CySat: Satellite Mission Design

Team Members:

Alex Constant, Alexis Aurandt, Chandler Jurenic, Jeffrey Richardson, John Lenz, Scott Dressler

Client:

Make 2 Innovate (M:2:I)

Advisor:

Dr. Phillip Jones

Introduction

Problem Statement:

Around the world, students in Aerospace and related disciplines want to take their learning and apply it to a project that they can feel proud of, and that demonstrates their knowledge. Amateur satellites are becoming more and more popular as university projects for these students.

Solution:

The CySat satellite provides an opportunity for students at Iowa State to participate in a project that will both challenge them and fulfill their desire to be a part of putting a satellite in space. The role of our senior design team is to complete the implementation of the software that will allow the satellite to function and communicate.

Intender Users and Uses

The intended end users of the CySat satellite are M:2:I members. Users will use the Ground Station to send commands to and request data from the satellite over the course of its lifetime

Design Approach

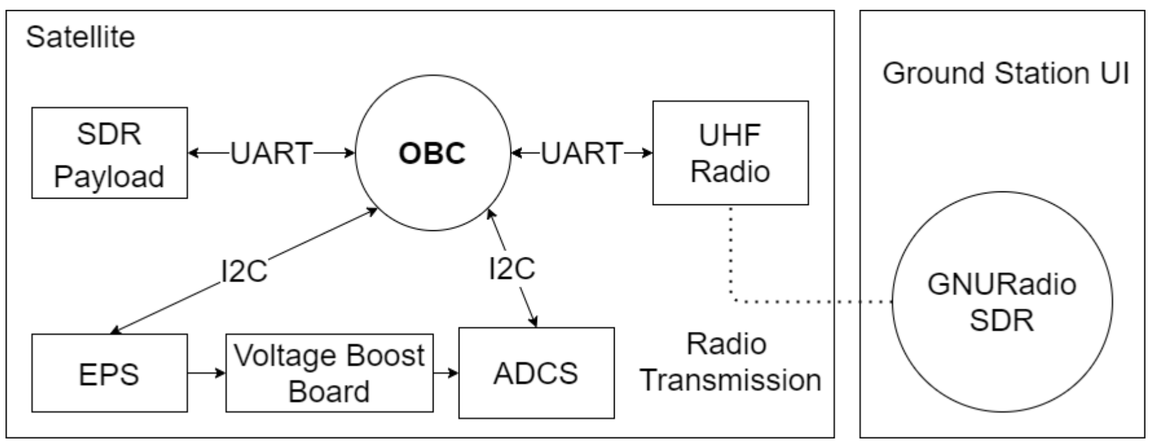

Fig 1: Communication Diagram

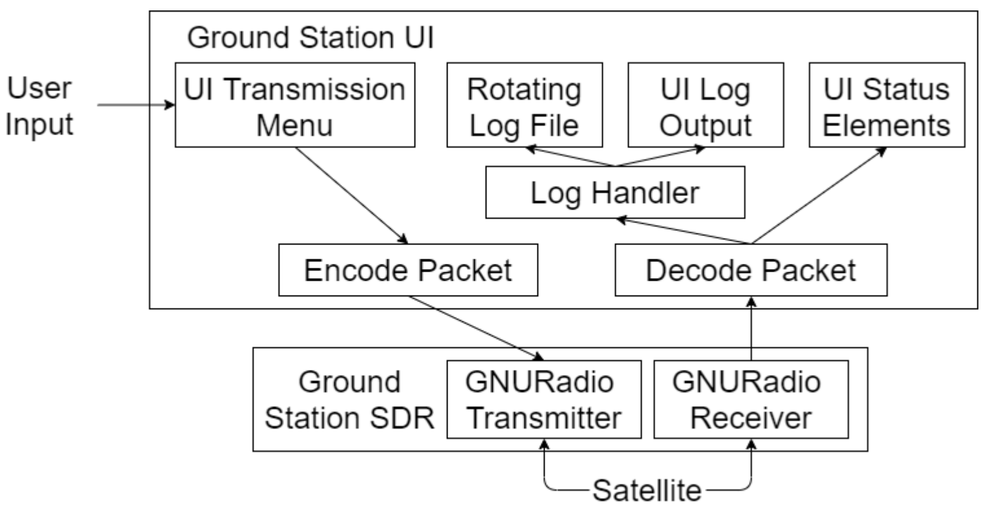

Fig 2: Ground Station Diagram

- CySat Packet Protocol defines consistent packets
- Transmission/Reception uses AX.25 packets to wrap CySat Packets
- SDR Payload collects soil moisture readings from Earth
- Ground Station SDR currently being designed

Terminology

OBC: On Board Computer
ADCS: Attitude Determination and Control System
EPS: Electrical Power System
SDR: Software Defined Radio

Project Resources

All hardware for this project was provided by M:2:I.

Design Requirements

Functional Requirements:

- Must power up no earlier than 30 minutes after deployment from ISS
- Must orbit Earth and collect and transmit soil moisture readings for 6 months
- Must receive and respond to commands from a Ground Station
- Must deorbit after lifetime

Nonfunctional Requirements:

- Ground Station UI must be performant and fault tolerant to minimize downtime

Engineering Constraints:

- Ground Station must use Python3 and GNURadio and connect to external SDR

Operating Environment:

- Satellite Operates in Space
- Ground Station operates on Ubuntu 20.04 Linux Machine

Relevant Standards:

- NASA and CubeSat hardware standards
- UART and I2C
- PC-104 header standard
- AX.25 Packet Protocol

Technical Details

Hardware:

- All subsystems EnduroSat, except ADCS
- OBC Type II
- UHF Tranceiver/Antenna Type II
- CubeADCS
- EPS 1
- Xilinx Zynq FPGA
- STM342f Discovery Board for Testing

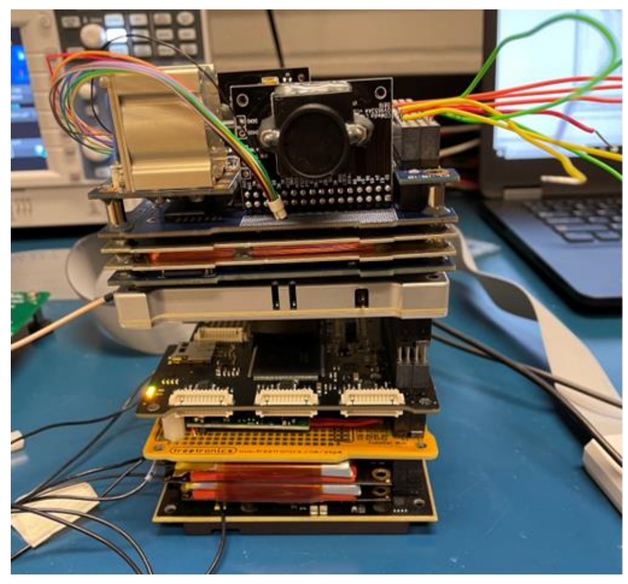

Fig 3. Full Satellite Subsystem Stack

Software:

- Python3 Ground Station
- GNURadio SDR

Testing

- Tests performed by connecting OBC to other subsystems on a Pumpkin board and ensuring communication
- Communications tests between OBC and EPS/ADCS subsystems complete
- Direct connection testing of packet protocol between OBC and Ground Station complete for previous version of Ground Station

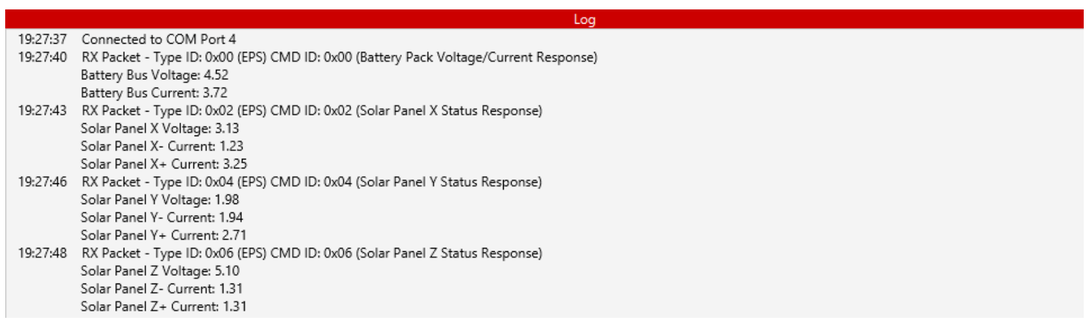

Fig 4. Packet Protocol Testing Results