The Rapid Response Radiation Survey (R3S) mission using the HISat Conformal Satellite Architecture

Nathanael Miller
NASA Langley Research Center
Mechanical Systems Branch (D202)
(757).864.4557
nathanael.a.miller@NASA.gov
Author’s Note

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THE TEAM

NASA LaRC:
Ryan Norman
Nathanael Miller
Hector Soto
Mark Jones
Rebecca Stavely
Adam Ben Shabat
Denisse Aranda
Casey Younger
Kerry Gough

NovaWurks:
Gene Jaeger
Alex Shim
Ish Sanchez
Mbuyi Khuzadi
Kevin Adinata

This presentation was developed in partnership with NovaWurks Inc.*

*Space for Everyone
Overview of Rapid Response Radiation Survey (R3S)

• Hosted payload
• Measure spectral and total dose in the LEO radiation environment
• Sensors deployed behind minimal spacecraft shielding
• Rapid Hardware Development (4 month effort)

• 29 Calendar Days from concept to near CDR
• Two document, 2 review project plan
• Use agile development processes
Nowcast of Atmospheric Ionizing Radiation for Aviation Safety

- Assess radiation exposure to commercial aircrews
- Fully physics-based model
  - Multiple components: SPE and GCR environment, nuclear and atomic interactions, geomagnetic field, radiation transport and atmosphere composition models
- Real time assessment with hourly updates
- Delivers a global map of radiation environment
- Assess the safety of a flight path in real-time

R3S support NAIRAS

- Transfer NAIRAS from research to operations
- Reduce uncertainty in radiation transport model
- Map radiation exposure as a function of geomagnetic field strength.

http://sol.spacenvironment.net/nairas/Dose_Rates.html
Sensors

- Radiation environment
  - Liulin-6SA2 LET (Linear Energy Transfer) spectrometer
  - Teledyne µDosimeter TID (Total Ionizing Dose) detector
- Geomagnetic field
  - Honeywell HMR2300 magnetometer
Redefining satellite “morphology”

- Satlets are defined as cellularized satellites
- Satlets enable changing satellite design geometries to accommodate any potential payload

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Cellularization

- Path to increased complexity without increased cost
- Standardized interface for component cells
- Software defined functionality of identical blocks
**HISat Architecture**

- **Building Blocks**
  - Payload Adapter
  - HiSat cells

- **Package of Aggregated Cells (PAC)**
  - Payloads interface on User Defined Adapter (UDA)

Image Credits: Novawurks Inc. all rights reserved
HISat UDA (User Defined Adapter)

Payload Interface
- Attach hosted payload to PAC (Package of Aggregated Cells)
- Standardized interface for experiment payload

Documents
- ICD: Novawurks Provides Design Document
- Safety document: LaRC provides safety document

HISat interface architecture

Experiment
Payload Interface
UDA
HISat PAC Interface
HISat PAC

R3S payload interface board
R3S UDA Interface

Sensor configuration

- Minimally shielded

Image Credit: Novawurks Inc.
R3S Operational Interface

Data:
- R3S Content defined by LaRC
- Format defined by NW

Science Data (.csv file)
- Housekeeping data
- Health data

Operational commands

HISat

R3S App

UDA I/F Board

A/D (4x)
- Test Signal
- Serial

R3S Conversion Board

μDosimeter

Magnetometer

Liulin Spectrometer

Satellite

Ground Station

LaRC Ops

R3S sensors
R3S Con-Ops

R3S time-line

- Standard Data Take period of 23.5 hours
- Minimum mission is one Data Take
Lab77 Model: Mission Natural Selection

**Lab Vocabulary**

- **Desirable** (aligns to a road map need)
- **Has a team** (able/willing to advance the concept)
- **Fits in an available platform.**

**Management Assessment**
- Aligns to a road map
- Technically feasible
- Team.
Rapid concept developments

- Engineering of the system
- 50% design complete
- No “Gotchas”

Elements of a Sys/50 Analysis

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Concurrent Engineering

- Entire system developed in parallel
- Facilitated conversations
- Collocated* for duration of the study
- 1st order engineering products developed in near real time

* tele-presence for remote team members
LaRC EDS facility

- **EDS: Designed to design**
  - layout supports facilitated, concurrent, customer-in-the-loop activity

“We shape our buildings; thereafter they shape us.” - Winston Churchill
Rapid Response Radiation Survey (R3S)

- Made possible by:
  - Space Technology Mission Directorate
  - NovaWurks HISat architecture
- Supports Nowcast of Atmospheric Ionizing Radiation for Aviation Safety (NAIRAS) transition to operations
  - Reduce uncertainty in radiation transport model
  - Map radiation exposure as a function of geomagnetic field strength
- Developed using:
  - NovaWurks User Defined Adapter
  - Lab77 mission natural selection process
  - LaRC Engineering Design Studio (facilitated concurrent engineering)


Characterization

- **Cesium 137**
  - Exposed to @ 3 dose rates/distances