Raoul Grimoldi, 13th December 2022
ERASMUS AUDITORIUM - ESTEC

OHB ITALIA

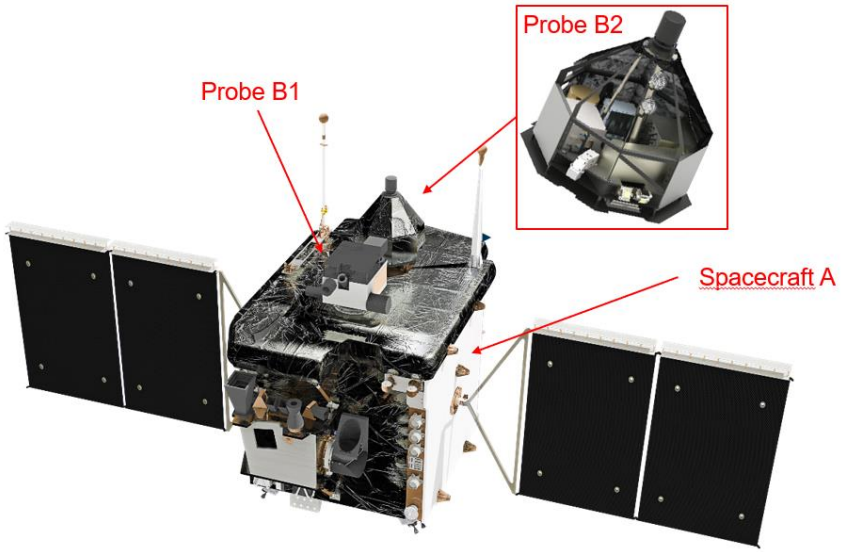
SPACE SYSTEMS

GR740 User Day 2022

Hi-REL On board computer for low-cost applications

Comet Interceptor mission

- Comet Interceptor is an ESA mission with payload contributions from ESA Member States and with an international participation by JAXA
- Mission selected in June 2019 as a Fast track mission in the ESA Science Programme, for a nominal launch in 2029, on a shared Ariane 6.2 flight, with the ESA mission ARIEL
- The mission will travel to an as-yet undiscovered comet, making a flyby of the chosen target when it is on the approach to Earth's orbit.
- OHB Italia has been selected as Prime Contractor for phases C/D/E1 and is also in charge of the **Probe B2 Data Handling System (OBC)**



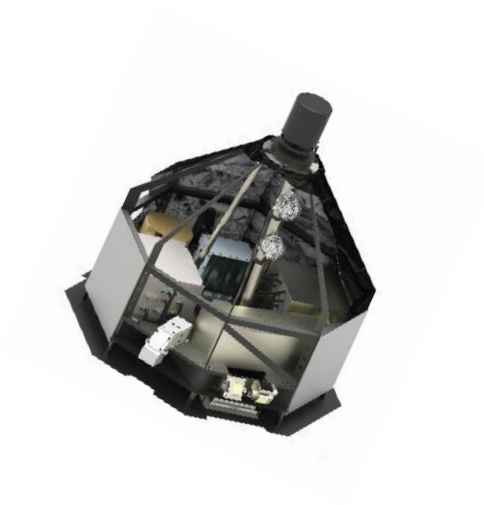
Spacecraft Features:

Mass: 975kg
Power: 888 W

Probe B2 overview

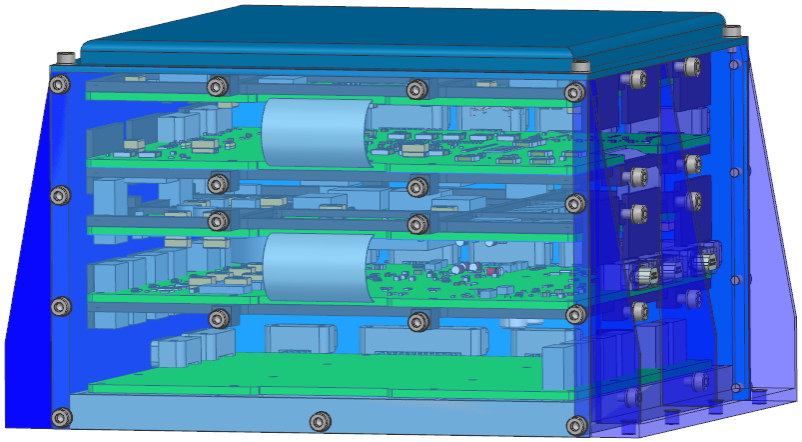
Probe B2 includes the following equipment:

- **On Board Computer (OBC)**, implementing both power and data handling functionalities, due to physical constrains imposed by Probe-B2 mechanical configuration, for mass/volume saving reasons
- Intersatellite Link transmitter for science data transfer to S/C A
- AOCS composed of Sun Acquisition Sensors (SAS) and Gyroscope
- Reaction wheel (RW)
- Thermal Control System (TCS) composed of heaters and thermistors
- Battery
- Three payloads
  - Entire Visible Sky (EnVisS)
  - The Optical Periscopic Imager for Comets (OPIC)
  - Dust Field & Plasma (DFP) including Flux Gate Magnetometer (FGM)

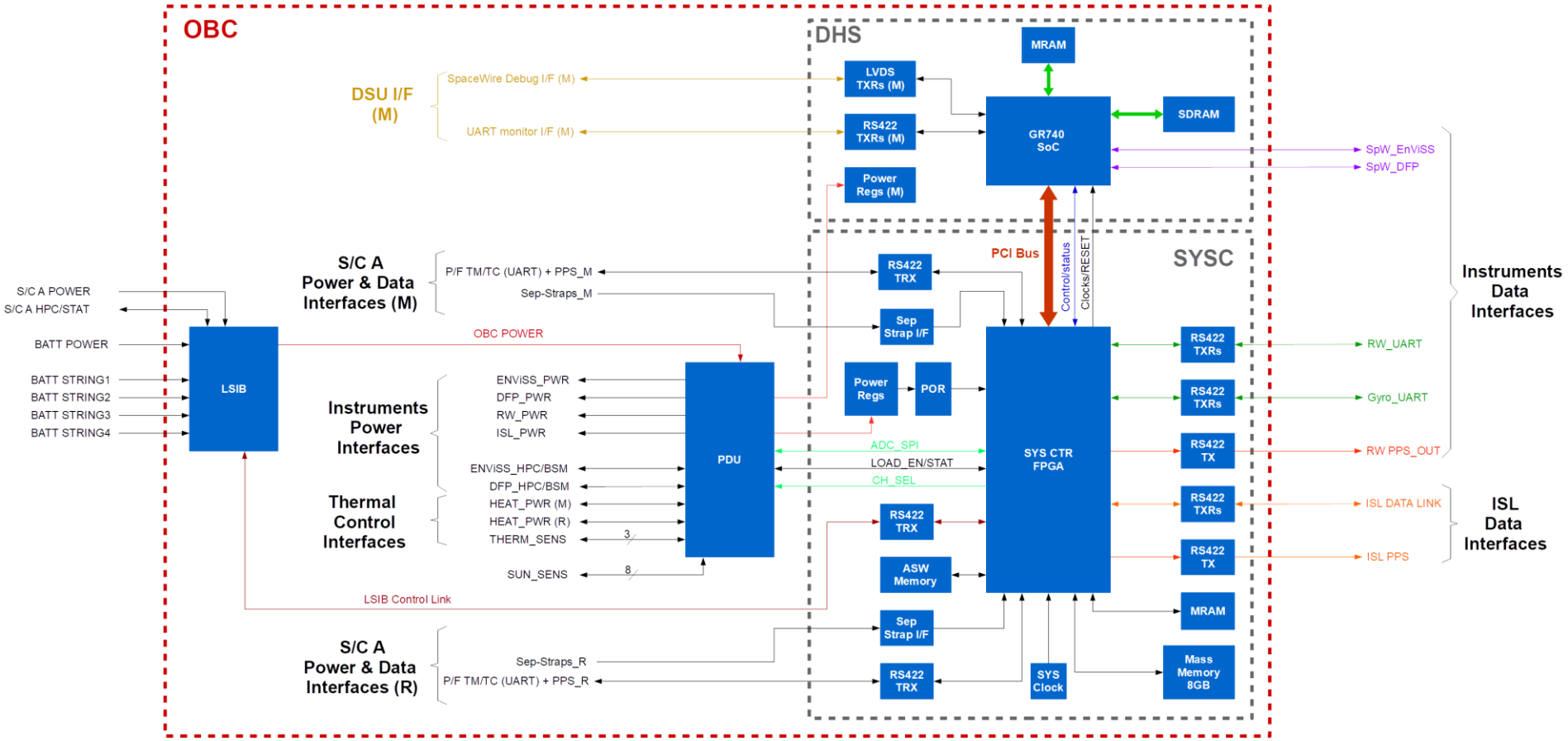


Probe B2 OBC design main challenges

- Low mass/volume
  - Height : 115.5 mm
  - Width : 200.0 mm
  - Depth : 164.4 mm
  - Mass : < 2,42 kg
- Low power < 18W with full loads active
- Radiation Hardening Assurance
  - TID > 10 kRad
  - SEL th > 40 MeV*cm2/mg (Si)
  - EEE parts latch-up immune
- PCB IPC 3 + space addendum
- ECSS design flow
- Design supported by a full set of analyses



Probe B2 OBC architecture



Probe B2 OBC architecture

Data Handling System

It is in charge to manage the whole probe B2 avionics by performing the following tasks:

- AOCS
- Instruments management (HK and science data acquisition)
- Avionics subsystems management
- Probe-B2 thermal control
- Data exchange with S/C A via both umbilical link and Intersatellite link
- FDIR (both at instruments and avionics level)

Life Support & Interface Board (LSIB)

It is dedicated to battery management and conditioning of power provided by S/C A

Power Distribution Unit (PDU)

It is dedicated to distribution to payloads and avionics subsystems of power coming both from S/C A and Probe-B2 battery

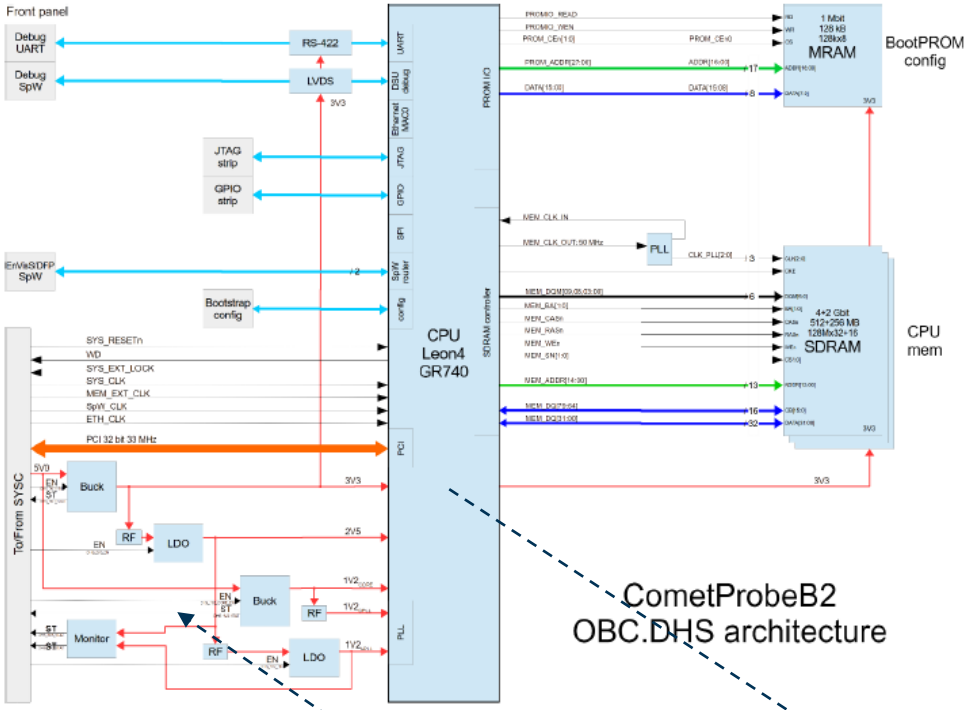
Probe B2 OBC architecture

System Controller (SYSC)

It performs the following functions:

- DHS and PDU supervising (activation/deactivation of both DHS module and instruments, faults recovery)
- Data exchange with DHS
- On Board Time (OBT) management based on PPS signal provided by S/C A
- On board time distribution to Probe-B2 users
- Science data storage in NV mass memory
- Formatting and coding of telemetry data stream to be transmitted to the S/C A via ISL

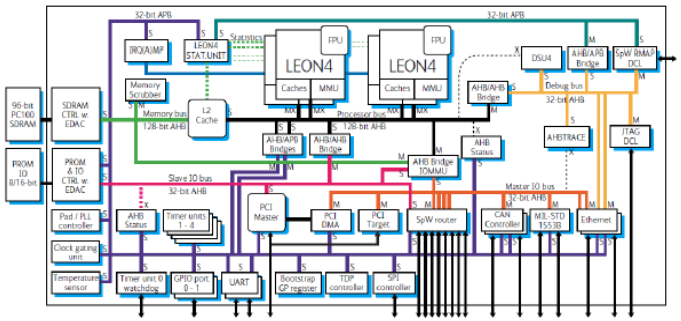
Probe B2 OBC architecture - DHS



Specifications:

- Boot PROM: two banks, 128kB each
- System Memory: 512MB with Reed-Solomon EDAC
- Two SpaceWire links with the instruments
- PCI local bus @ 33MHz for data exchange with the companion FPGA
- # active cores : 1
- CPU system clock frequency: 50 MHz

Local power conditioning composed by a set of independently controlled PoL regulators for CPU power sequencing implementation



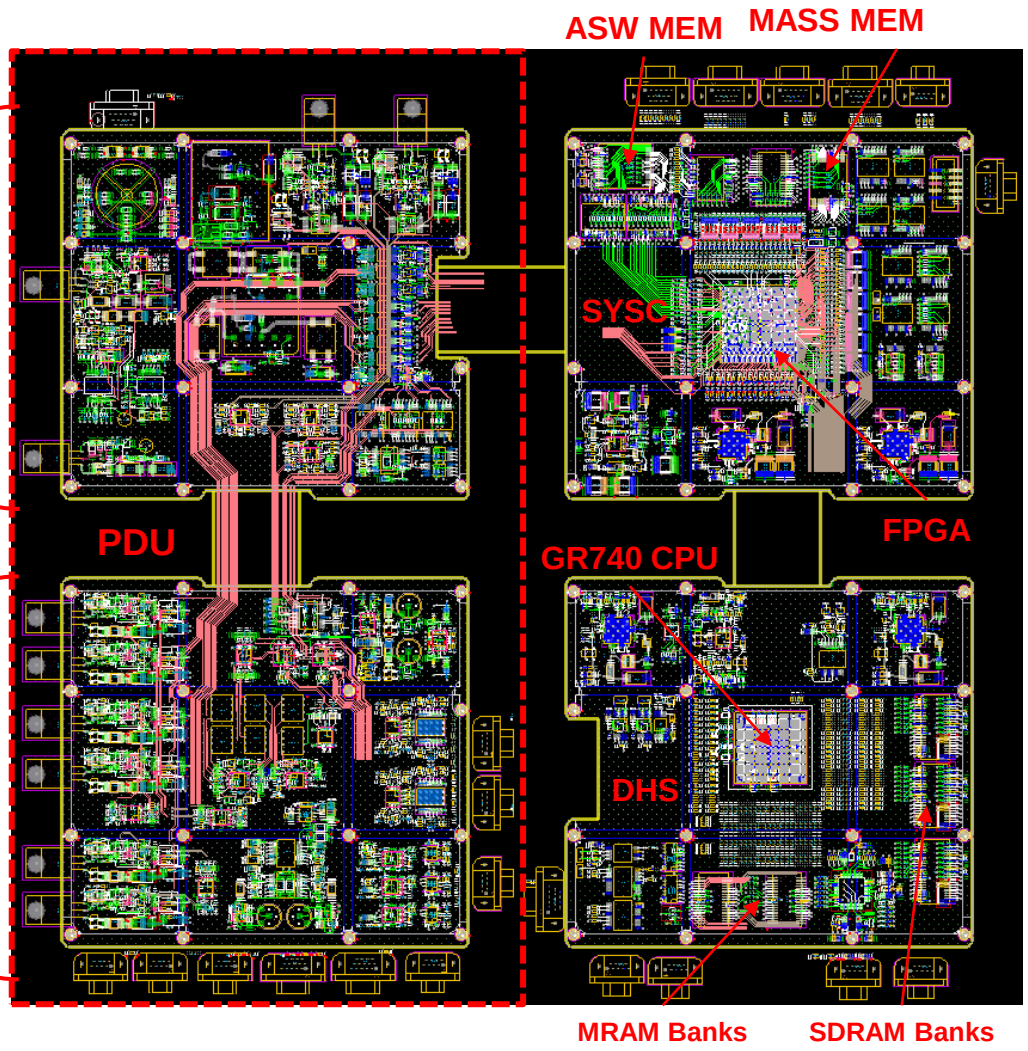
Probe B2 OBC EEE part selection

- **GR740 space plastic**
- RTG4 FPGA (MIL-STD-883 Class B)
- Rad-tolerant memories
- Space Plastic Radiation Tolerant parts for analogue & power functions
- Radiation tolerant hybrid DC/DC converters in H+ quality level
- Discrete parts
  - JANTXV parts for diodes
  - ESCC qualified parts for BJT
  - Rad-tolerant MOSFETs
  - Rad-tolerant Optocouplers
- AEC-200 (Automotive) for passive parts

TID > 20 kRad

SEL immune up to 45 MeV*cm2/mg (Si)

Probe B2 OBC layout



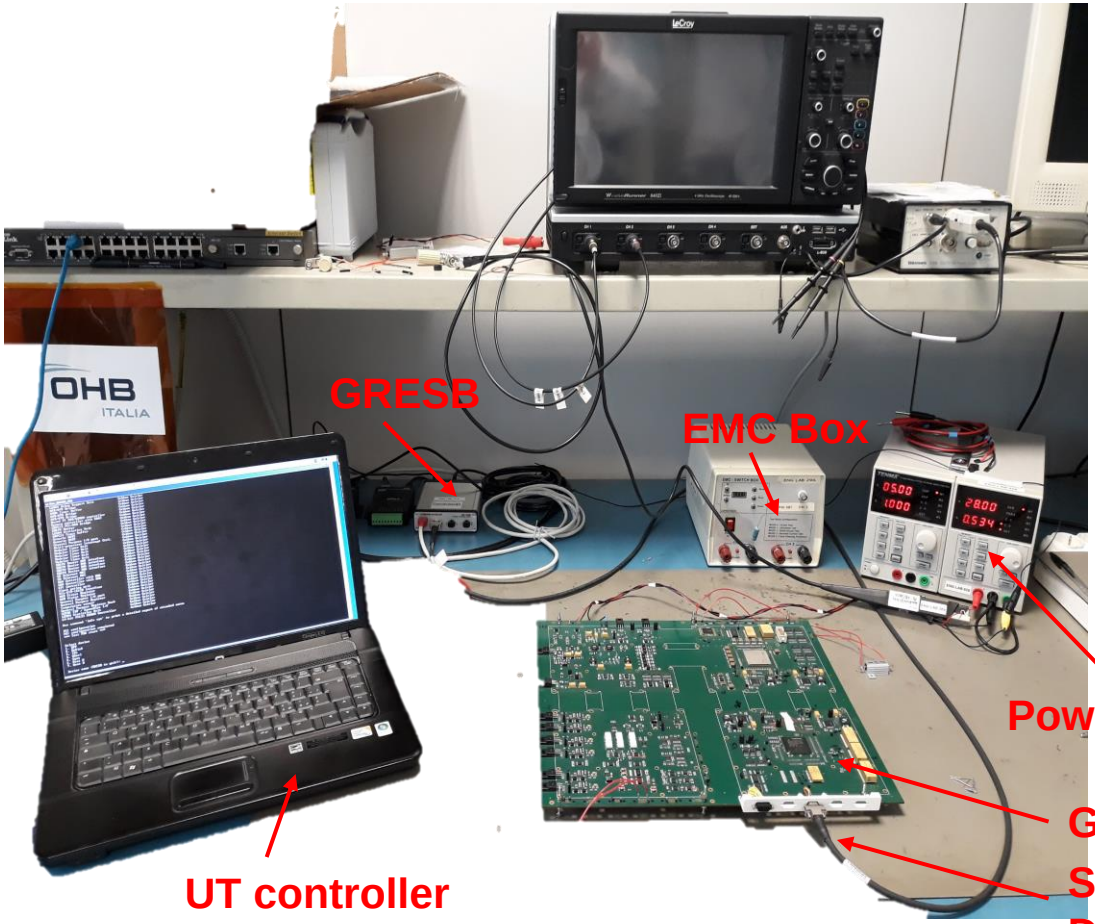
To achieve a high level of integration, the OBC architecture exploits the PCB rigid-flex technology to minimize the box volume and mass.

The use of complex SoC like the GR740 and high-density FPGA allows to integrate all OBDH functionalities in a small volume.

Removing the PDU power distribution section, the three rigid PCBs (DHS, SYSC and Local Power Conditioning) can be considered a very compact OBDH for small platforms

Probe B2 OBC Elegant Breadboard

An elegant BB has been developed for Probe-B2 as de-risking activity.

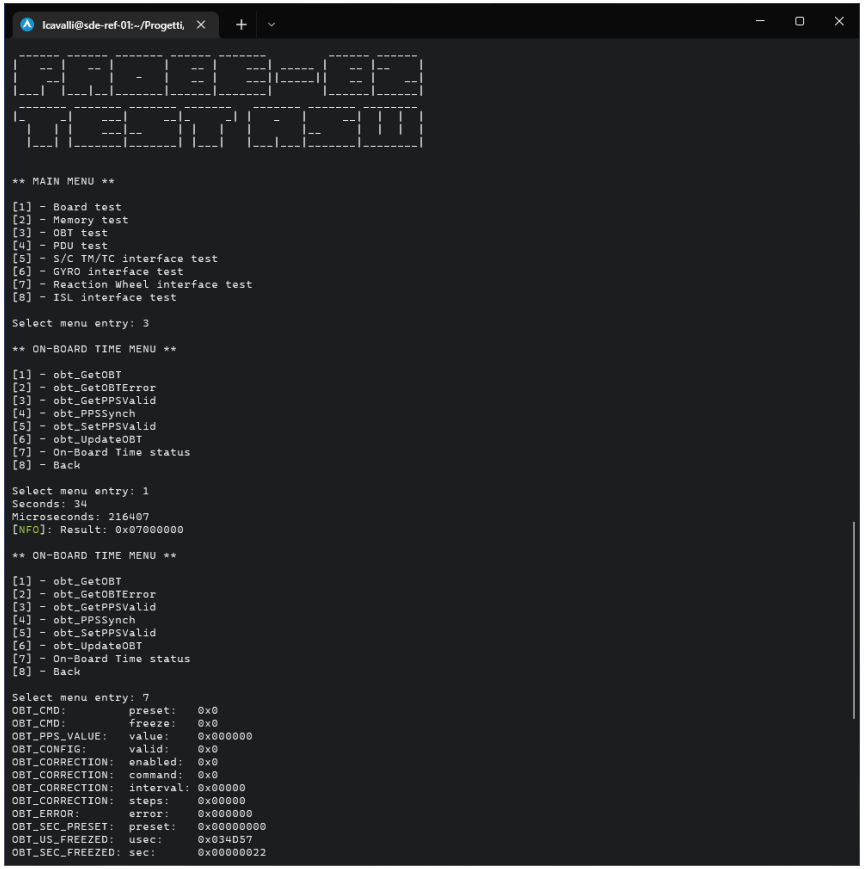


The BB is a representative model of the PDU, DHS and SYSC.

All functionalities of the OBC, with exception of battery management, have been implemented and successfully tested.

Probe B2 OBC Test Software

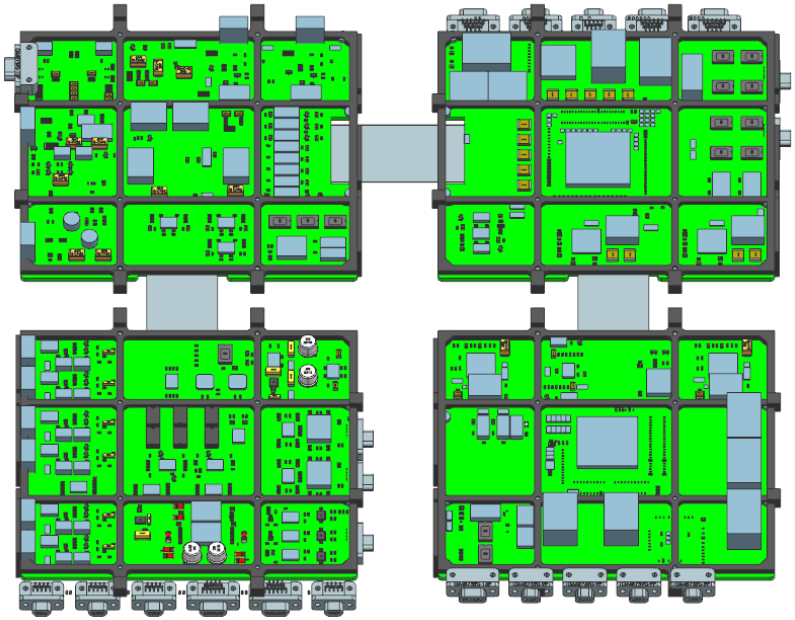
- The Elegant BB validation test campaign has been exploited by the TCL based scripting engine provided by GRMON.
- A set of test scripts has been prepared to evaluate the correctness of the design and the hardware/software interfaces.
- A test application (TASW) has been developed. The TASW is a single task RTEMS application exploiting a console over UART to allow to execute the test functionalities.
- The RTEMS used to produce the executable is the RTEMS QDP by ESA.

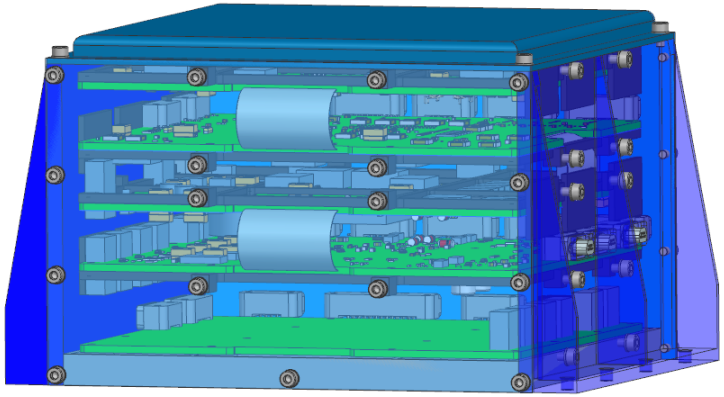


Probe B2 OBC Development

The following models are foreseen

- EQM model with Rigi-flex PCB to be housed in a representative mechanical design by end of 2023
- PFM Model delivered by August 2024.





Probe B2 OBC in OHB - Italia OBC Roadmap

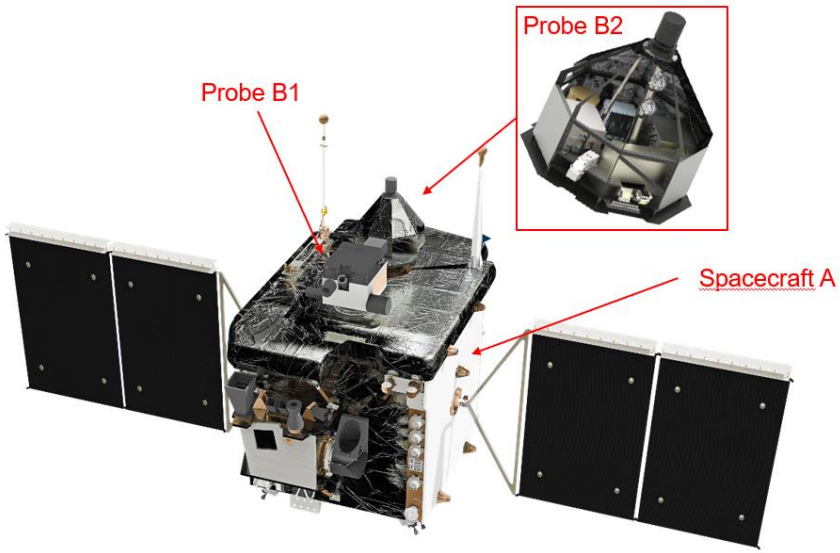
- GR740 SoC has been selected for the OHB-I new generation OBC architecture being available on the market on both Space Plastic and Class 1 quality level
- The designed architecture can be applied for

- High Rel Space Computer for mainstream missions adopting Class 1 parts with more standard form factor (e.g. Space VPX or cPCI Serial)
- “New Space” missions where RHA and well proved reliability is required

- The architecture is scalable in term of

- Computational power/Power consumption
- EEE part quality level / cost

- Probe B2 OBC represent the first implementation of the “New Space” version, fully customized with additional functions required for Comet-Interceptor mission



Thank You for your attention!

Raoul.Grimoldi@ohb-italia.it