- 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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- Brazilian Space Agency (**AEB**)

- National Council of Scientific for Technological Development (**CNPq**)
Federal Institute of Santa Catarina (IFSC)
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Introduction

- 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**.
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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

Downlink Beacon

Downlink

HPA

Switch

Transceiver

Radio Transmitter & Modulator

Encoder (encapsule AX.25 frame)

Control Unit

I2C Bus Protocol

Microcontroller

I2C Data Bus

Control Bus

Uplink

LNA

Radio Receiver & Demodulator

Decoder (decapsule AX.25 frame)
Communication system

- **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 **Power 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
- **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**
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
- 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 I²C and 1 Wire)
- Dedicated µC (MSP430) (Architecture 2)
- **MPPT** ICs (Architecture 3)
- **MPPT ICs;**

Architecture diagram with schematic connections for solar panels, MPPT controllers, ADC channels, MAX1112, MAX9920, BQ26220, DS2780, Battery Monitor, Li-Ion Battery, and Voltage Regulators.
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Drivers
- Basic intermodule communication
- Communication
- EPS (Electrical Power System)
- Attitude
- Payload

Applications
- Measurement
- Monitor
- UTMC (TM+TC)
- Log
Command Application

Command

receive(addr,data)

send(EPS,shutdown)

Trigger TM
Operating System

- 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 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!

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