Monarch-Two
Preliminary Design Review

ODU
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Mission Overview
Mission Overview

• The mission of Monarch-Two is to evaluate and design a smartphone based flight system and transmitter with flight data collection capabilities

• Smartphone
  – Create a system that can record data and create a modulated signal for transmission through the radio

• Transmitter
  – Create a system that can transmit a signal that can be received and demodulated at ODU (Requires Special Port)

• Data Collection
  – Create a system that can collect and report flight data (Acceleration, Gyroscopic movement and Magnetometry)
Mission Overview (cont.)

We expect to prove that a smartphone is a viable and low cost platform for sounding rocket and balloon flights that allows faster development through software based design. This is useful, as it allows the complexity of data handling and radio communication to be simplified to a significant degree for general applications.
Theory and Concepts

• Smartphone capabilities
  – Onboard storage
  – Audio Hardware
  – High performance processor
  – Cameras
  – Battery

• Other Research
  – PhoneSat
  – STRaND
Flight Timeline

- **t ≈ 0 min**: Low N₂, Low spin
- **t ≈ 5.5 min**: Chute deploys
- **t ≈ 15 min**: Splash down

**G-switch triggered**

**t ≈ 0**
- Transmission begin
- Phone boots
- Sensors calibrated

**Apogee**

**t ≈ 2.8 min**
Altitude: ≈115 km

**t = -1 min**

**t ≈ 15 min**
Splash Down

RockSat-C 2016
CoDR
Expected Results

• Expected Outcomes
  – Data collection at a high rate throughout flight
  – Transmission of data to ground
  – Successful operation of control system through entire flight
Success Criteria

• Minimum Success Criteria:
  – Smartphone Operation
  – Ground Station Reception

• Comprehensive Success Criteria:
  – Minimum Success
  – Full Data Downlink
  – Complete Flight Data
# Broad Functional Requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic: The system will have functional logic that operates on the collected data.</td>
<td><strong>Test</strong></td>
<td>Code will be tested and shown to function under the conditions and duration of the flight.</td>
</tr>
<tr>
<td>Transmission: The radio will be capable of transmitting at a power level capable of reaching ODU through the entire flight.</td>
<td><strong>Demonstration</strong></td>
<td>The radio will be shown to operate at a measured power level that is mathematically sufficient to reach ODU.</td>
</tr>
<tr>
<td>Data Generation: The system will collect flight data of several types, to cover all types of expected flight movements.</td>
<td><strong>Test</strong></td>
<td>Data will be collected for the expected duration of the flight to verify proper operation.</td>
</tr>
<tr>
<td>Structure: The system will conform to the balance and distribution requirements.</td>
<td><strong>Analysis</strong></td>
<td>The system will be analyzed in solidworks to ensure proper mass distribution.</td>
</tr>
</tbody>
</table>
Functional & Design Requirements:

- Functional Requirement
  - Logic
    Smartphone
    Signal Packet Generation (Test)
    Data storage (Test)
  - Co-processor
    Data Collection (Test)
    Communication with Smartphone (Test)
  - Transmission
    Radio Transmission (Demonstration)
  - Data Generation
    9DOF Sensor (Test)
    High-G Sensor (Test)
    High-DPS Sensor (Test)
  - Structure
    Balanced (Analysis)
De-Scopes & Off-Ramps

• Descopes
  • Simplify Data Collection
  • Reduce code complexity

At this point funding should be fully realized, so no cost off-ramps should be encountered unless large issues arise later on.
System Overview
System Block Diagram

Diagram components:
- 9DOF board
- High-DPS
- High-G
- Internal sensors
- SD Card
- Teensy
- Smartphone
- Battery bank
- G-Switch
- Wallops Trigger
- Radio
- SD Card
System design - Physical Model

- Batteries
- Main circuit
- Phone Holder
- Power circuit
- Radio
- G-Switch
RockSat Compliance

• Mass
  – We can easily fit within mass budget, based on our design from last year being fairly under mass.
• Volume
  – Volume is a similar situation, we have a similar layout and plate count from last year.
• Early Activation
  – Early activation is a must, we need time to allow the phone to boot into the operating system and become flight-ready.
• Special Request
  – A special port is required for our radio transmission.
Design Overview: Shared Can Logistics

We have no preference in orientation, and await our assignment for a partner.
Subsystem Design
Mechanical
Subsystem Design Section

- Balanced design through Solidworks
- Two plate design
- Upper plate using batteries for ballast
Material Choice

Makrolon is the material of choice for the plates due to its optimum strength and material characteristics, especially the non conductive nature. This allows an ideal mounting situation where there is little concern about potential shorts to the plate due to PCB flex under launch stresses.

Mounts will be constructed from sheet aluminium as they were last year.
Risks

• Risk 1: Physical failure of joints  
  – Rigorous physical testing should be performed early
• Risk 2: Machine shop failures could cause plate and other manufacturing errors  
  – Purchase an excess of consumable construction material
Subsystem Design

Circuit Board
Subsystem Design Section

- Similar to last year’s flight package, using same parts as they were satisfactory.
- Circuit must be improved to fit the smartphone integration.
- Power system will be using last year’s design, as it worked well.
Block diagram
Trade Studies

- All parts for the sensors and power circuit are being chosen for their proven effectiveness and familiarity from last year.
- Any part changes will be considered if other solutions present themselves.
- It’s better to stick with a part we know and have working code for than to shift to a new part without major advantages, especially given that the part we used prior was effective.
Risks

• Risk 1: Circuit fails in flight
  – We need to make sure it is properly assembled and laid out prior to late stage testing.

• Risk 2: Circuit is non-functional
  – Design review should be made by multiple team members to spot bad connection layouts faster.
Subsystem Design
Code
Subsystem Design Section

- Two sets of code, counted as a single subsystem
- Coprocessor runs updated version of Monarch-One flight code
- Smartphone requires a more complex system
- Interface also required
Code Functional Overview

- Coprocessor (Teensy) collects sensor data
- Stores it to the SD card
- Transfers to Smartphone
- Smartphone also stores it
- Creates a packet of data
- Creates a modulated signal to feed to the radio.
Risks

- Risk 1: Code completion could take longer than anticipated and create a testing issue.
  - Code must be made a priority.
- Risk 2: Code could fail during flight, leaving payload dead in the air.
  - Testing must be thorough and continual.
Test/Prototyping Plan
Prototyping Section

• Radio
  – Was suboptimal last year
  – Need to verify ground station

• Smartphone Code
  – Single point of failure
  – Must be well tested
Prototyping Plan

- What will you build/test between now and CDR to mitigate risks?

**Risk/Concern**
- Concern about antenna design and radio transmission strength
- Single point of failure, significant code requirements

**Action**
- Verify radio operation and antenna design
- Begin strong code generation and testing
Project Management Plan
Organizational Chart

Faculty Advisors:
Dr. Bob Ash
Dr. Dimitrie Popescu
Dr. Christopher Bailey

Project Lead:
Connor Huffine

Radio:
Ashley Cox

Mechanical:
Cian Branco
Joseph Torrez
Robert Torrez
Adam Horn

Electrical:
Connor Huffine
Cameron Kowaki
Ashley Smith

Sponsors:
ODU
VSGC
Schedule

- November
  - Complete concrete designs
  - Begin PCB fabrication
  - Early physical prototyping
- December
  - Code in a testable state
  - PCB finished
  - Radio ready
  - Winter break
- January
  - System Assembled and testable
- February
  - Long duration testing
- March
  - Time allocated to rework any discovered issues
- April
  - Ready to fly
  - Additional stretch code refinement
## Preliminary budget

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<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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Conclusion

1. Complete Designs
2. Begin ordering parts
3. Recruit additional members