National Aeronautics and Space Administration

Adapting the Rad-Hard CubeSat Avionics Technology Sphinx for Interplanetary Missions

Principal Investigator: Dr. Yutao He, Section 349
Co-I: Dr. Glenn Lightsey, Georgia Institute of Technology
Graduate Student: Andrew Fear, Georgia Institute of Technology
Program: SURP

Objectives

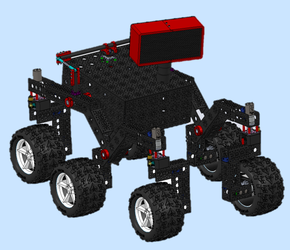
- Establish a strategic partnership between the JPL Advanced Computer and System Technologies technical group and the Space Systems Design Laboratory (SSDL) at George Institute of Technology
- Develop the Sphinx-based common avionics platform for future interplanetary exploration as a hands-on training opportunity for principal investigator leadership, scientific, engineering, and project management skills among both students and early career professionals.

Technical Approach

• Combine the path-to-flight Sphinx avionics technology with Open Source Rover (OSR) technology

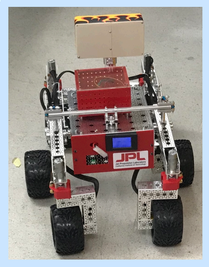
Flight-Worthy Sphinx

- Rad-Hard GR712: 300 krads TID
- 100 MHz Dual-Core
- 256 MB SDRAM
- 32 MB NOR Flash
- 8 GB NAND Flash
- SpaceWire|RS422|SPI|I2C|GPIO|RS232
- Size: 10 cm x 10 cm (CubeSat 1U)
- Mass: 129 gram
- Power: 2.5W (Average)



Open Source Rover

- Scaled-down 6-wheel robot
- Raspberry Pi as the “brain”
- JPL Mars rovers-like structures
- Maker-class common hardware
- Open-sourced custom-design
- Open source basic software



Flight-like Avionics Testbed

- OSR-body
- Sphinx brain
- Allow other flight-worthy hardware, software, sensors, etc. to be developed and tested on a common avionics platform
- Facilitate more effective training of the future space workforces
- Enable the rapid concept prototyping

FY’19 Accomplishments

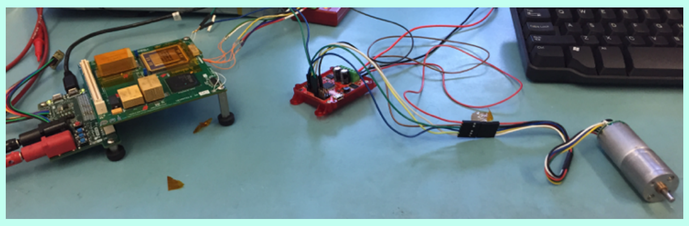
Successfully ”Implant” the OSR Raspberry brain with Sphinx

Ported Linux to Sphinx

- Image size: ~4MB
- Includes
  - Linux BSP
  - File System
  - Reduced software packages such as Python

Controlled all motors by Sphinx

- Using the Sphinx UART to drive motors



Ported F' Framework

- Compiled and ran skeleton framework on Sphinx running Linux
- Wrote Roboclaw driver in C++

Benefits to NASA and JPL

- Access Georgia Tech’s unique expertise to develop new capabilities in small satellites and systems engineering
- Raise awareness of the Sphinx technology with stakeholders and future customers outside of JPL who may incorporate the design into their proposals
- Help train and recruit the talents from Georgia Tech into JPL.

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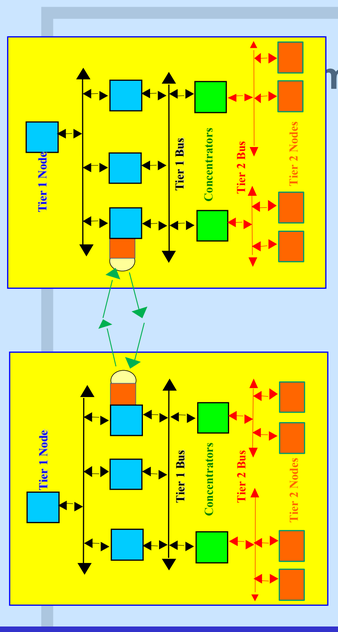
- Establish a strategic partnership between the JPL Advanced Computer and System Technologies technical group and the Space Systems Design Laboratory (SSDL) at George Institute of Technology
- Through the partnership the Sphinx-based system will evolve into a common avionics platform for future interplanetary exploration that can be used as a hands-on training opportunity to develop principal investigator leadership, scientific, engineering, and project management skills among both students and early career professionals.



Technical Approach

- **Leverage COTS IP core for NEXUS BIU (Bus Interface Unit) development**
- **Develop 4-node FPGA-based testbed for performance evaluation and characterization**
- **Extend VisualSim-based software testbed for Serial RapidIO enhancement**
- **Form the standard in conjunction with other governmental, industrial, and academia agencies to assure the effort to go beyond the task**

FY'11 Accomplishments

Benefits to NASA and JPL

Enabling what missions?
Expanding current state of the art?

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