National Aeronautics and Space Administration

Small Spacecraft Avionics Subsystem for Planetary Science Missions

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Program: FY21 R&TD Strategic Initiative **Strategic Focus Area: System Level Integration for Small Satellite Components**

Objectives

The objective of the FY21 task was to mature key aspects of the design and perform testing required to achieve TRL 5. After successfully performing TRL 5 testing the final goal was to wrap-up the documentation and perform the Technical
Readiness Assessment. Key activities:

- Complete the integration of the NAND flash controller in the Sabertooth FPGA and perform file system testing.
- Implement and test the Fault Management Unit (FMU) health collection logic. this is part of the critical technology
- element which will require lab testing in order to achieve TRL 5
- Implement and test the Fault Management Unit state table logic. this is other part of the critical technology element which
- will require lab testing in order to achieve TRL 5
- Demonstrate application of flight software drivers for processor interfaces: spacewire, NAND flash. Archive the design and documents in preparation for infusion
- Conduct the TRA reviews and release the TRA document

Significance/Benefits to JPL and NASA

The goal for FY21 was to complete the develop of the remaining low-level functionality of the Sabertooth and test in a relevant environment and pass our TRA review FY21. Significance of the results demonstrating the form fit and function of Sabertooth has achieved TRL 5 which was the top-level goal of the SRTD

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Publications

NTR	Status	Title	Form Type	NTR Date	Creation Date
52115	PENDING	FPGA Port Auto-Coding Tool (PortGen)	NTR	16-SEP-2021	16-SEP-2021
50435	PENDING	FPGA Register Block Generator Tool (RegGen)	NTR	16-SEP-2021	21-DEC-2016

Approach and results

The technical approach for FY21 involves completion of the development of the FPGA firmware and the F-Prime software drivers and managers, and integrate these completed elements into the existing Sabertooth avionics (figure 1) and validate the assembly in a relevant environment - demonstrating TRL5 readiness of the platform.

<u>Completed the collector subsystem.</u>
This year the design for the Sabertooth collector subsystem was implemented, simulated, and then validated in the lab against the requirements.

<u>Completed the state table.</u>
The state table was implemented, simulated and tested this FY. Combined with the collectors these 2 elements represent the critical technology element (CTE) as defined by the technical readiness assessment guidelines.

<u>TRL 5 testing</u>
The collector/state table design was tested in hardware within the brass-board representation of the Sabertooth hardware running flight-grade software and firmware. The circuit responded as required and satisfied the requirements to proceed to a Technical Readiness Assessment (TRA)

<u>NAND controller</u>
We completed the integration of the NAND flash controller and verified read/write/DMA functions with file system software

<u>Documentation</u>
Design files, analysis, test, simulations, specifications, theory of operation and other documents have been uploaded to github to ready the design for infusion into proposals and flight missions.

Background

One of the major strategic goals of the Solar System Exploration Directorate is to develop next generation small spacecraft capabilities for planetary space science missions. This strategic goal was established in response to NASA's strong interest in using small spacecraft (<180kg) for planetary exploration

Small spacecraft planetary space science missions require development of subsystems with high performance, low mass and power, long life capabilities and low cost.

The technologies that are included in this R&TD initiative include avionics, thermal and solar power technologies. Propulsion and communication technologies are being considered separately under different initiatives. This task is focused on the development of avionics system required for future deep space small spacecraft, and mature the platform to TRL5

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