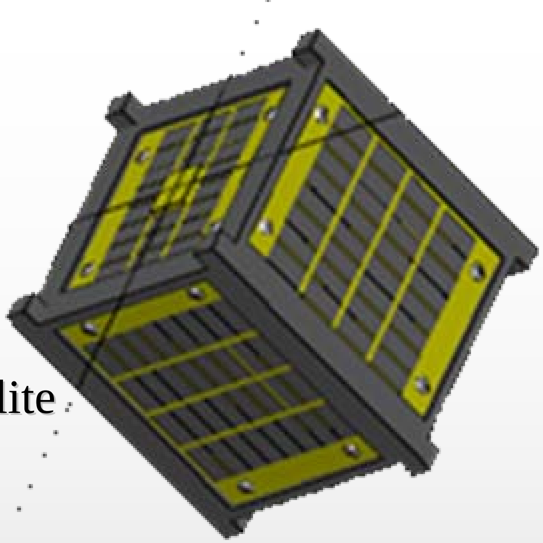
KUTESat

Kansas Universities Technology Evaluation Satellite

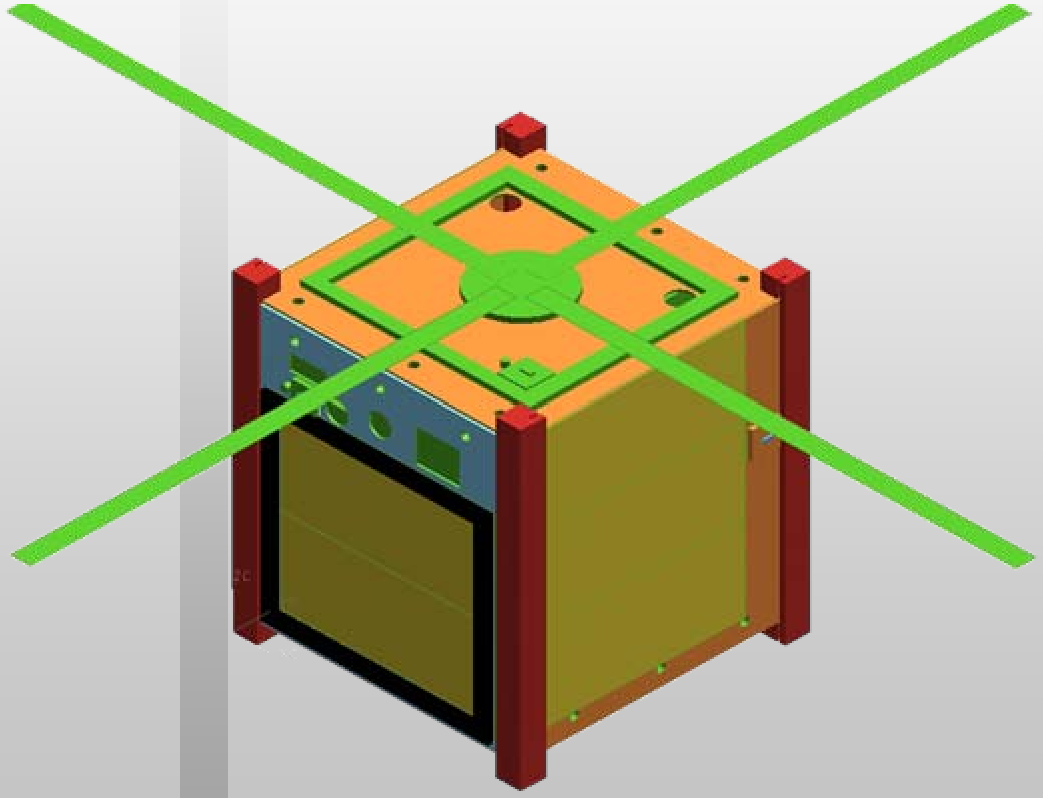


Pathfinder

Presented by:
Marco Villa
KUTESat Project Manager

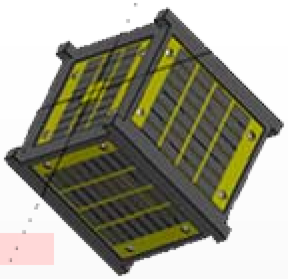
Cubesat Developers' Workshop - San Luis Obispo, CA - April 8-10, 2004

SUMMARY



- **Objectives**
- **KUTESat Program Overview**
- **Pathfinder Overview**
- **Payload**
- **ADCS**
- **Conclusions**
- **Summary**

Objectives of the KUTESat Program



Kansas
Universities
Technology
Evaluation
Satellite

1. **Develop the ability to design, build, test and operate spacecraft at University of Kansas**
2. **Establish a smooth team interaction among various Kansas Universities**
3. **Design and test an innovative miniature maneuvering control system (MMCS)**
4. **Develop and test prototype satellites of the type needed for the JPL Solar Sail mission or NASA Mars NetLander mission**
5. **Promote interest in space activities and establish a space industry in Kansas**

KUTESat Program Overview

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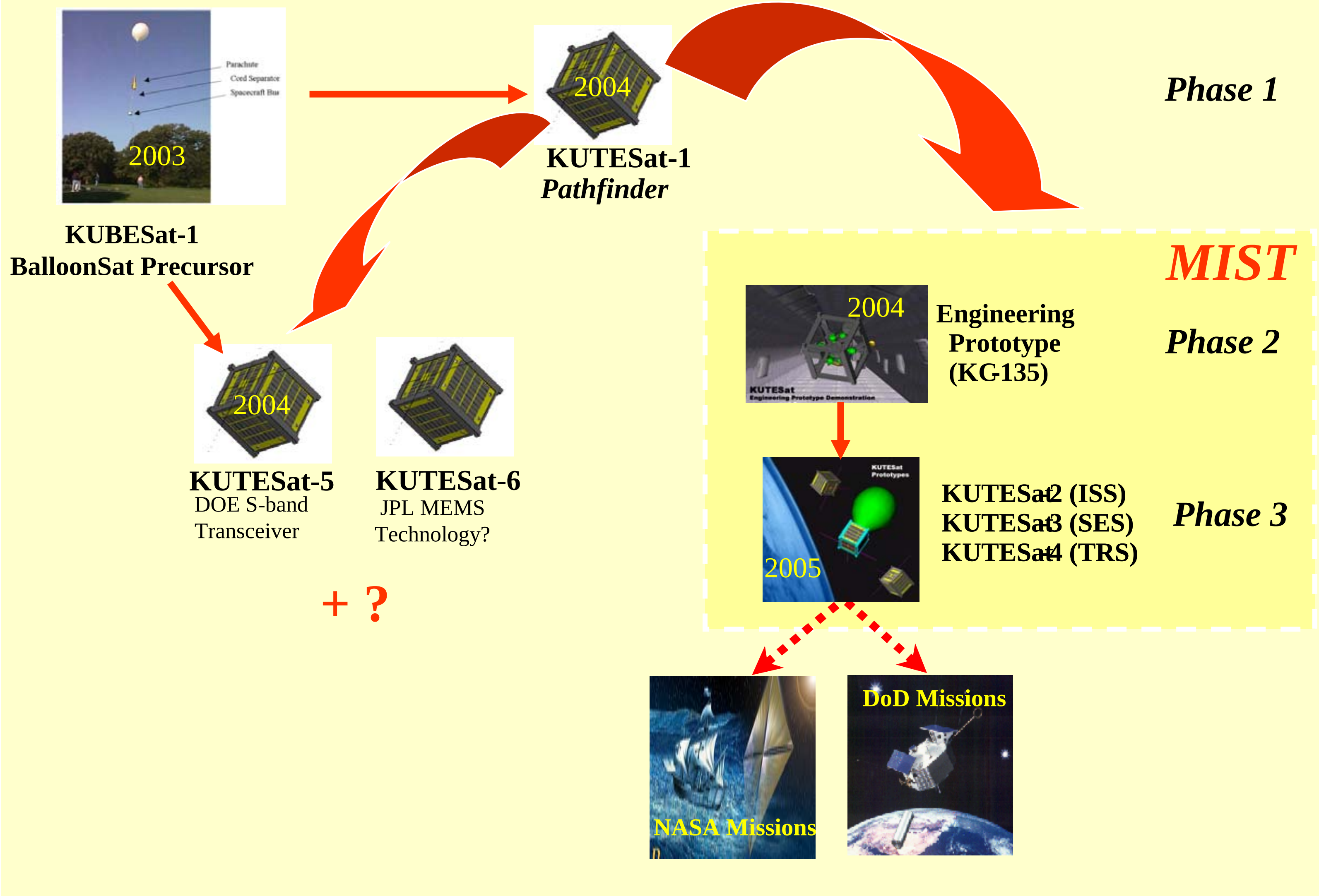
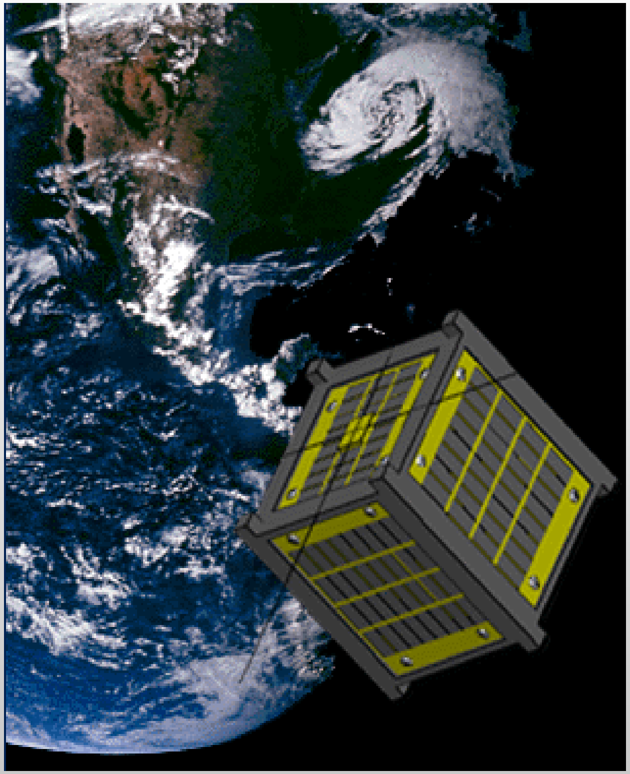


Pathfinder Overview

- **Objective**
  - develop and operate a simple pico-satellite in low Earth orbit (LEO)
- **Highlights**
  - HAM transmitter and receiver
  - Four dosimeters
  - Digital imager
- **Launch late 2004**
  - Baikonur Cosmodrome
  - Dnepr Launch Vehicle



Pathfinder Overview

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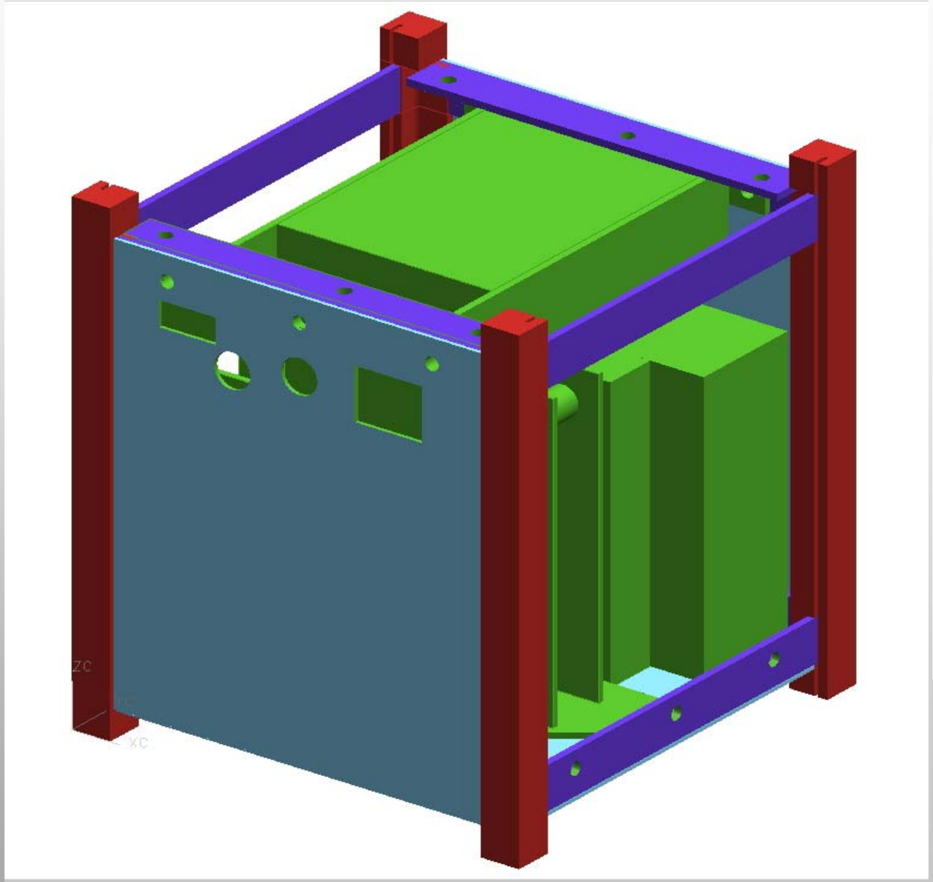
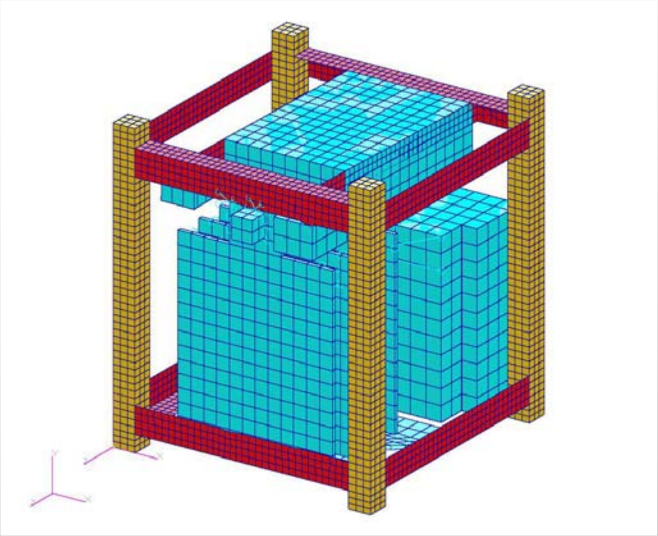
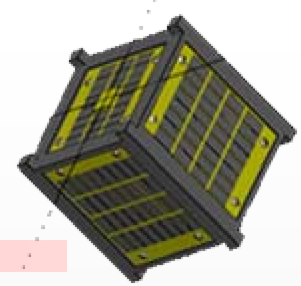


CAD Model



Finite Element Model

Payload Data Flow Chart



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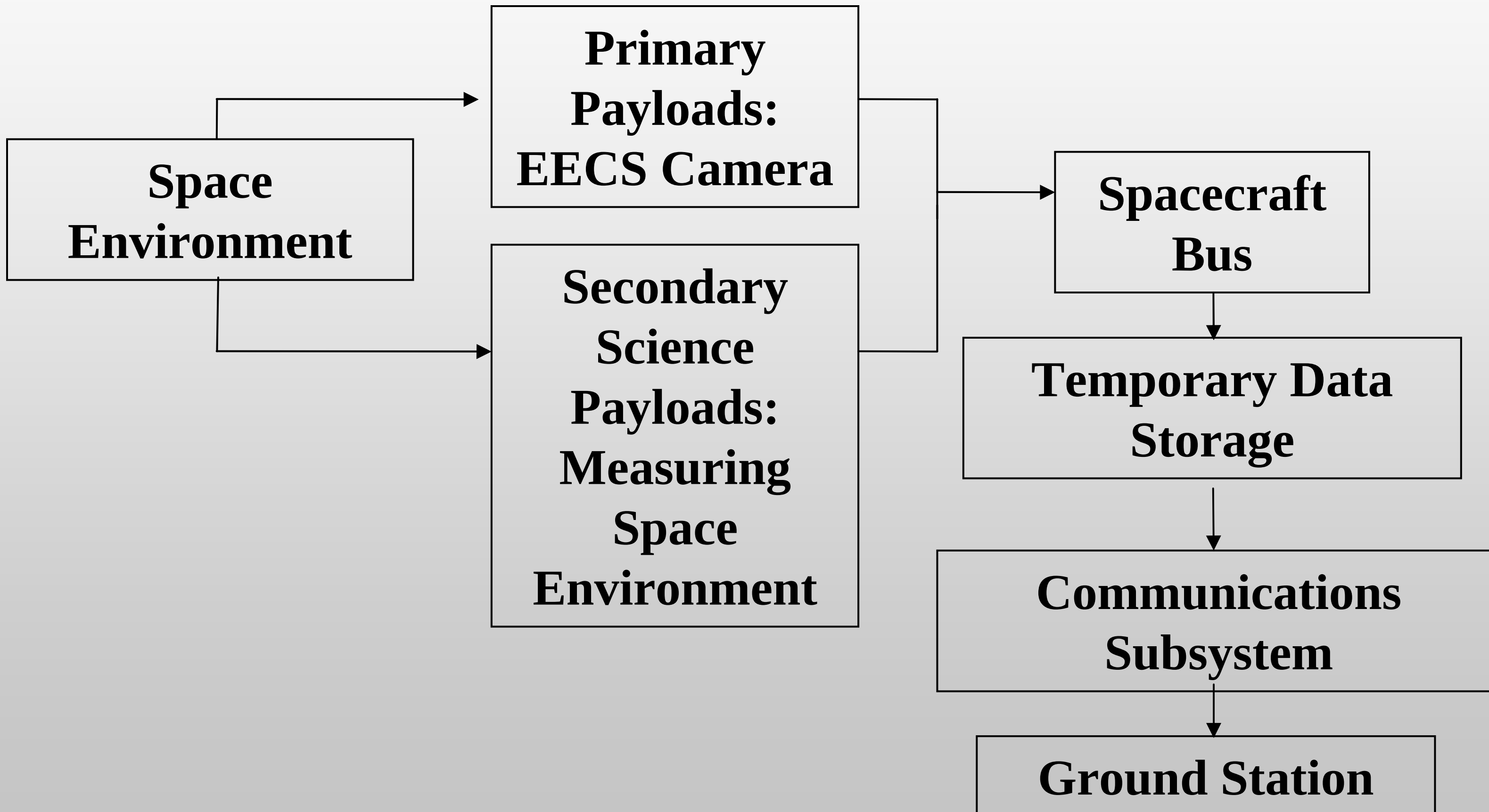

Specifications on Imaging Instrumentation

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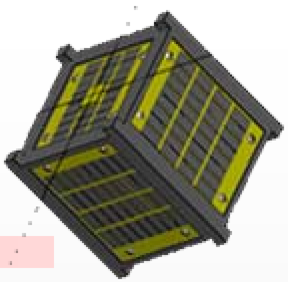
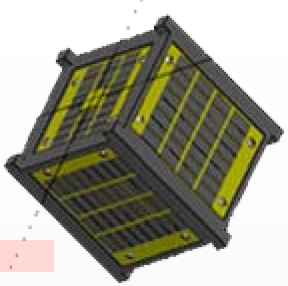
- **Integrated CMOS imager, image processor and optics**
- **Dimensions: 8 mm x 8.5 mm x 7.13 mm**
- **Weight:10 g**
- **2.9 V DC power, 18mA typical current**

Specifications on Imaging Instrumentation



- **Sensor**
  - **352x288 color**
  - **8 bit A/D**
- **Processor**
  - **Serial Output (also parallel available)**
  - **JPEG data format**
  - **I2C serial bus control**
- **Optics**
  - **55 degree fixed field of view**
  - **Fixed focus (near infinity)**
  - **Plastic lens**
  - **F/# 2.6**

Camera Board



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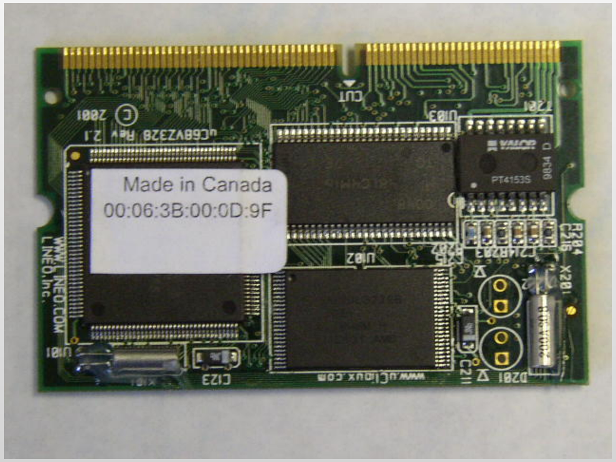
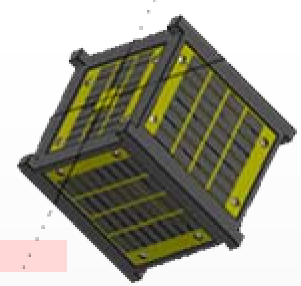
- **Camera is mounted on instrument board of KUTEsat with camera lens hole between TestPort and FlightSwitch.**
- **Direct control of camera module is with PIC on Instrument board.**
- **Control and Image transfer between CTDH and Instrument board is over SPI communication bus.**

CTDH

- **Controls when image is taken**
- **Loads image from Instrument board into flash memory file system as individual files.**
- **Image is downloaded to Ground Station on command from Ground Station using FTP.**
- **Can store > 50 images.**



ADCS



- The ADCS shall provide the satellite attitude data with a minimum accuracy of 15 degrees at all times.
- **Attitude Determination**

- **Magnetometer, Sun sensors and Temperature**

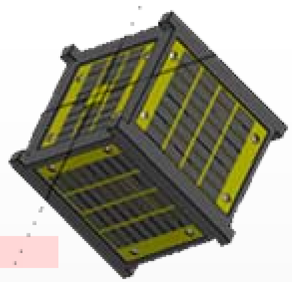
- **Attitude Control**

Magnetorquers

- **Limited size - do not take up space inside the satellite**
- **No moving parts - decreases complexity and increases lifetime**
- **Decided to use three magnotorquers for attitude control**

Coils: **36 AWG bus bar copper wire coated with non conductive epoxy to make them rigid.**

Acknowledgements



- **Sponsors**

The University of Kansas

Swales Aerospace – Getting Your Ideas Off The Ground

Biomorphic VLSI

College and Fellowship Program – National Space Grant – NASA

Agilent Technologies

JPL

Contouring Specialists

Honeywell

Thanks for your attention!

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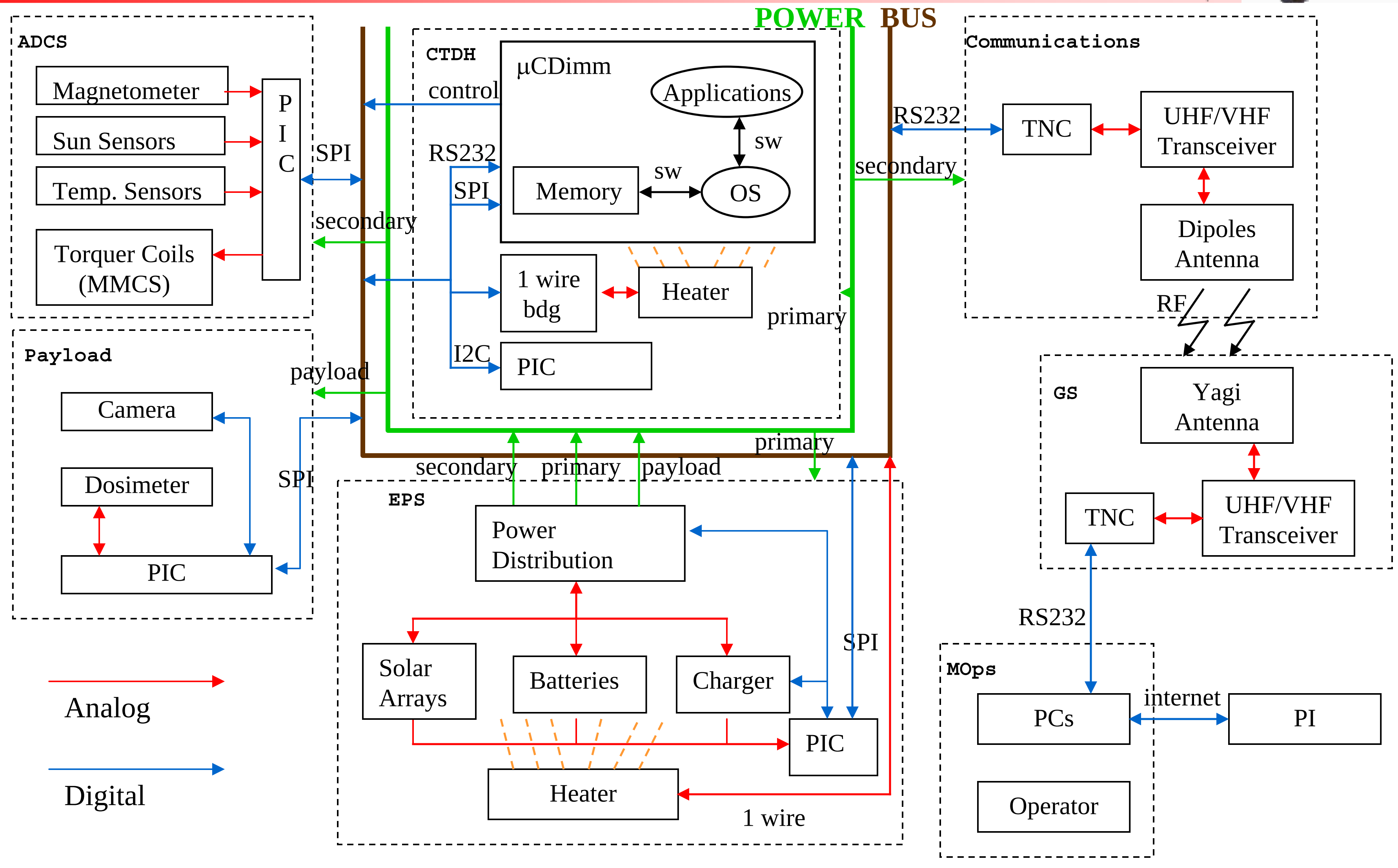
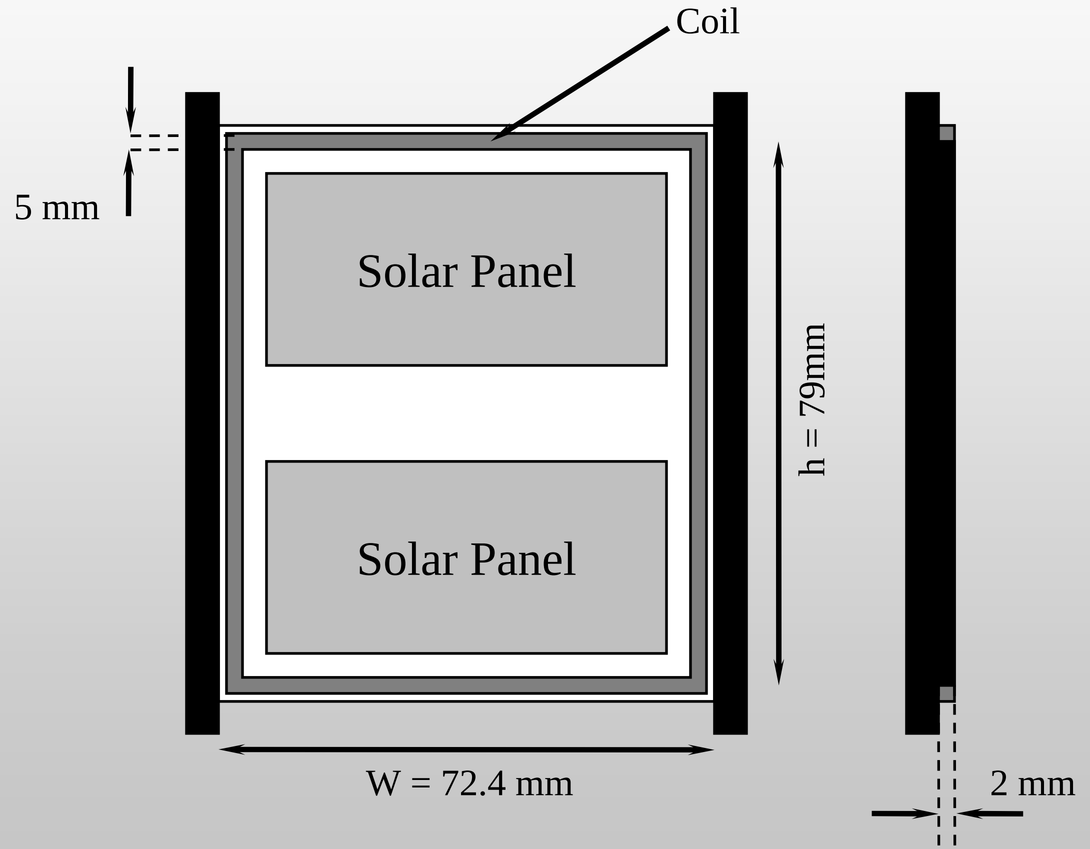
Pathfinder Overview

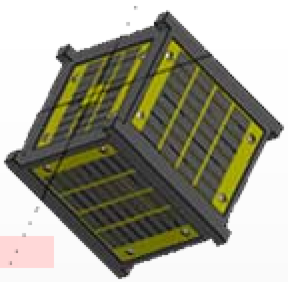


Torquer Coil Design

- •Project Plan
- •Astro
- •Payload
- •Structures
- •Thermal
- **•ADCS**
- •EPS
- •CTDH
- •Comm
- •GS
- •MOPs
- •Int. & Launch



ADCS operation modes



1.	**Initialization:**	**The power supply unit turns the power on to the ADCS subsystem.**
2.	**Fail Safe:**	**The ADCS will be on standby until it receives a command to go into detumbling mode**
3.	**Detumbling:**	**Detumble the satellite**
4.	**Power Safe:**	**Point a corner of the satellite to the sun to maximize power input to the solar panels**
5.	**Camera:**	**ADCS will change the attitude of the satellite to acquire a photo**

Attitude Determination Methods

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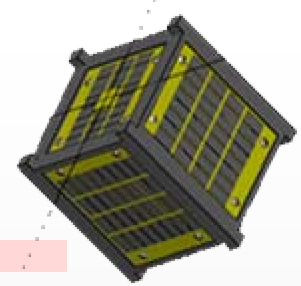
- **Deterministic Solutions:**

  Need at least two vector measurements obtained at a single point of time to determine the three axis attitude

- **Recursive Estimation Algorithms**

  These use both the present and the past measurements for determining the attitude. The Kalman filter and the Extended Kalman filter are the most popular of these methods.

Attitude Determination Algorithms



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1. **Process sensor data**
2. **On-board sun model**
3. **On-board orbit model**
4. **On-board magnetic field model**
5. **Albedo correction**
6. **Deterministic attitude determination**
7. **Extended Kalman Filter for attitude determination**

ADCS External Interfaces

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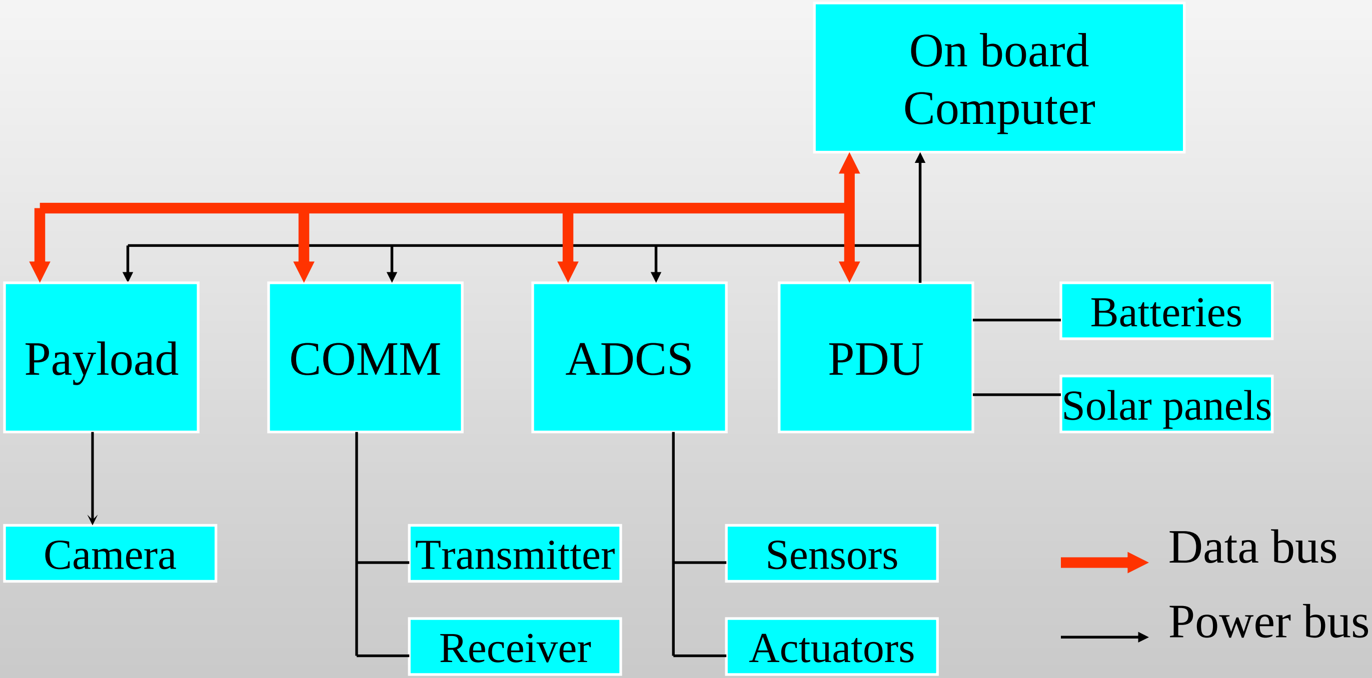
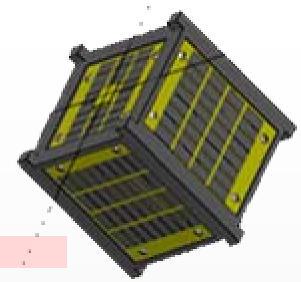


Attitude Determination and Control Hardware



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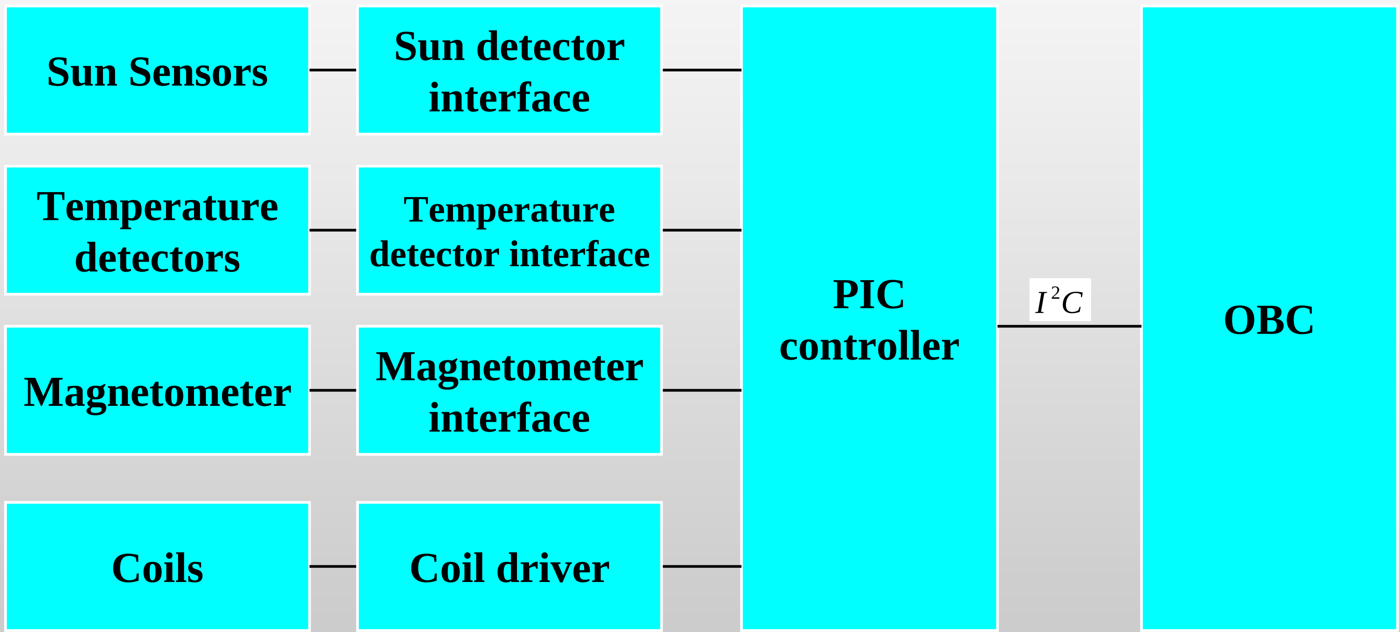

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