CubeSats @ AIAA SmallSat Conference

*.Sat & GeneSat-1 Overview

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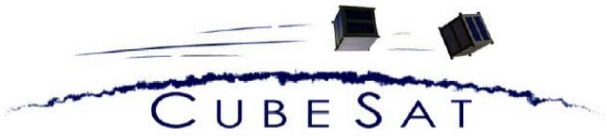
Utah State University
Logan, UT



Introduction

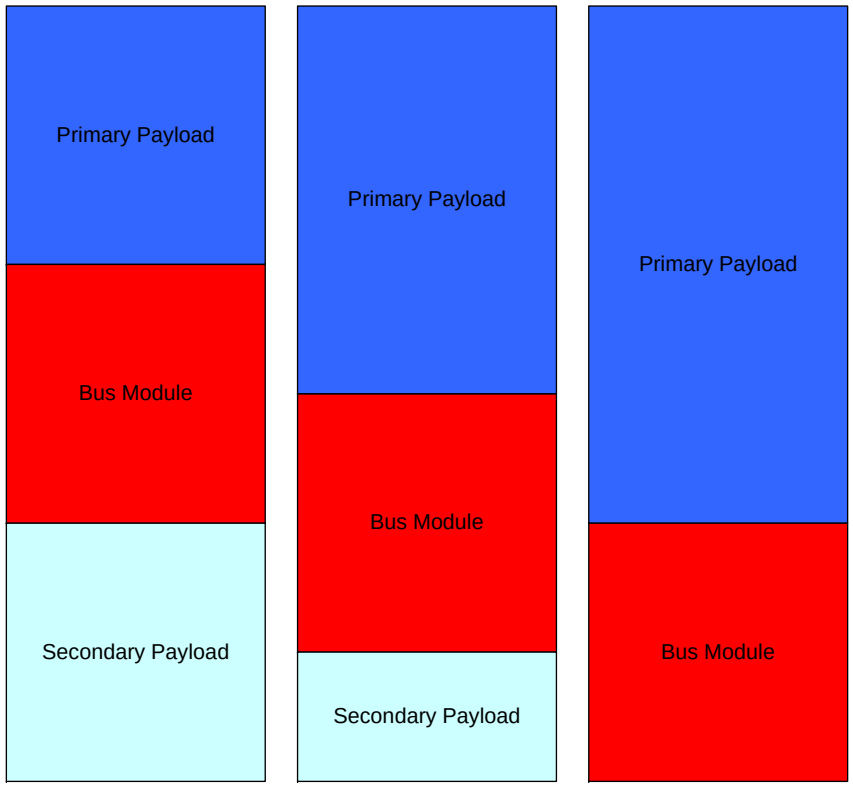
- Today's Primary Goal…
  - High-level overview of services provided by the *.Sat Spacecraft Bus to the GeneSat-1 Mission Payload Module
- *.Sat Mission Statement
  - To provide a standard CubeSat Bus as a support platform for educational and scientific space experiments.
- Nomenclature
  - *.Sat CubeSat Bus (covers Ground Segment and Space Vehicle)
  - GeneSat-1 Mission and Payload

Agenda

- Topics of discussion
  - Basic requirements
  - Design status
  - Spacecraft/Bus layout
  - System interfaces
  - GeneSat-1 Mission Payload
  - Bus Services to payload (Subsystems)

Basic Requirements

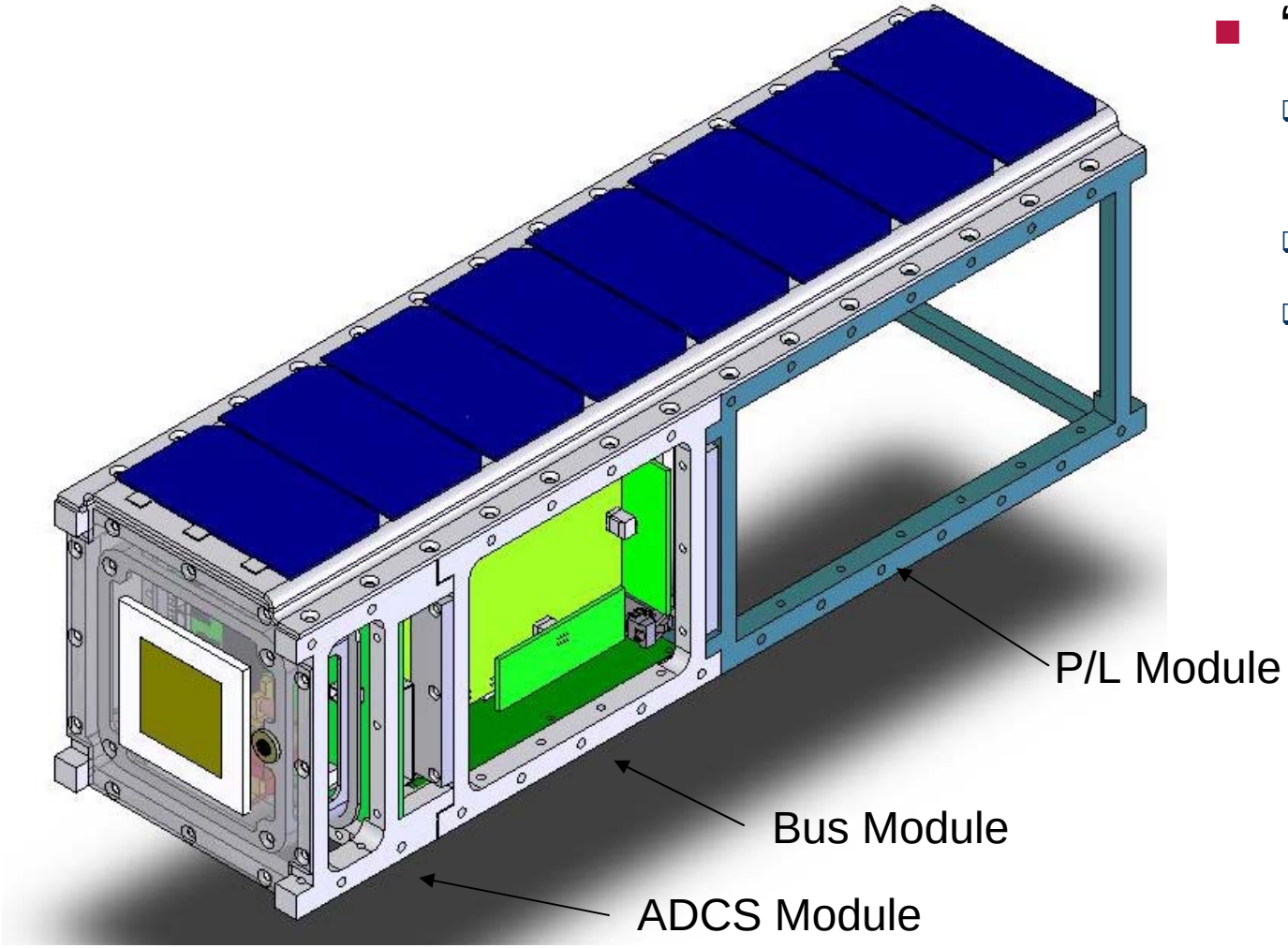
- "Standard" Bus
  - Adherence to the CubeSat Design Specification
  - Modular configuration
    - 1.0, 1.0, 1.0
    - 1.5, 1.0, 0.5
    - 2.0, 1.0 (no active ADCS)
  - Standardized interface(s)
- LEO Orbit
  - Fly as secondary payload
- One-year Design Cycle
  - Must be complete on 30 September 2004 in a "flight-ready" configuration



Design Status

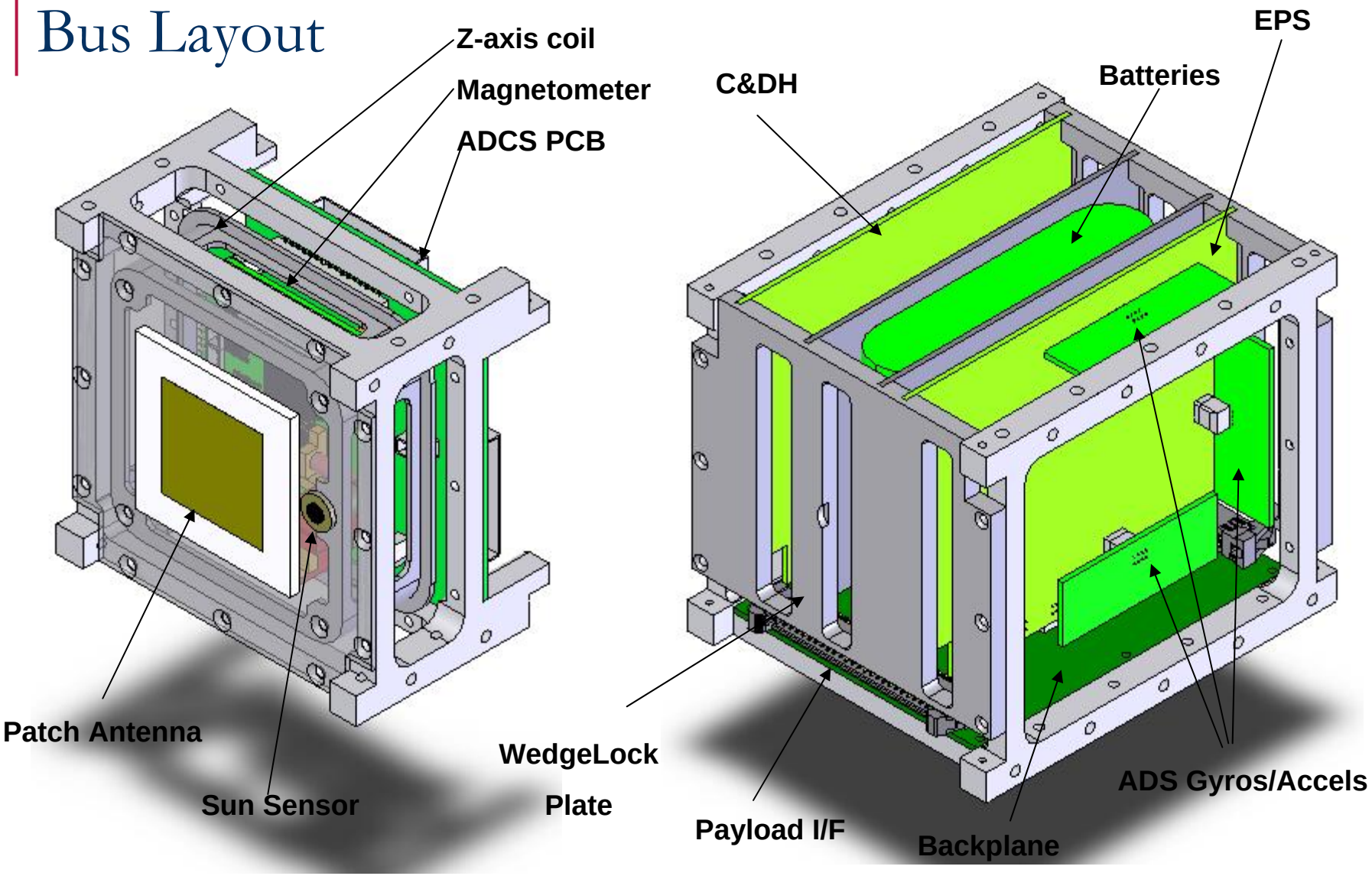
- Heritage
  - NemaSat Bus Program, 2003
    - Lead by Mike Gonzales
- Current status
  - Electronics are fabricated and in test
  - Structure fabricated and undergoing Alodine processing
  - Environmental testing to begin in September timeframe
  - Software programming and testing ongoing
  - On track for delivery of hardware 30 September 2004. Validation and test may not be complete.
  - Payload integration with initial EDU in November 2004
  - Launch slated for Autumn 2005 aboard Dnepr (SS-18) LV

Spacecraft layout

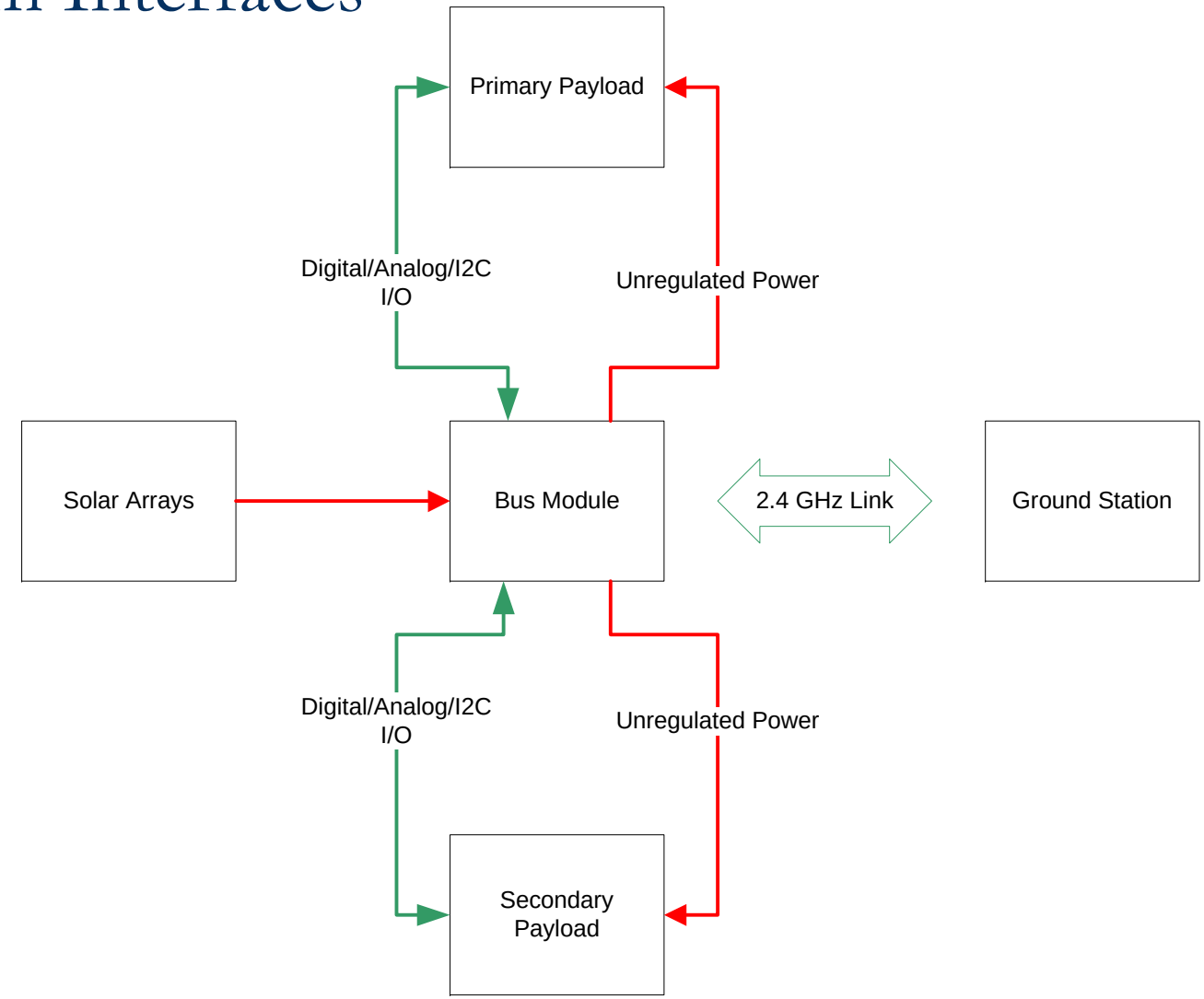


- "Triple Cube"
  - 100x100mm "footprint"
  - 340mm long
  - 3kg mass

Bus Layout


Z-axis coil
Magnetometer
ADCS PCB
C&DH
Batteries
EPS
Patch Antenna
Sun Sensor
WedgeLock
Plate
Payload I/F
Backplane
ADS Gyros/Accels

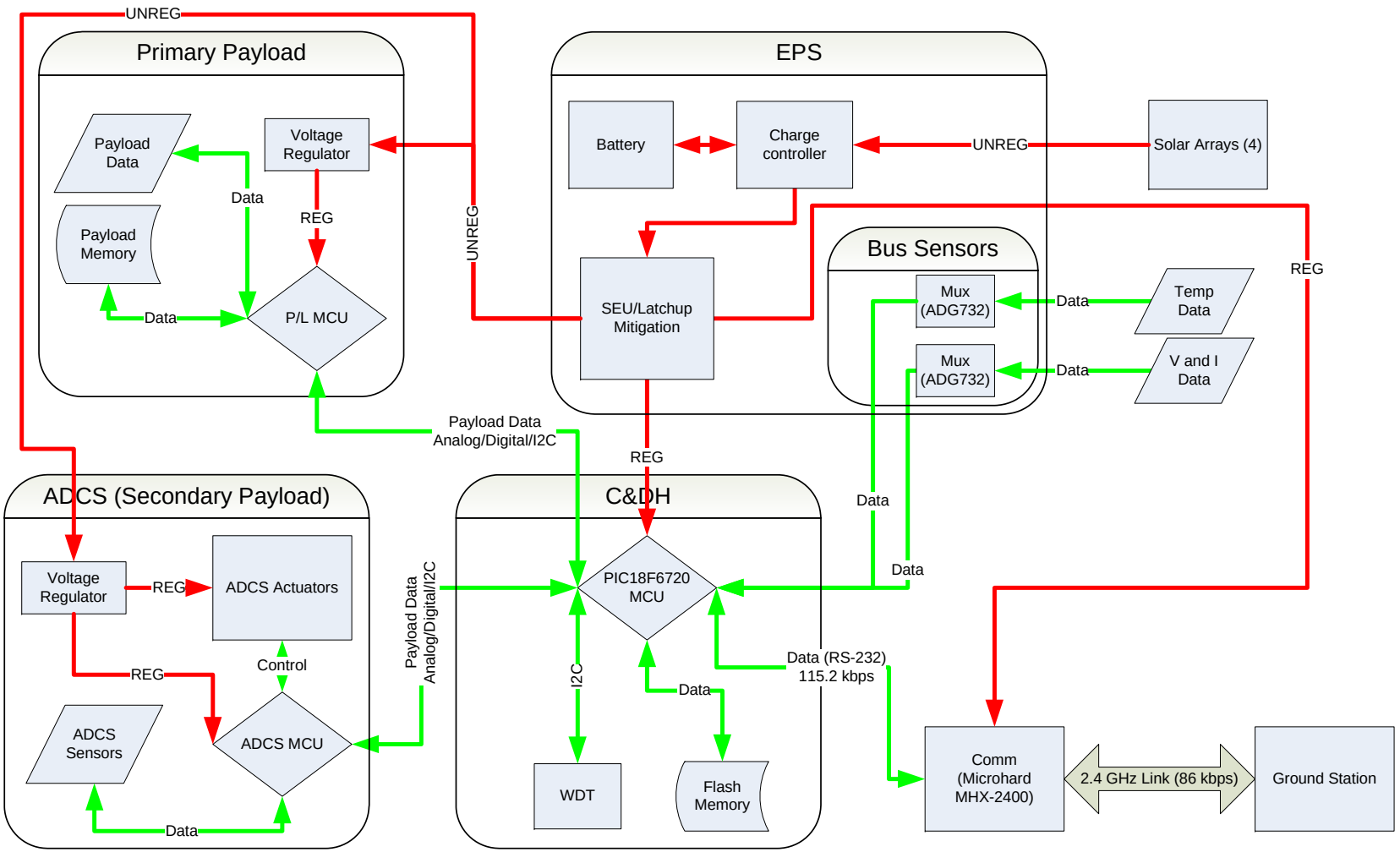
System Interfaces



NASA/Ames Astrobionics GeneSat-1 Payload

- Self-contained genetic research experiment
  - 8-10 wells
  - Fluidic media
  - Optical sensor system
- Gene-expression in E. coli bacteria
  - Micro-g environment
  - Space radiation
- In-Situ Genetics (ISGEN)
  - GeneSat-1 is a precursor to the future ISGEN (In-Situ Genetics) missions (bigger bird)
  - Will fly other increasingly complex organisms
  - Opportunities for launches up to twice per year

Data/Power Flow

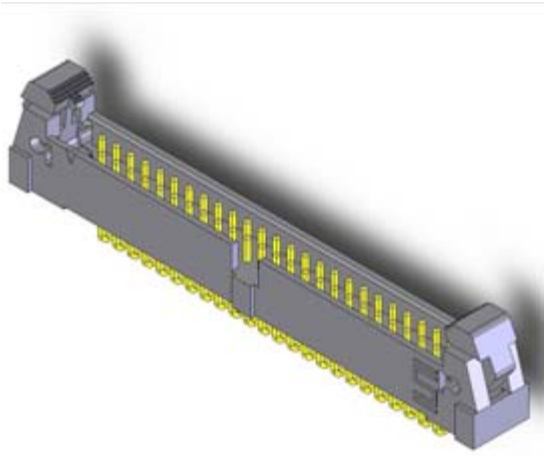


Bus Services to Payload

- Attitude Determination and Control (ADCS)
  - Passive ADCS ("Zero-Cube" option)
    - Permanent magnets and hysteresis rods
    - Pointing aligned to Earth's magnetic field
  - "Active" magnetic torque system
    - Onboard orbit propagator and magnetic field model
    - Sun sensors and magnetometer
    - "B-dot" rate-damping and Nadir-Pointing modes
- Communications
  - 2.4 GHz ISM-band radio (Microhard MHX-2400)
  - Circularly-polarized patch antenna (up to 8dBi gain)
  - Up/Downlink of data/telemetry/commands

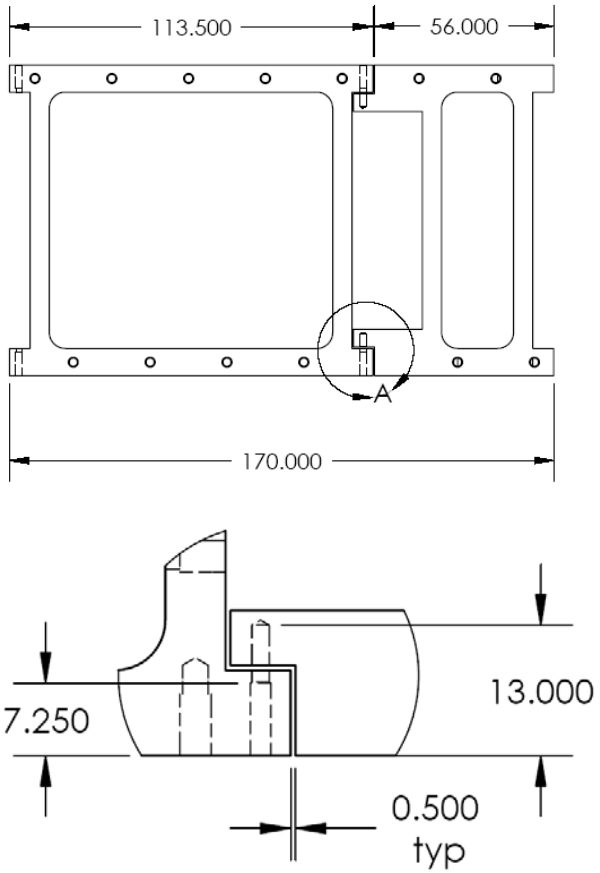
Bus Services to Payload (continued)

- Command and Data Handling (C&DH)
  - PIC18F6720-based architecture
  - Three banks SPI Flash memory (2 MB each)
  - S/C health monitoring (T, V, I, accels/rates)
  - Single-event upset and latch-up mitigation
  - Dual payload interfaces
- Software
  - Salvo Pro RTOS
  - Time stamping and data exchange w/ payload (via I^2C)
  - Command set for Payload(s)



Bus Services to Payload (continued)

- Electrical Power (EPS)
  - 28% Spectrolab UTJ cells on four body panels (8 cells/panel)
  - Unregulated Bus Voltage to Payload(s)
  - 2.0 – 4.0W peak power to Payload(s)
  - Protection circuits (hardware-based latch-up mitigation)
  - Hysteresis discharge protection for Li-Ion battery banks
- Structures
  - Standardized mechanical interface
  - Payload module may be designed by customer if desired
  - Alodined 7075 Aluminum frames fabricated with Electrical Discharge Machining (EDM) process
  - Anodized 5050 Aluminum sheet metal body panels



Bus Services to Payload (continued)

- Thermal
  - Computer simulation in Thermal Desktop/SINDA
    - Bus operational range from +10°C to +70°C
    - -10°C to +75°C range for hardware allowables
  - Bus thermally isolated from Payload(s)
  - Primary payload has access to cold-plate open to space
  - Thermally benign environment for biological payload
    - +3°C to +37°C ±3°C survival range
- Ground station
  - 6-meter dish at Stanford
  - Full-motion tracking
  - Mercury Ground Station software (Internet-based infrastructure)

Questions and comments?

- Key supporters
  - NASA/Ames Astrobionics
    - John Hines and Bruce Yost
  - Space Technology Center
    - Dave Engelbert
  - Stanford University Space Systems Development Laboratory (SSDL)
    - Professor Bob Twiggs
  - CalPoly CubeSat Team
    - Professor Jordi Puig-Suari
- Contact
  - http://ssdl.stanford.edu/stardotsat/