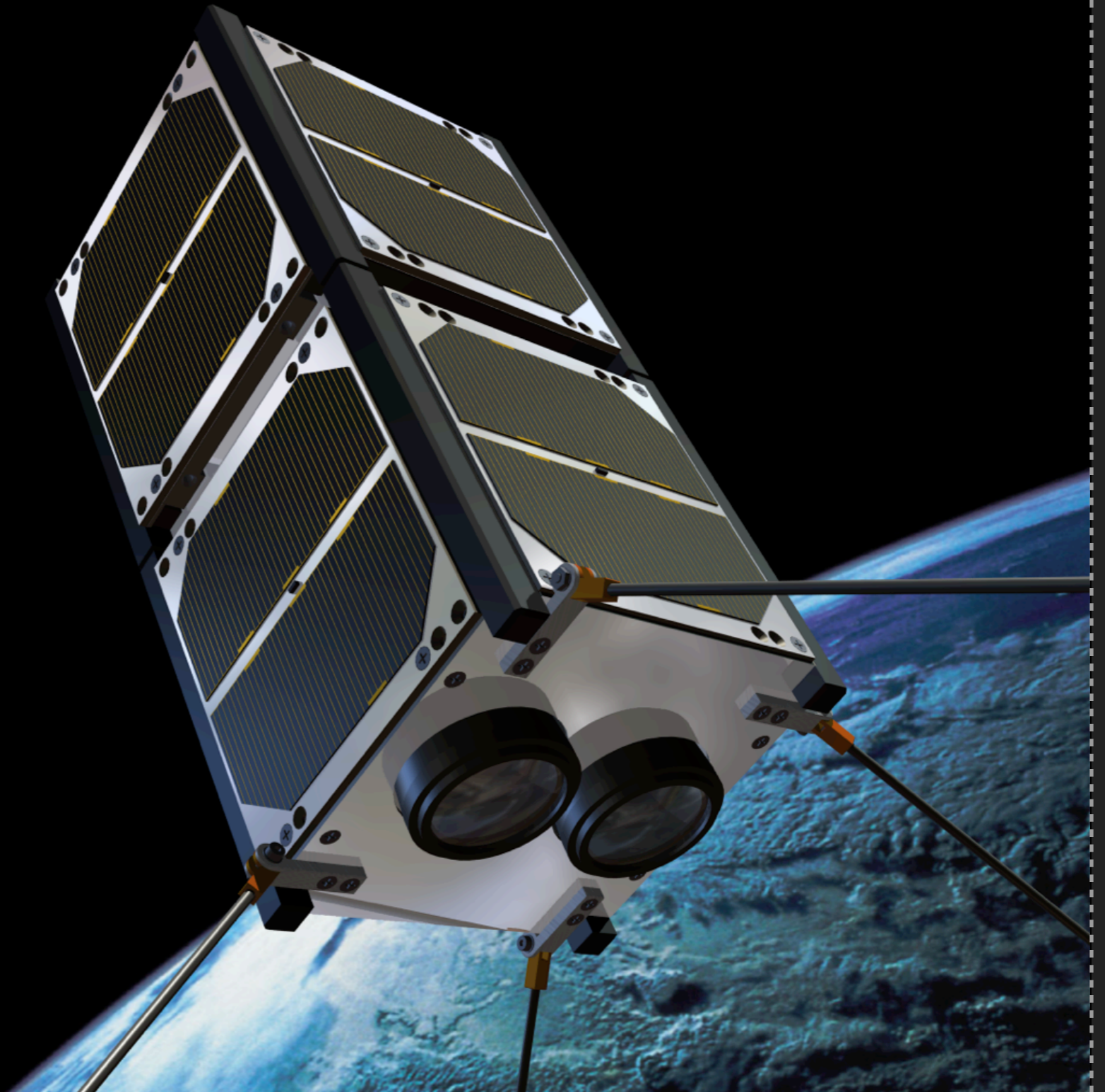


Software Frameworks for Rapid Mission Development

Presented by:

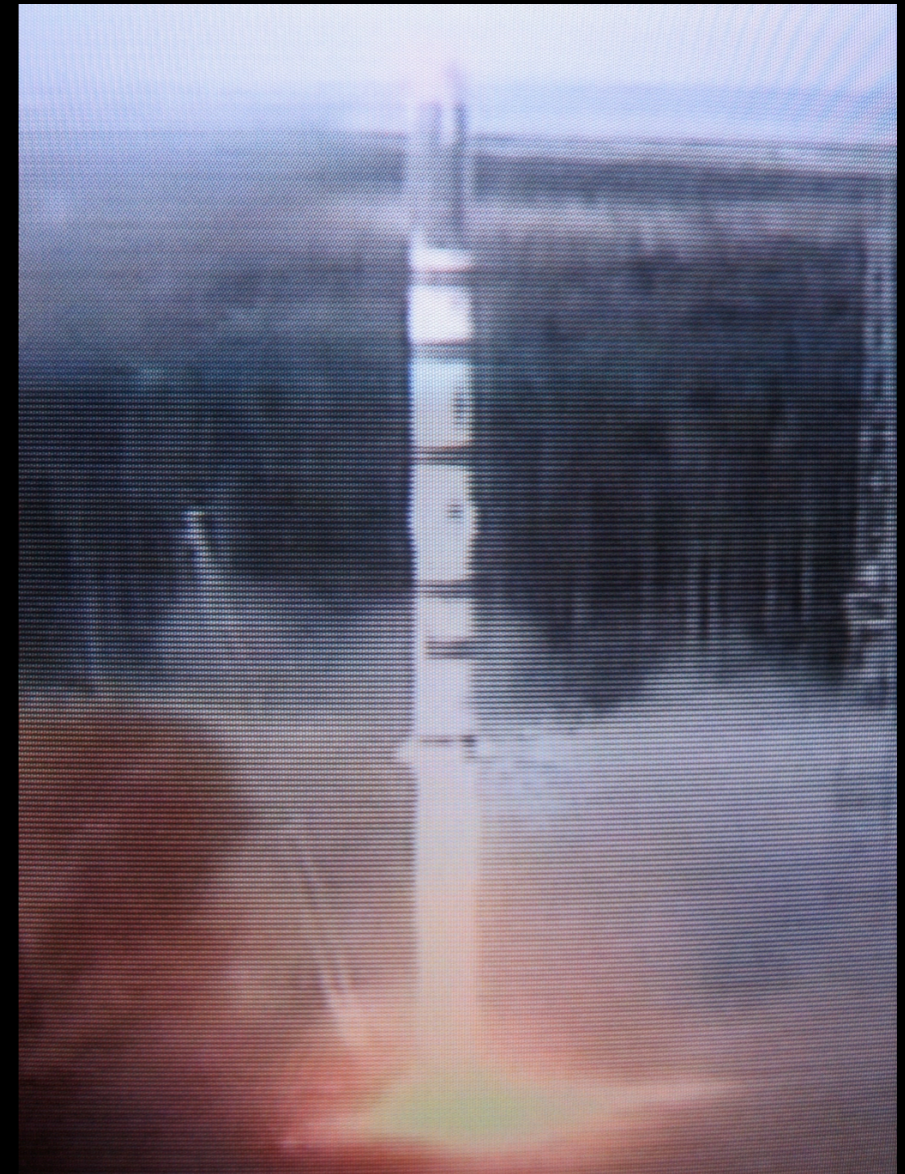
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GomSpace Aps
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Software Frameworks for Rapid Mission Development

Agenda:

- GomSpace at a glance
- Hardware product port-folio
- Software frameworks
 - Cubesat Space Protocol
 - Command and Datahandling
 - Attitude Determination and Control System
 - Mission Operations Platform
- Licensing models and availability



GomSpace at a Glance

Origins

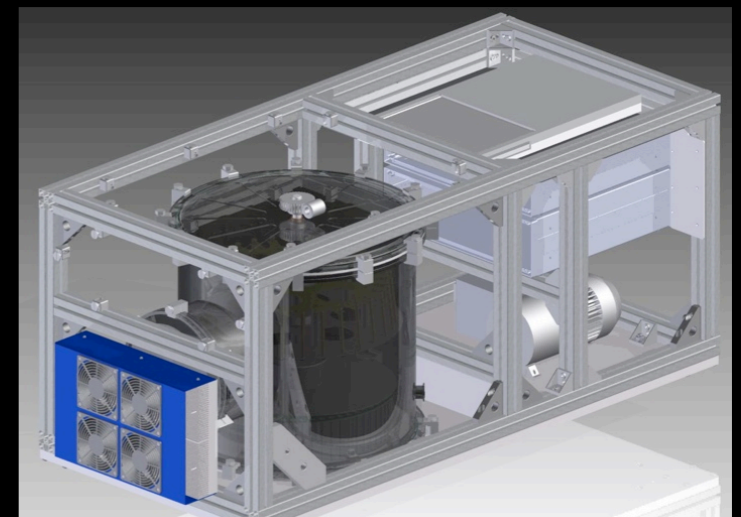
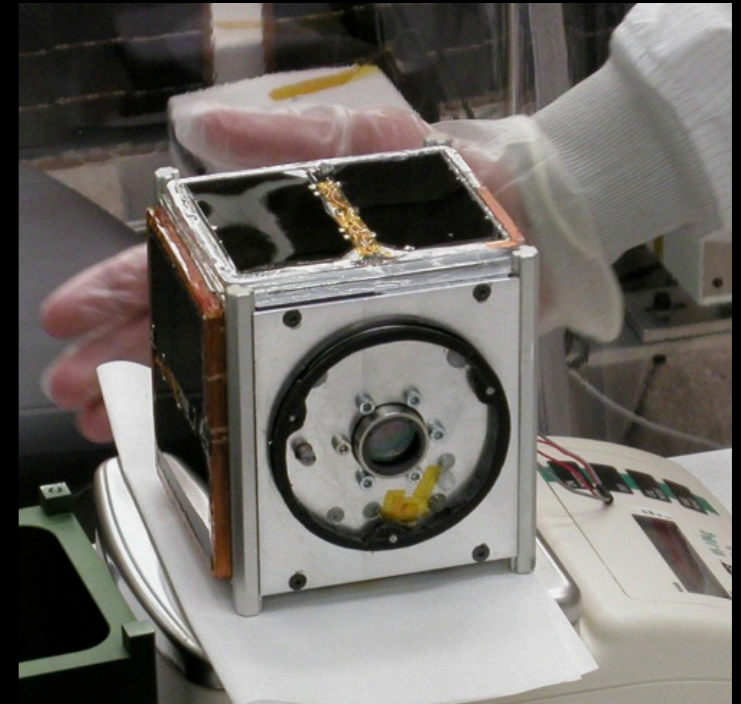
- A start-up company based on research done at Aalborg University 2001-2007, e.g. AAU-Cubesat launched in 2003
- Established in 2007 as a private limited company

Locations and staff

- Aalborg, Denmark
 - 5 full time staff, 3 project staff
 - 2 interns, 1 phd student
- Palo Alto, California
 - Co-located with the Danish Innovation Center
 - Legal subsidiary under establishment
 - Adding staff in Q3 2011

What we do

- Nano-satellite subsystems and software frameworks
- Nano-satellite complete platforms (customers, research)
- Consulting and system development within the space domain, e.g. for ExoMars and re-entry missions



GomSpace Hardware Products

Product Philosophy

- Based on flight experience
- Interoperable with products from other vendors
- Easy integration - towards plug'n'play

COTS Components

- Help you to focus on mission objectives
- Reduce the design space challenge
- Reduce risk - technical and schedule

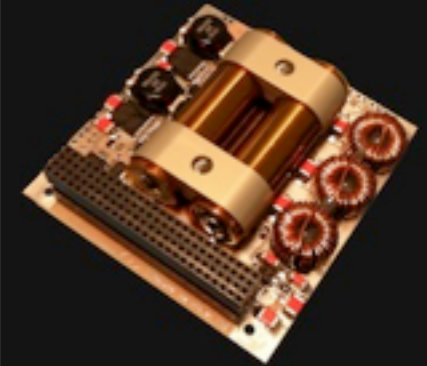
OBC

On-Board Computer Systems



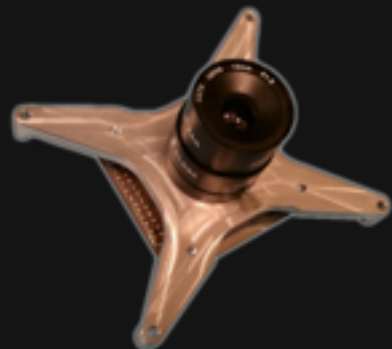
EPS

Power Conditioning and Distribution



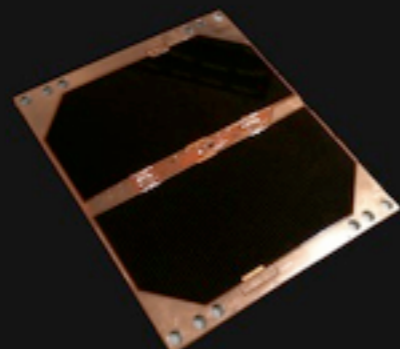
CAM

3 Megapixel Camera System



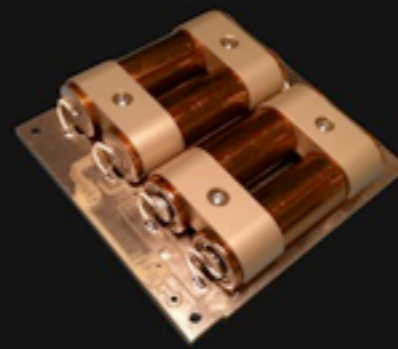
Solar Cells

Integrated Solar Panels w/ sun sensor and gyro



BATT

LI-Ion Battery Module 8.4-16.8V 1800-3600mAh



COM

Spacelink Communication Systems



ADCS

Attitude Control System w/ PWM drivers



COTS = Mission Focus!

Cubesats are still a challenge

- Small: yes - simple: not really!
- Many technical disciplines needs to be mastered concurrently
- A lot of modules and interfaces needs to come together in the integration phase

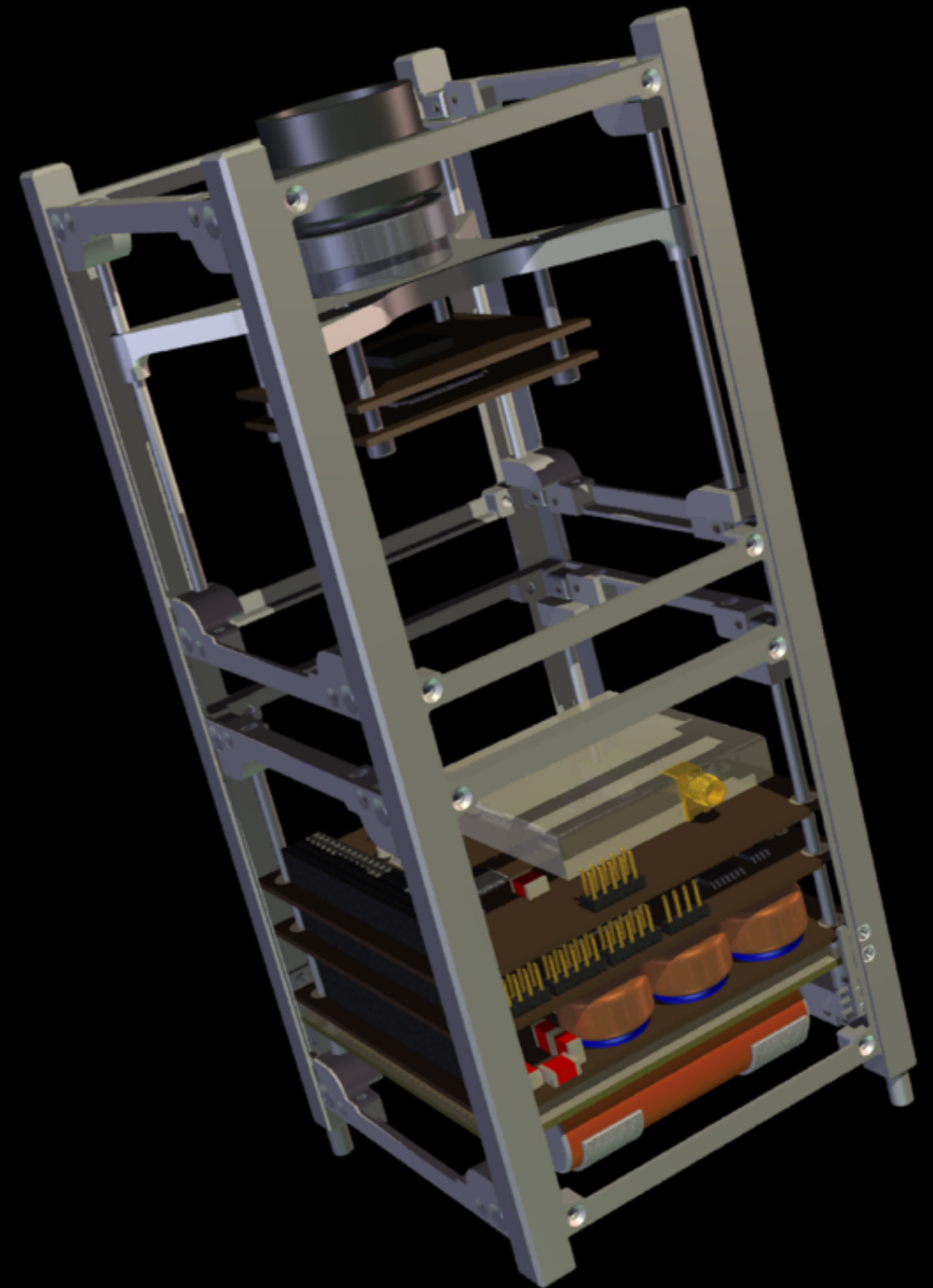
Software is especially challenging

- “but it is just software” or “we can handle that in software”
- Problems only starts showing up when integration starts (which is always too late)

What COTS can do for a project (HW & SW)

- Accelerate schedule, reduce risk
- Focus resources on novel development, not re-inventing wheels
- Allow integration testing to start early

Missions will have different COTS requirements!



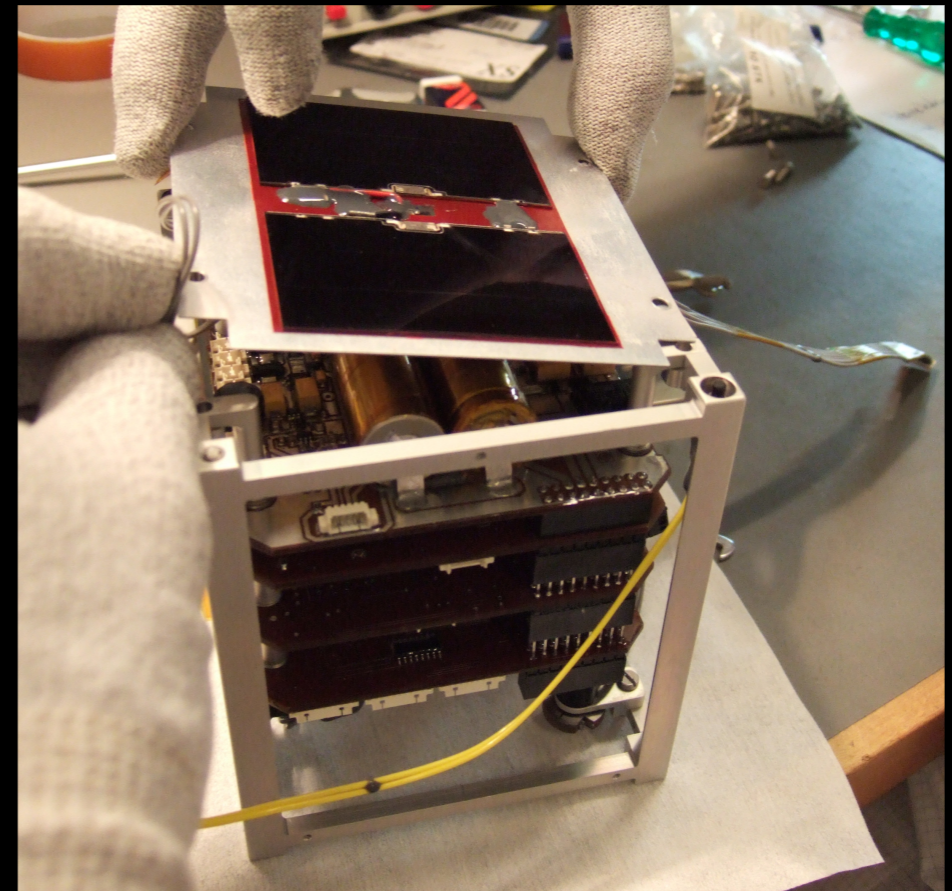
GomSpace Software Overview

Modules/Frameworks:

- CSP: Cubesat Space Protocol
- CDH: Command and Datahandling
- ADCS: Attitude Determination and Control
- MOP: Mission Operations Platform

Implementation of on-board software:

- Implemented in C (defensive programming)
- Runs on top of FreeRTOS operating system
- Written for portability (especially ADCS)



The Cubesat Space Protocol (CSP)

Technical Objectives

- Allow a service oriented network topology extending a network transparently across space and ground segments.
- Ease integration between subsystems - plug'n'play.

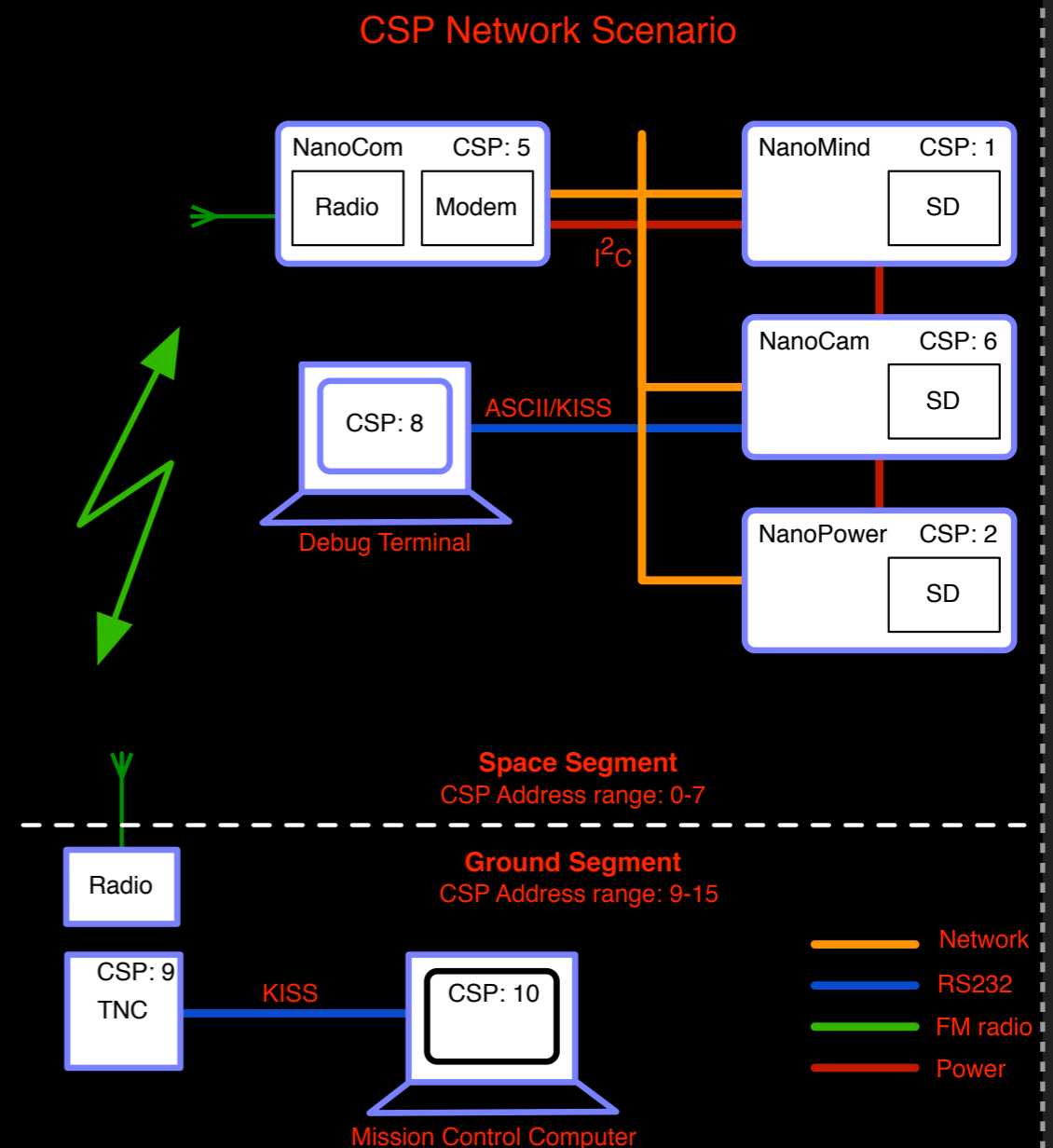
Current Compatibility

- Operating systems: FreeRTOS, POSIX
- Architectures: ARM, AVR8, AVR32, x86
- Interfaces: I2C, CAN, RS-232, CCSDS, HDLC, loop-back

Status

- Used in all GomSpace systems
- Core parts open source (Google code)
- Collaboration encouraged

<http://code.google.com/p/cubesat-space-protocol/>



Command and Data Handling Framework

Features

- Journalized filesystem implementation
- Robust file transfer protocol (on top of CSP)
 - Authorization supported
 - Encryption supported
 - Compression supported
- Remote software upload and management
- Flight planner
 - Command authorization & execution
 - Command sequence management
 - Mode management and autonomous functions
- Autonomous house keeping collection with file back-end
- Distributed Logging system
- Mission parameter database server



Attitude Determination & Control Software Framework

Features

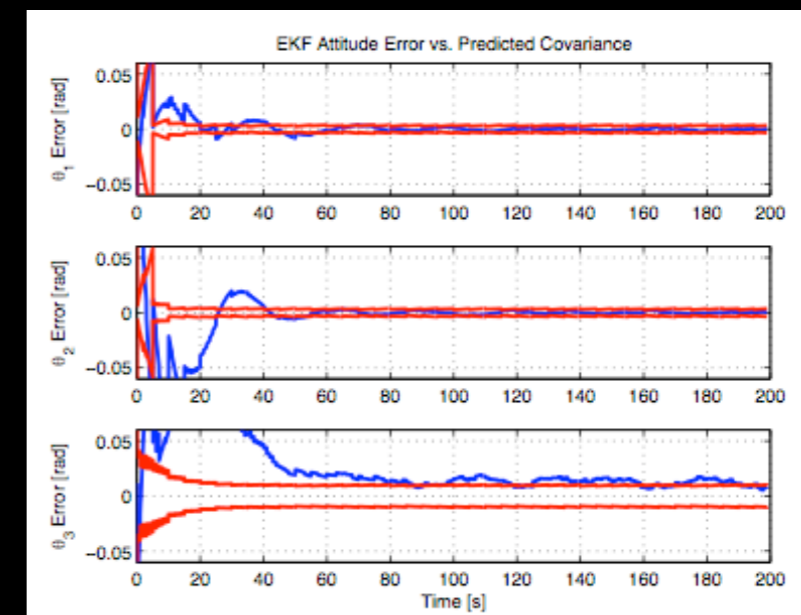
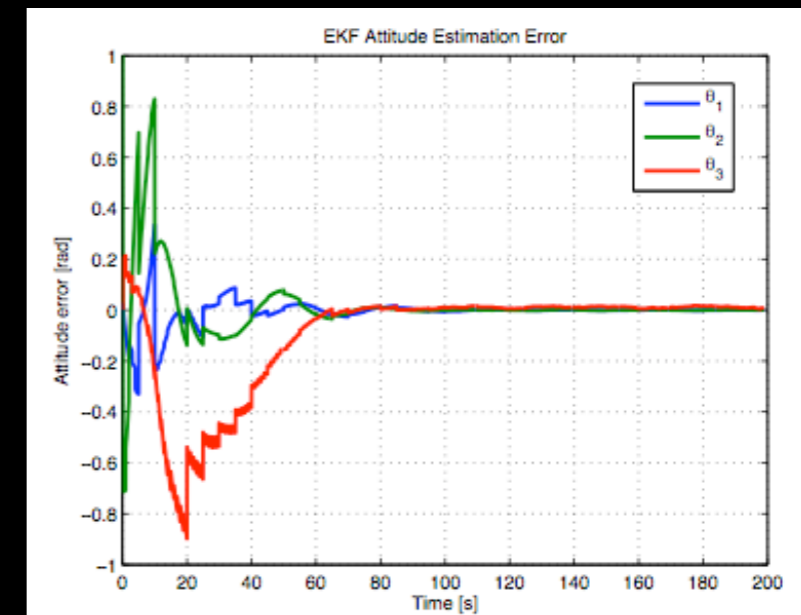
- Ephemeris models: orbit, magnetic field, sun, earth rotation, eclipse
- Quaternion based Unscented Kalman Filter for attitude determination
- De-tumbling control modes (B-Dot)
- Nadir and inertial pointing modes
- Matlab model for test and tuning of parameters

Compatibility

- Initially only GomSpace products:
 - Panels: magnetorquer, sun-sensor, gyro
 - OBC: magnetometer, PWM drivers, processor
- Drivers for other hardware parts will be developed

Performance

- Determination accuracy: 3-5 degrees
- Pointing accuracy: 6-10 degrees



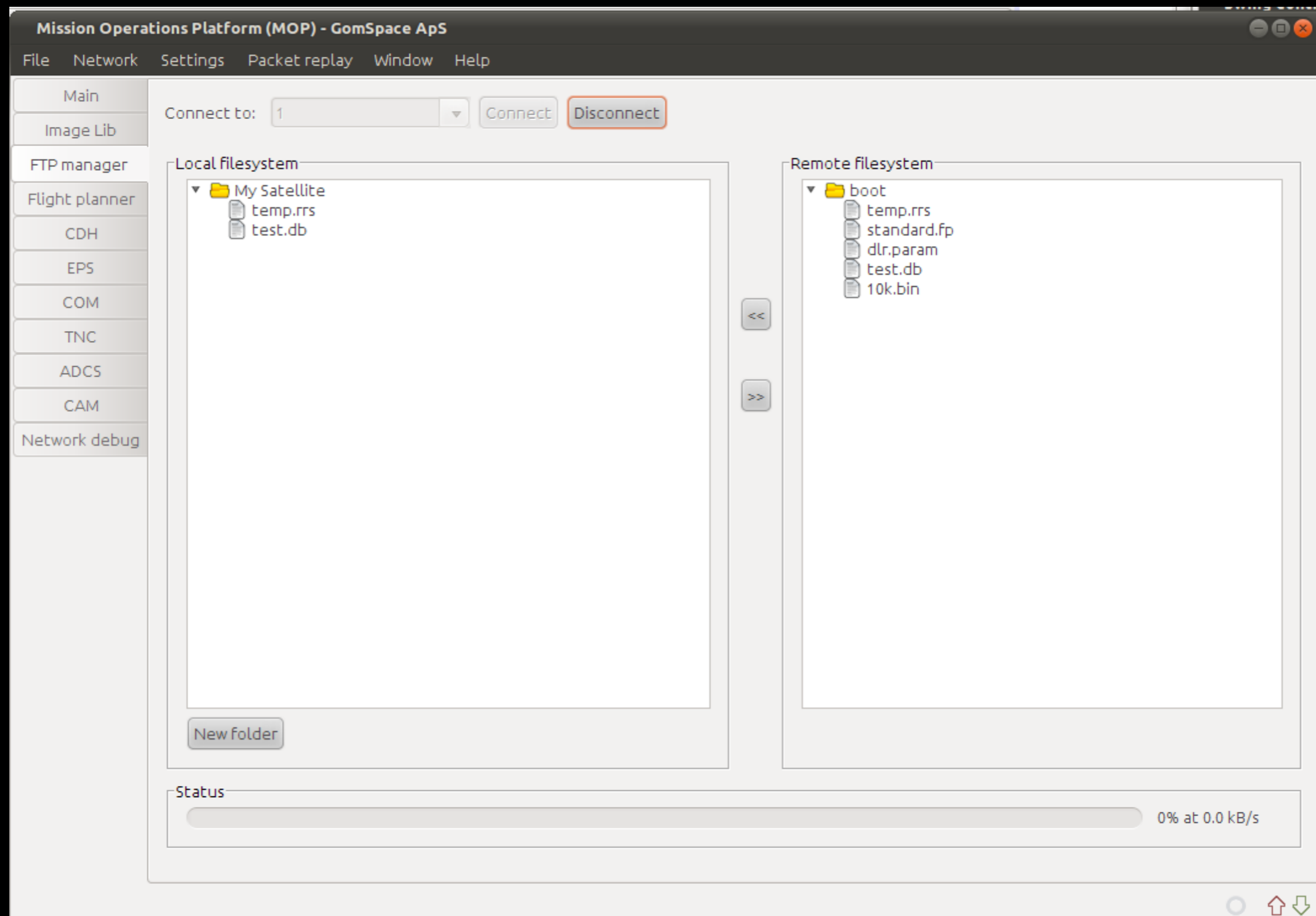
Mission Operations Platform

Main Features

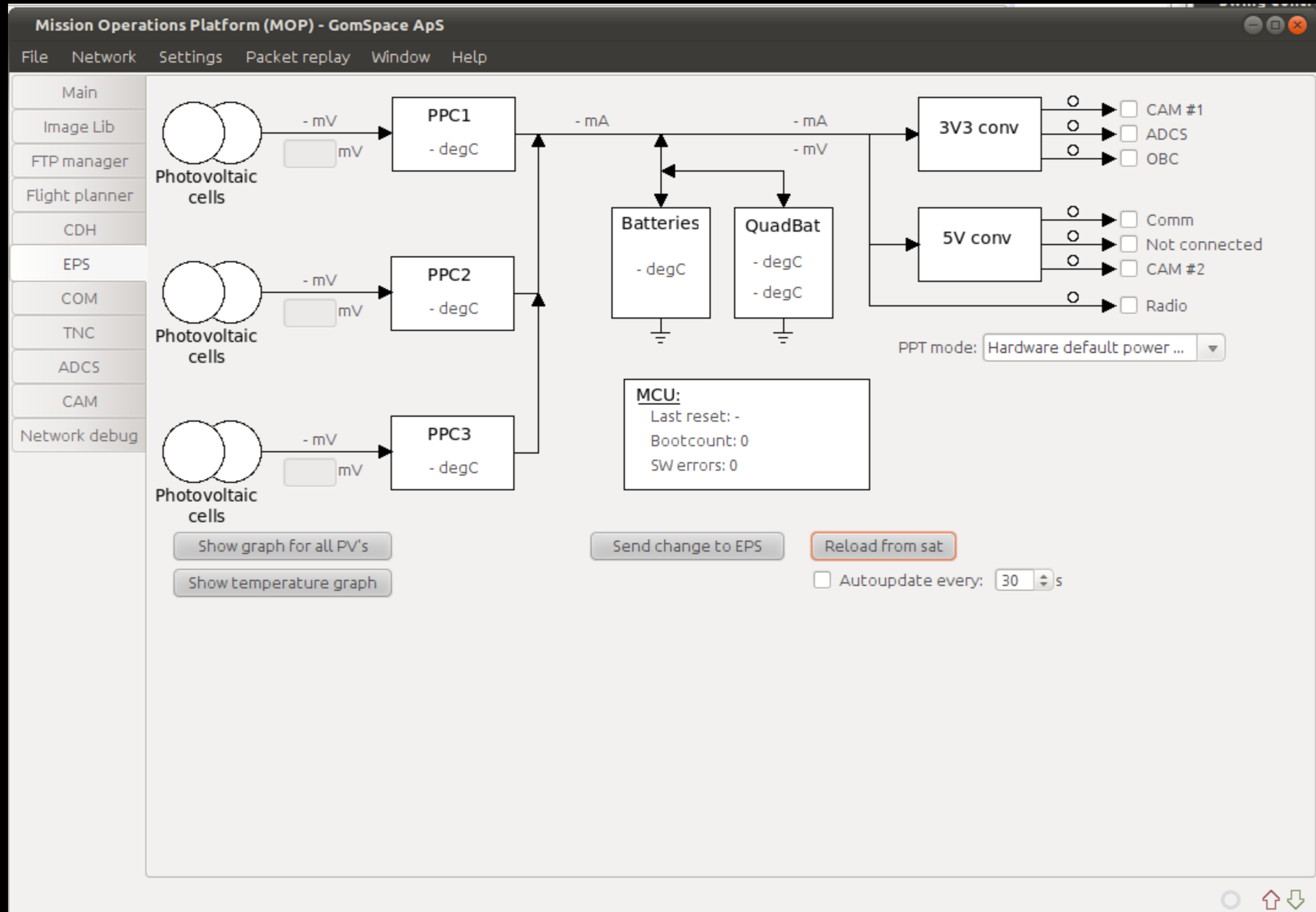
- Robust communication with satellite including file transfer
- Plug-in for each subsystem (incl. SW systems)
 - Graphical representation for TM
 - Plotting functions for historical data
 - Graphical commanding (TC)
- Flight planner to build, edit and upload flight plans including scripting for autonomous functions
- Activity logging and data storage to SQL database
- Software upload function



Mission Operations Platform - Example



Mission Operations Platform - Example



Licensing Models and Availability

Licensing Options (TBC)

- Source - license
 - Full source disclosure
 - Per mission fee
 - One year support and updates included
- Binary license
 - Binary library precompiled for NMA712 + skeleton code as source
 - Per mission fee
 - One year support and updates included

Availability

- May: Pricing and overview information on homepage
- June: Extensive documentation packages available
- July: Products available for purchase

Software is currently in testing with select customers.



Contact Information

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