- Federal University of Santa Catarina (UFSC)
- Florianópolis/SC - Brazil

Agenda

- Partnership
- Introduction
- Subsystems
  - Payload
  - Communication System
  - Power System
  - On-Board Computer
  - Attitude Control System
  - Ground Station
  - Launching
- Conclusion

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Funding

- Brazilian Space Agency (**AEB**)

- National Council of Scientific for Technological Development (**CNPq**)

Partnership

- Federal Institute of Santa Catarina (**IFSC**)

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GSE Embedded Systems Group

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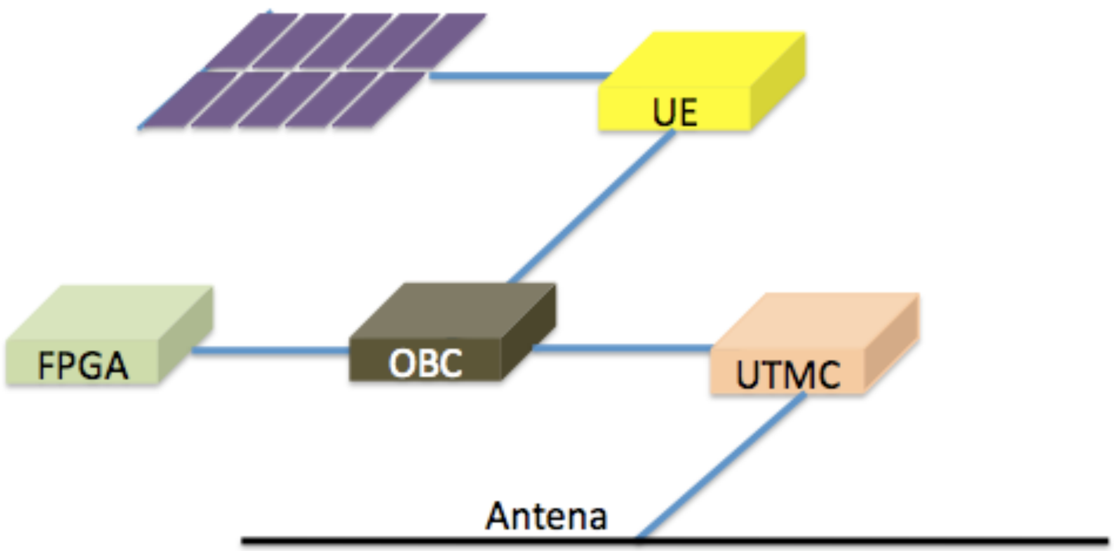
- The project's main goals are:
  - **To inspire** both undergraduate and graduate **students** to work in the space field
  - To establish a **strong cooperation** network among **industry and university** institutions

- The system was divided in modules in order to make it **reusable** in future projects and to make tests and **formal verification**.



General Architecture

Agenda

- Partnership
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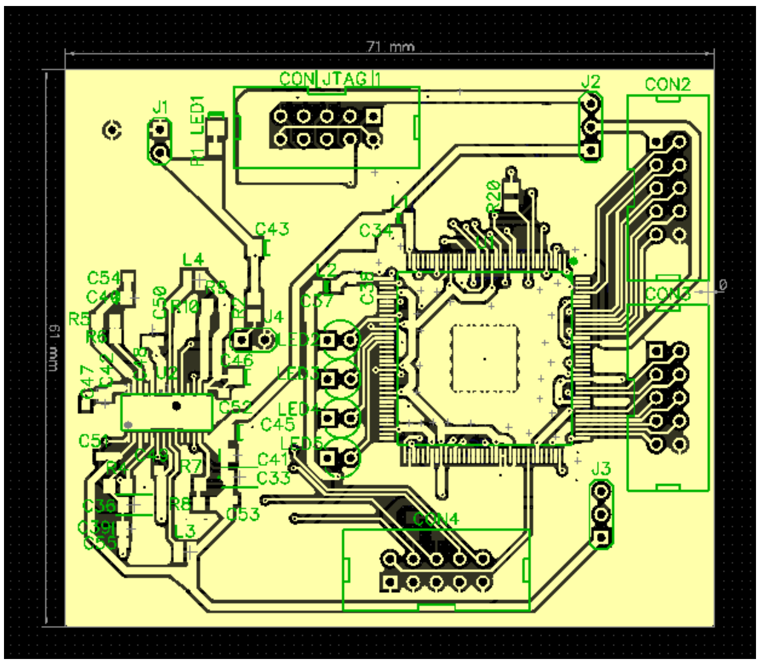
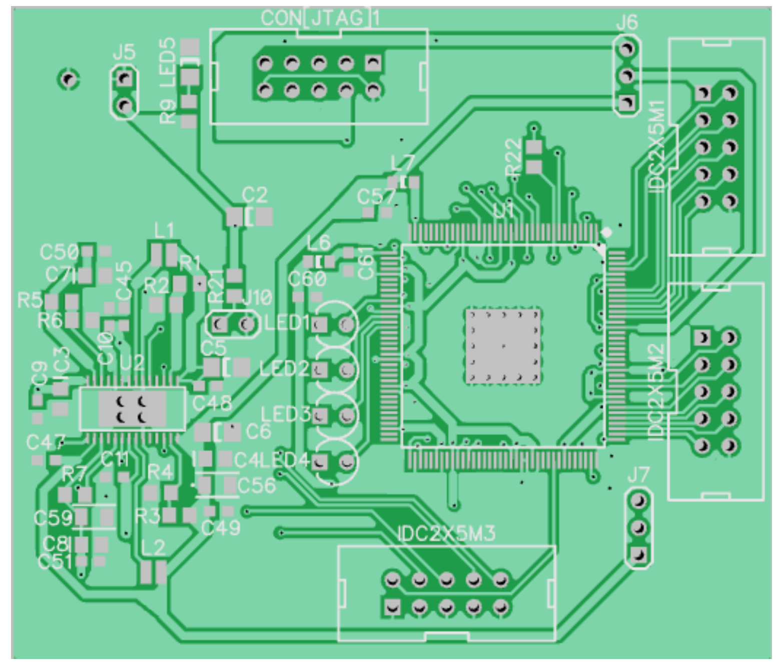
Payload Targets

- To study **COTS FPGA's** behavior when exposed to radiation
- To study **energy harvesting** technologies applicable to nano-satellites environment





Schematic of the FPGA board used in the payload

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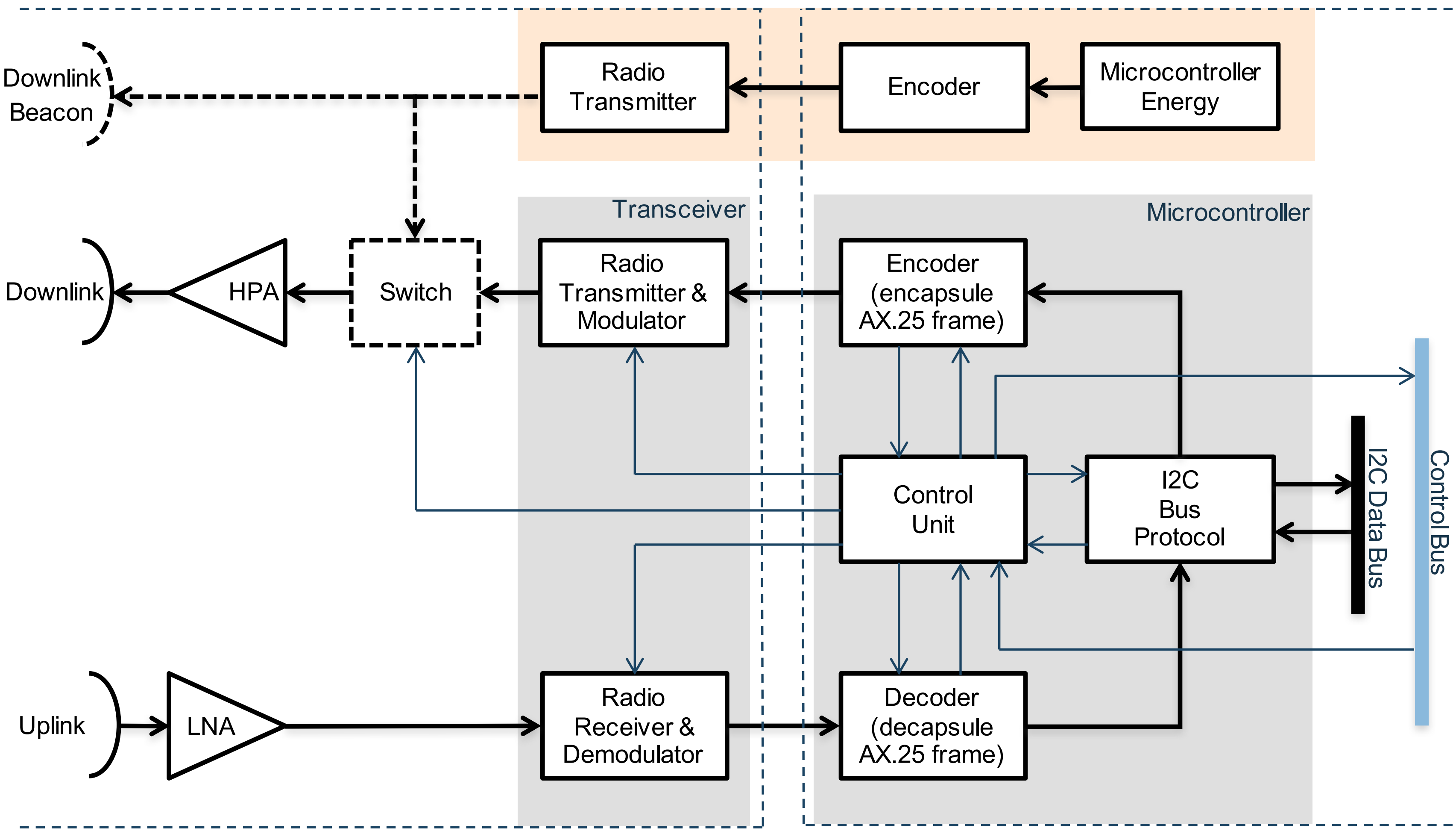
Communication system - **Requirements**

- The Communication subsystem verify the **integrity** of the frame and the command received from a ground station.

- A **beacon** transmitter is required using independent communication resources:
  - The beacon must send data from the Power System
  - Even if the Communication System fails, the Beacon should **always** be able to send Power System data
  - The beacon must avoid unnecessary battery consumption

Communication system - **Architecture**



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- Transceiver
  - **Uplink (UHF)** is always available to receive data from Earth;
  - **Downlink (UHF)** downloads data when scheduled or requested by Earth
- Beacon
  - UHF shares Downlink's antenna or VHF with own antenna
  - Beacon transmits data from the P**ower System**
  - **Scheduled transmission** to avoid unnecessary battery consumption
  - Use of Morse Code
- Communication Protocol
  - **AX.25** (detects errors, but does not fix them)
  - **CCSDS** (future work)

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Orbit Modeling Considerations

- Worst case orbit – **Equator plane**
- Circular orbit
- Altitude: **310 Km**
- Antenna's face always pointing to Earth
- **5 faces** covered by solar panels
- Free rotation around 'z' axis

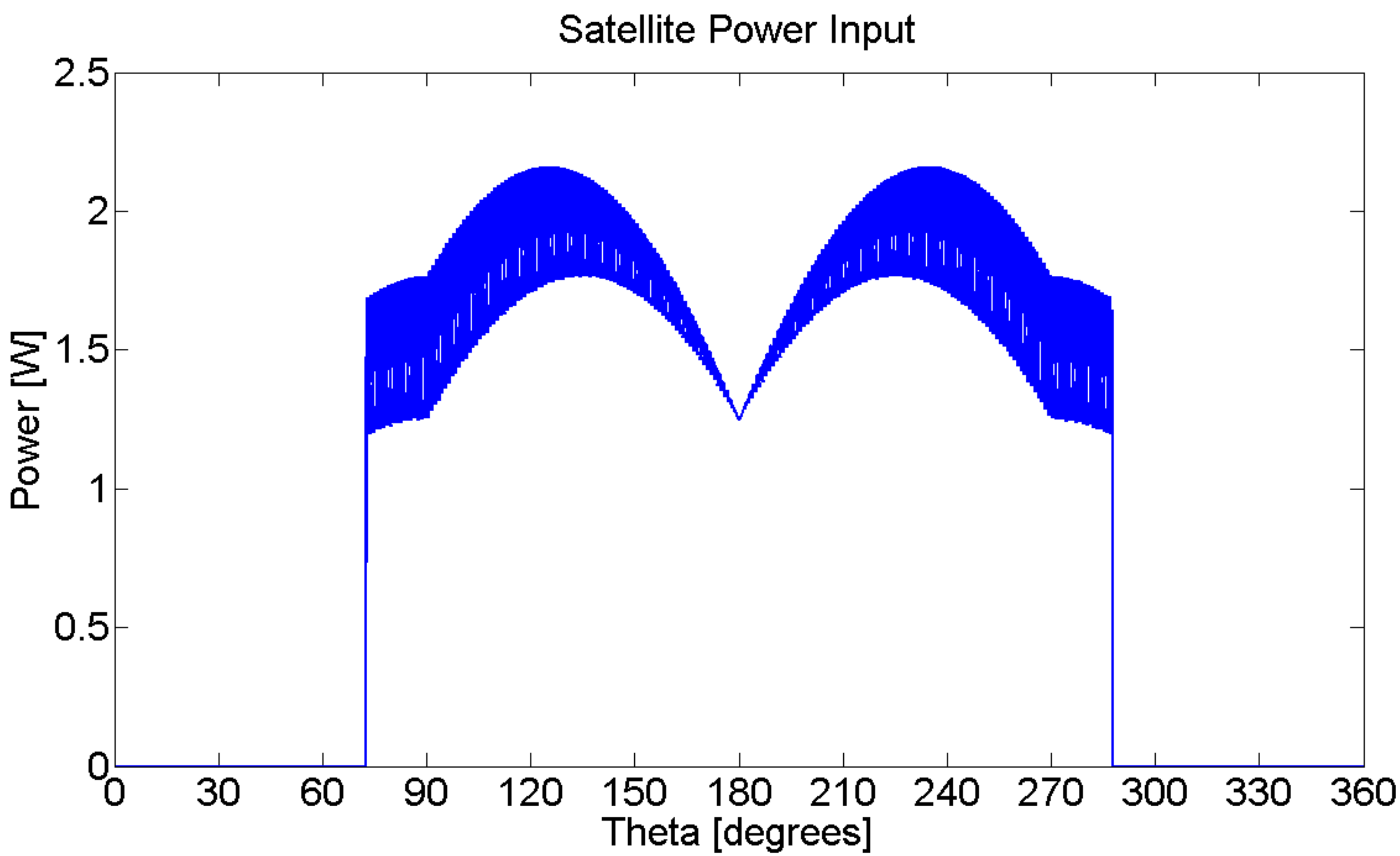
Interorbital Solar Panel PCB

- **15 solar cells** per PCB
- **5 sets** in parallel of 3 cells in series
- Open circuit voltage per set: **6.6 V**
- Total short-circuit current: **155 mA**

Source: interorbital.com

Orbit Modeling Simulation

- Average power: **1.055 W**



Architectures

- At least **three** different architectures
- Allow students to design the **complete architecture** (from design to implementation)
- **Compare** architecture's performance (simulations and experiments)
- Select the best one for the satellite

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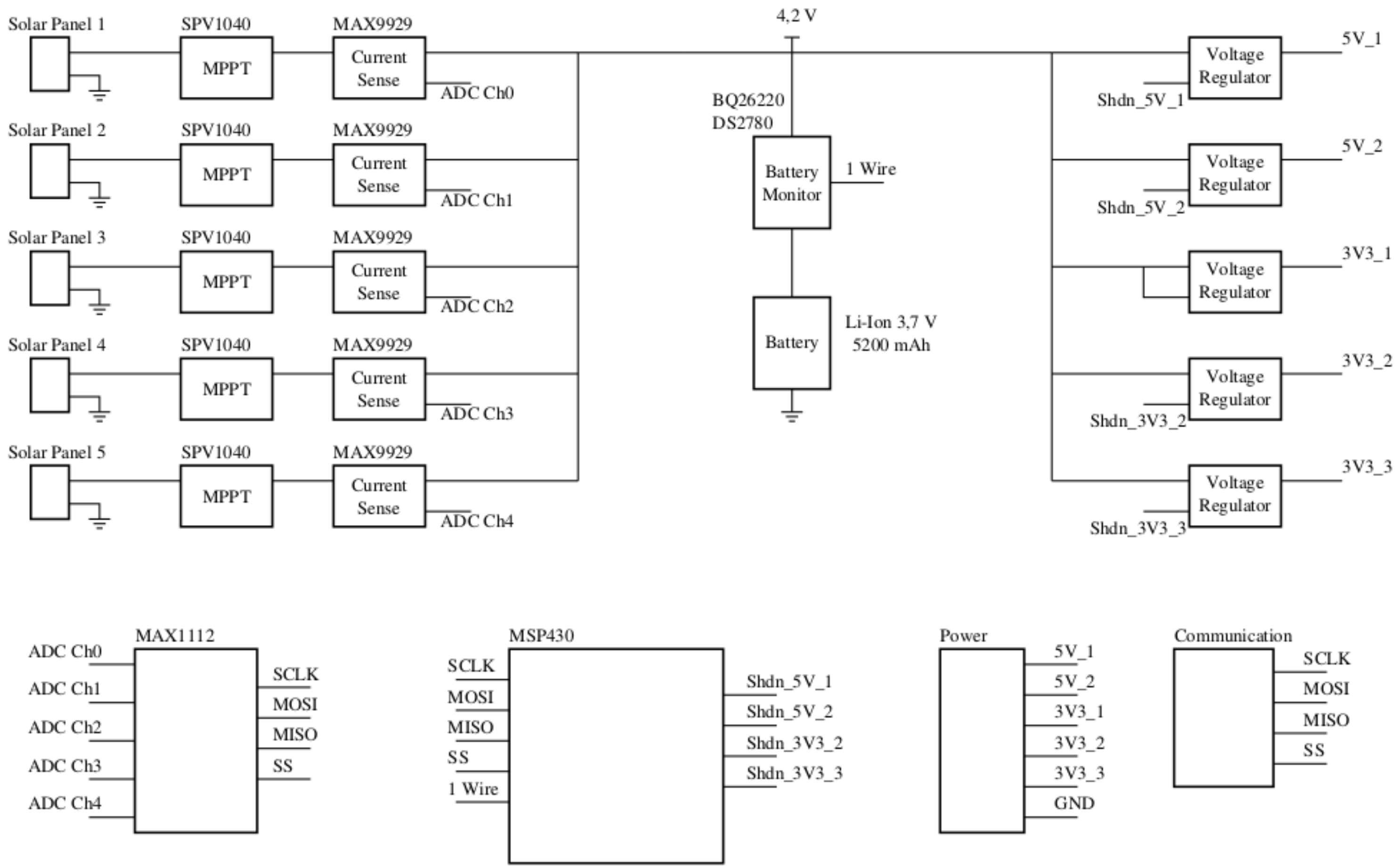
- Solar panel **current measurement**
- Dropout converter to 4.2 V
- Battery monitoring
- Multiple power buses 3.3 V e 5 V (on/off)
- **OBC** controlled (SPI or I^2C and 1 Wire)
- Dedicated μC (MSP430) (Architecture 2)
- **MPPT** ICs (Architecture 3)

Architecture

- **MPPT** ICs;



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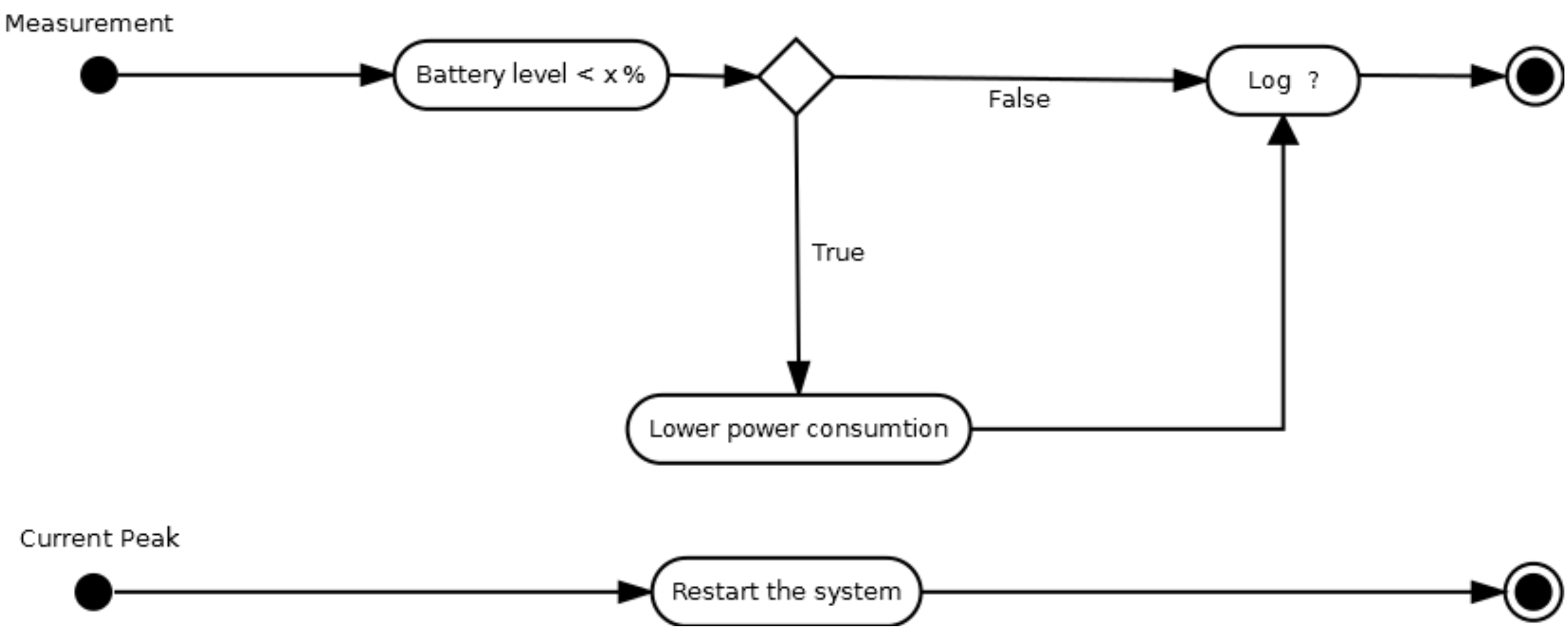
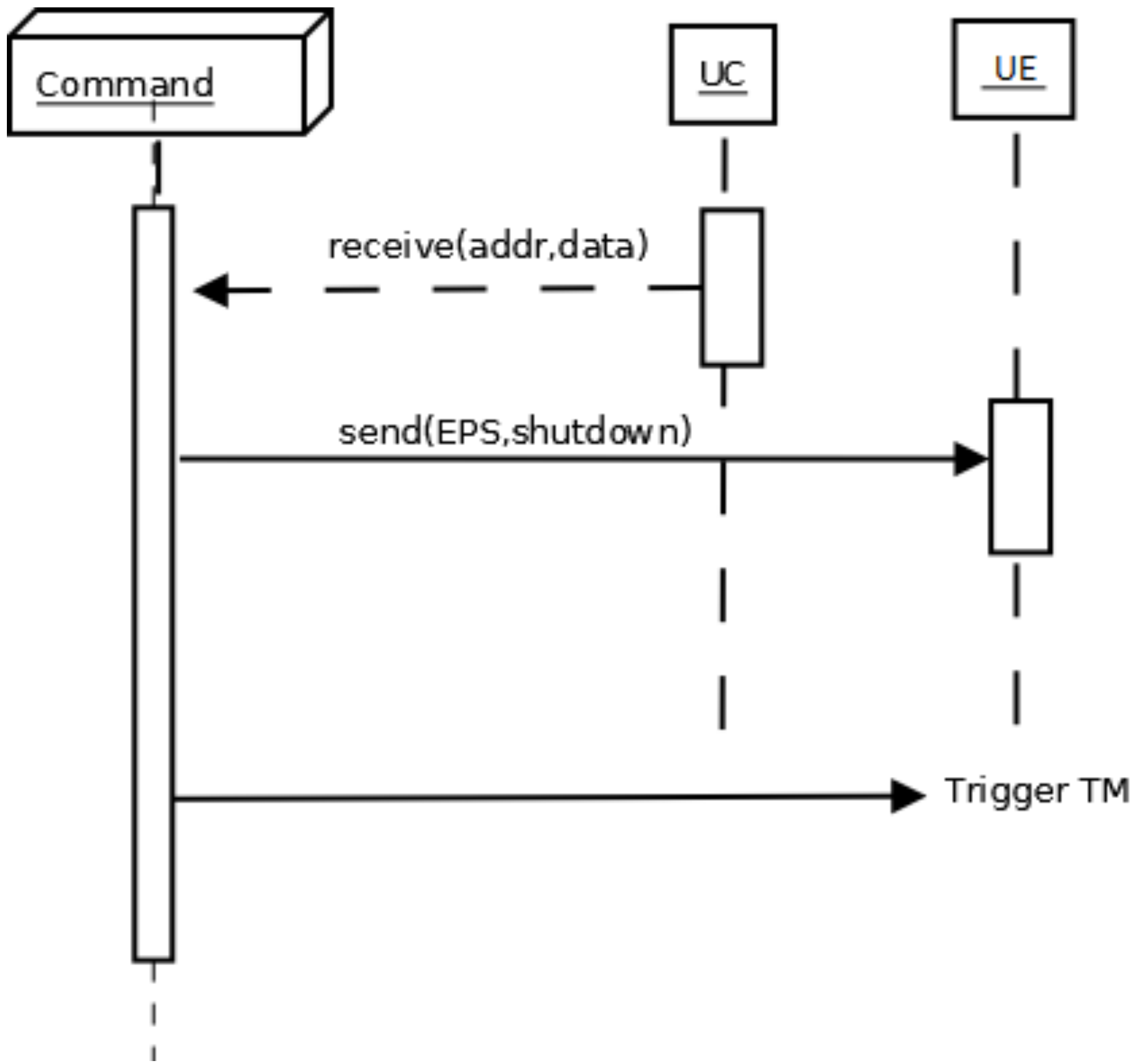
On Board Computer (OBC) - Software Solution

- **Drivers**
  - Basic intermodule communication
  - Communication
  - EPS (Electrical Power System)
  - Attitude
  - Payload
- **Applications**
  - Measurement
  - Monitor
  - UTMC (TM+TC)
  - Log

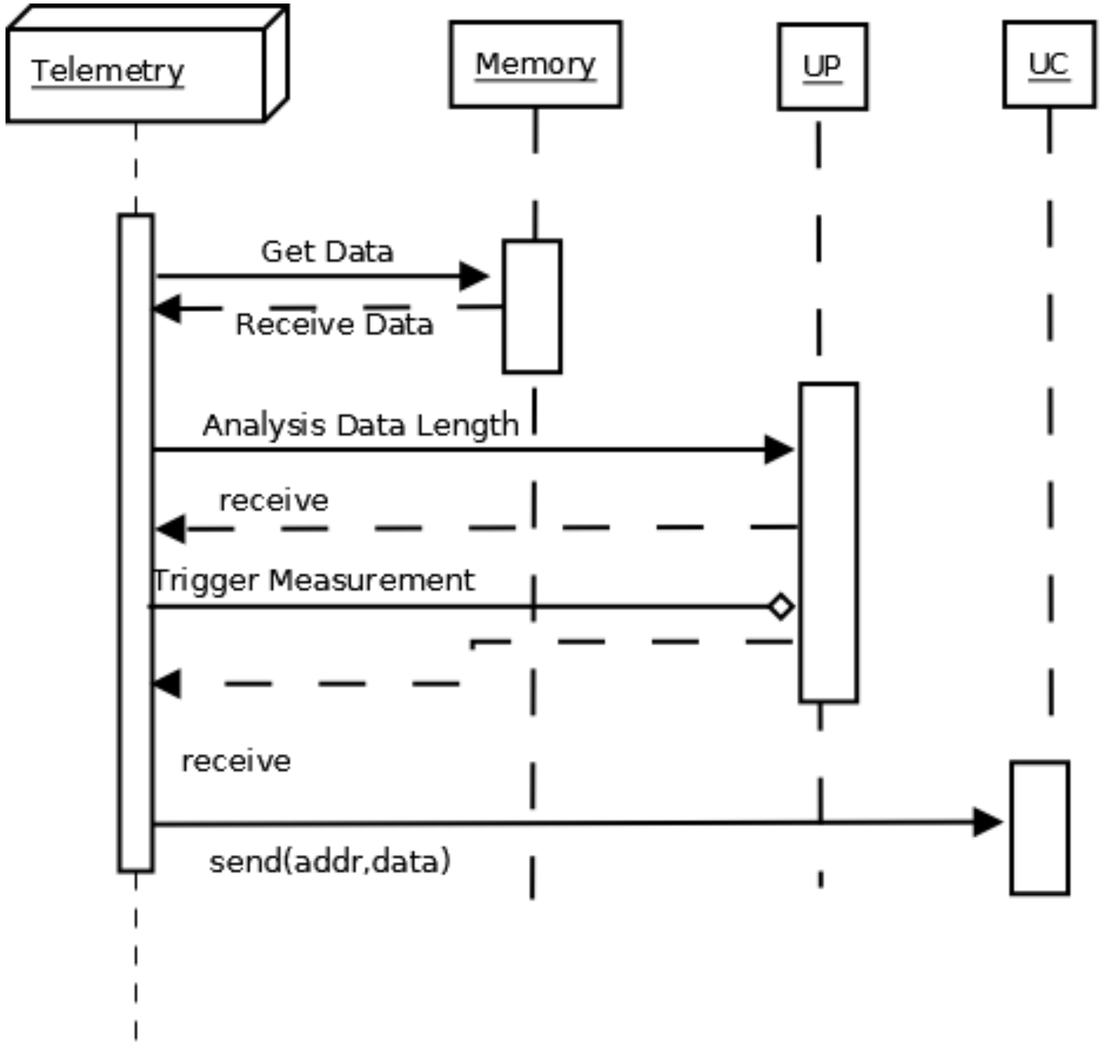
Monitor Application



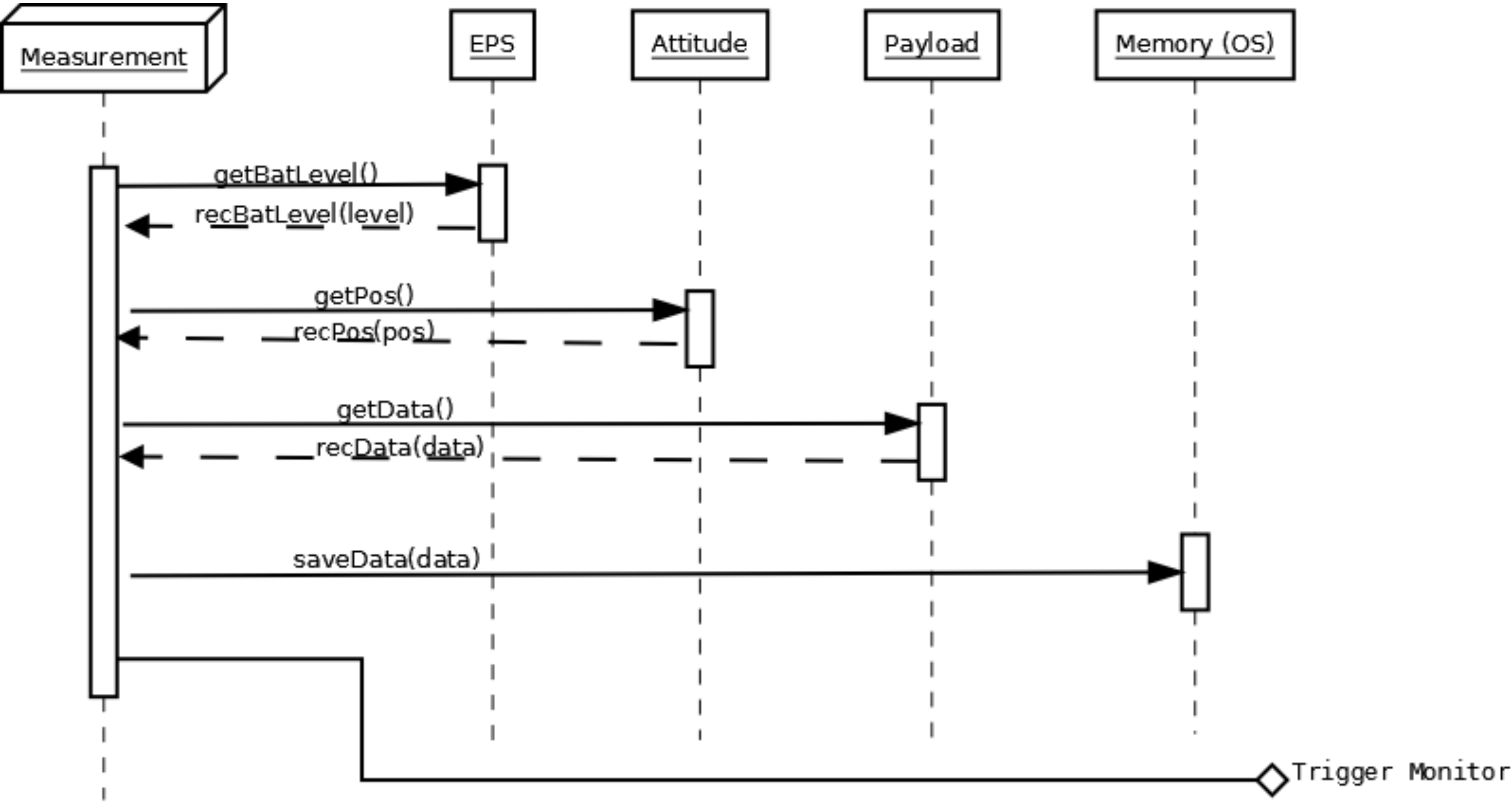
Command Application



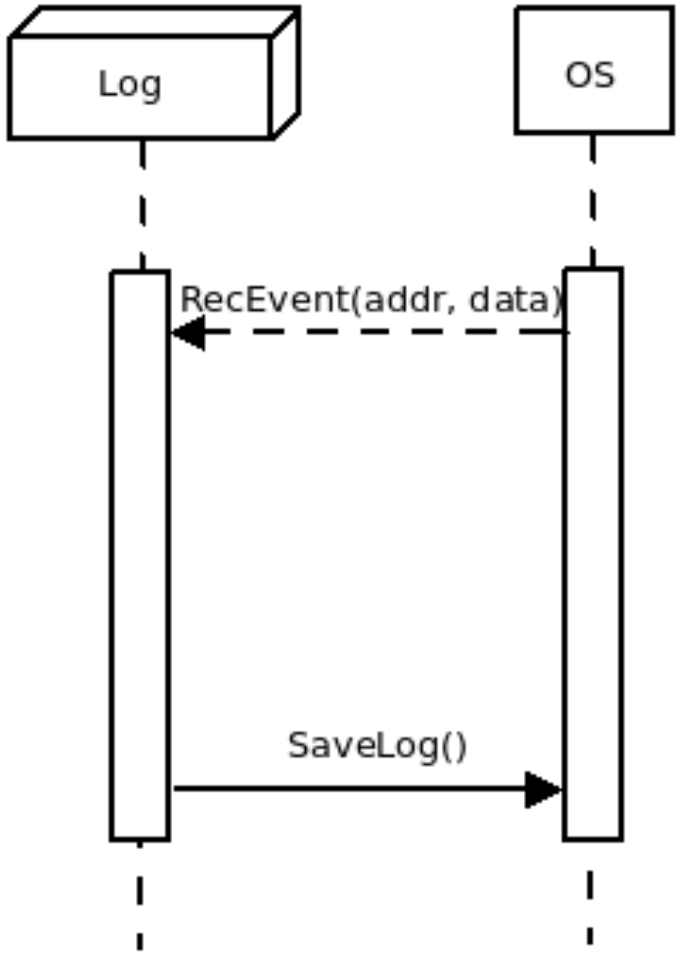
Telemetry Application



Measurement Application



Log Application



- Reliability
- Architecture **compatibility**
- Allow application **priority setup**
- Power and memory consumption
- **Library** availability

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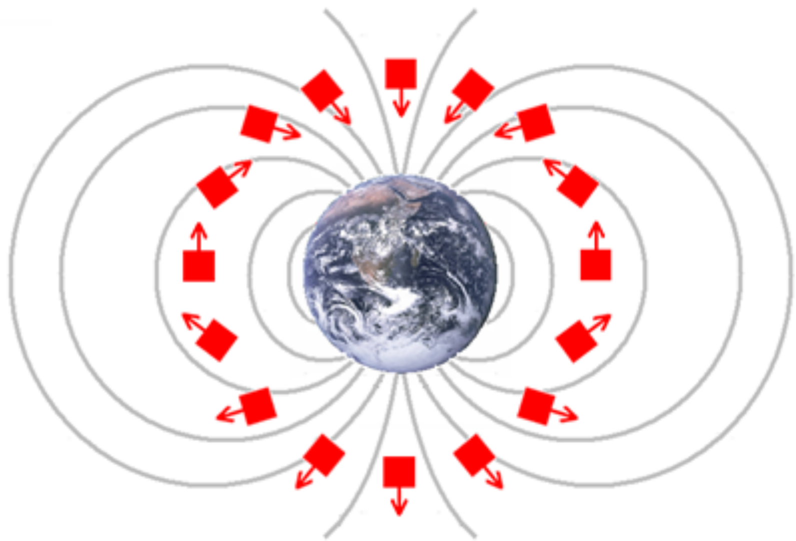
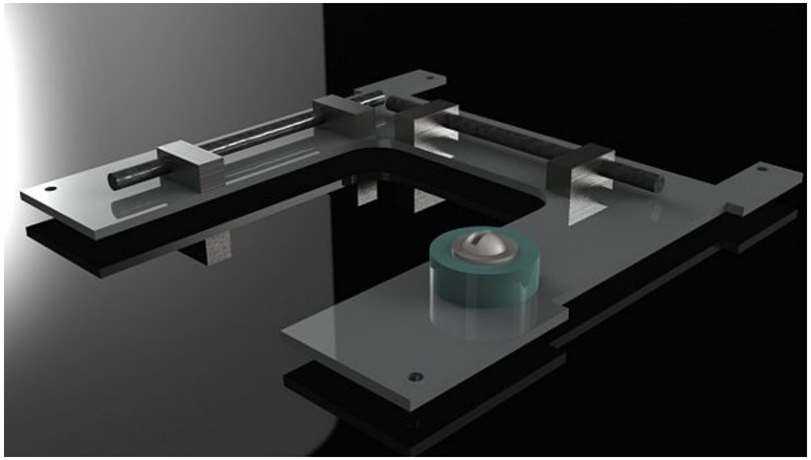
- **Passive** attitude stabilization: permanent magnets and hysteresis rods
  - Stabilization in only **two** of three rotation axes.





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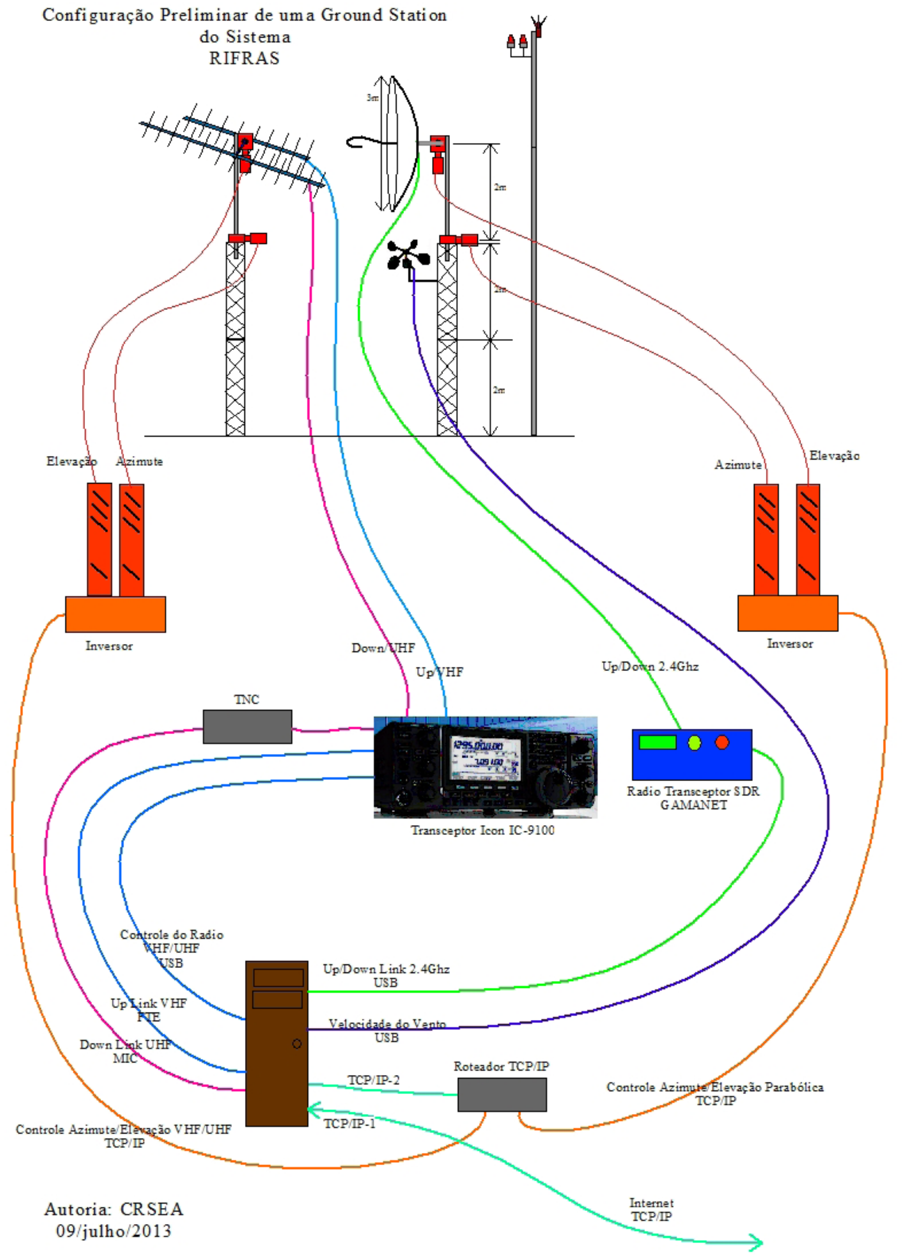
Ground Station

- UHF Antenna:
  - Frequency: **430-450 MHz**
  - Forward Gain: **15.5 dB**
- VHF Antenna:
  - Frequency: **144-148 MHz**
  - Forward Gain: **11.1 dB**



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Launching

- Launching is planned for **2016**

Source: interorbital.com

Conclusion

- The **requirements** and the features of each subsystem were defined
- The students are **learning**, **being inspired** and **enjoying** the project
- Besides, they are exchanging information with **other universities** and **institutes**
- Also, students are learning and feeling what is like to be in a **real engineering project**

Thank you for your attention!

Victor Menegon

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