Jet Propulsion Laboratory
California Institute of Technology

The Prototype Development Phase of the CubeSat On-Board Processing Validation Experiment (COVE)

Thor Wilson

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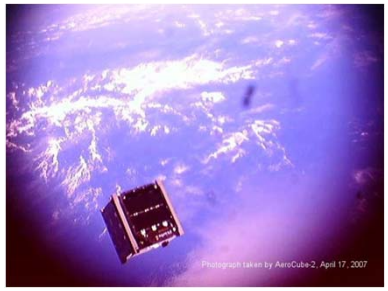
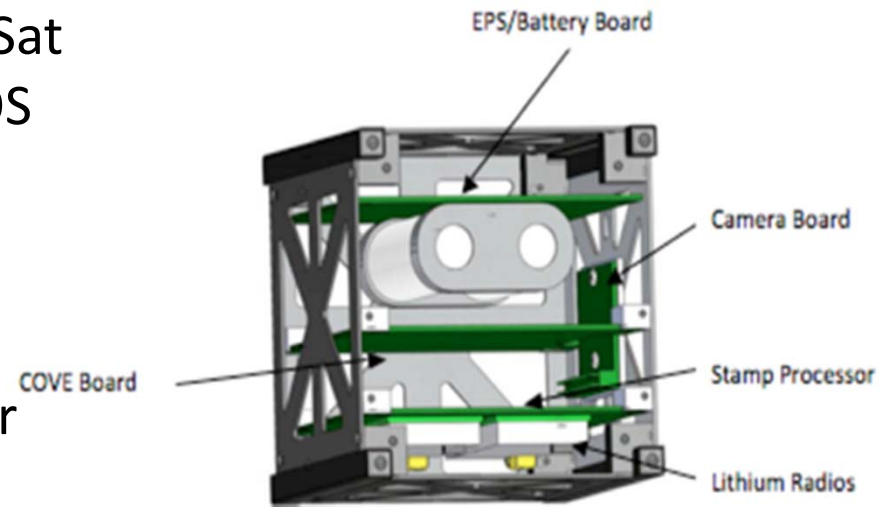
CubeSat Overview

- Started in mid-late 1990's at University level
- Expanding to industry and government
- 1U is 10 cm cube and 1kg. Up to 3U max for P-POD
- Rapid and economical access to space



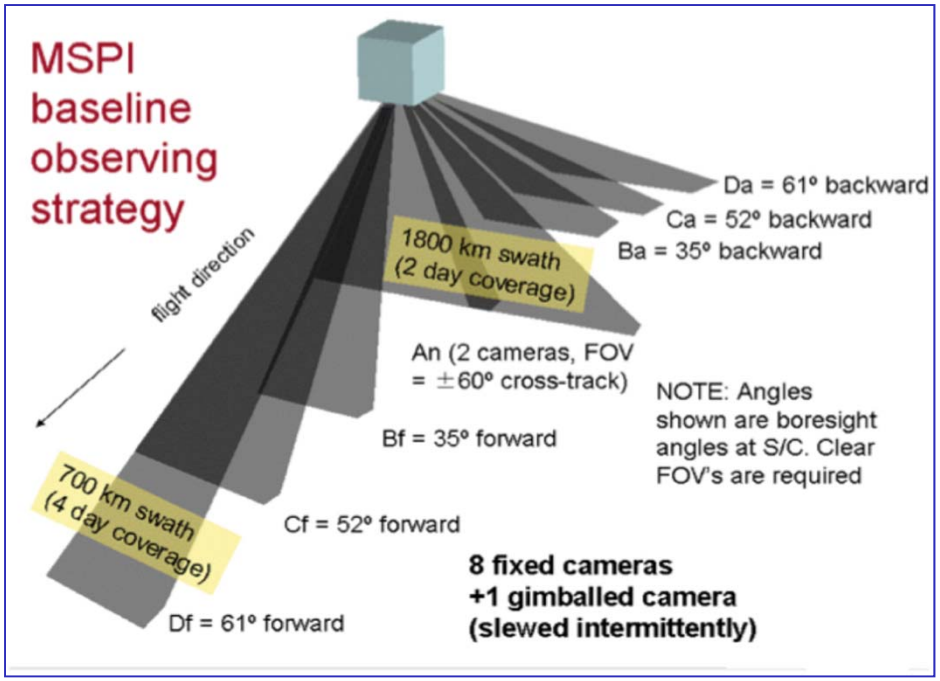
M-Cubed Overview

- University of Michigan (UM) CubeSat
- Payload: Omnivision OV2655 CMOS sensor (2 MPixel)
- ACS: Permanent magnet and hysteresis material for passive magnetic control
- C&DH: Stamp9G20 flight computer
- Communications: Two Lithium-1 radios transmitting over UHF and receiving over VHF
- EPS: UM 1U EPS with Lithium-Ion battery cells. BTJM Solar Cells (2 per face)
- Structure: Custom UM 1U structure compliant with CalPoly specifications



MSPI OBP Overview

- AIST[1] task (3 years), funded by ESTO[2]
- Targeting the Decadal Survey Aerosol-Cloud-Ecosystem (ACE) mission
- Multiangle SpectroPolarimetric Imager (MSPI) instrument
- A single (1 of 9) MSPI camera must process 95 MB/s of raw video data; data reduction to 0.45 MB/s is required
- On-board processing (OBP) is done via a least-squares fitting algorithm
- **Implemented on the Virtex-5FXT FPGA**
- Year 3 technology validation on AirMSPI camera via ER-2 flight demo
- *Paper to be presented on this task in Session 6.01 on Thursday AM*



1 Advanced Information System Technology (AIST)
2 Earth Science Technology Office (ESTO)

COVE Overview

SmallSat platforms can rapidly advance the Technology Readiness Level (TRL) of key instrument components and serve as platforms for new science observations

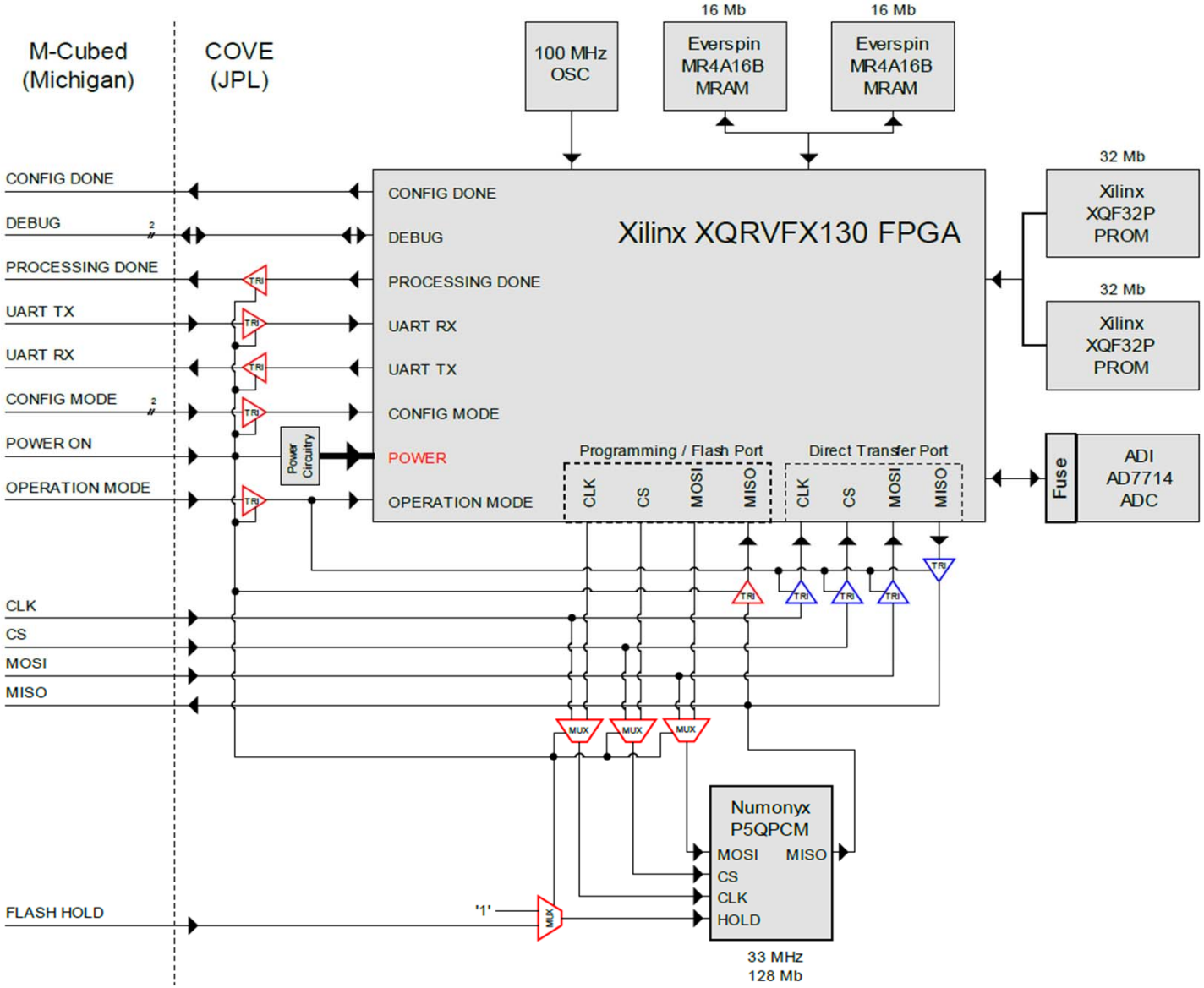
Space-borne validation (of MSPI OBP algorithm and Virtex-5 FPGA) at low cost.

- 18-month technology demonstration task funded by ESTO
- COVE Payload architected as two electronics boards:
  - Processor board with Virtex-5 FPGA that communicates with M-Cubed bus
  - Daughter power board to regulate secondary voltages
- Complete M-Cubed and integrate COVE payload; deliver for P-Pod integration
- Launch manifested through NASA ELaNA call

COVE to M-Cubed Interface

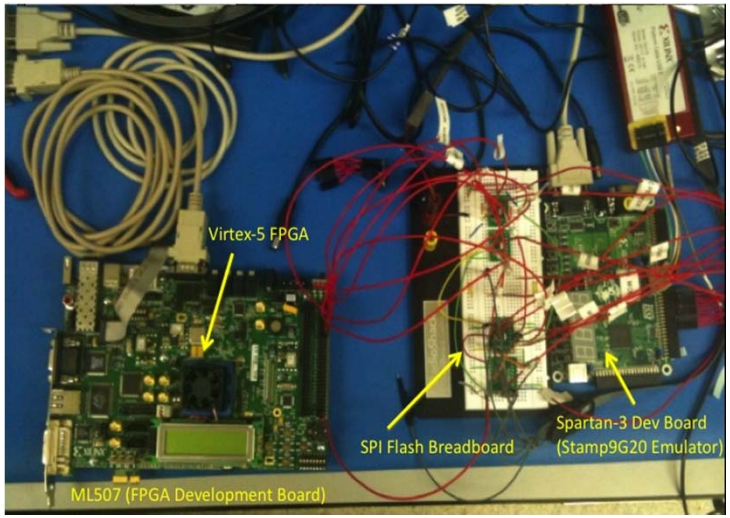
- Mass allocation (to COVE): 100g
- Power allocation (to COVE): 100 mW continuous and 6W for 60 seconds during image processing
- Communications: SPI interface to transfer data
- Operations:
  - COVE will be continuously running in low power mode (FPGA off)
  - When M-Cubed is ready, image data is transferred to COVE
  - Image is processed by the Virtex-5 FPGA (OBP algorithm)
  - Processed data is transferred back to M-Cubed
  - COVE returns to low power mode
  - Image and processed data are downlinked for ground validation

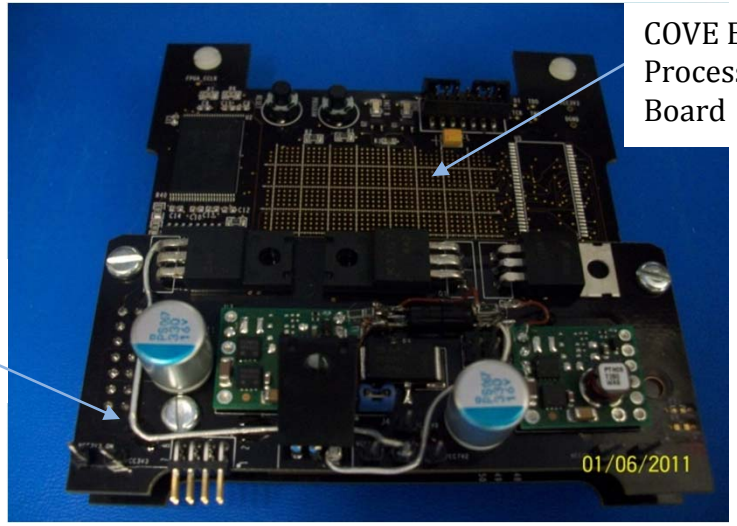
COVE Block Diagram



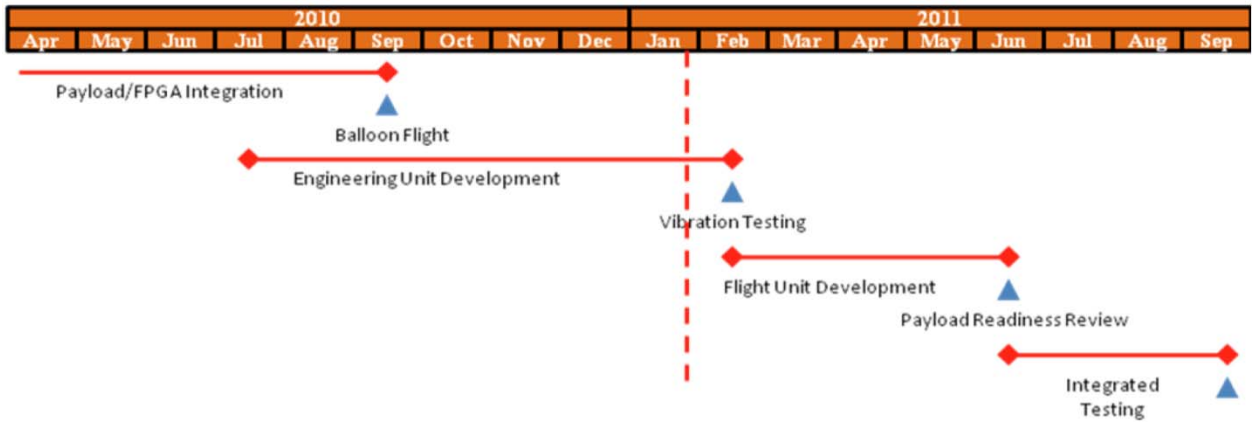
COVE Prototype Validation

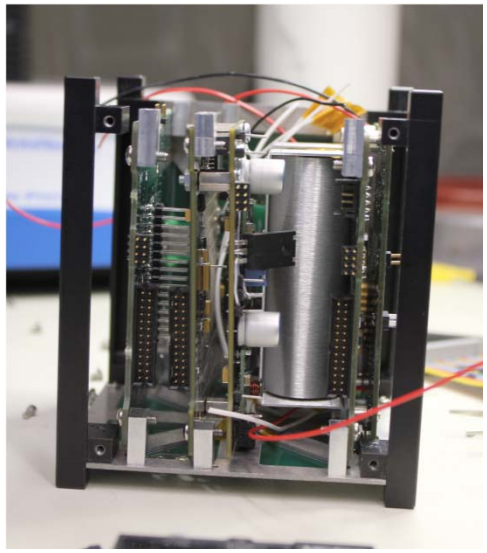
- Validation of prototype design using Xilinx ML507 board (with Virtex-5 FPGA), a Spartan-3 board (to emulate the Stamp M-Cubed C&DH), and bread board of interface electronics
- Validated concept of operations
- Multiplexer and tri-state buffer latencies verified to support flash read/write requirements
- Successful end-to-end data transfer over SPI interface allowed confidence to move to a flight-like EM development
- Delivered COVE EM to U. Michigan





Future Work





- Environmental testing of M-Cube/COVE EM (at U. Michigan)
- Build, assembly, and test of COVE flight hardware (at JPL) and M-Cubed flight hardware (at U. Michigan)
- Delivery and integration of COVE into M-Cubed (at U. Michigan)
- Integration of M-Cubed with P-POD (at CalPoly SLO)
- Launch on NPP scheduled Oct. 2011 (Vandenberg AFB)

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