An Overview of CubeSats from a Systems Engineering Perspective

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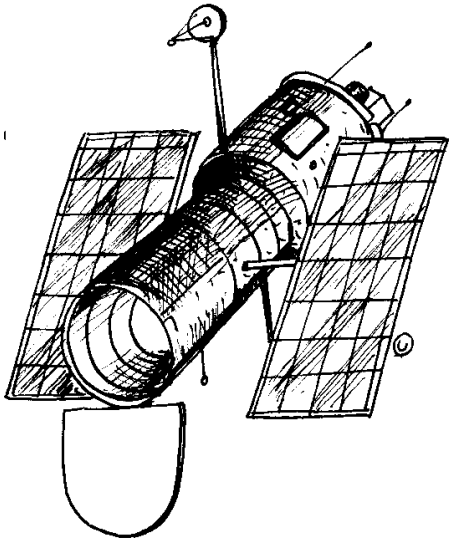
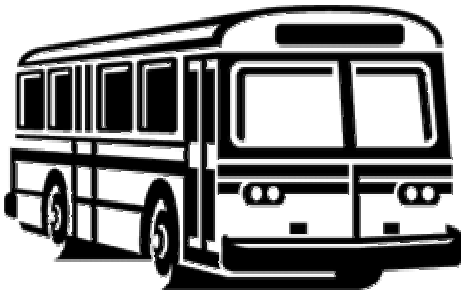
Introduction





Introduction

Solution: CubeSats

- Standardized packaging
  - 1 U Package
    - Dimensions: 10 x 10 x 10 cm
    - Mass < 1 kg
  - Up to 3 U
- Reduction in mission cost
- Reduction in development time
- Improved system redundancy

Photo acknowledgements: Czech Amateur Cubesat

Mission Overview

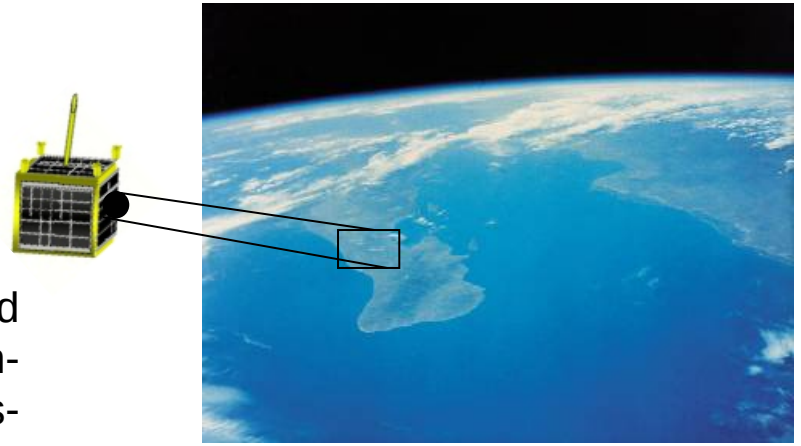
Motivation: Hurricane Katrina

- August 29, 2005
- “the most destructive natural disaster in U.S. history” -*White House*
- $96B in property damages
- Death toll: over 1,300 persons
- “local communications system wasn’t simply degraded; it was, at least for a period of time, destroyed” -*White House*

Photo of Hurricane Katrina

Mission

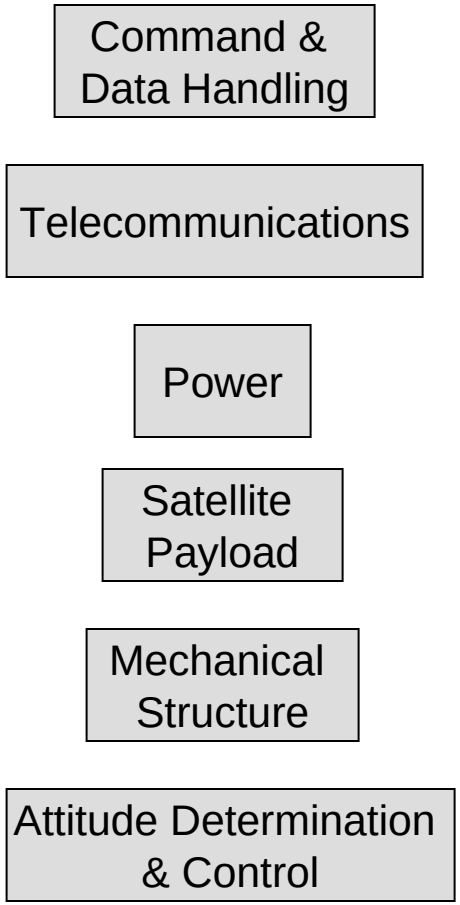
- Proof-of-concept nanosatellite used to demonstrate operation of eye-in-the-sky satellite node in crisis-management or disaster-monitoring network.



Ho`okele mission concept

Photo acknowledgements: NOAA

System Overview



Telecommunications

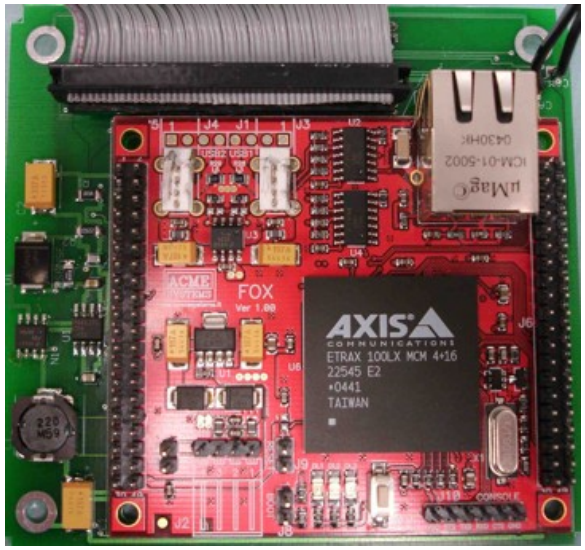
Objectives

- Provide a reliable wireless communication link
- Support data downlink (satellite >> ground)
- Support command uplink (ground >> satellite)
- Acts as satellite's "mouth" and "ears"

Command & Data Handling

Objectives

- Process telemetry and command information
- Schedule satellite tasks and processes
- Communicate with and control entire satellite
- Acts as satellite's "brain"



Power

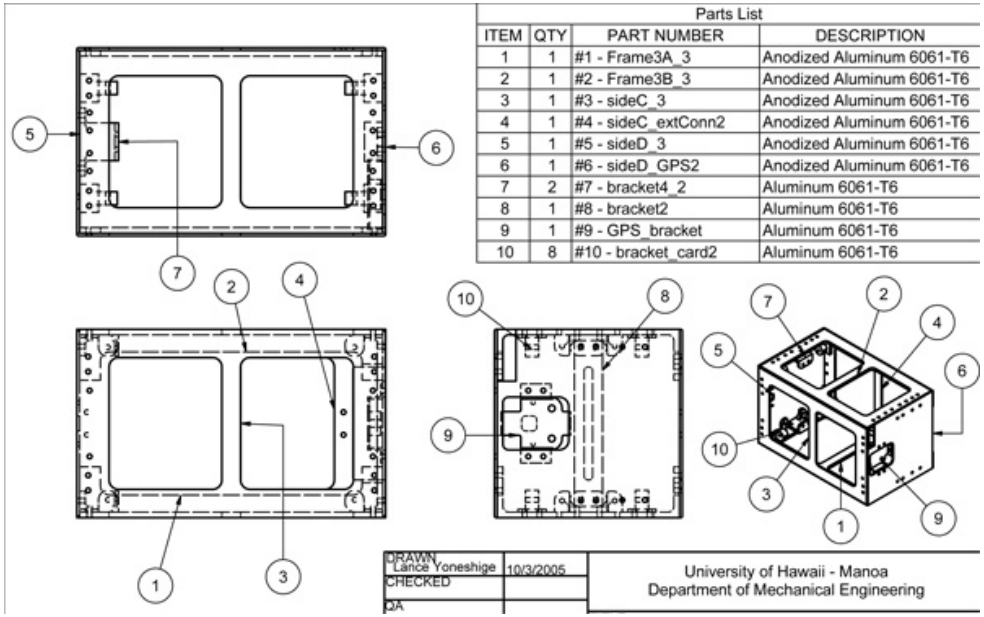
Objectives

- Collect and store energy from available sources (i.e., solar)
- Generate electrical power for satellite systems
- Acts as satellite's "gas tank" and "engine"

Mechanical Structure

Objectives

- House satellite components
- Protect systems from launch and space conditions
- Acts as satellite's "chassis"



Attitude Determination & Control

Objectives

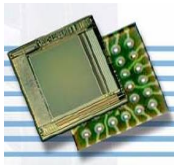
- Measure satellite attitude (location, velocity and pointing)
- Stabilize satellite's attitude (passive and/or active control)
- Dynamically adjust satellite orbit/attitude

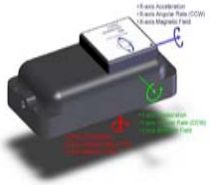
Payload

Objective

- *“To provide low-earth orbit satellite images for use in crisis management and disaster mitigation, and demonstrate inter-satellite communications in an expandable satellite network.”*

Aug. 2005 - Hurricane Katrina.
Source: NASA





Ho`okele Integrated System

Commercial-Off-The-Shelf Components

Telecommunications:

1 -- 2.4-GHz *Microhard MHX-2400* radio

Power:

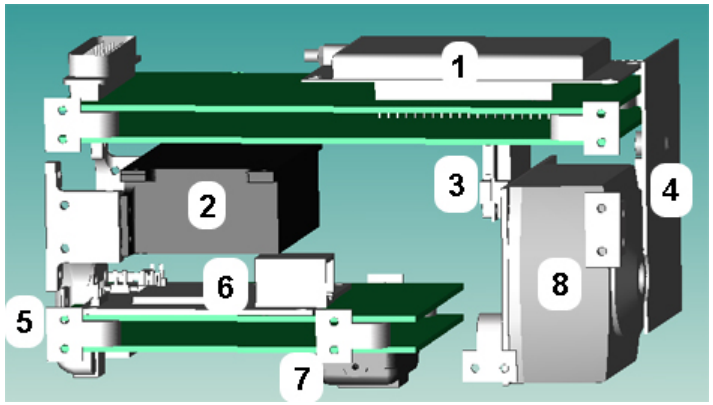
2 -- 4.2 Ah *Varta Microbattery* Li+ battery

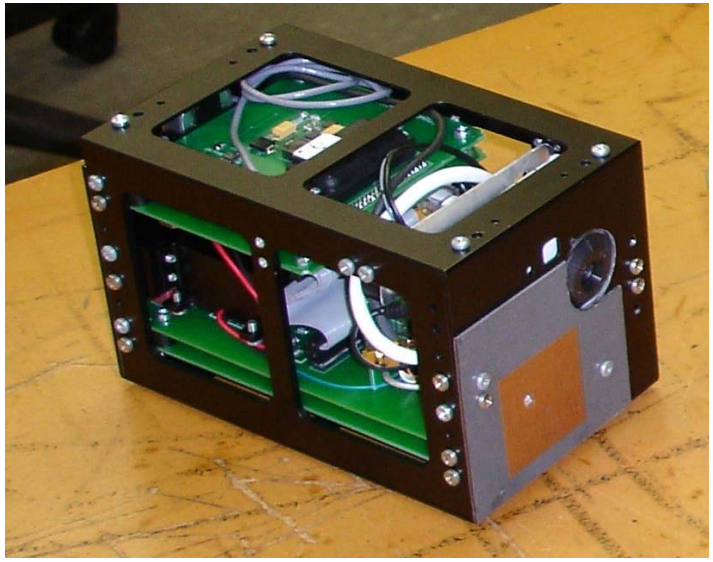
Command & Data Handling:

6 -- *ACME* Linux-based microcontroller

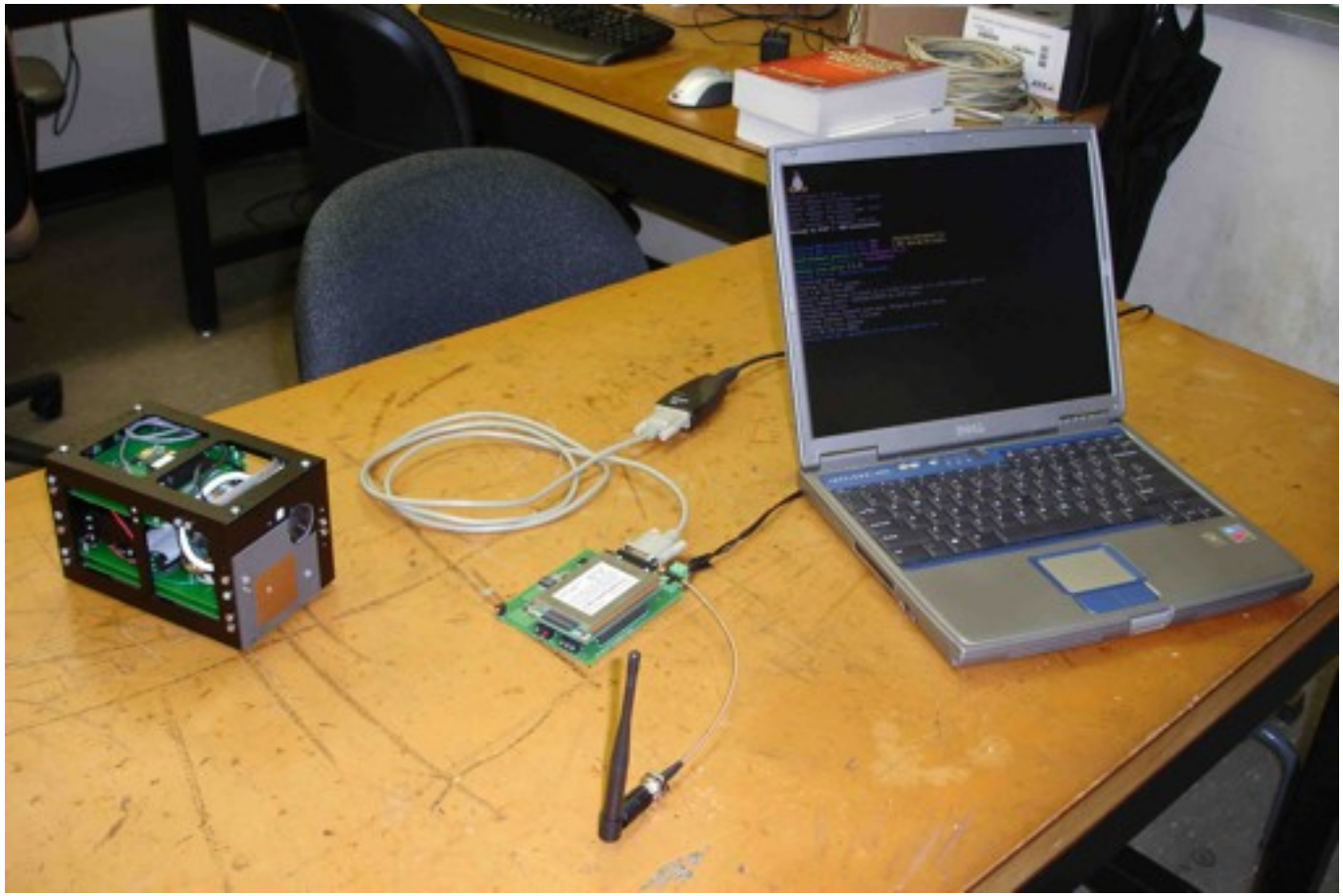
Payload:

3 -- *Garmin GPS-15* receiver
5 -- *Garmin* GPS antenna
7 -- *MEMSense* inertial measurement unit (gyro, accelerometer, magnetometer)
8 -- *AXIS 206M* digital camera





Ho`okele Integrated System



Satellite Demonstration

Verification Tests

- Communication link established (4 miles)

Photos Taken by Ho`okele. Apr. 16, 2006.

Google Earth rendering of mid-range testing environment.

Lessons Learned

- Choose a mission
- Choose a design to accomplish mission
- Use a modular approach
- Test, Troubleshoot, Retest