CDR Presentation Outline

• Section 1: Mission Overview
• Section 2: System Overview
• Section 3: Subsystem Design
• Section 4: Prototyping/Analysis
• Section 5: Manufacturing Plan
• Section 6: Testing Plan
• Section 7: User Guide Compliance
• Section 8: Project Management Plan (PMP)
1.0 Mission Overview

All
The NNU RockSat-X team will test the feasibility of flexible electronics in the harsh environment of space.
Mission Overview: Mission Objectives

- Successfully deploy and activate passive, flexible RFID tags after rocket skirt separation
- Successfully gather analog data using FleX ADC and compare it to internal ADC of microcontroller
- Capture video of deployed electronics
Mission Overview: Theory and Concepts

- Passive RFID temperature tags should return temperature values once the reader is activated
- RFID tags used in aeronautical travel
- RFID temperature tags increasing water reclamation efficiency on ISS
  - Flexible tags are new technology
  - Provide weight and volume saving electronics
ConOps

Altitude

- **t ≈ 75 sec**
  - Altitude: 95 km
  - *Deploy Boom*

- **t ≈ 70 sec**
  - Altitude: 75 km
  - *Skirt Deployment*

- **t ≈ 0.6 min**
  - Altitude: 60 km
  - *Begin storing RFID data,*

- **t ≈ -180 sec**

- **t ≈ 5 sec**
  - Initiate motor timers
  - Activate Cameras
  - Boot Phone

- **t ≈ 5.5 min**
  - *Chute Deploys*

- **t ≈ 15 min**
  - *Splash Down*

- **t ≈ 330**
  - Altitude: 75 km
  - *All systems off*

- **t ≈ 280 sec**
  - TE-2 Activate
  - *Bring Boom in*

- **t ≈ 2.8 min**
  - Apogee
  - Altitude: ≈ 115 km

- **t ≈ 0.6 min**
  - Altitude: 60 km
  - *Begin storing RFID data,*

- **t ≈ 5 sec**
  - Initiate motor timers
  - Activate Cameras
  - Boot Phone

- **t ≈ 5.5 min**
  - *Chute Deploys*

- **t ≈ 15 min**
  - *Splash Down*

- **t ≈ 330**
  - Altitude: 75 km
  - *All systems off*

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  - Altitude: 60 km
  - *Begin storing RFID data,*

- **t ≈ 5 sec**
  - Initiate motor timers
  - Activate Cameras
  - Boot Phone

- **t ≈ 5.5 min**
  - *Chute Deploys*

- **t ≈ 15 min**
  - *Splash Down*
## Timed Event Matrix

**Date: 12/9/15**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time On</th>
<th>Units</th>
<th>Dwell Time</th>
<th>Units</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSE 1</td>
<td>T-180</td>
<td>(T-X) (sec)</td>
<td>Flight (~500) (sec)</td>
<td></td>
<td>Provide Power to Microcontrollers/motors/FleX ADC/various components</td>
</tr>
<tr>
<td>GSE 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-R</td>
<td>T+5</td>
<td>(T+X) (sec)</td>
<td>Flight (~325) (sec)</td>
<td></td>
<td>Provide logic signal to MCU, initiate motor timer, activate cameras, begin Android/RFID boot</td>
</tr>
<tr>
<td>TE-1</td>
<td>T+280</td>
<td>(T+X) (sec)</td>
<td>Flight (~50) (sec)</td>
<td></td>
<td>Provide logic signal to MCU, begin motor retraction</td>
</tr>
<tr>
<td>TE-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Mission Overview: Expected Results

- The RFID tags are expected to return temperature values 2 feet from the rocket
  - Power will decrease as distance increases
    - Getting power values is yet to be determined
- The FleX ADC will return digital values that are reasonably accurate when compared to internal microcontroller ADC
Mission Overview: Minimum Success Criteria

– Receive at least one temperature value from RFID tag
– Capture video footage of boom deployment
– Gather analog data using FleX ADC
Mission Overview: Comprehensive Success Criteria

- Fully extend boom with attached RFID tag
- Collect both temperature and TX power via passive RFID tag
  - Measure power variation over deployed distance
- Capture video of full deployment
- Collect all analog data using FleX ADC, store it in OBC, and compare with internal ADC of MCU
- Return components undamaged
2.0 System Overview

All
Systems Overview: System Changes Since PDR

- FUR form
- Power Supply
  - Use 12V supply with 5V switching reg
  - Optoisolators
- Changes
  - RFID system
    - Android boot-up
    - Still have other option
  - 2 Arduino MCU’s
## Top Level Requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boom will fully extend to approximately 2 feet and successfully retract</td>
<td><strong>Demonstration</strong></td>
<td>Boom will extend at less than 1 inch per second and will be shown to accomplish that.</td>
</tr>
<tr>
<td>The RFID tag and FleX ADC will produce valid testing results prior to flight</td>
<td><strong>Test</strong></td>
<td>Full sequence testing will prove the validity of the components and lack any interference with Wallops systems</td>
</tr>
<tr>
<td>The full system shall fit on a single RockSat-X deck</td>
<td><strong>Inspection</strong></td>
<td>Visual inspection will verify this requirement</td>
</tr>
<tr>
<td>The system shall survive the vibration characteristics prescribed by the RockSat-X program.</td>
<td><strong>Test</strong></td>
<td>The system will be subjected to these vibration loads in June during testing week.</td>
</tr>
</tbody>
</table>
System Overview: Science Design Overview

• Sensors to be used
  – RFID temp tag
  – Accelerometer
  – Add pressure sensor
  – Add more detailed IMU if pins available
  – Stepper motor and tape measure
    • Precise distance control
System Overview: Functional Block Diagram

![Functional Block Diagram]

- Power Regulator
- Flex ADC Experiment
- Motor and Camera control
- Smart Phone
- RFID Experiment
- RFID Tag
- Temperature Sensor
- Microcontroller

Key:
- 28V
- 12V
- 5V
- 3.3V
- Data
- Digital Input
- Analog Signal
- Telemetry
System Overview: Mechanical Design

- Max height with deck: 4.74 in
- All components outside of keep-out zone
- Materials:
  - 6061 machined aluminum
  - Rubber gasket
  - Teflon
System Overview: Isometric View

GoPro 2

GoPro 1

RFID Reader

RFID tag
System Overview: Isometric View

Electronics Box

GoPro 1
System Overview: Top View

Boom mechanism
System Overview: Bottom View
System Overview: Side View 1
System Overview: Side View 4
System Overview: Electrical Design
Electrical Design: Arduino Schematic 1

- ATMEGA 328 MCU (2.5V)
- SD breakout (5V supply, 2.5V logic)
- FleX ADC (2.5V)
- Telemetry connections
- Accelerometer (3.3V)
- 2.5V and 3.3V regs (5V supply)
Electrical Design: Arduino Schematic 2
Electrical Design: Arduino Schematic 2

• ATMEGA 328 MCU
• Stepper motor driver
  – L293D chip
    • Suggestions?
• Transistors for GoPro
  – May change depending on GoPro control
• 6N138 Optoisolators
Electrical Design: EPS
Electrical Design: EPS

• CUI PQA50 5V or 12V supply
  – Based on suggestion
• If 12V, step down to 5V with smaller switching regulator
System Overview: Software Design

Arduino 1
- GSE Power On, Arduinos on
  - Check TE-1
  - Check TE-2
  - Initialize motors, timer, Android boot
- Initialize GoPros

Arduino 2
- Initialize Serial Comm
- Begin SD and I2C

- Reset ADC
- Read ADC Value
- Read Sensor Value
- Save to SD
- Open Arete App
- Read RFID Tag
- Store in internal SD
System Overview: Description of Partnerships

• **American Semiconductor and Partner**
  – Financial support
  – Electrical design and troubleshoot assistance

• **Arete mobile**
  – RFID reader manufacturer
  – Communication has been minimal
De-Scopes and Off-Ramps

- Remove one GoPro from payload
- Hope to use GoPro Hero 4 Session cameras
  - Switch to Hero 3 if control fails
- Continue using Android phone if audio processor doesn’t work
System Overview: Special Requests

• NNU has no special requests from Wallops
3.0 Subsystem Design

All
Subsystem Design:

- Mechanical Structure/Deployment
- RFID reader and control
- OBC
- FleX ADC
- EPS
Subsystem Design: Mechanical Structure/Deployment

- Parts to machine:
Subsystem Design: Mechanical Structure/Deployment

![Diagram of mechanical components](image)

- **Boom mechanism**
- **Stepper Motor**
- **Gear motor**
- **Lead Screw**
- **Teflon Lead Nut (not shown)**
Subsystem Design: Mechanical Structure/Deployment

- Pololu Gearmotor
  - Power: 12V/500mA
  - Torque: 4.8 lb·in
  - Press-fit
- Kiatronics Stepper Motor
  - Power: 12V/200mA
  - Torque: 0.69 lb·in
  - Bolt-on
Subsystem Design: Mechanical Structure/Deployment

- Tape Measure Boom
  - Shortened tape (~2.5 ft)
  - Decreased reel diameter
  - Custom 3D-printed housing
- RFID tag attachment
  - Space grade epoxy

http://www.simpjects.nl/images/springload_2.JPG
Subsystem Design: OBC

- See provided schematics
- Individual PCB
- Arduino chip 1
  - I2C interface with FleX ADC
  - SPI communication with SD
  - Interface with Telemetry connector
    - RS232 if available
    - 8 parallel lines for either data transfer or indicators
  - 5 analog lines for sensors
  - 2.5V and 3.3V regulators for ADC and accelerometer
    - AnalogRead voltages
Subsystem Design: OBC

• See provided schematics
• Arduino chip 2
  – Motor and GoPro control
  – Stepper motor and DC motor with drivers
    • H-Bridge for DC
    • L293D stepper driver
  – Transistor GoPro control
    • Update GoPro model?
  – Optoisolators for TE’s
Risk Matrix: (OBC)

OBC.RSK.1: Deployment will fail if programming is not robust
OBC.RSK.2: Mission will fail if OBC is unable to perform the tasks
Subsystem Design: EPS

• Individual PCB
• CUI 5V - 12V power supply
  – capacitors across input and output?
  – 0V line output connect to ground?
• Likely follow 12V DC/DC converter with smaller 5V switching regulator
Risk Matrix: (EPS)

EPS.RSK.1: Mission will fail if regulators overheat/malfunction
EPS.RSK.2: New system will be required if 12V DC/DC converter and 5V switching regulator won’t handle load
EPS.RSK.3: New power regulation will be required if regulators fail prior to launch
Subsystem Design: FleX ADC

- Very similar setup to 2016 experiment
- Code is already written
  - Minor Changes
- I2C Communications
- 8-bit digital values
- 2.5V
  - Program ATMEGA to run at 2.5V
- PCB with ZIF connector
  - To be exposed, live data more important than post flight testing
- 3.3V Accelerometer (ADXL 200g’s)
## Risk Matrix: (FleX ADC)

<table>
<thead>
<tr>
<th>Possibility</th>
<th>EPS.RSK.1: ADC will short if not handled properly</th>
<th>EPS.RSK.2: ADC will fail if EPS fails</th>
<th>EPS.RSK.3: ADC may reset frequently if code is not robust or fully functional</th>
<th>ADC is unable to be provided by ASI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC.RSK.3</td>
<td>Light Green</td>
<td>Light Yellow</td>
<td>Yellow</td>
<td>Green</td>
</tr>
<tr>
<td>ADC.RSK.2</td>
<td>Medium Yellow</td>
<td>Medium Red</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>ADC.RSK.1</td>
<td>Dark Red</td>
<td>Dark Maroon</td>
<td>Maroon</td>
<td>Maroon</td>
</tr>
</tbody>
</table>

### Consequence

- **ADC.RSK.2**: ADC will short if not handled properly
- **ADC.RSK.1**: ADC will fail if EPS fails
- **ADC.RSK.3**: ADC may reset frequently if code is not robust or fully functional
- **ADC**: ADC is unable to be provided by ASI
Subsystem Design: RFID Tag/Reader

- Android phone will be stored in sealed box
  - Audio cable: electronics box to drawer
- Will only require 5V power input from a Timed Event line
- Mostly Android application controlled
  - Some source code modification
- Internal memory
  - Difficult to access if not retrieved
Risk Matrix: (RFID Tag/Reader)

<table>
<thead>
<tr>
<th>Possibility</th>
<th>ADC.RSK.2</th>
<th>ADC.RSK.1</th>
<th>ADC.RSK.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPS.RSK.1:</td>
<td>Would not retrieve data if box fails</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPS.RSK.2:</td>
<td>Battery could run low if launch is delayed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPS.RSK.3:</td>
<td>Difficulty in saving data</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## NNU RockSat-X Weight Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Component</th>
<th>Total Weight (lbf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STR</td>
<td>Electronics Box</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>Drawer (w/ boom)</td>
<td>5.2</td>
</tr>
<tr>
<td></td>
<td>Deck</td>
<td>3.425</td>
</tr>
<tr>
<td>EPS</td>
<td>Regulators</td>
<td>0.18</td>
</tr>
<tr>
<td>RFID Experiment</td>
<td>Arete Pop</td>
<td>0.077</td>
</tr>
<tr>
<td></td>
<td>Smartphone</td>
<td>0.25</td>
</tr>
<tr>
<td>OBC</td>
<td>GoPros</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>Arduinos</td>
<td>0.25</td>
</tr>
<tr>
<td>Other</td>
<td>Bolts/Wires</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>13.2</strong></td>
</tr>
<tr>
<td><strong>Under</strong></td>
<td></td>
<td><strong>1.8</strong></td>
</tr>
</tbody>
</table>
## Subsystem Design: Detailed Power Budget

### NNU - Power Budget

**12/11/15**

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Start Time (min)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATMEGA 328P</td>
<td>5.0</td>
<td>0.10</td>
<td>-3</td>
<td>8.5</td>
<td>0.50</td>
<td>0.01</td>
</tr>
<tr>
<td>ATMEGA 328P</td>
<td>2.5</td>
<td>0.10</td>
<td>-3</td>
<td>8.5</td>
<td>0.25</td>
<td>0.01</td>
</tr>
<tr>
<td>FleX ADC</td>
<td>2.5</td>
<td>0.01</td>
<td>-3</td>
<td>8.5</td>
<td>0.03</td>
<td>0.00</td>
</tr>
<tr>
<td>DC Motor</td>
<td>12.0</td>
<td>0.50</td>
<td>1.2</td>
<td>1</td>
<td>6.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Stepper Motor</td>
<td>12.0</td>
<td>0.20</td>
<td>1.5</td>
<td>1</td>
<td>2.40</td>
<td>0.00</td>
</tr>
<tr>
<td>Accelerometer</td>
<td>3.3</td>
<td>0.01</td>
<td>-3</td>
<td>8.5</td>
<td>0.03</td>
<td>0.00</td>
</tr>
<tr>
<td>Micro SD Breakout</td>
<td>5.0</td>
<td>0.15</td>
<td>-3</td>
<td>8.5</td>
<td>0.75</td>
<td>0.02</td>
</tr>
</tbody>
</table>

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.07</strong></td>
<td></td>
<td></td>
<td></td>
<td>9.96</td>
<td>0.06</td>
</tr>
<tr>
<td>Total Power Capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Over/Under</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.94</td>
<td></td>
</tr>
</tbody>
</table>

# of Flights Margin 15.6
4.0 Prototyping/Analysis Results/Pans

All
Prototyping Results/Plan:

- Android phone/RFID reader interface
  - Automatic boot-up achieved
  - Data storage is next step
- Components ordered
  - Optoisolators
  - SD breakout
  - Accelerometer
  - Sensors
Analysis Results/Plans:

• So far, Android control of RFID reader
  • Automated
• Lead Screw drawer concept shown by 2015 mission
• Tape measure concept demonstrated
  • Minimal change from prototype stage
5.0 Manufacturing Plan

All
Mechanical Elements

• Manufacture:
  • Housings
    • Drawer, motor housings (Aluminum)
  • Lead Nut (Teflon)

• Purchase:
  • Circular connectors
  • GoPros
  • Lead Screw (1/4 10 ACME Steel)
  • Gasket/O-ring
Electrical Elements

• Manufacture:
  • 3 custom PCBs
    • Arduino 1, 2, and EPS
  • Possible small 4th board to attach FleX ADC connector
  • Anticipate 4 – 5 total board revisions
• Purchase all sensors and components
Software Elements

• ADC control code already complete
  • Adding analog sensors is simple

• Control Code for motors and GoPros
  • Simple

• Still require software control of Android phone
  • Automatic power on and data retrieval
6.0 Testing Plan

All
Testing Plan: Mechanical Testing

- Solidworks stress analysis on design
- Waterproof testing
  - Fully submerge housings
  - Also demonstrated by 2015 mission
- Test deployment at all angles on each axis
Testing Plan: Electrical Testing

- **EPS**
  - Prototype (breadboard) and measure current levels under a load

- **Test RFID reader near different metals and materials**

- **Ensure motor and GoPro control by microcontroller**

- **Full system testing using 30V supply for GSE and TE’s**

- **Inhibit GoPro activation for launch**
Testing Plan: Software Testing

• First software testing is Android/RFID control
  • Demonstrate full automation
• Initialize control using microcontroller
• Adequately store all gathered data
• Retest ADC functionality and data storage many times
Testing Plan: System Level Testing

- December – January
  - Test fully automated RFID control
- January
  - Test EPS under load
  - Test motor and GoPro control
  - Implement ADC code and store data
  - Begin machining mechanical components
- February – April
  - Test mechanical components as they become available
- April
  - Fully system testing/integration preparation
7.0 User Guide Compliance

\textit{All}
## User Guide Compliance: Summary

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of gravity in 1&quot; plane of plate?</td>
<td>YES, X: 0.61 in, Y: .78 in, Z: 1.50 in</td>
</tr>
<tr>
<td>Weight 30.0 +/- 1.0 (15.0 +/- 0.5) lbs?</td>
<td>YES, 15 lbs with ballast</td>
</tr>
<tr>
<td>Max Height &lt; 10.75” (5.13”)</td>
<td>YES</td>
</tr>
<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>YES, 4.74 in from deck</td>
</tr>
<tr>
<td>Within Keep-Out Zone</td>
<td>YES</td>
</tr>
<tr>
<td>Using &lt; 10 A/D Lines</td>
<td>Using 5 lines</td>
</tr>
<tr>
<td>Using/Understand Parallel Line</td>
<td>YES, 8 lines</td>
</tr>
<tr>
<td>Using/Understand Asynchronous Line</td>
<td>YES if Available</td>
</tr>
<tr>
<td>Using X GSE Line(s)</td>
<td>YES, GSE 1</td>
</tr>
<tr>
<td>Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)</td>
<td>YES, TE-1 and TE-2</td>
</tr>
<tr>
<td>Using X Redundant Power Lines (TE-R)</td>
<td>NO</td>
</tr>
<tr>
<td>Using &lt; 1 Ah</td>
<td>YES, 0.06</td>
</tr>
<tr>
<td>Using &lt;= 28 V</td>
<td>YES</td>
</tr>
<tr>
<td>Using RF (If yes, list frequency and TX Power)</td>
<td>YES, 915 MHz @ 360 miliwatt TX power</td>
</tr>
<tr>
<td>Using deployable?</td>
<td>YES, but speed is under 1 inch per second</td>
</tr>
<tr>
<td>Whole team consists of US Persons</td>
<td>YES</td>
</tr>
<tr>
<td>Using ITAR and/or Export Controlled hardware</td>
<td>NO</td>
</tr>
</tbody>
</table>
## User Guide Compliance: Power Interface

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>GSE, main payload power, MCU, Motors, ADC, components</td>
</tr>
<tr>
<td>10</td>
<td>TE for motor, RFID, and GoPro activation</td>
</tr>
<tr>
<td>11</td>
<td>TE for motor activation</td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>
## Telemetry Connector--Customer Side

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Collect analog sensor data</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Collect analog sensor data</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Collect analog sensor data</td>
<td>22</td>
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<td>4</td>
<td>Collect analog sensor data</td>
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<td>5</td>
<td>Collect analog sensor data</td>
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<tr>
<td>6</td>
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<td>7</td>
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<tr>
<td>8</td>
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<td>9</td>
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<td>10</td>
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<td>11</td>
<td></td>
<td>30</td>
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<tr>
<td>12</td>
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<td>31</td>
<td>N/C</td>
</tr>
<tr>
<td>13</td>
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<td>32</td>
<td>Collect FleX-ADC data /results</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>33</td>
<td>Common ground to OBC</td>
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<tr>
<td>15</td>
<td></td>
<td>34</td>
<td>N/C</td>
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<td>16</td>
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<td>N/C</td>
</tr>
<tr>
<td>17</td>
<td>N/C</td>
<td>36</td>
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</tr>
<tr>
<td>18</td>
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<td>37</td>
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<tr>
<td>19</td>
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</tbody>
</table>
8.0 Project Management Plan (PMP)

Name of Presenter
Team Organizational Chart

Advisors:
Dr. Dan Lawrence
Dr. Stephen Parke

Team Leaders:
Braden Grim
Mitch Kamstra
Jameson Krueger

Mechanical Team:
Braden Grim
Jameson Krueger
Tyler Hestand

Team Communication:
Jameson Krueger

Electrical Team:
Mitch Kamstra
Caleb Wolf
## Approximate Budget

### NNU RockSAT-X 2016 Team Budget

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Cost Minus Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Cost:</strong></td>
<td><strong>Shared Deck</strong> $30,310.00</td>
</tr>
<tr>
<td><strong>Hardware:</strong></td>
<td><strong>Funding</strong> $0.00</td>
</tr>
<tr>
<td>Controller</td>
<td>$50</td>
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<tr>
<td>Camera(s)</td>
<td>$400</td>
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<tr>
<td>Electronics</td>
<td>$500</td>
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<tr>
<td><strong>Materials:</strong></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>$300</td>
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<tr>
<td>Machine tools</td>
<td>$300</td>
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<tr>
<td><strong>Other:</strong></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>$300</td>
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<tr>
<td>PCB material</td>
<td>$100</td>
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<tr>
<td><strong>RockSAT Fees:</strong></td>
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</tr>
<tr>
<td>Deposit</td>
<td>$2,000.00</td>
</tr>
<tr>
<td>Sharing Payload Cost</td>
<td>$14,000.00</td>
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<tr>
<td><strong>Funding:</strong></td>
<td></td>
</tr>
<tr>
<td>ISGC (Travel)</td>
<td>$14,360.00</td>
</tr>
<tr>
<td>NNU (Launch/supplies)</td>
<td>$8,450.00</td>
</tr>
<tr>
<td>ASI and Partner (launch)</td>
<td>$7,500.00</td>
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</table>

<table>
<thead>
<tr>
<th>Travel</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flight BOI-DCA</strong></td>
<td>$650.00</td>
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<tr>
<td><strong>Quantity</strong></td>
<td>4</td>
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<tr>
<td><strong>10 day Hotel</strong></td>
<td>$89.00</td>
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<tr>
<td><strong>Quantity</strong></td>
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<tr>
<td><strong>Daily Food</strong></td>
<td>$40.00</td>
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<tr>
<td><strong>People</strong></td>
<td>5</td>
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<tr>
<td><strong>Days</strong></td>
<td>10</td>
</tr>
<tr>
<td><strong>Vehicle Rental</strong></td>
<td>$800.00</td>
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<tr>
<td><strong>Large SUV</strong></td>
<td>$800.00</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Single Trip Total</strong></th>
<th><strong>Two Trip Total</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$7,180.00</strong></td>
<td><strong>$14,360.00</strong></td>
</tr>
</tbody>
</table>

**ISGC (Travel)** $14,360.00

**NNU (Launch/supplies)** $8,450.00

**ASI and Partner (launch)** $7,500.00

**ISGC Deposit Total** $2,000.00

**Two Trip Total** $30,310.00

**Funding** $30,310.00
Team Mentors

• American Semiconductor
  – Partner Company - more involvement
• Faculty
  – Dr. Dan Lawrence
  – Dr. Stephen Parke
## Contact Matrix

### Team Name/School Here: Northwest Nazarene University

#### Fall 2016 RS-X Contact Matrix

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Day Phone</th>
<th>Cell Phone</th>
<th>Receive Texts?</th>
<th>Email</th>
<th>Citizenship</th>
<th>OK to Add to Mailing List?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advisor</td>
<td>Dan Lawrence</td>
<td>(208) 608-0534</td>
<td>(208) 608-0534</td>
<td>Yes</td>
<td><a href="mailto:mdlawrence@nnu.edu">mdlawrence@nnu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Advisor</td>
<td>Stephen Parke</td>
<td>(208) 697-2318</td>
<td>(208) 697-2318</td>
<td>Yes</td>
<td><a href="mailto:sparke@nnu.edu">sparke@nnu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Team Member</td>
<td>Jameson Krueger</td>
<td>(208) 602-5279</td>
<td>(208) 602-5279</td>
<td>Yes</td>
<td><a href="mailto:jkrueger@nnu.edu">jkrueger@nnu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Team Member</td>
<td>Braden Grim</td>
<td>(208) 899-3897</td>
<td>(208) 899-3897</td>
<td>Yes</td>
<td><a href="mailto:bgrim@nnu.edu">bgrim@nnu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Team Member</td>
<td>Mitch Kamstra</td>
<td>(509) 879-8465</td>
<td>(509) 879-8465</td>
<td>Yes</td>
<td><a href="mailto:mkamstra@nnu.edu">mkamstra@nnu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
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</table>
# Team Availability Matrix

**Team Name/School Here:** NNU

**CoDR RS-X Team Availability Matrix**

<table>
<thead>
<tr>
<th>Oct 12-16</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>8:00 AM</td>
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<td>9:00 AM</td>
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<td>4</td>
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<tr>
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<td>2:00 PM</td>
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<tr>
<td>3:00 PM</td>
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<td>3</td>
</tr>
<tr>
<td>4:00 PM</td>
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<tr>
<td>5:00 PM</td>
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<td>2</td>
<td>4</td>
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</tr>
</tbody>
</table>
PMP: Worries

• Biggest challenge still RFID reader
  – Much success with Android automation
    • Thanks to CTU
  – Still looking into using different audio processor to handle reader data
    • Better option as it allows for telemetry access

• Telemetry decisions
  – Depends on pairing
  – Advice on using parallel lines?
## PMP: Approximate Schedule

<table>
<thead>
<tr>
<th>Date Accomplished</th>
<th>System to be tested/Designed</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/29/15</td>
<td>Fully Prototype Android System</td>
</tr>
<tr>
<td>12/15/15</td>
<td>Order all EPS and OBC components</td>
</tr>
<tr>
<td>1/15/16</td>
<td>Breadboard ADC circuitry</td>
</tr>
<tr>
<td>1/15/16</td>
<td>Begin machining components</td>
</tr>
<tr>
<td>1/20/16</td>
<td>Integrate EPS and OBC/ADC</td>
</tr>
<tr>
<td>1/20/16</td>
<td>Make final camera decision</td>
</tr>
<tr>
<td>2/2/16</td>
<td>Select RFID interface method</td>
</tr>
<tr>
<td>February</td>
<td>STR</td>
</tr>
<tr>
<td>February - April</td>
<td>Continue machining and testing throughout</td>
</tr>
</tbody>
</table>
PMP Worries

• Machining schedule for intricate components
  – Should begin machining in January
  – Materials ordered soon
  – Concepts proven
    • Can be improved
Flexible electronics open many possibilities for in space applications. The low weight, low volume, deformable characteristics allow for cheaper shipment and greater possibilities for usage in space.

Steps to prepare for STR
- Begin ordering materials and components
- Continue prototyping unfamiliar systems