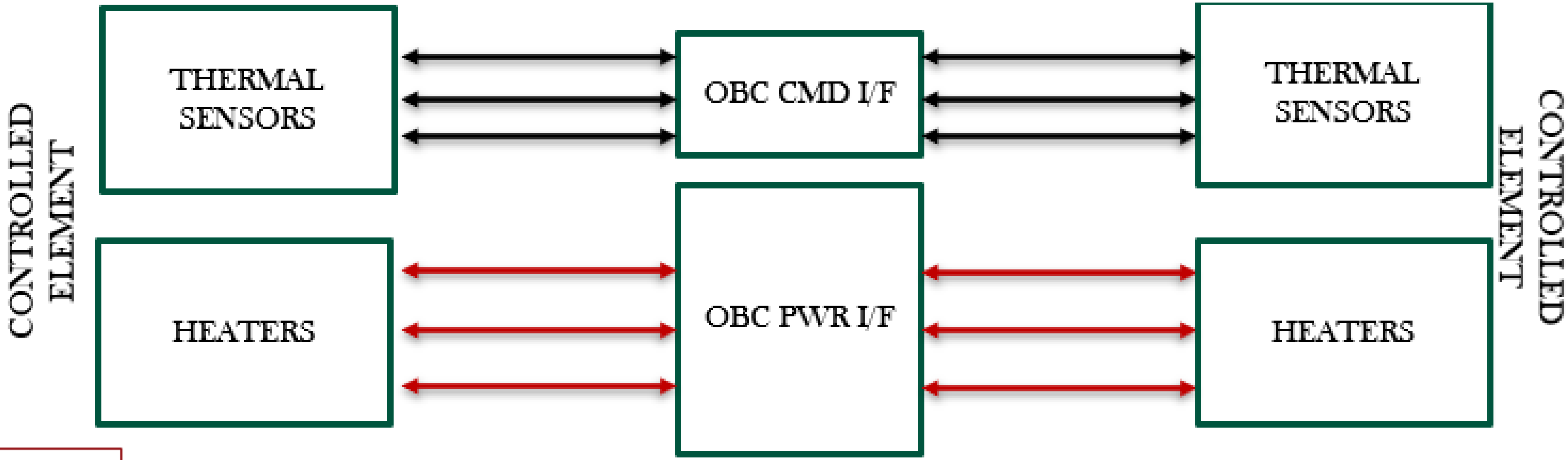
UNIVERSITÀ DEGLI STUDI DI PADOVA

Development of a local thermal control unit (TCU) for parts of satellites and extraterrestrial habitats

Delia Visconi - 40th Cycle

Admission to 1st year
Meeting - 13.11.2024

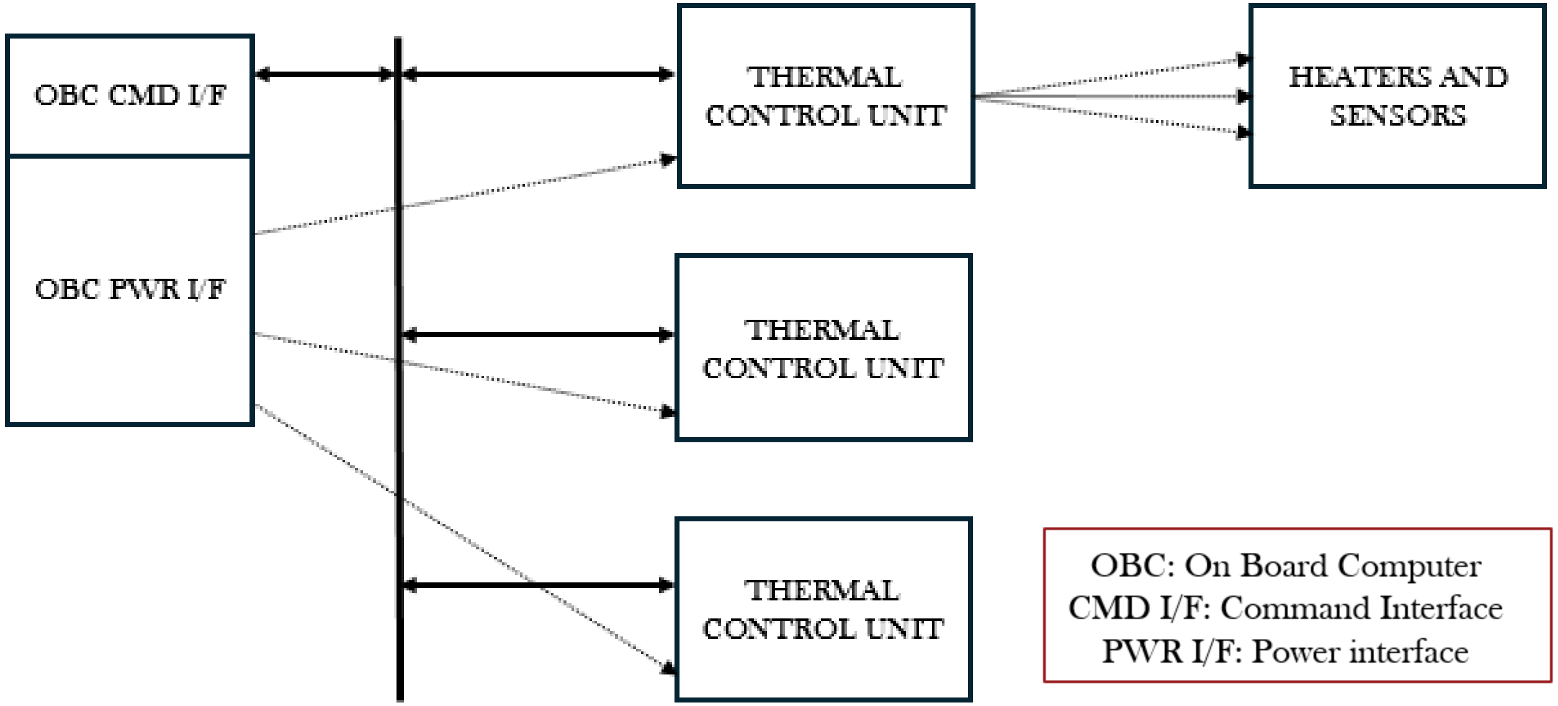
Centralized vs localized thermal control



OBC: On Board Computer
CMD I/F: Command Interface
PWR I/F: Power interface

Only a minimal portion of the OBC lines is dedicated to thermal control

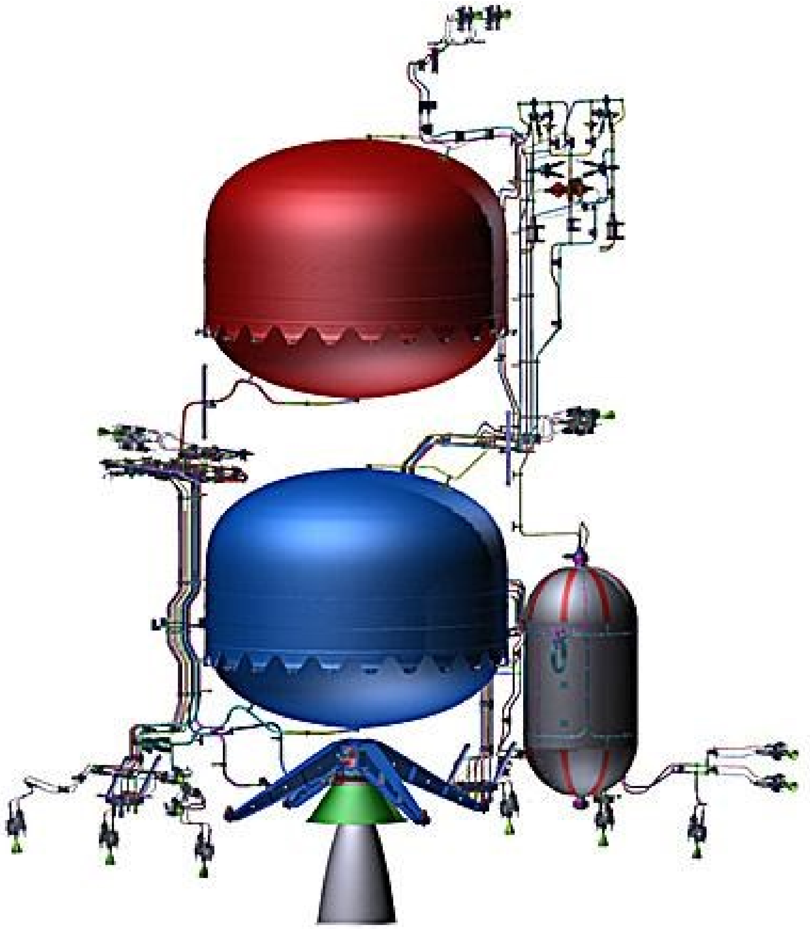
Centralized vs localized thermal control



OBC: On Board Computer
CMD I/F: Command Interface
PWR I/F: Power interface

- Possibility to integrate a **greater number of sensors (better control of the heating system)**
- Reduction in **wiring complexity**
- Increased **fault tolerance**
- Reduction in OBC **data load**
- **Recycling of heat** generated by the TCU to reduce the power requirements of components
- **Reduction in wiring length** implies better accuracy

Where is the solution suitable?



The TCU will be strategically positioned in critical areas of the satellite:

- Propulsive system tanks
- Pipelines
- Bus/payload interface
- Attitude control thrusters

MEDIUM TO LARGE SATELLITES

Case of study overview

A more effective thermal control of the subsystems leads to significant scientific advancements in the mission

Attitude control of the Euclid satellite: thrusters that stabilize the satellite during pointing phases

CENTRALIZED TCS:

Inconsistent heating needs: orientation can cause some thrusters to be in shadow, other in sunlight

↓

The OBC simultaneously controls all the heaters

↓

- Overheating of sun-exposed thrusters (or they could be too cold)
- Reduction subsystem performance

Case of study overview

<u>A more effective thermal control of the subsystems leads to significant scientific advancements in the mission</u>

Attitude control of the Euclid satellite: thrusters that stabilize the satellite during pointing phases

LOCALIZED TCS:

<u>Autonomous heater management</u>: ability to turn heaters on/off as needed

- Ensures proper heating for precise stabilization
- Leads to sharper images and higher-quality scientific data

Research project phases and goals

First year

1. Bibliographic research: review of the state of the art and technical reports
2. Initial simulation on a real case (or a hypotetical scenario) to evaluate benefits in terms of power and mass budget
3. Functional requirements and specifications (analysis of product safety and reliabililty (e.g. radiation resistance)
4. Preliminary software and electronic design

Second year: breadboard development and testing

1. Build the breadboard, followed by testing and validation (potentially at Zoppas).
2. Detailed software development.
3. COTS-based prototype for short-duration, non-scientific space missions.

Third year: will be dedicated to digital twins and final testing for scientific purpose missions.

Thanks for the attention

Università degli Studi di Padova