Brazilian Inter-University CubeSat Mission Overview


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

- Partnership
- Introduction
- Subsystems
  - Communication System
  - Power System
  - On-Board Computer
  - Attitude Control System
  - Payload
  - 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

- It is our first cubesat project.
The system was divided into modules in order to make it reusable in future projects and to make tests and formal verification.
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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

**Transceiver**
- Radio Transmitter & Modulator
- Encoder (encapsule AX.25 frame)

**Microcontroller**
- Encoder (decapsule AX.25 frame)
- Control Unit
- I2C Bus Protocol

**Downlink**
- Beacon
- HPA
- Switch

**Uplink**
- LNA

**Control Bus**
- I2C Data Bus

**Radio**
- Transmitter & Modulator
- Receiver & Demodulator

**Energy**
- Energy

**Additional Components**
- Microcontroller Energy
- Encoder
- Decoder
- I2C Bus Protocol

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- 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**

Source: interorbital.com
Average power: 1.055 W
- 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 and 5 V (on/off)
- **OBC** controlled (SPI or I²C and 1 Wire)
- Dedicated µC (MSP430) (Architecture 2)
- **MPPT** ICs (Architecture 3)
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On Board Computer (OBC) - Software Solution

Applications

- Measurement
- Monitor
- Command
- Log
- Telemetry

RTOS

FreeRTOS

Drivers

- Basic intermodule communication
- Attitude Driver
- Power System Driver
- Communication Driver
- Payload Driver

Hardware

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On Board Computer (OBC) - Software Solution

Applications

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RTOS

FreeRTOS

Drivers

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Hardware

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OBC: Measurement Application

getBatLevel()
recBatLevel(level)

getPos()
recPos(pos)

getData()
recData(data)

tsavaData(data)

Trigger Monitor
OBC: Monitor Application

- Measurement
  - Battery level < x %
    - False
      - Log ?
    - True
      - Lower power consumption
- Current Peak
  - Restart the system
OBC: Telemetry Application
On Board Computer (OBC) - Software Solution

- Measurement
- Monitor
- Command
- Log
- Telemetry

FreeRTOS

- Basic intermodule communication
- Attitude Driver
- Power System Driver
- Communication Driver
- Payload Driver

Hardware

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OBC: 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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Payload Targets

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

PCB of the FPGA board used in the payload
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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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