

UKube-1

UKube Program, its Payloads & Enabling Technologies

Steve Greenland

With thanks to all those involved -

UK Space Agency

Bright Ascension

EADS Astrium

AMSAT-UK

University of Strathclyde

Open University

University of Bath

UKSEDS

RALSpace

University of Dundee

Steepest Ascent

Cape Peninsula University of Technology

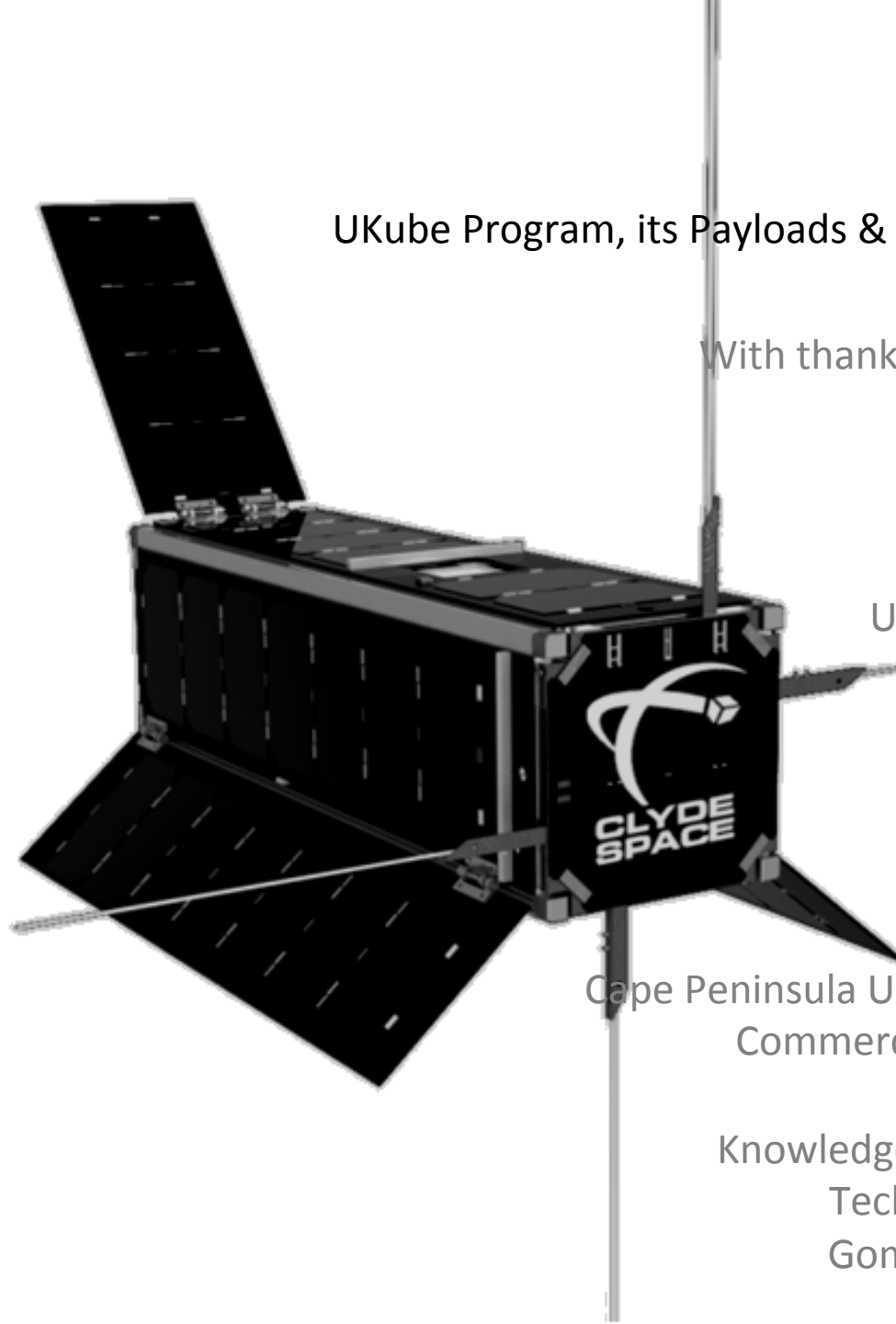
Commercial Space Technologies

SciSys

Knowledge Transfer Partnerships

Technology Strategy Board

Gomspace / ISIS / Pumpkin

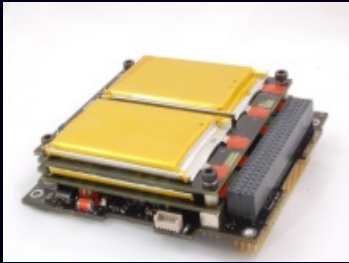


Company timeline



Company formed late 2005

First OTS product (CubeSat EPS)



Bespoke modular power systems



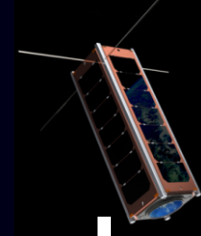
First website to purchase space OTS



First flight heritage (ITUpSAT1)



Clyde Space CubeSat platform



First bespoke solar panel sales



First hi-rel variant product



OTS product range expanded beyond power subsystem



Expanded to current facilities

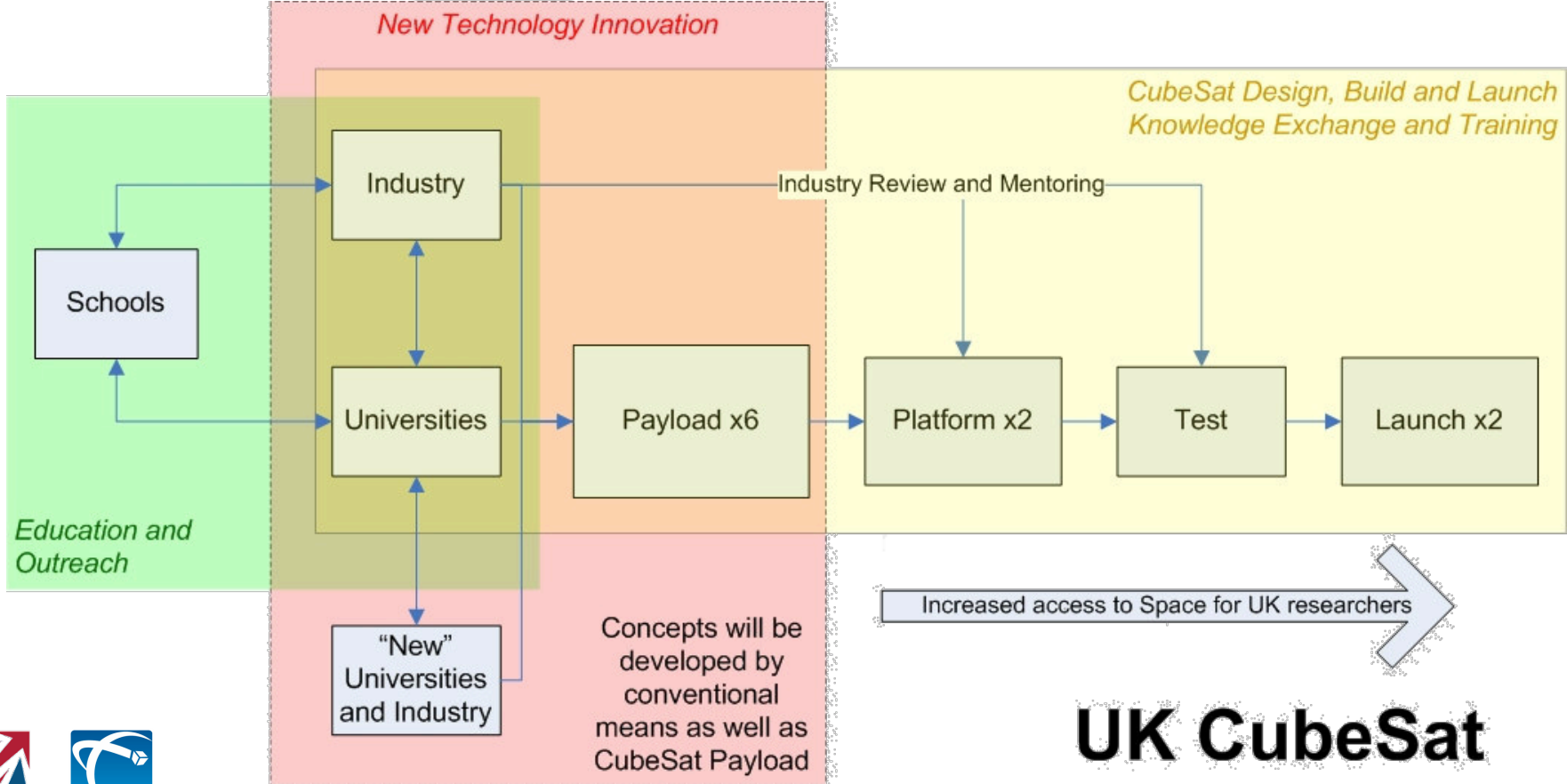
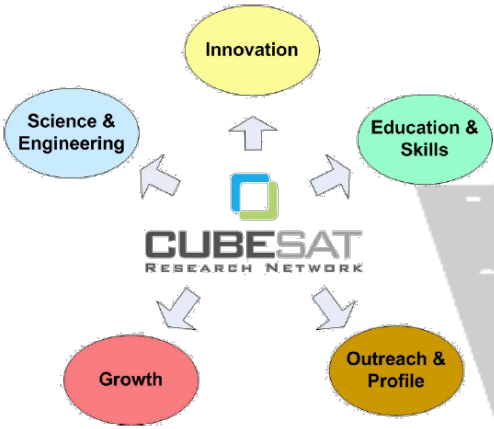


ESA / ISO Quality Processes



- > TO 1.5mGBP
- > 20 employees
- > 200 CubeSat EPS

UKube approach



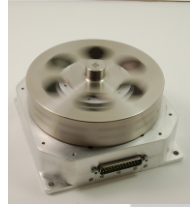
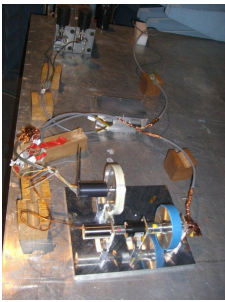
UK CubeSat



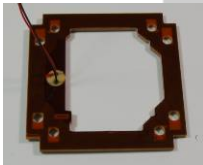
UKube-1 requirements

- Five core mission objectives:
 - UKube-1 shall demonstrate new UK space technology.
 - UKube-1 shall demonstrate the capability of useful science to be performed within a CubeSat sized spacecraft.
 - UKube-1 shall demonstrate industry and university based training in spacecraft development.
 - UKube-1 shall demonstrate education and outreach in STEM subjects.
 - UKube-1 shall demonstrate Payload Kick-Off to flight qualified spacecraft in less than 12 months.
- Defined such that the significant parts can be met before reaching the launch pad

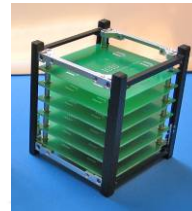
Why Clyde Space involvement?



Attitude control

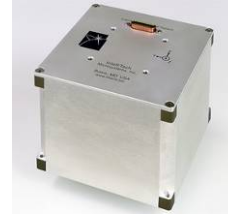


[PUMPKIN]



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One-stop shop



[IMI]



Telemetry & switching



Batteries

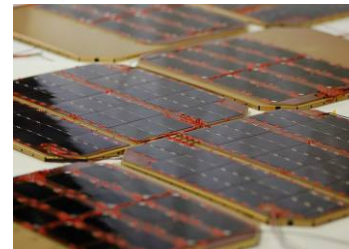
Electric power system



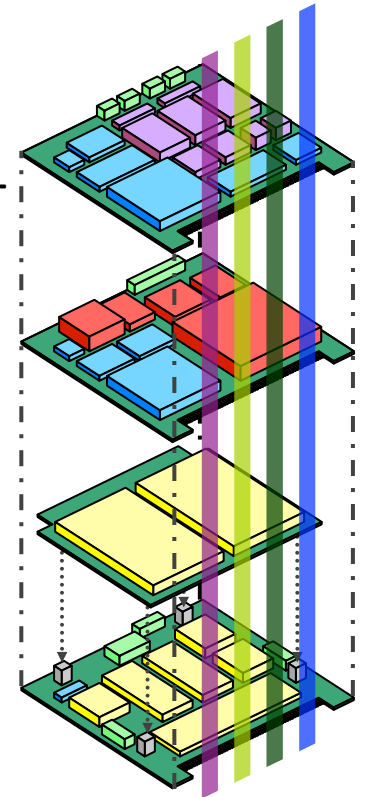
Structures



Solar arrays

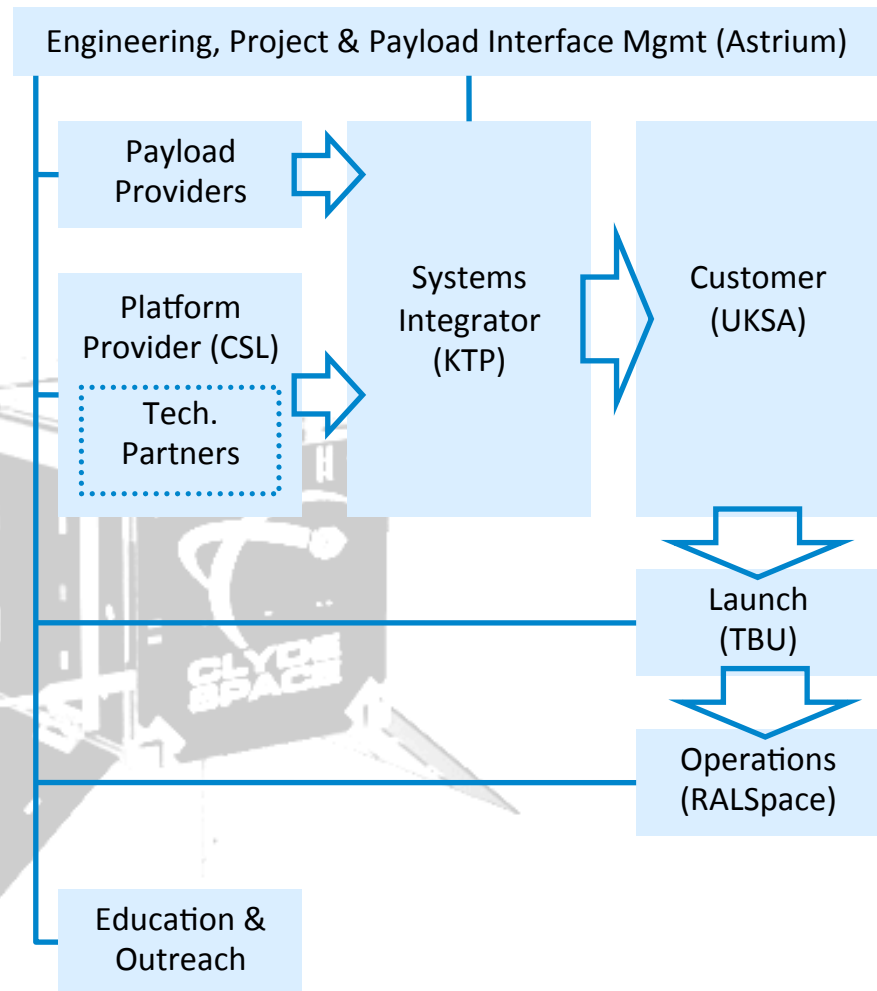


Modular interface concepts

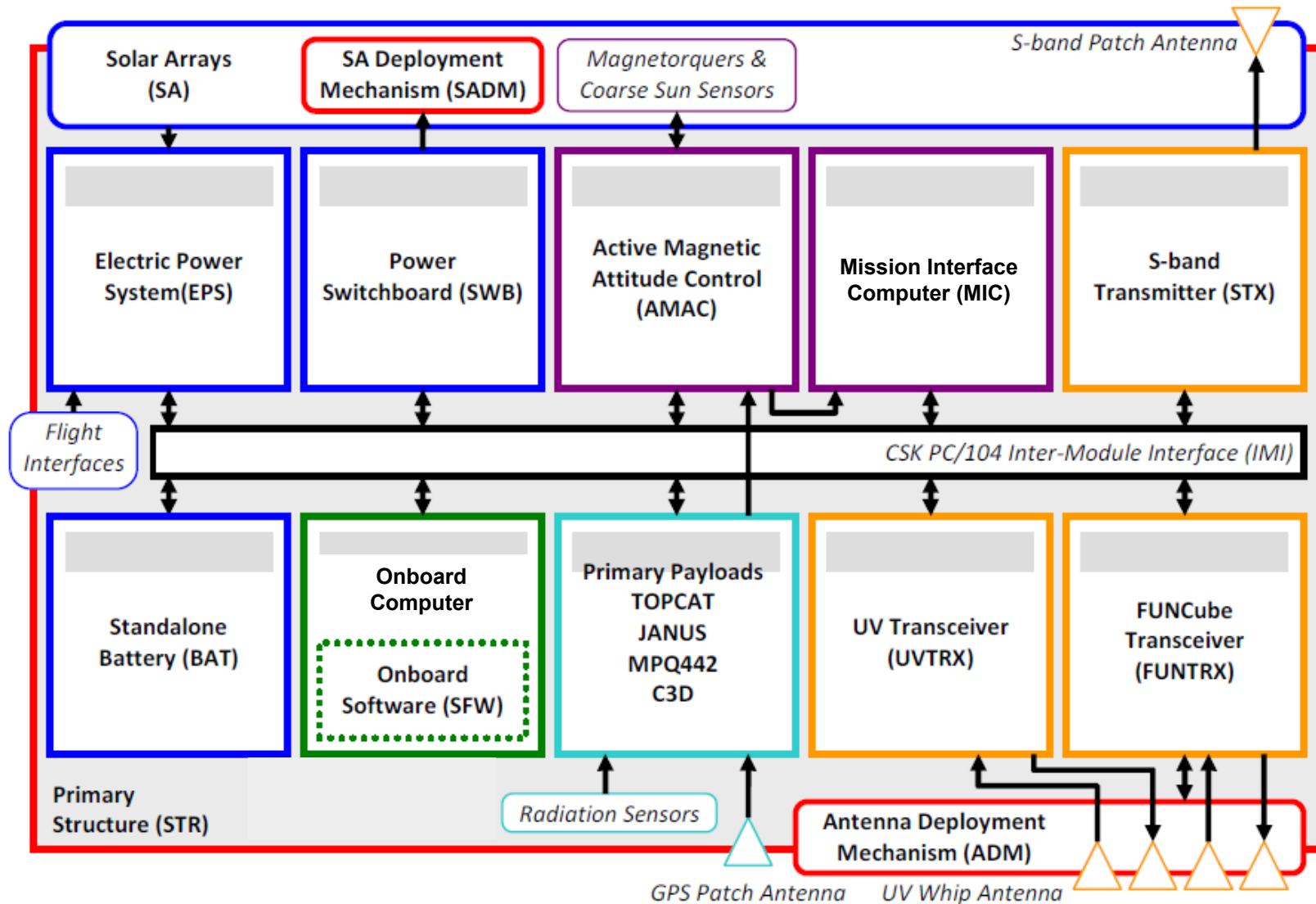


Program constraints

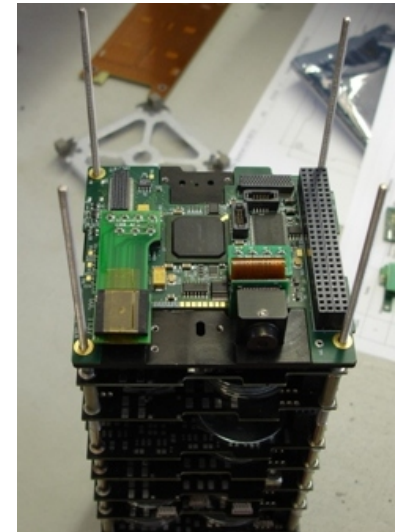
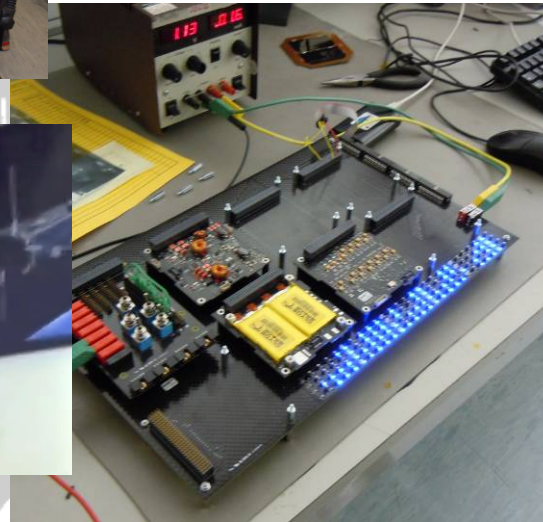
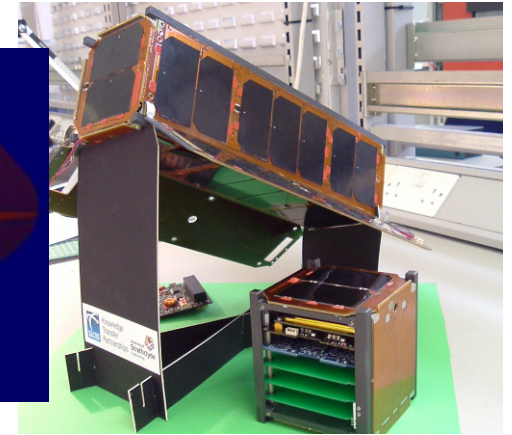
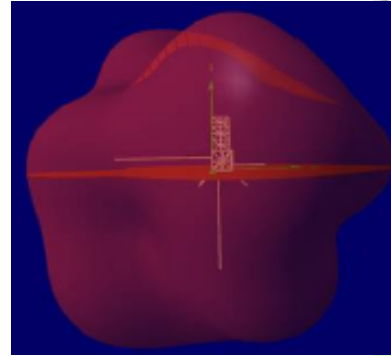
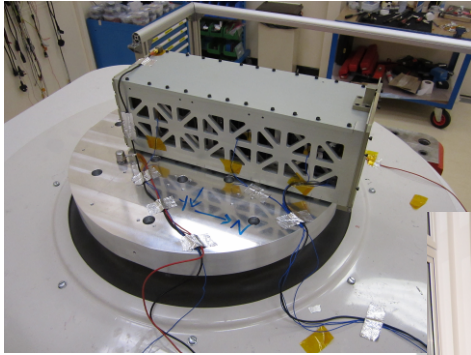
- UKube-1 heavily constrained by resources
 - personnel
 - timescales
- Free launch is the shared objectives for all parties
- Design part-driven by coalition of the willing
 - balanced by Astrium
- In March 2011, 4 payloads were selected from 22 proposals
- From July 2011, program organisation has changed with CSL taking on management responsibility



Modular architecture

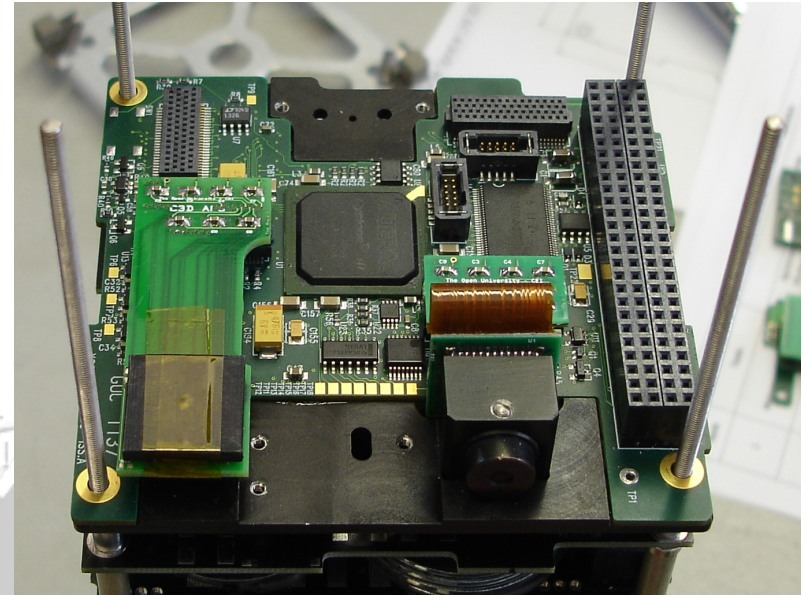


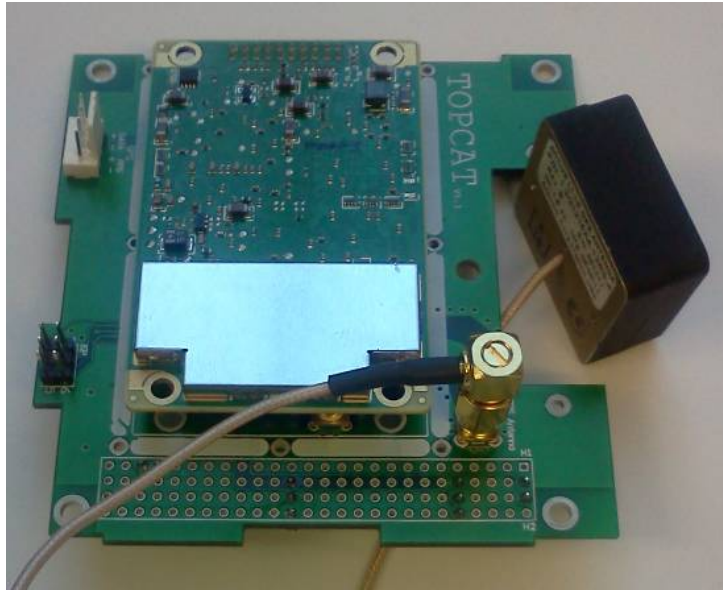
Current status



- Launch early 2013 Soyuz Fregat

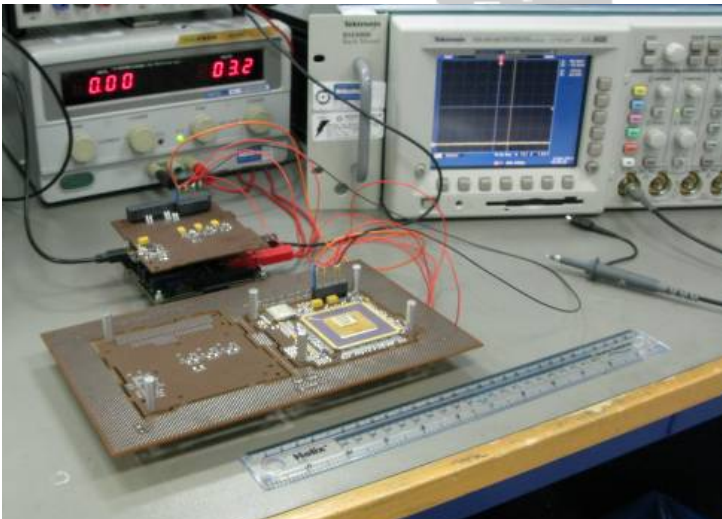
- CMOS radiation damage monitoring
 - Total ionising
 - Single event
- Narrow and wide field imaging
- Onboard image processing
 - histographic image rejection
 - thumbnailing and compression
- Technology demonstration of CMOS for future ESA missions, e.g. JUICE



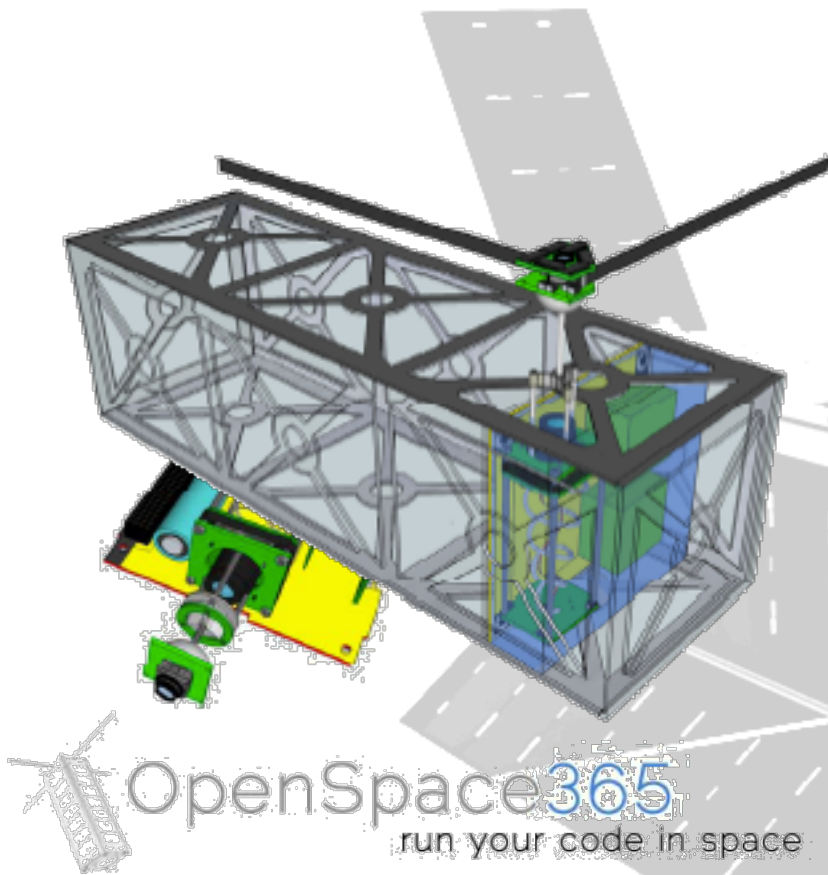


- Topside Ionospheric Occultation Assisted Tomography
- L1/2 space-grade GPS receiver
- Interface with ADCS for orbit positioning





- Space radiation based random number generation
- Applicability to patents for telecommunications
- EADS Astrium application of non-space grade SRAM based FPGAs



- Only outstanding payload awaiting integration with FlatSat
- A pocket satellite
 - OpenSpace365 - Arduino
 - Orbitview (popout camera)
 - SuperLab - superconductors
 - SuperSprite – satellite on a chip with a UHF downlink

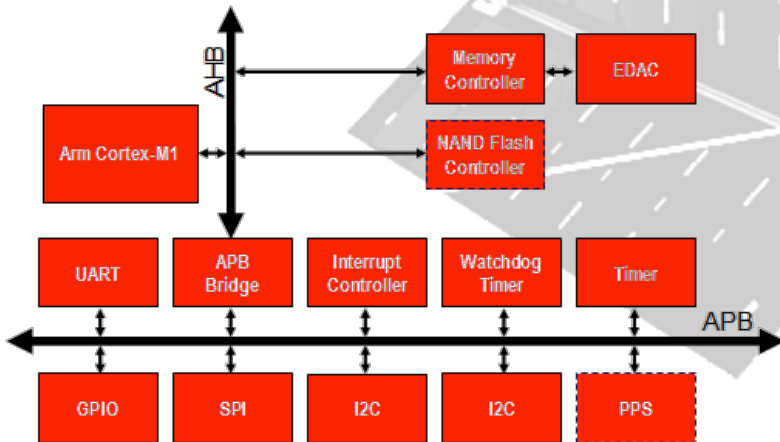
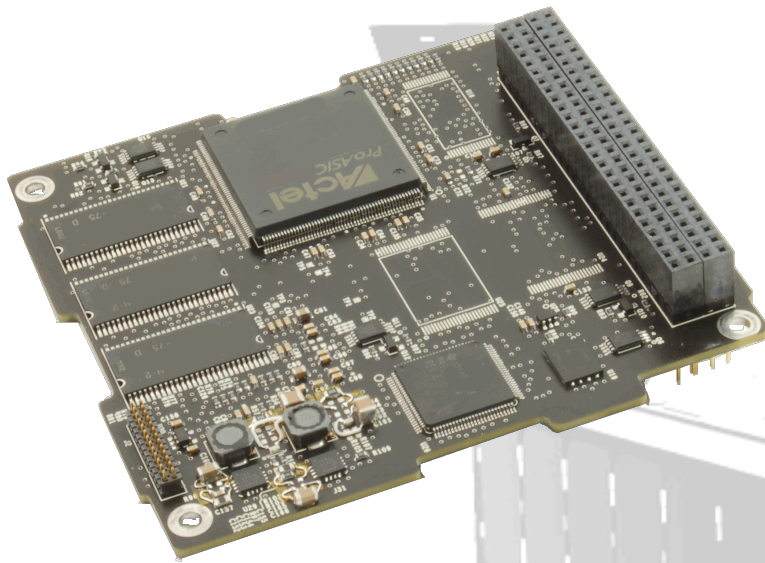
Mission Interface Computer

- Supports asymmetric redundant architecture
- FPGA-based primary processor
- Radiation tolerant design

– 2 MB SRAM

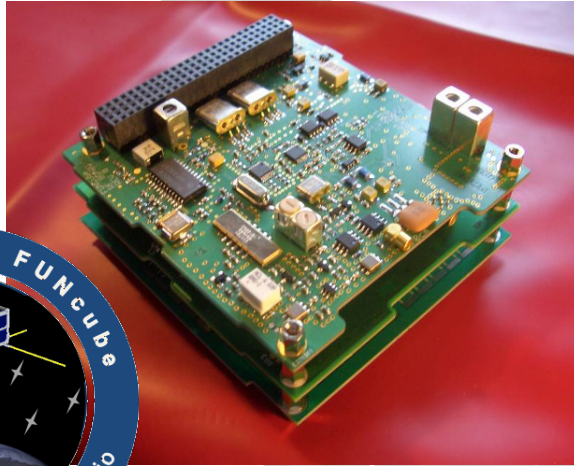
– 2 GB NAND FLASH

- Looking for partners for further development



FUNCube Transceiver

- AMSAT-UK transceiver
- Meets UKube-1 education and outreach objectives
- FUNCube dongle allows satellite to be received
- Backdoor transceiver



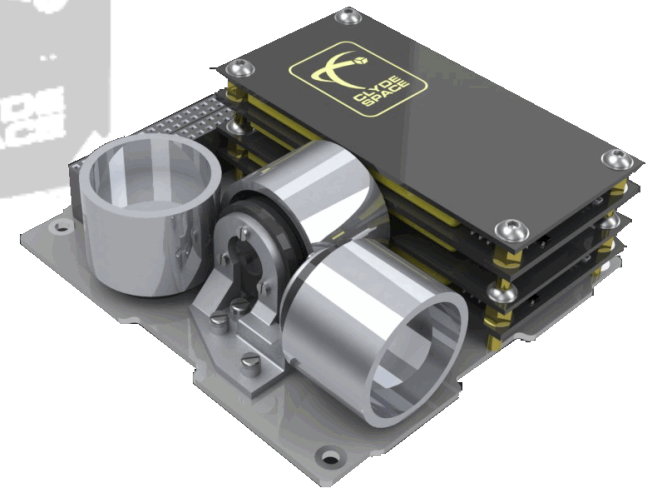
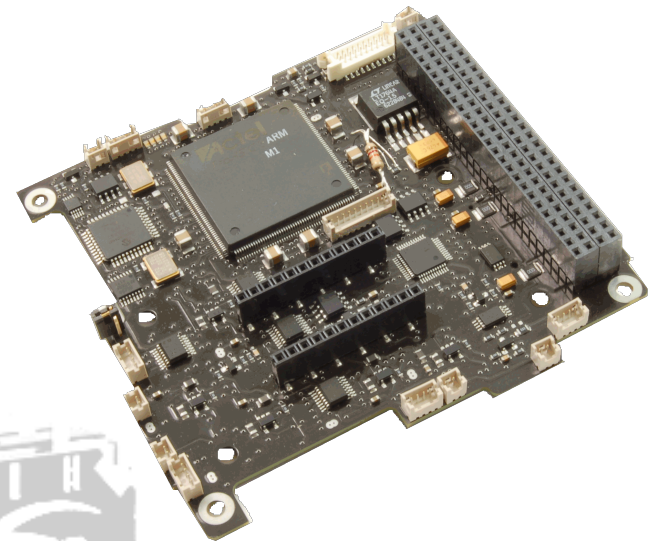
Deployable Solar Arrays

- Redundant thermal knife deployment
- Longitudinal and lateral hinge designs
- Support designs for > 35 W instantaneous power
- Solar arrays feature integrated sun sensors

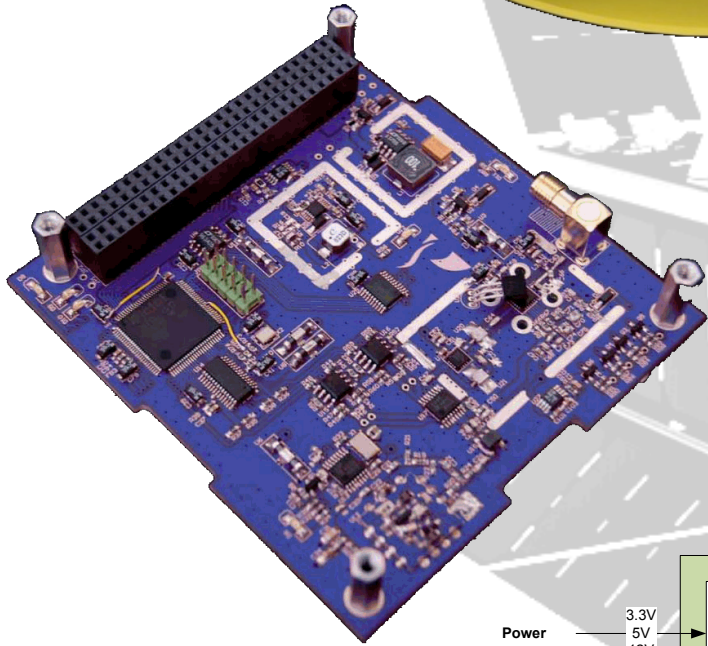
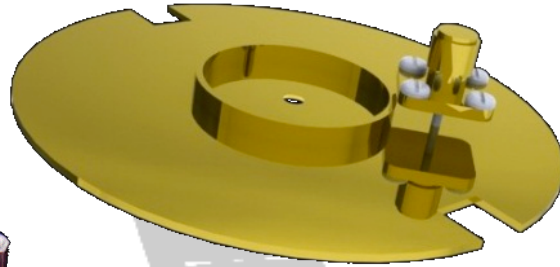


Active Magnetic Attitude Control

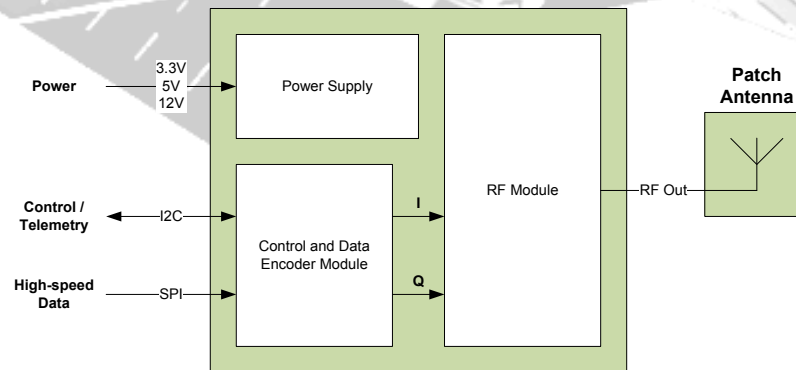
- FPGA based design with embedded control modes
 - Magnetic and inertial sensors
 - Magnetorquer actuation
 - Coarse sun sensors
 - Interface to TOPCAT GPS
- Future compatibility
 - High performance computing
 - 3-axis reaction wheels



S-band Transmitter

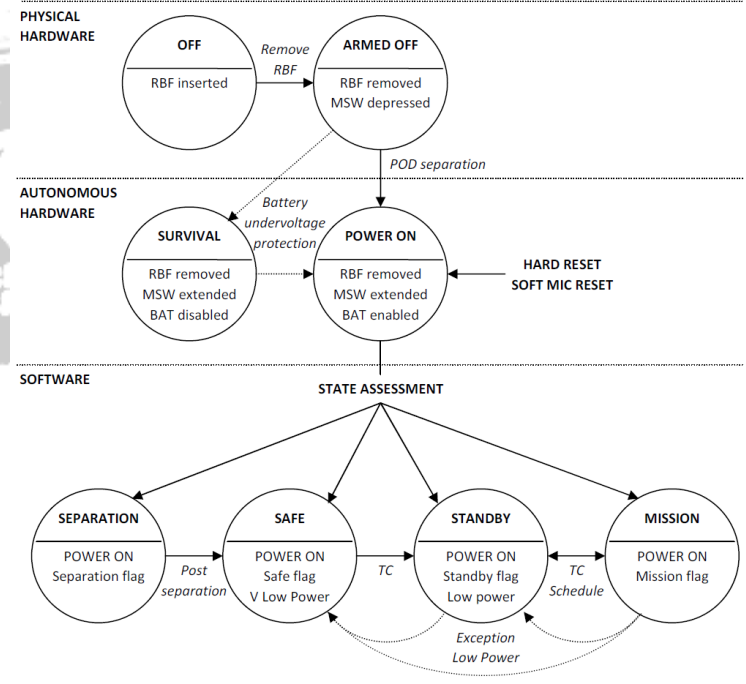
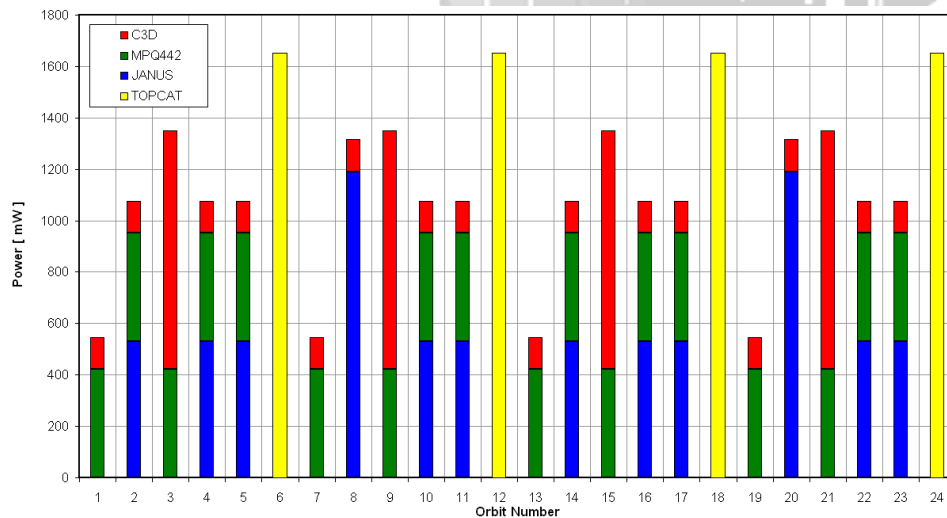


- High data rate transmitter
 - < 2 Mbps
 - Tx power 21 dBm to 30 dBm
 - 2400 – 2450 MHz in 500 kHz
 - SNR of 20 dB (min)
 - Spurious responses < -30 dBc
 - Open Network Encoding



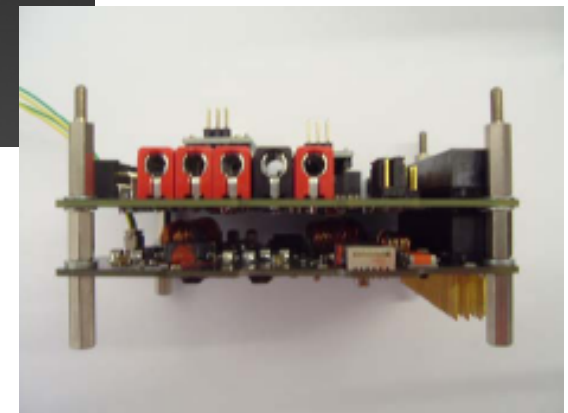
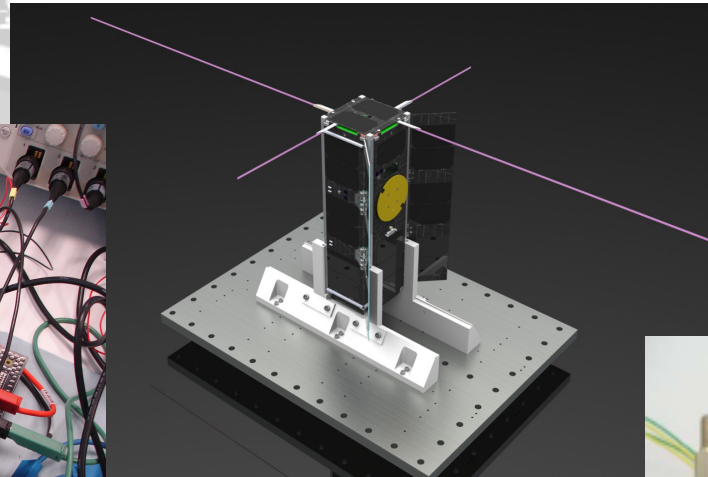
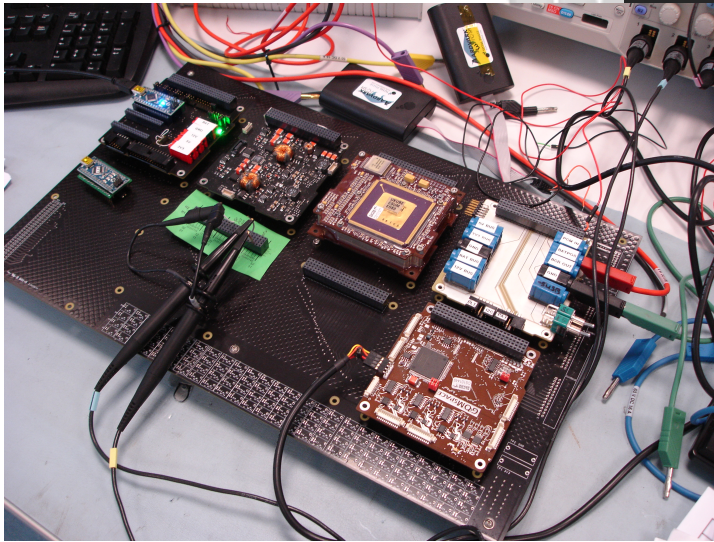
Onboard Software

- Developed with Bright Ascension
- freeRTOS-based
- CCSDS compatible with modified PUS
- Onboard operations scheduler
- File based data transfers



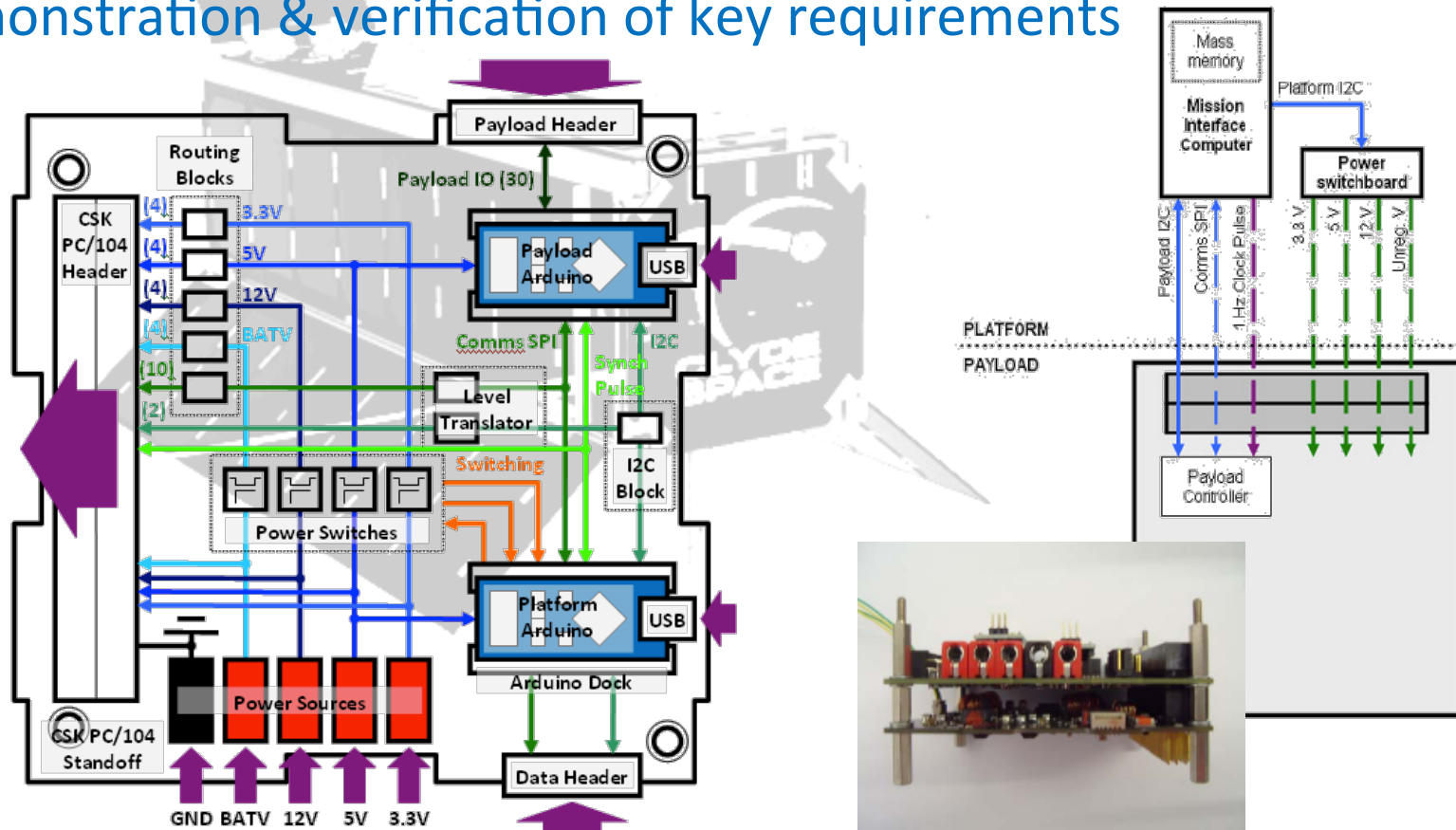
MEGSE Developments

- Payload interface emulator
- FlatSat board and peripherals
- Integration & environmental test jig



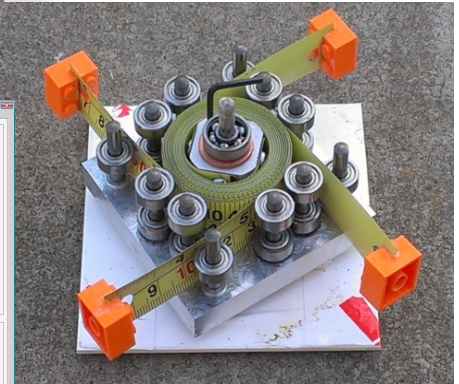
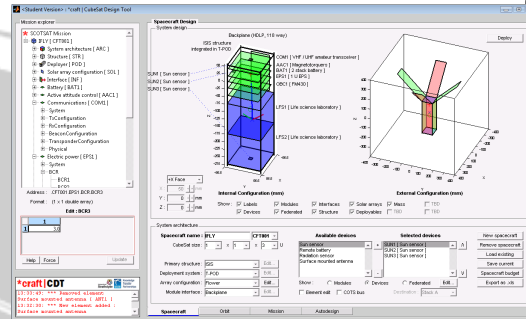
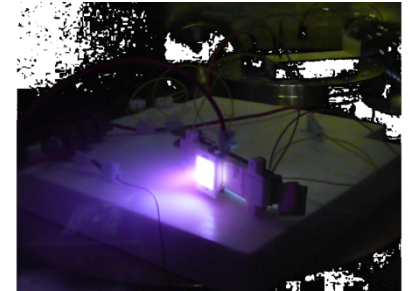
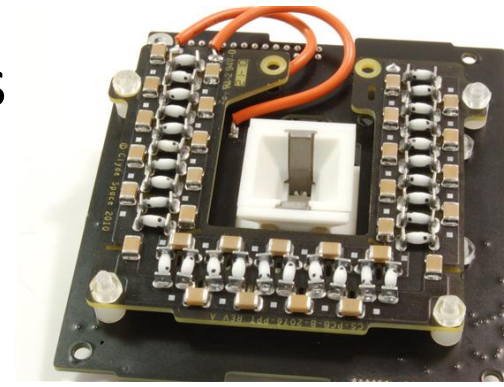
Distributed concurrent development

- Interface between platform & payload managed through interface emulator
 - Facilitate concurrent development of platform & payload
 - Demonstration & verification of key requirements



Developments for future UKube missions?

- Plasma pulse thrusters
 - ESA ITI
- Deorbit (solar) sail
 - UKSA / TSB
- ADCS testbed
 - UKSA / TSB
- Mission design tools
 - SFTC (iCASE)
- Inter-satellite link
 - industry sponsored



A satellite is shown in space, tilted at an angle. The satellite has a rectangular body with a series of solar panels or sensors on its side. The Earth's blue and white horizon is visible in the bottom right corner. The background is black with some stars.

questions?

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