Implementation of SDM–Lite for Space Plug and Play Avionics (SPA) CubeSats

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Team

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Partnerships: COSMIAC – Brian Zufelt, Craig Kief
Overview

- Space Systems Lab and COSMIAC background
- SPA in low power and low data rate environments
- 8051-based ASIM
- SDM–Lite applications
New NanoRacks/CubeLab Standard on the ISS, July 2010

KYSat-1 2006
KYSat-2 2013
PRINTSat and RAMPART 2012
High Altitude Balloons (Background Image)

First CubeSats Ejected into Sub-Orbital Space, March 2010
First Flight, Composite Super Loki, December 2007
COSMIAC provides Years of experience in design and consulting for SPA development

Recent development includes
- ORS$^2$ SPA centered 6U satellite (scheduled launch 2013)
- Trailblazer SPA centered 1U Satellite (scheduled launch 2013)
- Consulted on a SPA interface for the MAI–400 ADACS
- Provides training on new and Innovative SPA products (AAC Virtual Satellite Integrator)
SPA–1 (I2C based)

- SPA–1 developed for small spacecraft (NanoSats, CubeSats)
- SPA–1 utilizes I2C as the communication layer between ASIM and SDM
- The CubeLab bus is currently being modified to allow SPA–1 devices to be tested on orbit
  - Rapid SPA–1 device testing in microgravity
  - Increase TRL
SDM–Lite Bus

- **SDM**
  - Compiled for VXWorks and Linux
  - 32-bit microcontroller
  - Supports SPA–O, SPA–S, SPA–U and SPA–1
  - Supports high power and high data rate SPA devices
  - Very large code base

- **SDM–Lite**
  - Targets low–power, low–resource microcontrollers
  - Full XTEDS support being supported soon
  - Targets SPA–1 devices
  - Small code base
SDM–Lite Bus

- Applications for a SDM–Lite Bus
  - Lower power design for smaller spacecraft (1U–2U)
  - Ability to manage smaller portions of a larger SPA network and bridge connections to a faster SPA protocol like SPA–U(USB), and SPA–S (Spacewire)
8051-based ASIM

- 3K RAM
- 7K Flash
- SPI, UART, I2C
- Useful for ASIM in CubeSats
- Tested with Full SDM
- Tested with SDM-Lite
Trailblazer

- 1U Satellite
- SPA Centered Bus with a SDM–Lite approach
  - Manages 5 ASIMs through an 8–bit microcontroller
  - Allows modules to be directly integrated into another SPA bus design without modification. (Radio on ORS²)
- Manifested on ORS3 through ELaNa IV
KySat–2 Mission

Goals:
- Educational/Public Outreach through photos and sensor data for K–12
- Distributed processing architecture
- Verify Stellar Gyroscope method for attitude determination
SPALab Overview

- Extension of collaboration with NASA Ames Research Center
- Enables SPA–1 devices to be rapidly tested in microgravity on the ISS
- Reconfigurable experiments through the use of upload scripts
- Can be reconfigured by astronaut mid-flight
- Data and experiment return available
SPALab bus

NanoRack Platform

USB TYPE B INTERFACE

+5v/USB

USB

ELC

SPA CubeLab Bus

Additional power reserves

8-10v

+5v

5v

3.3V

EPS

I2C

USB SD access with bypass

3.3V

USB

I2C CONTROL

SD CARD DATA (SPI)

C&DH

Payload Interface Module

3.3V

SPI/USB

SD1

3.3V

SD0

SPA Device or Generic Payload

Real Transfer

3.3V

SPA-1 enabled CubeLab Bus 4/28/2013
Summary

- SPA in low power and low data rate environments
- 8051–based ASIM
- SDM–Lite applications
  - Trailblazer
  - KYSat–2
  - SPA Lab
Thank You

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Space Systems Laboratory
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Master’s Thesis
Providing a Persistent Space Plug-and-Play Avionics Network on the International Space Station
http://uknowledge.uky.edu/ece_etds/16/

COSMIAC
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