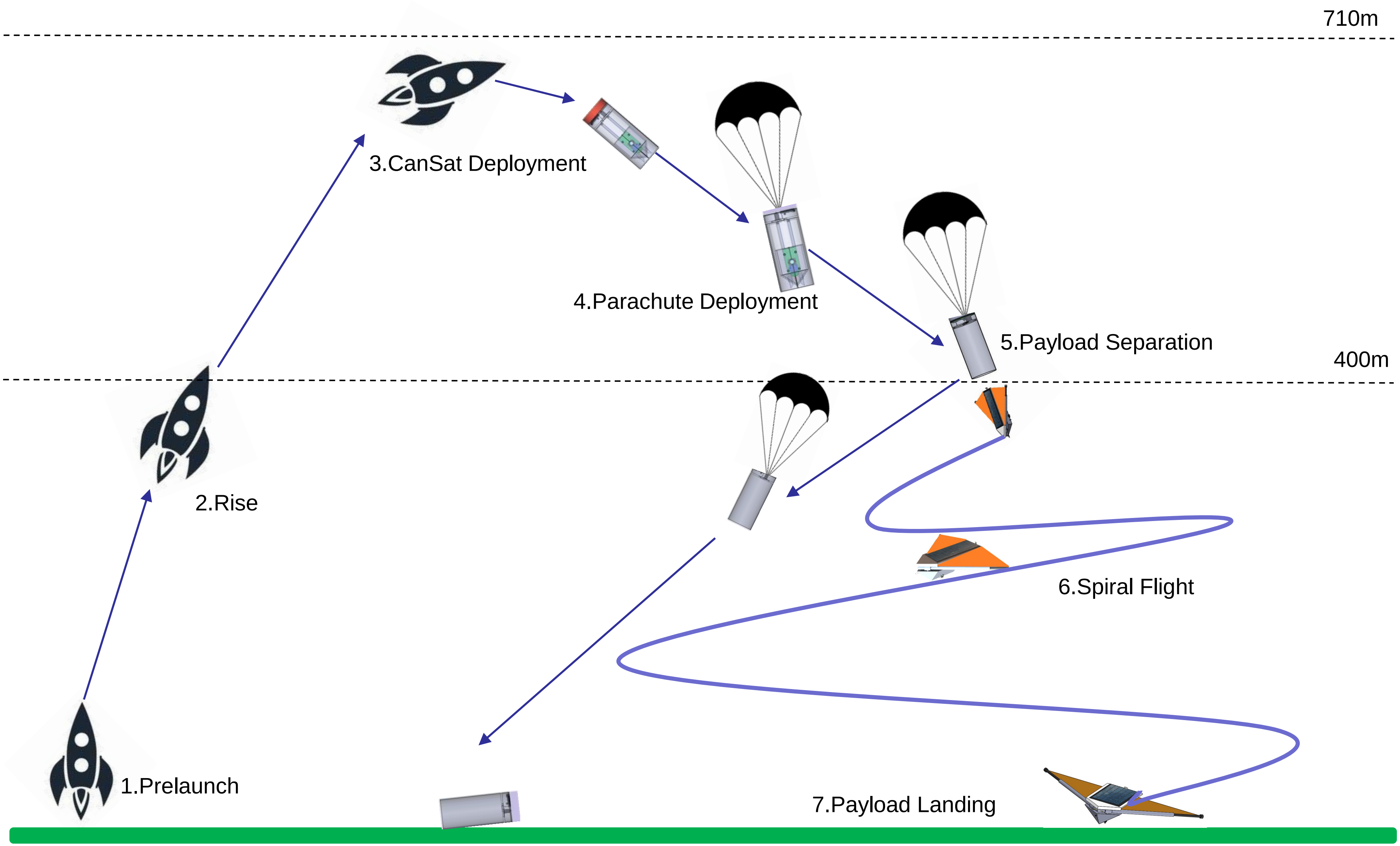


Physical Layout – Overall CanSat





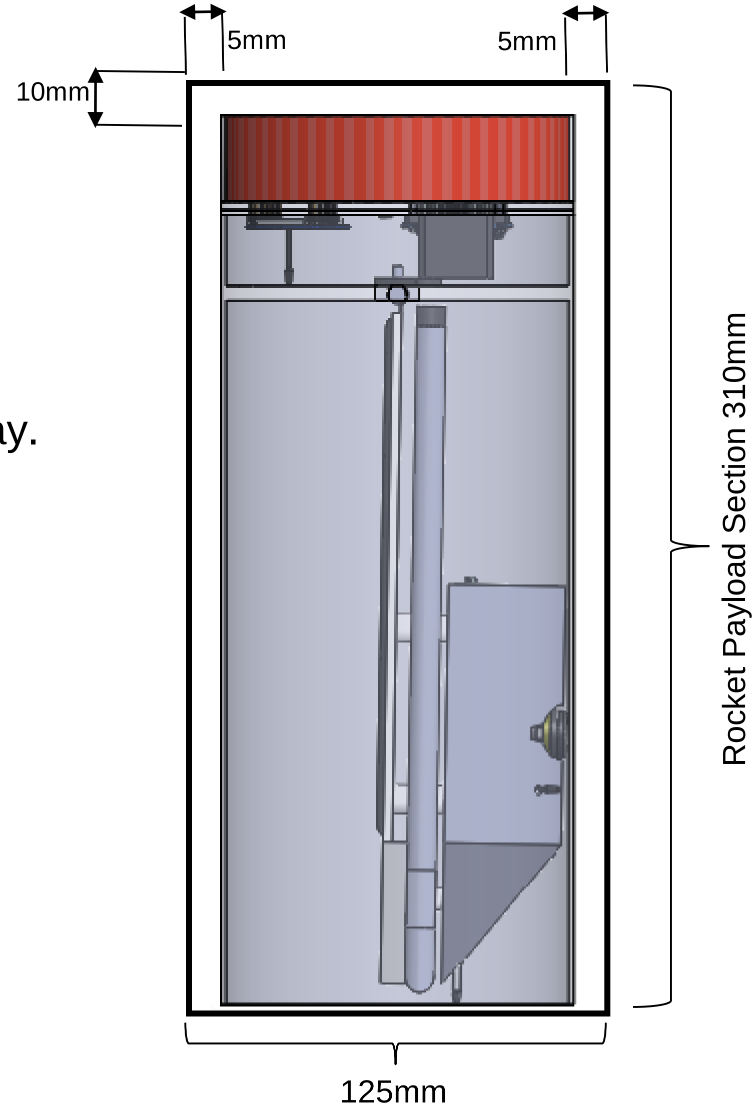
System Concept of Operations



Launch Vehicle Compatibility

- CanSat will be placed in RPS upside down.
- Launch vehicle compatibility directly. impact mission success. If it does not fit inside RPS, no point at all.
- Keeping in mind dimension requirements, CanSat was designed to fit in RPS with safe tolerances.
- We will test proper sizing by a RPS prior to launch day.

- **Rocket Payload Section:** 310mm x 125mm
- **Container:** 300mm x 115mm
- **Glider:** 300mm x 100mm



Sensor Subsystem Design

SELİM ÖZTÜRK

Sensor Subsystem Overview

Sensor Type	Model	Used For	Location
Magnetometer	MPU-9250	Calculating compass direction	Payload
Air Pressure	BMP280	Calculating air pressure	Payload & Container
Pitot Tube	Homemade pitot tube with two BMP280	Calculating air speed	Payload
Air Temperature	BMP280	Calculating air temperature	Payload & Container
Solar Power Voltage	Voltage Divider	Calculating solar power voltage	Payload
Battery Voltage	Voltage Divider	Calculating battery voltage	Container
Camera	LinkSprite LS-Y201	Taking images of the ground.	Payload

Sensor Subsystem Requirements

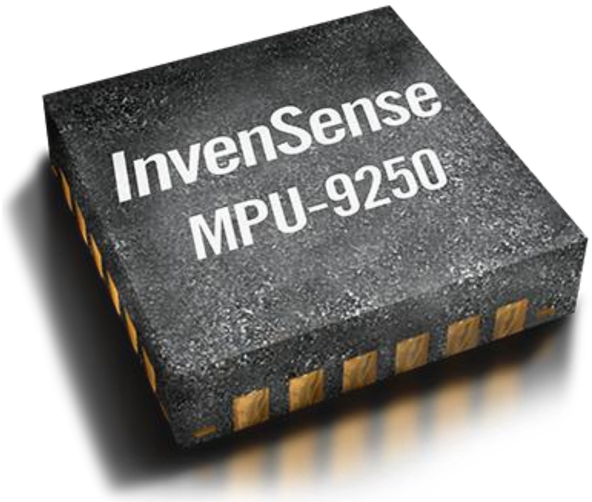
ID	Requirement	Rationale	Priority	Parents
SS-01	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Competition Requirements	High	SR-09
SS-02	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Competition Requirements	High	None
SS-03	Operation voltage 3.3V or lower	Payload Requires Power	Medium	None
SS-04	Measurement of barometric altitude	Required For Telemetry	High	SR-11
SS-05	Measurement of air temperature	Required For Telemetry	High	SR-11
SS-06	Measurement of battery voltage	Competition Requirement	High	SR-11
SS-07	Measurement speed of air	Competition Requirement	High	SR-11
SS-08	Measurement of compass direction	Competition Requirement	High	SR-11
SS-09	Camera is needed for imaging	Competition Requirement	High	SR-27
SS-10	The resolution of the camera shall be a minimum of 640x480 pixels in color.	Competition Requirement	High	SR-27

Magnetometer Trade & Selection

Sensor	Resolution	Size (mm)	Interfaces	Supply Voltage (V)	Full-Scale Range (G)	Sample Rate (Hz)	Cost ($)
HMC5983	12 bit	3 x 3 x 0.9	I²C & SPI	2.16 - 3.6	± 8	160	4
MPU-9250	14 bit	3 x 3 x 1	I²C & SPI	2.4 - 3.6	± 48	400k	14

MPU-9250 was chosen;

- ✓ High range and resolution
- ✓ Very high sample rate
- ✓ A 9-axis MotionTracking device
- ✓ 3-axis gyroscope, 3-axis accelerometer, 3-axis magnetometer



Air Pressure Sensor Trade & Selection

Sensor	Resolution (hPa)	Size (mm)	Interfaces	Supply Voltage (V)	Range (hPa)	Sample Rate (Hz)	Cost ($)
BMP180	0.03	3.6 x 3.8 x 0.93	I²C	1.8 - 3.6	300 - 1100	128	2.5
BMP280	0.01	2 x 2.5 x 0.95	I²C & SPI	1.71 - 3.6	300 - 1150	157	6
LPS25H	0.2	2.5 x 2.5 x 1	I²C & SPI	1.7 - 3.6	260 - 1260	25	3

BMP280 was chosen as Payload & Container air pressure sensor;

- ✓ High resolution
- ✓ High sample rate
- ✓ I²C & SPI interfaces
- ✓ Very low current draw – 2.74 μA

Payload Pitot Tube Trade & Selection

Sensor	Resolution (hPa)	Module Size (mm)	Interfaces	Supply Voltage (V)	Range (hPa)	Sample Rate (Hz)	Cost ($)
Homemade pitot tube with two BMP280	0.01	20 x 15 x 5	I²C & SPI	1.71 - 3.6	300 - 1150	157	12
Px4 Pitot Tube	0,0084	18 x 20 x 10	I²C	2.7 – 5.5	68 - 10342	-	55

Homemade pitot tube with two BMP280 was chosen;

- ✓ Lightweight
- ✓ Already have 1 Bosch BMP280
- ✓ Custom pitot tube easier to integrate into glider.

The speed will be calculated by the Bernoulli equation;

Stagnation pressure ($\boldsymbol{p_t}$) = static pressure ($\boldsymbol{p_s}$) + dynamic pressure ($\boldsymbol{\rho V^2/2}$)

$$p_t = p_s + \left(\frac{\rho V^2}{2}\right) \qquad V = \sqrt{\frac{2(p_t - p_s)}{\rho}}$$

Where $\boldsymbol{\rho}$ *is air density in* $\boldsymbol{kg/m^3}$

Air Temperature Sensor Trade & Selection

Sensor	Accuracy (°C)	Size (mm)	Interfaces	Supply Voltage (V)	Range (°C)	Cost ($)
BMP280	± 1	2 x 2.5 x 0.95	I²C & SPI	1.71 - 3.6	-40 to +85	6
LM35	± 0.5	4.30 × 4.30	Analog	-0.2 - 35	-55 to 150	1.8
DS18B20	± 0.5	4.30 × 4.30	One Wire	3 - 5.5	-55 to 125	1.5

BMP280 was chosen as Payload & Container air temperature sensor;

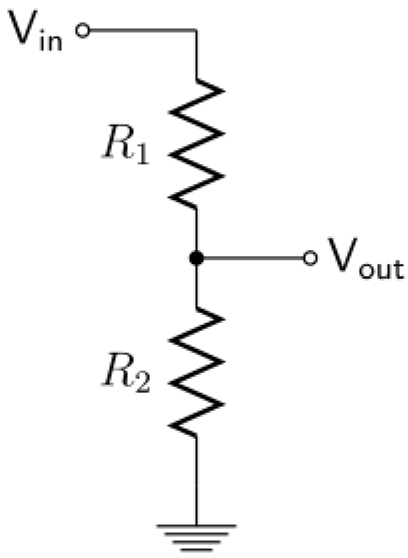
- ✓ Pressure sensor bundle allows for better system integration
- ✓ High accuracy and update rate meeting requirements
- ✓ I²C & SPI interfaces
- ✓ Acceptable range and accuracy
- ✓ Very low current draw – 2.7 µA

Voltage Sensor Trade & Selection

Sensor	Accuracy (mV)	Size (mm)	Weight (gr)	Supply Voltage (V)	Range (V)	Cost ($)
Phidgets Precision	73	30 x 30	5	5	-30 to +30	15
Voltage Divider	4.88	15 x 3	0.2	~	~	0.01

Voltage Divider was chosen as Payload Solar Power & Container Battery voltage sensor;

- ✓ Voltage Divider to ADC on microcontroller
- ✓ Low cost
- ✓ Easy communication



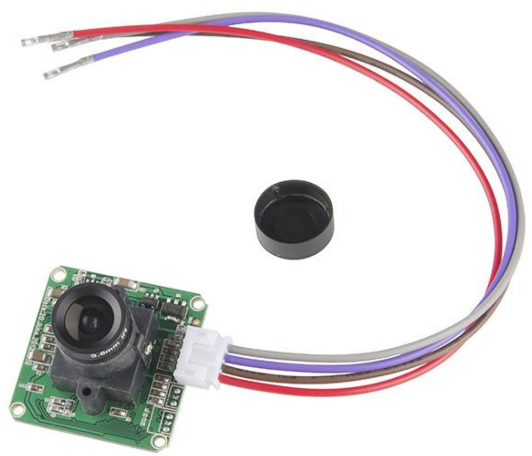
$$V_{out} = \frac{R_2}{R_1 + R_2} \cdot V_{in}$$

Bonus Camera Trade & Selection

Sensor	Resolution	Size (mm)	Interfaces	Supply Voltage (V)	Weight (gr)	Cost ($)
LinkSprite LS-Y201	640 x 480	32 x 32	UART	3.3 - 5	20	45
Sparkfun CMOS Camera	728 x 488	32 x 32	RCA analog output	6 - 20	26	32
Serial TTL Camera VC0706 Processor	640 x 480	32 x 32	UART	5	24	40

LinkSprite LS-Y201 was chosen;

- ✓ Acceptable resolution
- ✓ UART interface
- ✓ Support capture JPEG from serial port
- ✓ 3.3V power supply
- ✓ Low current consumption 100mA



Descent Control Design

EMRULLAH MAHMURAT

Descent Control Overview

Descent Control System is consisting of parachute for container and delta wing for glider

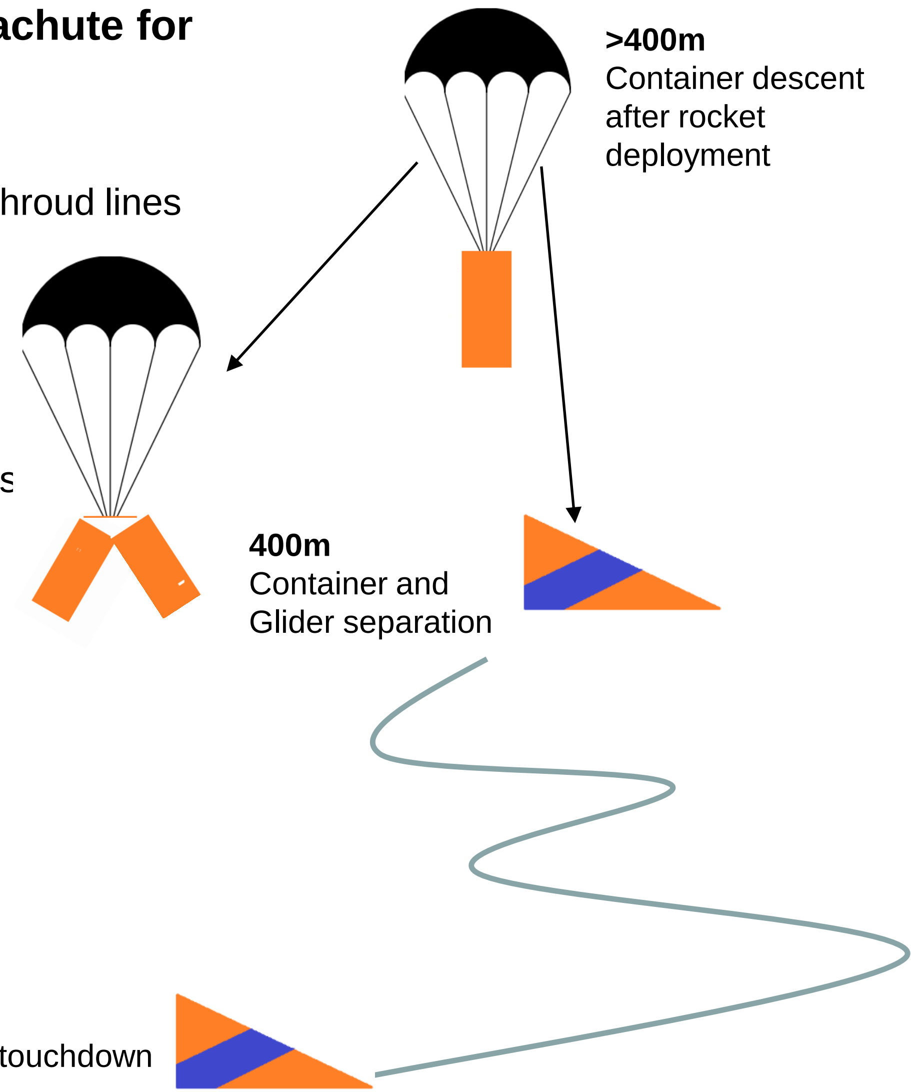
- Parachute will be composed of ripstop nylon fabric, shroud lines

and swivel.

- Delta wing will be made from 3d printed

wing sticks, ripstop nylon.

- Since payload shall be powered by solar panels thus we designed it as it gives enough area for panels
- Biggest area we can get is center line of container
- And wing sticks can be folded down of panel sheet
- And fabric can be folded between the sticks
- A trigger will activate wing sticks right after container separation
- Then neodymium magnets shall latch the sticks
- The trigger can be rubber band/ string.



Descent Control Requirements (1 of 2)

ID	Requirement	Rationale	Priority	Parents
DC-01	Total mass of 500+/-10gr	Competition Requirement	High	SR-01
DC-02	No part of the glider may extend beyond the container.	Competition Requirement	High	SR-02
DC-03	Container shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length including the container passive descent control system with safe tolerances	Competition Requirement	High	SR-03
DC-04	The container shall use a passive descent control system. It cannot free fall. Parachute is highly recommended	Competition Requirement	High	SR-04
DC-05	The CanSat shall deploy from the rocket payload section.	Competition Requirement	High	SR-05

Descent Control Requirements (2 of 2)

ID	Requirement	Rationale	Priority	Parents
DC-06	The glider shall not be remotely steered or autonomously steered. It must be fixed to glide in a preset circular pattern of no greater than 1000 meters diameter. No active control surfaces are allowed.	Competition requirement CanSat should be easy to find	Medium	None
DC-07	All descent control device attachment components shall survive 30 Gs of shock.	CanSat must be enough durable to rocket launch and separation	High	SR-08
DC-08	All descent control devices shall survive 30 Gs of shock.	All descent control devices must be enough durable to rocket launch and separation.	High	SR-08
DC-09	The glide duration shall be as close to 2 minutes as possible.	Competition Requirement	High	SR-23
DC-10	Glider shall be a fixed wing glider. No parachutes, no parasails, no parafoils, no auto-gyro, no propellers. Hang glider design where the electronics section has a hard attachment point is allowed.	Competition Requirement	High	None

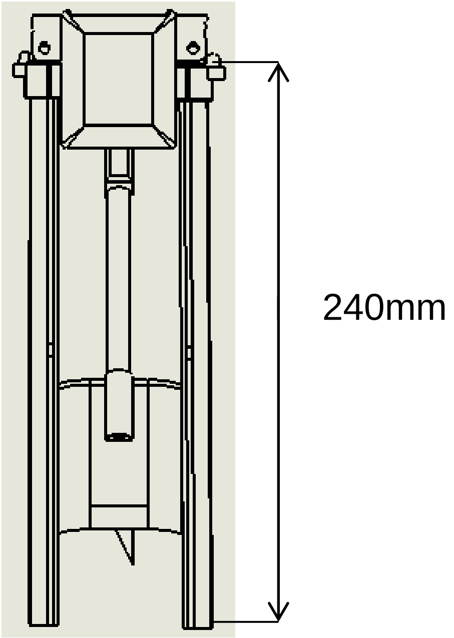
Container Descent Control Strategy Selection and Trade

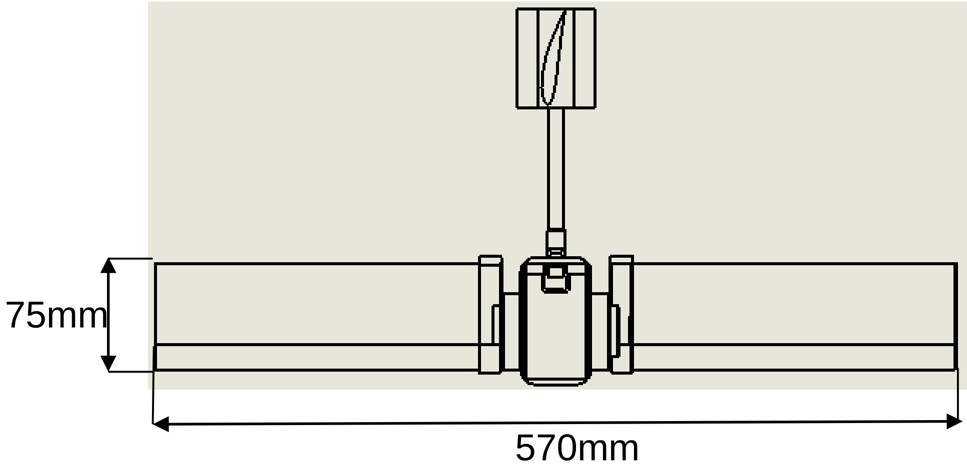
DCS Method	Advantages	Disadvantages
Parachute	Provide stable descent Easy to fabricate Lightweight and easy folding	Drifting
Parafoil	Can control landing container	Difficult to manufacture

- **Container Descent Control System: Parachute with spill hole**
  - Can be easily placed in container
  - Orange color selected since its visibility in daylight
  - Extra care will be taken to DCS connections for shock force survival of parachute
  - Swivel for preventing parachute lines from twisting will be used
  - Parachute will be designed as modular as it can be tested before flight
  - Spill hole will be included for reducing swaying

Payload Descent Control Strategy Selection and Trade (1 of 5)

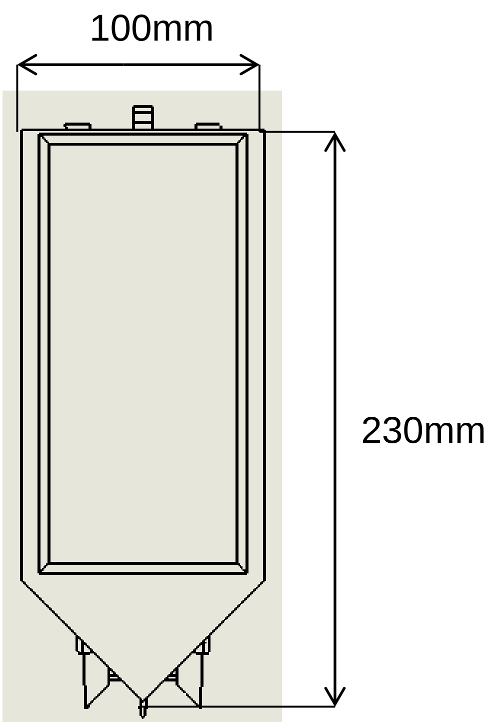
DCS Method	Advantages	Disadvantages
One axis rotated Dihedral wing	Stable flight Safe folding mechanism	Heavy Lack of space inside payload for electronics

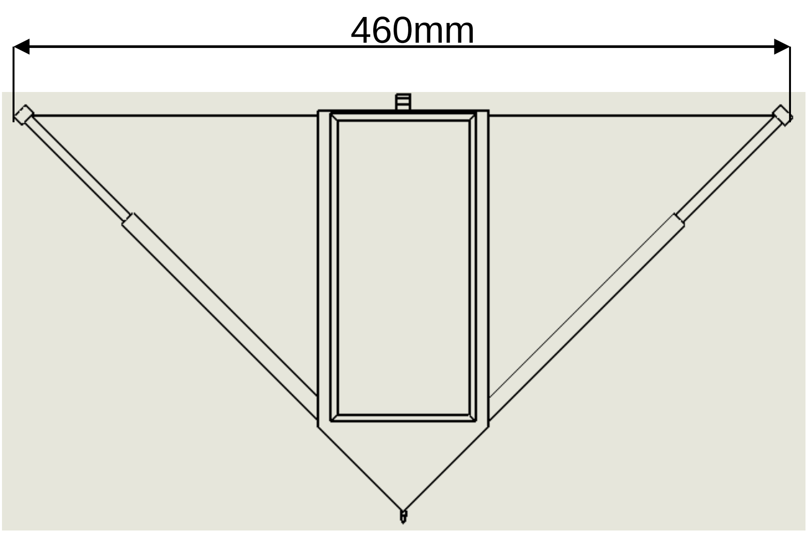




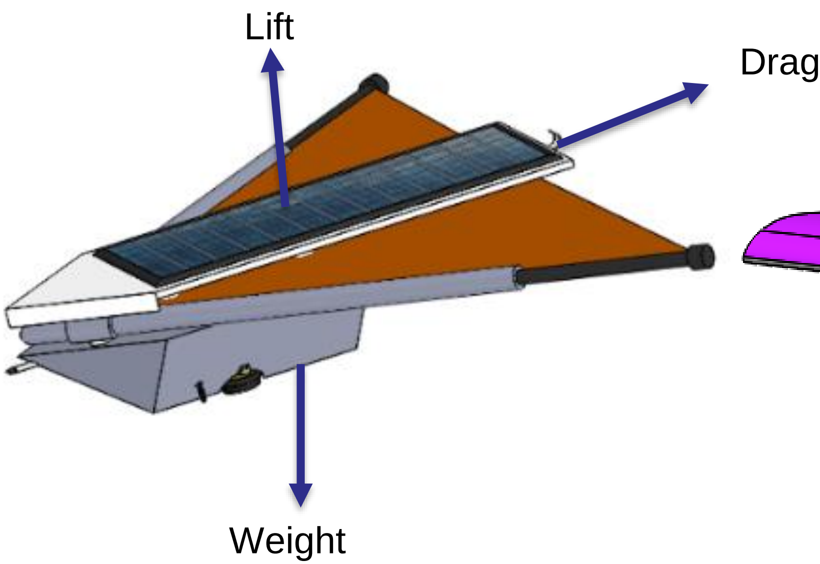
Payload Descent Control Strategy Selection and Trade (2 of 5)

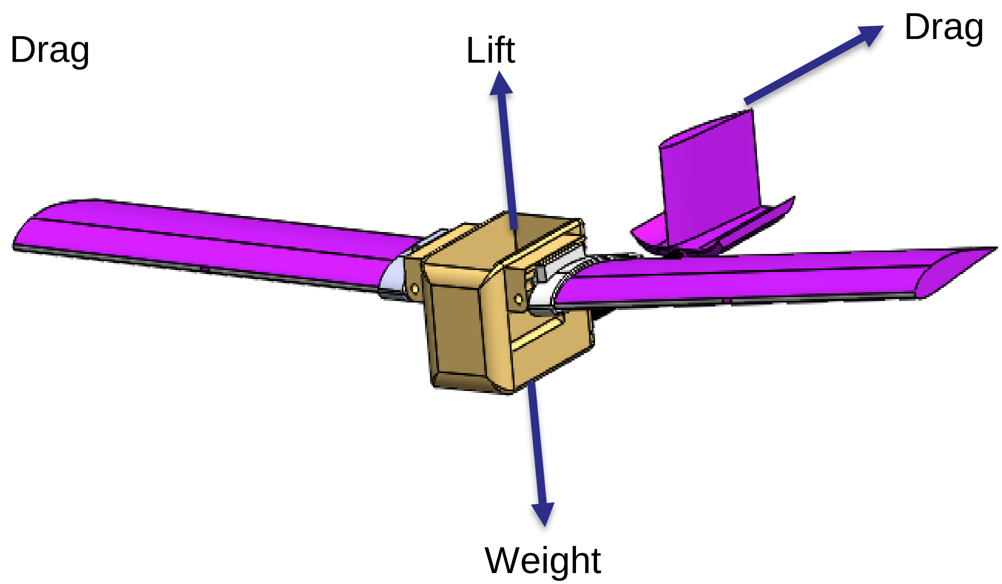
DCS Method	Advantages	Disadvantages
Delta wing	Very simple design Lightweight Do not occupy much space inside payload Enough space for solar panels	Drifting but can be refined with vertical stabilizer





Payload Descent Control Strategy Selection and Trade (3 of 5)





Glide ratio : 2.96

Glide angle : 71.33°

Glide ratio : 2.48

Glide angle : 68.03°

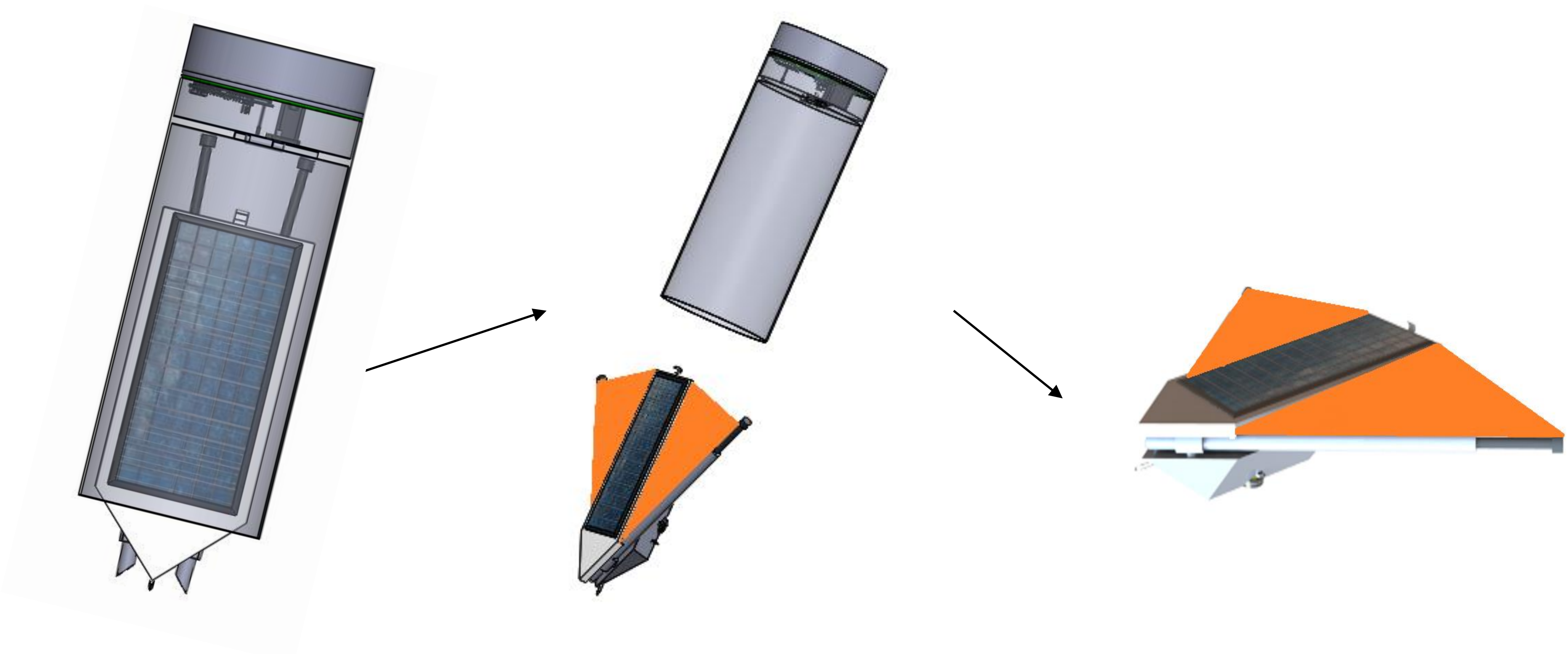
- Weight - gravity acts in the downwards direction
- Lift - acts perpendicularly to the vector representing airspeed
- Drag - acts parallel to the vector representing the airspeed

Glide ratio is the forward speed divided by sink speed :

$$\frac{L}{D} = \frac{\Delta s}{\Delta h} = \frac{\vartheta_{forward}}{\vartheta_{down}}$$

- **Payload Descent Control System: Delta wing**
  - Fit in container
  - Allow more space for electronic
  - Allow enough space for solar panels
  - Reduce descent rate satisfactorily
  - İn addition, we calculated glide ratio of each design and finally decided delta wing strategy because this one's glide ratio is higer than dihedral's glide ratio
  - And higer glide ratio will ensure stable flight, also considering this design better fits to solar panels placement.
  - Spiral flight will be provided by turning vertical stabilizer relatively right. (in the picture-right, vertical stabilizer is broken as result of tests).

Container and Glider Separation Procedure



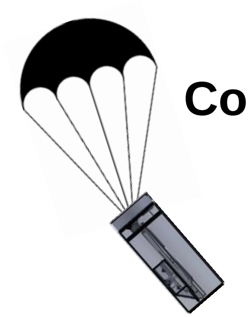
Pre deployed Deployed Gliding

Descent Rate of Container

Descent rates calculated using terminal velocity equation

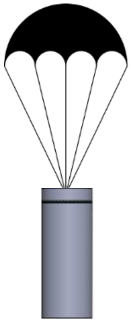
$$v = sqrt(\frac{2W}{C_d r A})$$

- C_d : Drag coefficient of Parachute
- C_d : 1.75(typical)
- r : Air density
- r :1.225 $^{kg}/_{m^3}$
- A : Parachute area



Container + Payload velocity;

$8{,}21\, m/s$



Container velocity;

$4{,}68\, m/s$

- Area is calculated $S = \frac{\pi d^2}{4}$
- Mass of CanSat(Container + Glider) is 500g

- Area is calculated $S = \frac{\pi d^2}{4}$
- Mass of container is 200g

Descent Rate Estimates (2 of 3)

Descent Rate of Glider

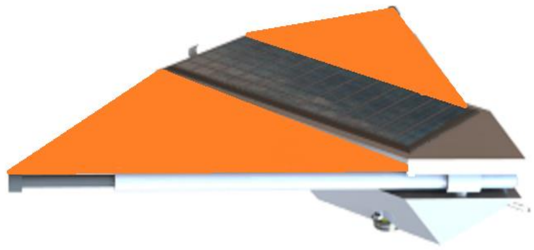
Descent rate estimated using the following formula;

$$v = sqrt(\frac{2W}{C_d r A})$$

- w : Mass of glider (approximately 300g)
- C_d : Drag coefficient (0.8704 estimated)
- r : Air density
- A : Frontal area of glider

Estimated horizontal velocity : 9.8 m/s

Estimated vertical velocity : 3.33 m/s



Payload velocity;

$10{,}35\ m/s$

Descent Rate Estimates (3 of 3)

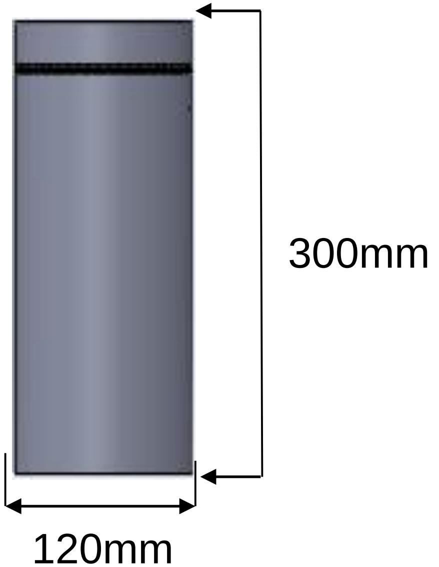
Descent Rate Estimation

PART	MASS(g)	ESTIMATED VELOCİTY(m/s)
CONTAINER + PAYLOAD	500	8.21
ONLY CONTAINER	200	4.68
PAYLOAD	300	10,35

Mechanical Subsystem Design

SELAHATTİN KÖK

Mechanical Subsystem Overview

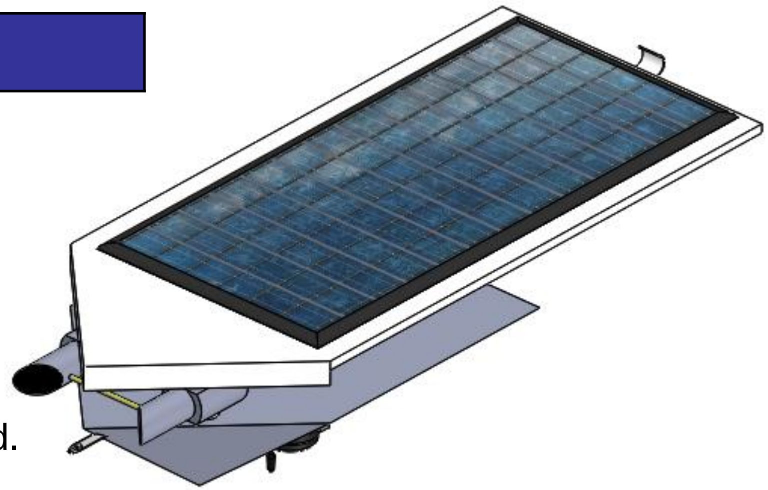


Container

- Container is made from fiberglass because of **strength** and **transparency**
- Parachute is allocated in top of the container
- Color of container is **orange** because of high visibility
- Battery and electronic system are allocated under the parachute because of safe location and fixed structure in the container
- Separation mechanism is shift-rod which is actuated by servo motor

Glider

- Glider structure and wing sticks are 3D printed from **ABS**
- Strained rubber band unfolds the wing sticks
- Delta **wing cord** is **230mm** and **wing span** is **430**mm
- Rotation parts are made from rulmans
- Wing sticks are rotated around the rulmans
- Wing kite is **ripstop nylon**
- PCB is bolted to fuselage
- Wing sticks are kept deployed with magnets and rubber band. Magnets/latches are very strong to keep them to together



Mechanical Sub-System Requirements (1 of 3)

ID	Requirement	Rationale	Priority	Parents
MS-01	Total mass of 500+/-10gr	Competition Requirement	High	SR-01
MS-02	No part of the glider may extend beyond the container.	Competition Requirement	High	SR-02
MS-03	Container shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length including the container passive descent control system with safe tolerances	Competition Requirement	High	SR-03
MS-04	The container shall use a passive descent control system. It cannot free fall. parachute is highly recommended	XBee modules are reliable RF modules as well as easy to use	Medium	SR-04
MS-05	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section.	Smooth Deployment	High	SR-05
MS-06	The container shall be a florescent color, pink or orange	High Visibility	Medium	SR-04
MS-07	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Competition Requirement	Medium	SR-05

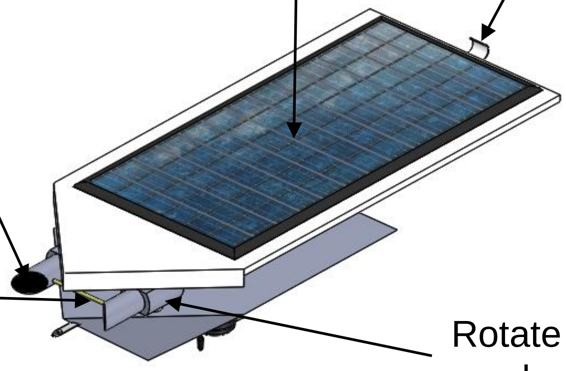
Mechanical Sub-System Requirements (2 of 3)

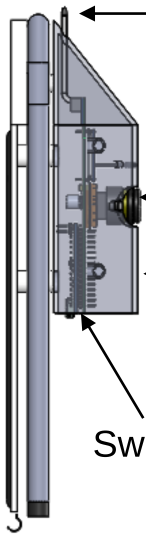
ID	Requirement	Rationale	Priority	Parents
MS-08	The rocket airframe shall not be used as part of the CanSat operations.	Competition Requirement	Medium	SR-
MS-09	The CanSat (container and glider) shall deploy from the rocket payload section.	Competition Requirement	High	SR-05
MS-10	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Prevention from environmental affections	Medium	SR-09
MS-11	All structures shall be built to survive 15 Gs acceleration.	To survive during rocket deployment	High	SR-08
MS-12	All structures shall be built to survive 30 Gs of shock.	To survive during rocket launch	High	SR-08
MS-13	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	To survive during rocket deployment and launch	High	None

Mechanical Sub-System Requirements (3 of 3)

ID	Requirement	Rationale	Priority	Parents
MS-14	All mechanisms shall be capable of maintaining their configuration or states under all forces	All mechanisms must be prevented from environmental impact.	High	None
MS-15	Mechanisms shall not use pyrotechnics or chemicals	Chemicals or pyrotechnics may contanct with anything and can damage people or environment	High	SR-10
MS-16	Mechanisms that use heat (e.g., nichrome wire) shall not be exposed to the outside environment to reduce potential risk of setting vegetation on fire.	No heating mechanisms shall be used	Medium	SR-10
MS-17	Both the container and glider shall be labeled with team contact information including email address.	Loss Prevention	Medium	None
MS-18	The container shall contain electronics and mechanisms to release the glider at the required altitude.	Competition Requirement	High	SR-22

Payload Mechanical Layout of Components Trade & Selection (1 of 2)





- All electronic components and PCBs are located inside the fuselage. PCB and all electronics must be stable (not moving) and protected.
- Camera location is center of gravity as possible because its weight
- Pitot tube is located outside of fuselage due to it measures air speed correctly.
- Container and glider attach together via hinge. Hinge will be made from aluminum because it must survive
- during the launch.
- Rubber band is located front of wing sticks. Rubber band must be strong because during the deployment it
- can approach the wing sticks.
- Rotate mechanism is located between wing sticks and fuselage. Wing sticks rotate 45 degree around of
- mechanism.

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

Material	Strength [kN*m/kg]	Advantage	Disadvantage
Carbon fiber	2800	High strength and less weight	Expensive
Nylon	55	Less weight and easy of manufacturing	Less durable
3D – ABS	70	Lower density and cheap	Less strength than Carbon fiber

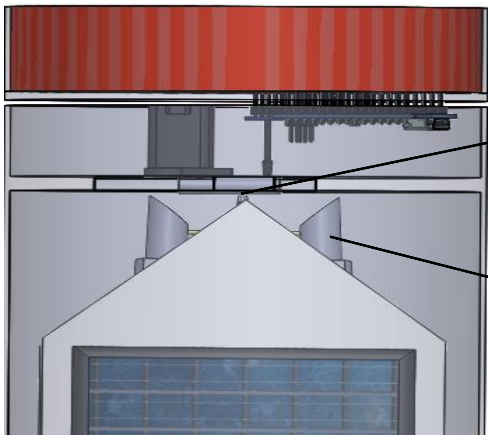
Glider fuselage and wing sticks will be 3D printed from ABS in order to its higher strength than nylon and its less expensive than Carbon fiber.

Material	Cost	Advantage	Disadvantage
Parachute fabric	2-3$ per meter	Can be easily found	Weak
Ripstop nylon	1.27-1.37$ per meter	Lightweight, Favorable strength to weight ratio	Not available in Turkey

Delta wing kite will be ripstop nylon because of its versatility, tensile strength and lightweight characteristic.

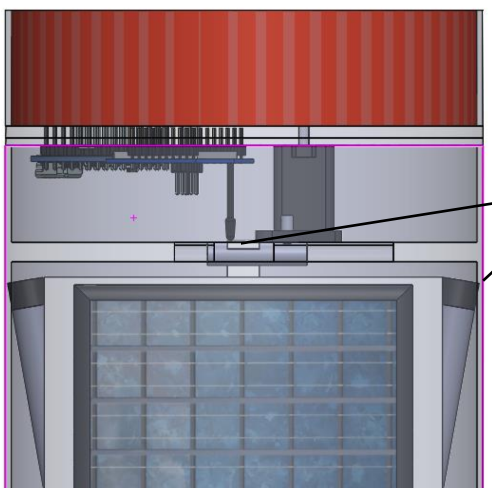
Payload Pre Deployment Configuration Trade & Selection

We have two options for pre deployment configuration. The glider will be placed upside down in the container or vice versa. We have decided that the glider will be placed upside down so extensible wing sticks will facilitate separating the glider.



Hinge and attachment point

Extensible wing sticks



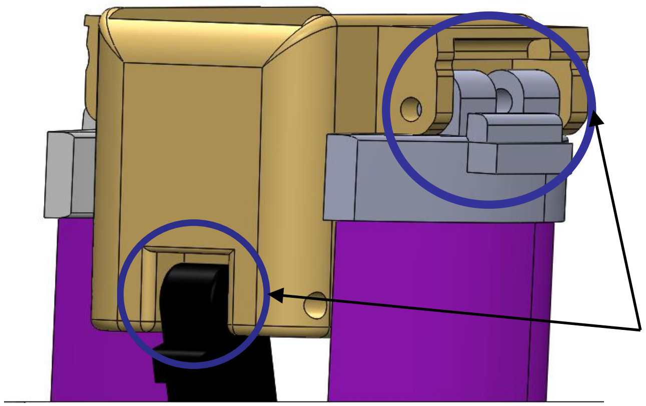
Hinge and pressure point

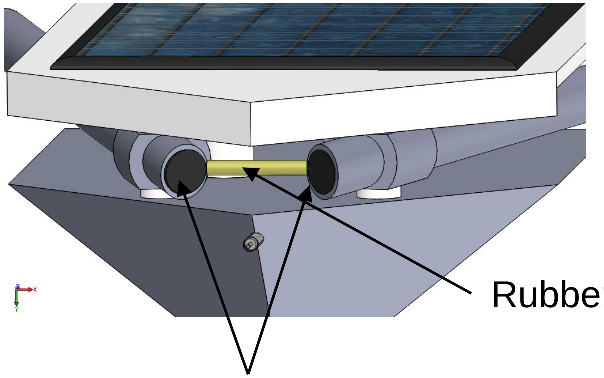
- The glider will be attached to the container by a **hinge**
- There is a **rubber** edge of wing sticks that is why it wants to deploy the mechanism thanks to wing sticks apply great pressure to the container bulk
- Friction at pressure point facilitate keeping the payload stowed configuration
- The friction provides fixed the glider in the container during launch
- This hinge will made from metal, because this hinge shall be resist high pressure
- Deployment system will be in the container
- Separation mechanism will be **triggered** when the altitude drops below **400 meters**

Payload Deployment Configuration Trade & Selection (1 of 3)

Mechanism Type	Advantage	Disadvantage
Three fold design	Basic mechanism	Extra tail mechanism
Delta wing design	Only use tire and magnet ,one rotation axis	Angular rotation

- Mechanism type will be delta wing design because there is only one rotation axis and simple design.
- Spring on tail flex because of high angle and this problem cause glider will not be full deployed.



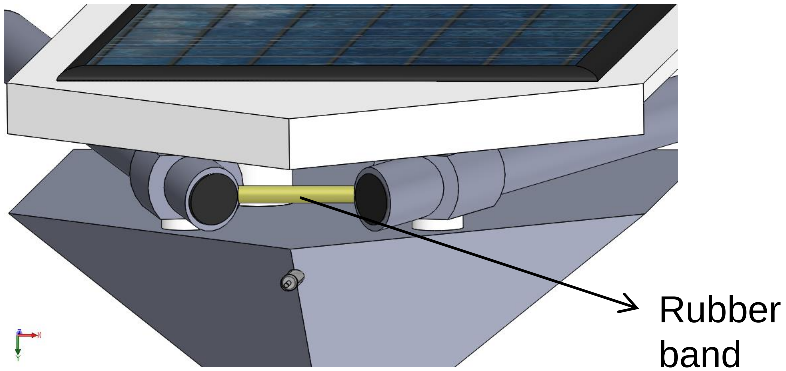


Payload Deployment Configuration Trade & Selection (2 of 3)

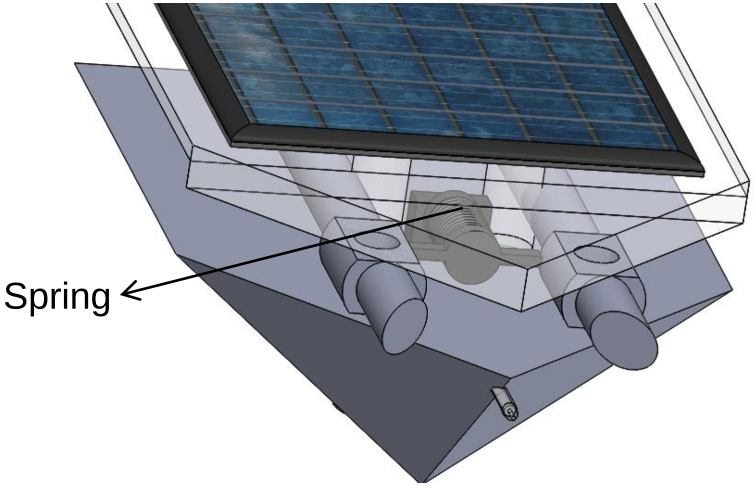
And we have two options for delta wing deployment configuration:

- Spring system
- Rubber band system

Rubber band system



Spring system

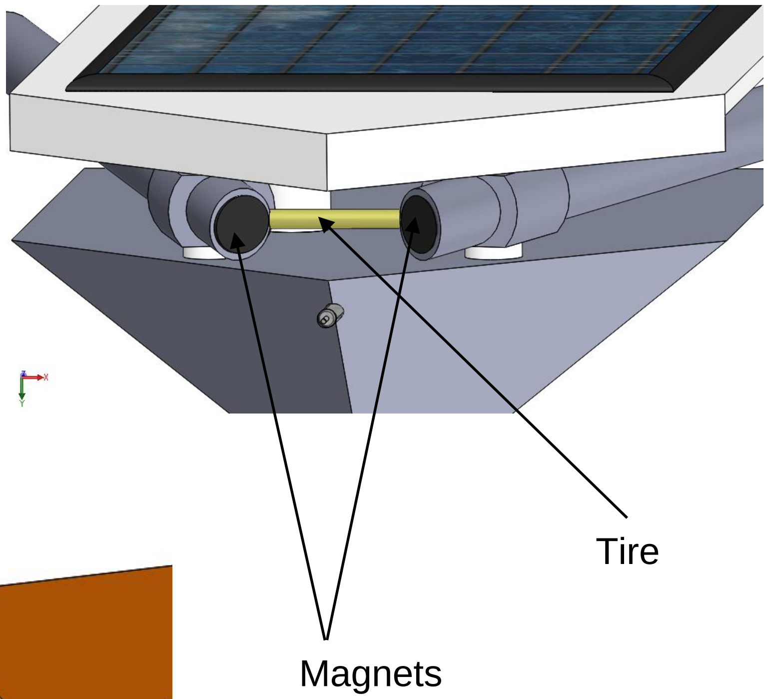


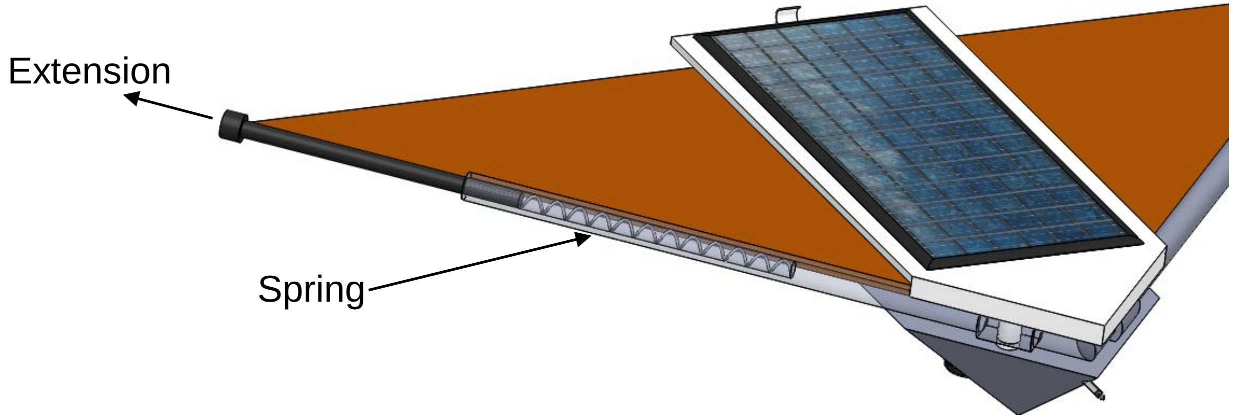
Rubber band deployment is selected because spring system is more complicated and the spring is strong, that is why wing sticks will press highly inside of the container so payload may not deploy and payload may squeeze into the container. However rubber band is applying less force sowing sticks will press slightly comparing to spring system for this reason payload will deploy smoothly.

Payload Deployment Configuration Trade & Selection (3 of 3)

DEPLOYMENT CONFIGURATION

- Wing sticks deployed thanks to traction force of tire when glider release from container
- Magnets will help to full deployment when edge of wing sticks approach
- Magnets will fix wing sticks.
- When the glider deploy from container wing sticks will stretch.
- Wing nylon attach to wing sticks and fuselage
- Wing nylon will open as wing sticks deployment





Container Mechanical Layout of Components Trade & Selection (1 of 3)

We have two options for container design:

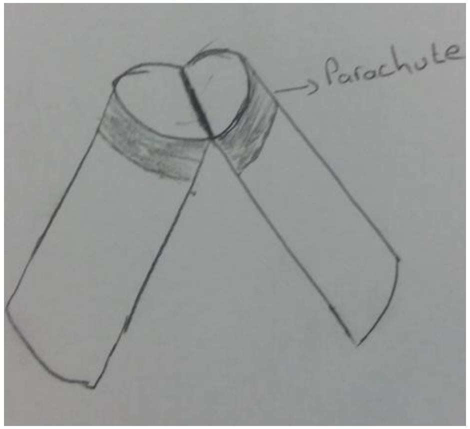
- Separable design
- Fixed design

Separable design:

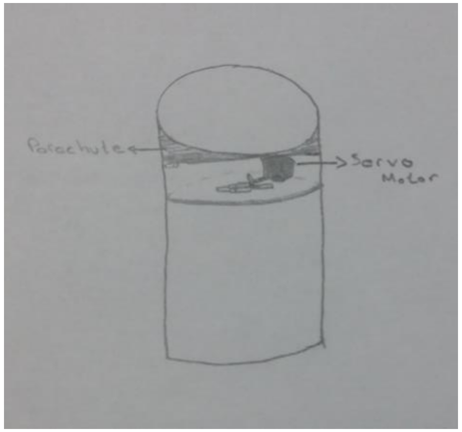
- The separable design container can rotate around a middle axis. There are rope and spring, which keep together two parts of the container. The rope melted by resistance in the container when altitude become 400 meters.

Fixed design:

- There is a servo motor in the fixed container. The servo is attached to slide mechanism also slide mechanism is attached to payload with hinge. The servo motor is started and it moves the slide mechanism, then the payload is released from the glider when altitude becomes 400 meters.



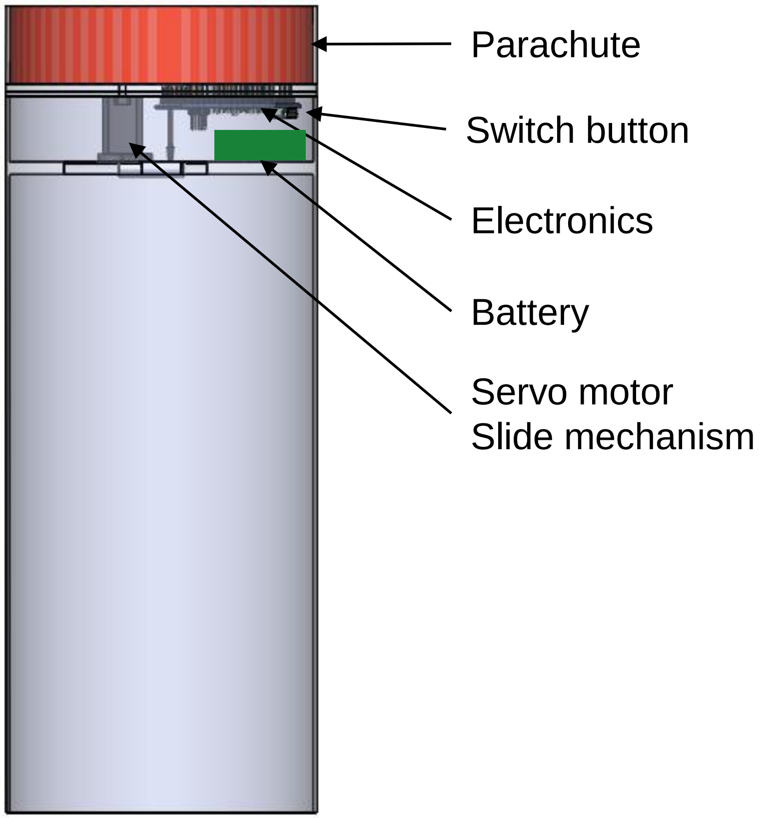
SEPARABLE DESIGN



FIXED DESIGN

Container will be fixed design because:

- Location of electronics is durable and fixed.
- Glider release from container easily comparing to separable design.
- Parachute opens easily comparing to separable design.



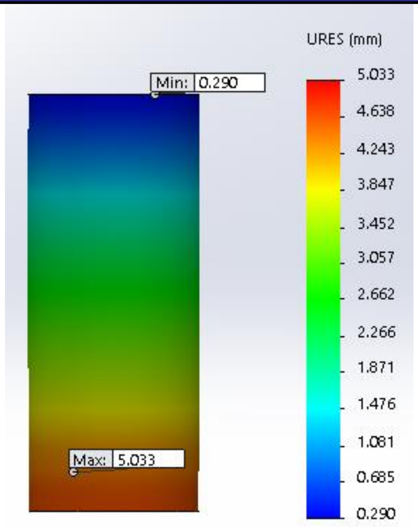
Container consisted three parts: parachute part, electronics part, glider part. Glider part and electronics part attach via slide mechanism and there are plank and PCB between parachute part and electronics part.

- PCB electronics is located top of the container
- The parachute is located above PCB electronics
- Servo and battery are located under PCB electronics
- Switch button is located under the parachute

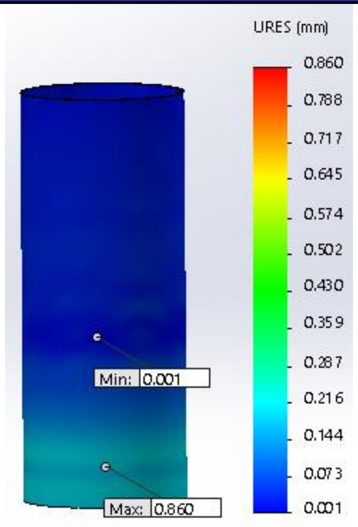
Material	Tensile Strength(PSI)	Advantage	Disadvantage
ABS	6160 - 6500	Cheap and available	Weak
Fiber Glass	42,000 - 34,000	Durable and transparency, survive for high temperature	Expensive

Container must be thin. ABS is not durable for thickness that is why glider will be made from fiber glass. Fiber glass has a high strength to weight ratio. Fiber glass can survive high temperature and Fiberglass is non-conductive and radio frequency transparent.

30 Gs of Shock Test

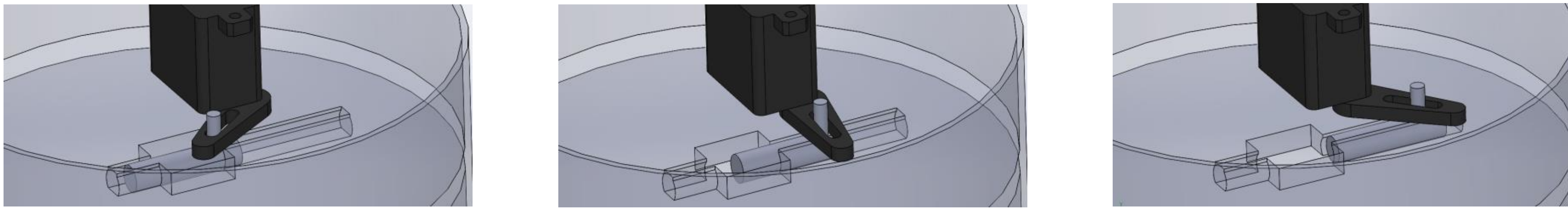


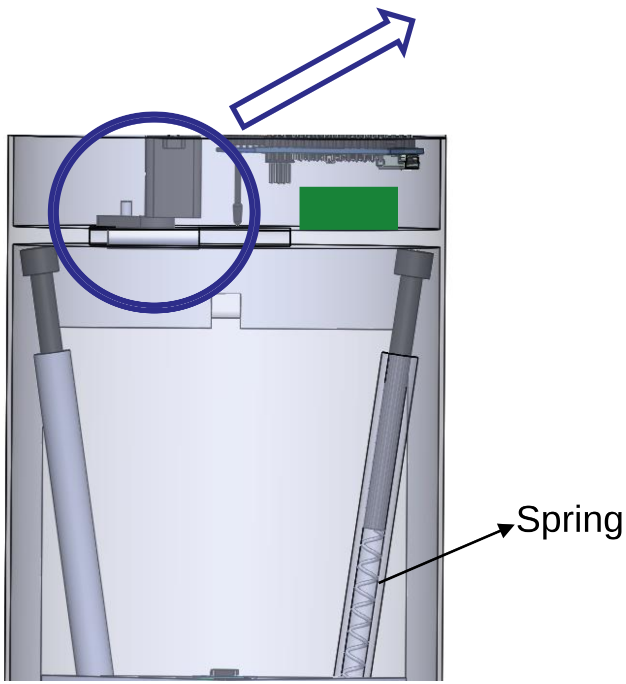
ABS



Fiber Glass

Payload Release Mechanism





- The glider will be connected to a container via a hinge and hinge attached with servo motor and slide mechanism.
- We have got a servo motor and a spring for deploying configuration.
- Slide mechanism moved by servo motor when altitude drops 400 meters.
- Hinge and slide mechanism separate.
- Glider release from container owing to spring thrust.
- Friction at the pressure point can be neglected by comparison to spring thrust.
- Magnets and tire supply to attach wing sticks.

Electronics Structural Integrity

Electronic component mounting methods

- Electronic components such as PCB and camera module will be attached to fuselage via bolts.
- The battery will be in keeping special holder. The holder will be glued to fuselage with high strength adhesive/epoxy/

Electronic component enclosures

- For container, all electronic components will be fixed under parachute.
- For a glider, all electronic components will be enclosed in the fuselage.
- Pitot tube, the camera lens and XBee antenna will stick out outside of the fuselage.

Securing electrical connections

- To minimize bunch of cabling issue, every single electronic component is soldered on the PCB. But to make sure we will use high adhesive/

Descent control attachments

- For container, Parachute fabric is rigid material – ripstop nylon
- Parachute shroud line are attached to swivel. And swivel is attached to wire and finally wire is connected to container.
- As container absorbs most of the shock, it will be made from fiberglass.
- For glider, Rotation points of wing sticks are carbon fiber standoffs & bolts.
- Since glider shape is more complex rather than conventional gliders, it will be made from ABS.

Mass Budget

CONTAINER		
COMPONENT	**MASS**	**SOURCE**
BODY	20g	Estimated
PARACHUTE	15g	Datasheet
SERVO MOTOR	9g	Datasheet
BATTERY	48g	Datasheet
ELECTRONICS	20g	Measured
TOTAL	112g	

CONTAINER	112g
GLIDER	282g
MARJIN	106g
TOTAL	500g

- If the mass of CanSat become <500g we will add weight in the container as using proper solid.

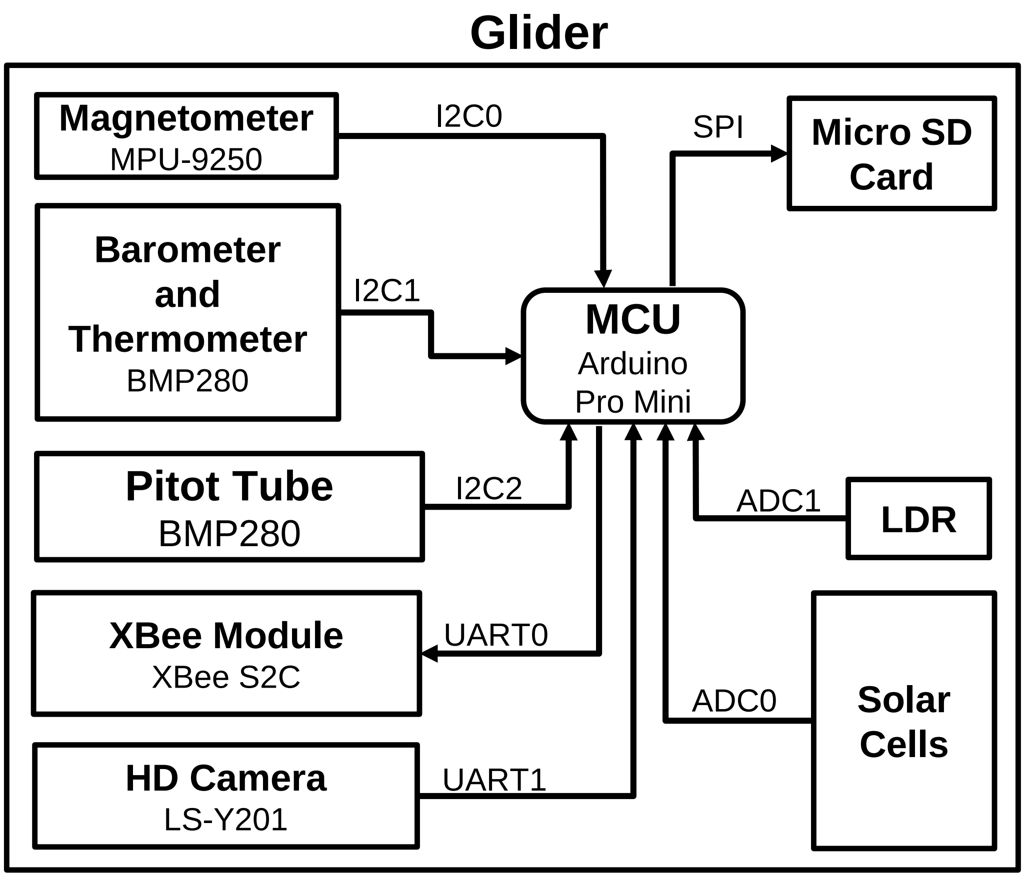
GLIDER		
COMPONENT	**MASS**	**SOURCE**
FUSELAGE	118g	Measured
SOLAR PANEL	60g	Datasheet
WING STICKS	40g	Measured
CAMERA	10g	Datasheet
PITOT TUBE	13g	Datasheet
XBee	6g	Datasheet
ARDUINO	3g	Datasheet
BMP280	4g	Datasheet
OTHER ELECTRONICS	15g	Estimated
RIP STOP NYLON	13g	Measured
TOTAL	282g	

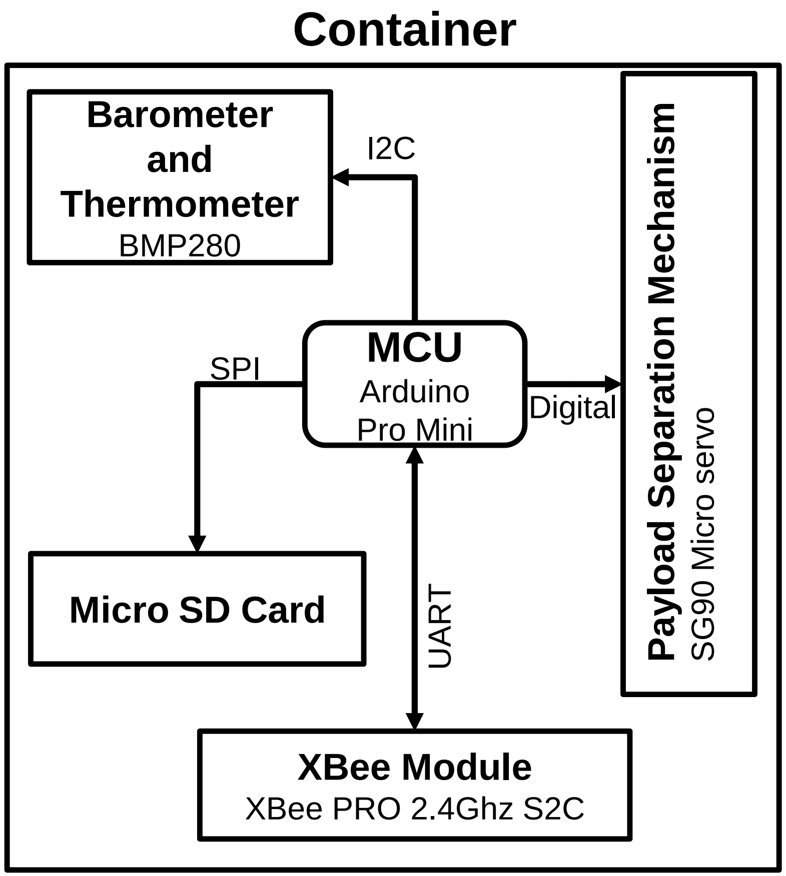
Communication and Data Handling (CDH) Subsystem Design

İLKİN ALİYEV

General Description

- Communication & Data Handling (CDH) subsystem of CanSat is primarily responsible for communication with the ground station.





CDH Requirements

ID	Requirements	Comment	Priority	Parents
CDH-01	During descent, the glider shall collect air pressure, outside air temperature, compass direction, air speed and solar power voltage once per second and time tag the data with mission time	This data enables to analyze glider flight characteristic.	High	SR-11
CDH-02	During descent, both glider and container shall transmit telemetry at 1Hz Rate	Competition Requirement	Medium	None
CDH-03	Telemetry shall include mission time with one second or better resolution, which begins when the container and glider is powered on. Mission time shall be maintained in the event of a processor reset during the launch and mission	Time reference for every collected packet	High	SR-12
CDH-04	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.	XBee modules are reliable RF modules as well as easy to use	High	SR-13
CDH-05	XBee radios shall have their NETID/PANID set to their team number.	Radio interference prevention	High	None
CDH-06	XBee radios shall not use broadcast mode.	Broadcast mode is slower	Medium	None
CDH-07	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost	Competition Challenge	Medium	SR-15
CDH-08	The container shall transmit telemetry from the time being turned on and placed on the launch pad until 2 seconds after releasing the glider.	Re-entry Container is responsible for releasing glider at stable conditions	Medium	SR-24
CDH-09	The container telemetry shall include team number, indication of container telemetry, altitude, temperature and software state.	This data enables to analyze container flight	High	None

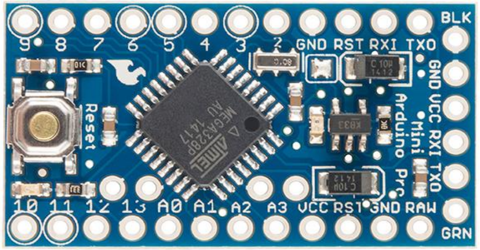
Payload Processor & Memory Trade & Selection (1 of 2)

Model	Input Voltage (V)	Power Consumption (mA)	Clock Speed (MHz)	Flash memory	Interfaces
Arduino Nano Atmega328p microcontroller based mini board	5 – 12	50	16	32Kbyte	UART-1 SPI-1 I²C-1 Analog Input Pins-6
Arduino Pro Mini Atmega328p microcontroller based mini board	3.35 - 12	10	8 (for 3.3v version)	32KB of which 2 KB used by bootloader	UART-1 SPI-1 I²C-1 Analog Input Pins-6
STM32F4 ARM cortex M4 based microcontroller	1.8 - 5	1	168	1000	Many multiple interfaces

Arduino Pro mini was chosen as MCU both for payload and container

Arduino Pro Mini fulfils mission requirements.

✓ Low power(10mA)
✓ Enough clock speed
✓ Enough interface for communicating with sensors, XBee and SD card



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

Model	Storage Capacity	Interface	Type	Size (mm)	Supply Voltage (V)
Microchip 24AA256	256 kBit	I²C	EEPROM	6.4 x 3.1	1.7V - 2.5
Microchip SST25VF080B	8 MBit	SPI	Flash	4.9 x 6	2.7 - 3.6
SanDisk 8 GB Micro SD Card	8 GByt	SPI	Flash	24 x 32 x 2.1	2.7 - 3.6

SanDisk 8 GB Micro SD Card was chosen as Payload & Container Storage Unit;

- ✓ High capacity is required to save photos
- ✓ It is easier to transfer photos and telemetry data from SD card

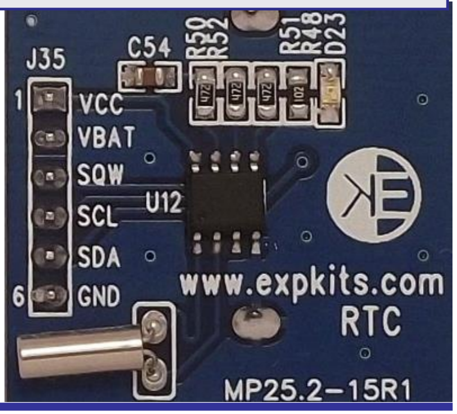
Real-Time Clock

❖ Pro mini has no internal RTC, so the hardware real-time clock will be used for both payload and container.
❖ Because, if the solar energy fails (or reset), software clock could not show the real-time correctly. So that a hardware real-time clock will be used.

RTC	Resolution (s)	Size	Interfaces	External Battery (V)	Supply Voltage (V)	Cost ($)
DS1302	1	8-Pin DIP 8-Pin SO	3 Wire	2.0 - 5.5	2.0 - 5.5	4.5
DS1307	1	8-Pin DIP 8-Pin SO	I²C	2 – 3.5	4.5 - 5.5	4.5
DS1338	1	8-Pin µSOP 8-Pin SO 16-Pin SO	I²C	1.3 - 3.7	1.71 – 5.5	4.5

DS1338 was chosen as Payload & Container RTC;

✓ DS1338 fulfils mission requirements
✓ Resolution (1 second)
✓ I²C interface
✓ Low supply voltage (3.3V)
✓ Battery backup included
✓ Small size



Antenna Trade & Selection

Antenna was chosen based on Link budget calculation and XBee model.

Link Budget

Gain Factors: RF Transmitting Power, Supply Voltage, Antenna Gain, receiver sensitivity

Loss Factors: Cabling, FSLP

- FSPL (dBm) =20 log(d)+20 log(f)-147.55 (where d is in meters and f is in hertz)
- Using 2.4 GHz XBee radios, at a max distance of 1 km in horizontal gives a 1.5 km maximum total distance
- FSPL = 103.6 dBm
- The cable losses will be maximum 3 dBm.
- XBee transmit power = +17 dBm
- XBee wire antenna gain = +1.5 dBi , Duck Antenna gain 2.1dBi
- XBee receiver sensitivity = -100 dBm
- Ground station antenna gain = 14 dBi

Transmit Power – Losses + Antenna Gain > Receiver Power

- 17 - (103.6 + 3) + (14 +1.5) > -100 dBm
- 17 - (103.6 + 3) + (14 +2.1) > -100 dBm
- Which gives us a a very good link margin of **26 dBm** for Glider and **25.4 dBm** for Container

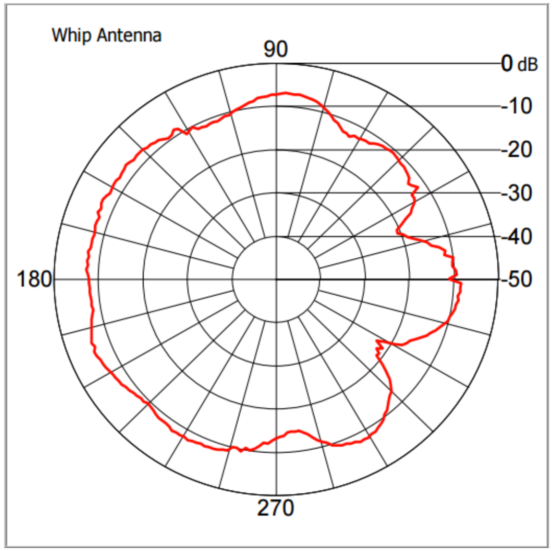
Payload Antenna Trade & Selection

Antenna Type	Gain	Advantages	Disadvantages
Wire Antenna on XBee	+1.5dBi	Smaller space	Low gain, Should be out of SV for clear communication
PCB Antenna on XBee	-1.5dBi	No space occupation	Very low gain
External Duck Antenna	2.1dBi	Good gain	Relatively larger to be compatible with SV RPSMA connector needed

Payload Antenna: Wire Antenna

- Coming with XBee Pro S2C
- Has enough gain despite smaller size

900Mhz frequency band is not permitted in Turkey so we use 2.4 GHz.



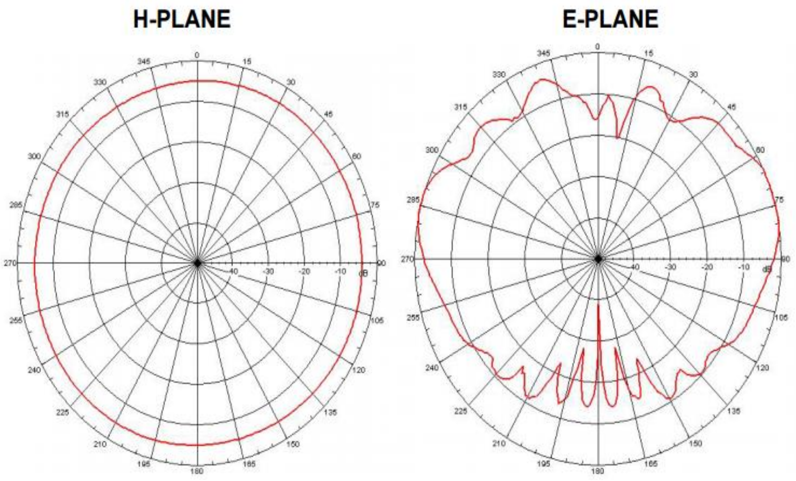
Radioation Pattern of Wire Antenna

Container Antenna Trade & Selection

Antenna Type	Gain	Advantages	Disadvantages
Wire Antenna on XBee	+1.5	Smaller space	Poor gain
PCB Antenna on XBee	-1.5	No space occupation	Very low gain
External Duck Antenna	2.1	Good gain	Bigger space inside container Relatively expensive

Container Antenna: External Duck Antenna

- A better gain
- Enables Range up to 1 mile
- 2.4 GHz Frequency



Radioation Pattern of Duck Antenna

Payload Radio Configuration

XBee	Frequency Band (Ghz)	Outdoor/Rf Lıne-of-Sight Range (M)	Transmit Current (mA)	Transmit Power (mW)	Supply Voltage	Cost ($)
XBee S1	24	100	45	1	2.8 - 3.4	25
XBee S2C	24	1200	33 45 boost mode	3.1 6.3 boost mode	2.1 - 3.6	24
XBee Pro S2C	24	3200	120	63	2.7 - 3.6	38

XBee S2C was chosen;

- ✓ Acceptable range (1200meter with even wire atnenna)
- ✓ Low transmit current t (43mA boost mode)

- Firmware on XBee will be updated using the XCTU utility.
- XBee NETID must be set to our team number is 5851.
- Communication to be done in API mode.
- XBees will be operating in multicast mode
- This device will be an endpoint.

We Started Radio Prototyping and Testing!

Container Radio Configuration

XBee	Frequency Band (Ghz)	Outdoor/Rf Line-of-Sight Range (M)	Transmit Current (mA)	Transmit Power (mW)	Supply Voltage	Cost ($)
XBee Pro S1	24	1600	215	60	2.8 - 3.4	42
XBee S2C	24	1200	33 45 boost mode	3.1 6.3 boost mode	2.1 - 3.6	24
XBee Pro S2C	24	3200	120	63	2.7 - 3.6	38

XBee Pro S2C was chosen as Container & GCS XBee;

- ✓ High range
- ✓ Low transmit current

- Firmware on XBee will be updated using the XCTU utility.
- XBee NETID must be set to our team number is 5851.
- Communication to be done in API mode.
- This device will be an endpoint.

We Started Radio Prototyping and Testing!

Payload Telemetry Format

- Payload Telemetry is included;

i. <TEAM ID> is our team number is 5851.
ii. Insert the word GLIDER in this position.
iii. <MISSION TIME> is the time since power up in seconds.
iv. <PACKET COUNT> is the count of transmitted packets.
v. <ALT SENSOR> is the altitude with one meter resolution.
vi. <PRESSURE> is the measurement of atmospheric pressure.
vii. <SPEED> is the measurement from the pitot tube (meters/second).
viii. <TEMP> is the sensed temperature in degrees C with one degree resolution.
ix. <VOLTAGE> is the voltage of the CanSat power bus.
x. <HEADING> is the CanSat glider heading measured by magnetometer.
xi. <SOFTWARE STATE> is the operating state of the software.
xii. <PHOTO COUNT> is the count of saved picture.

- Data is transmitted at default Baud Rate of 9600 in continuous mode.
- Upon powering up, the CanSat glider shall collect the required telemetry at a 1 Hz sample rate. The telemetry data shall be transmitted with ASCII comma separated fields followed by a carriage return in the following format:

<TEAM ID>,GLIDER,<MISSION TIME>(<HOUR>,<MINUTE>,<SECOND>),<PACKET COUNT>,<ALT SENSOR>, <PRESSURE>,<SPEED>, <TEMP>,<VOLTAGE>,<HEADING>,<SOFTWARE STATE>,<PHOTO COUNT>

- Data frame example is ‘‘5851,GLIDER,12,00,00,1,400,10200.32,3.3,34.68,5.4,90,TOUCHDOWN,1’’.

Container Telemetry Format

- Container Telemetry is included;

i. <TEAM ID> is our team number is 5851.
ii. Insert the word GLIDER in this position.
iii. <MISSION TIME> is the time since power up in seconds.
iv. <PACKET COUNT> is the count of transmitted packets.
v. <ALTITUDE> is the altitude with one meter resolution.
vi. <TEMPERATURE> is the temperature of the container.
vii. <VOLTAGE> is the voltage of the CanSat container power bus.
viii. <SOFTWARE STATE> is the operating state of the software.

- Data is transmitted at default Baud Rate of 9600 in continuous mode.

- Upon power up, the CanSat container shall transmit telemetry at a 1 Hz rate until two seconds after deploying the glider. The telemetry data shall be transmitted with ASCII comma separated fields followed by a carriage return in the following format:

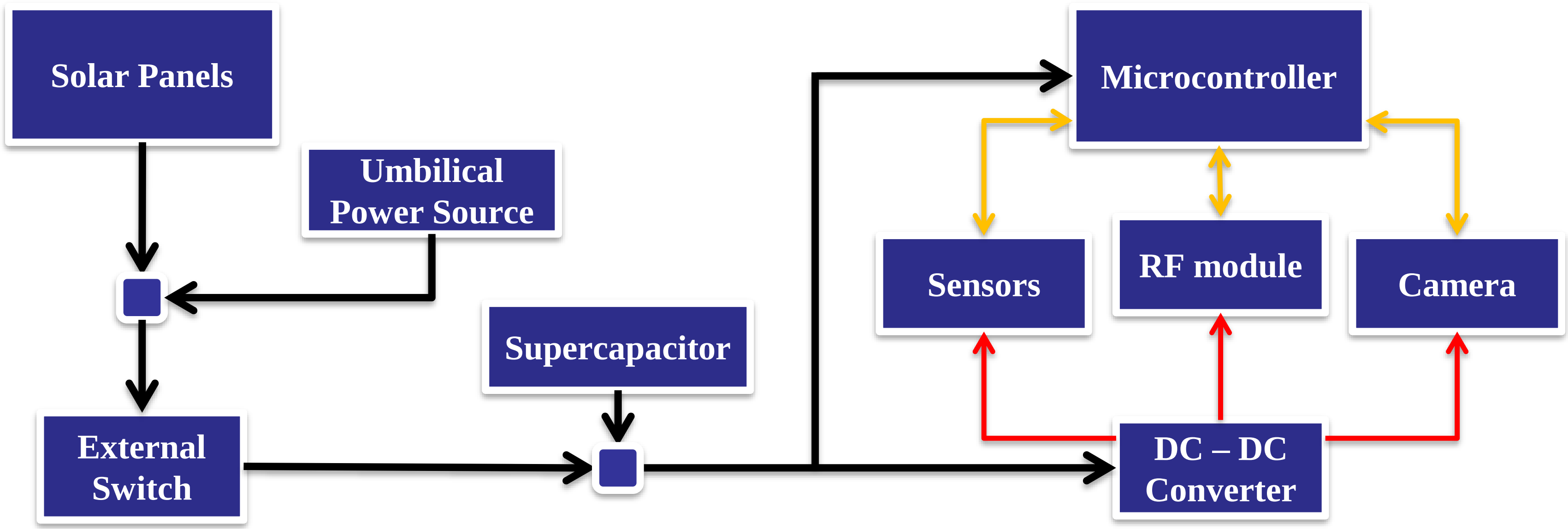
<TEAM ID> ,CONTAINER,<MISSION TIME>(<HOUR>,<MINUTE>,<SECOND>),<PACKET COUNT>, <ALTITUDE>,<TEMPERATURE>, <VOLTAGE>,<SOFTWARE STATE>

- Data frame example is ‘‘5851,CONTAINER,12,00,00,1,400,34.68,5.2,LAUNCH’’.

Electrical Power Subsystem (EPS) Design

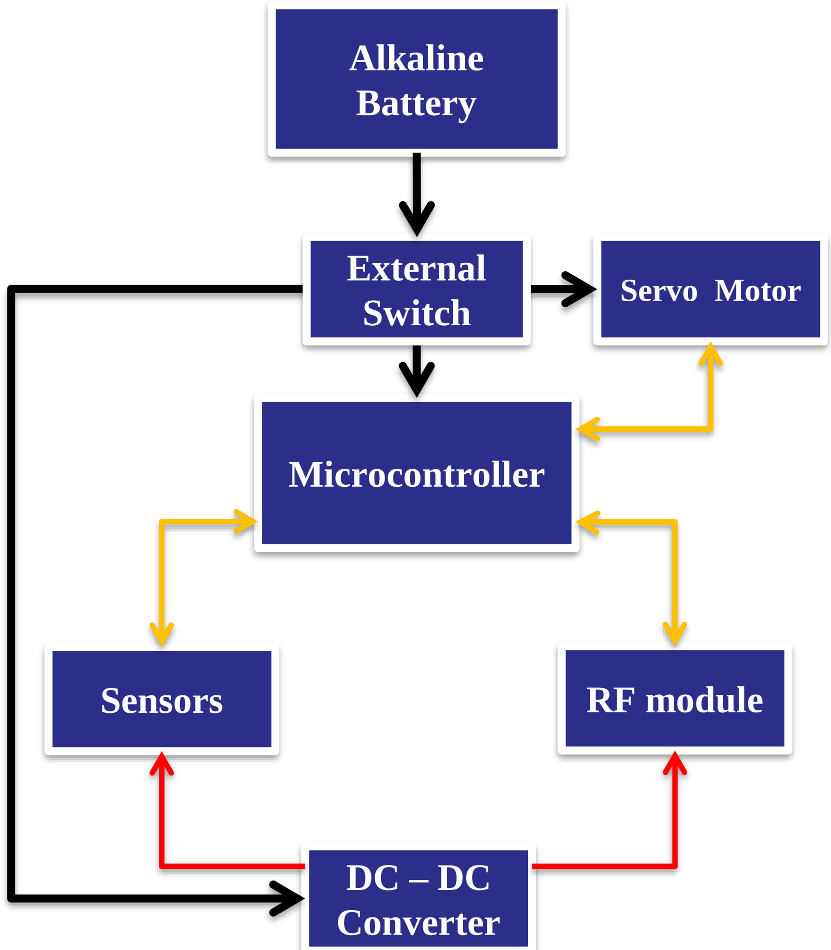
CAHİT ABDULLAH MISIRLI

EPS Overview Payload



- **Solar Panels (5.5 V – 360 mA)**
  Harvest the energy from sunshine and then provide energy for our payload
- **Umbilical Power Source**
  Used to test the payload electronic system
- **Supercapacitor**
  Connected in parallel to keep voltage within the tolerance
- **DC – DC Converter (S7V8F3)**
  Efficiently regulate the voltage

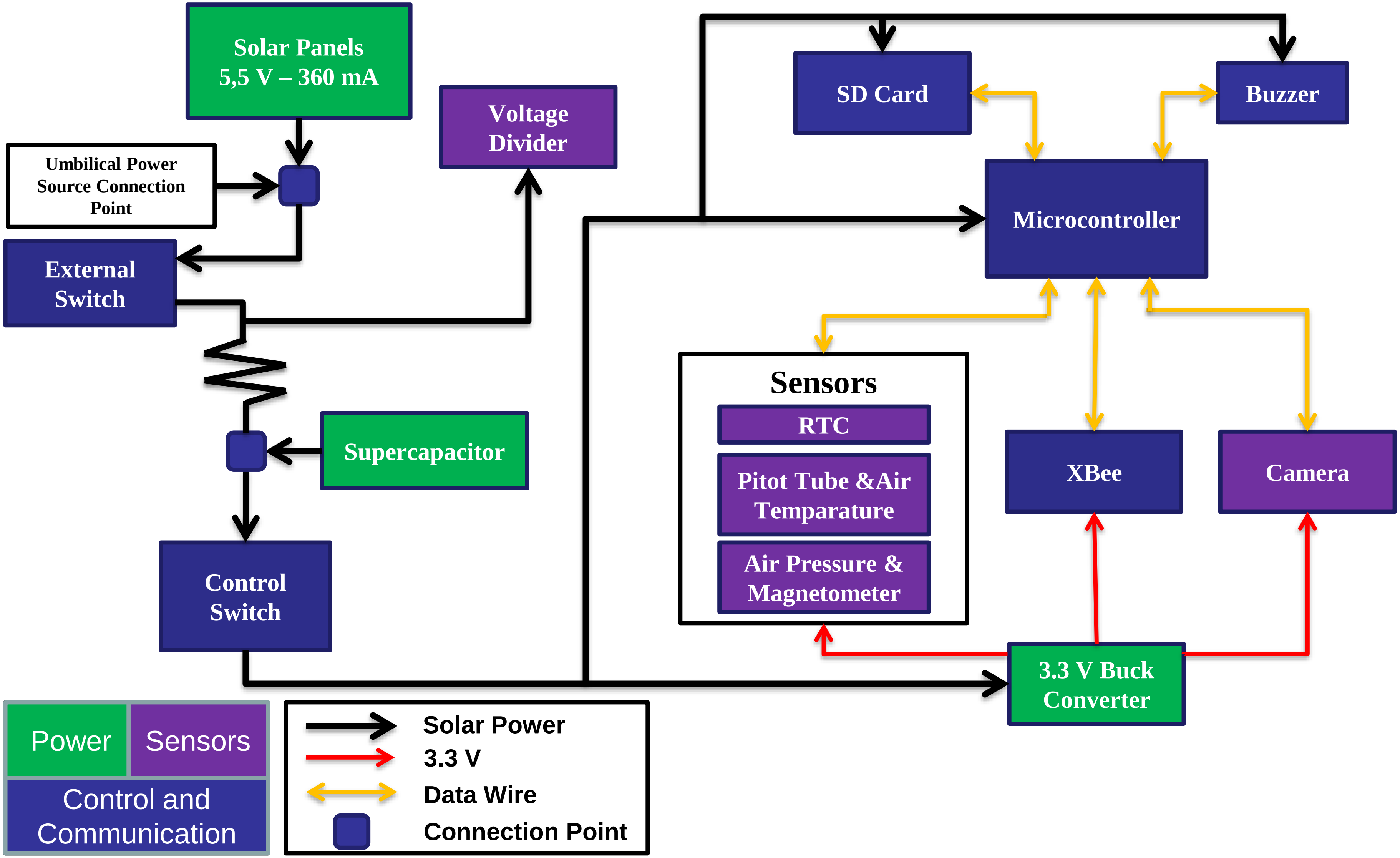
EPS Overview Container



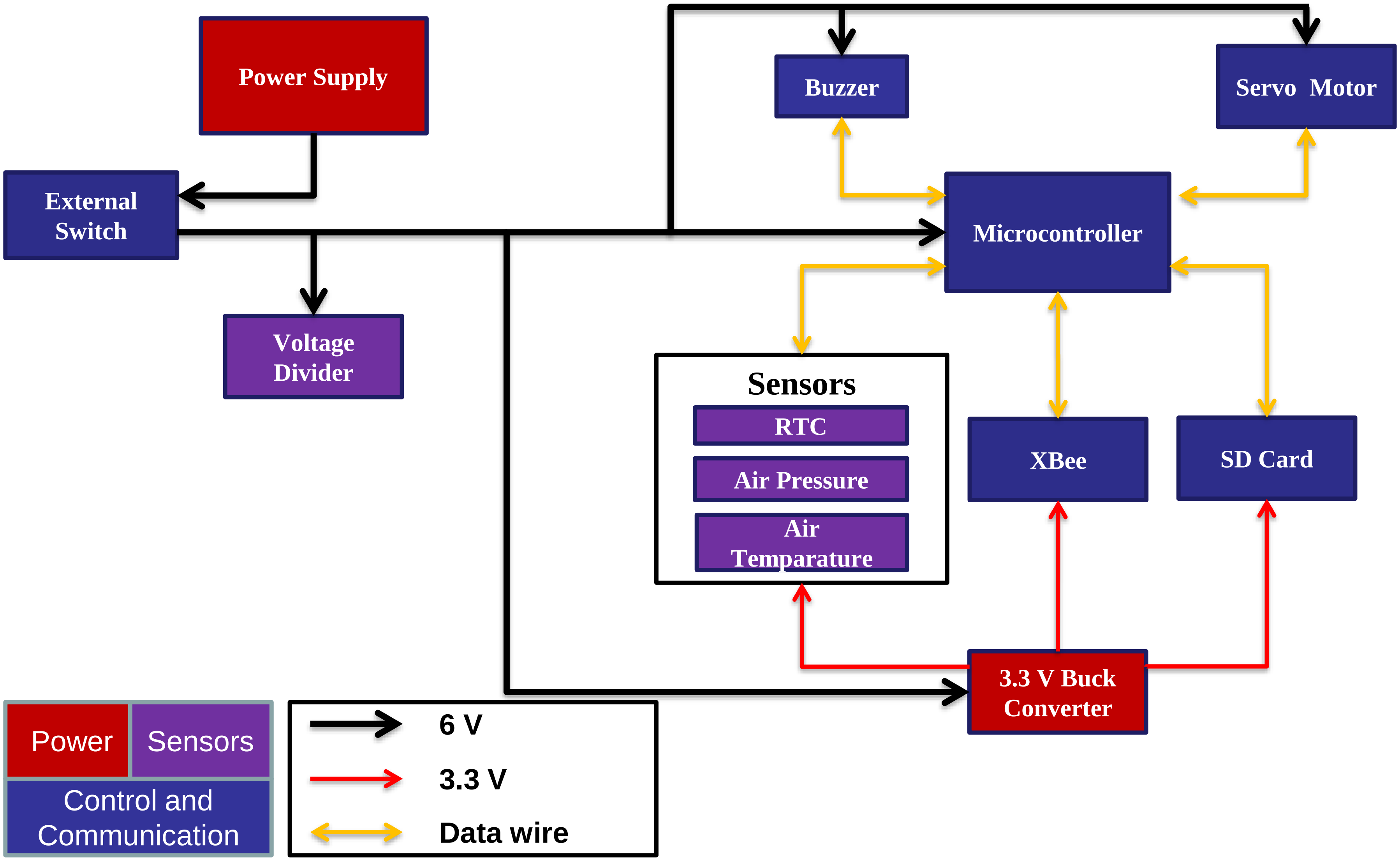
- **Alkaline Battery**
  Supply electrical energy for subsystem of container
- **RF module**
  Transmits telemetry data
- **Servo Motor**
  Actuates separation mechanism

EPS Requirements

ID	Requirement	Rationale	Priority	Parents
EPS-01	The glider electronics must be all solar powered except for the time keeping device.	Competition Requirement	Very High	SR-14
EPS-02	Cost of the CanSat shall be under $1000.	Competition Challenge	Medium	SR-15
EPS-03	The glider must include an easily accessible power switch	The glider can be powered off immediately in emergency situation	High	SR-06
EPS-04	The container electronics shall be powered by only alkaline batteries.	Competition Challenge	Medium	SR-22
EPS-05	The glider shall use a time keeping device to maintain mission time. The time keeping device can use a small coin cell battery.	Time reference for every collected packet	Medium	SR-25
EPS-06	The time keeping device battery shall be a coin cell battery with a capacity limit of 240 mAh and with no more than a 1 ma discharge rate	1mA is enough for RTC module.	High	None
EPS-07	An audio beacon for the glider shall be included and powered off of the solar power.	To find glider after touchdown	High	None



Solar Panels
5,5 V – 360 mA
Voltage Divider
Umbilical Power Source Connection Point
External Switch
Supercapacitor
Control Switch
SD Card
Buzzer
Microcontroller
Sensors
RTC
Pitot Tube &Air Temparature
Air Pressure & Magnetometer
XBee
Camera
3.3 V Buck Converter
Power
Sensors
Control and Communication
Solar Power
3.3 V
Data Wire
Connection Point



Power Supply
External Switch
Voltage Divider
Buzzer
Servo Motor
Microcontroller
Sensors
RTC
Air Pressure
Air Temparature
XBee
SD Card
3.3 V Buck Converter
Power
Sensors
Control and Communication
6 V
3.3 V
Data wire

Payload Solar Power Trade & Selection

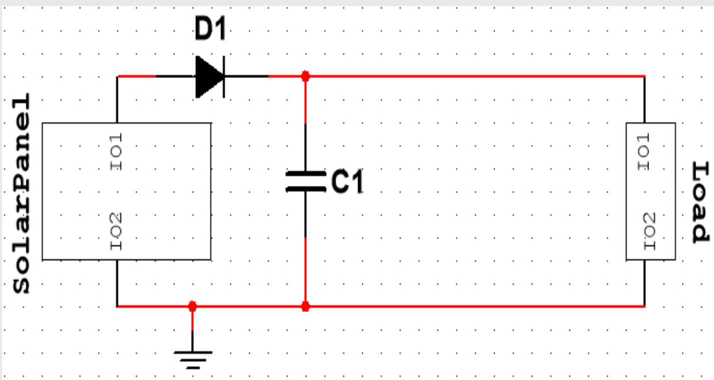
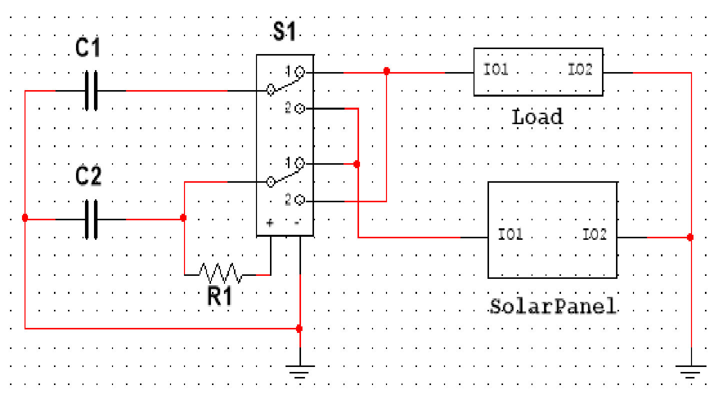
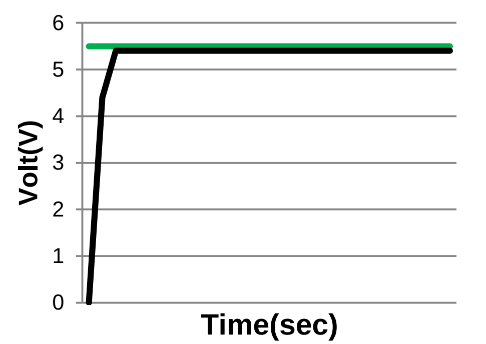
Models	Open Circuit Voltage(V)	Typical Voltage (V)	Typical Current (mA)	Efficiency	Weight (g)	Dimensions (mm)	($)Price
SKU – 313	8.2	5.5	360	%17	60	80x180x2	7.95
SW-0.15	1.8	1.5	100	%14	5	52x27x3	1,45
MPT4.8-75	6.4	4.8	50	%16	1.9	73x94x0.22	11,95

We chose **SKU – 313** solar panels for our payload;

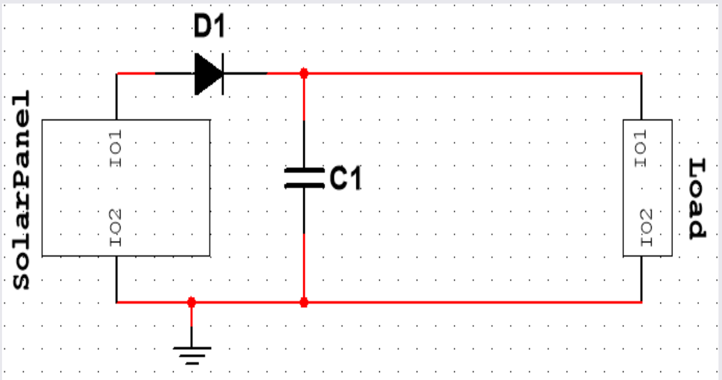
Rationales:

- Suitable size for payload mechanism
- Sufficient voltage and current for system
- High efficiency

Payload Energy Management Strategy Trade Study (1 of 2)

	Designs	Description	Advantages
Design 1: Asterix		➢ Use the solar power directly. ➢ Diode prevents feedback from supercapacitor to solar panel. ➢ Connect supercapacitor in parallel to tolerate voltage of solar power.	➢ When the solar panel look sunshine, instantly transfer generated energy to electronic system. ➢ Simplicity in design ensure mission success.
Design 2: Obelix		➢ Use the solar power from stored device. ➢ Two supercapacitor feed the system one by one periodically and panels charge supercapacitors in the same way simultaneously. ➢ The relay which are used as switching element enables solar power to electronic system.	➢ Provides stable voltage to the load. **Power Profiles** 

Payload Energy Management Strategy Trade Study (2 of 2)

Selection	Reasons
	➢ Asterix is more productive and more applicable. ➢ Obelix comprise of upward components so, he needs to bigger area. ➢ Obelix starts to feed the system after plenty of time whereas, asterix starts immediately.

➢ We use 1 F supercapasitor in our energy conversion circuit.

Size(mm)	Maximum Voltage(V)	Weight(g)
6x7.6	5.5	2.75

Container Battery Trade & Selection

Models	Type	Capacity (mAh)	Voltage	Weight (g)	Dimensions (mm)	($)Price
	Alkaline	319	9	48.5	48,5 x 26,2 x 17,2	1.37
	Alkaline	560	9	45	48,5 x 26,2 x 17,2	3.95
	Alkaline	900	1.5	11.9	10.5 x 44.5	5.49 (4 pieces)

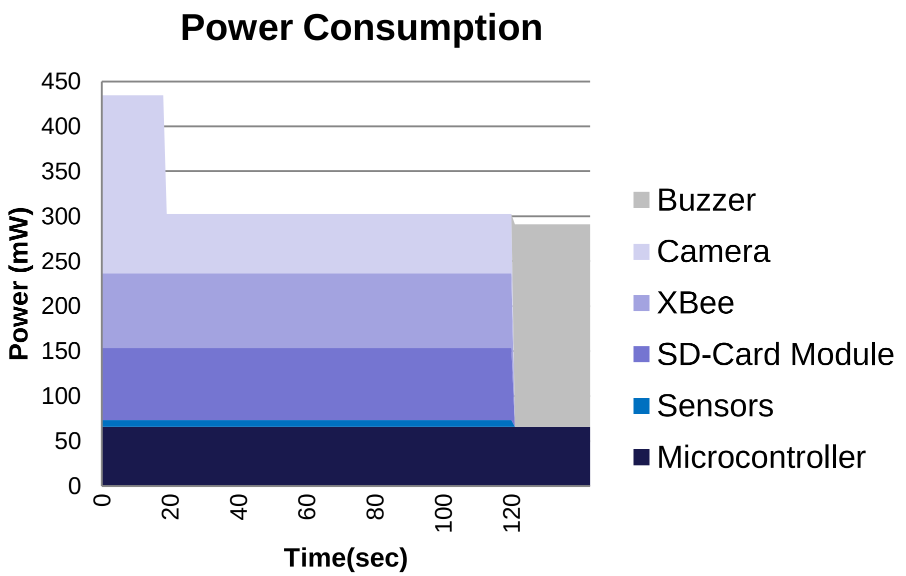
- We chose **Energizer EcoAdvanced XR91 AAA Batteries** for our container.
- We used 4 pieces batteries in series. We have 6.0 V and 900 mAh capacity.

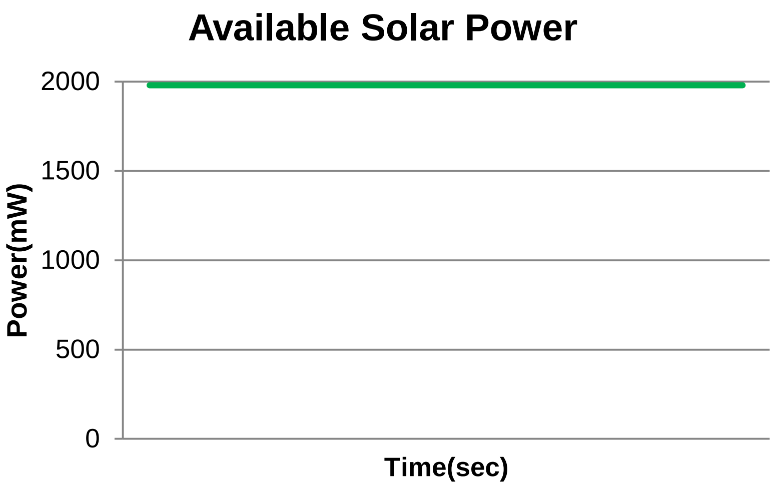
Rationales:
- More Eco-friendly (Unlike the others, made of recycled batteries)
- Higher capacity
- Favorable size

Payload Power Budget (1 of 2)

Components	Voltage (V)	Active Mode Current (mA)	Idle Mode Current (mA)	Duty Cycle(%)	Avarage Current (mA)	Avarage Power (mW)	Source
Microcontroller	3.3	20	10	100	20	66	Datasheet
Air Pressure	3.3	0.01	0.001	100	0.01	0.033	Datasheet
Magnetometer	3.3	0.3	0.01	100	0.3	0.69	Datasheet
Pitot Tube & Air Temperature	3.3	0.01	0.001	100	0.01	0.033	Datasheet
Camera (LS-Y201)	3.3	100	20	50	60	198	Datasheet
SD Card	3.3	40	12	50	26	80	Datasheet
XBee	3.3	45	20	20	25	83	Datasheet
Real Time Clock	3.3	0.2	0.1	100	0.2	0.66	Datasheet
Buzzer	5.5	50	0.1	100	20	225	Datasheet
Voltage Divider	5.5	0.2	0.2	100	0.2	1.1	Measurement

Payload Power Budget (2 of 2)





		Total Power Consumption (mW)	Total Power Available (mW)	Margins (mW)
During Flight	0-20 s	431,2	1980	1548,8
	20-120 s	300,3	1980	1679,7
During Recovery		291	1980	1689

Container Power Budget

Components	Voltage (V)	Active Mode Current (mA)	Idle Mode Current(mA)	Duty Cycle(%)	Avarage Current (mA)	Avarage Power (mW)	Mission Time (in a hour)	Total Energy Consumption (mWh)	Source
Microcontroller	3.3	20	10	100	20	66	3600 sec	66	Datasheet
Air Pressure	3.3	0.01	0.001	100	0.01	0.033	3600 sec	0.033	Datasheet
Air Temperature	3.3	0.01	0.001	100	0.01	0.033	3600 sec	0.033	Datasheet
SD Card	3.3	40	12	50	26	80	3600 sec	80	Datasheet
XBee(Transmit)	3.3	120	20	20	25	83	3600 sec	83	Datasheet
XBee(Receive)	3.3	31	10	20	14	46.2	0 sec	33	Datasheet
Real Time Clock	3.3	0.2	0.1	100	0.2	0.66	3600 sec	0.66	Datasheet
Servo Motor	4.8	100	5	50	52.5	252	1 sec	24.1	Datasheet
Buzzer	5.5	50	0.1	100	20	225	0 sec	0.55	Datasheet
Voltage Divider	5.5	0.2	0.2	100	0.2	1.1	3600 sec	1.1	Measurement

Total Budget	288.5	Estimated
Available Power (Alkaline Battery)	3600	Datasheet
Margins	3311.5	

Flight Software (FSW) Design

CAHİT ABDULLAH MISIRLI
SELİM ÖZTÜRK

FSW Overview

Basic FSW Architecture

- FSW shall collect the required telemetry at a 1 Hz sample rate and send the telemetry through XBee.

Programming languages

- C/C++

Development Environment

- Arduino IDE

Brief summary Container FSW tasks

- Read sensors data at rate of 5Hz
- Calculate the average value of sensor data
- Transmit collected sensor data packet
- Write packets to SD card
- Initiate glider separation mechanism
- Activate buzzer when touchdown

Brief summary Glider FSW tasks

- Read sensors data at rate of 5Hz
- Calculate the average value of sensor data
- Transmit collected sensor data packet
- Write packets to SD card
- Capture image of ground and write it to SD card
- Activate buzzer when touchdown

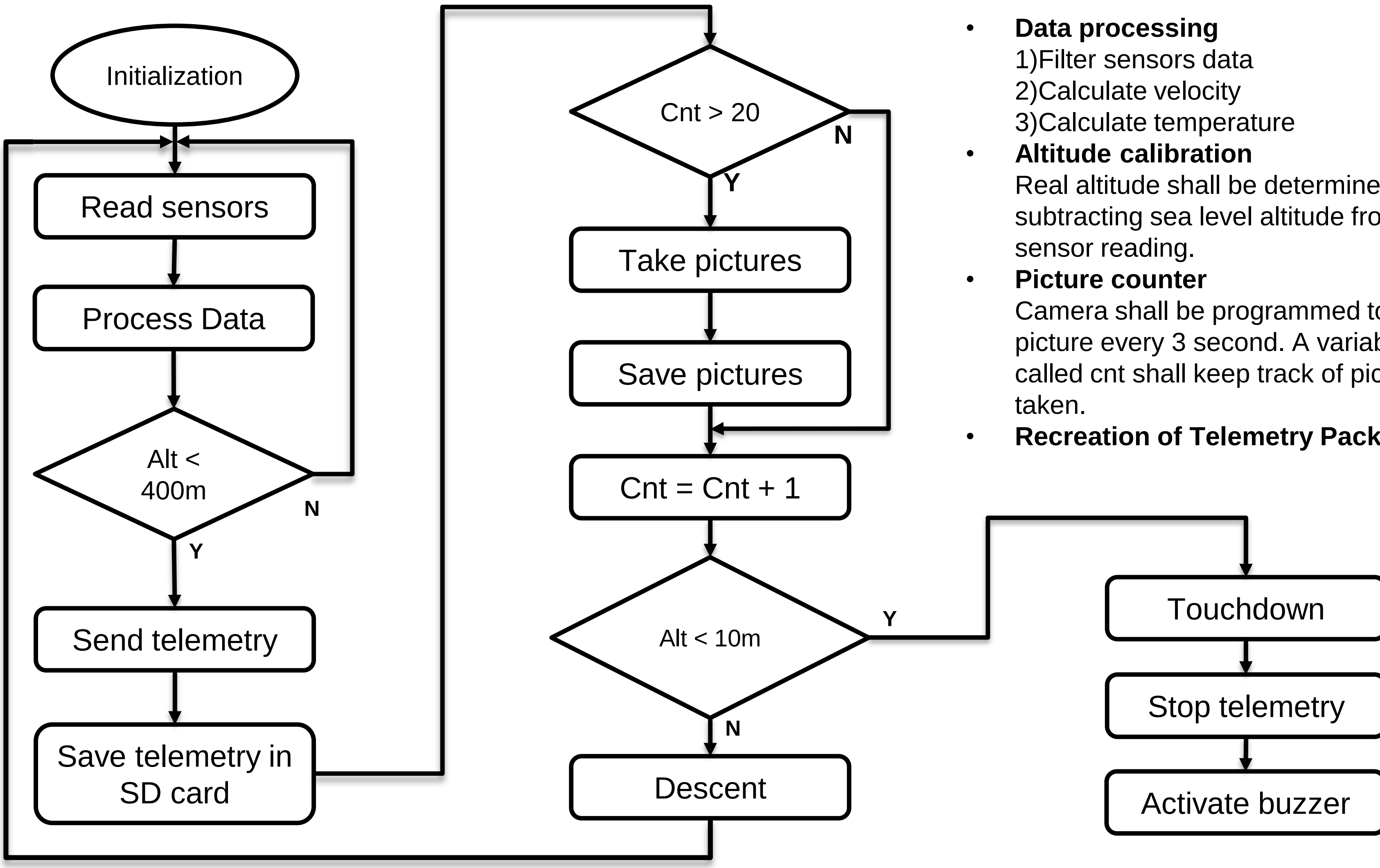
FSW Requirements (1 of 2)

ID	Requirement	Rationale	Priority	Parent
FSW-01	The glider must be released from the container at 400 meters +/- 10 m.	Competition Requirements	High	SR-07
FSW-02	During descent, the glider shall collect air pressure, outside air temperature, compass direction, air speed and solar power voltage once per second and time tag the data with mission time.	Competition Requirements	High	SR-11
FSW-03	During descent, the glider shall transmit all telemetry. Telemetry can be transmitted continuously or in bursts.	Competition Requirements	High	None
FSW-04	Telemetry shall include mission time with one second or better resolution, which begins when the container and glider is powered on. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Competition Requirements	High	SR-12
FSW-05	All telemetry shall be displayed in real time during descent.	Competition Requirements	High	None
FSW-06	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Competition Requirements	High	None
FSW-07	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission.	Competition Requirements	High	SR-20

FSW Requirements (2 of 2)

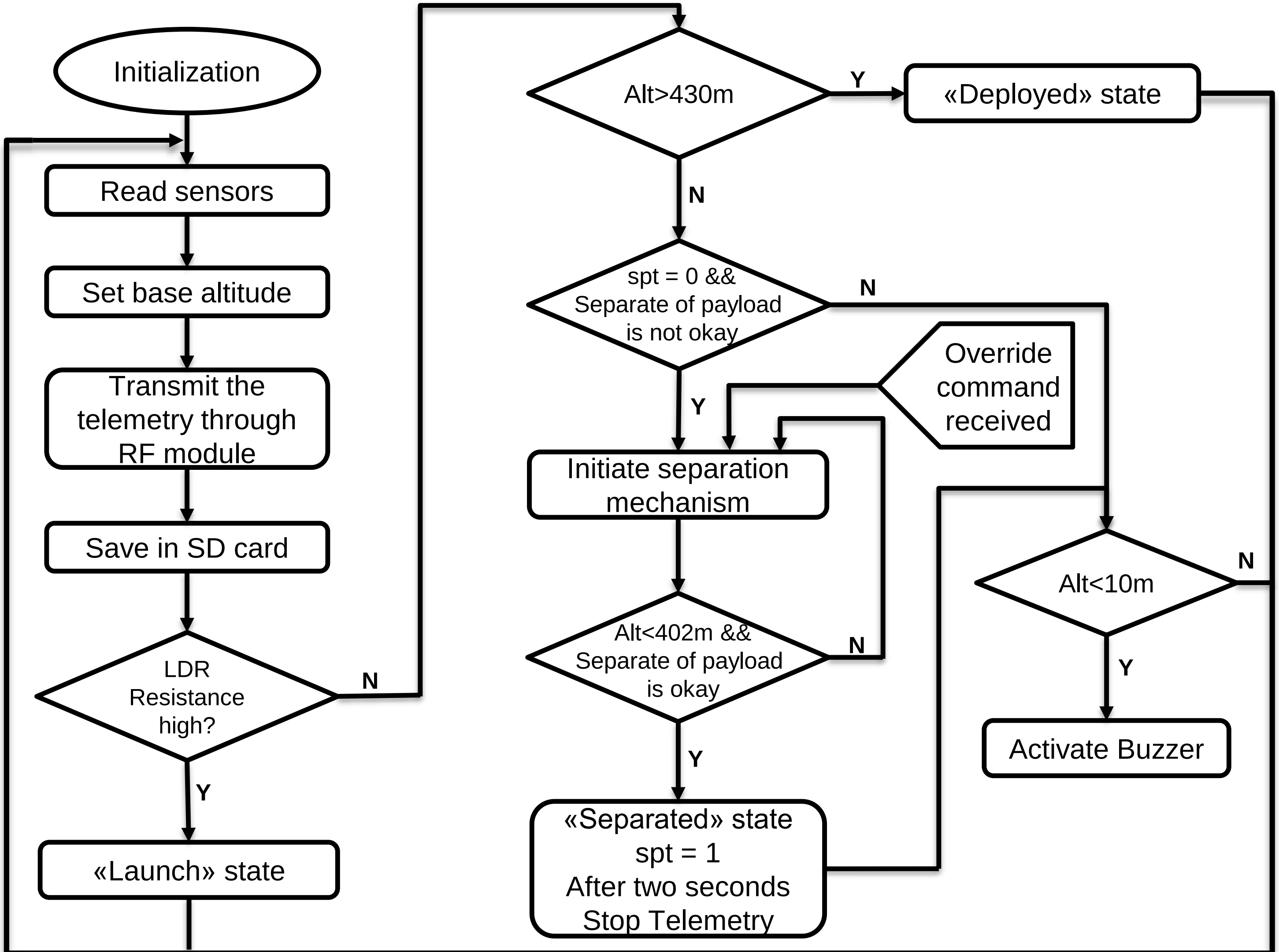
ID	Requirement	Rationale	Priority	Parent
FSW-08	The CanSat container shall have a payload release override command to force the release of the payload in case the autonomous release fails.	Competition Requirements	High	None
FSW-09	The container shall transmit telemetry from the time being turned on and placed on the launch pad until 2 seconds after releasing the glider	Competition Requirements	High	SR-26
FSW-10	The container telemetry shall be transmitted once per second.	Competition Requirements	High	None
FSW-11	The container telemetry shall include team number, indication of container telemetry, altitude, temperature and software state.	Competition Requirements	High	None
FSW-12	No lasers allowed.	Broadcast mode is slower	Medium	SR-21
FSW-13	A color camera shall be added to take picture of ground as often as possible	Competition Requirement	Medium	SR-27

Payload FSW State Diagram



- **Data processing**
  1)Filter sensors data
  2)Calculate velocity
  3)Calculate temperature
- **Altitude calibration**
  Real altitude shall be determined by subtracting sea level altitude from sensor reading.
- **Picture counter**
  Camera shall be programmed to take picture every 3 second. A variable called cnt shall keep track of picture taken.
- **Recreation of Telemetry Packets**

Container FSW State Diagram



- Until glider separation in telemetry spt will be zero.
- Spt is variable for keeping glider separation status. Until glider separation in telemetry spt will be zero.
- Container shall be connected to glider with via header cables and the cables will be connected to digital input of MCU.
- When the glider is separated from container, digital input will give 0 which indicates separation is executed successfully.

Software Development Plan

Prototyping And Prototyping Environments

- Arduino IDE is used as prototyping environment.
- Arduino NANO board and breadboard is used for prototyping basic CanSat hardware.

Test Methodology

- Laboratory tests
- Outdoor tests
- Wireless communication tests

Development Team

- İlkin Aliyev
- Selim Öztürk
- Cahit Abdullah Mısırlı

Software Subsystem Development Sequence

- To avoid late software development, tasks are slice into small chunks.
- So far sensors and SD card module are interfaced with MCU. In the next period, the camera will be interfaced as it is received.
- Finally first prototype of FSW will be integrated into hardware.

Ground Control System (GCS) Design

İLKİN ALİYEV

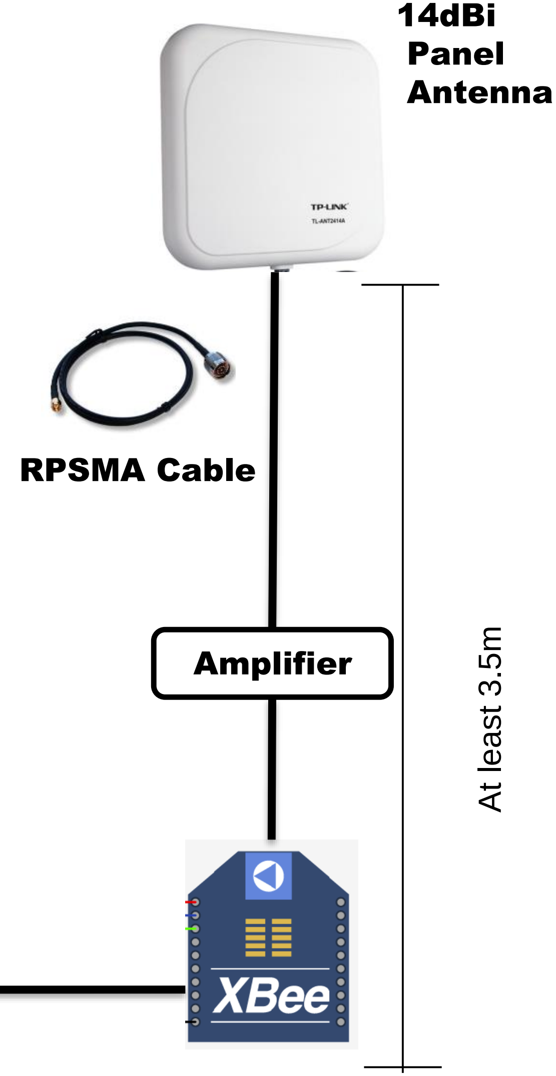
GCS Overview

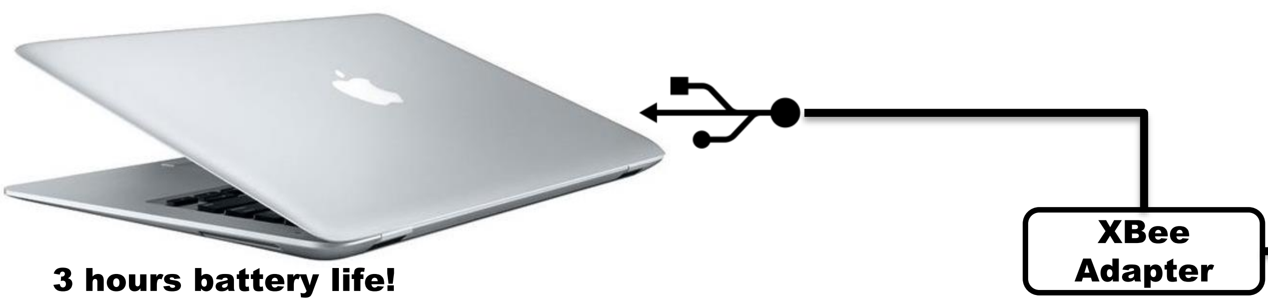
There are 3 main components of at Ground Station.

Directional Panel Antenna boosts received signal.
Amplifier provides sufficient power for antenna boosting.
XBee Pro S2C receives incoming telemetry from CanSat and forwards the to Laptop simultaneously.

Software developed in Matlab receives data packets via serial port and then;

- Clearly displays the telemetry data
- Plots required parameters
- Plots glider position using airspeed and compass values
- Save as .CSV file in real time.





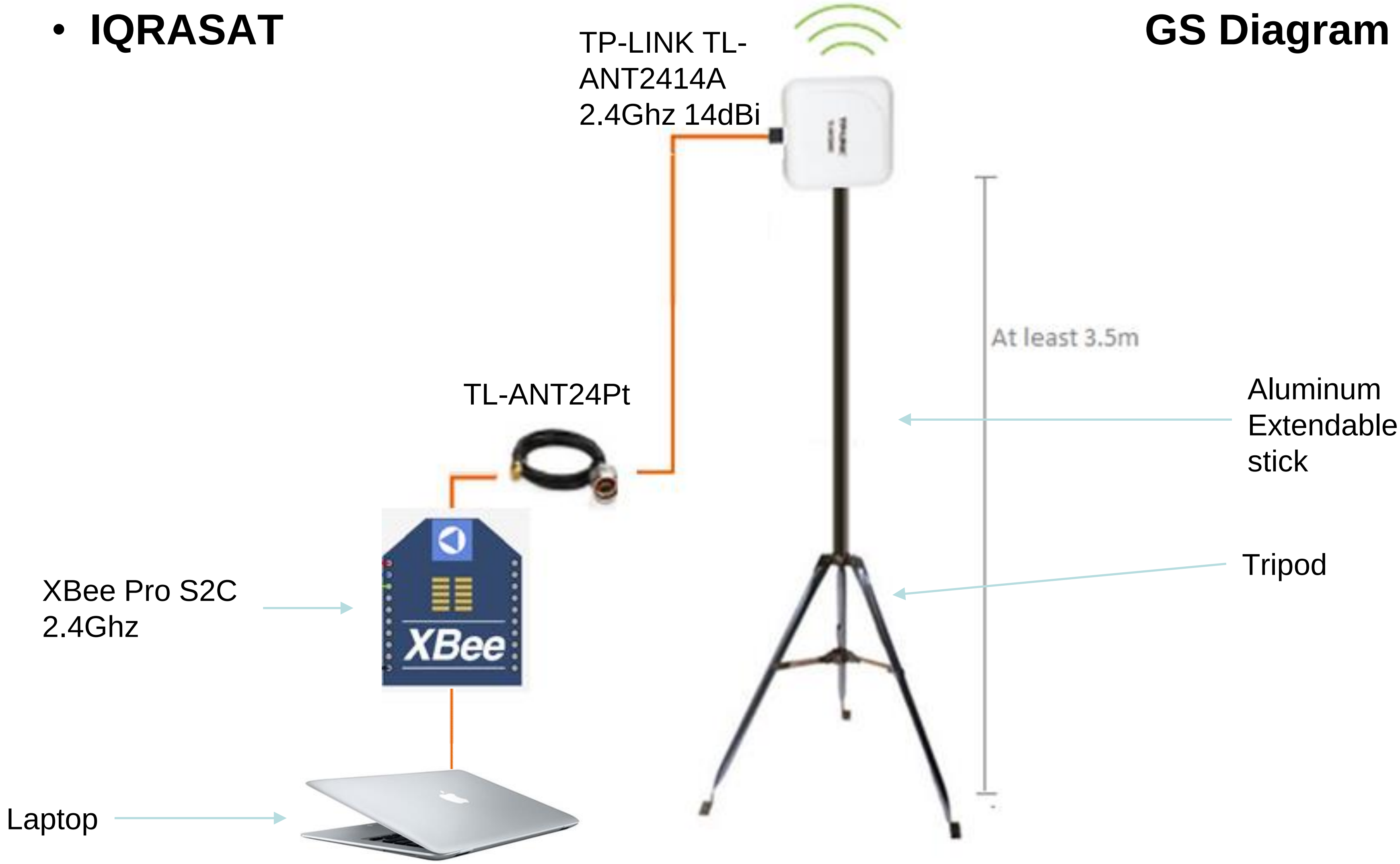
GCS Requirements

ID	Requirement	Rationale	Priority	Parent
GCS-01	Each team shall develop their own ground station.	Monitoring telemetry data	High	SR-16
GCS-02	All telemetry shall be displayed in real time during descent.	Competition Requirements	High	None
GCS-03	All telemetry shall be displayed in engineering units (meters, meters/sec, Celsius, etc.)	Data Standardization	High	SR-18
GCS-04	Plotting of pressure, outside temperature, altitude and glider speed changing	Seeing those data in time spectrum enables to catch change more easily	High	SR-19
GCS-05	The ground system shall display a two dimensional map of estimated glider position based on speed and heading telemetry data.	Observing glider trajectory gives us chance of refinement of glider flight characteristics	High	SR-19
GCS-06	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBee radio and a hand held antenna.	The GUI is running in Laptop that is why laptop is needed. Battery is need since no AC line is available in the competition area. XBee receives telemetry from CanSat and Antenna strengthens the signal	High	SR-17
GCS-07	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Competition Requirement	High	None

GCS Design

- **IQRASAT**

GS Diagram



Specifications

Battery Operating Time	Overheating Mitigation	Auto Update Mitigation
Our laptop battery is capable of operating more than whole mission, which is corresponds to 3 hours.	For preventing ultra sun effect from GS, we will use an umbrella. On the other hand the laptop fan is cooling the system sufficiently.	We have two options for auto update resolution. First, we will turn off updating and set it up as it will ask us when auto update needed. Secondly, we will scan the laptop before. We will remove any software that is found to have potential risk.

Antenna Model	Type	Gain [dBi]	Maximum Range[m]	Size [mm]	Price [$]
TP-LINK TL-ANT2414A 2.4Ghz 14dBi	Directional	14	5000	120x120x40	75.25
LB83002083	Yagi	15	8000	500x70x21	68.15
HG2409U	Omnidirectional	9	2400	322x20	58.76

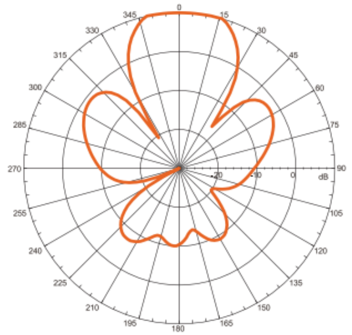
Chosen Antenna: TP-LINK TL-ANT2414A 2.4Ghz 14dBi

- CanSat payload is a spiral flight performing glider, that is why we have to chose directional or yagi type antenna.
- Selected antenna is a panel antenna.
- It has good gain and small size.
- To be compatible with XBee modules, only 2.4 GHz antenna models are considered.
- Antenna connector is Reverse Polarized SMA type.
- Antenna radiation pattern and setup is presented in the next slide.

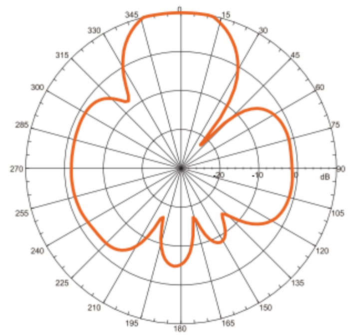
GCS Antenna Trade & Selection (2 of 2)

- **Radiation Pattern**

V-Plane Co-Polarization Pattern



H-Plane Co-Polarization Pattern

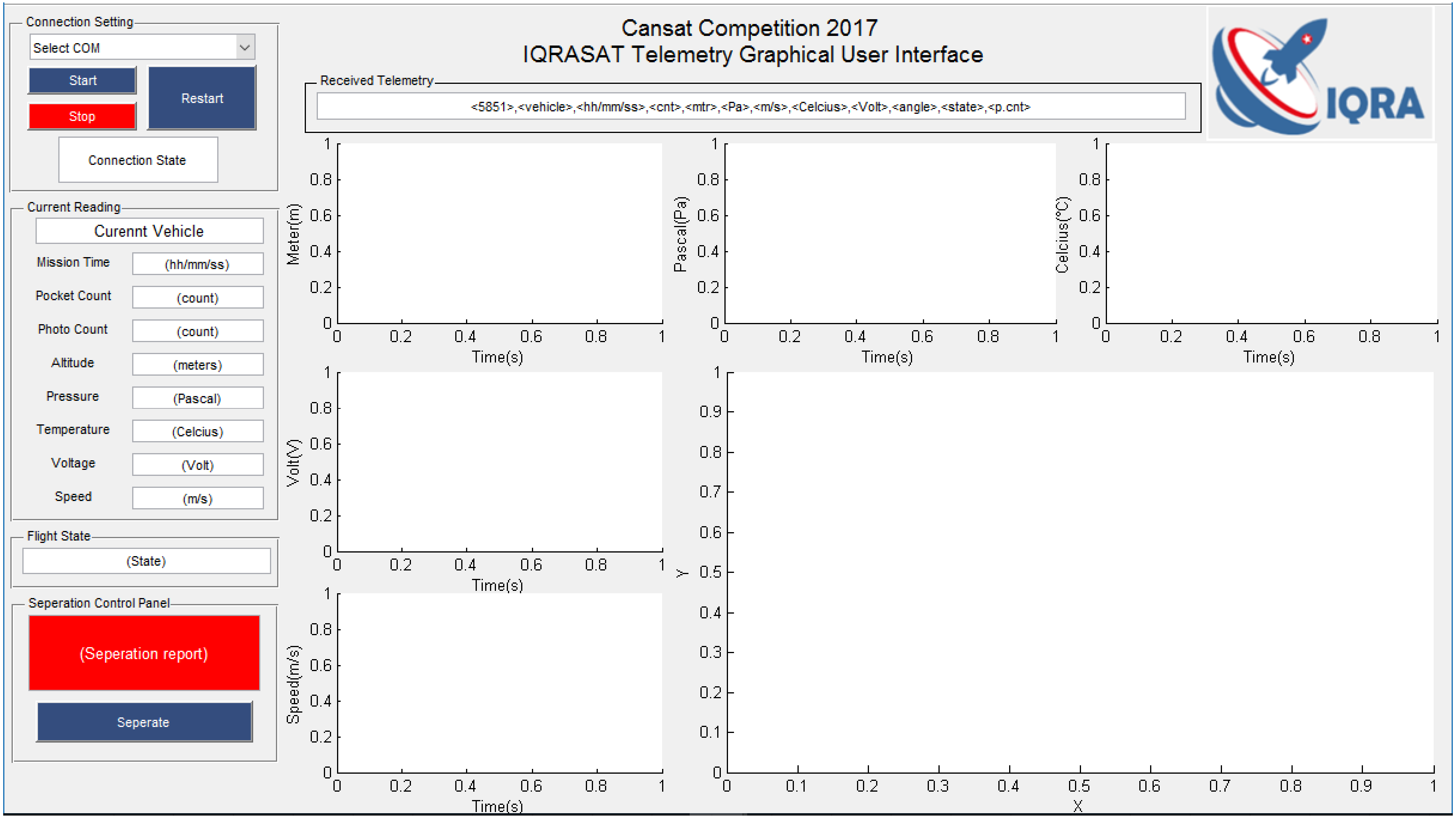


- **Antenna mast height and mounting strategy**
  - The antenna will be set up by extendable tripod.
  - Antenna is directional so it will be able to be manipulated by GS Crew member.
  - Using tape measure, length of setup will be verified.
- **Things To Consider**
  - While designing Ground Station of CanSat, every single parameter of system was brainstormed.
  - Exceptional cases besides foreseen ones shall be detected while range test.

GCS Software (1 of 2)

- **GCS application was decided to be designed using Matlab as it offers more strong plot functions.**
- **It will read received telemetry data periodically. Recreation of packets in FSW will cause updating of the GUI.**
- **No Commercial off-the-shelf (COTS) software will be used.**
- **The Simple Matlab GUI shall have several capabilities.**
  - Display full telemetry
  - Plot some parameters.
  - Save in .CSV or Excel file
  - Special dedicated command panel
- **Only one interface/GUI panel will present either container or glider telemetry.**
  - First, the container will be launched this time until glider separation the GUI will display container telemetry
  - After glider get separated from the re-entry container the simple application will project the glider telemetry
  - Special indicators will report both vehicle states (flight state, separation situation)
- **The GUI will utilize from cyclic interrupt for telemetry reading.**
  - When new data is available in serial port, the GUI will instantly implement the events.
  - This will also enable sending command to CanSat when it is not separated
- **The GUI will plot 2 dimensional map/trajectory of a glider using speed and compass values.**
  - First, x and y axis will be determined. X is considered as the max diameter of the glider landing area, whereas Y is altitude.
  - After the formulas, X = 400 - v*sin(a).*t, Y = v*cos(a).*t + 500   which specify the axis coordinates plotting will update every second.
  - v refers to received speed and a to direction.

GCS Software (2 of 2)



CanSat Integration and Test

SELİM ÖZTÜRK

CanSat Integration and Test Overview

CanSat Integration

Structure assembly → Electronic mounting → Glider DCS → Glider & Container → Parachute

1. Glider structure is 3D Printed. Solar panels will be placed on the fuselage.
2. First, electronic components will be mounted to the PCB. Then camera module and pitot tube will be mounted. The camera lens and pitot tube is stuck out. Also XBee wire antenna is stuck out.
3. Glider wing sticks will be integrated to fuselage. And kite will be mounted to wing sticks so that extendable wing sticks can harm the kite when they deploy. Magnets and rubber band will be mounted to wing sticks.
4. Glider wing will be folded and the kite will be folded safely so that it can deploy correctly. Ring behind the glider is attached to container rod. And the rod sifted to closed position. This part is extremely important thus right before launch container will be held by our hand the rod will be shifted to make sure that there is no mechanical problem in glider releasing.
5. Finally, the parachute will be attached to the container and folded in a container parachute section.

Subsystem Level Testing Plan

Subsystem	Tested Product	Test
Sensors	BMP280	• Take altitude samples with BMP280 from places with altitude difference. • Compare the same locations with Google Earth altitude. • Compare the temperature data of BMP280 with the thermometer.
	MPU-9250	• Compare the heading data of the sensor with the compass.
	Voltage Divider	• Compare the values displayed by the MCU with the values of the multimeter.
CDH	MCU	• Test communication with sensors. • Test processing power and memory sufficiency.
	DS1338	• Compare RTC data with computer time.
EPS	Solar Panel	• Measure the current and voltage values by connecting the load (rheostat) to panel.
Radio Communications	XBees	• Test communication with XCTU.
FSW	Software	• Test provide system requirements.
Mechanical	Separation Mechanism	• Test separation of payload under force.
Descent Control	Glider	• Test glide in a circular pattern with a drone.

Integrated Level Functional Test Plan

Glider Test

- After integrating all parts of the glider and the container some tests must be performed.
- First, we need to make sure that the solar panels are harvesting. Therefore first harvest test applied. The multimeter is connected to glider and is held in one hand, while the other hand holds the glider. We will flight the glider with our hand change the panel angle and see what is the voltage/current level.
- After all, glider shock/acceleration survival must be tested. Thus we will throw it from 15 meters height faculty building no matter where it will land, stone, rock etc.

Communications

- First, we must verify communication between sensors and MCU. Therefore, electronics will be connected to a PC and we will observe sensor subsystem working properly. Then we must verify CDH subsystem working. So XBee radios will be tested. Here also GS GUI will be tested.
- Finally one is the range test. at least 600 meters range we must see this range can only ensure mission success.

Mechanisms

- Separation mechanism testing will be done in such way. After CanSat wholly integrated. The entire system will be held in one hand and fled with our hand to right and left to simulate the real parachute descent. Then Remote command will be sent from GS and see whether there is any issue of in glider separation.

Deployment

- Deployment tests will be applied to wing opening parts. A rubber band of the glider must be renewed before the launch. And also the rubber band must be stretched a few times before the flight.

Environmental Test Plan

Test	Purpose	Procedure
Drop	• To generate 30Gs of shock to check • Parachute attachment point survival to violent rocket deployment. • Whether container holds glider inside it. • Every single component mounts survival, including battery mount.	I. Secure a 1 m rope to the ceiling (which is 2m up from ground). II. Secure the other end of rope to parachute attachment point of container. III. Raise CanSat up 80cm line with the rope. IV. Release and let it drop. V. Observe the result of the test. If there is no damage perform a functional test to check.
Thermal	• To verify CanSat can maintain up to 65 degree.	I. Generate a foam insulation chamber and place CanSat into the chamber. II. Seal the thermal chamber and turn on the hair dryer. III. Circulate hair dryer and heat the air in the chamber. IV. Monitor temperature and make sure temperature is range is 65 degrees. V. Maintain range for two hours. VI. Remove the CanSat and perform a visual inspection. Test any mechanisms and structure to make sure the integrity has not been compromised. VII. Perform functional tests to verify CanSat can operate as expected.
Vibration	• To verify workmanship of the glider and mounting integrity of all component such as battery, camera, actuator, PCB and other connections by generating 30Gs of shock and 15Gs of acceleration.	I. Turn the sander upside down and secure it in a bench vise. II. Perform a functional test of the CanSat. III. Place CanSat on the sand paper part of the sander and secure with duct tape. IV. Over one minute turn the sander on, wait two second to power up to full speed, turn off. As soon as sander stop moving repeat until one minute is complete. V. Remove CanSat from test fixture and inspect it for any damage. VI. Review accelerometer data to determine the intensity of the vibrations.

Mission Operations & Analysis

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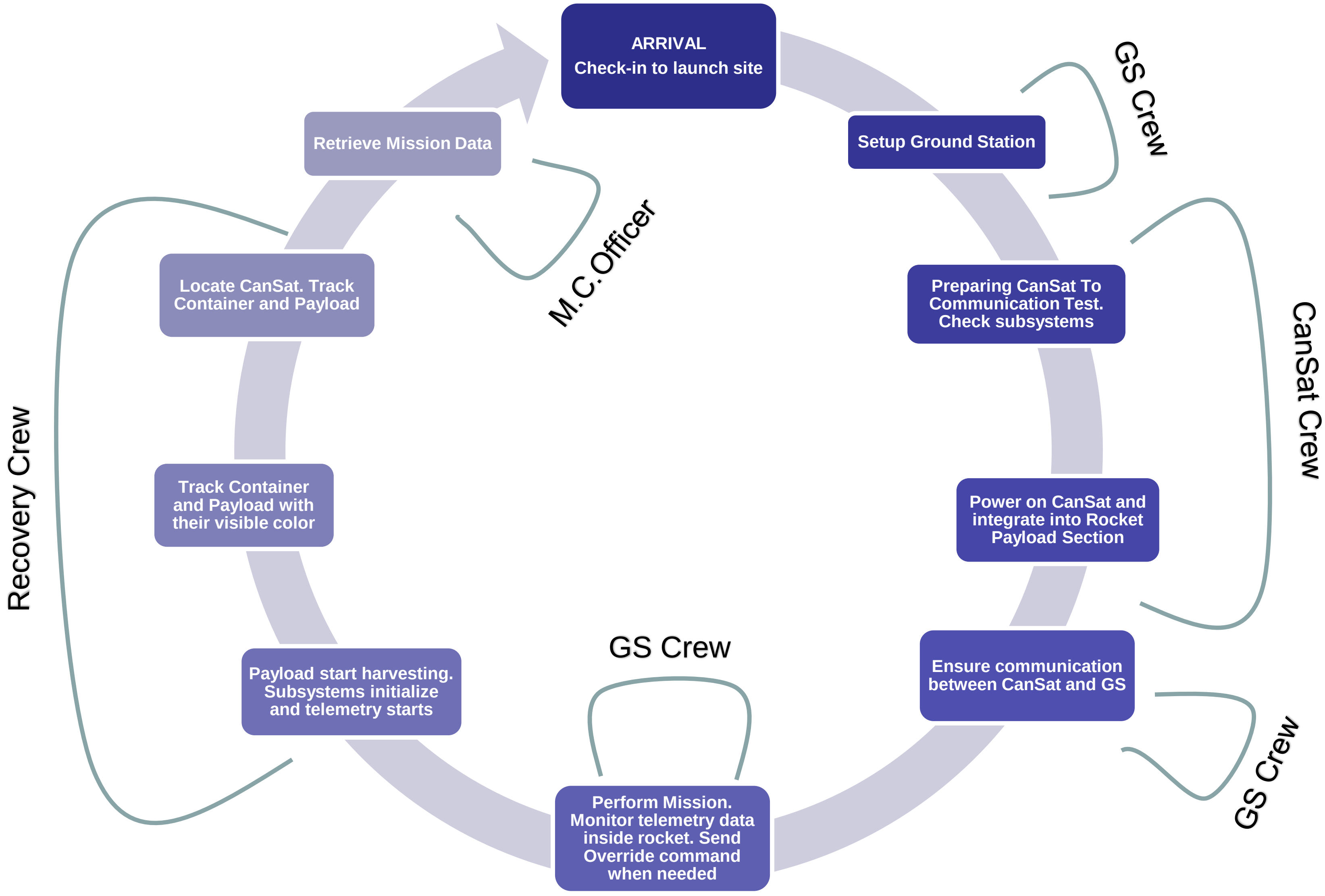
Overview of Mission Sequence of Events



Mission Operations Manual Development Plan

- The Mission Operations manual will be developed based on the provided competition mission operations manual.

- Checklist :
  - Ground Station Configuration
  - CanSat Preparation
  - CanSat Integration
  - Launch Preparation
  - CanSat Recovery

- The manual shall be revised and prepared again until CDR. Every detail related to mission day shall be included.

- Two copies will be ready before last day.

CanSat Location and Recovery

- **Container and Payload Recovery**
  - Container and Payload will be recovered using buzzers.
  - Florescent structure and orange parachute of container will help tracking and increase tractability.
  - The payload orange kite also will help recovery crew tracking.
  - Recovery crew will be well-coordinated and extra accurately track both vehicles.
  - Both vehicles will be labeled with team contact information.

The purpose of this section is to summarize and cross reference the compliance to the CanSat Competition Mission Guide requirements.

Requirements Compliance

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Requirements Compliance Overview

- ✓ Currently, our design meets mission requirements.
- ✓ However in order to maximize mission success we must conduct several different tests such as drop test, FSW functionality correctness, sensor accuracy, stable and spiral flight, RF range test and so on.

- ✓ Our system must survive rocket launch and deployment, that is why drop test from a high building is needed.

- ✓ Our FSW must be functioning correctly thus we will use interrupts for the software.
- ✓ The highest interrupt will be competition crush detection because FSW must realize any crush happening in FSW. And other interrupts for telemetry, Remote override command.

- ✓ Our choice for this year mission is triangular or delta wing glider. We all agreed that it is the simplest design for this year mission of competition.
- ✓ The trick here is to fit all this requirements into 300mm x 115mm can. For this, we firstly studied energy consumption of our payload and identify what dimension of solar panels we need for harvesting. We investigated high efficient solar panels.
- ✓ In the second semester, The final design which is triangular glider will be built and tested. In parallel to real life tests, in ANSYS software tool flight simulation will be done to collect more data for analyzing the vehicle flight characteristic.

Requirements Compliance (1 of 6)

Rqmt Num	Requirement	Comply No Comply Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
1	Total mass of the CanSat (container and glider) shall be 500 grams +/- 10 grams.	Comply	58	Probably, we shall add modular weight to our Container
2	The glider shall be completely contained in the container. No part of the glider may extend beyond the container. One circular end of the cylindrical container may be open (no door enclosure is required); however, the glider may not extend outside the container.	Comply	17 19	Win sticks are completely fitting inside container. No part is extend
3	Container shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length including the container passive descent control system. Tolerances are to be included to facilitate container deployment from the rocket fairing.	Comply	17 19	Constructional clearance is left
4	The container shall use a passive descent control system. It cannot free fall. A parachute is allowed and highly recommended. Include a spill hole to reduce swaying.	Comply	30 33	Parachute controls container descent
5	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section.	Comply	53 54	Cylindrical shape
6	The container shall be a florescent color, pink or orange.	Comply	54	Florescent color
7	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Comply	54	
8	The rocket airframe shall not be used as part of the CanSat operations.	Comply	54	

Requirements Compliance (2 of 6)

Rqmt Num	Requirement	Comply No Comply Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
9	The CanSat (container and glider) shall deploy from the rocket payload section.	Comply	18	
10	The glider must be released from the container at 400 meters +/- 10m.	Comply	90	Servo triggered shift-rod mechanism
11	The glider shall not be remotely steered or autonomously steered. It must be fixed to glide in a preset circular pattern of no greater than 1000 meter diameter. No active control surfaces are allowed.	Partial	37	Tests need to be done
12	All descent control device attachment components shall survive 30 Gs of shock.	Partial	33	Tests need to be done
13	All descent control devices shall survive 30 Gs of shock.	Partial	33, 55, 57	Tests need to be done
14	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	Comply	57	
15	All structures shall be built to survive 15 Gs acceleration.	Partial	57	Tests need to be done
16	All structures shall be built to survive 30 Gs of shock.	Partial	57	Tests need to be done
17	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	57	

Requirements Compliance (3 of 6)

Rqmt Num	Requirement	Comply No Comply Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
18	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Partial	57	To ensure this, we must freefall our CanSat from Faculty building
19	Mechanisms shall not use pyrotechnics or chemicals.	Comply	56	No pyro/chemical
20	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	56	No mechanism use heat
21	During descent, the glider shall collect air pressure, outside air temperature, compass direction, air speed and solar power voltage once per second and time tag the data with mission time.	Comply	21=28 88	Glider equipped with proper sensors
22	During descent, the glider shall transmit all telemetry. Telemetry can be transmitted continuously or in bursts.	Comply	69, 88	Continuous mode
23	Telemetry shall include mission time with one second or better resolution, which begins when the container and glider is powered on. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Comply	70,89	When processor reset RTC shall retrieve the time
24	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	66, 68	2.4Ghz radios are used
25	XBee radios shall have their NETID/PANID set to their team number.	Comply	68	TeamID to NETID
26	XBee radios shall not use broadcast mode.	Comply	68	Multicast mode

Requirements Compliance (4 of 6)

Rqmt Num	Requirement	Comply No Comply Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
27	The glider electronics must be all solar powered except for the time keeping device may use a coin cell battery. No batteries are allowed. Super capacitors are allowed and must be fully discharged at launch.	Comply	82	Solar panels provide sufficient energy
28	Cost of the CanSat shall be under $1000. Ground support and analysis tools are not included in the cost.	Comply	119, 120	
29	Each team shall develop their own ground station.	Comply	93-100	
30	All telemetry shall be displayed in real time during descent.	Comply	99, 100	Our GUI catch up all incoming telemetry using events and brought shows
31	All telemetry shall be displayed in engineering units (meters, meters/sec,Celsius, etc.)	Comply	100	
32	Teams shall plot each telemetry data field in real time during flight. In addition, the ground system shall display a two dimensional map of estimated glider position based on speed and heading telemetry data.	Comply	100	Even under ultra sunlight, human eye can observe our GUI graphs change
33	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBee radio and a hand held antenna.	Comply	95, 96	
34	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line. AC power will not be available at the ground station operation site.	Comply	95, 96	Lenovo Yoga laptop tripod antenna is whole thing
35	Both the container and glider shall be labeled with team contact information including email address.	Comply	109	It will be done

Requirements Compliance (5 of 6)

Rqmt Num	Requirement	Comply No Comply Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
36	The flight software shall maintain a count of packets transmitted, which shall increment with each packet transmission throughout the mission. The value shall be maintained through processor resets.	Comply	70	The value shall be written to EEPROM and retrieved from there in case of reset
37	No lasers allowed.	Comply		We don't need laser
38	The glider must include an easily accessible power switch which does not require removal from the container for access. Access hole or panel in the container is allowed.	Comply	Payload trade selection	
39	The container shall contain electronics and mechanisms to release the glider at the required altitude.	Comply	56, 90	Shift-rod
40	The container electronics shall be powered by only alkaline batteries.	Comply	81	Glider and container power sources are ecofriend
41	The glide duration shall be as close to 2 minutes as possible.	Partial	41	Tests need to be done
42	The CanSat container shall have a payload release override command to force the release of the payload in case the autonomous release fails.	Comply	100	
43	Glider shall be a fixed wing glider. No parachutes, no parasails, no parafoils, no auto-gyro, no propellers. Hang glider design where the electronics section has a hard attachment point is allowed.	Comply	15, 37	Our spectacular delta wing glider
44	The glider shall use a time keeping device to maintain mission time. The time keeping device can use a small coin cell battery.	Comply	64	RTC has it

Rqmt Num	Requirement	Comply No Comply Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
45	The time keeping device battery shall be a coin cell battery with a capacity limit of 240 mAh and with no more than a 1 ma discharge rate.	Comply	64	
46	The container shall transmit telemetry from the time being turned on and placed on the launch pad until 2 seconds after releasing the glider.	Comply	90	
47	The container telemetry shall be tramsmitted once per second.	Comply	90	
48	The container telemetry shall include team number, indication of container telemetry, altitude, temperature and software state.	Comply	71	
49	An audio beacon for the glider shall be included and powered off of the solar power.	Partial	82, 89	No sure how glider will land
50	An audio beacon is required for the container.	Comply	84, 90	

Management

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CanSat Budget – Hardware

Electrical Costs			
Descriptiona	Quantity	Price[$]	Status
Arduino Pro Mini (C&P)	2	5.15	Actual
XBee s2c (P)	2	38	Actual
XBee Pro s2c (C)	1	25	Actual
BMP280 – pressure sensor for pitot tube (P)	2	6	Actual
BMP280 – (pressure+ compass) (C&P)	1	32.07	Actual
Servo Motor (C)	1	3.28	Actual
RTC DS1338 (C&P)	1	2.85	Actual
LS-Y201 Camera mod. (P)	1	45	Actual
5.5V Solar panel(P)	1	7.95	Actual
Buzzer (C&P)	2	1.18	Actual
9V Battery (C)	1	4	Actual
SD card socket (C&P)	1	2.25	Actual
SD card (C&P)	1	6.50	Actual
Supercapacitor (P)	-	20	Estimated
Subtotal		**277.25**	Estimated

Mechanical Costs			
Description	Quantity	Price[$]	Status
Ripstop nylon (C&P)	4 merer	62.45	Actual
Rubber band (P)	N/A	8.16	Actual
Swivel (C)	1	12.05	Actual
ABS filament (P)	0.5 Kg	17.33	Actual
Screw, nuts etc. (C&P)	N/A	20	Estimated
Rocket Payload Section	1	25	Estimated
Spring (P)	1	4.15	Estimated
Neodymium magnets(P)	1	2.14	Actual
Other parts (C&P)	1	20	Estimated
Subtotal		**172.68**	Estimated

- No component is reused from previous years.
- C - Container
- P - Payload

Total CanSat Budget: 451.93

CanSat Budget – Other Costs

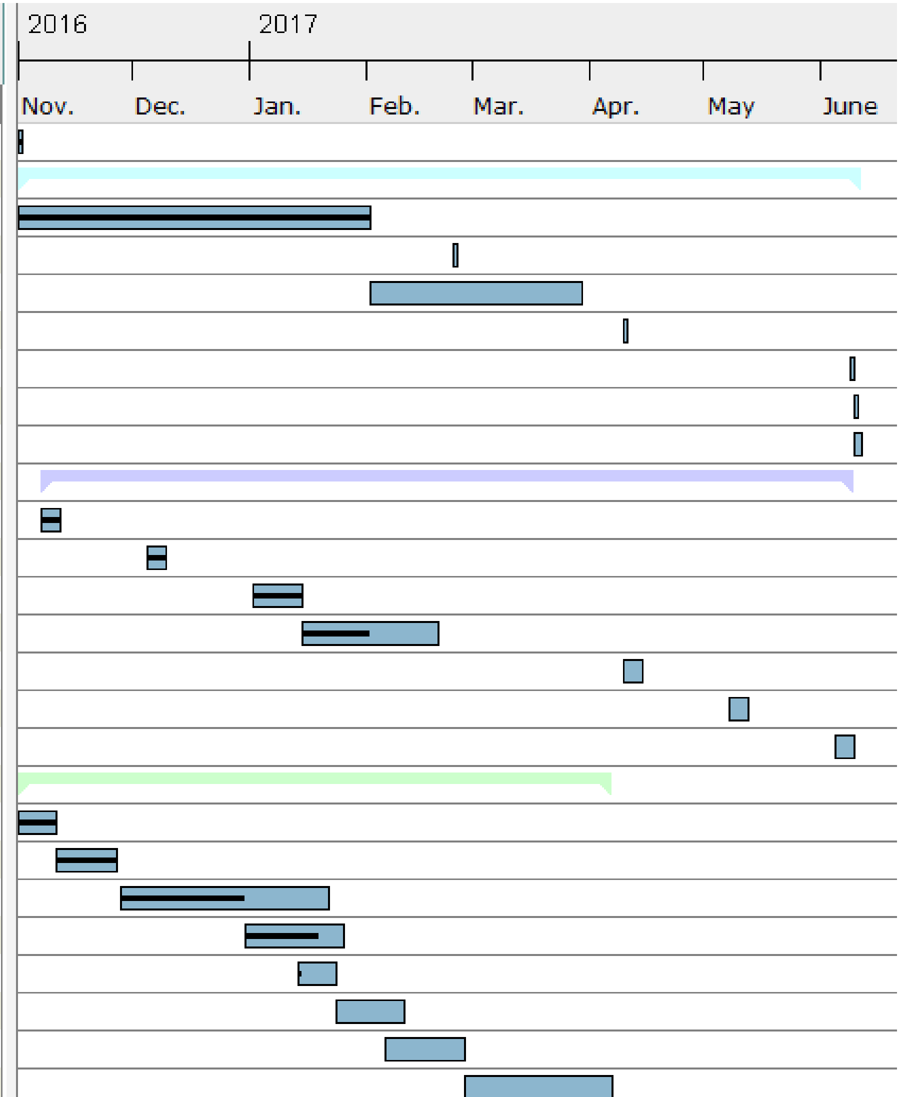
Ground Control System Costs			
Description	**Quantity**	**Price[$]**	**Status**
XBee Pro S2c	1	43	Actual
TP-LINK TL-ANT2414A panel antenna	1	75	Actual
Mounting hardware	N/A	25	Actual
Other Costs			
Prototyping % Testing	N/A	500	Estimated
Competition Attendance Fee	1	100	Actual
Travel	6 (person)	700	Estimated
Hotel	6 (days)	75	Estimated
Food	6 (person)	120	Estimated
Car Rental	3 (days)	100	Estimated
	Subtotal	1438	

- Total funding from the university is 2000$. This funding includes components ordered, 3D & PCB printing and laboratory & test facilities.
- For travel and following costs, sponsors are contacted. We will specify this until CDR.

Description	Cost[$]
CanSat Hardware	451.93
Ground Control System	143
Other Costs	6270
Total	6864.93

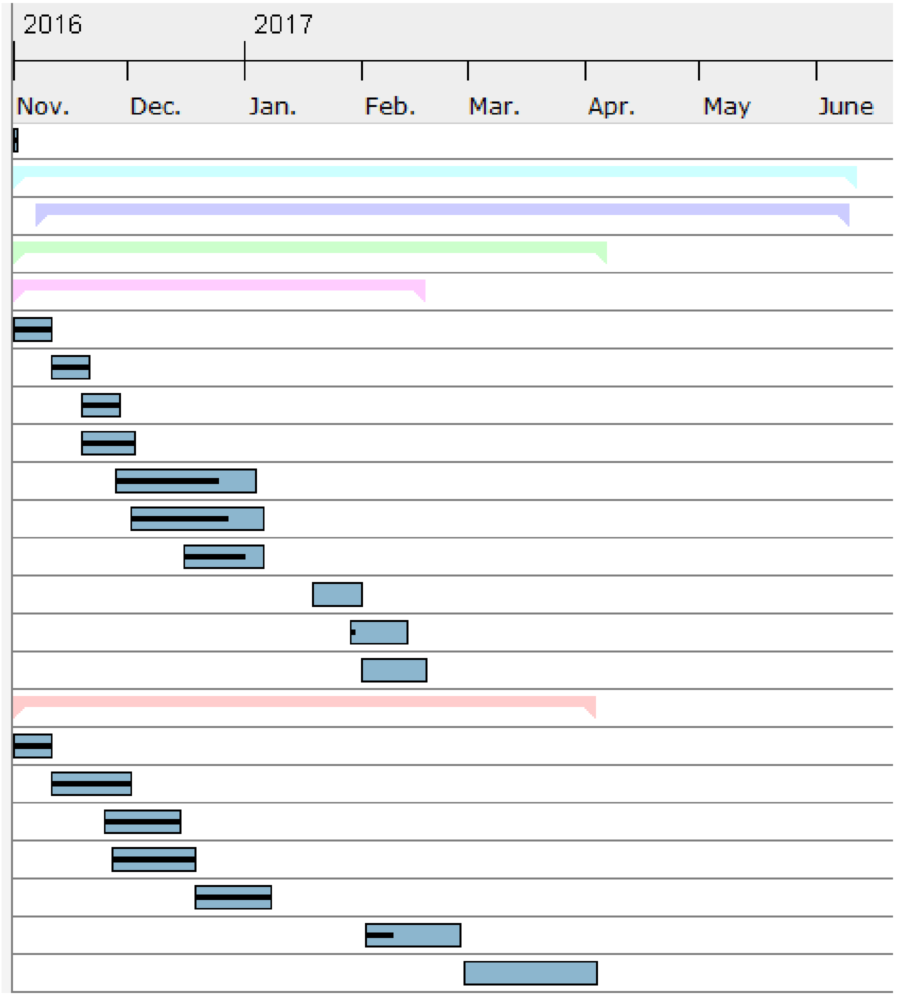
Program Schedule (1 of 2)

Mission	Start	Finish	Comp.
Start of CanSat	01.11.2016	01.11.2016	100
Competition Milestones	01.11.2016	11.06.2017	60
PDR	01.11.2016	01.02.2017	100
PDR Teleconference	24.02.2017	24.02.2017	0
CDR	02.02.2017	29.03.2017	0
CDR Teleconference	10.04.2017	10.04.2017	0
The Preflight Briefing	09.06.2017	09.06.2017	0
Launch	10.06.2017	10.06.2017	0
PFR	10.06.2017	11.06.2017	0
Academic Milestones and Holidays	07.11.2016	09.06.2017	55
1st Midterm Fall Semester	07.11.2016	11.11.2016	100
2nd Midterm Fall Semester	05.12.2016	09.12.2016	100
Final Exam Fall Semester	02.01.2017	14.01.2017	100
Semester Holiday	15.01.2017	19.02.2017	50
1st Midterm Spring Semester	10.04.2017	14.04.2017	0
2sd Midterm Spring Semester	08.05.2017	12.05.2017	0
Final Exam Spring Semester	05.06.2017	09.06.2017	0
Software Team Schehude	01.11.2016	06.04.2017	40
Reviewing Mission Guide	01.11.2016	10.11.2016	100
Design of FSW Algorithm	11.11.2016	26.11.2016	100
Design of GCS	28.11.2016	21.01.2017	60
XBEE Configuration Settings	31.12.2016	25.01.2017	75
Testing Communication XBEE	14.01.2017	23.01.2017	10
Reading Data from Sensors	24.01.2017	10.02.2017	0
Design of FSW	06.02.2017	26.02.2017	0
Improve FSW	27.02.2017	06.04.2017	0



Program Schedule (2 of 2)

Mission	Start	Finish	Comp.
Start of CanSat	01.11.2016	01.11.2016	100
Competition Milestones	01.11.2016	11.06.2017	60
Academic Milestones and Holidays	07.11.2016	09.06.2017	55
Software Team Schehude	01.11.2016	06.04.2017	40
Electrical Team Schedule	01.11.2016	17.02.2017	63
Reviewing Mission Guide	01.11.2016	10.11.2016	100
Reviewing Electronic Structure	11.11.2016	20.11.2016	100
Select of Sensors	19.11.2016	28.11.2016	100
Select of Solar Cell	19.11.2016	02.12.2016	100
Design Electronic System	28.11.2016	03.01.2017	75
Design Electrical System	02.12.2016	05.01.2017	75
Design of Pcb	16.12.2016	05.01.2017	80
Testing Pcb	19.01.2017	31.01.2017	0
Testing Electrical System	29.01.2017	12.02.2017	10
Testing Electronic System	01.02.2017	17.02.2017	0
Mechanical Team Schedule	01.11.2016	03.04.2017	65
Reviewing Mission Guide	01.11.2016	10.11.2016	100
Reviewing Mechanic structures of Systems	11.11.2016	01.12.2016	100
Research Plane Construction Materials	25.11.2016	14.12.2016	100
Research Plane Construction Tools	27.11.2016	18.12.2016	100
Design Mechanic System	19.12.2016	07.01.2017	100
Testing Mechanic System	02.02.2017	26.02.2017	30
Improve Mechanic System	28.02.2017	03.04.2017	0



Conclusions

Major Accomplishments

- First Team tried to understand the mission guide clearly. And simultaneously we made solid research.
- Several different configurations were considered and two important designs were prototyped and tested.
- Energy harvesting and power management strategy were designed.
- All components were ordered and is expected to receive till PDR teleconference.
- FSW was designed and is under development.

Major Unfinished Work

- Energy harvesting system must be tested.
- All sensors must be verified and integrated into main FSW.
- More tests with quadcopter must be conducted continuously, over and over again to verify system integrity
- PCB design must be finished.
- FSW will be finished.

In conclusion, Whole system is preliminary designed. Entire FSW functions were listed. For the next stage we need components to test. And they are ordered. Right after the components are received the overall CanSat system will be developed and tested continuously including both environmental and guide tests. We deeply believe that we will represent our country proudly.

Thank You