CanSat 2016
Preliminary Design Review (PDR)
Version 2.0

Team # 3640

Triton CanSat

Presentation Outline

- Systems Overview – Angelica Deguzman
- Sensor Subsystem Design – Satyam Patel
- Descent Control Design – Shraddha Gharmalkar
- Mechanical Subsystem Design – Shraddha Gharmalkar
- Communication and Data Handling (CDH) Subsystem Design – Satyam Patel
- Electrical Power Subsystem (EPS) Design – Satyam Patel
- Flight Software (FSW) Design – Satyam Patel
- Ground Control System (GCS) Design – Satyam Patel
- CanSat Integration and Test – Shraddha Gharmalkar
- Mission Operations and Analysis – Angelica Deguzman
- Requirements Compliance – Angelica Deguzman
- Management – Angelica Deguzman

Team Organization

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Project Manager
Junior

Mark Anderson
Faculty Adviser

Derek Ung
Technical Adviser

Shraddha Gharmalkar
Mechanical Team Lead
Junior

- Ronald Zarotsky, Junior
- Stephen Northway, Freshman
- Christian Ramirez, Sophomore
- William Heyman, Freshman

Satyam Patel
Electrical Team Lead
Junior

- Winson Quan, Junior
- Lin Hein, Sophomore
- Sabrina Trinh, Senior

Acronyms

A – Analysis
CDH – Communication and Data Handling
D – Demonstration
DCS – Descent Control System
EPS – Electrical Power Subsystem
FSW – Flight Software
GCS – Ground Control System
GPS – Global Positioning System
I – Inspection
MS – Mechanical Subsystem
Req – Requirement
SR – System Requirement
SS – Sensor Subsystem
T – Test
VM – Verification Method

Systems Overview

Angelica Deguzman

Mission Summary

- Cansat will consist of container and glider
- Container will protect the glider during rocket launch and after rocket deployment
- Glider shall separate from the container and descend in a circular pattern of less than 1000 m
- The glider will collect air pressure, temperature, and GPS position and send data to GCS at a rate of 1 Hz
- Air speed of glider will be collected with a pitot tube and will be compared to GPS velocity
- The glider will take a picture of the ground at the request of a judge and shall be retrieved after landing
- Telemetry packet will include time of last command received and number of times it was received
- Transmission will stop after the glider lands and audio beacon will activate

❖ Bonus objective: Have not decided on the pursuit of a bonus objective yet.

System Requirement Summary

ID	Requirement	Rationale	Priority	Children	VM
SR-1	Total mass of the CanSat shall be 500 +/- 10 grams	Sets constraints on material choice, dimensioning, and costs	High	MS-1	D,A
SR-2	Glider will be completely contained in container	Protects glider from environment and constrains dimensions	High	DCS-5, MS-2	I,D,T
SR-3	Container dimensions must fit in 125 mm diameter x 310 mm length, including tolerances.	Limits glider dimensions, and tolerances ensure rocket fitting	Medium	MS-3	D,I
SR-4	Container must use a passive descent control system	Allows cansat to descend safely at a constant velocity	Medium	DCS-3	A,D,T
SR-5	The container shall not have sharp protrusions	Container will not get stuck in payload section of rocket	Medium	MS-4	D
SR-6	Container shall be florescent pink or orange	Ensures easy retrieval of container after landing (visible)	Low	MS-5	D,I
SR-7	Rocket airframe will not be used for CanSat performance	Makes sure that CanSat can operate independently	Medium	MS-6	D
SR-8	CanSat will deploy from payload section	Dictates how CanSat will separate from the rocket	Low	MS-7	A,I
SR-9	Glider will be released at 400 +/- 10 m	Competition requirement	High	FSW-7, DCS-1	T,A,D
SR-10	Glider will be a fixed wing and follow a circular pattern of less than 1000 m	Competition requirement	High	DCS-2	D,I

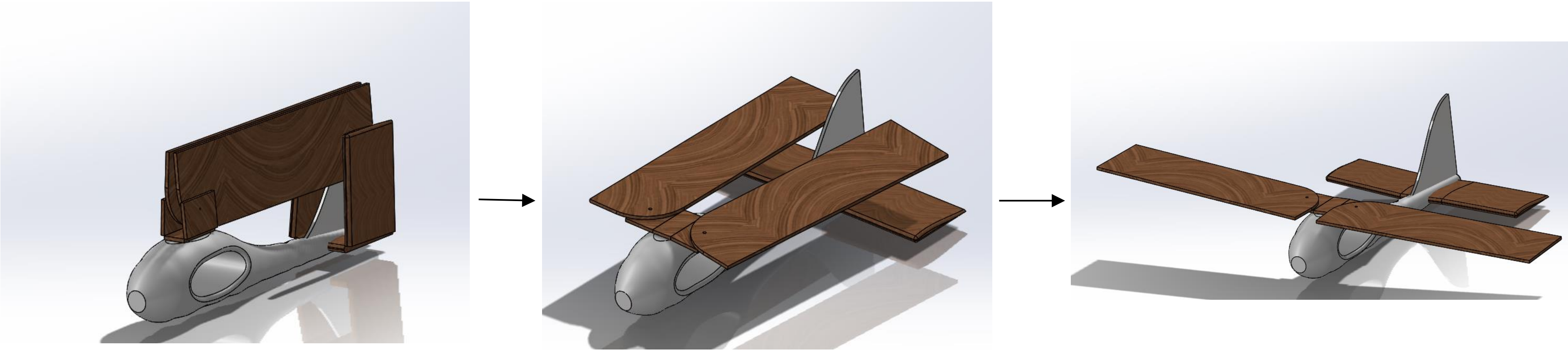
System Requirement Summary

ID	Requirement	Rationale	Priority	Children	VM
SR-11	All CanSat components must survive 30 Gs of shock and 15 Gs of acceleration	Tests confirm if CanSat can withstand rocket launch and separation	Medium	MS-15	I,A
SR-12	All electronics must be properly mounted and shielded	Protects sensors from the environment and ensures CanSat remains functional	Medium	SS-1, MS-8	D
SR-13	Glider will collect air pressure, temperature, and battery voltage at a rate of 1 Hz and transmit data to GCS	Competition requirement	High	SS-2 CDH-1 FSW-1 GCS-3	T,I,A,D
SR-14	Telemetry begins when glider is turned on and mission time shall be collected	Competition requirement	High	CDH-2	D,I
SR-15	XBEE radios shall be used for telemetry data	Competition requirement	High	CDH-3	T,A
SR-16	Glider will have imaging camera pointed at the ground with a minimum of 640x480 pixels in color	Competition requirement	High	SS-3	I
SR-17	Cost of CanSat will be less than $1000	Ensures project is affordable and allows teams to create a budget	Medium	SS-4, MS-9	I
SR-18	Teams will build their GCS with telemetry plotted in real time in engineering units	Teams can see the progress of their CanSats in real time	High	GCS-1	T,D

System Requirement Summary

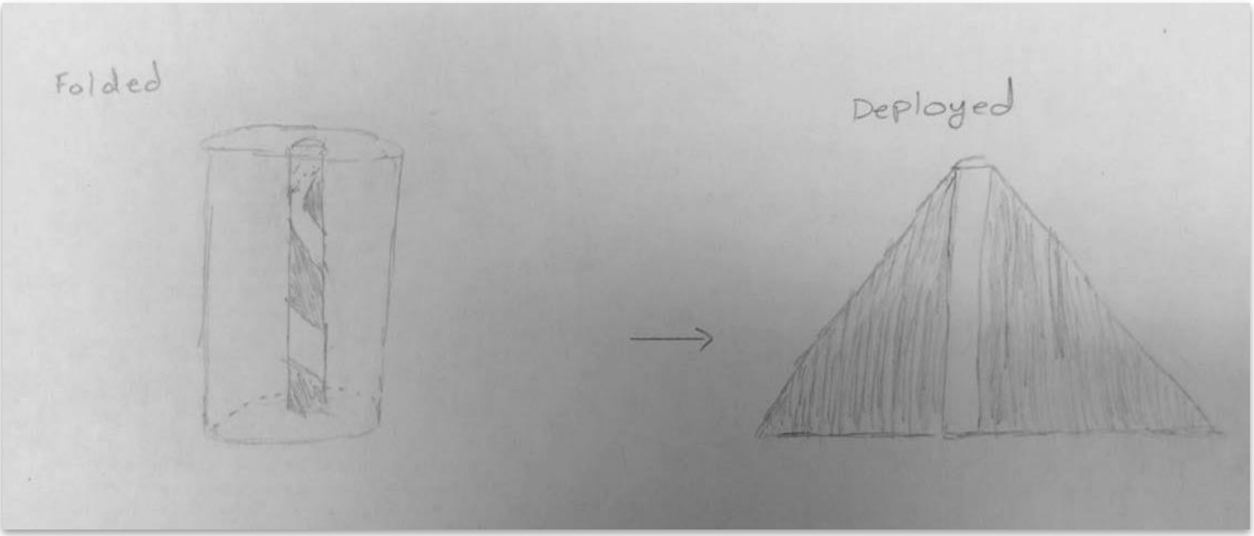
ID	Requirement	Rationale	Priority	Children	VM
SR-19	GCS must be portable and have at least two hours of battery life	Allows for an ease of operation during competition	Low	GCS-2	D,I
SR-20	Container and glider will be labeled with team contact information	Ensures team retrieval of CanSat	Low	None	I
SR-21	Glider will have an accessible power switch	Allows for easy access for powering the glider	Medium	EPS-1	D
SR-22	Camera will capture and image by command and save for retrieval	Competition requirement	High	FSW-5	D,I
SR-23	Glider will have a pitot tube and will compare actual and GPS velocity	Competition requirement	High	SS-5	D,A,T,I
SR-24	CanSat will have an override system	In case release mechanism fails	Medium	CDH-4 FSW-6	D
SR-25	Audio beacon will turn on after glider lands	In order to locate the glider	Medium	FSW-9	D,I
SR-26	Glider duration will be approximately 2 minutes	Ensures glider will not just nose dive	High	DCS-6	A,I,D,T
SR-27	Glider will use a fixed wing mechanism	No parachute, rotary aircraft, or parasails.	Medium	DCS-7, MS-14	D,T,A

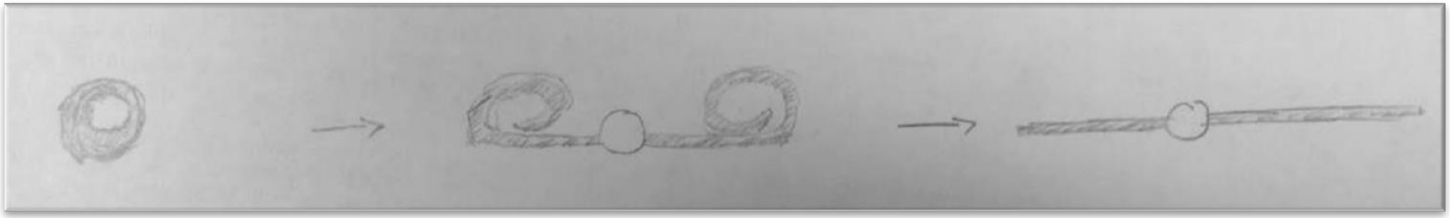
Configuration 1	Description	Pros	Cons
Conventional Glider	- Two sets of spring loaded hinges for wing, one for horizontal tail - Foldable rigid wings and horizontal tail. Wing materials consists of balsa.	- Easily balanced - Dynamically stable	-Many mechanisms need to be implemented



System Level CanSat Configuration Trade & Selection

Configuration 2	Description	Pros	Cons
Delta Glider	-Spring steel loaded wings. -Wing material consists of cloth.	-Easily fitted into container	-Prone to wing flight instability -Difficulty in fitting electronics

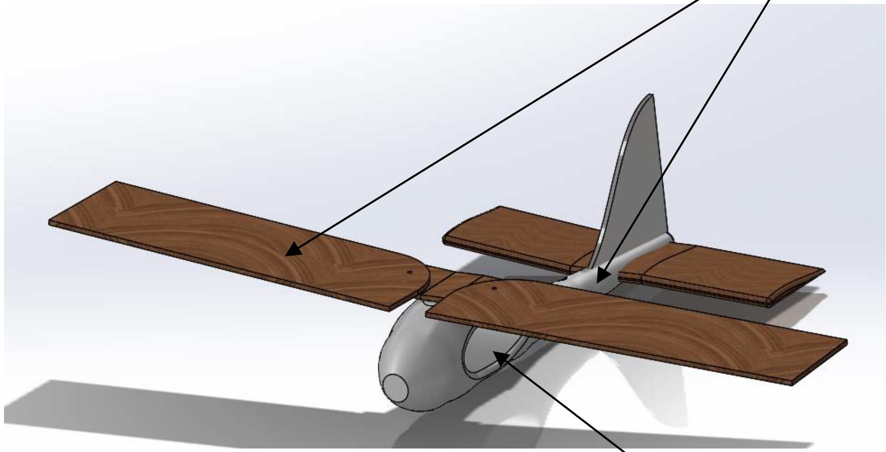




System Level CanSat Configuration Trade & Selection

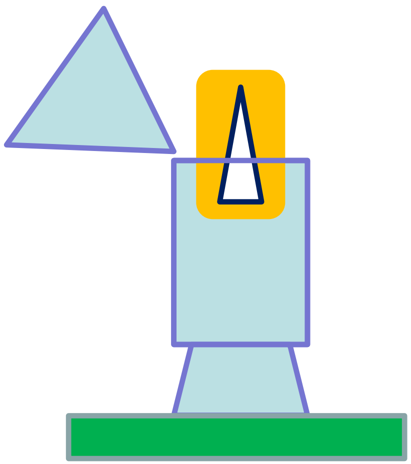
Configuration Chosen	Rationale
Configuration 1 Conventional Glider	- More stable during flight - Easier to integrate with electronics - Easier access to materials - Easier to fabricate

Balsa for wings, foam for fuselage. Easier materials to obtain compared to spring steel. Easier to fabricate compared to spring steel.

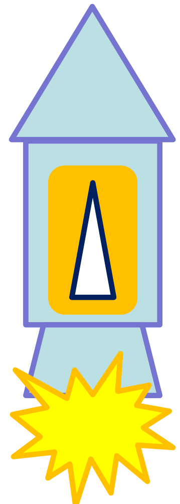


Easier to integrate electronics

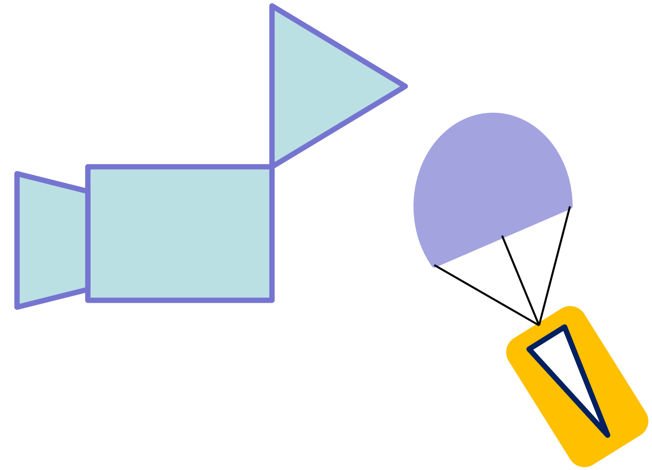
System Concept of Operations



Pre-Launch
- Final check on CanSat
- Glider is turned on
- CanSat is fitted into rocket payload section
- GCS is set up
- CanSat begins collecting telemetry data

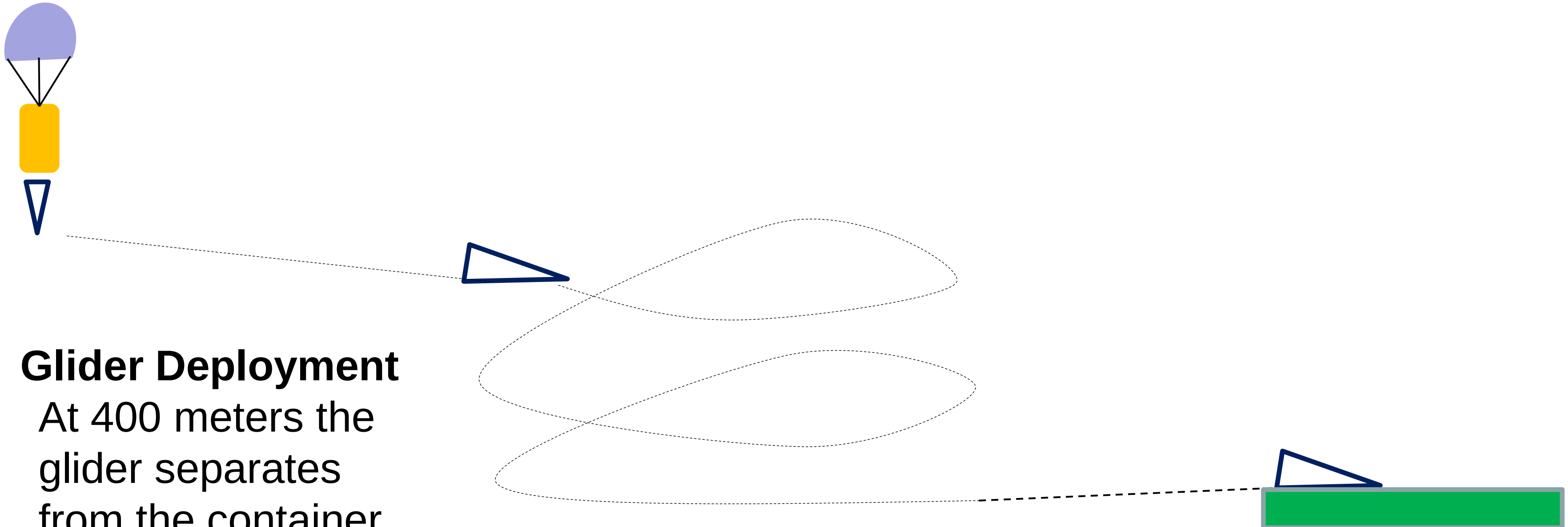


Launch
- CanSat continues to receive telemetry data
- Data is transmitted in real time and plotted in GCS



Rocket Separation
- Rocket ejects CanSat from payload section
- CanSat parachute is deployed
- CanSat decelerates

System Concept of Operations



Glider Deployment

- At 400 meters the glider separates from the container with the release mechanism
- The glider begins collecting air pressure, temperature, GPS data, and airspeed

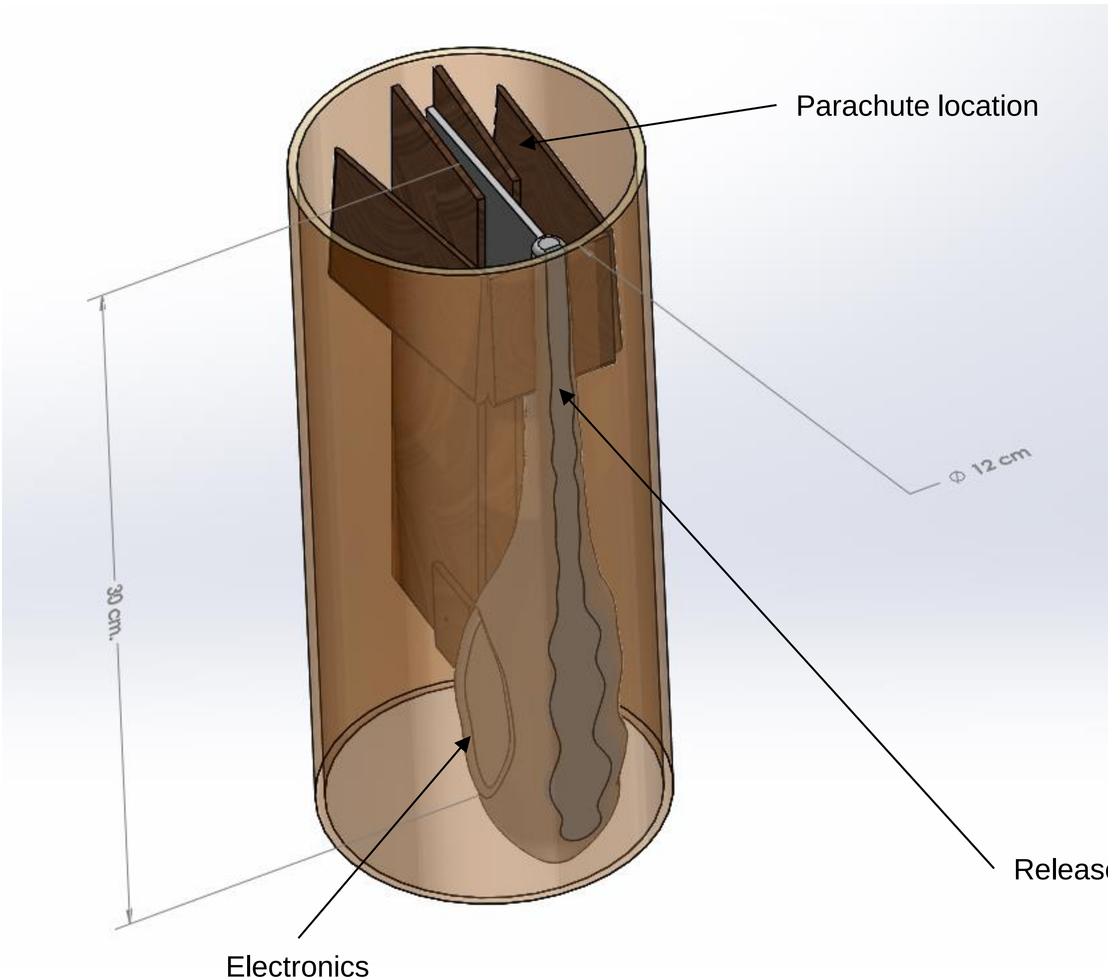
Glider Flight

- Glider levels out while container descends with parachute
- Glider flies in a circular pattern less than 1000 m in diameter
- Captures an image at the discretion of the judge and stores it on board
- Glides in air for about 2 minutes

Landing

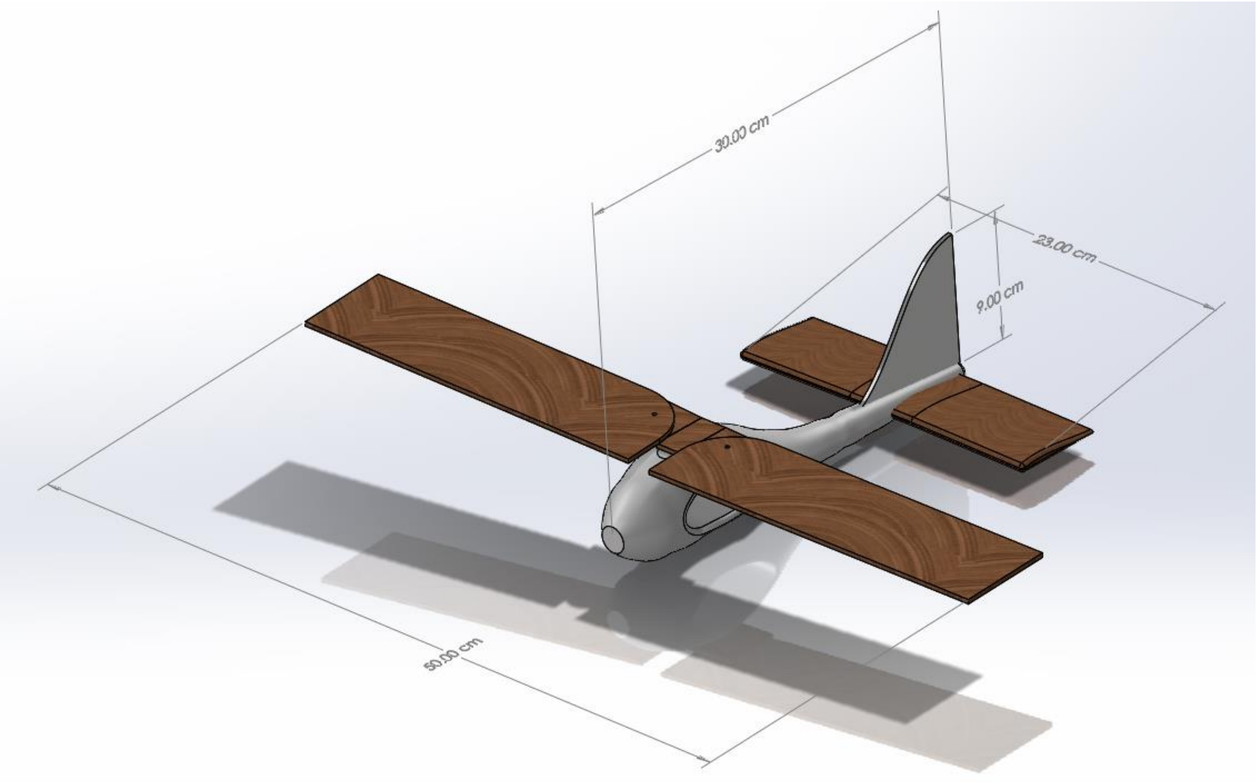
- Glider lands on ground
- Transmission of telemetry data ends
- Audio beacon turns on
- Retrieve CanSat and extract data

Physical Layout



- Launch Configuration
  - Parachute will be on top
  - Payload front section will be placed facing the bottom
  - Release mechanism will be at the tail of the glider
  - Wings will be folded
  - Electronics will be in the gap

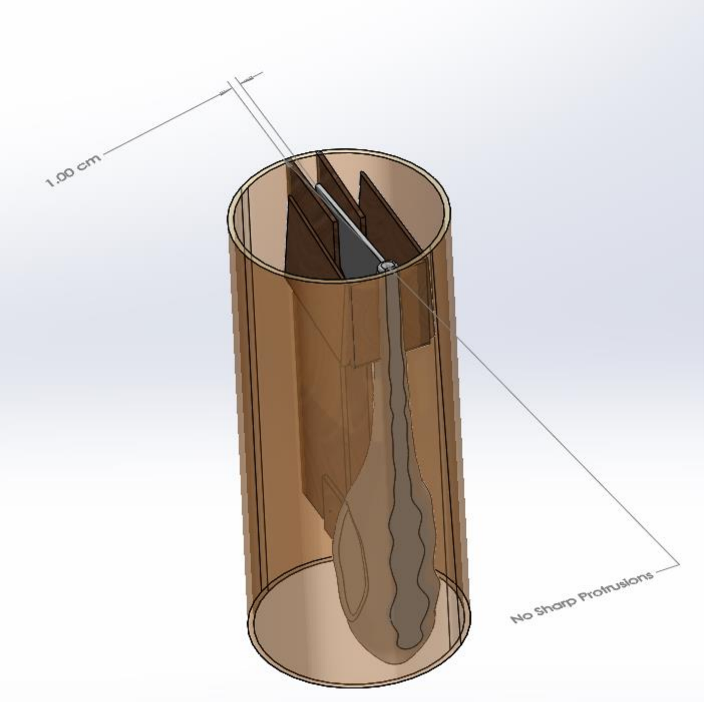
Physical Layout



- Deployed Configuration
  - Wing and horizontal stabilizer are open
  - Electronics are within the gap

Launch Vehicle Compatibility

- CanSat will be placed upside down in the payload section of the rocket
  - This is so that when the rocket ejects the payload section, the cansat will descend in the correct orientation.
- Payload section compatibility will be verified at competition
  - Integrated CanSat will be placed inside rocket payload section to ensure that it can easily slide in and out



- Clearances
  - Clearance between payload and container included (1.00cm)
  - Wing edges will be filleted to avoid sharp protrusions

Sensor Subsystem Design

Satyam Patel

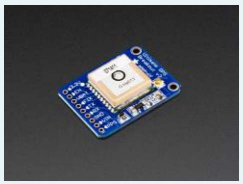
Sensor Subsystem Overview

Name	Sensors	Use	Location
Pololu Sensor Package	Gyro, Accelerometer, Compass, barometer, Temperature	Used for Altitude and temperature sensing. Also useful for orientation.	Payload
3DR Pitot Tube	Differential pressure sensor	Used for calculating airspeed	Payload
Adafruit GPS	GPS	Used for determining position	Payload
Adafruit serial Camera	Camera	Used for taking images of the ground.	Payload
Photoiode	Photoiode	Used for communication between cansat and container for release	container

Sensor Subsystem Requirements

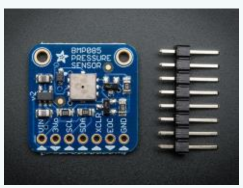
ID	Requirement	Rationale	Priority	Parent	VM
SS-1	All electronics must be properly mounted and shielded	Protects sensors from the environment and ensures their functionality	Medium	SR-12	D
SS-2	Glider will collect air pressure, temperature, and battery voltage at a rate of 1 Hz and transmit data to GCS	Outlines which sensors are needed to collect required telemetry data	High	SR-13	T,A,I
SS-3	Glider will have imaging camera pointed at the ground with a minimum of 640x480 pixels in color	Pixel requirement ensure a clear enough image of the ground during competition	High	SR-16	T,D
SS-4	Cost of CanSat will be less than $1000	Sensors must be budgeted accordingly	Medium	SR-17	I
SS-5	Glider will have a pitot tube and will compare actual and GPS velocity	Competition requirement	High	SR-23	D
SS-6	CanSat will use microcontroller to collect data from the sensors	Team requirement	High	None	T,A,I
SS-7	Sensors will need collect accurate data	Optimizations in sensor capability will improve the overall CanSat	Medium	None	I
SS-8	Glider will need a GPS receiver	GPS will be used to gather position and velocity of the glider	High	None	T

GPS Receiver Trade & Selection

GPS Model	Specifications	Pros	Cons
Adafruit Ultimate GPS V3 	-165 dBm sensitivity 10 Hz updates 66 channels 5V input 20mA current draw 7.1 grams	Low current Draw High update rate Low weight	High price
EM-506 	-163dBm sensitivity 48 channels 5V input 55mA current draw 16 grams	Smaller size	High current draw High price High weight

GPS Model Chosen	Rationale
Adafruit Ultimate GPS 	Lower current draw, and weight, as well as higher sensitivity.

Air Pressure Sensor Trade & Selection

Air Pressure Sensor	Specifications	Pros	Cons
Pololu AltImu 	0.8 grams I2C interface 2.2-5.5V supply 6mA draw	Lightweight Small Multiple sensors	High library count
BMP085 	1.2 grams I2C interface 3-5V input 1mA draw	Low current draw	Heavy

Air Pressure Sensor chosen	Rationale:
Pololu AltImu 	Has Multiple sensors all on one I2C interface.

Pitot Tube Trade & Selection

Pitot Tube Model	Specifications	Pros	Cons
3DR APM 2.6 Airspeed Sensor Kit 	Analog Output 5V supply 10mA current draw	Analog input	More noise
3DR Pixhawk Airspeed Sensor Kit 	I2C interface	less noise high resolution	would require extending I2C bus

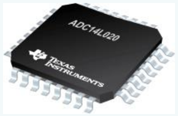
Pitot Tube Model Chosen	Rationale:
3DR analog airspeed kit 	Analog input does not require extending I2C bus

Air Temperature Sensor Trade & Selection

Temperature Sensor Model	Specifications	Pros	Cons
Pololu AltImu 	0.8 grams I2C interface 2.2-5.5V supply 6mA draw	Lightweight Small Multiple sensors	High library count
TMP36 	.1 grams Analog output 2.7 - 5.5V input 50μA draw	Lightweight Small Low power	separate sensor

Temperature Sensor Model Chosen	Rationale:
Pololu Altimu 	All in one package

Battery Voltage Sensor Trade & Selection

Battery Voltage Sensor Model	Specifications	Pros	Cons
Onboard ADC (Sparkfun pro-micro)	10 bit resolution	Onboard Ease of implementation	lower resolution
ADC14L020 	14 bit resolution	Higher Resolution	External device

Battery Voltage Sensor Model Chosen	Rationale:
Onboard ADC	Onboard and easy to implement

Camera Trade & Selection

Camera Model	Specifications	Pros	Cons
Adafruit serial jpeg camera 	640x480 image Serial interface	Serial interface	Weight
Sparkfun CMOS camera module 	728x488 RCA analog output	High resolution	RCA output

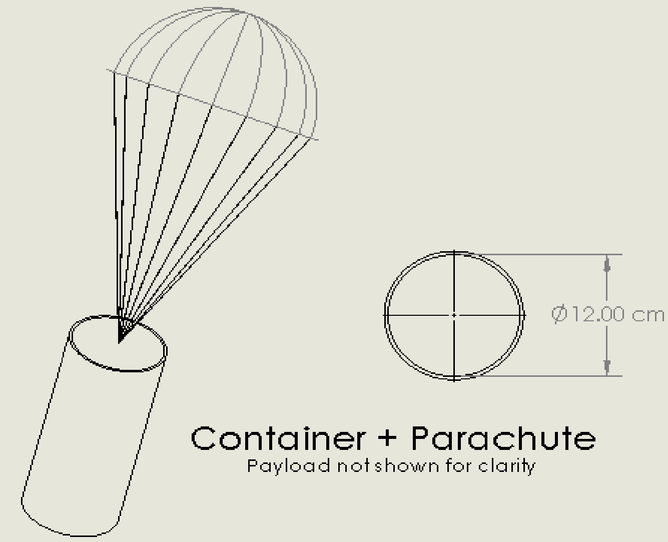
Camera Model Chosen	Rationale:
Adafruit Camera 	Has a Serial interface

Descent Control Design

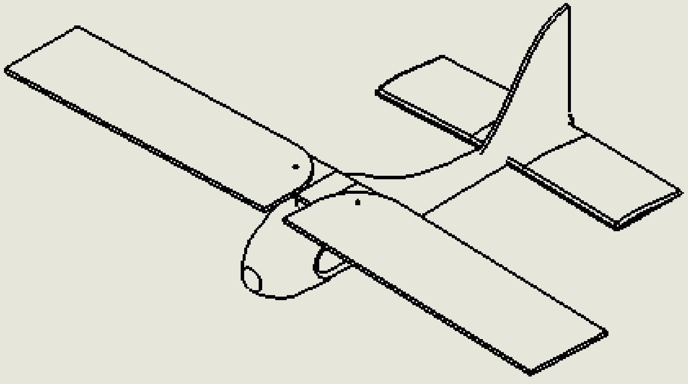
Shraddha Gharmalkar

Descent Control Overview

- **Container**
  - Polycarbonate container- 12cm diameter, 31cm length.
  - Uses passive descent methods after separation from rocket (parachute)
    - Round Parachute made out of nylon fabric with spill hole used to reduce cupping with a radius of approximately 0.65 meters. (Requirement #4)
- **Glider**
  - Fixed wing glider, high wing, conventional tail.
  - Fuselage, vertical stabilizer made out of foam.
  - Wing, horizontal stabilizer made out of 1/8th inch thick balsa sheets.
  - Released at 400 meters from the container using separation mechanism
  - Follows a circular path of less than 1000 m during descent for approximately 2 minutes.
  - Utilizes a folding mechanism for the wings

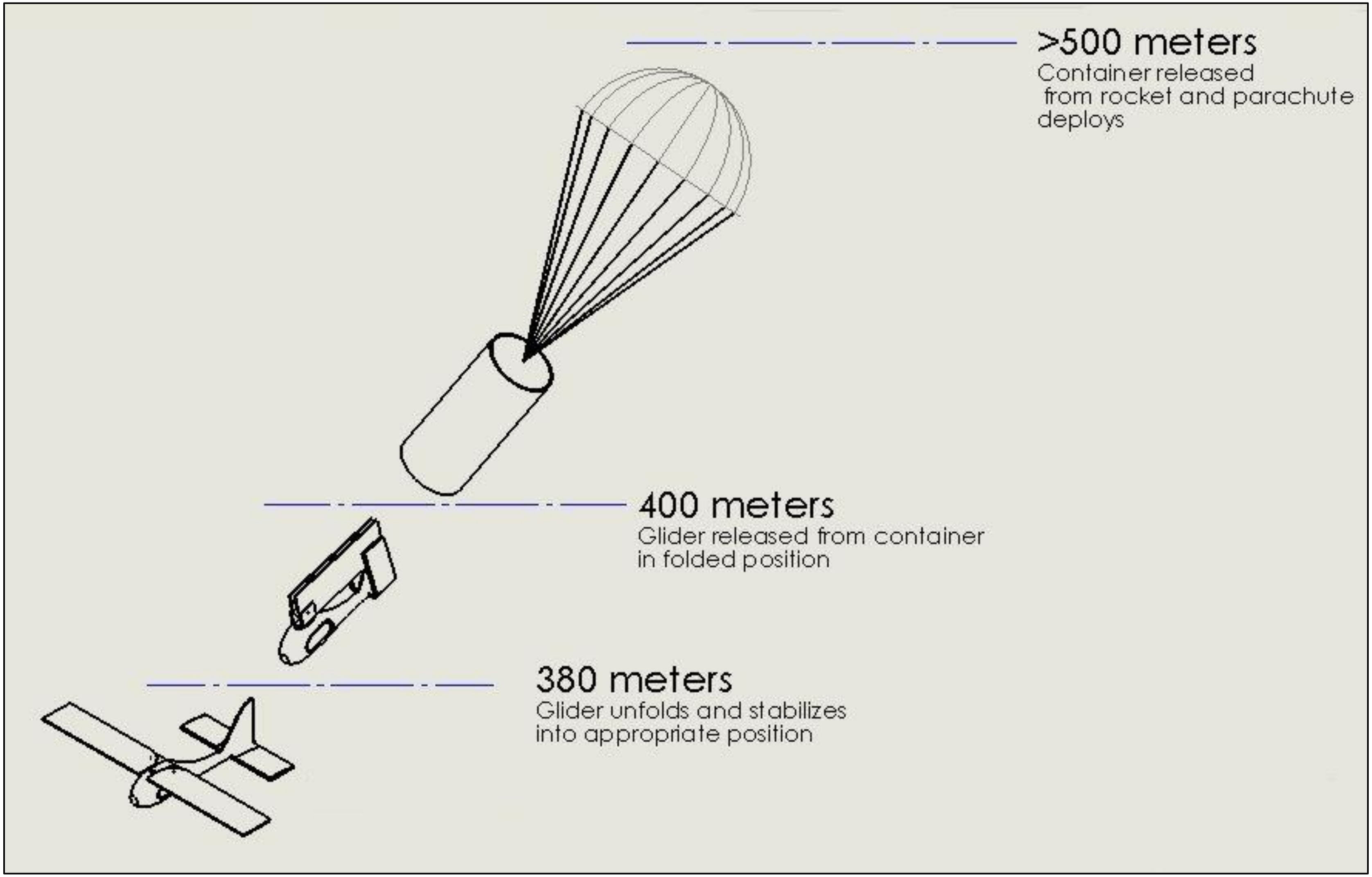


Container + Parachute
Payload not shown for clarity



Glider Descent Control System

Descent Control Overview



Descent Control Overview

- **Container Requirements**
  - Dimensions of container based on requirement to fit inside envelope of 12.5 cm diameter X 31 cm length
  - Material for container (polycarbonate) selected to ensure it keeps the glider intact.
  - Color selection – Florescent pink *(Requirement 6)*
  - Edges of container sanded to ensure that container doesn't get stuck in rocket *(Requirement 5)*
  - Release of container completely independent of the structure of the rocket *(Requirement 7, 8)*
- **Glider Requirements**
  - Glider designed and fabricated so that it is fixed to glide. No control surfaces are used for any operation of the glider *(Requirement 11)*
  - Glider dimensions determined by taking into account:
    - Size of the container so that glider doesn't extends beyond the container. Folding mechanisms used to fit large components (like wing) inside container. *(Requirement 2, 3)*
    - Mass that needs to be supported. Wings, horizontal & vertical stabilizer, and fuselage were designed to produce enough lift to support the weight while minimizing drag. *(Requirement 1)*

Descent Control Overview (Cont'd)

- **Glider Requirements (Continued)**
  - All parts of glider are rigid and properly fixed so that the glider maintains its configuration throughout the flight. Appropriate material is chosen to develop these qualities.

    (Requirement 18)
  - Glider designed so that it glides for approximately 2 minutes from the time of deployment at 400 meters to the time of reaching the ground. *(Requirement 10, 46)*
    - This included choosing optimal wing area, making the glider more aerodynamic to reduce drag, and minimizing the weight of the glider itself. Also, a relatively high aspect ratio was chosen to minimize induced drag.

Descent Control Requirements

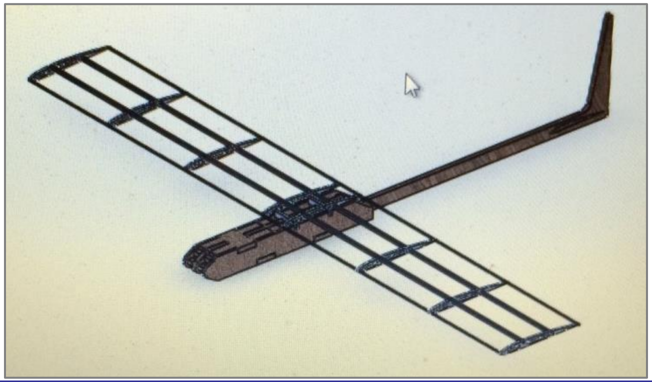
ID	Requirement	Rationale	Priority	Parent	VM
DCS-1	Glider will be released at 400 +/- 10 m	Competition requirement	High	SR-9	D,I,A
DCS-2	Glider will follow a circular pattern of no more than 1000 m in diameter	Competition requirement	High	SR-10	D
DCS-3	The container must use a passive descent control system	Competition requirement	Medium	SR-4	D,A,T
DCS-4	Glider will be level during its flight	So the camera can take a picture of the ground and glider does not nose dive	High	None	T
DCS-5	The glider must fit inside the container, may include folding mechanisms	Glider must be protected during launch, competition requirement	High	SR-2	D,I
DCS-6	The glider will fly for approximately 2 minutes	Competition requirement	High	SR-26	D,A
DCS-7	Glider will be a fixed wing	Competition requirement, ensures standard glider design	Medium	SR-27	D,T
DCS-8	Glider will be able to release itself from the container	Ensures glider will not be stuck in the container	Medium		D,I

Container Descent Control Strategy Selection and Trade

Topic	Options	Chosen	Reason
Container Materials	1) Polycarbonate 2) Styrofoam 3) Balsa Wood	Polycarbonate	Strong, inexpensive, light and better at absorbing impact energy than other materials.
Color	1) Fluorescent Pink 2) Fluorescent Orange	Fluorescent Pink	Group vote, easy to see in grass.
Shock force survival for- a) Fuselage b) Wing	a) 1) balsa, 2) foam b) 1) cloth, 2) balsa 3) foam	a) Foam b) Balsa reinforced with carbon fiber/ fiberglass	Shock absorbing foam has no chance of failing. Reinforced balsa easy to construct
DCS Connections	1) Servo Motor 2) Screw 3) Kevlar	Servo motor connected	Easiest to separate with latch mechanism.
Parachute	1) Conical w/o spill hole 2) Round w/ spill hole	Round w/ Spill Hole Parachute	Best at increasing drag of the container, spill hole to reduce cupping.
Preflight Review Testability	1) Yes 2) No	Yes	All parts will be rigorously tested to specification given the competition guide.

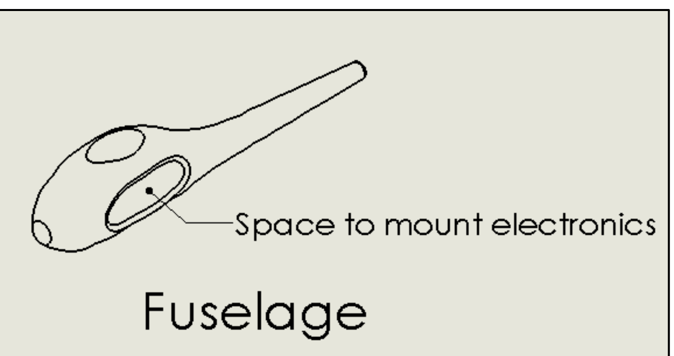
Payload Descent Control Strategy Selection and Trade

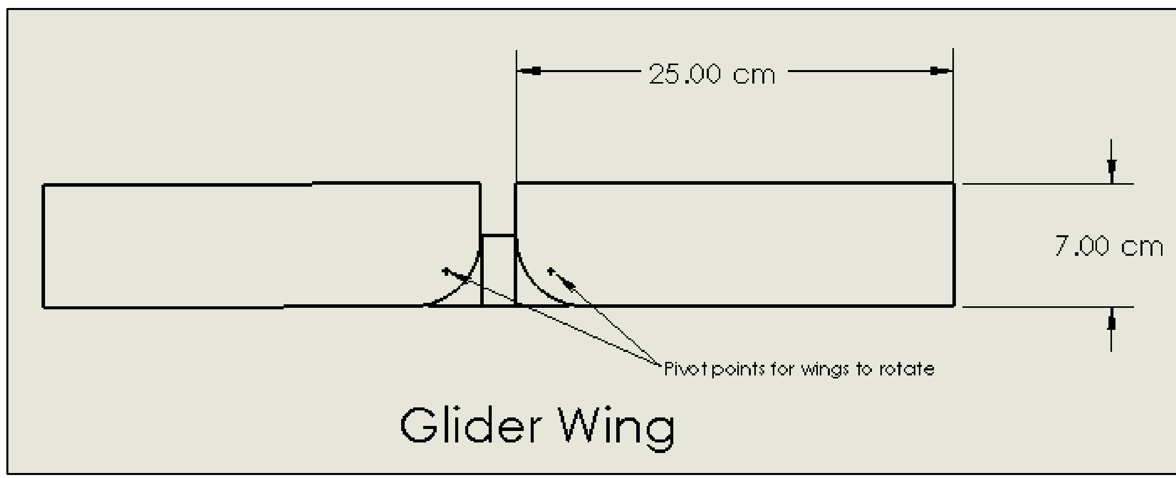
Payload Configuration 1	Properties	Pros	Cons
Balsa Design	- Fuselage type = Balsa 1/4inch thick with 2D cross sections - Fuselage length = 56 cm - Wing type: Balsa airfoils with spars and covered with Mylar - Wing area = 500 cm^2 -Wing span = 80cm -Weight of glider with payload = 400 grams	- Lift up to 250 grams (not including glider weight) - Easy to mount electronics	- Not so aerodynamic - Heavy fuselage - Hard to fabricate - Wing span too large - Small glide ratio - Difficult to meet container dimensions



Payload Descent Control Strategy Selection and Trade

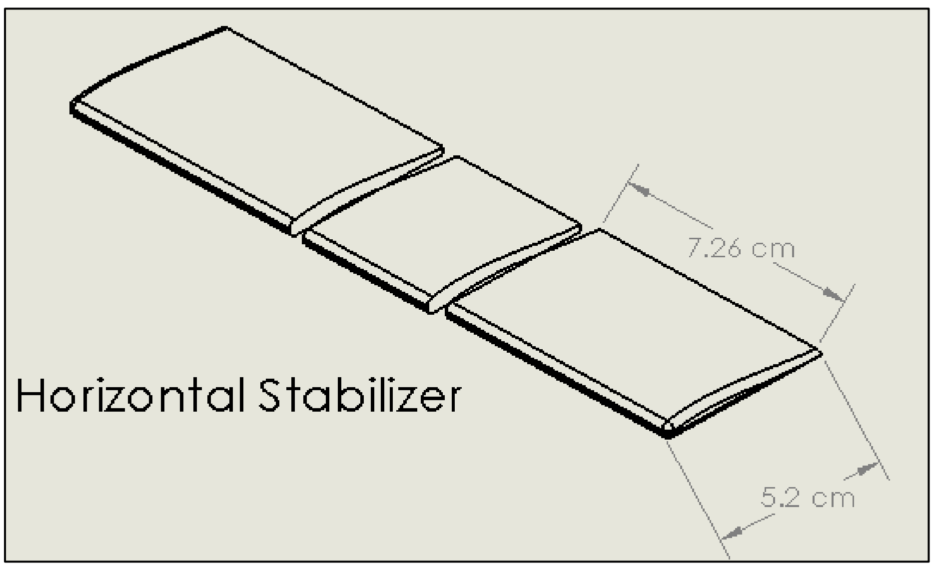
Payload Configuration 2	Properties	Pros	Cons
Foam/Balsa Hybrid Design	- Fuselage type = Foam - Fuselage length = 30 cm - Wing type: 1/8 inch thick balsa sheets reinforced with fiberglass/ carbon fiber - Wing area = 375 cm^2 - Wing span = 50 cm - Weight of glider with payload = 150 grams - Wing connected with an axel to fuselage	- Foam fuselage is lightweight, aerodynamic, cheap, easy to manufacture, and durable - Easily testable - Balsa wing is easy to fabricate and easier to fit in container - Foam is more shock absorbent - Foam can easily store and secure electronics	- Difficulty in mounting wing - Difficulty in manufacturing precise measurements for fuselage

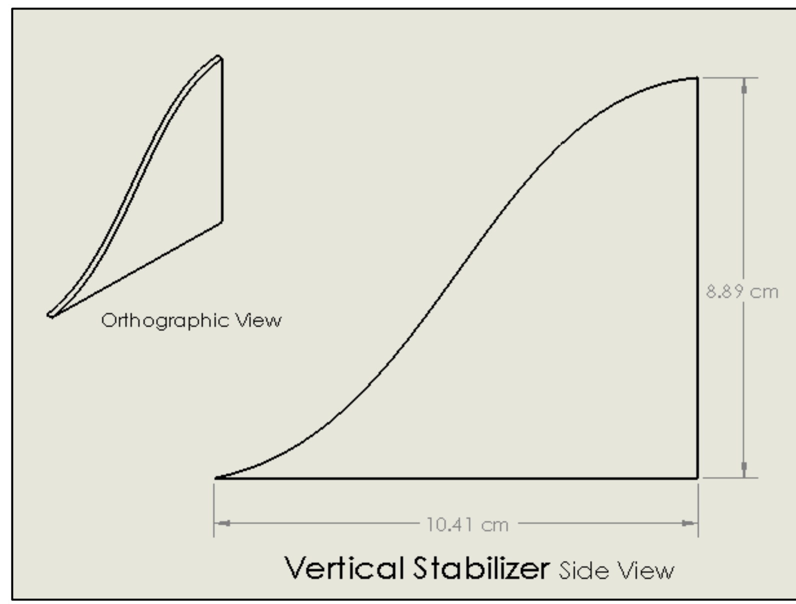




Payload Descent Control Strategy Selection and Trade

Payload Configuration 2 (continued)	Properties	Pros	Cons
Foam/Balsa Hybrid Design	- Vertical stabilizer fixed - Vertical wing height = 8.69cm - horizontal span = 14.52 cm	- Smaller weight =smaller wing dimensions (easier to fit in container) - Foldable horizontal stabilizer allows for easy fit in container - Dimensions of tail increase lift of glider	





Payload Descent Control Strategy Selection and Trade

Payload Configuration Chosen	Rationale
Balsa/Foam Hybrid	- Better materials for shock absorbency - Complies with dimensioning constraints - Easier to manufacture - Generates more lift - More aerodynamic

Descent Rate Estimate Formulas

Descent Rate Estimates Calculated using Terminal Velocity Equation

Eq (1)

$$v = \sqrt{\frac{2mg}{\rho A C_D}}$$

Eq (2)

$$S = \frac{\pi d^2}{4}$$

Eq (3)

$$S = \frac{2W}{\rho C_D v^2}$$

Eq (4)

$$L = \frac{C_L \rho v^2 A}{2}$$

S = Surface Area
ρ = Air Density at Deployment Altitude (1.205 kg/m^3)
g = Acceleration due to Gravity (9.81 m/s^2)
v = Desired Descent Velocity
d = Diameter of the Parachute
C_D = Coefficient of Drag (assumed 1.5)
W = Weight of the CANSAT
A = Wing Area
L = Lift Force
C_L = Coefficient of Lift

Descent Rate Estimates

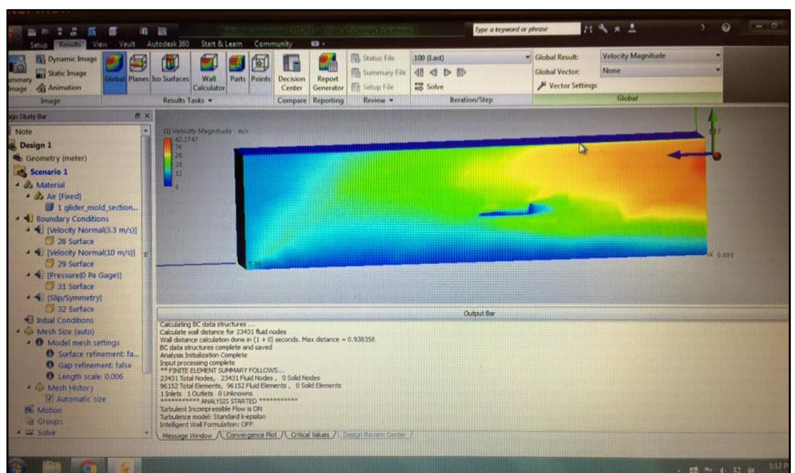
- **Container + Glider**
  - Assume container properly ejects from rocket and parachute deploys
  - Assume height of 500 meters.
  - Assume coefficient of drag to be 0.75
  - Using equation (1) :
    - Container + Glider weighs 500g, with a 65 cm diameter parachute, at a height of 500 meters, it should fall at **0.922 m/s.**
- **Container**
  - Assume parachute is still attached to container and is fully functioning
  - Using equation (1):
    - Container weighs 340 grams, it should fall at **0.76 m/s.**
-

Descent Rate Estimates

- **Glider**
  - Assuming the glider deploys properly at 400 meters height
  - Assume atmospheric conditions allow glider to fly in a stable manner
  - Using equation (3):
    - Glider weight =160g, C_L is 0.4, desired glider speed: vy = 3.3 m/s

      Wing area needed = **<u>350 cm^2</u>**

      Thus with this wing area, the glider should descend at a vertical velocity of **<u>3.3 m/s</u>** and a horizontal velocity of **<u>12.3 m/s</u>**.

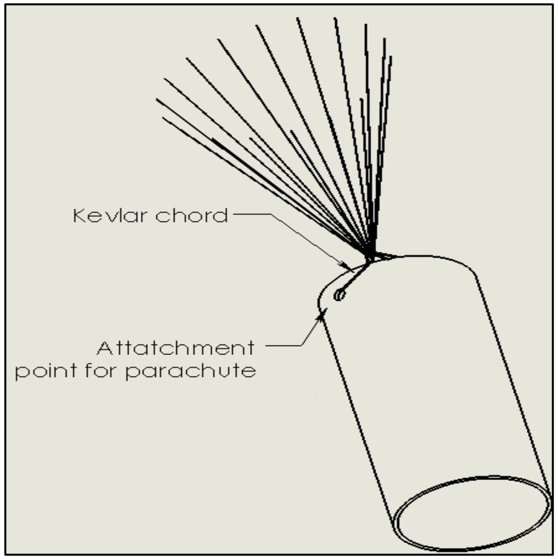


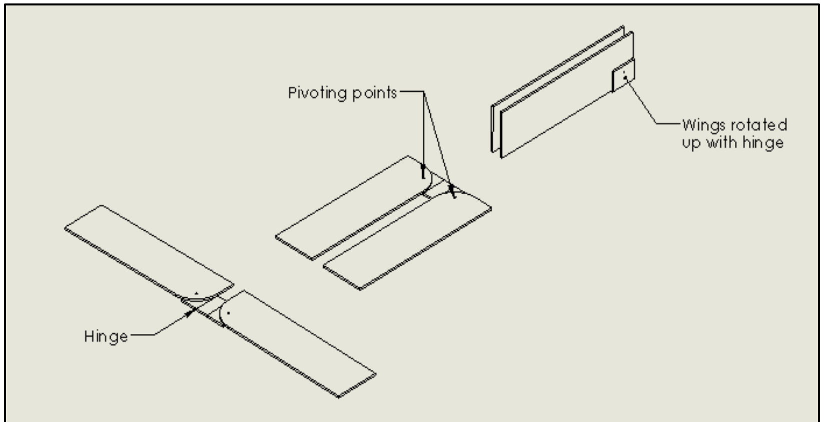
Mechanical Subsystem Design

Presenter Name(s) Go Here

Mechanical Subsystem Overview

- **Container**
  - 12 cm diameter by 31 cm length
  - Material – polycarbonate strong enough to protect glider.
  - Parachute attached to container with Kevlar chord knotted to drilled holes
- **Payload**
  - Wings and horizontal stabilizer folded using hinges and fiberglass reinforcement tape
  - Glider will be a high wing with conventional tail
  - Components folded out with the restoring forces of springs and rubber bands
  - Fuselage will be constructed from foam





Wing Folding Mechanism

Mechanical Sub-System Requirements

ID	Requirement	Rationale	Priority	Parent	VM
MS-1	Total mass of CanSat shall be 500 +/- 10 grams	Competition requirement, limits mass budget	Low	SR-1	A,D
MS-2	Glider will be contained in container	Competition requirement, creates dimension constraints	High	SR-2	A,D,I
MS-3	Container dimensions shall fit in a 125 mm diameter by 310 mm long envelope	Competition requirement, compatibility with rocket	Medium	SR-3	D
MS-4	The container shall now have sharp protrusions	Competition requirement, CanSat will not get stuck in rocket	Low	SR-5	D,I
MS-5	Container shall be florescent pink or orange	Competition requirement, ease of retrieval after landing	Low	SR-6	D
MS-6	Rocket airframe will not be used for CanSat operations	Competition requirement, CanSat must operate independently	Low	SR-7	D,A
MS-7	CanSat will deploy from rocket payload section	Competition requirement, sets orientation of CanSat	Low	SR-8	D,I
MS-8	All electronics shall be properly mounted on glider	Competition requirement, safe usage of sensors	Medium	SR-12	D,A
MS-9	Cost of CanSat will be less than $1000	Competition requirement, sets mechanical budget	Medium	SR-17	I
MS-10	Glider shall not break upon landing	Protects electronics, material selection is prioritized	High	None	D,T

Mechanical Sub-System Requirements

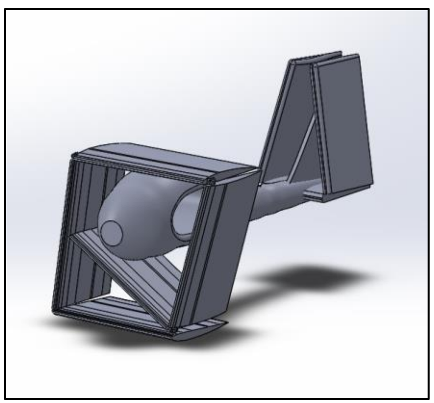
ID	Requirement	Rationale	Priority	Parent	VM
MS-11	Container will house release mechanism	Allows CanSat and container to separate	Medium	None	D,T,I
MS-12	Glider shall be made with compartment to fit electronics	Ensure integration of electrical subsystem in glider	Medium	None	D,T
MS-13	Glider will have a folding mechanism for wing	So glider may fit inside the container	High	None	D,I,A,T
MS-14	No control surfaces are used for any operation of the glider	Competition Requirement	Medium	SR-27	I
MS-15	All structures must withstand 15 Gs of acceleration and 30 Gs of shock.	Competition Requirement	Medium	SR-11	D
MS-16	Fabricate with reinforcements (fiberglass/carbon fiber), strong adhesives, and rounded edges (fillets)	Ensures that cansat can withstand all required levels of shock.	Medium	None	I,A,D
MS-17	Space will be allocated to mounting electronics with proper mounts and shield	To protect the sensors from the rocket launch and descent	Medium	None	D
MS-18	Glider will require folding mechanism for wing and horizontal stabilizer	In order to fit within container dimensions	High	None	D,I,T,A

Mechanical Layout of Components Trade & Selection

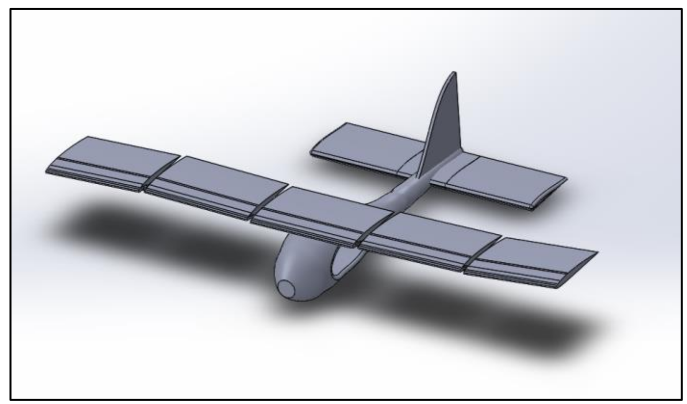
Issues	Options	Layout Chosen	Rationale
Need to create a wing that can fit into the competition container.	1)A stiff wing design requiring multiple components (balsa). 2)A flexible design using spring steel.	Stiff Wing Design	Spring steel provided critical concerns with its weight and behavior during gliding flight
Need to create torque between wing components to deploy the collapsible wing into a sturdy glider.	1)Use spring loaded hinges with a stopper to lock the wings into place. 2)Use high elasticity rubber with a stopper to lock the wings into place.	Spring Loaded Hinges	Spring loaded hinges are compact and reliable, while rubber creates complications and uncertainty for our design.
Need a mechanically stable way to design the collapsible wing.	1)Break both the right and left wing into three components parallel to the chord. 2)Fold the wings along the fuselage and then parallel to the vertical stabilizer.	Along the fuselage and parallel to the vertical stabilizer.	Breaking the wing into three components created instability. Keeping the wing intact was the better solution.
Need method of deploying glider out of container.	1)Use a spring launcher. 2)Latch mechanism with servo.	Latch mechanism	Latch mechanism is the easiest to manufacture and more reliable method of separating

Mechanical Layout of Components Trade & Selection

Mechanical Layout 1	Description	Pros	Cons
Four Fold Design	Wing collapses around the fuselage	-no interference with tail -easy to fabricate	-not stiff enough for flight -wing must be made smaller to fit in container



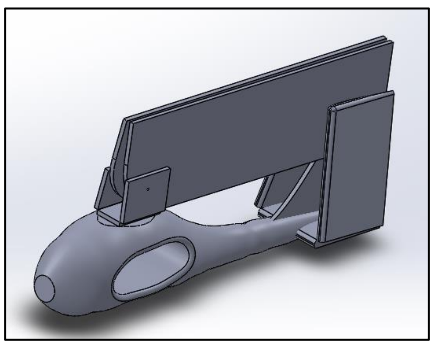
Folded position in container



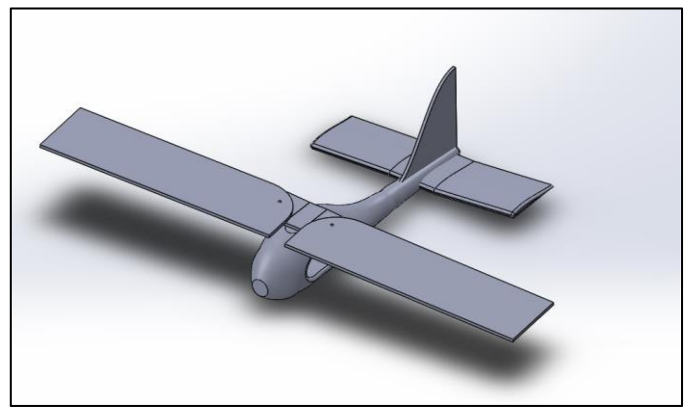
Unfolded gliding position

Mechanical Layout of Components Trade & Selection

Mechanical Layout 1	Description	Pros	Cons
Two Hinge Design	Wings folded along fuselage body. Wings first spring down, then spring out.	-correct wing area fits in container -easy to fabricate -stiff enough for flight	-need to implement a strong enough spring mechanism



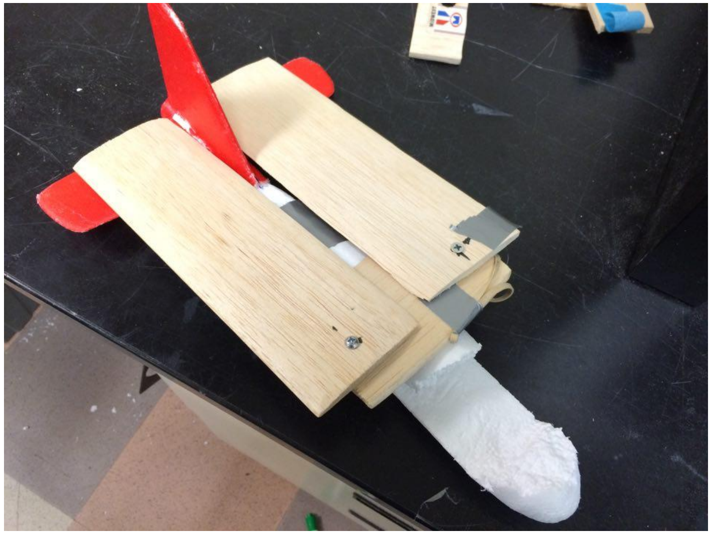
Folded position in container



Unfolded gliding position

Mechanical Layout of Components Trade & Selection

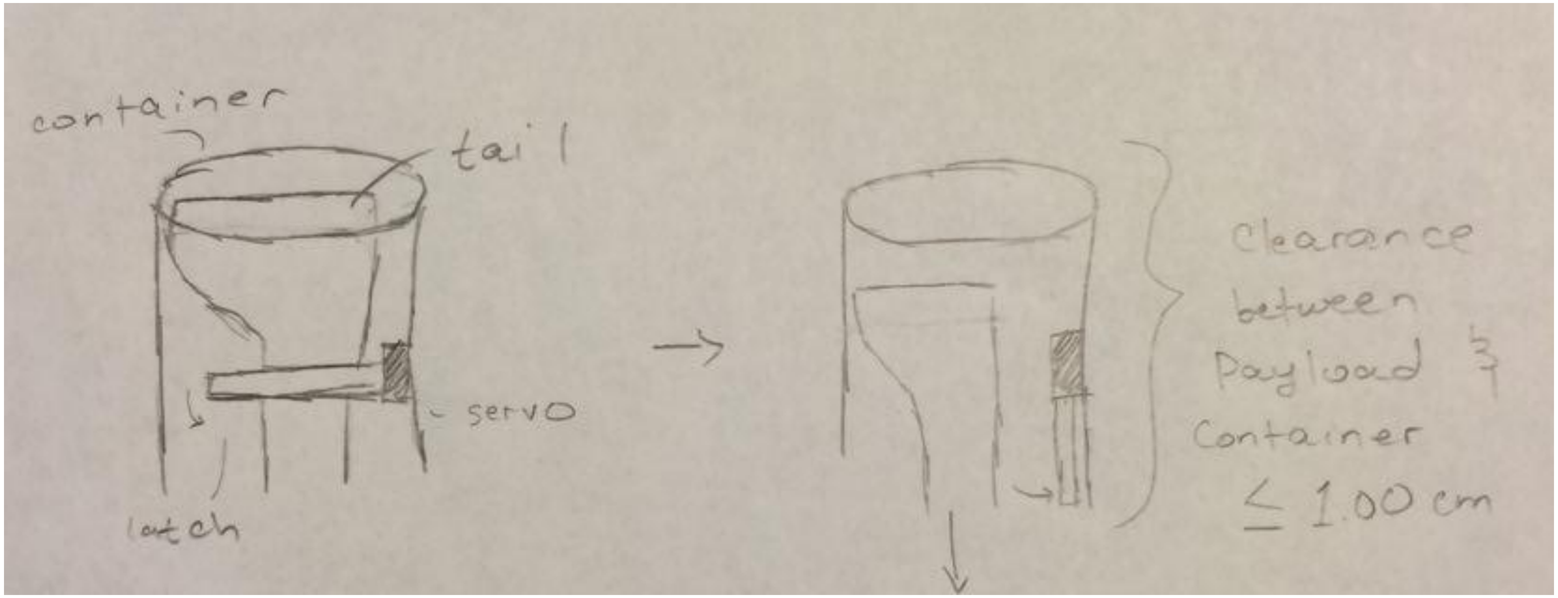
Mechanical Layout Chosen	Rationale
Two Hinge Design	-complies with all dimensioning constraints -easy to fabricate -good materials to work with



Material Selections

Material	Mechanical Component	Qualities
Balsa Wood	All wing components and stabilizers.	Lightweight Density 160 kg/m^3
Carbon Fiber	All wing components and stabilizers.	Modulus of 30 msi UTS of 125 ksi Protect against stress on the wings
Foam	Fuselage Body	Lightweight Strong foundational body Shock absorbent
Polycarbonate	Container	Sturdy Damage resistant Simple and easy to find
Aluminum	Spring loaded hinges, stoppers, screws	Strong enough to withstand tension from springs
Glue, fiberglass, tape	Reinforcement	Adhesive qualities

- **Servo Latch Mechanism**
  - Servo will be connected to container and a latch that holds the payload in place
  - Servo will be placed on the container so there is clearance for separation
  - At specified altitude, servo will move latch and detach glider from container



Structure Survivability Trades

Topic	Options	Chosen	Reason
Container: Servo for release mechanism	1) Bolted attachment 2) Adhesives 3) Heavy duty tape 4) Zip tie	Shock absorbent, high peel strength adhesives	Most secure way to attach servo, lightweight, shock absorbing
Glider: Pitot tube	1) Adhesives 2) Zip tie 3) Tape	Shock absorbent, high peel strength adhesives attached using 3D printed mount	3D printed mount is aerodynamically shaped to reduce drag. Adhesive is most secure way to attach mount to fuselage
Glider: All other electronics	1) Mounts with screws 2) Zip tie 3) Adhesives	Shock absorbent, high peel strength adhesives	Most lightweight way to attach electronics
Glider: Descent control attachments	1) Tape 2) Adhesives 3) Mounts and screws	Shock absorbent, high peel strength adhesives with proper mounts and screws as needed.	Shock absorbent adhesives provide strong attachment points and distribution of stress during possible impact

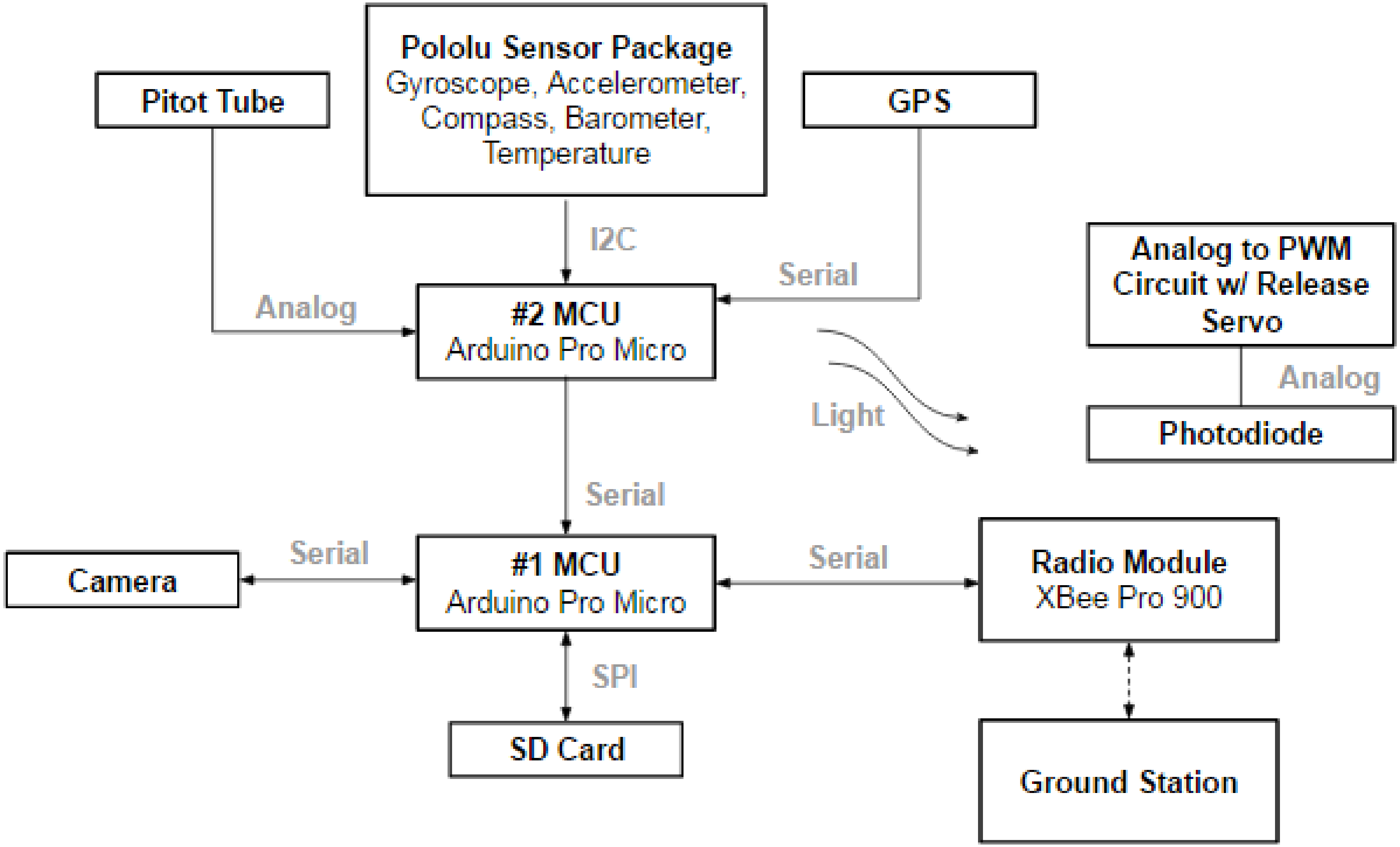
Mass Budget

Component	Part	Mass
Container	Container (parachute + tube + ballast)	340g (40g + 50g + 230g)
Payload	Fuselage (estimate)	30-35g
	Horizontal Stabilizer (measured)	3g
	Vertical Stabilizer (measured but can be reduced by changing material)	4-5g
	Wing (uncertainty from adding bolts or springs estimated)	16-22g
	Payload Battery (data sheet)	22g
	Container Battery (data sheet)	22g
	Digital Electronics (GPS, Camera,wires, mounts, Microcontroller, etc)	50-60g
	Container Servo (data sheet)	7.1g
TOTAL	**-**	**500g ± 7 (494.1-515.1g)**

Communication and Data Handling (CDH) Subsystem Design

Satyam Patel

CDH Overview



CDH Requirements

ID	Requirement	Rationale	Priority	Parent	VM
CDH-1	Glider will collect air pressure, temperature, and battery voltage at a rate of 1 Hz and transmit data to GCS	Competition requirement	High	SR-13	A,D,T
CDH-2	Telemetry begins when glider is turned on and mission time shall be collected	Competition requirement	High	SR-14	T,D
CDH-3	XBEE radios shall be used for telemetry data	Competition requirement	High	SR-15	I
CDH-4	CanSat will have an override system	In case release mechanism fails	Medium	SR-24	D,I
CDH-5	Transmission will end once the glider lands	Glider will stop collecting unnecessary data	Medium	none	D
CDH-6	XBEE shall have NETID/PANID set to their team number	Competition requirement	Low	None	I,D
CDH-7	XBEE will not use broadcast mode	Competition requirement	Low	None	I
CDH-8	Team will plot in real time during descent	In order to track if any problems are occurring with sensors	High	None	D,T,I

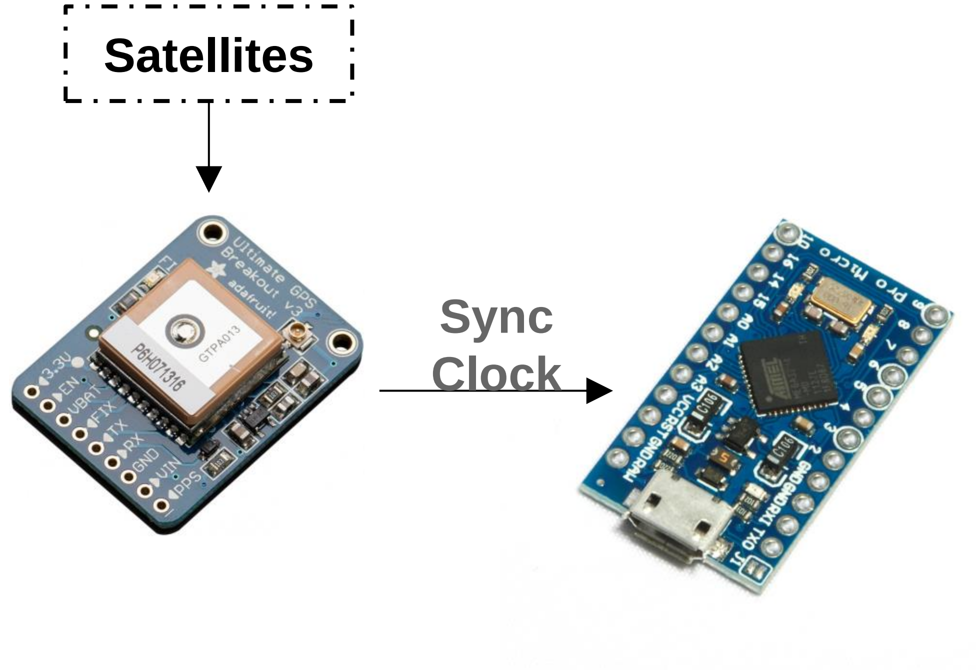
Processor & Memory Trade & Selection

Processor	Voltage	Flash Memory	Clock Speed	Interface	I/O Pins
ATmega32U4 on Arduino Pro Micro	6-20V	32 KBytes	16 MHz	4 UART 1 SPI 1 I2C	20
BCM2836 SoC on Raspberry Pi	5V	1 GBytes	900 MHz	UART, SPI, and I2C interfaces available with drivers	40
ATmega2650 on Arduino Mega	6-20V	256 KBytes	16 MHz	4 UART 1 SPI 1 I2C	54

Processor Chosen	Rationale:
ATmega32U4 on the Arduino Pro Micro	-Despite the Arduino Mega and Raspberry Pi having far more flash more memory, it was an excess amount of memory packed onto unnecessarily big boards. The 2 Arduino Pro Micro's flash memory total would be 64 KBytes, along with an additional SD card. -The weight of 2 Arduino Pro Micros (total of 13g) would be less than one Arduino Mega (34.9g) or one Raspberry Pi (45g).

Real-Time Clock

- **Not using separate Real Time Clock module.**
- **Instead syncing internal Arduino Pro Micro's clock to GPS's time**



Antenna Trade & Selection

Antenna	Gain	Frequency	Dimensions	Range (Line of Sight)
Integrated XBee Pro 900 Wire Antenna 	1.9 dBi	902-928 MHz	82.55mm in length	up to 6 miles
900MHz Duck Antenna RP-SMA 	2 dBi	900/1800 MHz	105mm in length, 10mm in diameter	up to 6 miles

Antenna Chosen	Rationale:
Integrated XBee Pro 900 Wire Antenna	-Adding on a Duck Antenna would have added on an additional 13g. -The Integrated Wire Antenna and Duck Antenna have nearly the same gain, frequency, and line of sight range.

Radio Configuration

Setup of Xbee modules:

- ID will be set to team number
- **DH** (Destination address High) will be set to **SH** (Serial Number High) of other module
- **DL**(Destination address Low) will be set to **SL** (Serial Number Low) of other module
- This ensures point to point communication between the GCS and Arduino only

Transmission:

- Transmission will be handled by the Arduino and GCS via serial communication

Impact:

- Cansat needs enough power to run the long range XBees
- Cansat will need a design that allows communication to the ground to be unhindered

Telemetry Format

- Telemetry will be saved in .csv format on the onboard SD card and ground station, allowing the judges to download and view the entire mission's data.
- Data will be separated by a ','.

<TEAM ID>,<MISSION TIME><PACKET COUNT>,<ALT SENSOR>, <PRESSURE>,<SPEED>, <TEMP>,<VOLTAGE>,<GPS LATITUDE>,<GPS LONGITUDE>,<GPS ALTITUDE>,<GPS SAT NUM>,<GPS SPEED>,<COMMAND TIME>,<COMMAND COUNT>,[<BONUS>]

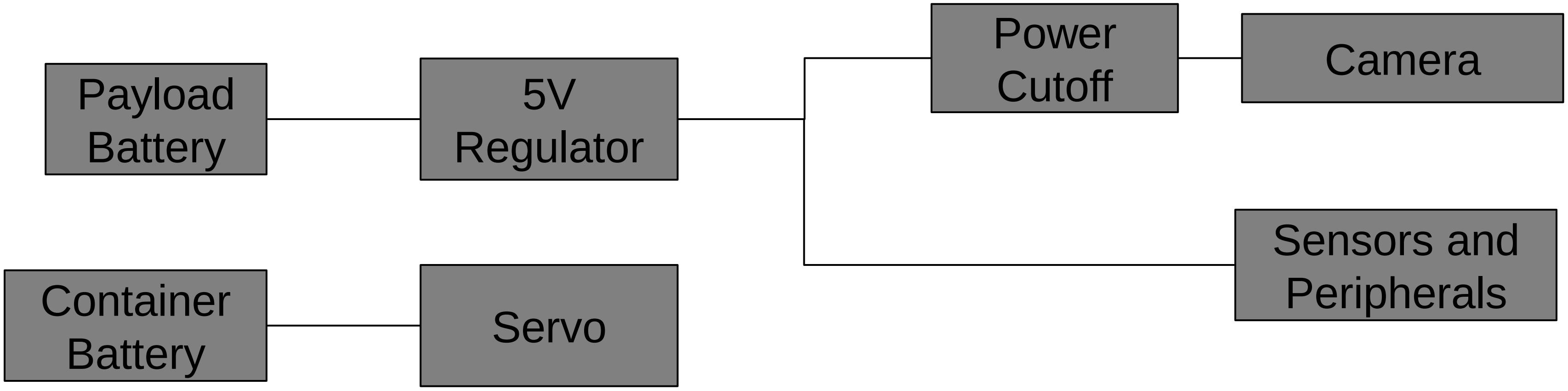
<TEAM ID>	Four-digit team ID	**<GPS LONGITUDE>**	Latitude from GPS receiver
<MISSION TIME>	Time since power up in secs.	**<GPS LONGITUDE>**	Longitude from GPS receiver
<PACKET COUNT>	Number of transmitted packets	**<GPS ALTITUDE>**	Altitude from GPS receiver
<ALT SENSOR>	Altitude, w/ 1m resolution from non-GPS sensor	**<GPS SAT NUM>**	Number of satellites
<PRESSURE>	Atmospheric pressure	**<GPS SPEED>**	Speed from GPS receiver
<SPEED>	Speed of glider, gathered from pitot tube	**<COMMAND TIME>**	Time of last imaging command received
<TEMP>	Temperature in °C	**<COMMAND COUNT>**	Number of imaging commands received
<VOLTAGE>	Voltage of power bus	**<BONUS>**	Signify transmission of image to ground station

Electrical Power Subsystem (EPS) Design

Satyam Patel

EPS Overview

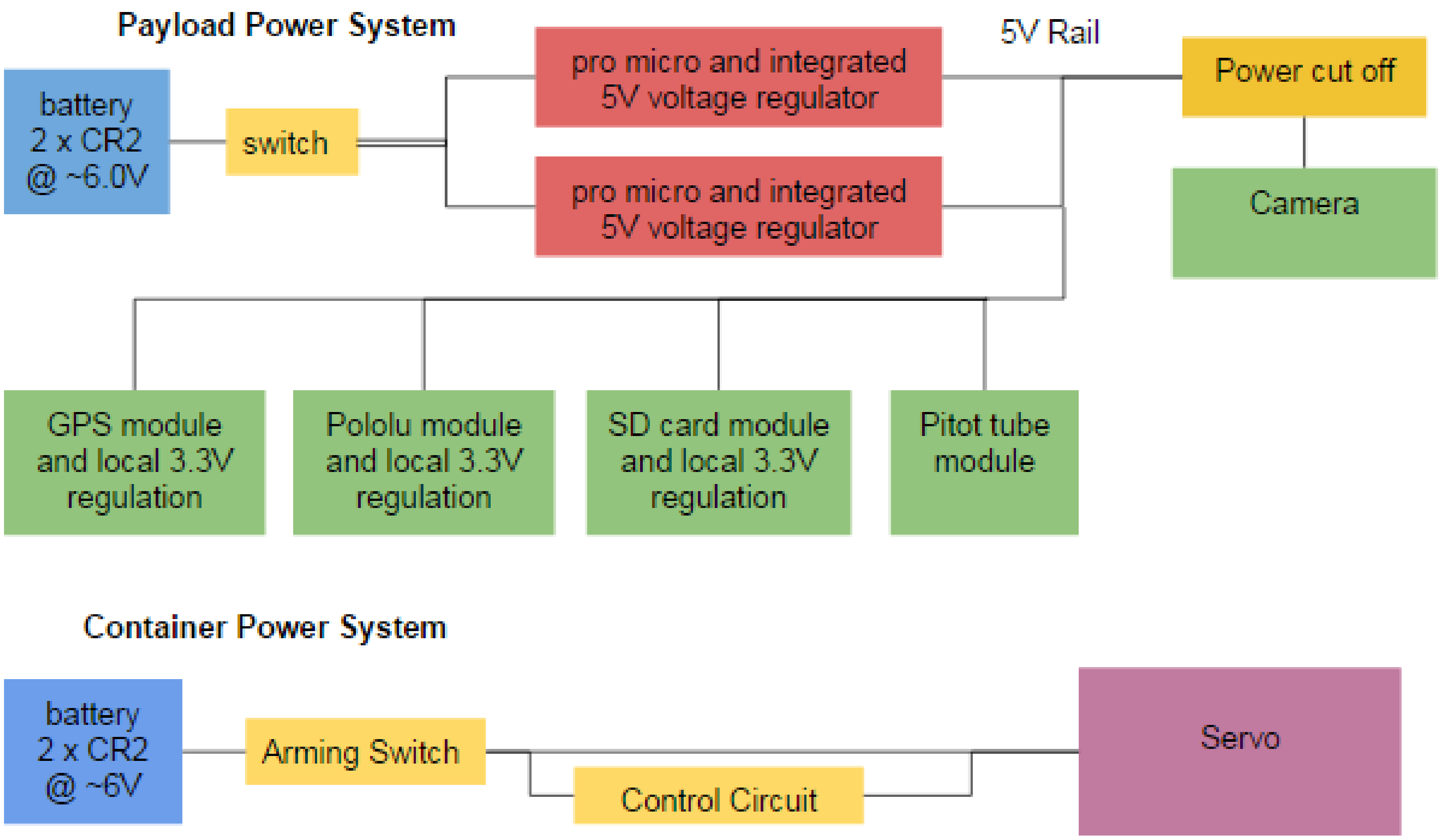
Key Components	Purpose
Payload Battery	Energy storage for glider
5V regulator	Provide power for other components
Camera Power Cutoff	Reduce standby power consumption
Container Battery	Energy storage for release servo



EPS Requirements

ID	Requirement	Rationale	Priority	Parent	VM
EPS-1	Glider will have an accessible power switch	Competition requirement	High	SR-21	I
EPS-2	Alkaline, Ni-MH, Lithium ion or Ni-Cad cells must be used	Competition requirement	High	None	D,I
EPS-3	The glider will collect battery voltage once per second	Competition requirement	High	None	T,A
EPS-4	Gilder will have enough power to operate for approximately 1 hour on standby	Ensure operational readiness at competition	Medium	None	I,D
EPS-5	Glider will have enough power to operate for 10 minutes with full capabilities	Ensure operation throughout flight	High	None	A,I,D
EPS-6	Payload Power system must be lightweight	allows for better glider performance	Medium	None	D
EPS-7	Payload Power system must provide 5V	5V is required by the microprocessor and sensors	High	None	T,I
EPS-8	Container Power system must power servo on standby for 1 hour	Ensure operational readiness at competition	High	None	D

Electrical Block Diagram



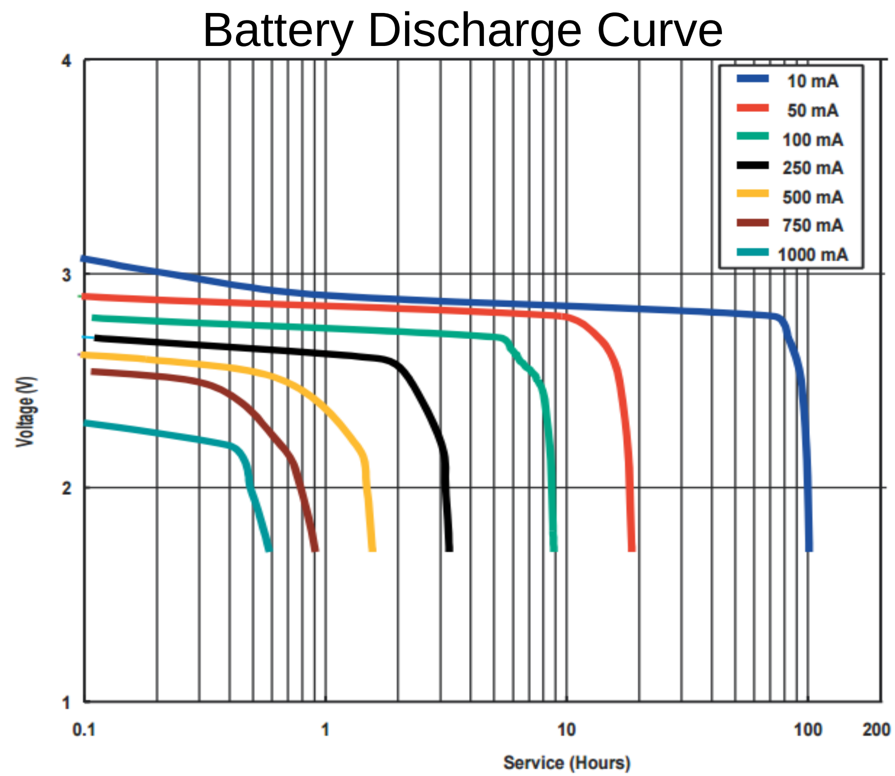
Payload Battery Trade & Selection

Battery	Chemistry	Cell Voltage	# Cells for >5V	Max Current	Capacity @ 500mA	Total Weight
CR2	Li/MnO2	3.0V	2	1000mA	~500mAh	22g
NCR18650	LiNiCoO2	3.6V	2	5400mA	~2700mAh	93g
AAA Alkaline	Zn/MnO2	1.5V	4	1000mA	~500mAh	23g

Battery Chosen	Rationale:
CR2 	-Light Weight -Enough capacity for 1 hour of operation (@500mA) -Sufficient current rating

Power Budget

Component	Max Current Draw	Source
Sparkfun Pro Micro Microcontroller	20 mA	Datasheet
Second Pro Micro Microcontroller	20mA	Datasheet
GPS	20mA	Datasheet
Pololu	6mA	Datasheet
pitot tube	10mA	Datasheet
XBee radio	300mA	Datasheet
SD card	25mA	Datasheet
Total w/o Camera	401mA	
Camera	75mA	Datasheet
Peak Current Draw	481mA	



With a drop-out voltage of 350mV at 500mA, the MIC5219 regulator on the Sparkfun Pro Micro will allow us to operate for close to 1 hour assuming max current draw. In reality, current draw will be much less.

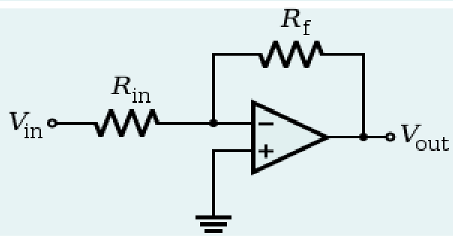
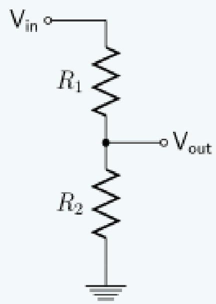
The camera will be unpowered until it need to be powered.

Container Power System

- Two CR2 batteries with 500~mAh capacity
- BMS-306DMAX Digital Micro Servo for Release Mechanism
  - ~200mA no load current draw
    - ❖ Estimated from online sources for similar servos
  - Torque At 6.0V: 2.0kg/cm , 25 oz/in
- Enough power for to power container at standby for 2.5 hours

- Wireless communication for release via photodiode
  - digital circuit draws insignificant power relative to servo

Power Bus Voltage Measurement Trade & Selection

Technique	Circuit	Pro	Con
Op-Amp		Low impedance output	Cost complexity requires negative voltage supply
Voltage Divider		Ease of implementation	High impedance output

Technique Chosen	Rationale:
Voltage Divider	- max expected voltage of 8V - dynamic range of 5V on Analog to Digital Converter - Resistors of R_1=30kΩ and $R_2$50kΩ would be used. - 10 bit resolution provides 4.88mV of resolution - High impedance input of the Analog to Digital Converter negates advantage of the op-amp

Flight Software (FSW) Design

Satyam Patel

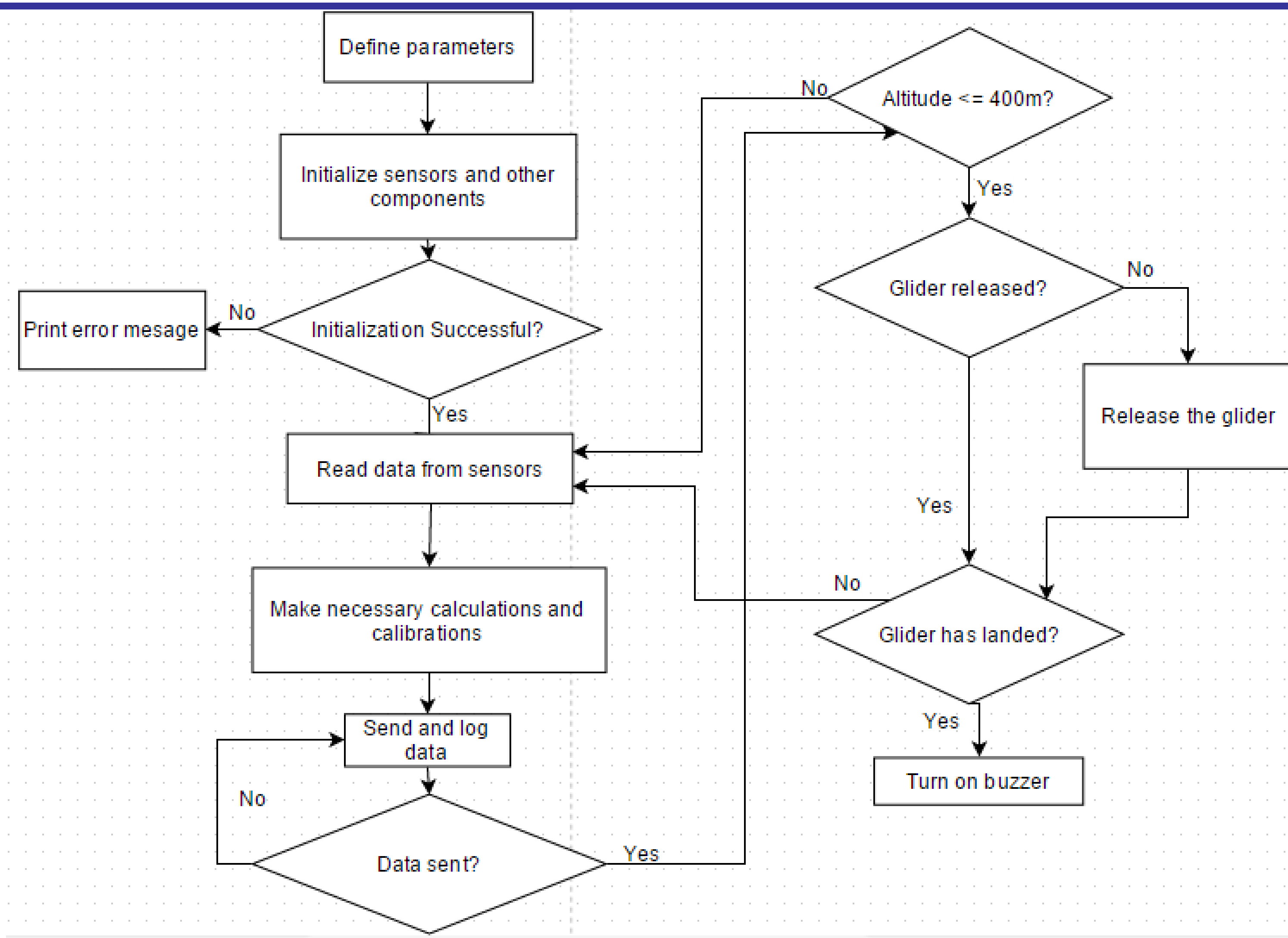
FSW Overview

- **Overview of the CanSat FSW design**
  - Read data from sensors
  - Do necessary calculations (e.g. speed conversion)
  - Send data (telemetry) through Xbee
- **Flight summary**
  - Release the glider from the container depending at 400 meters
  - Initialize each sensor and SD card
  - Collect data
  - Average the stored data to correct sensor errors
  - Transmit the processed data once per second to ground station
  - Turn on buzzer after landing

FSW Requirements

ID	Requirement	Rationale	Priority	Parent	VM
FSW-1	Glider will collect air pressure, temperature, and battery voltage at a rate of 1 Hz and transmit data to GCS	Competition requirement	High	SR-13	
FSW-2	Flight software will maintain a count of packets transmitted	Competition requirement	High	None	
FSW-3	CanSat will display telemetry data using engineering units	Keeps all records consistent	Low	None	
FSW-4	Teams will collect and plot data in real time	Competition requirement	High	none	
FSW-5	Glider shall receive a command to capture and image of the ground and store the image on board for retrieval	Camera requirement	High	SR-22	
FSW-6	CanSat will have an override system	In case release mechanism fails	Medium	SR-24	
FSW-7	Glider will be released at 400 +/- 10 m	Competition requirement	High	SR-9	
FSW-8	Transmission ends once glider lands	Competition requirement	High	None	
FSW-9	Audio beacon will turn on after glider lands	In order to locate the glider	Medium	SR-25	

CanSat FSW State Diagram



Glider FSW Plan

- **How glider flight software will accomplish the objectives:**

Pseudocode

Detects launch

Starts collecting data and transmitting data

if altitude = 400m or receives command from GCS, release glider from the can

continue collecting and transmitting data

if glider lands, stop sending data and turn on buzzer

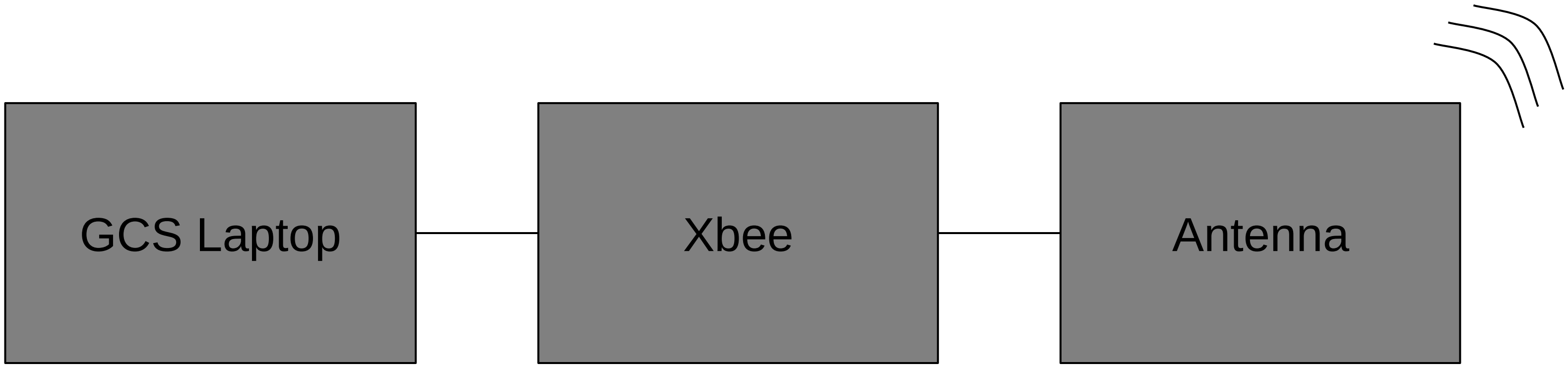
Software Development Plan

- Weekly meetings to set goals for the week
- Weekly work day to accomplish software development goal set for the week
- Dividing up tasks to tackle multiple problems at once
- Testing each sensor and telemetry using real life scenarios

Ground Control System (GCS) Design

Satyam Patel

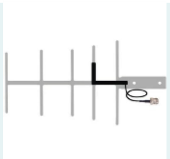
GCS Overview

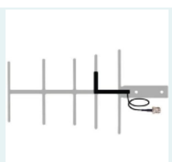


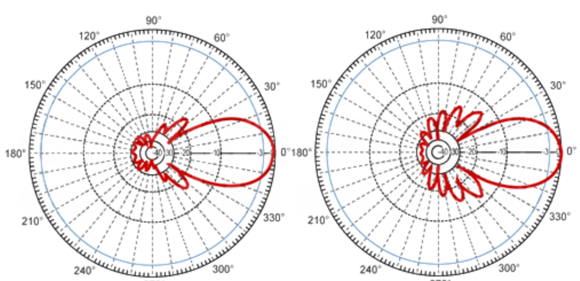
GCS Requirements

ID	Requirement	Rationale	Priority	Parent	VM
GCS-1	Teams will build their GCS with telemetry plotted in real time in engineering units	Teams can see the progress of their CanSats in real time	High	SR-18	T,I
GCS-2	GCS must be portable and have at least two hours of battery life	Allows for an ease of operation during competition	Low	SR-19	I
GCS-3	Glider will collect air pressure, temperature, and battery voltage at a rate of 1 Hz and transmit data to GCS	Competition requirement	High	SR-13	D,A,T
GCS-4	GCS will include laptop computer, XBEE radio, and hand held antenna	Competition requirement	High	None	I,A
GCS-5	GCS will transmit failsafe release command to cansat	Competition requirement	High	None	D

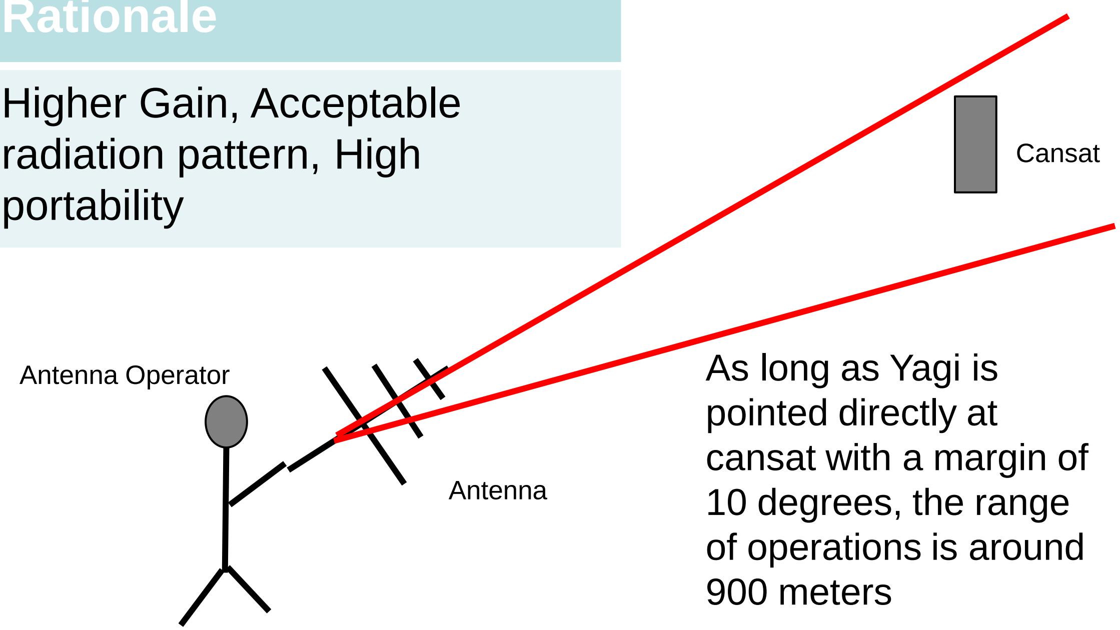
GCS Antenna Trade & Selection

Antenna		Specifications	Pros	Cons
Yagi		10dB Gain	High Gain Highly Portable	Highly Directional
EM-506		8dB Gain	High Gain Awkward to hold	Highly Directional

Antenna Chosen		Rationale
Yagi Antenna		Higher Gain, Acceptable radiation pattern, High portability



Vertical Horizontal



As long as Yagi is pointed directly at cansat with a margin of 10 degrees, the range of operations is around 900 meters

Telemetry display/Logging to CSV

- Telemetry data logging and display as well as bonus image receiving will be done using custom python GUI .

Real-time plotting software design

- Python program reads serial input from Xbee and plots it using Matplotlib (Python library) all inside one GUI.

Data archiving and retrieval approach

- Data will be logged to a plain text file with a .csv extension and read from same file for plotting. Plotting and serial data monitoring occur in parallel.

Command software and interface

- GUI also sends commands via serial through the Xbee at the push of a button.

CanSat Integration and Test

Shraddha Gharmalkar

CanSat Integration and Test Overview

- **Cansat Subsystems include Mechanical Subsystem (Container and Glider), Descent Control System (Parachute), Electronics + Sensor Package.**

- **Glider and Parachute will be placed inside Container, and secured with detachable latching mechanism.**
  - Parachute will be attached to the top of the container with knots and strong adhesives. Glider will be held in place in the container with detachable latch and some cushioning. Servo release mechanism will detach glider from container.
- **Electronics + Sensor Package will be placed inside of Glider, and secured with adhesives.**
  - Ensure no sensors are obstructed, and electronics are sufficiently protected from environment. Check that vibration, thermal and drop properties are sufficient.

CanSat Integration and Test Overview

- **Glider is highest priority. Ensure it can fit into container, release from Container, and circle in required fashion**
  - Place Glider in folded form into container to test for fit
  - Release mechanism ground test required + failsafe electronic release test at simulated altitudes.
  - High altitude drop test without electronics required to ensure circling is correct, and prevent damage to electronics
- **Electronic subsystems must be secured and functioning properly.**
  - Test individual electronic components, use pitot tube, anemometer and leaf blower to test for velocity accuracy.
  - Use known altitude to test pressure sensor’s accuracy
  - GPS accuracy test compare to pitot tube and altitude pressure sensor
  - Communication distance test use large line of sight distance to confirm accuracy and reliability
  - Test remote controllability of camera

CanSat Final Integration and Tests Check

- **CanSat must pass required environmental tests and must include the following before flight readiness check.**
  - 10 second long video showing the successful drop test.
  - 10 second long video showing the vibration tests.
  - Photo showing a display indicating temperatures during the thermal testing.
  - Photo showing the results of the fit check.
  - Completed checklist on page nine of required environmental tests document, including:
    - 7 different types of drop tests
    - 3 different types of vibration tests
    - 5 kinds of thermal tests
    - 2 types of fit checks and 2 final tests.

Mission Operations & Analysis

Angelica Deguzman

Overview of Mission Sequence of Events

Arrival

- Arrive at launch site
- Check in
- Set up GCS
- Set up CanSat

Mission Control Officer | GCS Crew | CanSat Crew

Pre-Launch Preparation

- Perform weight check and fit check
- Perform communications test
- Perform antenna check
- Obtain rocket
- Power on CanSat
- Check that telemetry data is being received

GCS Crew | CanSat Crew

Launch

- Insert CanSat into payload section of rocket
- Mount rocket on stand
- Wait until instructed to begin final checks
- Go through mission operations manual
- Collect data during launch

Mission Control Officer | CanSat Crew

Overview of Mission Sequence of Events

Descent

- Ensure CanSat is separated from container at 400 m (use override system if release mechanism failed)
- Check that the glider is collecting data
- Track flight pattern with GPS
- Wait for judge's command to take a picture
- Transmission ends when glider lands
- Audio beacon shall be activated

GCS Crew

Recovery

- Recovery crew will disperse into the field at the designated time
- Will retrieve container and glider
- Find container by florescent color
- Find glider using audio beacon and GPS

Recovery Crew

Data Retrieval

- Data is taken from the glider
- GCS data will be compared to telemetry data
- Data will be reviewed and analyzed by the team
- Begin writing post flight review with data

All Teams

Mission Operations Manual Development Plan

- **Mission Operations Manual Outline**
  - Crew roles and plans of action
  - Safety guidelines
  - Schedule of launch
  - GCS configuration
  - CanSat preparation and integration guidelines
  - Launch operations of each crew
    - ❖ GCS crew sets up station and monitors data after CanSat is turned on
    - ❖ CanSat crew integrates CanSat into rocket and mounts on stand
    - ❖ Mission control officer gives the “okay” for launch after final checks have been completed
    - ❖ Recovery crew watches out for container and glider during descent
    - ❖ GCS crew watches for glider release, overrides system if needed
    - ❖ GCS crew waits for judge command to capture an image
    - ❖ Recovery crew waits for designated time to retrieve CanSat

CanSat Location and Recovery

- **Container Recovery**
  - Container descent will be monitored by recovery team
  - It will be easily spotted during descent by parachute
  - After landing florescent pink color will allow ease of visibility
- **Payload Recovery**
  - Recovery crew will watch for glider during descent
  - GCS crew will track glider with GPS
  - Glider will activate an audio beacon after landing
  - Will be easy to find with audio and GPS aid

❖ **If not recovered CanSat will have address label on container and payload so it may be returned later if found**

Requirements Compliance

Angelica Deguzman

Requirements Compliance Overview

- **Comply**
  - Mechanical
    - ❖ Glider meets all dimensional requirements
    - ❖ CanSat meets mass requirements
    - ❖ Glider meets flight pattern requirements
    - ❖ Container meets launch verification requirements
  - Electrical
    - ❖ GCS meets communication requirements
    - ❖ Most sensors collect data at required sampling rate
    - ❖ Flight software meets all requirements
    - ❖ Power sources meet requirements

- **Not Comply**
  - Mechanical
    - ❖ CanSat has not finished all tests
  - Electrical
    - ❖ Camera has not been integrated

Requirements Compliance

Req #	Requirement	Comply/Partial Comply/No Comply	Reference Slides	Comments
1	Total mass of the CanSat shall be 500 g +/- 10 g.	Comply	43	
2	The glider shall be completely contained in the container. No part of the glider may extend beyond the container.	Comply	15	
3	Container shall fit in a cylindrical envelope of 125 mm diameter x 310mm length.	Comply	15,43	
4	The container shall use a passive descent control system. It cannot free fall.	Comply	15	
5	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section.	Comply	17	
6	The container shall be a florescent color, pink or orange.	Comply	15	
7	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Comply	17	
8	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.	Comply	17	
9	The CanSat (container and glider) shall deploy from the rocket payload section.	Comply	17	

Requirements Compliance

Req #	Requirement	Comply/Partial Comply/No Comply	Reference Slides	Comments
10	The glider must be released from the container at 400 meters +/- 10 m.	Comply	40	
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.	Comply	14	
12	All descent control device attachment components shall survive 30 Gs of shock.	Partial Comply	44	Testing needed
13	All descent control devices shall survive 30 Gs of shock.	Partial Comply	44	Testing needed
14	All electronic components shall be enclosed and shielded from the environment with the exception of sensors.	No Comply	35	After circuit is integrated
15	All structures shall be built to survive 15 Gs acceleration.	Partial Comply	44	Testing needed
16	All structures shall be built to survive 30 Gs of shock.	Partial Comply	44	Testing needed
17	All electronics shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.	Comply	49,51	
18	All mechanisms shall be capable of maintaining their configuration or states under all forces.	Comply	44	
19	Mechanisms shall not use pyrotechnics or chemicals.	Comply	n/a	
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	7	

Requirements Compliance

Req #	Requirement	Comply/Partial Comply/No Comply	Reference Slides	Comments
21	During descent, the glider shall collect air pressure, outside air temperature, and battery voltage once per second.	Comply	19,20	
22	During descent, the glider shall transmit all telemetry at a 1 Hz rate.	Comply	19	
23	Telemetry shall include mission time with one second or better resolution, which begins when the glider is powered on. Mission time shall be maintained in the event of a processor reset during the launch and mission.	Comply	55	
24	XBEE radios shall be used for telemetry.	Comply	55	
25	XBEE radios shall have their NETID/PANID set to their team number.	Comply	55	
26	XBEE radios shall not use broadcast mode.	Comply	55	
27	The glider shall have an imaging camera installed and pointing toward the ground.	Partial Comply	26	Needs to be integrated
28	The resolution of the camera shall be a minimum of 640x480 pixels in color.	Comply	8	
29	Cost of the CanSat shall be under $1000.	Comply	99	
30	Each team shall develop their own ground station.	Comply	77	
31	All telemetry shall be displayed in real time during descent	Comply	77	

Requirements Compliance

Req #	Requirement	Comply/Partial Comply/No Comply	Reference Slides	Comments
32	All telemetry shall be displayed in engineering units	Comply	8	
33	Teams shall plot data in real time during flight.	Comply	76	
34	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	77	
35	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line.	Comply	78	
36	Both the container and glider shall be labeled with team contact information including email address.	Comply	7	
37	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	71	
38	No lasers allowed.	Comply	n/a	
39	The glider must include an easily accessible power switch which does not require removal from the container for access.	Comply	64	
40	The glider must include a battery that is well secured to power the glider.	Comply	65	
41	Lithium polymer cells are not allowed due to being a fire hazard.	Comply	65	
42	Alkaline, Ni-MH, lithium ion built with a metal case, and Ni-Cad cells are allowed. Other types must be approved before use.	Comply	65	

Requirements Compliance

Req #	Requirement	Comply/Partial Comply/No Comply	Reference Slides	Comments
43	The glider shall receive a command to capture an image of the ground and store the image on board for later retrieval.	Partial Comply	19	After camera is integrated
44	The telemetry shall indicate the time the last imaging command was received and the number of commands received.	Comply	71	
45	The glider vehicle shall incorporate a pitot tube and measure the speed independent of GPS. The speed shall be compared with GPS speed.	Comply	20	
46	The glide duration shall be as close to 2 minutes as possible.	Comply	14	
47	The CanSat shall have a payload release override command to force the release of the payload in case the autonomous release fails.	Partial Comply	9	Will be done after release mechanism
48	A buzzer must be included that turns on after landing to aid in location.	Partial Comply	71	After circuit is integrated
49	Glider shall be a fixed wing glider. No parachutes, no parasails, no autogyro, no propellers.	Comply	12	

Management

Angelica Deguzman

CanSat Budget – Hardware

CanSat Subsystem	Item	Quantity	Price
SS	Arduino	1	$19.95 – actual
	Pololu	1	$27.95 – actual
	Camera	1	$39.95 – actual
	Airspeed sensor/pitot tube	1	$24.95 - actual
	GPS	1	$39.95 - actual
DCS	Balsa 1/8 inch sheets	10	$22.90 - actual
	Springs	1 pack	$10.99 - actual
	Adhesive	1	$6.16 - actual
	Parachute	1	$25.29 - estimated
MS	Foam Blocks	7	Donated
	Polycarbonate	2	$30.40- actual
	Screws	1 pack	$5.75
	Rocket Payload section	1	$25.14 – actual
EPS	Batteries	2 packs	$5.00 - estimated

CanSat Budget – Other Costs

CanSat Other Costs	Item	Quantity	Price
GCS	Computer	1	n/a
	Antenna	1	$30.00 - estimated
CDH	Processor	1	n/a
	Antenna	1	$54.95 - estimated
	SD Card	1	$20.00 – estimated
Test	Environmental Parameters	-	n/a
	Prototyping	-	n/a
Travel	Airfare	$400 x 10	$4000 – estimate
	Hotel room	$100 x 3	$300 – estimate
	Car rental	$300 x 2	$600 – estimate

CanSat Budget – Total

CanSat Income	Description	Amount
Sponsors	L3 Telemetry West	$1000 – actual
	Northrop Grumman	$1000 – actual
	General Atomics	$500 – estimated
Grants	California Space Grant	$1300 – estimated
	Matching Funds @ UCSD	$2000 – estimated
	AIAA @ San Diego	$200

CanSat Subtotal	Amount
CanSat Hardware Costs	-284.38
CanSat Non-Hardware Costs	-5004.95
CanSat Income	+6000
CANSAT TOTAL BUDGET	$710.67

Program Schedule

Fall Quarter September 28, 2015 – December 5, 2015

Objective	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Administrative										
Recruit	■									
Look for sponsors	■	■	■							
Budget		■	■	■						
Purchase Materials				■	■	■				
Start PDR							■	■	■	■
Register Team (Nov 30)										■

Objective	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Mechanical										
Research/Design	■	■								
Glider Dimensioning			■	■	■					
Material Selection				■	■					
Glider Fabrication						■	■	■		
Prototyping/Testing								■	■	■

Program Schedule

Fall Quarter September 28, 2015 – December 5, 2015

Objective	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Electrical										
Purchased sensors										
Set up FSW										
Wrote GCS software										
Communications tests										
Integrate electronics										

Fall Quarter
- Registration deadline to apply for competition in week 9
- Glider finalized designs were chosen and prototyped
- FSW and GCS software completed

Program Schedule

Winter Quarter January 4, 2016 – March 11, 2016

Objective	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Administrative										
Continue PDR										
PDR Due (Feb 1)										
Begin CDR										
PDR Teleconference										

Objective	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Mechanical										
Design folding mechanism										
Fabricate folding										
Test folding										
Design turning mechanism										
Fabricate turning										
Test turning										
Integrate with sensors										
Environmental tests										

Winter Quarter January 4, 2016 – March 11, 2016

Objective	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Electrical										
GPS parsing										
Test pitot tube										
Data logging to SD card										
GPS integration										
Antenna diversity testing										
Communications error correction										

Winter Quarter

- PDR due Week 5
- Glider maneuvers will be completed
- Electronic systems architecture will be completed

Program Schedule

Spring Quarter March 24, 2016 – June 3, 2016

Objective	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Administrative										
CDR Due										
CDR Teleconference										
Budget for travel										
Begin PFR										
Prepare for Texas										

Objective	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Mechanical										
Design release										
Prototype release										
Test/integrate release										
Test entire CanSat										
Test Launch										

Program Schedule

Spring Quarter March 24, 2016 – June 3, 2016

Objective	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Electrical										
Battery integration										
Canister power systems										
Packaging										
Final testing										

Spring Quarter

- CDR due week 1
- CanSat should be fully integrated
- Integrated tests shall be completed

Conclusions

- **Accomplishments**
  - Glider designs are completed
  - Mechanical prototyping and testing are in the works
  - Electrical circuit design complete
  - Software complete
  - Communications tests are in the works
- **Unfinished**
  - Integration
  - Environmental tests
- **Conclusion:** All preliminary designs are complete and are currently being fabricated/tested. We believe we have the necessary components to begin integrating the entire CanSat and pass all environmental tests.