

Next generation modular processing system for miniaturized remote sensing instruments

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MOTIVATION

The study of climate-relevant processes in the atmosphere using airborne platforms is an important contribution to understanding our environment. **The need for ever longer measurement times and higher resolution** requires a new generation of data acquisition and instrument control.

Based on the airborne instrument **GLORIA**[1], a first prototype of a smaller balloon version has been developed, which will be extended to a miniaturised modular sensor platform in a next step.

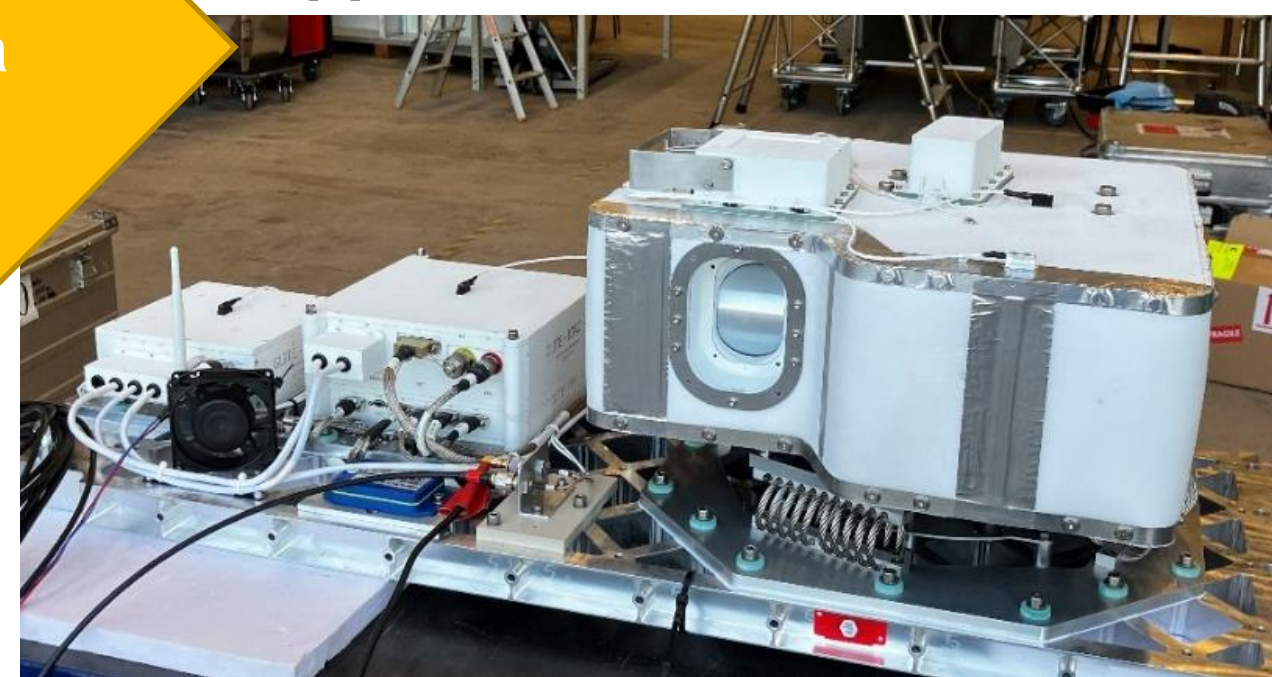
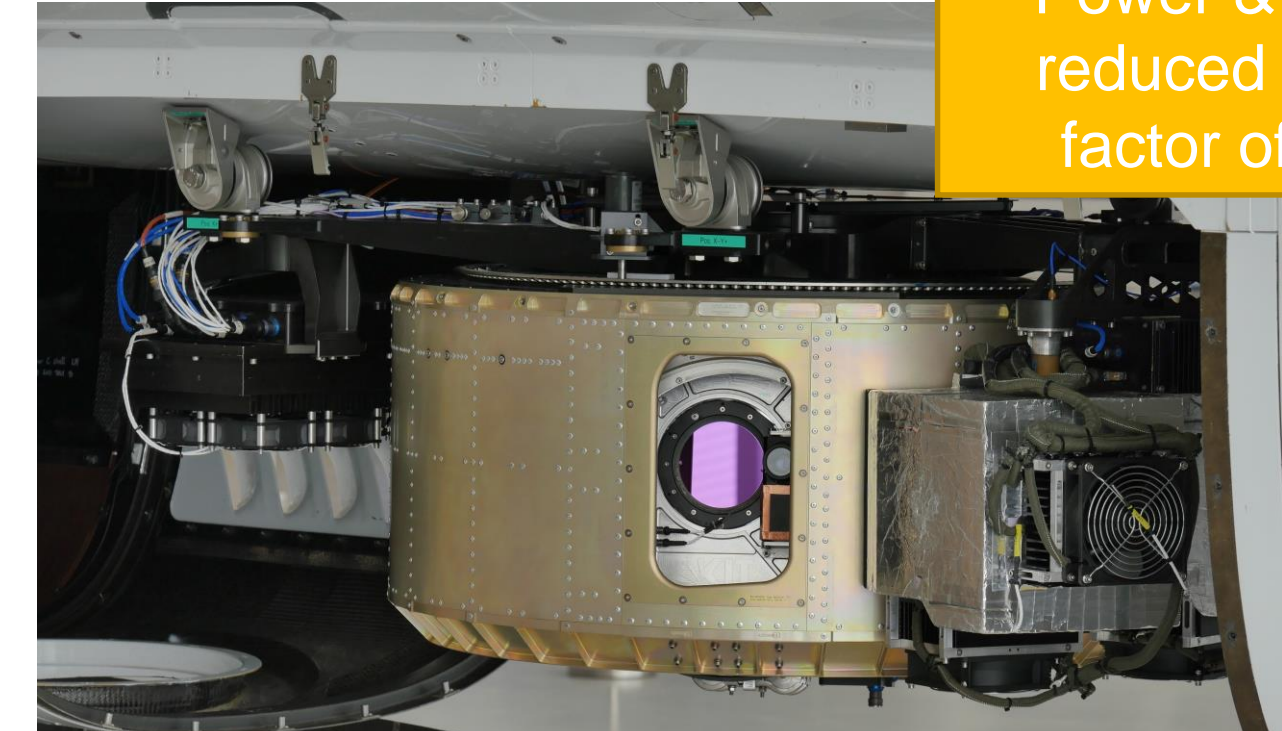


[2]



[3]

Power & size
reduced by a
factor of 10



CHALLENGES

To meet the requirements of future instruments, a number of conditions must be met:

- **Reduce the volume, mass and power consumption** of the entire data acquisition and instrument control hardware
- **Modular** and adaptable to a wide range of different instruments
- Powerful to enable **on-board processing** and **data compression**
- System reliability with hardware & software redundancy
- Rugged design for harsh environments (temperature, pressure)

DESIGN & IMPLEMENTATION

System-on-Module (SoM) with AMD Zynq Ultrascale+

- Processing System (PS) with Quad-Core ARM Cortex A53 (1.5 GHz) and RT Dual-Core ARM Cortex R5F (600 MHz), Mali500 based GPU, 4 GB DDR4 Ram,
- Reprogrammable Logic (PL) with over 200 GPIO, 16 high speed transceivers, DSP slices
- M2 interfaces for storage and Wifi / BLE (16 GB M2 SSD available)
- PCIe, UART, I2C and many more interfaces
- QSPI and eMMC Flash memory

High-speed application interface

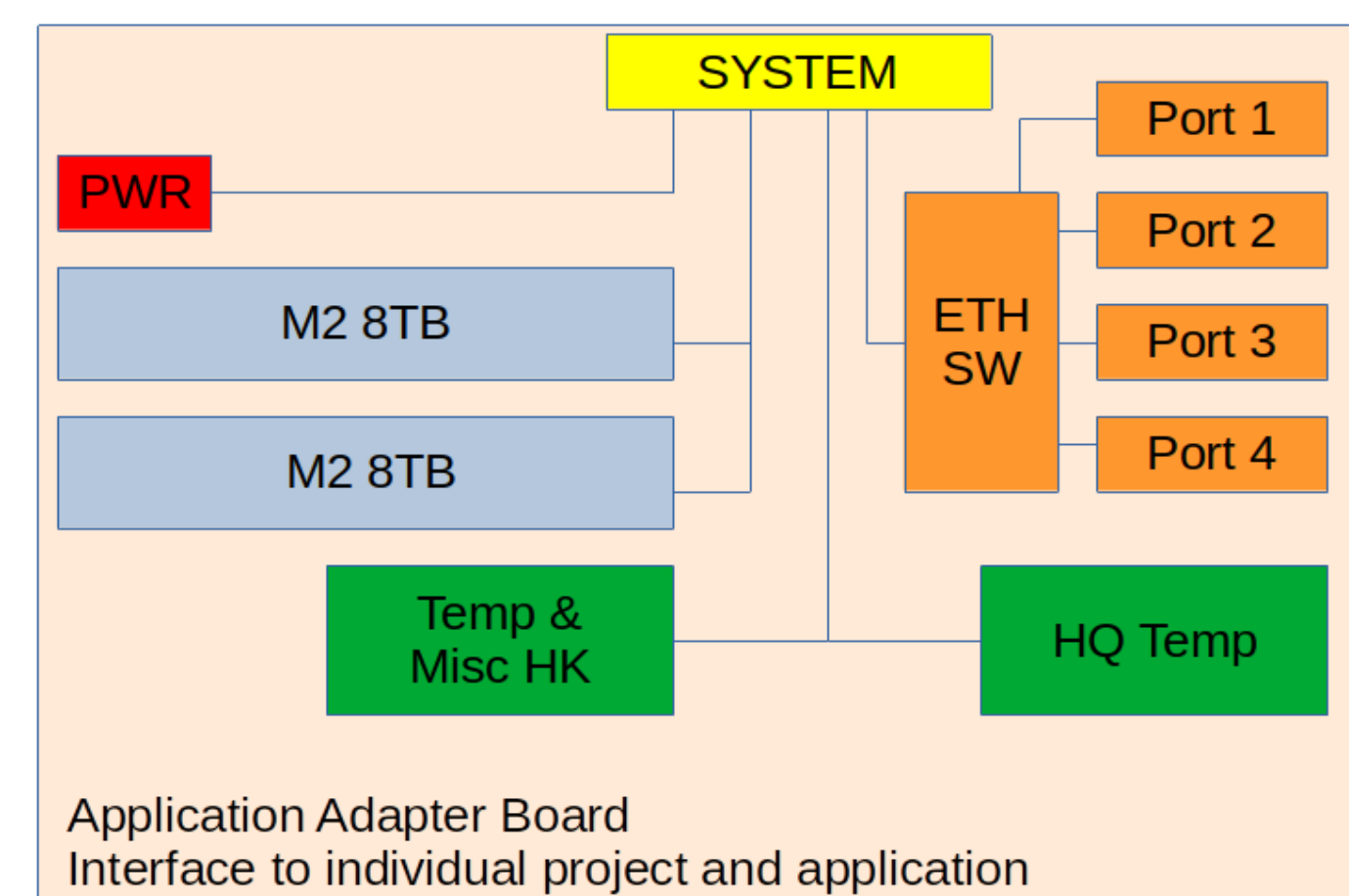
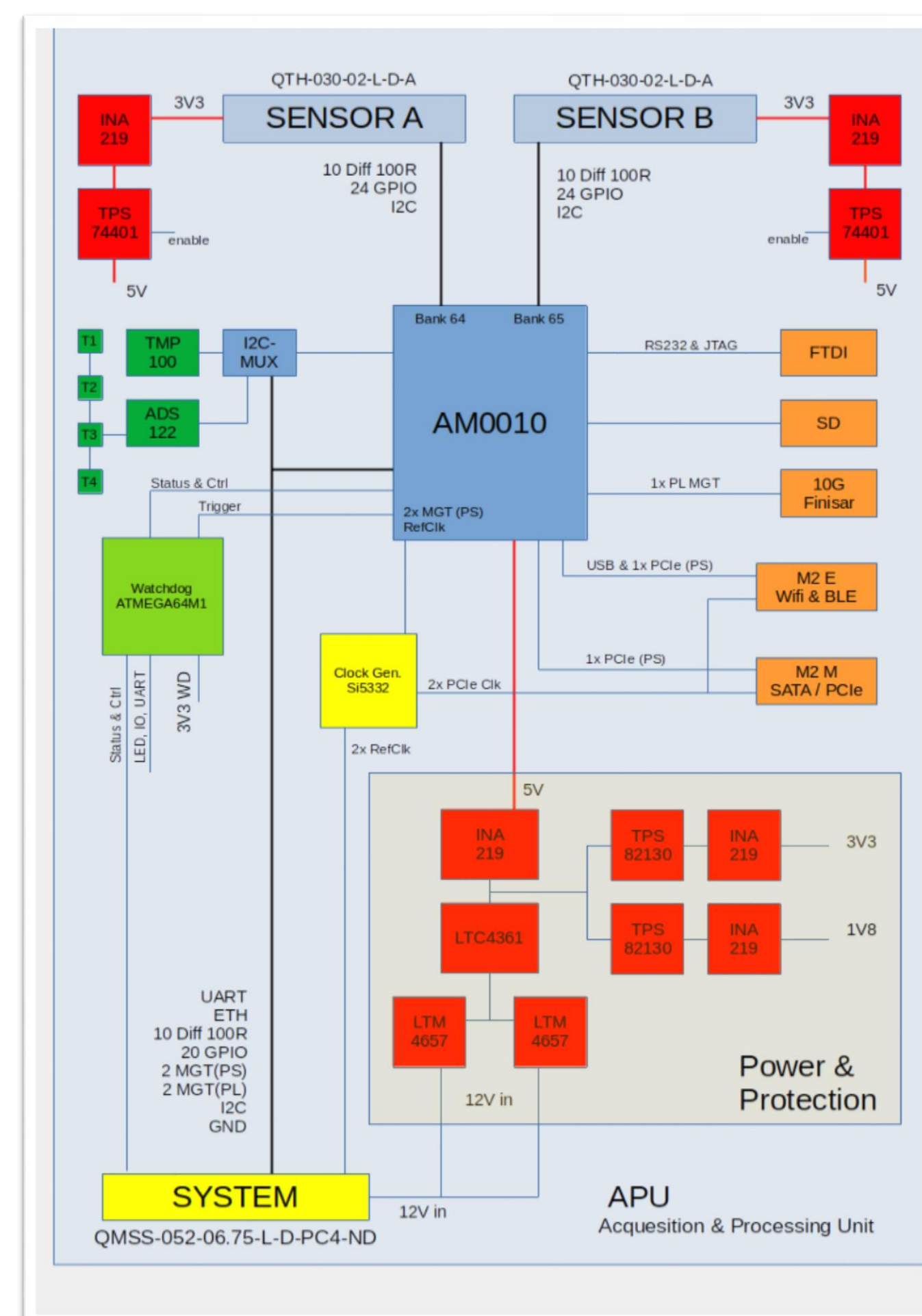
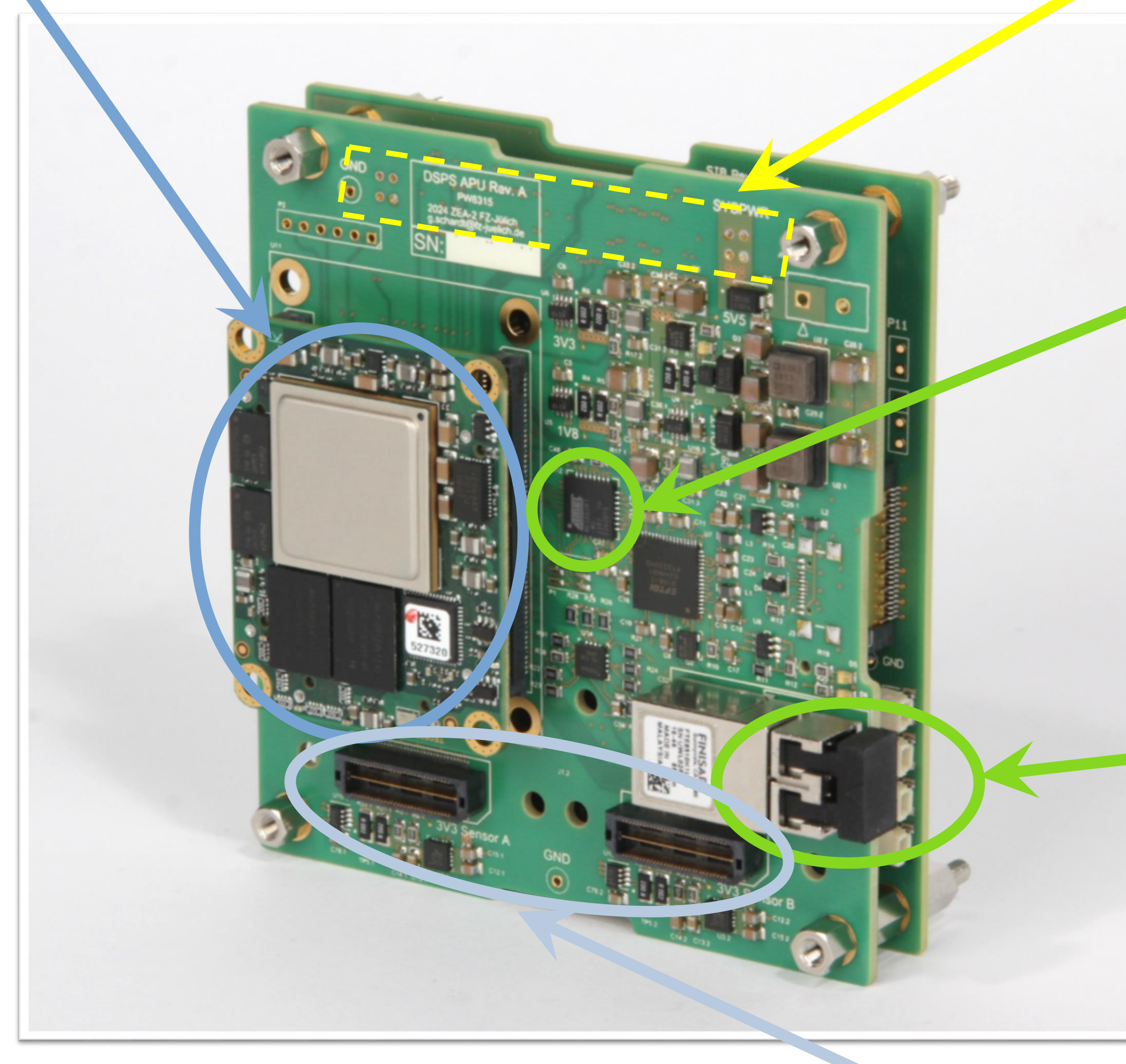
- Two MGTs from PL and PS each up to 16 GBit/s (PCIe, SATA, HDMI, etc.)
- 10 DP signals / 20 GPIO signals for additional sensors or housekeeping
- UART, I2C, 1 GB Ethernet
- Interface to application
- Mass storage card

Supervisor / Watchdog

- Power sequencing and monitoring, System watchdog
- Boot selection (golden Image from secured SD-Card)
- Radiation tolerant option available

10 G Fiber Ethernet

- Fast connection for
- Download to mass storage device
 - Readout high-speed sensors
 - Communication & control



Two sensor interfaces

- Connect two individual sensors to the FPGA part of the MPSoC module, independent of the interface
- Cameras, infrared detectors, particle scanners
- UART, I2C, SPI, CameraLink, CAN, SpaceWire, etc.
- 10 differential pairs, 20 single ended GPIOs, up to 1.26 GBit/s per pin
- Dedicated I2C bus for slow control and housekeeping data
- Rugged connector with flexible high speed cable

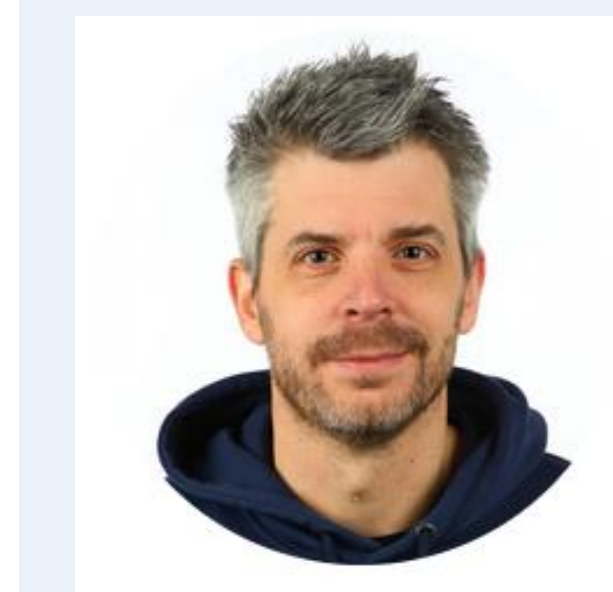
FEATURES

- Modular and customisable processing system in a **10x10 cm footprint**
- Multiprocessor module, with GPU and FPGA with more than **12 GFlops/s** on the ARM A53 [4]
- Power consumption in a realistic demo application is **less than 15 W**.
- Integrates on-board computer, instrument control, mass storage and data processing in a single platform
- Universal sensor interfaces
- High-speed application interface
- 10 Gb Ethernet
- Reconfigurable applications (in-system reconfigurable)

APPLICATIONS

- All types of instruments where small size, light weight and low power consumption are important.
 - Weather and stratospheric balloons
 - airborne instruments
 - Satellites
 - but also ROV (remotely operated underwater vehicle) or ground-penetrating radars
- First use will be as an on-board computer, instrument control and mass storage device in an upcoming balloon campaign.

CONTACT



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[1] Instrument concept and preliminary performance analysis of GLORIA, Felix Friedl-Vallon et al., 2006

[2] Picture of HALO with GLORIA-AB during StratoClim Testcampaign 2017, by Tom Neubert

[3] Picture of CNES Carmen Gondola with GLITE during Transat Campaign 2024, by Tom Neubert

[4] Evaluating the computational performance of the Xilinx Ultrascale+ EG Heterogeneous MPSoC, 2020 Jose A. Belloch et. al.