

ThingSat: an in-orbit research vehicle for experimenting with satellite IoT

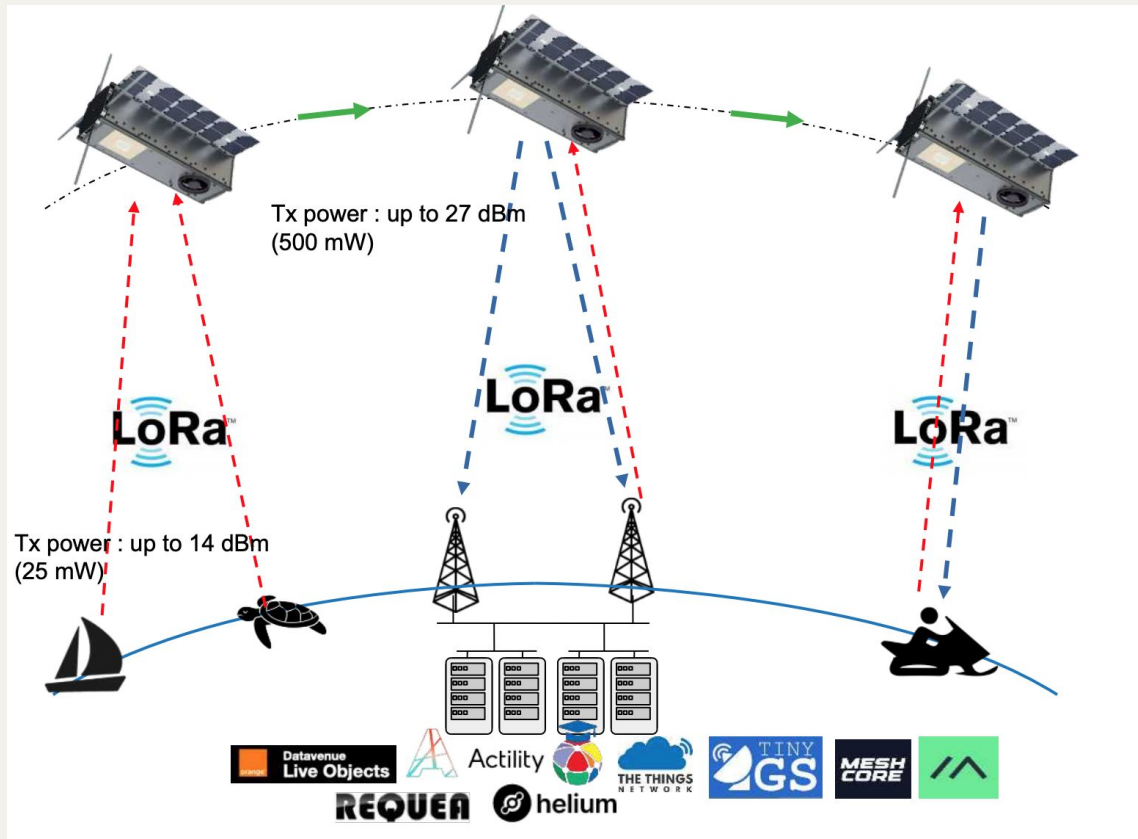
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Universit   Grenoble Alpes - Grenoble INP - Floralis

LIG Drakkar - CSUG

01 • BACKGROUND

A LoRa gateway in orbit



USE CASES

Remote sensing

Very isolated sensors
(with Terra Forma, IPEV, ...)



Tracking

Assets beyond coverage
(with Air Liquide)



Alerts

(Early) Warning Systems

Resilient networks

Meshtastic, MeshCore...



From ThingSat-1 to ThingSat-2

2022: ThingSat-1

- SSO LEO. 868 MHz and 2.4 GHz.
- Payload never operated: the satellite has been lost during high solar activity.

2024 2027: ThingSat-2

- SSO LEO. 868 MHz.
- Launch planned for 2024, then 2026, now postponed to early 2027.

2027-2030: COMETES

4 upcoming launches

- CSUT (NIMPH) : 2027
- CSU Côte d'Azur : 2028
- CSUG : 2029-2030
- CSUM : 2029-2030

The logo for the COMETES program, featuring a stylized satellite icon and the word "cometes" in a blue sans-serif font.

Since 2018 • regular flights on CNES stratospheric balloons (NLA) with our students.

BUILT BY



Grenoble University Space Center



Grenoble Informatics Laboratory



RF, Optic and Micro-nanoelectronics

Two boards, three uses

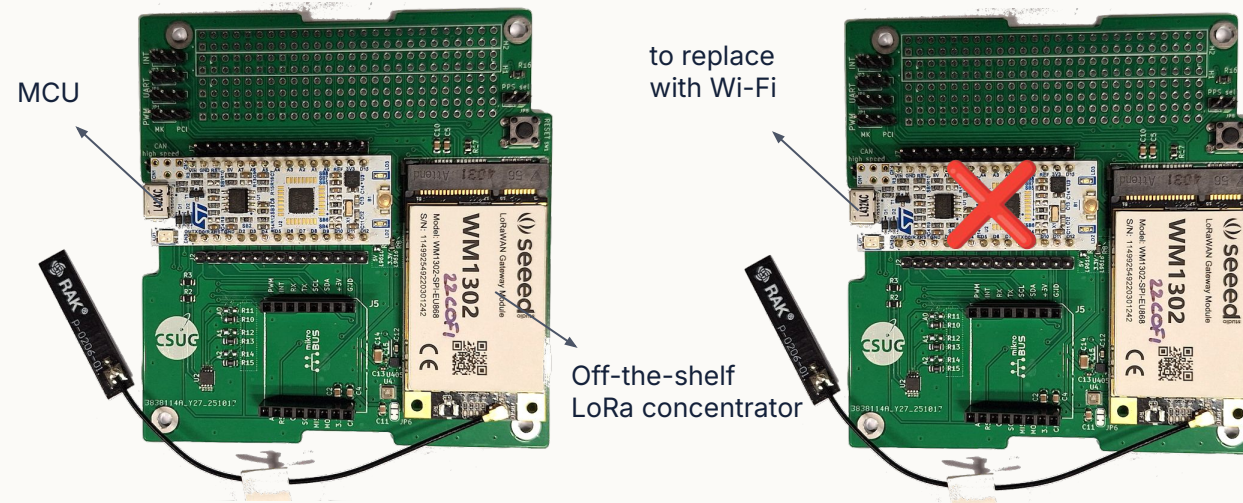
Dev board

Balloon

Educational flights running with RIOT-OS and Arduino.

Ground

Standard gateway running with RIOT-OS or Arduino.



Space board

Orbit

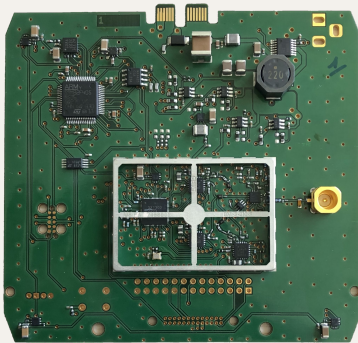
ThingSat Flight Model running with RIOT-OS



A home-made board, built to New Space standards

Space-grade PCB

- Arlon 35N substrate, ~€400 per PCB
- COTS or automotive-grade parts



In-house assembly at CEDMS (UGA)



- Within NewSpace constraints
- Soldered component checked (microscope, X-ray, BGA placement)
- We control our own schedule
- We keep the know-how in-house



A home-made antenna, measured in place

1 · Design and manufacturing

Patch antenna, circular polarization, 868MHz

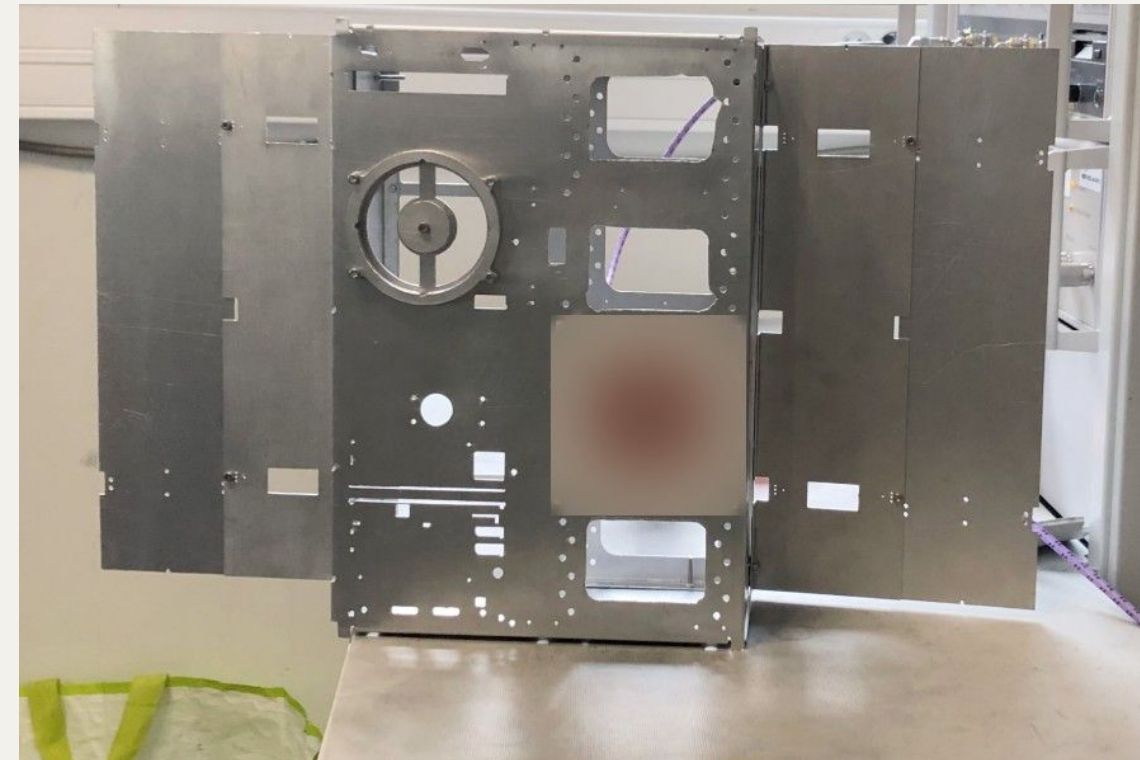
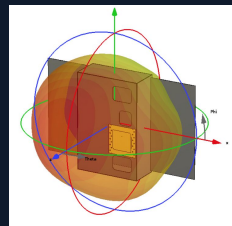
2 · Satellite mockup

Antenna mounted at its real position on the structure

3 · Anechoic chamber

Gain and pattern measured as in flight:

5 dBi, $\pm 30^\circ$ beamwidth



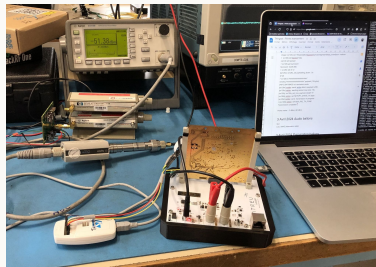
RF validation in lab

Conducted tests on the board, without antenna

Transmit power

Board → cable → power meter

27 dBm ✓



Receive sensitivity

LoRa node (0 dBm) → attenuator → board

Target: -136 dBm

Our bench stops at -110 dBm: with a 0 dBm source, the signal leaking through the air takes over below that.



Next: a LoRa-capable signal generator, transmitting directly at low power.

Integrated, validated, awaiting launch

Integration in our partner facilities

- **Emulator vs OBC:** two intense days on site to track a timing bug.
- **Antenna integration:** missing and untracked documentation led to last-minute rework of the satellite structure.

Validated on the satellite

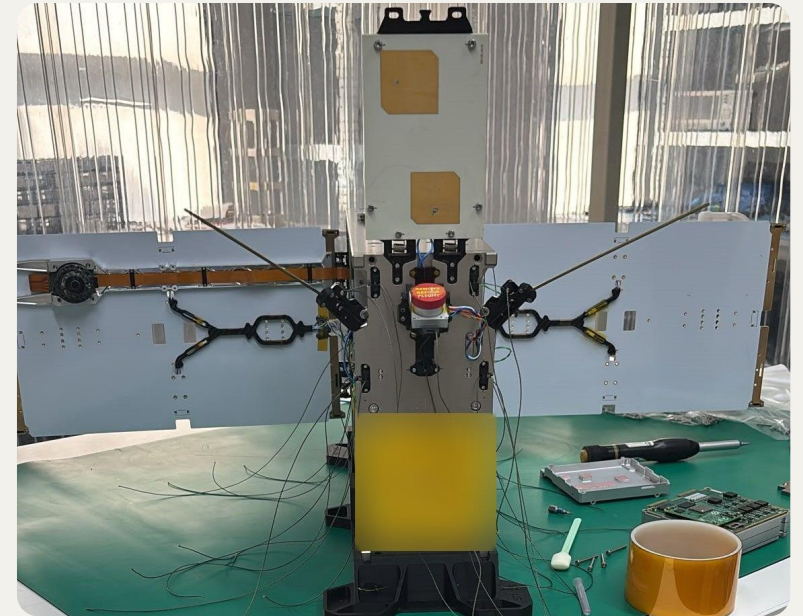
OBC ↔ Payload communication



Environmental tests



RF performance tests



- Lessons:**
- Don't wait until the last minute to test the communication with the FM OBC.
 - There is never enough documentation.

The final challenge: filing a satellite at 868 MHz

Non-space band: no space allocation at the ITU, a satellite can only use it by derogation (RR No. 4.4): it must not interfere with other services, and cannot claim protection from them.

- **Operator** "How do we file 868 MHz?"
- **Answer 1** "Not space frequencies: no filing needed"
- **Answer 2** "Needed, but only for Tx"
- **Answer 3** "Needed for Tx and Rx"
- **Their agency** Can't file it
X

Dead end: we turn to France, ANFR and CNES.

The topic is still new: **reach out to your national administration early.**

Filing through France

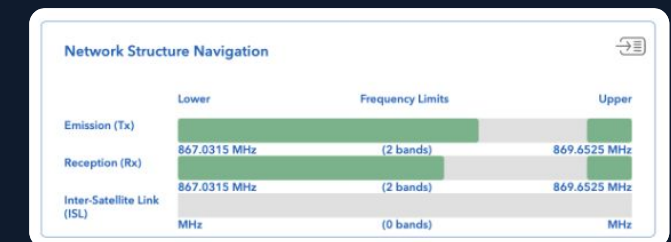
- **ANFR** possible, but you will have to pay a €20k French authorization fee
- **DGE** fee exempted for a research project
- **Defence** approval as exclusive holder of 862–869.2 MHz
- **CNES** agreement, filing under RR No. 4.4 + ECC/DEC/(25)02
- **ITU** Regions 2 and 3 need coordination → re-filed as space research (EH)
- **Approved** Ouf!

The path now exists: next time will be faster.

Research use is far more flexible than commercial use.

Identity

Satellite Network Name:	THINGSAT-2	→
Satellite Network Previous Name:	—	
Administration:	F (France)	
Network Organization:	—	
Space Plan/Non-Plan Bands:	Non-Plan	
Type of Satellite Network:	Non-Geostationary	
	—	



What it took

* thanks to our partners

TS-1

ThingSat-1

TS-2

ThingSat-2

Flying and integration

Hosted slot, market price **€100–150k/U**

Travel and logistics **~€15k**

Rework after integration issues **~€2k**

Building

TS-2 Payloads (EM + FM) **~€10k**

TS-1 Payloads (EM + FM) **~€10k**

Ground: LoRa ground stations,
end devices and dev boards **~€8k**

TVAC and vibration tests* **€0**

People

TS-2 Engineers, 2 × 1.5 yrs **~€150k**

TS-1 Project manager, 2 yrs **~€100k**

~75 students **~€40–50k**

Project budget, over 7 years, 2 missions

~€430k

+ permanent staff time, ~6 people part-time: ~€400k

≈ €840k in total

With our own 3U instead:

≈ €1–1.5M / mission

One payload, many platforms

ThingSat-1 · STORK-1

ThingSat-2 · ORBITEO ONE

ThingSat-3 · NIMPH

ThingSat-4 · NICECube

...

Each new platform means:

Antenna to redesign

Different connectors

Different form factor

Different comm. bus

Our answer: nothing is standard, so we are moving towards a multi-bus payload (CAN, RS485, I2C,...).

Thank you. Questions?

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