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CanSat 2023
Preliminary Design Review (PDR)
Outline
Version 1.0

Your Team # Here

Your Team Name Here

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Presentation Outline

- **Provide a simple outline of the presentation**
- **Indicate the team member(s) who will be presenting each section**
- **Terms:**
  - ***CanSat*** refers to the complete system containing both the ***Container*** and the ***Payload***
  - ***Container*** refers to the ***container*** component of the CanSat
  - ***Payload(s)*** refers to the ***Science Payloads or probe*** component of the CanSat

IMPORTANT PRESENTATION GUIDELINE:
Teams should only present slides with this star icon.
Other slides should be skipped to save time; they will be reviewed by the judges off line. However, be sure to have all slides in the version presented.
Presentations are to be 30 minutes in length.
Going over 30 minutes will result in points lost.

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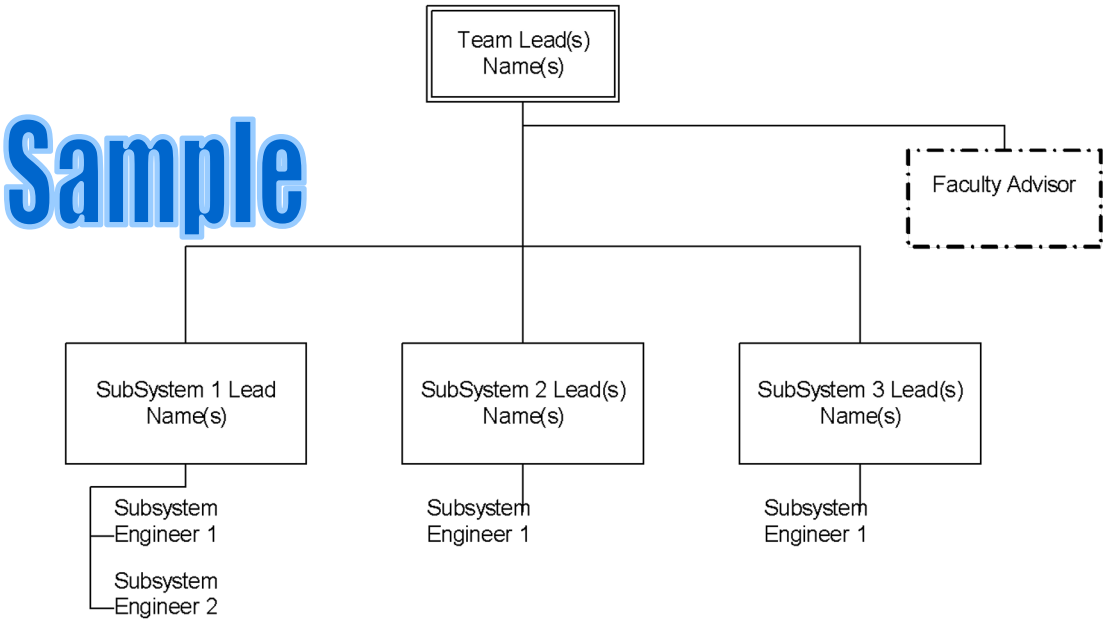
Team Organization

- **Single slide listing the team members and their roles**
  - If possible, please include year (freshman, sophomore, etc.) for reference
  - This only needs to be provided once for team members showing up multiple times on the org chart
- **Good format is the use of an organization chart, such as below:**



Acronyms

- **Provide a list of acronyms used throughout the presentation**
  - During presentations, do not read through these acronyms
    - These are for reference only

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The purpose of this section is to introduce the reviewer to the overall requirements and configuration of the CanSat. This provides a basis for the details presented in the subsystem sections.

Systems Overview

Presenter Name(s) Go Here

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Mission Summary

- **Overview of the mission objectives**
- **Indicate whether selectable objective (bonus) is being attempted**
  - Describe selection rationale
- **Include any external objectives (personal, laboratory or sponsor, class, etc.) relevant to the design**

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System Requirement Summary

- **Overview of system (mission) level requirements**
  - Use bullets or a table to demonstrate an understanding of the mission requirements
  - Do not include all requirements, just high level system level requirements the describe the overall mission
- **The purpose of the table is to demonstrate the team understands the system-level requirements**
- **This table may be expanded to multiple tables as needed**

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System Level CanSat Configuration Trade & Selection

- **Present two preliminary system-level concepts considered**
  - What overall design concepts were considered
  - It may be helpful to split the team into groups and come up with independent designs
- **Present criteria for final configuration selection**
  - Include discussion of why the final configuration was selected
- **Include diagrams of various concepts considered**
- **Include variations on Concept of Operations (CONOPS) considered**
- **Limit discussions to 1-2 slides per preliminary configuration**
  - Presentation of the material may be at a cursory level (hit the highlights)
  - Each concept will be scored separately.
- **The two design concepts need to be significantly different. Changing orientation of circuit boards is not good enough.**

See slide discussing trade studies at the end of this PowerPoint

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System Level Configuration Selection

- The goal is to identify selected system level configuration
- List rationale for selection
- The rest of the design trades will be based on this selection

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Physical Layout

- **The goal is to present the physical idea of what the CanSat will look like for reference prior to getting into details of the CanSat design**
- **Diagram(s) showing physical layout of selected CanSat configuration**
- **Make sure to include:**
  - Dimensioned drawings
  - Placement of major components
    - Sensors, electronics, radio, power, mechanisms
  - Relevant configurations
    - Payload launch configuration, deployed configuration.
- **Can be on separate slides.**

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System Concept of Operations

- **Slide(s) providing overview of CanSat operations**
- **Include:**
  - Launch and descent operations
    - Be sure to include Payload operations
  - Post-launch recovery and data reduction
  - Focus on selected configuration CONOPS
- **Focus on how the CanSat will operate, not what everyone on the team will be doing (to be discussed at CDR)**
- **Simple flow diagrams and cartoons are a good way to present the CONOPS**
  - No hand-drawn diagrams

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Launch Vehicle Compatibility

- **Include a dimensioned drawing that shows *clearances* with the payload section**
  - Focus on launch configuration (Container + Payload)
  - Include all descent control apparatus (no sharp protrusions)
  - At PDR this may be allocated dimensions (if this is the case, these should be requirements at the system and subsystem levels)
  - What is the clearance? (Leave margin to allow *easy* deployment!)
- **Note:**
  - In past years there were a large number of CanSats that did not deploy from the payload sections of the rocket because of protrusions or because the CanSat was too wide to fit in the rocket
  - Lack of sharp protrusions and fit within the Launch Vehicle will also be scored at the Flight Readiness Review

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Sensor Subsystem Design

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Sensor Subsystem Overview

- **One slide providing an overview of the CanSat sensor subsystem**
  - Include summary of the selected sensors (type & models)
  - Include brief discussion of what the sensors are used for
  - Focus on selected component (not all components trades)

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Payload Air Pressure Sensor Trade & Selection

- **Summary of air pressure sensor trade study and selection**
  - –Include details such as interfaces, resolution, cost, size, weight and any other factors for the trade
  - –Show at least two different sensors (same for all other slides)
  - –Indicate which sensor is selected and reasons for selection

See slide discussing trade studies at the end of this PowerPoint

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Payload Air Temperature Sensor Trade & Selection

- **Summary of air temperature sensor trade study and selection**
  - –Include details such as interfaces, resolution, cost, size, weight and any other factors for the trade
  - –Show at least two different sensors (same for all other slides)
  - –Indicate which sensor is selected and reasons for selection

See slide discussing trade studies at the end of this PowerPoint

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Payload Battery Voltage Sensor Trade & Selection

- **Summary of Payload battery voltage sensor trade study and selection**
  - –Include details such as interfaces, resolution, cost, size, weight and any other factors for the trade
  - –Show at least two different sensors (same for all other slides)
  - –Indicate which battery is selected and reasons for selection

See slide discussing trade studies at the end of this PowerPoint

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Payload Tilt Sensor Trade & Selection

- **Summary trade study and selection of sensors used to measure payload tilt (to be used for leveling after landing)**
  - –Include details such as interfaces, resolution, cost, size, weight and any other factors for the trade
  - –Show at least two different sensors (same for all other slides)
  - –Indicate which sensor is selected and reasons for selection

See slide discussing trade studies at the end of this PowerPoint

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Payload GPS Sensor Trade & Selection

- **Summary trade study and selection of GPS receiver**
  - –Include details such as interfaces, resolution, cost, size, weight and any other factors for the trade
  - –Show at least two different sensors (same for all other slides)
  - –Indicate which sensor is selected and reasons for selection

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Payload Camera Trade & Selection

- **Summary of camera trade study and selection**
  - –Include details such as interfaces, resolution, cost, size, weight and any other factors for the trade
  - –Show at least two different sensors (same for all other slides)
  - –Indicate which sensor is selected and reasons for selection

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Bonus Camera Trade and Selection

- **Summary of camera trade study and selection**
  - –Include details such as interfaces, resolution, cost, size, weight and any other factors for the trade
  - –Show at least two different sensors (same for all other slides)
  - –Indicate which sensor is selected and reasons for selection

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Descent Control Design

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Descent Control Overview

- One slide providing an overview of the container and science payload descent control system(s)
- Include overview of the selected configuration and components necessary
- Include diagrams outlining descent control strategy for various flight altitude ranges

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Container Descent Control Strategy Selection and Trade

- **Summary of Container DCS strategy trade studies and selection**
  - Include details on container descent design and operation
  - Show at least two designs
  - Show selection and provide reasons for selection

See slide discussing trade studies at the end of this PowerPoint

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Payload Aerobraking Descent Control Strategy Selection and Trade

- **Summary of Container DCS strategy trade studies and selection**
  - Include details on payload descent design and operation
  - Show at least two designs
  - Show selection and provide reasons for selection

See slide discussing trade studies at the end of this PowerPoint

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Payload Aerobraking Descent Stability Control Strategy Selection and Trade

- **Summary of descent stability control strategy trade studies and selection**
  - Show details on active stability control or passive control
    - Discuss how to stabilize during aerobraking
    - Describe any mechanisms used
    - Show at least two designs
  - Show selection and provides reasons for selection

See slide discussing trade studies at the end of this PowerPoint

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Payload Parachute Descent Control Strategy Selection and Trade

- **Summary of Payload Parachute DCS strategy trade studies and selection**
  - Include details on parachute design and operation
  - Show at least two designs
  - Show selection and provide reasons for selection

See slide discussing trade studies at the end of this PowerPoint

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Descent Rate Estimates

- **Present descent rate estimates for the following CanSat configurations**
  - Cansat with payload
  - Payload aerobraking
  - Payload parachute released
- **Include discussion of**
  - Calculations used
  - Assumptions
- **This discussion can carry over to multiple slides if necessary**
- **Last slide summarizes results. Make sure final results are clearly identified.**
- **Only present the summary result in the review**

Mechanical Subsystem Design

Presenter Name(s) Go Here

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Mechanical Subsystem Overview

- **One slide providing overview of the mechanical subsystem**
  - Include overview of major structural elements, material selection, and interface definitions
  - Include science payload and container mechanical configurations

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Container Mechanical Layout of Components Trade & Selection

- **Key trade issues related to mechanical layout and component selection**
  - Show structure of Container
  - Identify location of electrical components
  - Identify major mechanical parts
    - mechanisms such as springs, hinges, etc.
- **Show at least two mechanical layouts**
- **Indicate selection and reasons for selection**
- **Show structural material selection(s)**

See slide discussing trade studies at the end of this PowerPoint

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Container Parachute Attachment Mechanism

- **Describe how the parachute will be attached to the container and how it is stowed before being released**
- **Include:**
  - Diagrams
  - Method of operation
  - Be detailed in how it works.
  - Keep it simple. Parachute just sits on top of container.

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Payload Mechanical Layout of Components Trade & Selection

- **Key trade issues related to mechanical layout and component selection**
  - Show structure of Payload
  - Identify location of electrical components
  - Identify major mechanical parts
    - mechanisms such as springs, hinges, etc.
- **Show at least two mechanical layouts**
- **Indicate selection and reasons for selection**
- **Show structural material selection(s)**

See slide discussing trade studies at the end of this PowerPoint

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Payload Aerobraking Pre Deployment Configuration Trade & Selection

- **Key trade issues related to how the payload is stowed in the container**
  - Show stowed configuration diagram
- **Explain mechanisms used to keep payload in stowed configuration**

See slide discussing trade studies at the end of this PowerPoint

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Payload Aerobraking Deployment Configuration Trade & Selection

- **Key trade issues related to how the payload transitions from stowed to deployed configuration**
- **Explain mechanisms used to transition to deployed configuration, ie hinges, springs, etc.**

See slide discussing trade studies at the end of this PowerPoint

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Payload Parachute Deployment Configuration Trade & Selection

- **Key trade issues related to how the payload parachute transitions from stowed to deployed configuration**
- **Explain mechanisms used to transition to deployed configuration, ie hinges, springs, etc.**

See slide discussing trade studies at the end of this PowerPoint

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Payload Uprighting Configuration Trade & Selection

- Key trade issues related to how the payload is made upright.
- Identify the upright orientation
- Explain mechanisms used to make the payload upright.

See slide discussing trade studies at the end of this PowerPoint

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Electronics Structural Integrity

- Electronic component mounting methods
- Electronic component enclosures
- Securing electrical connections (glue, tape, etc.)
  - Consider required judge verification during pre-flight check in
- Descent control attachments

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Mass Budget

- **Table(s) providing the following:**
  - Mass of each component of payload and container
  - Mass of each structural element
  - Sources/uncertainties – whether the masses are estimates, from data sheets, measured values, etc.
  - Total mass of all components and structural elements
  - Margin : The amount of mass (in grams) in which the mass budget meets, exceeds, or falls short of the mass requirement
- **Method of correction to meet mass requirement (based on the margin listed above)**
- **Must clearly distinguish between Container and Payload masses**

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Communication and Data Handling (CDH) Subsystem Design

Presenter Name(s) Go Here

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Payload Command Data Handler (CDH) Overview

- **One slide providing overview of the container CDH subsystem**
  - Should include selected components (with brief mention of what each component is for)
  - Focus on selected component (not all components trades)

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Payload Processor & Memory Trade & Selection

- Include boot time
- Include processor speed
- Include data interfaces (types and numbers)
- Include memory storage requirements, if applicable
- Show at least two choices
- Indicate selected choice and reasons for selection

See slide discussing trade studies at the end of this PowerPoint

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Payload Real-Time Clock

- **Describe design for Container real-time clock**
  - Hardware clock with independent power source
  - Reset tolerance
  - Real time clock should have independent battery backup to maintain time through power transients
- **Show at least two designs**
- **Indicate selected design and reasons for selection**

See slide discussing trade studies at the end of this PowerPoint

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Payload Antenna Trade & Selection

- Antenna selection criteria
- Antenna range and patterns
- Show at least two choices
- Indicate selected choice and reasons for selection
- Show where antenna is to be located

See slide discussing trade studies at the end of this PowerPoint

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Payload Radio Configuration

- **Show XBEE radio selection**
- **Show NETID**
- **Include transmission control**
  - How is this managed during each mission phase?
- **Note:**
  - Communications failures have occurred often over the past several years of the competition
  - You are encouraged to use your radios in all of your development and testing to better ensure mission success
    - Ideally you have started working with the radio and communications protocol

Start Radio Prototyping and Testing Early!

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Payload Telemetry Format

- **What data is included?**
  - **Check the competition guide for telemetry requirements**
- **How is data formatted?**
  - Include example frames with sample data and complete descriptions
    - Include Container frames and Payload relay frames
  - *Does the presented format match the Competition Guide requirements?*

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Payload Command Formats

- **List all supported commands with examples**
- **What data is included?**
  - –Check the competition guide for command requirements
- **How is command data formatted?**
  - –Include example commands with complete descriptions
  - –*Does the presented format match the Competition Guide requirements?*

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Electrical Power Subsystem (EPS) Design

Presenter Name(s) Go Here

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EPS Overview

- One slide providing overview of EPS components (with purposes)
- Include a diagram

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Payload Electrical Block Diagram

- **High-level schematic (not down to the resistor level) showing power connections**
  - Include all voltages and needed regulators
  - Include all major components
- **Include overview of how power will be controlled and verified externally without disassembling the CanSat**
  - i.e., an easily accessible external switch
    - This will be scored again at the Flight Readiness Review
- **Umbilical power source for use in test and safety inspection**

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Payload Power Trade & Selection

- **Describe power trade and selection.**
- **Show at least two designs**
- **Indicate selected design and reasons for selection**
  - –Remember no lithium polymer batteries!
  - –How is battery mounted and connected?
  - –If multiple cells used, how are the connected, series or parallel.
    - •If parallel, how do you match the cells, provide protection so one cell doesn't destroy the other cell
    - •Cells cannot be connected directly in parallel. Include diodes to isolate the cells from each other.

See slide discussing trade studies at the end of this PowerPoint

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Payload Power Budget

- **Power budget in tabular format which includes:**
  - Power consumption of each component in watt hours
  - Expected duty cycles for each component
  - Source/uncertainty for each line item
    - Estimate, data sheet, measurement, etc.
  - Total power consumed in watt hours
  - Power sources and total power available
  - Margin : Difference of battery watt hours versus payload power consumption in watt hours
    - Requirement defined in mission guide states that the payload must be powered for at least two hours

Flight Software (FSW) Design

Presenter Name(s) Go Here

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FSW Overview

- **Overview of the CanSat FSW design**
- **Should discuss**
  - Basic FSW architecture, a flow chart showing how the software flow
  - Programming languages
  - Development environments
  - Brief summary of the FSW tasks

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Payload FSW State Diagram

- **Software state diagrams defining the *states* and *transition conditions* of the flight software**
- **Include:**
  - Sampling of sensors (including rates)
  - Communications (command and telemetry)
  - Data storage (if applicable)
  - Mechanism activations
  - Major decision points in the logic
- **FSW recovery to correct state after processor reset during flight**
  - What data is used to recover?
  - **Identify reasons for reset, and methods of recovery**

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Simulation Mode Software

- Describe the implementation of simulation mode where simulated pressure sensor data is transmitted to the container so simulate the mission
- Describe simulation mode commands
- How is simulated sensor data substituted with real data?
- See the competition guide for detailed requirements

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Software Development Plan

- **A common CanSat problem is late software development**
- **Present a slide describing the plan for software development and plans to reduce the risk of late software development**
- **Include:**
  - Prototyping and prototyping environments
  - Software subsystem development sequence
  - Development team
  - Test methodology

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Ground Control System (GCS) Design

Presenter Name(s) Go Here

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GCS Overview

- **Include a simple context diagram showing major components (computers, antenna, adaptors, etc.)**

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GCS Design

- **Show diagram of ground station**
  - What components and how they connect
- **Specifications**
  - How long ground station can operate on battery
  - Overheating mitigation (how do you keep laptop from getting so hot, it stops operating? Remember, it will be hot and the ground station will be in the open sun.)
  - Auto update mitigation (how do you keep the OS from starting an update during operations? It has happened before with Windows OS)

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GCS Antenna Trade & Selection

- **Show selection of antennas or custom design**
- **Show antenna patterns**
- **Show any design for mounting antenna**
  - –Remember antenna will be hand-held or table top
- **Show at least two designs**
- **Indicate selected design and reasons for selection**

See slide discussing trade studies at the end of this PowerPoint

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GCS Software

- **Telemetry display prototypes**
- **Commercial off the shelf (COTS) software packages used**
- **Real-time plotting software design**
- **Command software and interface**
- **Telemetry data recording and media presentation to judges for inspection**
- **Describe .csv telemetry file creation for judges**
- **Simulation mode description**
  - –Describe how the ground system reads the profile and transmits simulation commands

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CanSat Integration and Test

Presenter Name(s) Go Here

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CanSat Integration and Test Overview

- **The goal(s) at PDR are**
  - Get teams thinking about how to put all the pieces together
  - Get teams thinking about how to test the integrated assembly to make sure it works as a unit
- **Discuss subsystem level test plans**
- **Discuss integrated level functional test plans**
- **Discuss environmental test plans**
- **Discuss simulation test plans**

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Subsystem Level Testing Plan

- **Discuss plans for testing each subsystem**
  - Sensors
  - CDH
  - EPS
  - Radio communications
  - FSW
  - Mechanical
  - Descent Control

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Integrated Level Functional Test Plan

- **Discuss tests to be performed after Payload and container are built**
  - Descent testing
  - Communications
  - Mechanisms
  - Deployment

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Environmental Test Plan

- **Discuss plans for environmental testing**
  - Drop test
  - Thermal test
  - Vibration test
  - Fit Check
  - VACUUM test

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Simulation Test Plan

- **Discuss plans for simulation testing**
  - What parts of the cansat get tested during simulation
  - How is the simulation implemented

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Mission Operations & Analysis

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Overview of Mission Sequence of Events

- **Preliminary launch-day sequence of events**
  - Should start with arrival at the launch site and proceed through recovery and data analysis
- **Include:**
  - Flowchart of events
  - Team member roles and responsibilities
  - Antenna construction and ground system setup
  - CanSat assembly and test
- ***Preliminary at PDR***

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Mission Operations Manual Development Plan

- **Discuss development and content of the Missions Operations Manual for your CanSat**

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CanSat Location and Recovery

- **Discuss how you will find your CanSats in the field**
  - Discuss container and payload recovery
  - Color selection of visible components
  - CanSat return address labeling
    - On the container and payload

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

Requirements Compliance

Presenter Name(s) Go Here

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Requirements Compliance Overview

- State current design compliance to requirements
- Summarize content of the detailed slides that follow
- If the design does not comply to the requirements, that is a serious issue – why?

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Requirements Compliance (multiple slides, as needed)

- **Provide a table demonstrating compliance to all competition base requirements**
  - Use the following format in as many slides as required

Rqmt Num	Requirement	Comply / No Comply / Partial	X-Ref Slide(s) Demonstrating Compliance	Team Comments or Notes
1	Total mass of the CanSat (science payload and container) shall be 500 grams +/- 10 grams.	**Comply**	**x, y, z**	**Everything should be green by CDR.**
2	CanSat shall fit in a cylindrical envelope of 125 mm diameter x 310 mm length. Tolerances are to be included to facilitate container deployment from the rocket fairing.	--	--	--
3	The container shall not have any sharp edges to cause it to get stuck in the rocket payload section which is made of cardboard.	**Partial**		Medium problem: why?
4	The container shall be a fluorescent color; pink, red or orange.	**No Comply**		***Big problem: why?***
5	The rocket airframe shall not be used to restrain any deployable parts of the CanSat.			
6	The rocket airframe shall not be used as part of the CanSat operations.			

Use the Green (Comply), Yellow (Partial Compliance), and Red (No Comply) color codes as shown in the examples above for each requirement

Management

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CanSat Budget – Hardware

- **Provide a table listing the costs of all CanSat flight hardware**
- **Table should include**
  - Cost of each component/hardware
  - Indication of whether these costs are actual, estimates, or budgeted values
  - Indication of hardware re-use from previous years
    - The current market value for re-used components should be included
    - *Note: re-used flight hardware has been known to be more likely to fail*
    - Include market value for any free components and materials

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CanSat Budget – Other Costs

- **The goal(s) of this budget are**
  - To provide an understanding of the overall design and development costs
  - Get the teams thinking about the overall costs including necessary funds for travel
  - Identify shortfalls in the budget that require attention
    - In the past some teams have not been able to attend the competition due to a lack of funds
    - If caught early enough, there are a number of resources for funding that may available to teams
- **Table(s) (same format as Hardware Budget) showing**
  - Ground control station costs
  - Other costs
    - Prototyping
    - Test facilities and equipment
    - Rentals
    - Computers
    - Travel
  - Sources of income
- **THE COMPETITION DOES NOT PROVIDE ANY DEVELOPMENT FUNDING OR DONORS**

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Program Schedule Overview

- **A one page Gantt summary chart showing task start and stop dates and durations shall be presented**
  - Schedule should include linkages between tasks to provide the team with an idea of what happens in the overall flow when milestones are not met on time
- **Make sure the schedule is readable in the presentation**
  - Failure to do so will result in a loss of points

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Detailed Program Schedule

- **Details of development schedule to include**
  - Competition milestones
  - Academic milestones and holidays
  - Major development activities with assignments
  - Component/hardware deliveries
  - Major integration and test activities and milestones
  - Team member vacations
- **This can be presented in Gantt chart or table format**
- **The goals of this schedule are to**
  - Provide a tool for the team to track progress of CanSat design and development
  - Provide tool for judges to assess trouble areas and offer ways for the team to best meet the objectives of the competition
- **Make sure the schedule is readable in the presentation**
  - This may require the schedule to be broken between multiple slides
    - Failure to do so will result in a loss of points

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Conclusions

- **Presentation summary and conclusions**
- **In general include the following:**
  - Major accomplishments
  - Major unfinished work
  - Why you are ready to proceed to next stage of development

Presentation Scoring & Additional Information

Do Not Include the Following Charts in the Presentations

The following slides provide additional information regarding presentation scoring, as well as recommendations for the presentations and slides

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Presentation Scoring

- **Each slide in this template is scored on a scale of 0 to 2 points**
  - 0 = missing or no compliance to the intent of the requirement
  - 1 = topic incomplete or partial compliance to requirement(s)
  - 2 = complete and demonstrates requirement(s) met
- **Each section of the presentation (System Overview, Sensor Subsystems, etc.) is weighted according to the table**
- **Each team will receive a link to a summary score sheet that will contain all their competition scores**

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PPT Template Use

- **All teams shall use this presentation template**
- **Team logos**
  - A team logo can be inserted into the placeholder location (and size) on the master slide
  - If no logo is to be used, remove the placeholder from the master slide
- **Team number and name must be in the footer of each slide**
- **On each slide, replace the "Name goes here" in the bottom left corner with the name of the person(s) presenting that slide**
  - This will allow the judges to know the person to address any questions or comments to

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Trade Studies

- **Recommendations for trade studies:**
  - Tabular format
  - Discuss criteria for selection
    - Studied configurations
    - Assessment criteria and ranking
- **Be clear on final component/configuration selections**
- **When using hardware from previous years, do the same**
- **Be consistent with trade study presentations**

- **Refer to past year presentations for examples of effective trade study presentation formats**

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Presentation Template Update Log (Do not include in presentation)

- **1.0 Initial version for 2023**