Universidad de Vigo

AEROSPACEGROUP

On orbit results of the HumSAT Payload, a data collection system based on CubeSats

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2016 Cubesat developers' Workshop

Cal Poly

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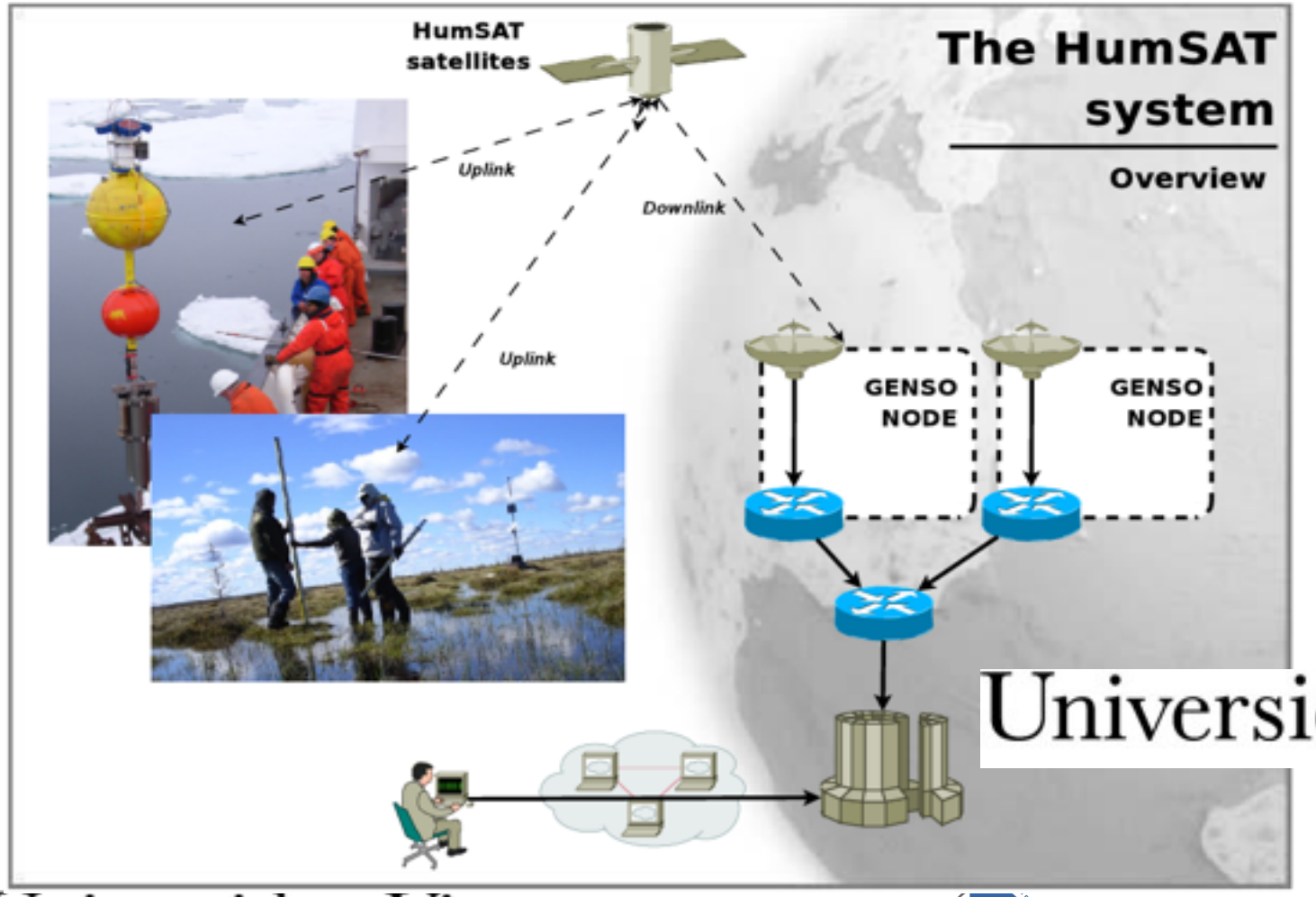
What is the HumSAT system?

HumSAT System



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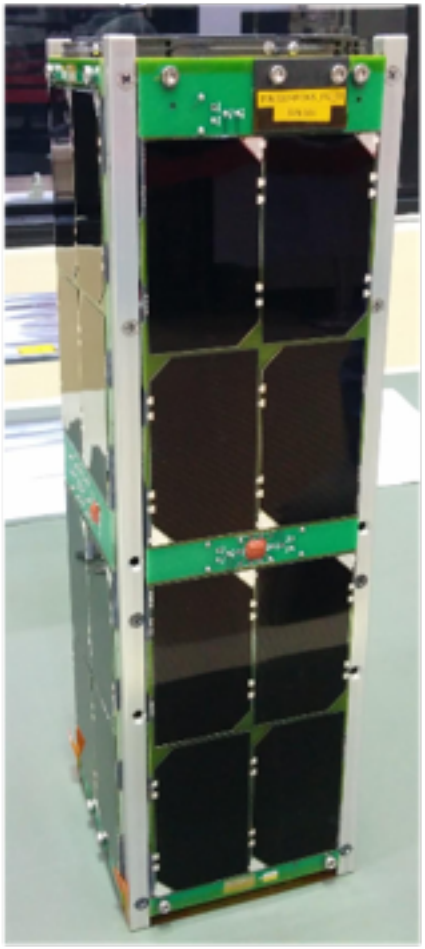
SERPENS Satellite



Sector B

Humsat Satellite

Sector A

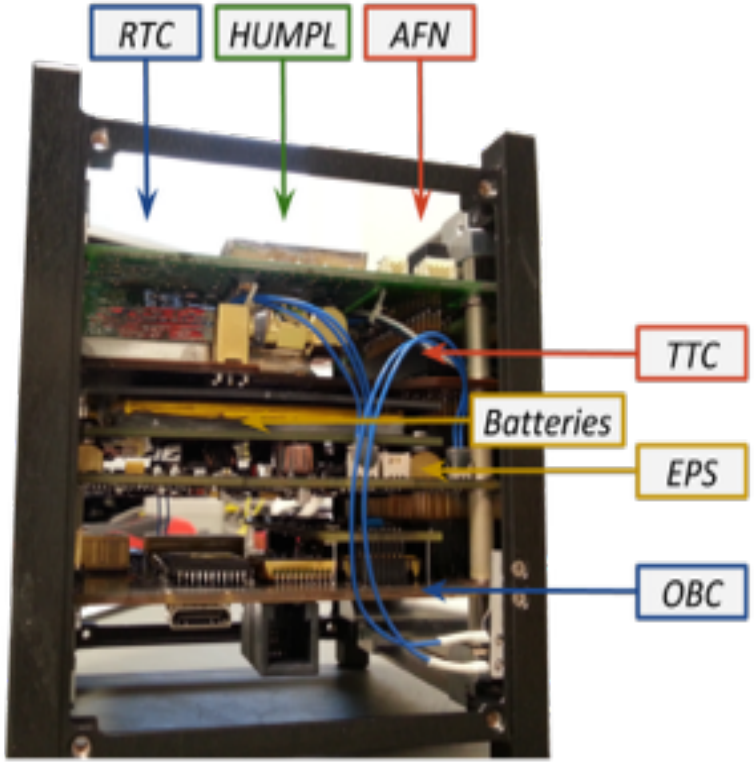
Brazilian University Consortium

3U Brazilian satellite

Funded by the Brazilian Space Agency

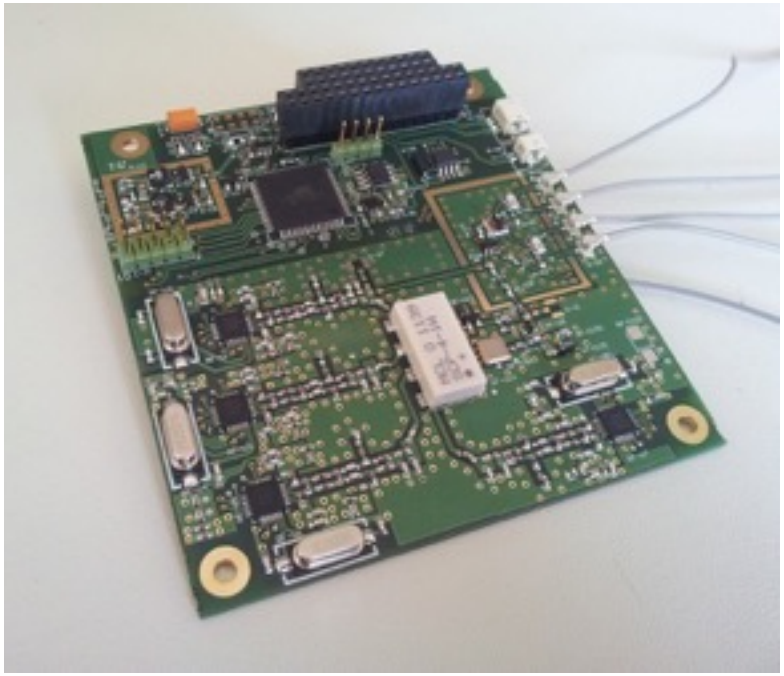
Leaded by the University of Brasilia

University of Vigo Platform



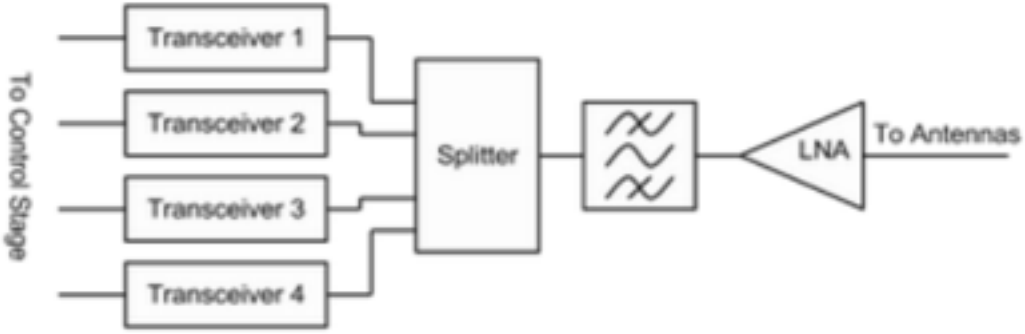
- **Platform Reliability:**
  - **> 4 Years** Operative in **3 different satellites**
  - More than **100.000 EXECUTED COMMANDS**
  - Inhouse subsystems development + COTS
  - Critical components = RAD-HARD
  - **Inhouse OBSW:** On Board SW
    - FDIR implementation (Failure detection, isolation and recovery)
    - High level of autonomy
    - High modularity for new payloads
  - **40 different Telemetries**
  - **84 Telecommands** direct and scheduler programming
  - Exhaustive system engineering effort and AIT:
    - TLYF (Test Like you Fly)
    - E2E
    - EMC Testing
    - ECCS Tailored Methodology for CubeSats developments
  - **LOW COST! (**Lowering the cost, without compromising reliability)
- **GSSW** (Ground Segment Software) based on ESA **PUS** (Packet Utilization Standard)

HumSAT Payload (HUMPL)



Configurable from Ground

High flexibility

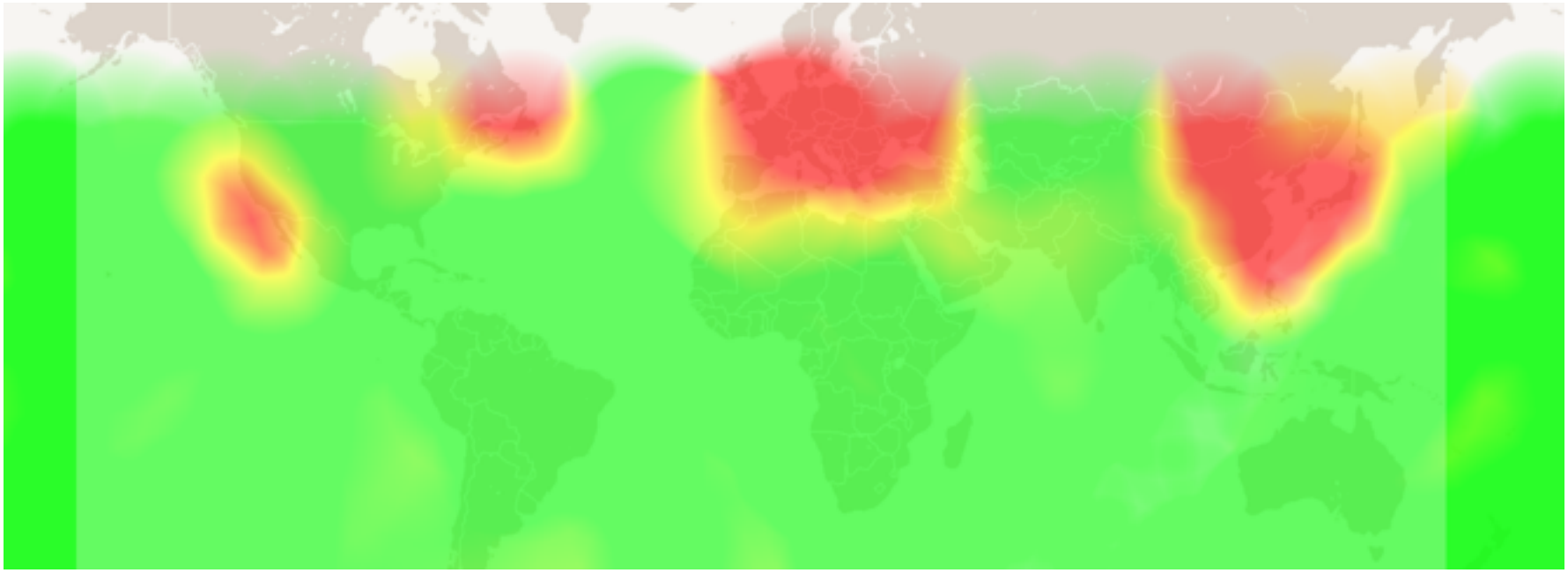


On orbit results

On orbit operation activities

1. Study and enhancement of the Terminals - HUMPL link
   a. Analysis of the Radio channel.
   b. Assessment of HUMPL Configuration and reception method.
   c. Evaluation of the communication chain.
2. Service to a pilot User Application

Analysis of the Radio channel



UHF Interference discovered

HUMPL Configuration and reception method

Different parameters of the HUMPL were modified and tested.

- Signal tracking.
- Bandwidth.
- Signal detection thresholds, etc.

Finally a new reception strategy, better adapted to the real channel than the ones initially proposed, was found.

Evaluation of the communication chain

Different elements of the communication chain between Terminals and HUMPL were tested.

Antenna

Transmission Power

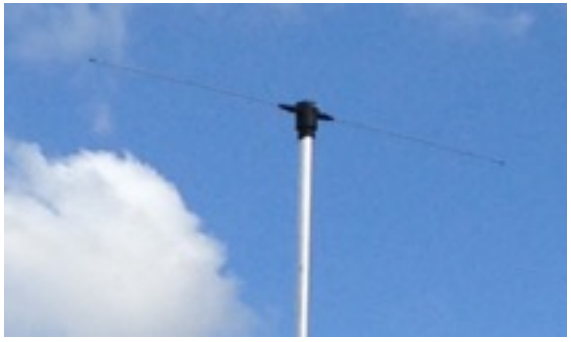
Error correction algorithms

...

Evaluation of the communication chain - Antennas

Eggbeater

Turnstile



Horizontal Dipole

Vertical Dipole

Evaluation of the communication chain - Error Correction Algorithm

Different Error Correction configurations were tested.

An increase in correct received packets of more than 50% can be achieved if the proper Error Correction algorithm is used.

The Reed-Solomon E16 recommended, by CCSDS, was selected.

Evaluation of the communication chain - Congestion

Many signals were transmitted simultaneously trying to congest the HUMPL.

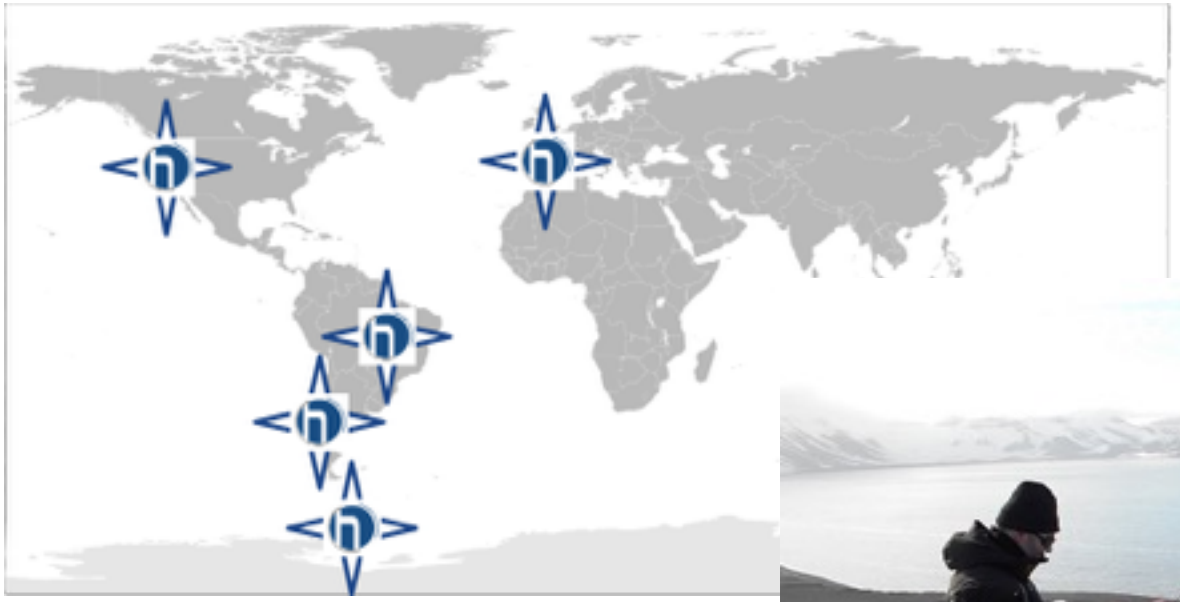
Its maximum capacity was studied.

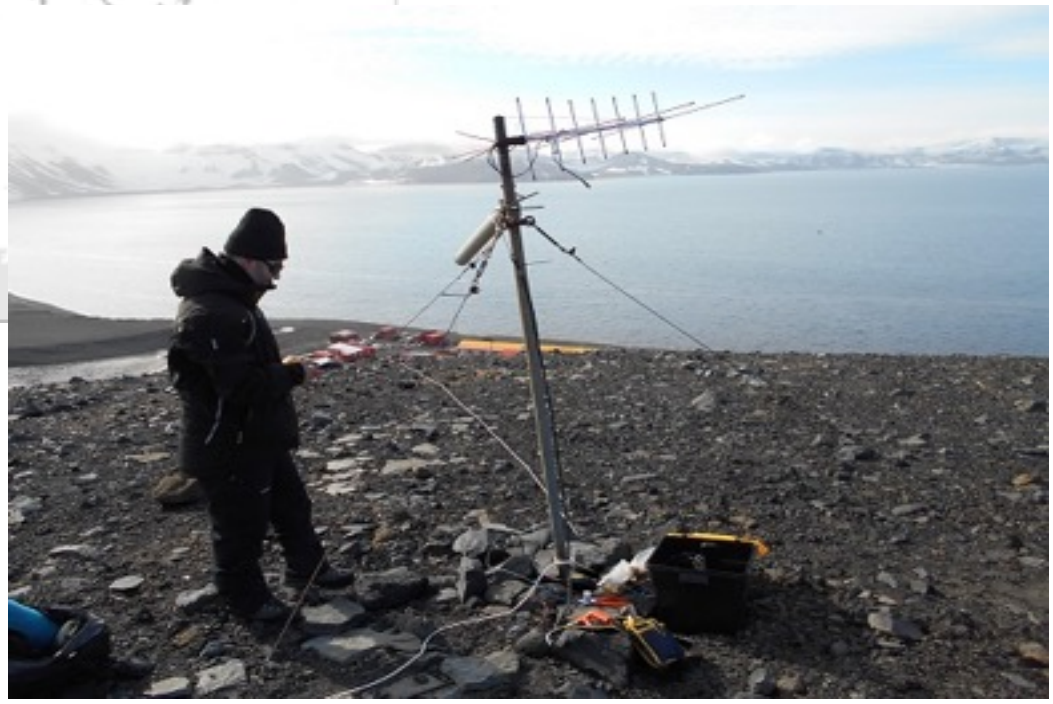
Two simultaneous signals can be demodulated by the HUMPL successfully if they are separated 4kHz or more.

Pilot User Application (1/3)

Several communication platforms, with a weather station, were distributed in different parts of the world.

Pilot User Application (2/3)





Pilot User Application (3/3)

Conclusions

The results gathered helped in the selection of the **best system configuration**.

The on orbit operation demonstrates that a Data Collection System implemented with a constellation of CubeSats **is feasible**.

HumSAT is being evolved to a **new generation** of the system with increased performance and capacity.

This new system, HumSAT 2.0, has **bidirectional capabilities and extended services**. It can be used as a starting point for the development of **commercial** data collection systems.

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Thank you very much for your attention!

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