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Michael Hlas
Jeremy Straub
Ronald Marsh

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Michael Hlas, Jeremy Straub, Ronald Marsh
Department of Computer Science, University of North Dakota

Overview

Software defined radios (SDRs) are poised to significantly enhance the future of small spacecraft communications. They allow signal processing to be performed on a computer by software rather than requiring dedicated hardware. The OpenOrbiter SDR (discussed in [1] and refined in [2]) takes data from the flight computer and converts it into an analog signal that is transmitted via the spacecraft antenna. Because the signal processing is done in software, the radio can be easily reconfigured. This process is done in reverse for incoming transmissions, which are received by the SDR and decoded by software. Figures 1 and 2 provide an overview of the communications framework for OpenOrbiter I. Figure 3 depicts the algorithm for the SDR software.

Onboard Communication

The onboard communications algorithm is depicted in Figure 3. Data is prepared for transmission by the TCP stack software onboard the OpenOrbiter spacecraft and queued while the spacecraft waits for a ground station signal. When a ground station is detected, the two cross authenticate. The satellite sends an initial report on its status including battery charge level, position, attitude and other details. Concurrently, the ground station transmits new tasks to the satellite. This data is sent over a connection based protocol in order to verify that the data is received properly. After this, the satellite switches to a connectionless protocol (e.g., UDP) which is used to send data such as payload system images or other collected sensor data. This data is checked for completeness by the ground station which requests retransmission if necessary.

Communication Protocols

The OpenOrbiter spacecraft includes two radio units. This provides redundancy as well as allowing simultaneous bi-directional communication. Traditionally, data is sent using a connectionless protocol such as UDP to increase the transfer rate. However, UDP doesn’t confirm packet receipt, so if errors occur, the ground station will have to detect them and request retransmission of the missing data. An enhancement to this approach is the use of the RUDP protocol, which provides the advantages of UDP with a delayed confirmation (similar to the confirmation used in TCP). It provides high data rates with data correction if there are any transmission errors.

Future Work

Assembly and testing of the radio, and development and validation of the supporting software, is ongoing. Current work focuses on low-cost method for flashing the firmware onto the radio with specialized hardware.

Acknowledgement

This poster is revised and updated from [7, 8].

References