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

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10th CubeSat Developers' Workshop
April 24-26th, 2013
San Luis Obispo, CA

Team

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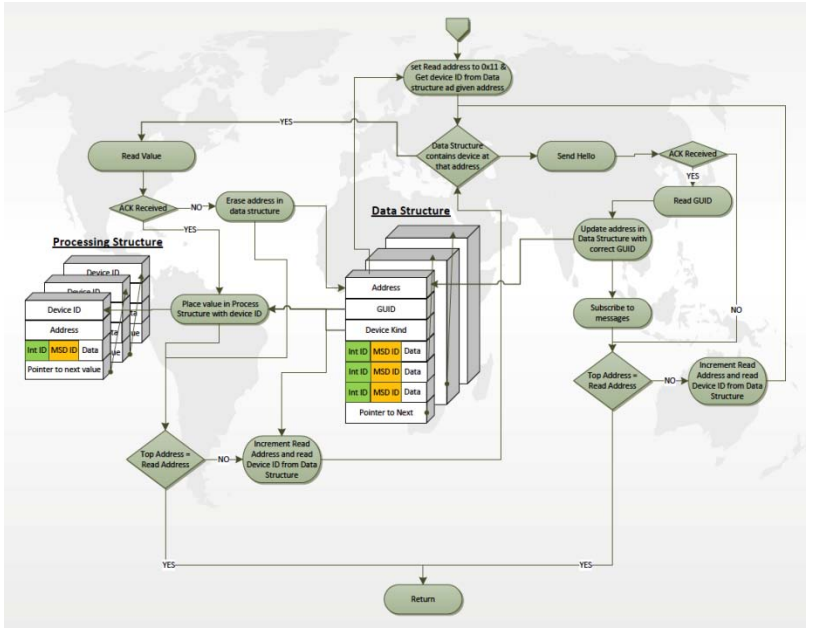
- Partnerships: COSMIAC – Brian Zufelt, Craig Kief

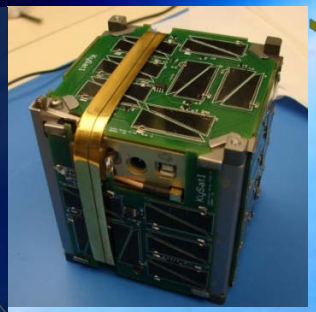
Overview

- Space Systems Lab and COSMIAC background
- SPA in low power and low data rate environments
- 8051-based ASIM
- SDM-Lite applications



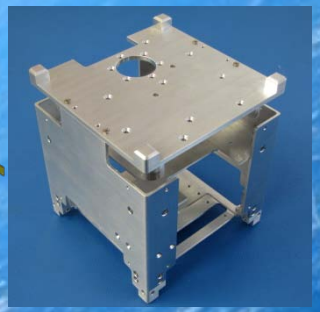
Space Systems Lab Missions

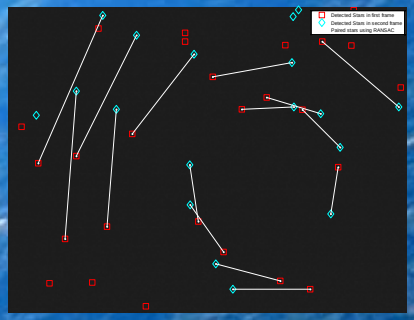
New NanoRacks/CubeLab Standard on the ISS, July 2010



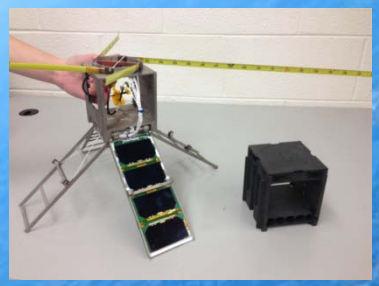
KYSat-1 2006

KYSat-2 2013





First CubeSats Ejected into Sub-Orbital Space, March 2010



PRINTSat and RAMPART 2012

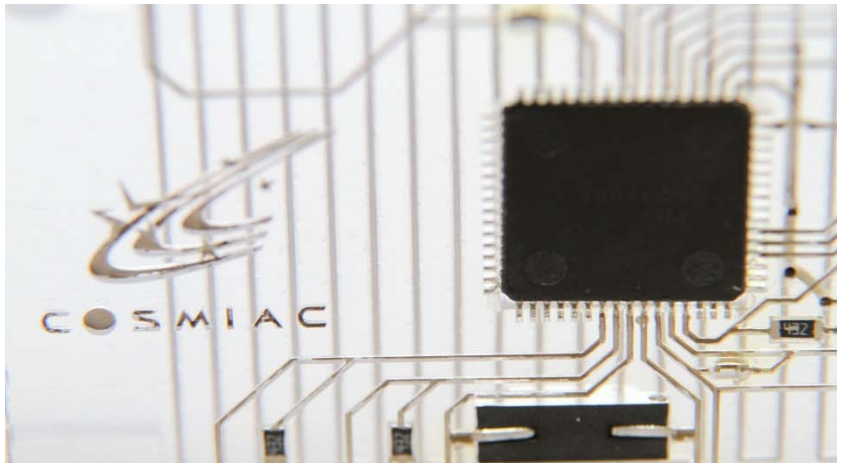
High Altitude Balloons (Background Image)

Garvey P-12A

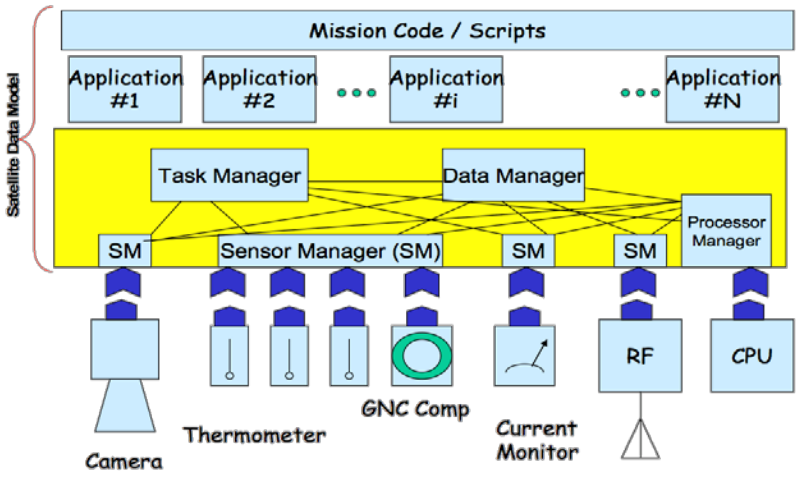
First Flight, Composite Super Loki, December 2007

COSMIAC

- 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 Network Overview



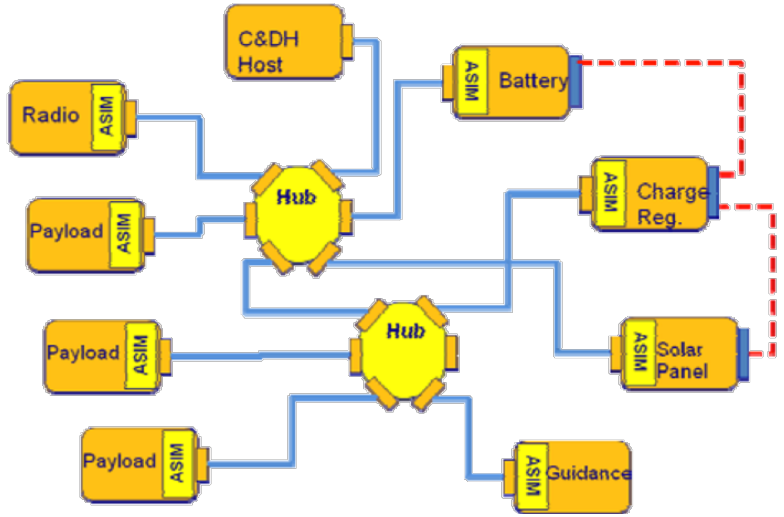


Image credit: AFRL

SPA-1 (I2C based)

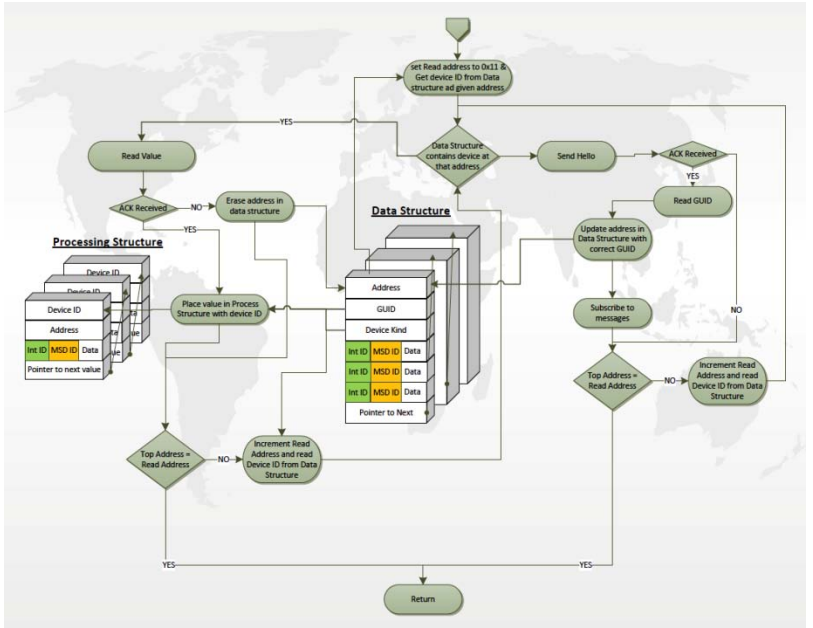
- SPA-1 developed for small spacecraft (NanoSats, CubeSats)
- SPA-1 utilizes I2C as the communication layer between ASIM and SDM
- The CubeLab bus is currently being modified to allow SPA-1 devices to be tested on orbit
  - Rapid SPA-1 device testing in microgravity
  - Increase TRL

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

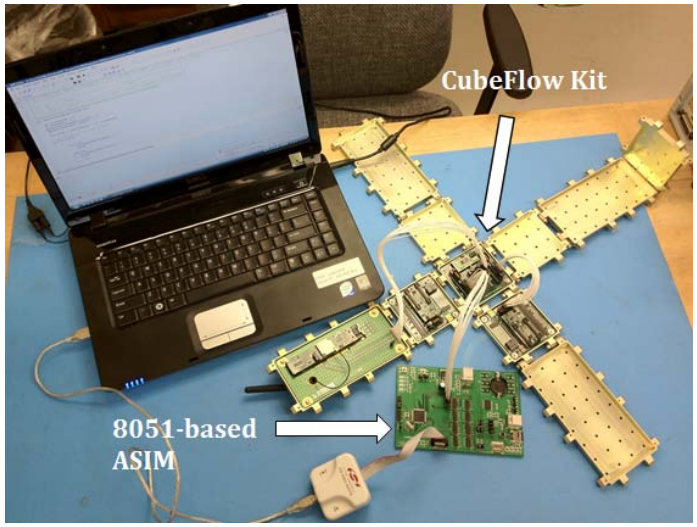
SDM-Lite Bus

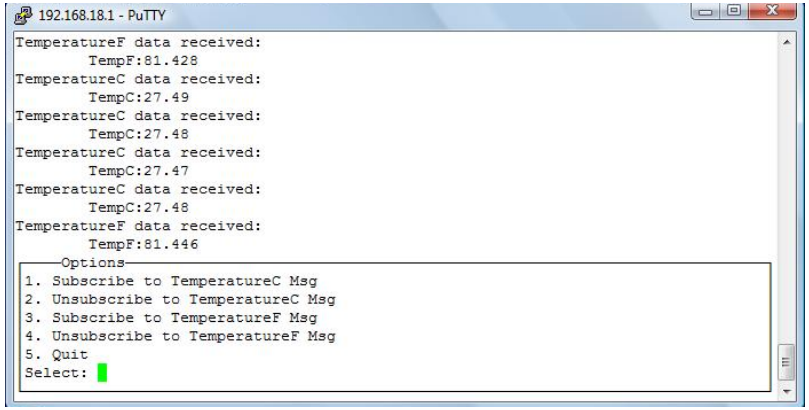
- Applications for a SDM-Lite Bus
  - Lower power design for smaller spacecraft (1U-2U)
  - Ability to manage smaller portions of a larger SPA network and bridge connections to a faster SPA protocol like SPA-U(USB), and SPA-S (Spacewire)



8051-based ASIM

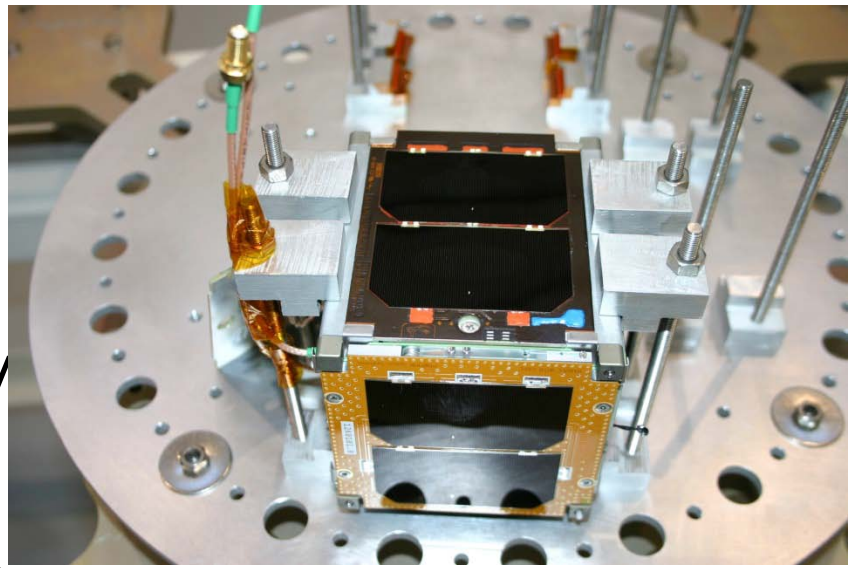
- 3K RAM
- 7K Flash
- SPI, UART, I2C
- Useful for ASIM in CubeSats
- Tested with Full SDM
- Tested with SDM-Lite





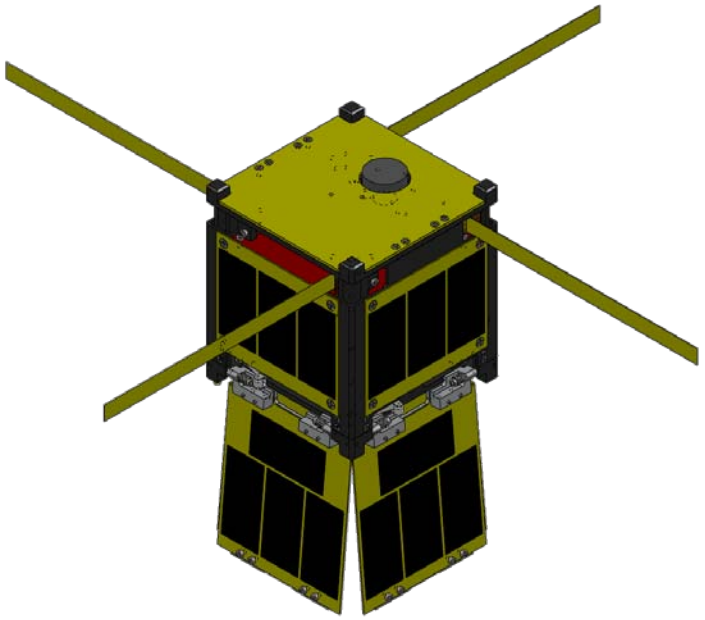
Trailblazer

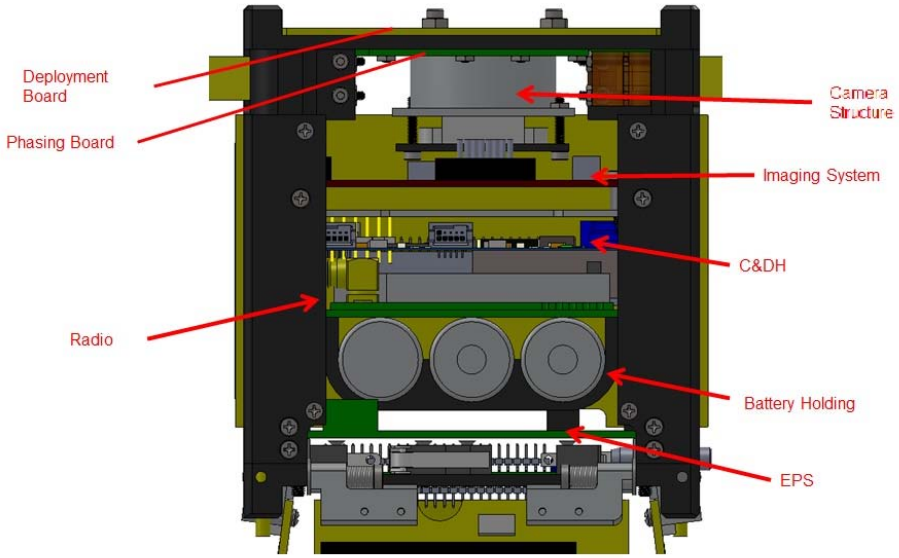
- 1U Satellite
- SPA Centered Bus with a SDM-Lite approach
  - Manages 5 ASIMs through an 8-bit microcontroller
  - Allows modules to be directly integrated into another SPA bus design without modification. (Radio on ORS^2)
- Manifested on ORS3 through ELaNa IV



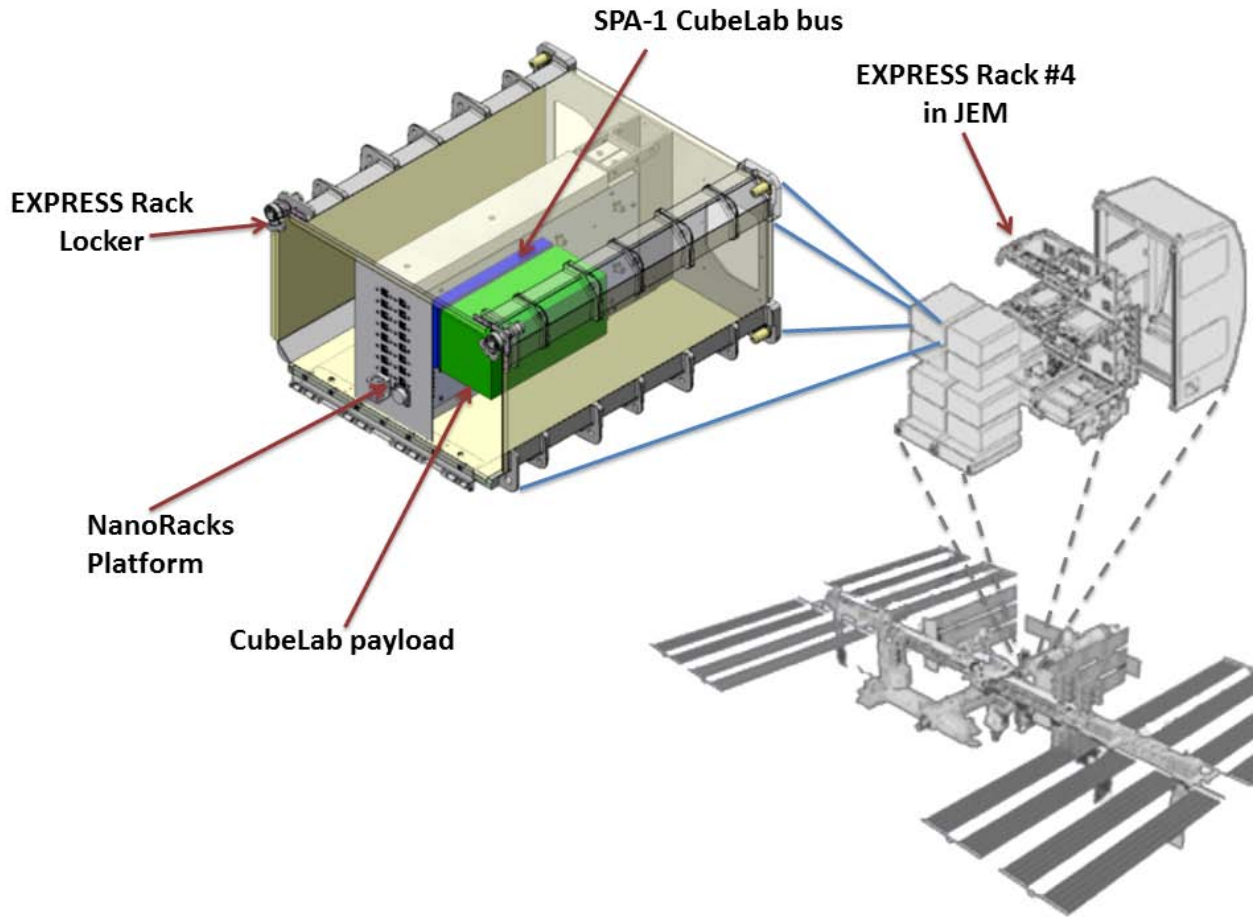
KySat-2 Mission

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



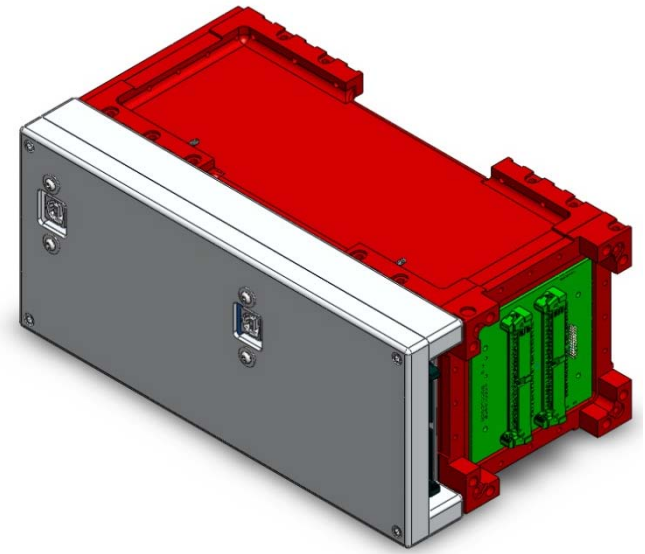


NanoRacks and CubeLabs on the ISS

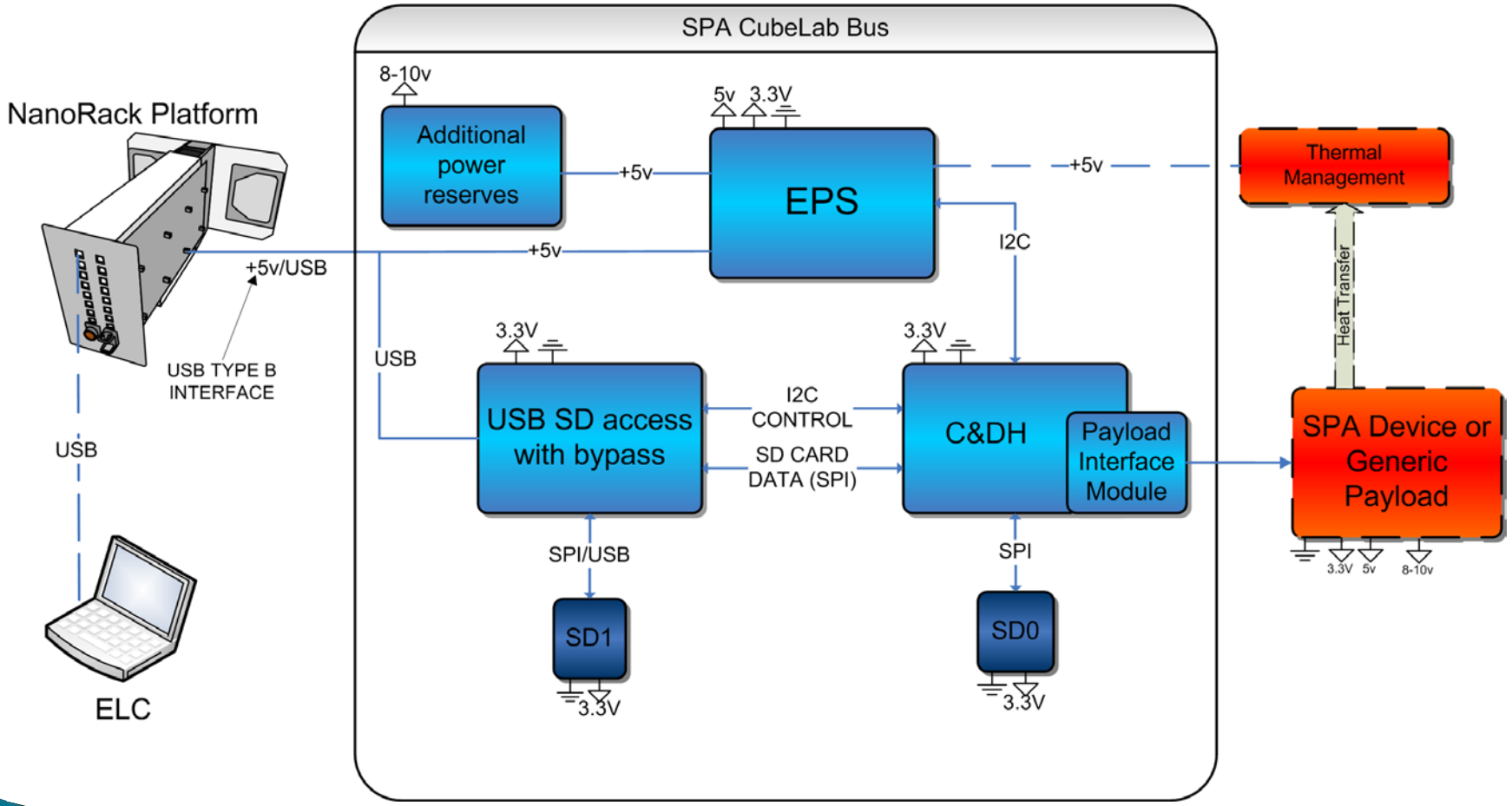


SPALab Overview

- 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


SPA CubeLab Bus
NanoRack Platform
8-10v
Additional power reserves
+5v
5v 3.3V
EPS
+5v
Thermal Management
+5v/USB
+5v
I2C
Heat Transfer
USB
USB TYPE B INTERFACE
3.3V
USB SD access with bypass
I2C CONTROL
SD CARD DATA (SPI)
3.3V
C&DH
Payload Interface Module
SPA Device or Generic Payload
USB
SPI/USB
SPI
SD1
SD0
3.3V
3.3V
3.3V 5v 8-10v
ELC

Summary

- SPA in low power and low data rate environments
- 8051-based ASIM
- SDM-Lite applications
  - Trailblazer
  - KYSat-2
  - SPALab

Thank You

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Presentation by Chris Mitchell
Space Systems Laboratory
University of Kentucky
http://ssl.engr.uky.edu

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
University of New Mexico
http://www.cosmiac.org