

# **NPSAT1 C&DH Software**

## ***Introduction***

NPSAT1 is a low-cost, technology demonstration satellite hosting a number of experiments. Commercial, off-the-shelf (COTS)-based technology will be implemented with custom designs to offer a low-cost command and data handling (C&DH) subsystem building on commercial, desktop PC architecture and standards-based specifications. In addition to an experimental C&DH subsystem, NPSAT1 will demonstrate the use of non-volatile ferroelectric RAM which is inherently radiation-tolerant and lithium-ion polymer batteries, state-of-the-art technology that will be employed offering high energy density (Watt-hr/kg) for space applications.

Experiments on-board NPSAT1 include two Naval Research Laboratory (NRL) payloads. The coherent electromagnetic radio tomography (CERTO) experiment and a Langmuir probe. The CERTO experiment is a radio beacon which, in concert with ground station receivers, is used to measure total-electron-content (TEC) in the ionosphere. The Langmuir probe will augment CERTO data by providing on-orbit measurements. The other experiments are of NPS origin. These include a novel design for a spacecraft computer board, a COTS visual imager (VISIM), and some micro-electromechanical systems (MEMS)-based rate sensors.

## ***NPSAT1 Command and Data Handler Description***

The NPSAT1 Command and Data Handler is the main on-board computer which orchestrates all spacecraft activities. Using asynchronous serial the C&DH communicates with four other subsystems. In addition the C&DH contains several spacecraft subsystems in which it directly controls. These are the CERTO/Langmuir probe, the Configurage Fault-Tolerant Processor, and the Modem and RF subsystem which is used for communication with the ground. The C&DH microprocessor is an ARM 79520. This microprocessor was selected because of its existing port to the Linux operating system, low use of electrical power, sufficient processing power for the C&DH functions, and suitable package for incorporating onto a flight printed circuit board.

In addition to the hardware which the C&DH needs to directly control, the C&DH needs to schedule on-board activities such as experiment scheduling, ground communication, and telemetry management from the other subsystems. And, the C&DH needs to be able to restart correctly and perform analyses on previously stored data in order to most efficiently operate the spacecraft.

## ***Description of Thesis Topics***

The software for the C&DH is too large of a project for one entire thesis topic. Instead many opportunities are available depending on one's interest and ability. The topic can be kernel and device driver oriented (Linux kernel configuration, Communication Controller driver, A/D handler, Error Detection and Correction driver, etc.), data and protocol oriented (communication protocols for subsystem and also RF, telemetry

storage, data correction, etc.), or more application oriented (subsystem interface, reset analysis, startup, standard tools, etc.).

This thesis will design, code, test, and document some portion of the C&DH software. The software will be developed in C or C++. Tools available are the standard GNU/Linux software development tools in addition to Metrowerks CodeWarrior and Platform Creation Suite for the ARM 79520 processor.

### ***Proposed Outline***

- NPSAT1 Introduction
- C&DH software requirements
- Software design and implementation
- Conclusions & Recommendations
- Appendix of Test Results, Test Data, Software

### ***Suggested References***

- NPSAT1 PDR Slides
- Sharp ARM79520 User's Manual.
- "Overview of the NPSAT1 Spacecraft Architecture and Technology Demonstration Satellite," D. Sakoda and J. Horning, Paper SSC02-I-4, 16<sup>th</sup> Annual AIAA/USU Conference on Small Satellites, Logan, UT 2002.