ÅAC Microtec™

Proven reliability for a new space age

Implementation of CAN-bus in high reliability LEON3FT platform for low cost NewSpace systems

Stefan Strålsjö
Business line manager Smallsat
Uppsala Sweden

CAN in space workshop 11-14 June 2019

WHO ARE WE?

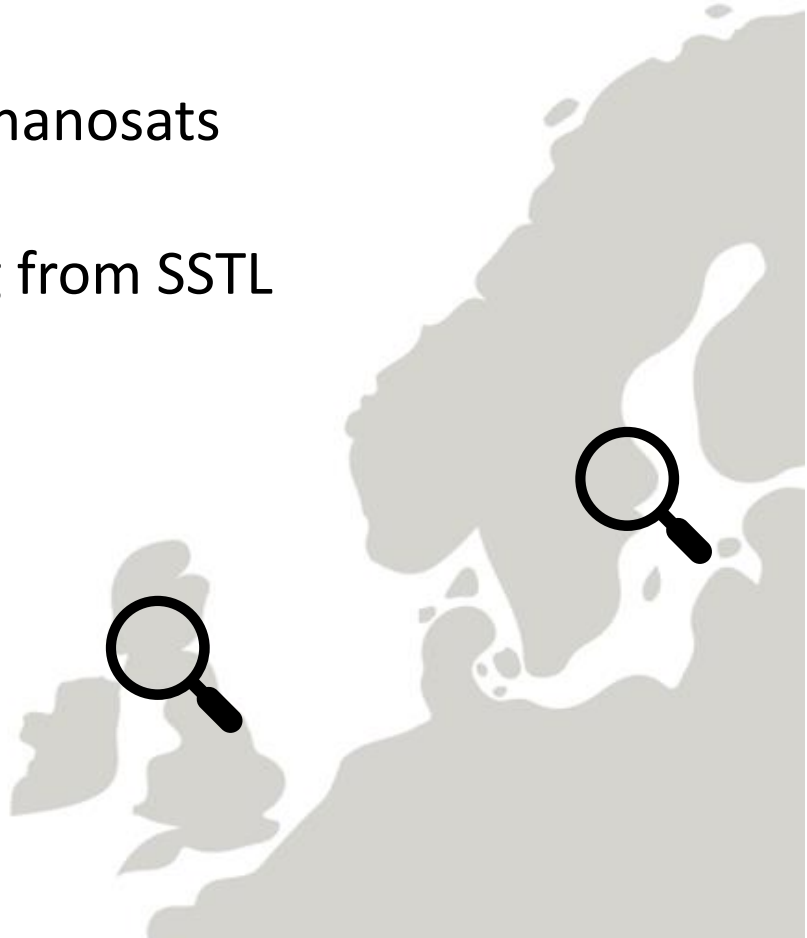
- **Small Satellites** from **1kg to 50kg**
- Focus on **quality** and **reliability**
- Ready for **volume production** and testing
- Unrivalled **flight heritage**

- **END-TO-END MISSION solutions** for customers including launch service and operations
- Attractive offering for **constellations and operators**
- Strong position for **high growth**

- **Award winning, globally recognized** for innovation and leading position in the small satellite market.

History

- Founded in 2005
- Facilities in Uppsala, Glasgow, Harwell, US
- Listed on the Nasdaq First North 2016
- Merged in 2018 to be provider of complete nanosats and subsystems for the smallsat market
- CEO, Luis Gomes joined in May 2019 coming from SSTL



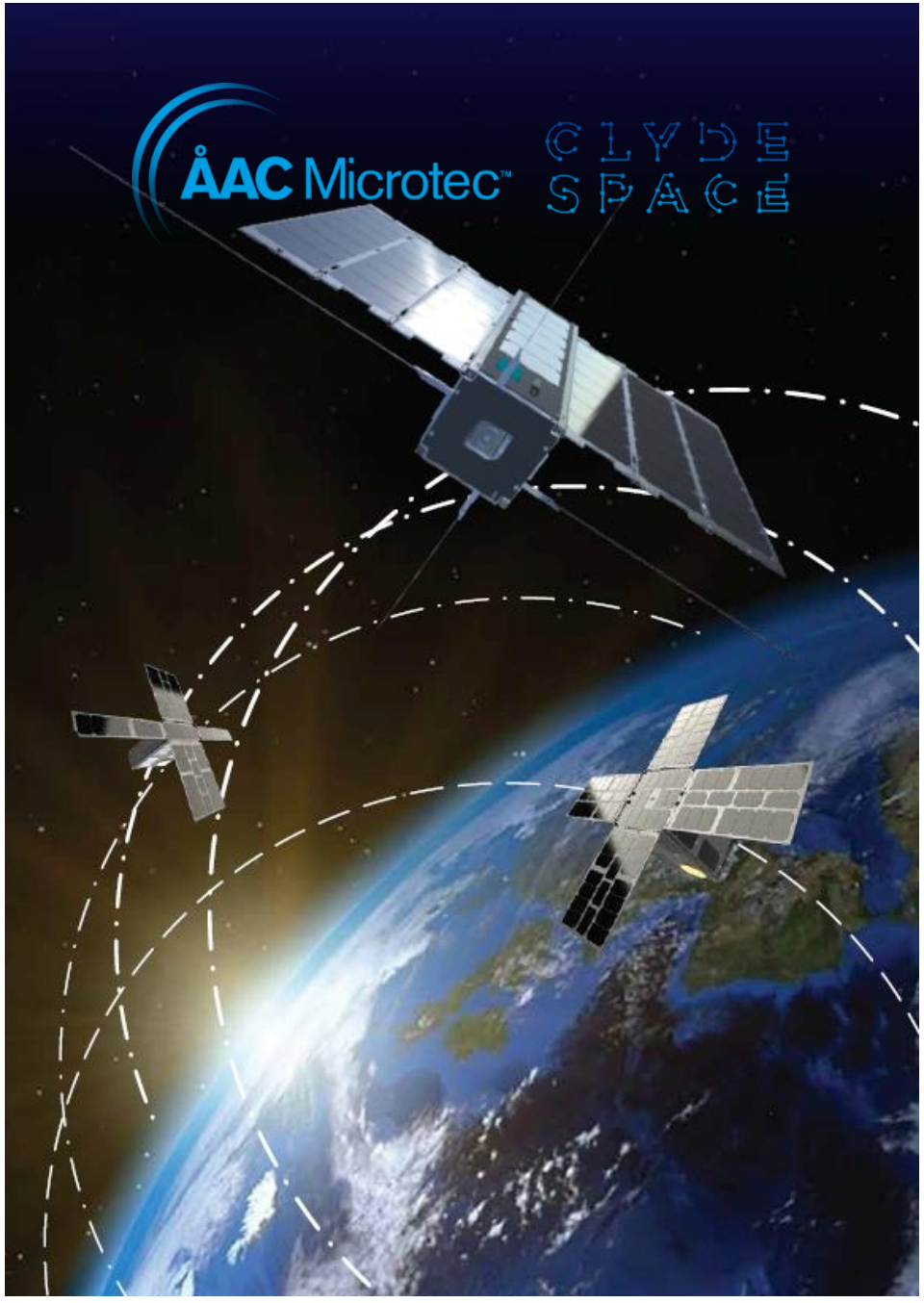
SMALL SATELLITE CONSTELLATIONS

Constellations
- A network of satellites
- Enables more frequent data collection

Constellations expected to account for 70% of future demand

Our strategy is to target constellation customers with
- Data delivery (Space-as-a-Service)
- Complete platforms
- Subsystems to platform integrators

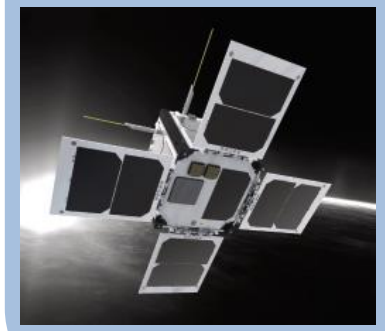
We are gaining momentum
- Multiple current orders for pilots from parties targeting to create constellations



Satellite products

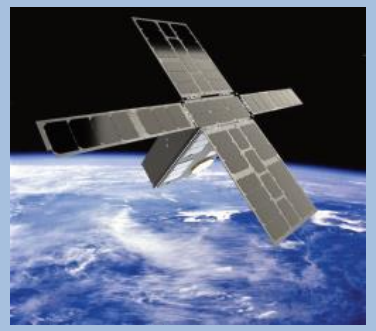
THE ‘EPIC’ CUBESAT RANGE

1U



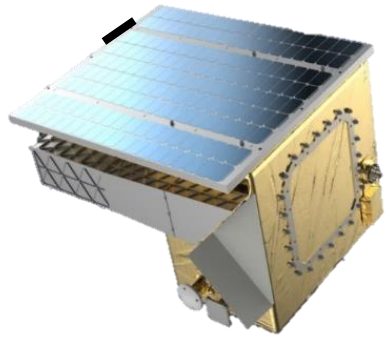
3U

6U



12U

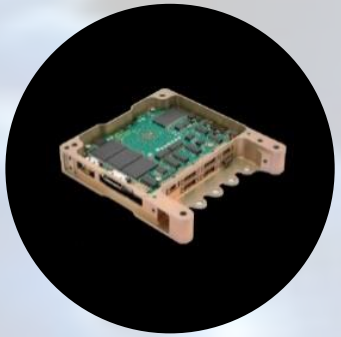
INNOSAT



1.2kg — 5kg — 10kg — 20kg — 50kg

Space as a service

Mission design and analysis



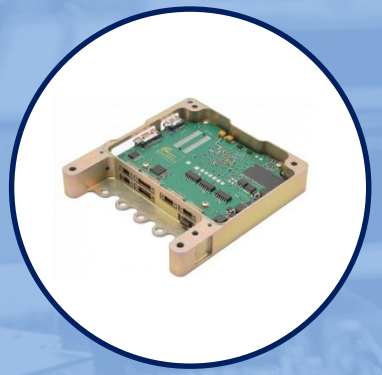
Subsystem manufacture and test

Spacecraft integration and test

Launch and deployment

On-orbit operations

FULL RANGE OF SUBSYSTEMS FOR SMALL SATELLITES



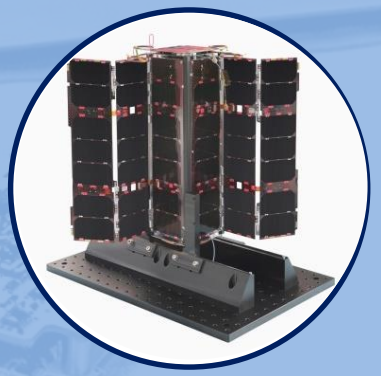
Computers

Power Systems

Batteries

Structures

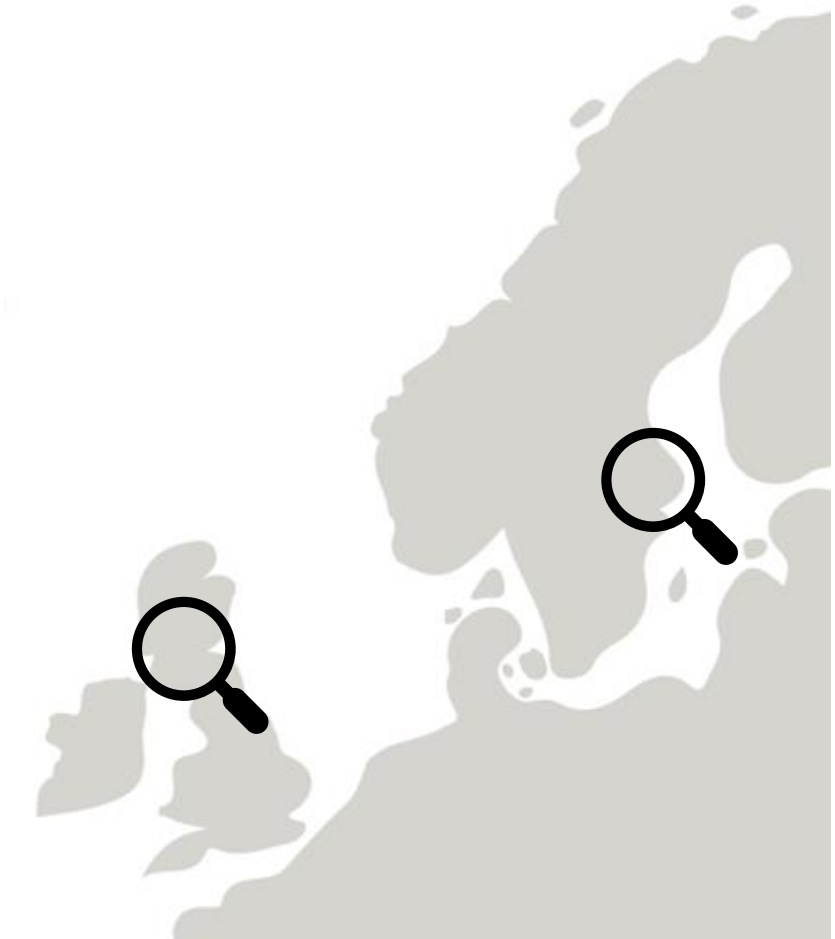
Pointing Control



Solar panels

Competences

- RnD on two sites
  - Power electronics
  - Flight software
  - FPGA development
  - Mechanical structures
  - Mission design and analysis
  - Satellite operations



Sirius Avionics

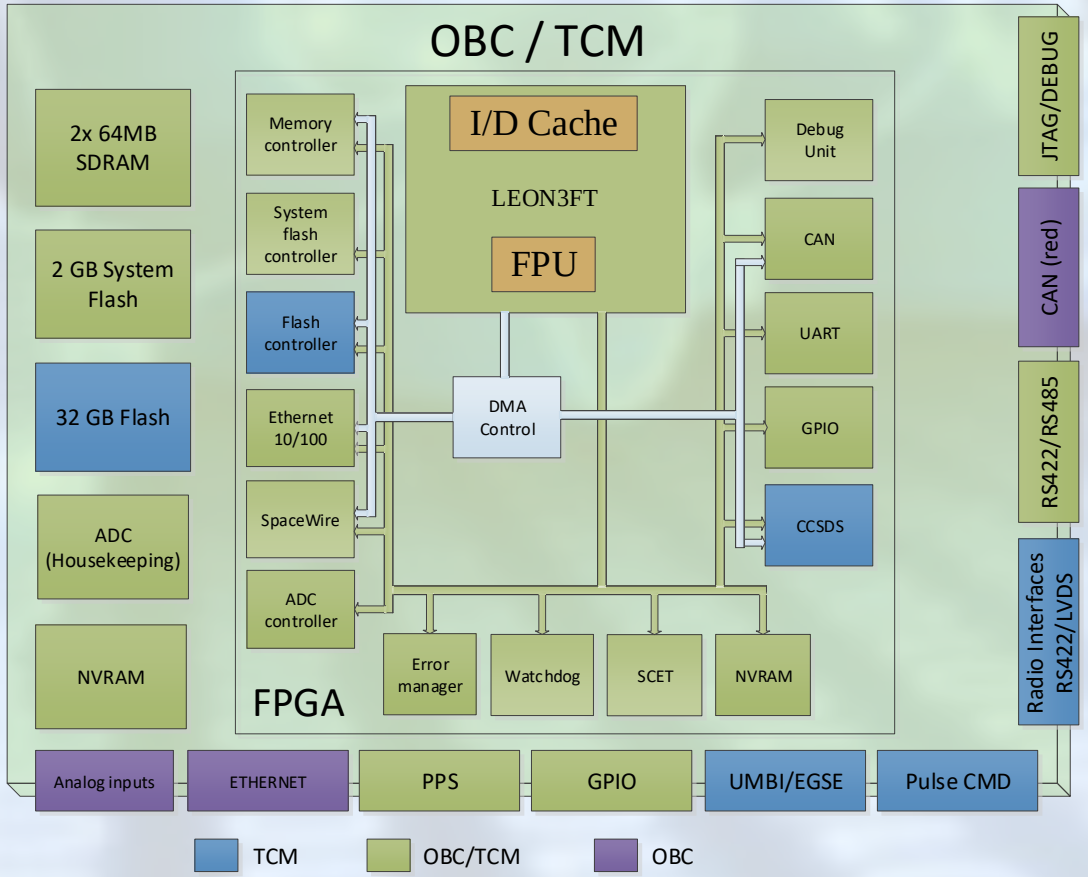
- First generation 2 products, OBC and TCM
  - System on chip with OpenRISC 1200
  - 5 years in LEO
  - Distributed system @50MHz
  - TID and SEE environmental tested
  - BootROM in TMR:ed FPGA
  - 2xSpacewire
  - 16GB mass memory
  - Small formfactor ~100gram
  - Modular design

Sirius Avionics

- Second generation products with LEON3FT was developed with Cobham Gaisler Sweden
  - System on chip with LEON3FT
  - All previous requirements fullfilled
  - Increased performance and reliability
  - Image upload via PUS commands
  - 32GB massmemory

Sirius System on a chip architecture

- SoC architectures implemented in FPGAs
- Mitigation techniques for radiation effects
- Peripherals are verified both in simulations and on hardware
- Realtime OS RTEMS 4.11
- CCSDS with CPDU
- DMA on critical paths
- GRMON3 for debug purposes



Sirius Avionics

- Extensions via add-on board
  - Ethernet
  - CAN bus (Redundant)
  - Spacewire router

Sirius Avionics

Add-on board CAN specifics

- GRCAN IP (Cobham Gaisler)
- CAN physical layer 3.3V
- Compatible with ISO11898-2
- Baud rate up to 1 Mbit/s

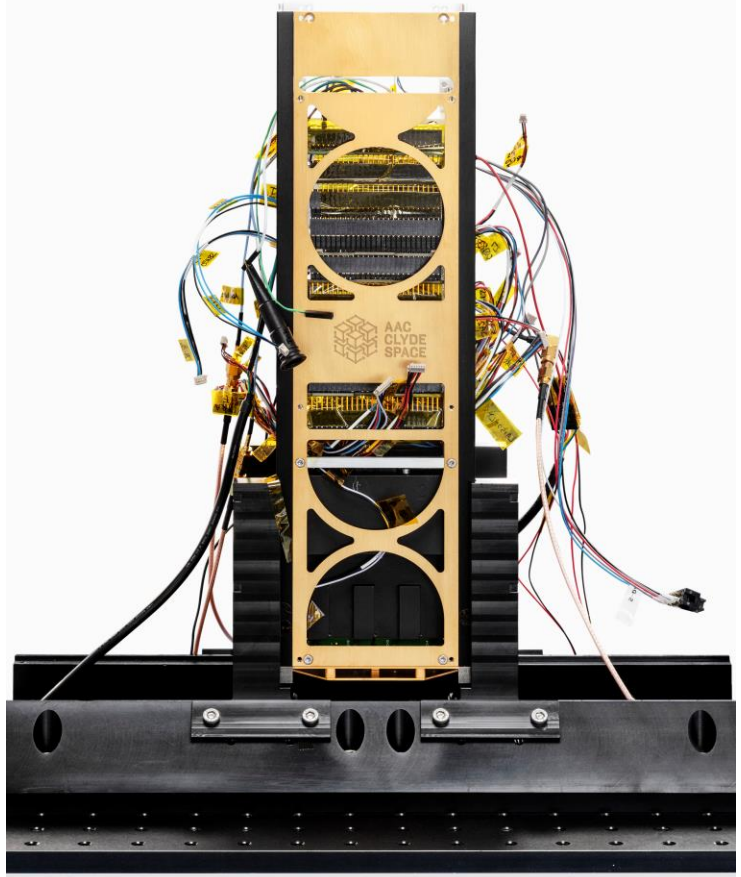
Sirius Avionics

- Radiation testing and mitigations strategies
  - TID testing up to 30krad
    - CO60 source
    - Low dose rate (0.1 to 0.2 krad(si)/h)
    - Components active during testing
    - ESCC 22900-2 compliant
  - SEE testing using Proton source

Radiation hardness by design

Involves programming and digital logic to correct malfunctions in the hardware.

- EDAC on all memories
- TMR:ed software images
- Fallback solution for SW config
- Watchdog
- Error managing (HK)



CUBE satellites

- Many cubesats using I2C and SPI
- Need of reducing harness and more reliable bus
- Using CAN is a step to take cubesats to a more mature level
- Protocols needs to be decided

CANopen on Sirius products

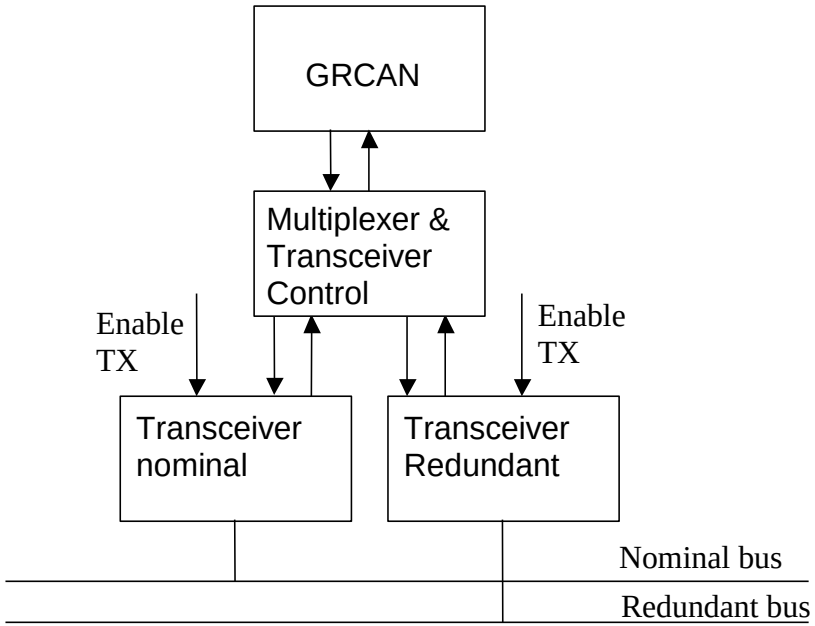
- Power systems (future) and avionics
- Sub-system provider
- Standardized solution to facilitate integration
- ECSS-E-ST-50-15C The CAN bus physical layer specification for spacecraft applications
- A generic higher layer protocol (CANopen) for use over CAN bus in spacecraft applications
- Testing: data throughput, redundancy and fault state handling

CANopen on Sirius products

- CANopen stack in SW
- Unconfirmed command and telemetry requests (ECSS-E-ST-50-15) for configuration and status of TCM LEON3FT (PDO)
- Block transfers by SDO for large data transfers depending on mission reqs.
- Time distribution over Spacewire

CANopen on Sirius products

- Bus management – Selective bus access one bus at a time – for redundant solution architectures



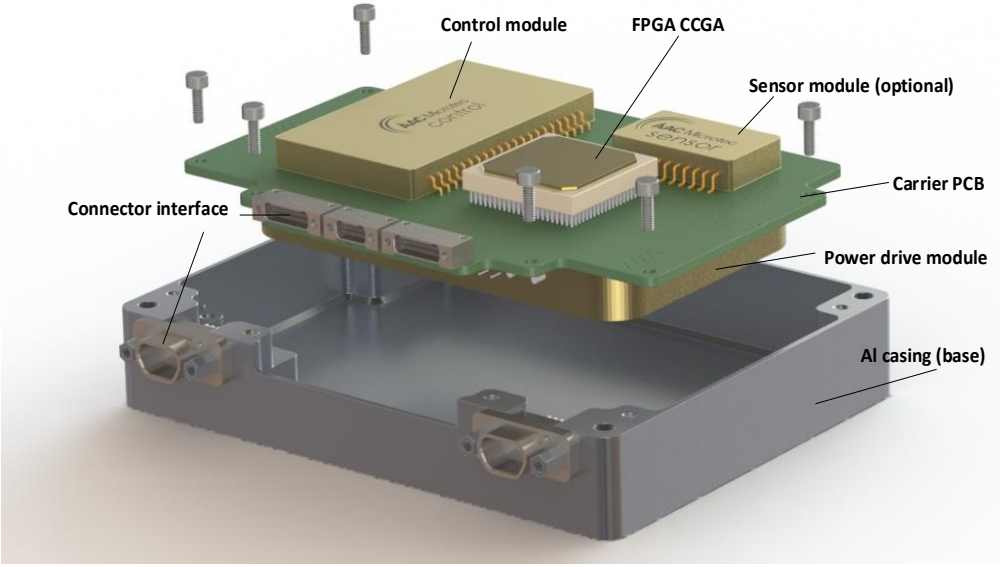
CAN in ÅAC Microtec products/projects

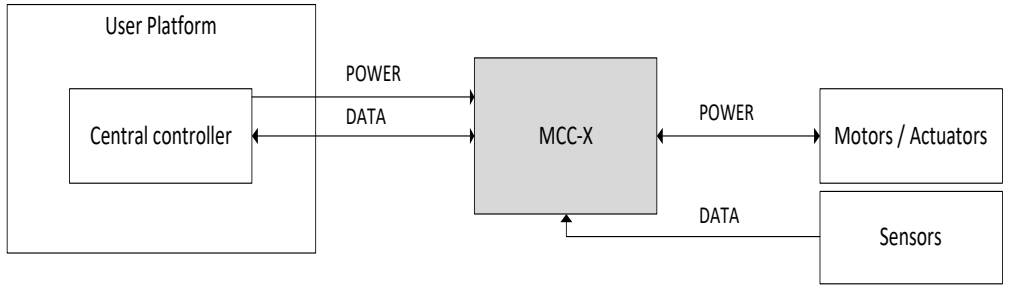
- Current support for CAN: MCC-X, Avionics
- Ongoing support for CAN/CANopen: Sirius OBC and TCM with LEON3FT
- Planned support for CAN/CANopen: PCDU

Exploration missions technology

MCC-X

- Miniaturized Motor Controller device for ESA eXploration missions based on modularized hybrid electronics
- Estimated 50% mass and volume savings compared to current Mars rover missions
- Modularized design enables usage of off the shelf electronics for a variety of motors and missions
- Small size and low temperature performance enables optimized placement of the electronics and reduced harnessing
- CAN bus – simple protocol over CAN Basic data frames with 11-bit identifiers. No extended frames or remote frames.





Questions and answers