1.0 Mission Overview
Mission Overview: Mission Statement

- **Mission Statement:**
  - Receive ADS-B and AIS transmissions in order to demonstrate the compatibility of a software defined radio (SDR) on different communication frequencies.

- ADS-B and AIS will replace radar tracking of aircraft and boats with radio tracking, a more flexible and efficient system.
  - ADS-B will be implemented on the Iridium NEXT constellation to begin the shift from radar to radio tracking.
  - FAA shift to implementation of ADS-B tracking is a “near certainty”

- This technology can increase the interoperability of satellite communications and enable a low cost ($15K) C2 RF transceiver for Class D missions
Mission Overview: Mission Objectives

• Modify an existing software defined radio unit to survive the expected loads of launch and reentry

• Complete detailed testing and launch operations using an advanced ground station.

• Successfully receive information via ADS-B and AIS signals on-board the payload and transmit plane/boat data to ground station via the amateur band.

• Demonstrate success of omni-directional antenna.
• Small satellites are becoming more and more prevalent in industry - all need tracking/communication capability.

• The government would like to avoid CubeSats overcrowding their communications networks.

• ADS-B and AIS allow for improved tracking of sea and airways.
  – The Iridium NEXT constellation is planning on incorporating ADS-B tracking for air traffic efficiency, illustrating the industry need.
ConOps

$t \approx 135.0$
Altitude: 135.9 km
(Post ACS pointing)
Begin transmitting/receiving
Dipole deployment

$t = 0 \text{ min}$

End of Malemute Burn
$t \approx 28.7 \text{ sec}$
Altitude: 17.2 km

$t \approx 199.7 \text{ sec}$
Apogee
Altitude: ≈153 km
Receive signal from VT ground station to switch transmission

$t \approx 28.7 \text{ sec}$
End of Malemute Burn
Altitude: 17.2 km

$t \approx 338.0$
Altitude: 68.9 km
(Power Shut-off)
End transmission

$t \approx 454.9 \text{ sec}$
Chute Deploys

$t \approx 876 \text{ sec}$
Splash Down

CDR 2017
## Concept of Operations

### ConOps Matrix

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>Altitude (km)</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T - 600</td>
<td>222 sec</td>
<td>Power flight computer and instrumentation, charge thermal knife circuit</td>
</tr>
<tr>
<td>T + 0</td>
<td>0</td>
<td>Redundant launch trigger and E310 power source</td>
</tr>
<tr>
<td>T + 135</td>
<td>135.9</td>
<td>Post ACS pointing - Begin transmission/reception onboard. Initiate dipole antenna deployment</td>
</tr>
<tr>
<td>T + 199.7</td>
<td>153</td>
<td>Apogee - Receive command from ground station to switch transmission from AIS to ADS-B</td>
</tr>
<tr>
<td>T + 338</td>
<td>68.9</td>
<td>Power shut off - End data transmission</td>
</tr>
</tbody>
</table>
## Concept of Operations

- **Timer Events Matrix**

<table>
<thead>
<tr>
<th>Event</th>
<th>Time On</th>
<th>Dwell</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSE 1</td>
<td>T-600 sec</td>
<td>938 sec</td>
<td>Power flight computer and instrumentation, charge thermal knife circuit</td>
</tr>
<tr>
<td>TE-R</td>
<td>T+000 sec</td>
<td>338 sec</td>
<td>Redundant launch trigger and E310 / amplifier power source</td>
</tr>
<tr>
<td>TE-1</td>
<td>T+135 sec</td>
<td>203 sec</td>
<td>Trigger for antenna deployment</td>
</tr>
<tr>
<td>GSE 2</td>
<td>unknown</td>
<td>unknown</td>
<td>Unknown College</td>
</tr>
<tr>
<td>TE-2</td>
<td>unknown</td>
<td>unknown</td>
<td>Unknown College</td>
</tr>
<tr>
<td>TE-3</td>
<td>unknown</td>
<td>unknown</td>
<td>Unknown College</td>
</tr>
</tbody>
</table>
Mission Overview: Expected Results

• Successful acquisition of aircraft/boat data via ADS-B and AIS signals via a dipole antenna (stored on payload and transmitted using RS232 as redundancy).
  – Position, speed, course, and identification

• Successful communication between the spacecraft and ground station.
Minimum Success Criteria:
– Collection of ADS-B or AIS signals and transmitted via SDR, RS-232, or on-board data collection.

Comprehensive Success Criteria:
– Constant collection of ADS-B and AIS signals, transmitted to the Virginia Tech ground station via SDR and patch antenna.
– Structural integrity maintained through reentry and splashdown
Top Level Requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>They deployable dipole antenna system shall reliably deploy with the thermal knife.</td>
<td>Demonstration</td>
<td>Deployment system will be repeatedly tested to ensure reliability.</td>
</tr>
<tr>
<td>They deployable dipole antenna system shall deploy 5 inches.</td>
<td>Demonstration</td>
<td>Deployment system will be repeatedly tested to ensure 5 inch deployment each use.</td>
</tr>
<tr>
<td>The patch antennas shall have the required radiative properties to communicate with ground stations</td>
<td>Test</td>
<td>We will test the dB and waveform from the patch antennas using anechoic chamber</td>
</tr>
<tr>
<td>The system shall survive the vibration characteristics prescribed by the RockSat-X program.</td>
<td>Test</td>
<td>The system will be subjected to these vibration loads in June during testing week.</td>
</tr>
</tbody>
</table>
2.0 System Overview
System Overview: Science Design Overview

Instruments

– Ettus E310 (SDR): 2x2 receive and transmit paths
– 2 Patch array and 2 Dipole Antenna

• Payload will receive ADS-B and AIS transmissions via the dipole antennae

• Ground station will receive ADS-B, AIS, and housekeeping data from the payload via L-band patch array.

• Payload will receive a signal from the ground station to switch between transmitting ADS-B and AIS
  – SD card used to store data locally
  – Data will be telemetered through rocket telemetry
  – Housekeeping data will be telemeterized over payload radio intermittently

• Payload and ground station will record transmit/receive commands and protocol changes
Systems Overview: System Changes Since PDR

• SDR model changed from picozed to Ettus E310
  – Heritage and software infrastructure with E310
• Flight computer switch from Arduino Mega to Teensy
  – size requirements
• None of these changes change any mission objectives/requirements.
Functional Block Diagram

Diagram showing various components and connections such as Temperature, Pressure, Coarse Acc., Fine Acc. and Gyro, Payload Radio E310, ADSD Dipole Antenna, AIS Dipole Antenna, SBAND Patch Antenna Array, C&DH Radio E310, and more. The diagram includes power supplies, data transmission, and ground connections.
System Overview: Mechanical Design

• Fabrication
  – Combination of in-house and professional machining
  – Materials: ABS Plastic, Aluminum, Steel, Nylon, Rubber
  – Designed with simple fabrication in mind
  – Team Capabilities:
    • Milling 6061 and acrylic
    • 3D Printing

• Remaining work
  – Finalize design of box interior.
  – Electric feedthrough
  – Antenna deployment design
System Overview: Electrical Design

- Flight Computer
  Teensy 3.6
  - Used for collecting data from housekeeping sensors, interpreting timer events, and communicating with Ettus E310

- Instrumentation
  Temperature Sensor
  - TMP102, 3.3V
  Altitude/Pressure Sensor
  - MPL311, 3.3V
  Fine Triple Axis Accelerometer and Gyro
  - MPU-6050, 3.3V
  Coarse Triple Axis Accelerometer and Gyro
  - ADXL193, 3.3V
Thermal Knife Schematic

This is the signal input to the circuit. 0V (GND) to this charges the capacitor and 5V cuts off the charging power supply and discharges the capacitor through the thermal knife.

V2

PULSE(5 0 10 0 0 4500 4550 1)

R1 120

N-Channel Mosfet (Actually DMG3420U Fet)

AP9465GEM

M3

R3 1

Thermal Knife (about 1 Ohm)

C1 10

10 Farad super-capacitor stores the energy to fire the thermal knife.

M2

FDS6975

R2 10k

P-Channel Mosfet (Actually DMG3415U Fet)

R5 120

12V power source for charging super-cap

Voltage divider to drop 12V to 2.4V to charge the super-cap

.tran 0 4600 0 1
Thermal Knife Circuit Image
System Overview: Software Design

• Housekeeping Software
  – Handle collection, processing, and interpretation of the data from the housekeeping instrumentation
  – Take data, store it locally, send it over NASA telemetry, and send it to the Ettus

• Command Software
  – Handle payload sequencing and event timing
  – (Flight computer) Wait for launch trigger (TE-1,2) to go HIGH and then signal Ettus to begin transmitting data.
  – (Deployer computer) Wait for TE-3 to go High and then begin deployment operation.

• Ettus Software
  – Handle data modulation, SGLS scheme implementation, and other various SDR related functionality
System Overview: Software Design - Timing Events

- Power On GSE1
  - Power on Teensy
  - Power on Sensors
  - Charge capacitors

- TERA
  - Power on both SDRs
  - Teensy Start timer

- Timer Event 1
  - SDR start transmitting/receiving
  - Antenna Deployment
System Overview: Description of Partnerships

• Orbital-ATK
  – Orbital ATK is interested in SDR compatibility with cubesats
  – Bi-weekly meetings to assist with radio research and other questions regarding the project
  – We are responsible for design and mechanical/electrical integration
  – Orbital ATK will provide select components that will be needed for this project (PicoZed)

• a.i. solutions
  – a.i. solutions has been a consistent partner with RockSat-X at Virginia Tech since 2014 payload
  – Bi-weekly meetings to assist with mechanical design and offer general payload advice
De-Scopes and Off-Ramps

• Payload was originally specified with the option to collect data using a SDR-based GPS receiver. This option has been removed due to computational and volume budget constraints.

• Potential space issue with both ADS-B and AIS dipole deployments (low probability)
  Downsizing to only collecting ADS-B or AIS is a possibility without compromising core mission objective
System Overview: Special Requests

• RF Request
  – See WFF FUR Form

• Pointing
  – See next slide

• Deployable Antenna
  – Fast deployment - will have video of deployment hitting team member
System Overview: Special Requests - Pointing
3.0 Subsystem Design
Subsystem Design: Antenna Deployment

- 2 Deployable Dipole Antennas
  - 5” (ADS-B)
  - 30” (AIS)
- Nichrome wire + spring deployment
- Unique telescoping design from fellow hokie
Telescoping Design
Subsystem Design: Antenna Deployment

- 2 Static Patch Antenna Arrays
  - 4”x4” S-Band
  - 2”x2” L-band

- Mounted to plate via special L-Brackets
## Risk Matrix: Antenna Deployment

### Risks:
1. Nichrome actuator fails to deploy a dipole antenna
2. Spring actuator overloads dipole antenna deployment structure
3. Dipole antenna fails to unroll
4. Patch antenna structure fails from launch vibrations
5. Dipole antenna deploys early and structure fails during launch

### Risk Matrix:

<table>
<thead>
<tr>
<th>Possibility</th>
<th>Risk 1,2</th>
<th>Risk 3</th>
<th>Risk 5</th>
<th>Risk 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consequence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Risk 1,2**: Low possibility, low consequence
- **Risk 3**: High possibility, high consequence
- **Risk 5**: Low possibility, high consequence
- **Risk 4**: High possibility, low consequence

---

**Consequence**:
- **Low**: Minor issues, no significant impact
- **Medium**: Increased complexity, potential delays
- **High**: Extreme impact, critical issues
  - **Red**: Withholding launch
  - **Yellow**: Post-launch repair required
  - **Green**: No major impact

---

**Possibility**:
- **Low**: Risk unlikely to occur
- **Medium**: Risk may occur
- **High**: Risk likely to occur

---

**Risk Mitigation**:
- For **Risk 1,2**: Regular maintenance checks, actuator testing
- For **Risk 3**: Structural redesign to improve stability
- For **Risk 4**: Additional damping mechanisms for vibrations
- For **Risk 5**: Early deployment monitoring and contingency plans

---

**Conclusion**:

- Prioritize mitigation strategies for **Risk 3** and **Risk 5** due to high consequence.
- Ensure regular maintenance and testing for **Risk 1,2**.
- Incorporate additional damping mechanisms for **Risk 4** to manage vibrations.

---

**Note**: This matrix provides a preliminary assessment and should be refined with more detailed analysis and stakeholder input.
Subsystem Design: Radio

- Payload radio reports decoded data to software interface with Electrical Subsystem.
- Command radio interfaces with payload radio to select ADS-B or AIS realtime data reporting.

- 2x Ettus Research USRP E310: onboard ARM; TX+RX
- Other components as listed in block diagram
- No significant changes expected
Subsystem Design: Radio Components

• Low-noise amplifier (x3)
• Bandpass Filters (x3)
• Power Splitter/Combiner (x2)
• Patch antennas
Subsystem Design: Patch Antenna Radiation Pattern

Total gain [dBi]

2395 MHz

Vertical plane

-15 < dBi < 6.5

Max gain: The: 30

sband_patch_double.out

Phi = 88
Subsystem Design: Dipole Antenna Radiation Pattern
Subsystem Design: Radio

- Feasibility of acquiring signal analyzed using STK

Elevation: 14.5°
Range: 517 km
Subsystem Block Diagram: Radio

AIS-B Dipole
Freq.= 1090 MHz
Leng. = 137.6 mm

AIS Dipole
Freq.= 162 MHz
Leng. = 1851.9 mm

Uplink Patch
Freq.= 1265 MHz

Downlink Patch
Freq.= 2395 MHz

Minicircuits VHF-145+
IL = -0.77 dB

Minicircuits V8FZ-1066+
IL = -1.68 dB

Minicircuits ZX60-P162LN+
G = 22.0 dB
NF = 0.54 dB

Minicircuits ZX60-P10.3LN+
G = 24.9 dB
NF = 0.6 dB

Payload
E310

Reference Note
Ref=SM2325-41
Gain=55 dB
P1dB=+41 dBm
IP3=+52 dBm
V=12 Vdc
I=4.3 A
Efficiency=25.1% (TBR)
Integrated Output Isolator
Mismatch Protection
Backed off to Pout=+34.3 dBm
DC Power Draw = 10.76 W (TBR)
Risk Matrix: Radio

Risk 1,2

Risk 3

Risk 1: Radio software/interface failure disables signal collection
Risk 2: Radio software/interface failure disables command radio
Risk 3: Unexpected failure of radio components during launch
due to unflown antenna mounts and RF components
## Subsystem Design: Detailed Weight Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Total Weight (lbf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload Deck</td>
<td>3.425</td>
</tr>
<tr>
<td>Electronics Box</td>
<td>3.832</td>
</tr>
<tr>
<td>Electric Stack</td>
<td>3.258</td>
</tr>
<tr>
<td>AIS Antenna</td>
<td>0.1</td>
</tr>
<tr>
<td>ADS-B Antenna</td>
<td>0.075</td>
</tr>
<tr>
<td>S-Band Patch Array</td>
<td>0.3</td>
</tr>
<tr>
<td>L-Band Patch Array</td>
<td>0.15</td>
</tr>
<tr>
<td>Power Amplifier</td>
<td>0.55</td>
</tr>
<tr>
<td>Hardware (estimate)</td>
<td>2</td>
</tr>
<tr>
<td>Electric components</td>
<td>0.3</td>
</tr>
<tr>
<td>Ballast</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14.99</strong></td>
</tr>
<tr>
<td><strong>Under</strong></td>
<td><strong>0.01</strong></td>
</tr>
</tbody>
</table>
## Subsystem Design: Detailed Power Budget

<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>Teensy</td>
<td>5.0</td>
<td>0.10</td>
<td>T-600 sec</td>
<td>15.6333333333</td>
<td>0.50</td>
<td>0.03</td>
</tr>
<tr>
<td>Houskeeping Instruments</td>
<td>3.3</td>
<td>0.10</td>
<td>T-600 sec</td>
<td>15.6333333333</td>
<td>0.33</td>
<td>0.03</td>
</tr>
<tr>
<td>Payload Ettus</td>
<td>9.0</td>
<td>0.20</td>
<td>T+000 sec</td>
<td>5.6333333333</td>
<td>1.80</td>
<td>0.02</td>
</tr>
<tr>
<td>Command Ettus</td>
<td>9.0</td>
<td>0.20</td>
<td>T+000 sec</td>
<td>5.6333333333</td>
<td>1.80</td>
<td>0.02</td>
</tr>
<tr>
<td>AIS Deployer</td>
<td>12.0</td>
<td>0.05</td>
<td>T-600 sec</td>
<td>15.6333333333</td>
<td>0.60</td>
<td>0.01</td>
</tr>
<tr>
<td>ADS-B Deployer</td>
<td>12.0</td>
<td>0.05</td>
<td>T-600 sec</td>
<td>15.6333333333</td>
<td>0.60</td>
<td>0.01</td>
</tr>
<tr>
<td>Power Amplifier</td>
<td>12.0</td>
<td>1.40</td>
<td>T+000 sec</td>
<td>5.6333333333</td>
<td>16.80</td>
<td>0.13</td>
</tr>
<tr>
<td>Preamps (x3)</td>
<td>12.0</td>
<td>0.36</td>
<td>T+000 sec</td>
<td>5.6333333333</td>
<td>4.32</td>
<td>0.03</td>
</tr>
</tbody>
</table>

|                  |             |                 |                  |               |        |       |
| Total            | 2.46        |                 |                  | 26.75         | 0.28   |       |
| Total Power      |             |                 |                  |               | 0.50   |       |
| Capacity         |             |                 |                  |               |        |       |
| Over/Under       |             |                 |                  |               | 0.22   |       |

# of Flights Margin: **1.8**
4.0 Prototyping/Analysis Results/Plans
Prototyping Results/Plan:

• What has been prototyped?
  – To date, we have breadboarded several electrical components to verify their functionality
  – Initial prototyping of the antenna deployer and testing of functionality
  – AIS dipole prototype finished
Breadboard Pictures

MPL3115A2

ADXL-193

MPU 6050
Dipole Deployment Prototype
Analysis Results/Plans:

• **Electric breadboarding**: The results were nominal and we are therefore prepared to move on with our intended circuit design.

• **Deployer**: Initial prototyping of deployer raises concerns over space and complexity
  – New, much simpler design has been theorized and next phase of prototyping begins this weekend.

• **Radio**: AIS reception testing mid-december at Virginia Beach
5.0 Manufacturing Plan
Mechanical Elements

• We intend to manufacture as many parts as possible in house

• Manufactured Components
  – Antennas and Deployment Systems
  – Shelving

• Purchased Components include:
  – 16 Pin Amphenal Connector (D38999/26WC98PN, D38999/24WC98SN)
  – Waterproof housing for electronics
  – Mounting hardware for patch antennas
  – Nichrome wires & spring for antenna deployment
  – General hardware

• Current plan is to have all mechanical components manufactured by mid-February
Electrical Elements

• The housekeeping/control PCB and 2 thermal knife PCB’s still need to be manufactured, populated, and soldered
  • Minor housekeeping/control PCB revisions are anticipated with Teensy 3.6
  • No PCB revisions are anticipated with thermal knife circuits
• All housekeeping/control components have been obtained
  • Teensy 3.6, sensors
• The current plan is to have all electrical payload components manufactured and operational by mid-February (conservative schedule estimate)
Software Elements

- Code for the housekeeping instrumentation and payload control is currently under development
- SDR related software development has already started development (GNU radio)
  - With assistance from Zach Leffke
- The current plan is to have all software developed by mid-February (conservative schedule estimate)
- Using github this year to protect codebase and manage versions
6.0 Testing Plan
Testing Plan: Mechanical Testing

• Weight requirements will be tested using an accurate scale after manufacturing is complete.
• Deployable antenna will be tested over several iterations after the completion of the subsystem to ensure reliable and expected operation.
• The electronics housing will be tested by sealing the electronics box entirely and submerging the housing in water for a long duration. Visual inspection of the interior will occur afterwards to ensure there were no leaks. This will occur directly after receiving the housing and gasket.
Testing Plan: Electrical Testing

- The housekeeping data sensors have been tested entirely
- PCB’s will be tested after they are manufactured to ensure construction and design were accurate
- Full mission simulations will occur after complete payload construction to ensure the electronics behave as expected
- We plan to include an inhibit to ensure the Ettus E310 is unable to transmit during testing at WFF
- Potential antenna deployment inhibit for safety of wallops staff
Testing Plan: Software Testing

• Software testing has begun with the full breadboarding of the housekeeping instruments

• Testing of the radio software will occur upon proper training of Ettus SDR module

• All software will be tested via subsystem simulations to observe if the subsystem behaves as expected
Testing Plan: Radio Testing

- GNU Radio implementation to be completed before testing can begin
- Radiation testing to be conducted prior to Wallops testing
  - Orbital ATK will provide test procedures
  - Transmit to VT ground station locally
  - Verify radiative properties of payload for flight using anechoic chamber
- Testing should be completed by late March or early April
- Inhibit will be required for WFF testing
Testing Plan: Dipole Deployment

• The deployable antenna testing will begin after the design and manufacturing of the subsystem is completed
• To test this subsystem, we will run a series of full subsystem tests in which the deployers operation will be confirmed
• We will observe whether the deployer operates as expected
7.0 User Guide Compliance
## 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>Will conform</td>
</tr>
<tr>
<td>Weight 15.0 +/- 0.5 lbs?</td>
<td>14.99</td>
</tr>
<tr>
<td>Max Height &lt; 5.13”</td>
<td>4.3</td>
</tr>
<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>YES</td>
</tr>
<tr>
<td>Within Keep-Out Zone</td>
<td>YES, see CAD models</td>
</tr>
<tr>
<td>Using &lt; 10 A/D Lines</td>
<td>N/A</td>
</tr>
<tr>
<td>Using/Understand Parallel Line</td>
<td>N/A</td>
</tr>
<tr>
<td>Using/Understand Asynchronous Line</td>
<td>Yes</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</td>
</tr>
<tr>
<td>Using X Redundant Power Lines (TE-R)</td>
<td>YES, TE-R</td>
</tr>
<tr>
<td>Using &lt; 0.5 Ah</td>
<td>0.28</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, see radio block diagram</td>
</tr>
<tr>
<td>Using deployable?</td>
<td>YES, will have video demonstrating safety</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>Power Pin</th>
<th>Function</th>
<th>Intended Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GSE 1</td>
<td>Power flight computer and instrumentation, charge thermal knife circuit</td>
</tr>
<tr>
<td>2</td>
<td>Timer Event Redundant (TE-RA)</td>
<td>Tied together, redundant launch trigger and E310 / amplifier power source</td>
</tr>
<tr>
<td>3</td>
<td>Timer Event Redundant (TE-RB)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Timer Event 1 (TE-1)</td>
<td>Trigger for ADSB/AIS antenna deployment</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Payload ground</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>Unused</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td>Unused</td>
</tr>
<tr>
<td>8</td>
<td>GND</td>
<td>Unused</td>
</tr>
<tr>
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## User Guide Compliance: Telemetry Interface

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</table>
8.0 Project Management Plan (PMP)
Management: Team Organization

Faculty Advisor:
Dr. Kevin Shinpaugh
kashin@vbi.vt.edu
Dr. Jonathan Black
jonathan.black@vt.edu

Team Sponsors
Virginia Tech SEC
Orbital ATK
a.i. solutions

Team Leaders:
Ethan Ohriner
ethano95@vt.edu
John Mulvaney
Johnwm1@vt.edu

Mentors
Zach Leffke
Eric Petrosky

Radio
Marcus Wanner
Sagar Govani
Johnny Jaffee

Computer/Electric
Tony Defilippis
Ramy Armanous
Nick Miller
Emma Manchester

Mechanical
Nick Corbin
Karl Vitale
Austin Hannon
Ishan Arora
Genevieve Gural
Rhythm Kim
Management: Team Mentors

• Dr. Kevin Shinpaugh
• Dr. Jonathan Black
• Zachary Leffke (Space@VT Ground Station manager)
• Eric Petrosky (Hume Center Graduate Student)
• Ben Hekman, Jamie Flower (Orbital ATK mentors)
• David Black (ai Solutions)
## Management: Monetary Budget

### Mission Expenses

<table>
<thead>
<tr>
<th>Critical Expenses</th>
<th>Amount</th>
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<tr>
<td>Earnest Deposit</td>
<td>$2,000.00</td>
<td>RockSat-X Flight Cost</td>
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<td>Launch Fee Installment 1</td>
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<td>Launch Fee Installment 2</td>
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<td>Payload Component Estimate</td>
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</tr>
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<td>Payload Manufacturing Estimate</td>
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### Non-Critical Expenses

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<tbody>
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<td>Housing Estimate (August Travel)</td>
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<td>Additional Team Travel Costs</td>
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<td>Food, gas, etc.</td>
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**Total Expenses:** $15,450.00

**Balance:** $7,754.51

### Project Funding

<table>
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<th>Organization</th>
<th>Amount</th>
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<td>VT Foundation</td>
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<td>AOE Department</td>
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<td>SEC DTE Spring 2015</td>
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<td>SEC DTE Fall 2016</td>
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<td>Orbital ATK Inc.</td>
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<td>VSGC</td>
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<td>a.i. solutions</td>
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**Total Funding:** $23,204.51

**Expected:** $16,204.51
Management: Preliminary Schedule

• NASA Design Review Process:
  – Critical Design Review
    • 7 December 2016
  – Spring Semester Design Reviews
    • Dates TBD

• Team Mission Schedule:
  – All design and CAD work completed
    • 1 January 2017
  – Payload subsystem testing completed
    • 1 March 2017
  – Payload integration and system testing completed (including ground station interaction)
    • 15 April 2017
  – Integration at Wallops
    • June 2017
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<tr>
<th>Time</th>
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<th>Tuesday</th>
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# PMP: Latest Contact Matrix

## Virginia Tech

### 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>Add to mailing list?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-Team Lead</td>
<td>John Mulvaney</td>
<td>859-433-0409</td>
<td>&lt;-- Same</td>
<td>Yes</td>
<td><a href="mailto:Johnwm1@vt.edu">Johnwm1@vt.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Co-Team Lead</td>
<td>Ethan Ohriner</td>
<td>703-343-5688</td>
<td>&lt;-- Same</td>
<td>Yes</td>
<td><a href="mailto:ethan095@vt.edu">ethan095@vt.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Team Member</td>
<td>Tony DeFilipps</td>
<td>520-820-5378</td>
<td>&lt;-- Same</td>
<td>Yes</td>
<td><a href="mailto:dtony@vt.edu">dtony@vt.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Team Member</td>
<td>Nick Miller</td>
<td></td>
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<td>Yes</td>
<td><a href="mailto:nmiller1@vt.edu">nmiller1@vt.edu</a></td>
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<tr>
<td>Team Member</td>
<td>Marcus Wanner</td>
<td></td>
<td></td>
<td>Yes</td>
<td><a href="mailto:marcusw@vt.edu">marcusw@vt.edu</a></td>
<td>U.S.</td>
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<tr>
<td>Team Member</td>
<td>Sagar Govani</td>
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<td>Yes</td>
<td><a href="mailto:sagar95@vt.edu">sagar95@vt.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
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<tr>
<td>Team Member</td>
<td>Genevieve Gural</td>
<td>703-346-3609</td>
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<td><a href="mailto:ggural@vt.edu">ggural@vt.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
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<tr>
<td>Team Member</td>
<td>Rhythm Kim</td>
<td>757-338-4164</td>
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<td>Yes</td>
<td><a href="mailto:rhythm@vt.edu">rhythm@vt.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
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<tr>
<td>Team Member</td>
<td>Emma Manchester</td>
<td>410-937-9696</td>
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<td><a href="mailto:emmam95@vt.edu">emmam95@vt.edu</a></td>
<td>U.S.</td>
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<tr>
<td>Team Member</td>
<td>Karl Vitale</td>
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<td>Yes</td>
<td><a href="mailto:vitalekw@vt.edu">vitalekw@vt.edu</a></td>
<td>U.S.</td>
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<tr>
<td>Team Member</td>
<td>Austin Hannon</td>
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<td>Yes</td>
<td><a href="mailto:austinfh@vt.edu">austinfh@vt.edu</a></td>
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<tr>
<td>Team Member</td>
<td>Romy Armanous</td>
<td>804-484-0400</td>
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<td>Yes</td>
<td><a href="mailto:romya7@vt.edu">romya7@vt.edu</a></td>
<td>U.S.</td>
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<tr>
<td>Team Member</td>
<td>Ishan Arora</td>
<td>703-653-4003</td>
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<td><a href="mailto:ishana97@vt.edu">ishana97@vt.edu</a></td>
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<tr>
<td>Team Member</td>
<td>Johnny Jaffee</td>
<td>203-240-7205</td>
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<td><a href="mailto:jjaffee@vt.edu">jjaffee@vt.edu</a></td>
<td>U.S.</td>
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<tr>
<td>Team Member</td>
<td>Nicholas Corbin</td>
<td>757-748-0492</td>
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<td>Yes</td>
<td><a href="mailto:cnick1@vt.edu">cnick1@vt.edu</a></td>
<td>U.S.</td>
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<tr>
<td>Team Member</td>
<td>Sean Roberts</td>
<td>610-470-4495</td>
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<td>Yes</td>
<td><a href="mailto:seannr13@vt.edu">seannr13@vt.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
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</tbody>
</table>
PMP: Worries

• Dipole antenna deployment failure
  – Still in the design process. Do not anticipate this being an issue at the end of design and prototyping. Much progress has been made since PDR.

• Power Amplifier
  – Potentially has altitude limit, may need larger electric box / additional box for temperature/pressure protection
PMP: Conclusions

• Last year’s RockSat @VT success begs for an elaboration to further push, test, and validate the capabilities of SDR. Given our success and experience with SDR, we are in a great position.

• Practical industry applications, with ADS-B being implemented on the Iridium NEXT constellation.

• Next Steps:
  – Continue design of antenna deployment.
  – Continue GNU radio development
  – Begin testing antenna components
  – Resolve any discrepancies between Arduino and Teensy Code