WIRELESS CUBESAT BUS INTERFACE TECHNOLOGY

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Abstract

For CubeSat systems, managing the increasing complexity of a wired interface poses major challenges to mission success. Testing, integration, and mission operation frequently requires CubeSats to be reconfigured for extended mission capability and system reliability. This research presents a Bluetooth-based wireless CubeSat interface technology, which replaces all wired communication. Experiments demonstrate the feasibility and adaptability of the proposed wireless CubeSat interface technology with increased reconfigurability compared to traditional wire-based interconnects.

Introduction and Problem Description

The past ten years have led to increased popularity for CubeSat launch platforms. Their low profile and reduced launch costs have enabled more scientific payloads into LEO. However, continual miniaturization of CubeSat platforms has meant that maintaining a wired interface becomes increasingly difficult to manage between subsystems and has consumed more of the CubeSat's total volume, as well as increasing chances of connection failure. For subsystems that do not require the full PC/104 headers functionality, this volume could be reduced to allow more subsystems to be integrated in a CubeSat mission. Subsystem communication and data transfer between subsystems could be altered to utilize a wireless interface, which would lower the total volume, simplify pre-launch assembly and allow for post-deployment reconfiguration. A BLE based solution was chosen due to advantageous performance compared to other wireless standards.

Research Conducted

Operational Setup

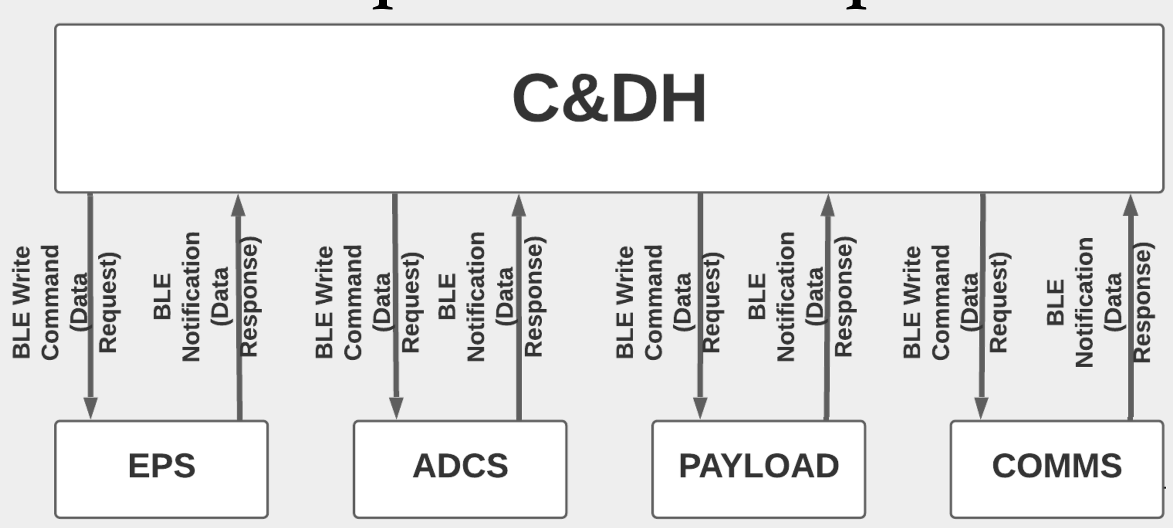

Figure 1:
Proposed Star Topology Setup of CubeSat Command and Data Flow

BLE interface would utilize the star topology of BLE 5.0 to connect each subsystem acting as a peripheral to a central node, which in the case of the CubeSat is the Command and Data handling (CDH) subsystem. The C&DH subsystem would send BLE write requests to each subsystem asking for various health diagnostics and sensor data, and each subsystem would respond with a BLE notification.

Constraints and Setup

Power limit: Within 5% of budget
Throughput: 90min orbit, 100MB file
Latency : Minimized
Packet Error Rate(PER) : < 2%

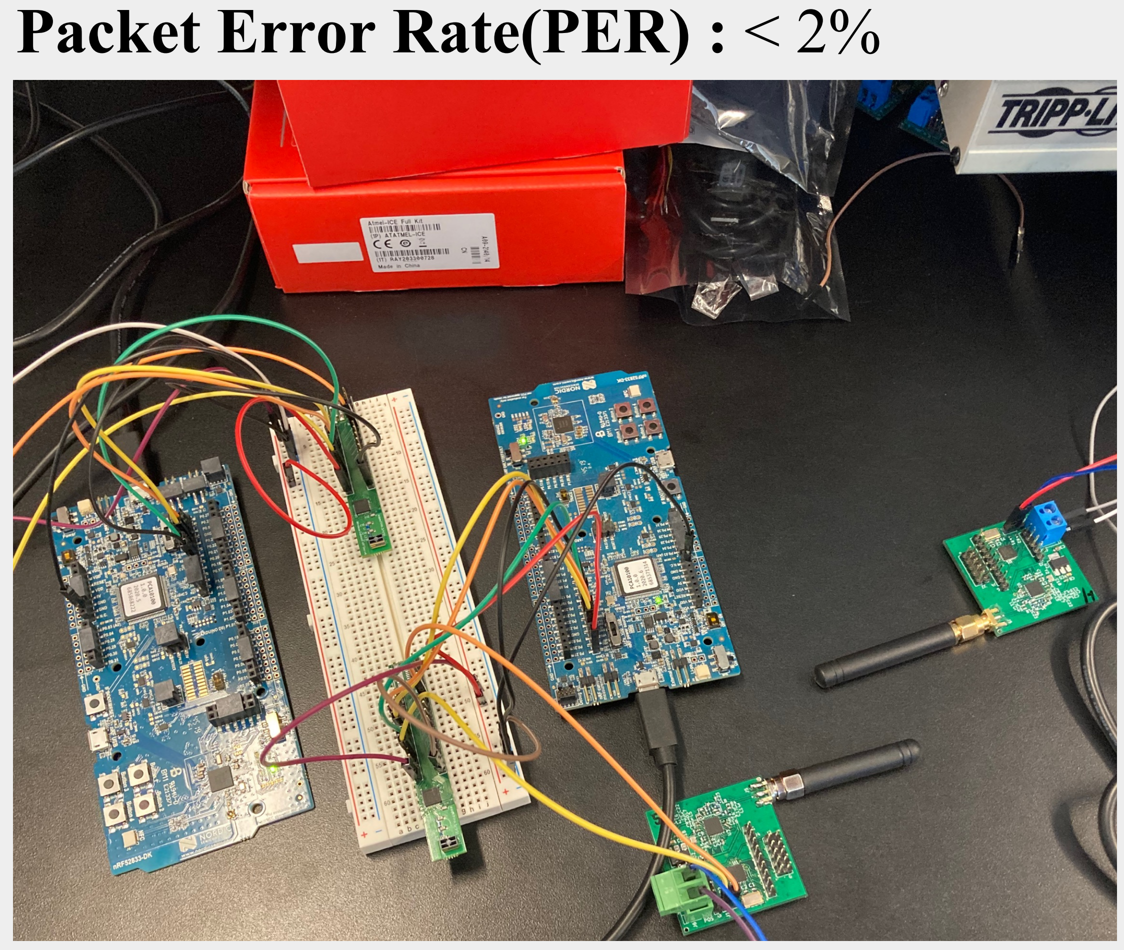

Figure 2:
nRF52833 BLE Prototype Boards Simulating Typical CubeSat Data Flow

A 100MB file was transmitted for each test at a Tx power of -4dBm and 10cm between each subsystem.

Results

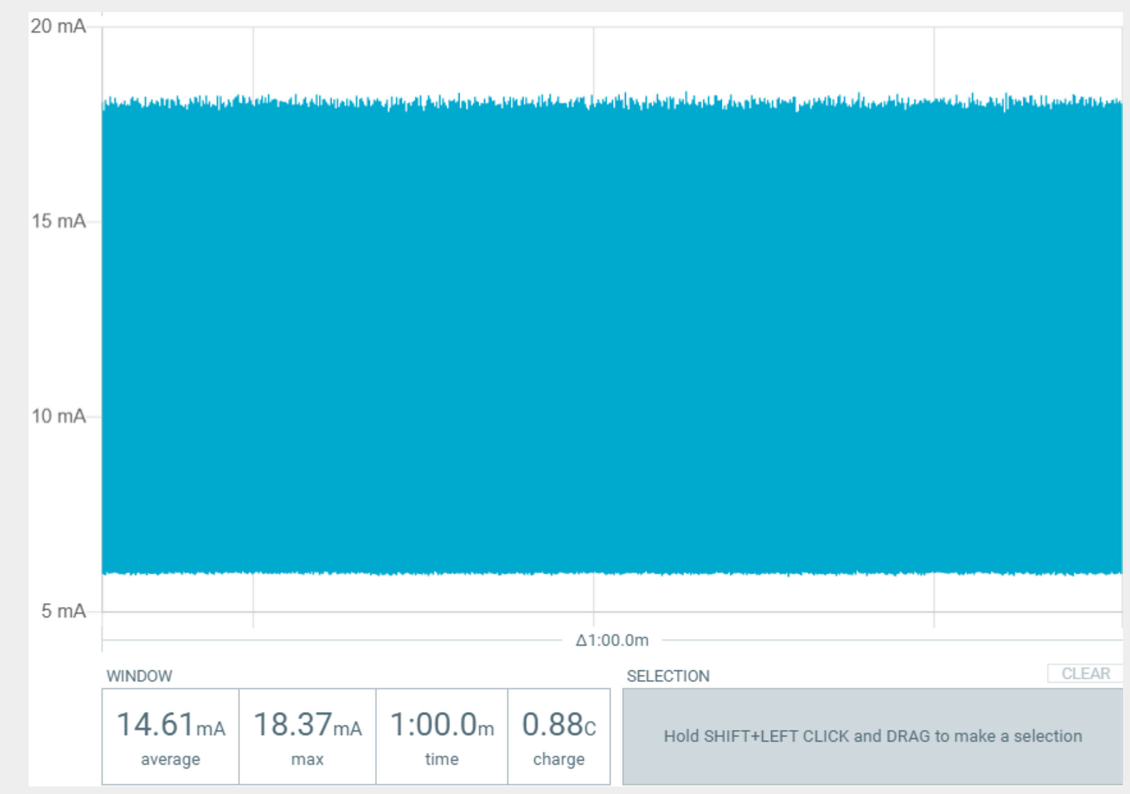

Figure 3:
Power Consumption Results from nRF Power Profiler

No.	Time	Source	PHY	Protocol	Length	Delta time (µs end to start)	SN	NESN	More Data	Event counter
2…	1…	Slave_0x98…	LE 2M	ATT	251	149	0	1	True	1177
2…	1…	Master 0x9…	LE 2M	LE …	0	3089	1	1	False	1178

Figure 4:
Sample Latency Results From Wireshark Trace of 100MB File Transmission

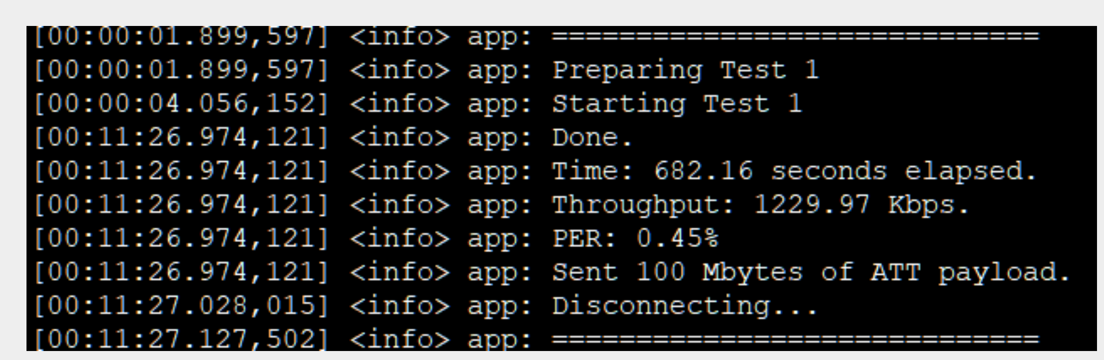

Figure 5:
Sample PER and Throughput Results for 100MB File Transmission

Conclusion and Future Work

Power consumption was 1.3% of power budget, within 5% constraint. Latency was 3.2ms, greatly decreased from previous years research. Average PER was 0.45%, within 2% constraint. Future work aims to perform thermo-vacuum testing to measure performance metrics in LEO-like environment, as well as testing on interference and near-field effects.

Acknowledgements

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