Flight hardware optimisation through modularity and building blocks

ESA EDHPC
October 2023

DEFENCE AND SPACE

Arnaud Wagner

AIRBUS

Export Control Information

a. National and EU regulation Export Control Assessment

This document has been assessed against applicable export control regulation in

☒ France ☐ Germany ☐ Spain ☐ UK ☐ Other: [*Specify the country*]

☒ and does not contains Controlled Technology1 and is therefore **« Not Listed / Not Controlled »**

☐ and contains Controlled Technology1 with export control classification [Insert classification number, e.g ML22x, Xexxx, AMAx]

Note : Any transfer of this document in part or in whole must be made in accordance with the appropriate export control regulations. Prior to any transfer outside of the responsible legal entity, confirmation of an applicable export licence or authorisation must be obtained from the local Export Control Officer (ECO).

b. US (ITAR/EAR) Export Control Assessment

☒ This document does not contains US origin Technical Data (Technology)

☐ This document contains « Technology » which is controlled by the U.S government under [*USML category number / ECCN*] and which has been received by [*Legal entity*] under the authority of [*Licence number / ITAR exemption / NLR*]

☐ This document contains technology which is designated as EAR99 (subject to EAR and not listed on the USML/CCL.)

Note : Any re-export or re-transfer of this document in part or in whole must be made in accordance with the appropriate regulation (ITAR or EAR) and applicable authorization. If in any doubt please contact your local ECO.

c. Technical Rater Information

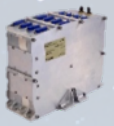
This document has been assessed by the following Technical Rater :

Assessed and classified by: Jean-Luc Poupat

Date classification completed: 01/09/2023

AIRBUS

Space Electronics key figures & facts



450
France workforce

> 1200 boards /y
> 150 unit /y

150 M€
Revenues
40% export

Space Agencies

Start-up, medium & big size companies

Institutions and Defence Agencies

Satellite Operators

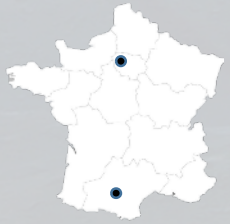
Governments, institutional and enterprises from multiple areas/ fields

1st

Worldwide Leader

> 60 M€ Export
Order Intake in 2022

Spacecraft Electronic Unit Supplier



Elancourt

Toulouse

Our Ambition

Be worldwide Electronics and Sensors / Actuators reference for Space

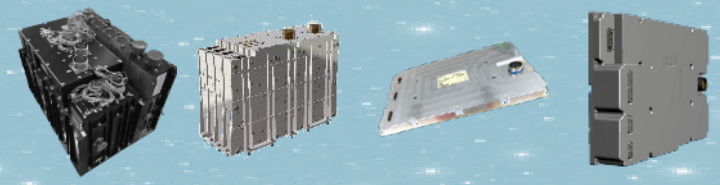
Master New Space & Conventional Space solutions from design and technologies, up to manufacturing & test processes

Pioneer and qualify space technologies for future spacecrafts, launchers & space systems

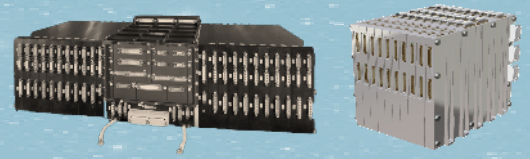
Be attractive for talents by offering key competences acquisition and efficient collective knowledge management

AIRBUS

Space Electronics reliable & large unit portfolio

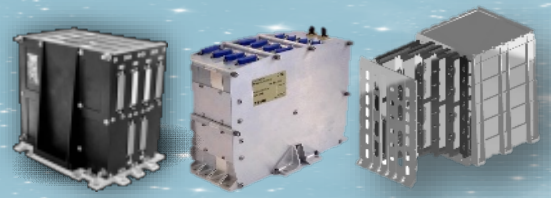


Electric Propulsion

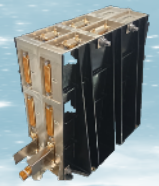


Power Distribution & Regulation

Power & Propulsion Units



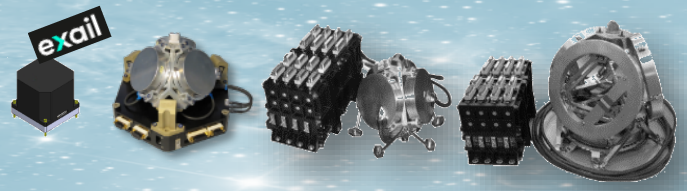
On-board Computers



Security

Payload Data Handling

Platform & Payload Processing Units



Fiber Optic Gyroscopes

Control Moment Gryroscope

Sensors & Actuators

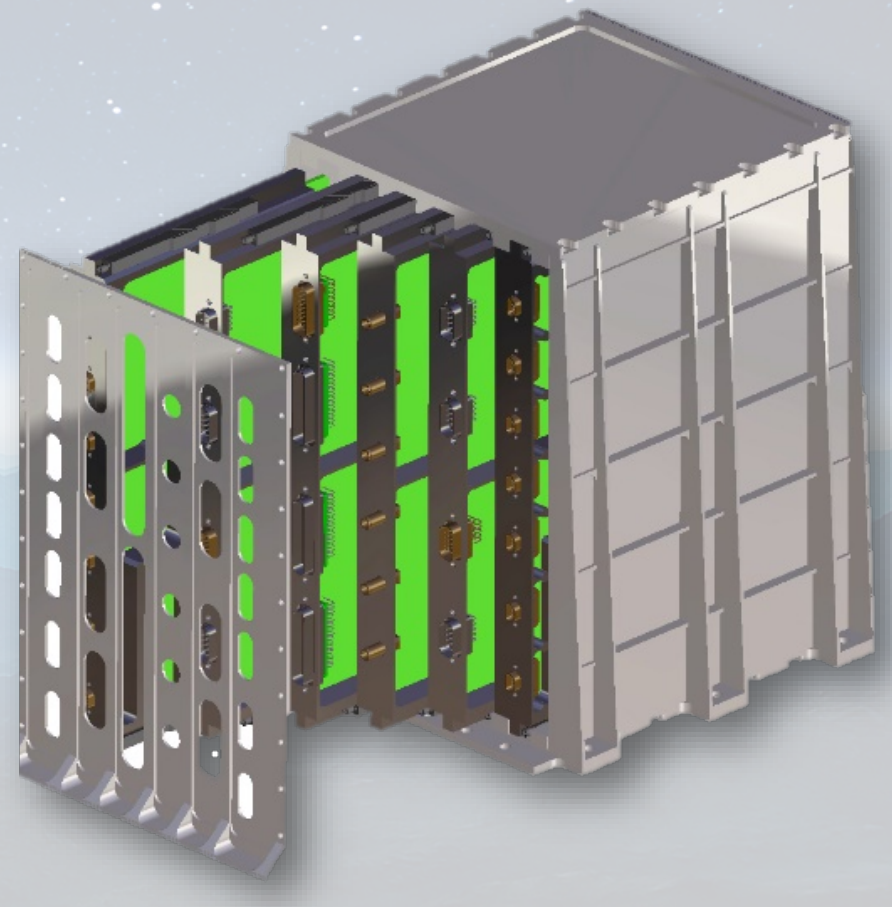
www.airbus.com/en/products-services/space/equipment

AIRBUS

Advantages of Modularity

Main **advantages to standardize** modular architecture

- Shorter development time
- Merge of Modules from different providers
- SW development improvement thanks to the use of standardized interfaces



Example of Modular OBC

Baseline Version

Power Module

Processor Module

Companion Module

Extended Version

GNSS Module

Telecom Module

AIRBUS

Threads of Modularity

All modularity **features not used** in orbit life

Increase of the electronic functions size

- Local power distribution
  - ➢ All local power shall be generated and not shared on the backplane
- Backplane Interface electrical drivers

Increase of volume and weight

- Mechanical features for rack

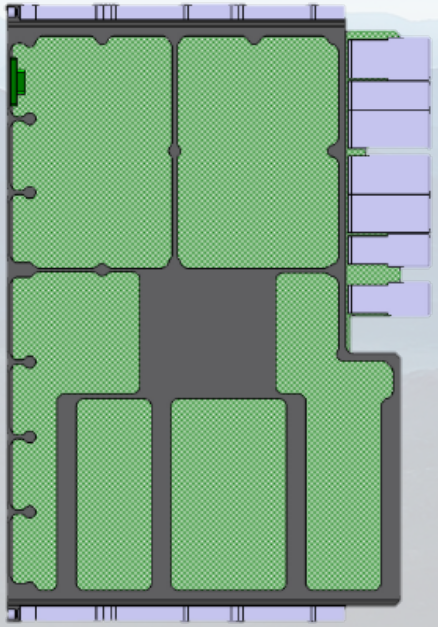
Generally **only one face of the unit reserved for connectors**

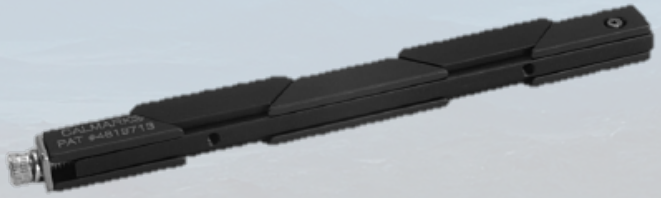
Standardization - Physical Impacts

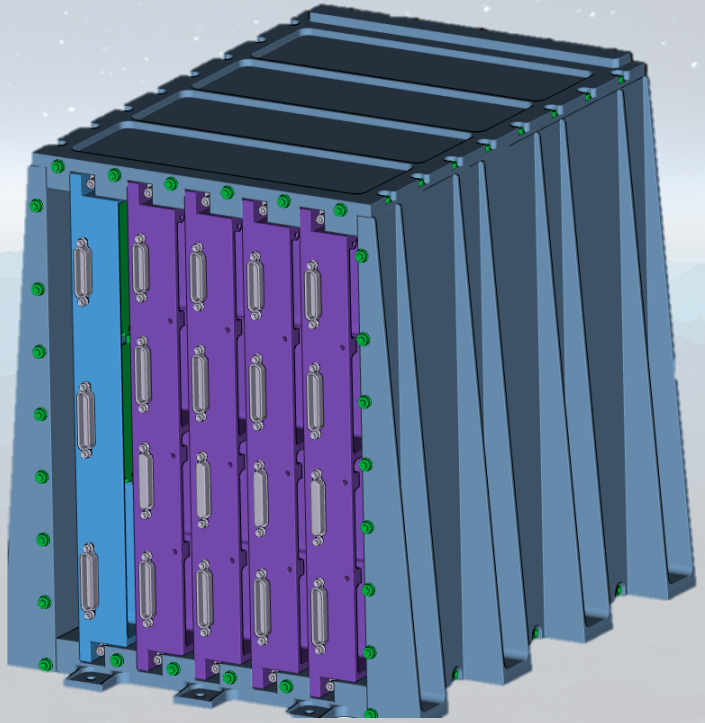
Standardization leads to **increase the mass and the size** (for a 6U extended cPCI):

- Weight more than 2 kg per module

- Frame alignment needs specific hardware (wedge-lock)







Standardization - Electrical Impacts

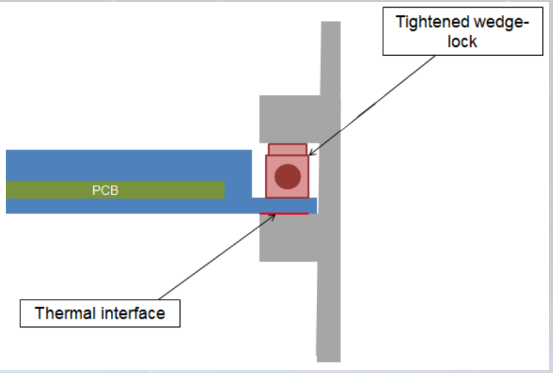
Standardization leads to **decrease electrical interfaces** (on back-plane):

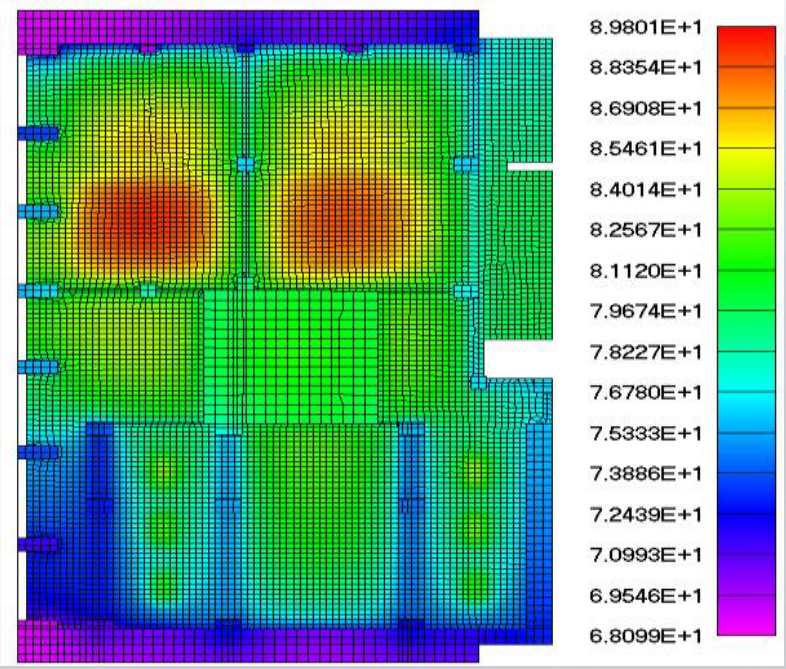
- Use of limited interfaces and buses : i.e. CAN, SpW, SpF
- Preference for serial communications
- Increase of data rate using on serial
- Power distribution on a single shared intermediate voltage.

Standardization - Thermal Impacts

The use of standardized modules may limit the power dissipation

- The locking and alignment hardware is generally the only thermal interface to the frame
- Limit of power dissipation around 30W per module

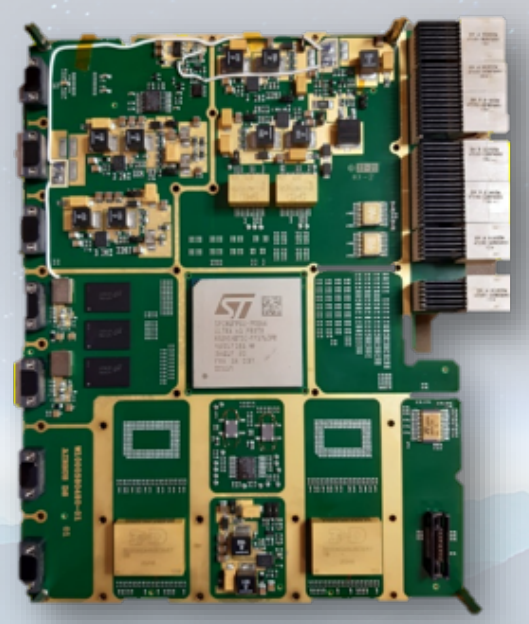




AIRBUS

Technologies

The **use of new SoC technologies** gives benefits to modularity



- Very high integration of the of the SoC (System on Chip)
- Reconfigurability even in space (FPGA)
- High processor performances

BUT:

- The modularity can limits the use of some interfaces of the SoC
  => use of HSSL and serial protocol to transmit data

- The local power distribution is complex and taking into account FDIR can be expensive in PCB surface
  => Use of integrated POL

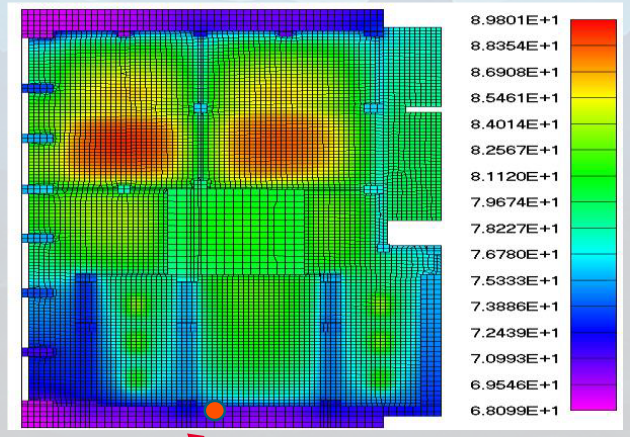
Qualification of modules

How to consider a module as **qualified at module level** (regarding the integration in a unit)

- **Test communication interfaces with margins on the back-plane interfaces**
  - Use standard worst case backplane to test interfaces between modules
  - Measure of signal at module to back-plane interface

- **It shall dissipate heat by the mechanical interfaces**
  - Proposal of a standardized module TRP with a position at the mechanical interface for thermal analysis

- **It shall be compliant with a standard vibration and shocks**
  - Use of a standard frame giving the mechanical constraints at module level



AIRBUS

Qualification of unit

Taking into account that **a qualified module can be relaxed to**:

- Hardware software integration
- Electrical test on serial interface by test at maximum speed
- During thermal test verify the local TRP at each module
- Mechanical tests

Conclusion

Development

- The modularity shall be at functional level i.e avoid merging different functions on one module
- Use preferably serial interface and only standardize interfaces on backplane
- Limit the power dissipation

Qualification

- Standardize the tests done at module level
- Margins shall be integrated on test results
- Use of a standard worst case frame for test

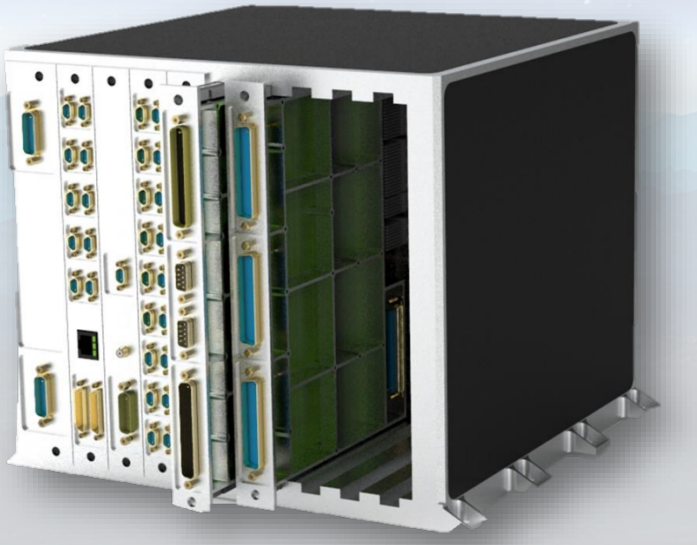


Illustration picture from ADHA working group

Thank you

AIRBUS