

Software-Defined Radios in Nanosatellites

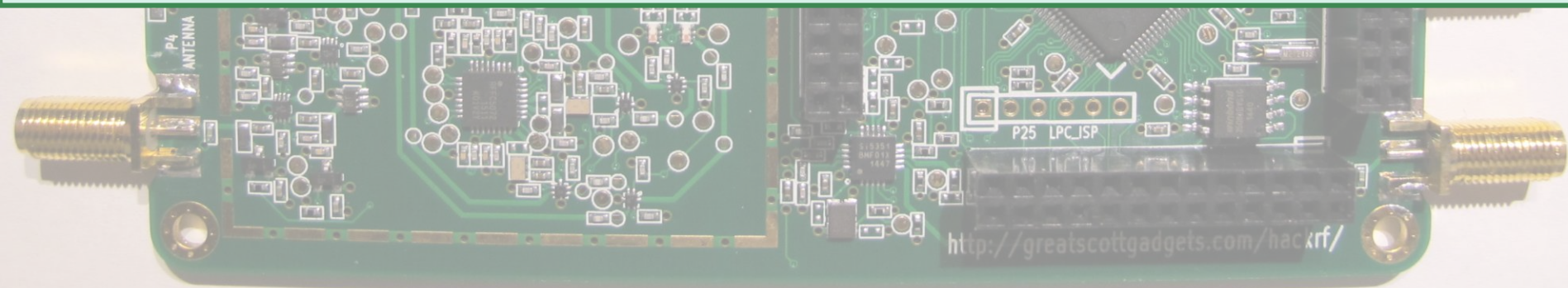


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Unsuccessful launch
Launch planned

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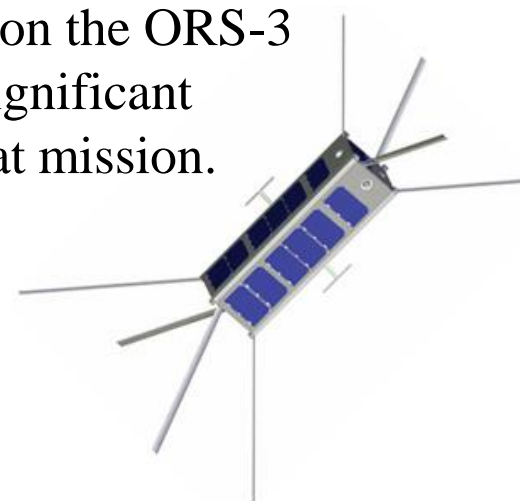
30. LinkSat

ORSES

Description

**Launched on
20-11-2013**

- **Organisation:** ORS Office, US Army SMDC
- **Partners:** -
- **Mission:** Operationally Responsive Space Enabler Satellite. To provide communications and data capabilities for underserved tactical users.
- **Equipment:** The ORS Office independently developed the **Vulcan Wireless Software Defined Radio (SDR)** and the Raytheon Gryphon Type-I NSA certified encryption for first flight demonstration on the ORS-3 Mission. The SDR and Type-I encryption will provide significant performance and security upgrades to any future CubeSat mission.
- **Mass:** 3U



Reentered on 3-01-2016

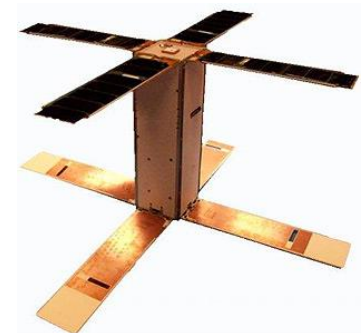
SNaP

Description

- **Organisation:** US Army SMDC
- **Partners:** -
- **Mission:** to develop user **software-defined radios** to provide beyond-line-of-sight communication for disadvantaged users in remote locations (continuation of the SMDC-ONE programme). These are much more capable in the communication arena and are a much more robust version of the previous SMDC nanosatellites. This is a Joint Capabilities Technology Demonstration that will focus on voice and data communications beyond line of sight and improved access to high value information.
- **Mass:** 3U (5 Kg)

Launched on
6-12-2013
8-10-2015

Reentered?



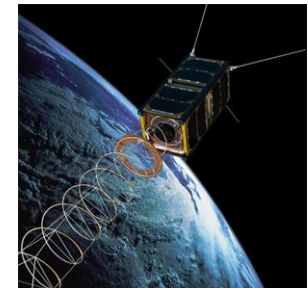
GOMX-1

Description

Launched on
21-11-2013

- **Organisation:** GomSpace
- **Partners:** Aalborg University, SDE Airport Solutions, Danish National Advanced Technology Foundation
- **Mission:** GATOSS (Global Air Traffic Awareness and Optimizing through Spaceborne Surveillance)
- **Primary payload:** Perform research and experimentation in space related to **Software Defined Radio (SDR)** with emphasis on receiving ADS-B signal from commercial aircraft over oceanic areas.
- **Secondary payload:** **NanoCam C1U colour camera** for Earth observation experimentation
- **Mass:** 2U

Reentered?



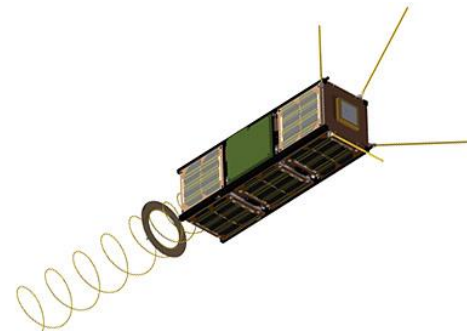
GOMX-3

Description

- **Organisation:** GomSpace
- **Partners:-**
- **Mission:** demonstrate aircraft ADS-B signal reception and geostationary telecommunication satellite spot beam signal quality using an L-band **reconfigurable software defined radio** payload. A miniaturised high data rate X-band transmitter developed by Syrlinks and funded by the French space agency CNES will also be flown as a third party payload.
- **Secondary payload:** **NanoCam C1U colour camera** for Earth observation experimentation
- **Mass:** 3U (4 Kg)

**Launched on
5-10-2015**

Reentered on 18-10-2016

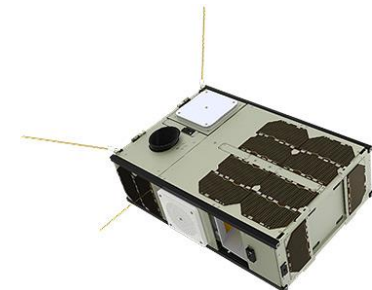


GOMX-4A

Description

- **Organisation:** GomSpace
- **Partners:** Danish Ministry of Defence and DALOS
- **Mission:** intended to contribute to surveillance of the Arctic, identify best-practice and future efforts reinforcing the Danish Defense's surveillance of the Arctic within the Kingdom.
- **Both 4A, 4B:** The two CubeSats will stay linked through a **new version of the software-defined radio** system demonstrated on GOMX-3. The same radio system will also be used for rapid payload data downloads to Earth. Nanospace in Sweden are contributing the highly miniaturised cold-gas thrusters for controlling the orbit, allowing future CubeSat-based constellations to be deployed quickly after launch.
- **Mass:** 6U (+6 Kg)

**TO BE
launched in
2018**

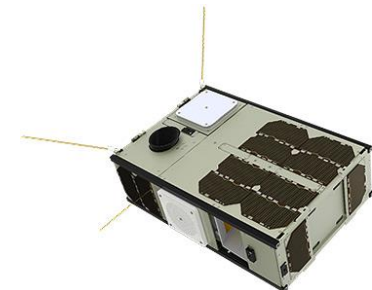


GOMX- 4B

Description

- **Organisation:** GomSpace
- **Partners:** ESA
- **Mission:** demonstrate inter-satellite linking and station keeping capabilities; key enabling technologies for future nanosatellite constellations. It features four 1 mN cold gas thrusters fueled by Butane to provide a total deltaV 15 m/s.
- **Both 4A, 4B:** Addition technology payloads include a compact hyperspectral imager called [HyperScout](#), developed by Cosine Research in the Netherlands; a miniaturised startracker from Innovative Solutions In Space, also in the Netherlands; an in-house ESA experiment to test components for radiation hardness; and an ADS-B antenna for aircraft tracking, developed from the GomSpace system tested on GOMX-3.
- **Mass:** 6U (+6 Kg)

**TO BE
launched in
2018**



SINOD-D 2

Description

**Launched on
08-10-2015**

- **Organisation:** SRI International (company)
- **Partners:** Tyvak
- **Mission:** SRI International NanoSat Orbital Demonstration
- **Primary payload:** High speed data downlink for wide-bandwidth CubeSat payloads via **software defined radio** communications
- **Mass:** 2U

Unknown status

SINOD-D 1

Description



**Launch
cancelled**

- **Organisation:** SRI International (company)
- **Partners:** Tyvak
- **Mission:** SRI International NanoSat Orbital Demonstration
- **Primary payload:** High speed data downlink for wide-bandwidth CubeSat payloads **via software defined radio** communications
- **Mass:** 2U

SINOD-D 3

Description

**Launched on
08-10-2015**

- **Organisation:** SRI International (company)
- **Partners:** Tyvak
- **Mission:** SRI International NanoSat Orbital Demonstration
- **Primary payload:** High speed data downlink for wide-bandwidth CubeSat payloads via **software defined radio** communications
- **Mass:** 2U

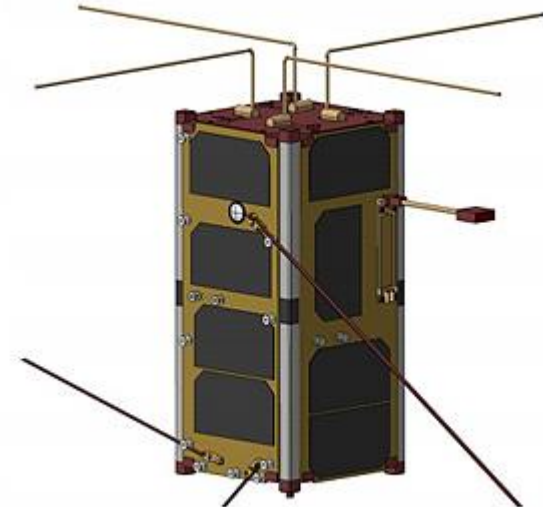
Unknown status

HavelSat

Description

**Launched on
18-04-2017**

- **Organisation:** Istanbul Technical University
- **Partners:** QB50, Havelsan, Gumush
- **Primary payload:** multi-needle langmuir probe, which will measure electron density during mission.
- **Secondary payload:** **Software Defined Radio**
- **Mass:** 2U (2 Kg)



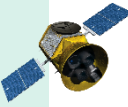
Operational?

TY6

Description

**Launched on
17-01-2018?**

- **Organisation:** Spacety (Chinese company)
- **Partners:** -
- **Mission:** Test **software defined radio** technology, which is with high flexibility and general utilization. Build an open standard and modular hardware platform, and is able to realize different functions by software. This will allow radio amateur to verify their software in space
- **Mass:** 6U



Description

**Launched on
17-01-2017?**

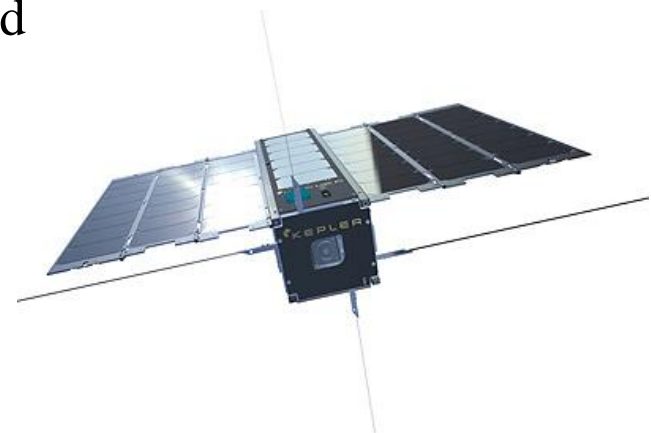
- **Organisation:** Spacety (Chinese company)
- **Partners:** -
- **Mission:** Test **software defined radio** technology, which is with high flexibility and general utilization. Build an open standard and modular hardware platform, and is able to realize different functions by software. This will allow radio amateur to verify their software in space
- **Mass:** 6U

KIPP, CASE

Description

**KIPP
launched on
19-01-2018**

- **Organisation:** Kepler Communications (Canadian start-up)
- **Partners:** Clyde Space
- **Constellation goal:** provide a vastly improved IoT backhaul for customers on the ground, as well as real time access to satellites in the same orbit.
- **Equipment:** deployable solar arrays, own **software defined radios (SDR)** and high gain antennas. Operations in Ka band
- **Mass:** 3U



Operational?

SPARC-1

Description

**TO BE
launched on
31-12-2018?**

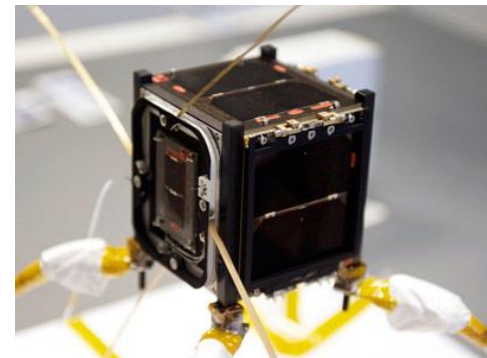
- **Organisation:** ÅAC Microtec (Swedish company)
- **Partners:** Swedish Defence Material Administration, US Air Force Research Laboratory
- **Primary objective:** Investigate and demonstrate Earth Observation as well as Space Situation Awareness for demonstration military utility as well a **software defined radio** with CCSDS communication. Demonstrate that military utility can be achieved using a nanosatellite, through the successful operation of the payloads described. A second objective is to demonstrate the operability of the platform itself and thereby allowing for future missions based on the same concept.
- **Second objective:** is to demonstrate the operability of the platform itself and thereby allowing for future missions based on the same concept.
- **Mass:** 6U

XaTcobeo

Description

**Launched on
13-02-2012**

- **Organisation:** University of Vigo
- **Partners:** INTA
- **Mission:** the deployment of XaTcobeo (formerly known as Dieste), a standard based 1U CubeSat (10 cm × 10 cm × 10 cm) in space, together with a ground segment which is being built at the Universidade de Vigo.
- **Payloads:** A **software defined reconfigurable radio** (SRAD) and a system for measuring the amount of ionizing radiation (RDS). There is also an experimental solar panel deployment system (PDM).
- **Mass:** 1U



LUME-1

Description

- **Organisation:** University of Vigo
- **Partners:** -
- **Mission:** IOD Platform for the validation of TOTEM, a **Software Defined Radio** payload. It will incorporate, in a very reduced volume, UHF and S-band communications; together with spectrum monitoring capabilities.
- **Mass:** 2U



**TO BE
launched on
31-12-2018?**

FloripaSat I

Description

**TO BE
launched on
31-12-2018?**

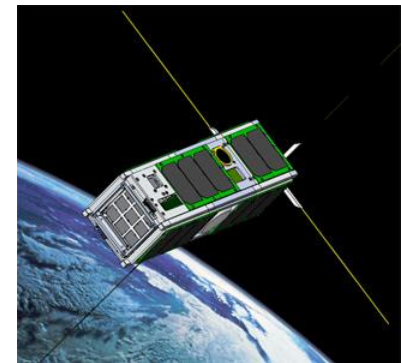
- **Organisation:** Federal University of Santa Catarina (Brazil)
- **Partners:** -
- **Mission:** Dual RF channel 70 MHz – 6 GHz **Software Defined Radio (SDR)** with on-board FPGA-based processing (under development).
Design, build, and test a satellite. Launch the satellite and communicate with it using the ground and space systems. Develop most of the modules used in the mission.
- **Mass:** 1U

ARMADILLO

Description

**TO BE launched
in 2018**

- **Organisation:** University of Texas
- **Partners:** -
- **Mission objectives:**
 - Characterize in-situ sub-millimeter level dust and debris particles in LEO by sensing impacts at varying times, directions and locations
 - Demonstrate ionospheric radio-occultation within a single CubeSat volume (10 cm × 10 cm × 10 cm) using a **software-defined dual frequency GPS receiver**
 - Train students in best systems engineering practices by executing a complete spacecraft life cycle from concept design to mission operations
- **Mass:** 3U

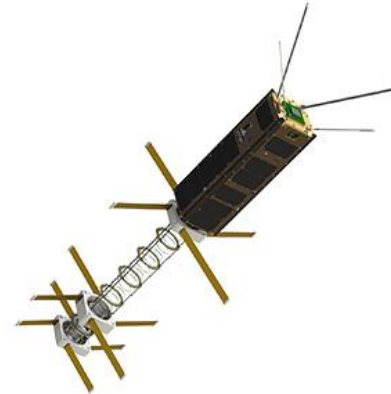


ICE-Cap

Description

**TO BE launched
in 2018**

- **Organisation:** US Navy PEO Space Systems
- **Partners:** Space Micro
- **Mission objectives:**
 - Demonstrate a cross-link from Low Earth Orbit to MUOS WCDMA in Geosynchronous Orbit
 - Polar UHF SATCOM relay using CubeSats
 - Mature and miniaturize radio, antenna and other technologies for potential responsive UHF SATCOM missions
- **Payload:** UHF **software defined radio** by Vulcan Wireless, the High Assurance IP Encryptor by InnoFlight, the high gain antenna by Physical Optics Corporation, the Omni antenna/Bus Integration/Flight Computer by Space Micro and the flight software by SSC PAC.
- **Mass:** 3U



SPACE-HAUC

Description

**TO BE launched
in 2018**

- **Organisation:** University of Massachusetts, Lowell
- **Partners:** -
- **Mission:** Science Program Around Communication Engineering with High Achieving Undergraduate Cadres Project. It's educational mission intended primarily as a hands-on student training mission that will also demonstrate X-band beam steering from a CubeSat platform. It's part of the ELaNa programme.
- **Payload:** consists of a **software defined radio**. The goal is to demonstrate the practicality of communicating at high data rates in the X band using a phased array of patch antennas on a CubeSat. The antennas will operate at frequencies of 8.0 to 8.4 GHz from an orbit of about 450 km.
- **Mass:** 3U (4 Kg)



STF-1

Description

**TO BE launched
in 2018**

- **Organisation:** NASA Independent Validation and Verification (IV&V) Program; West Virginia Space Grant Consortium (WVSGC); West Virginia University (WVU)
- **Partners:** -
- **Mission:** demonstrate a highly portable simulation and test platform that allows seamless transition of mission development artifacts to flight products. This environment will be highly portable and will decrease the development time of future CubeSat missions by lessening the dependency on hardware resources. It's part of ELaNa programme.
- **Payload:** Fast, Orbital, Total Electron Content (TEC), Observables and Navigation (FOTON) **software-defined multi-frequency Global Navigation Satellite Systems (GNSS) space receiver**; Langmuir probe; radio sounder; array of 3 particle counters; COTS photometer
- **Mass:** 3U (4 Kg)



VCC A, B, C

Description

**TO BE launched
in 2018**

- **Organisation:** Old Dominion University (ODU), Virginia Tech (VT), University of Virginia (UVA)
- **Partners:** -
- **Mission:** To obtain measurements of the orbital decay of multiple satellites to obtain in situ quantification of atmospheric drag and the variability of atmospheric properties and to evaluate and demonstrate a system to determine and communicate relative and absolute spacecraft position across an orbiting constellation. This objective will support the science investigation but will also demonstrate that small, low-power radios (both traditional and **software defined radios, or SDRs**) can be used for assessing relative satellite separation distances in constellation missions. It's part of the ELaNa programme.
- **Mass:** 1U (1 Kg)

ZACUBE 2

Description

**TO BE launched
in 2018**

- **Organisation:** French South African Institute of Technology (F'SATI), Cape Peninsula University of Technology (CPUT)
- **Partners:** -
- **Mission:** technology demonstrator.
- **Primary payload:** innovative **Software Defined Radio (SDR)** platform to address a wide range of communication needs and will be a test bed to validate vessel detection.
- **Secondary payload:** **medium resolution imager** to demonstrate the feasibility of future remote sensing applications such as ocean colour monitoring and large fire tracking.
- **Mass:** 1U (1 Kg)



FEES

Description

**TO BE
launched on
31-12-2019?**

- **Organisation:** GP Advanced Projects (Italian company)
- **Partners:** Polytechnic University of Milan
- **Mission:** Flexible Experimental Embedded Satellite. Test in orbit different technologies not yet space qualified and crucial for the further development and exploitation of miniaturized space platforms: in-orbit test of attitude determination/control architecture, commercial GPS receivers, IRIDIUM signal exploitation, test of a **Software Defined Radio**, Earth imaging with a **multispectral camera**.
- **Mass:** 300 g

3CAT-4

Description

**TO BE launched
on 2018/2019**

- **Organisation:** Polytechnic University of Catalonia (UPC, BarcelonaTECH)
- **Partners:** -
- **Mission:** Implements in a **Software Defined Radio** a «flexible microwave payload» to perform (sequentially): 1) dualband (L1, L2/L5) GNSS-Reflectometry, 2) L-band radiometry with digital Radio Frequency Interference detection and mitigation techniques, and 3) an experimental Automatic Identification System (AIS). It's part of Fly Your Satellite.
- **Mass:** 1U

Aalto-3

Description



**TO BE
launched on
31-12-2019?**

- **Organisation:** Aalto University (Finland)
- **Partners:** -
- **Mission:** **Software Defined Radio** payload. Wireless bus technology demonstration as a secondary payload.
- **Mass:** 1U

GOLF-TEE

Description

**TO BE
launched on
31-12-2019?**

- **Organisation:** AMSAT (US non-profit)
- **Partners:** Vanderbilt University
- **Mission:** Technology Evaluation Environment. Vanderbilt University Low Energy Proton (LEP) experiment. Deployable solar panels, ADAC (attitude determination and control), **Software Defined Radio (SDR) Transponder.**
- **Mass:** 3U

BRIAN

Description

**TO BE
launched on
31-12-2020?**

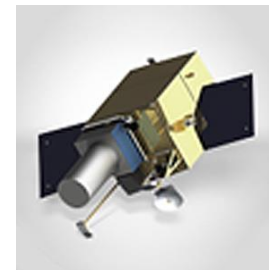
- **Organisation:** University of Buffalo (US)
- **Partners:** -
- **Mission:** Fly a **software defined radio** payload in order to characterise and develop a temporal and spatial map of the background radio noise on commonly used CubeSat bands.
- **Mass:** 3U

WFOV

Description

**TO BE
launched in
2020**

- **Organisation:** Space and Missile Systems Center (SMC)
- **Partners:** -
- **Mission:** to evaluate a new Overhead Persistent Infrared (OPIR) 6-degree staring sensor. Originally this was to be a hosted payload on a commercial geostationary comsat, but was redesigned as a free-flyer.
- **Payload:** amateur payload consisting of a **Software Defined Radio** designed and built by Rincon Research Corporation using support equipment and antennas designed by Virginia Tech and other volunteers to this effort.
- **Mass:** -

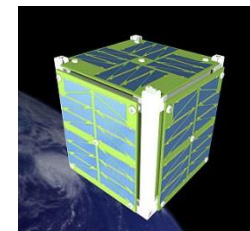


OPEN

Description

**TO BE
launched**

- **Organisation:** University of North Dakota (US)
- **Partners:** -
- **Mission:** reduce mission risk and cost for universities, researchers and other spacecraft developers through the creation of an open-hardware/open-source software framework for CubeSat development. The designs use low-cost commercial off-the-shelf parts and easily-to-fabricate printed circuit boards that can be made using the budget of \$5,000 in parts for a basic spacecraft. The designs, fabrication instructions, testing plans and educational/course integration notes produced as part of the OPEN effort will be made publicly available. It's part of the ELaNa programme.
- **Payloads:** The payload consists of a **visual light camera** and a **software-defined radio**.
- **Mass:** 1U (1 Kg)



DelFFi Delta, Phi

Description

**TO BE
launched**

- **Organisation:** Technical University of Delft (Netherlands)
- **Partners:** -
- **Mission objectives:**
 - Demonstrate autonomous formation flying using various Guidance, Navigation and Control (GNC) architectures.
 - Facilitate students with hands-on experience and cutting-edge technology.
 - Characterize low thermosphere with enhanced scientific return by using distributed observation on various geometric baselines.
- **Payload:** The GAMALINK is an advanced communications platform relying on the flexibility of **Software-Defined Radio (SDR)**. It empowers the formation of mobile wireless ad hoc networks in space, benefitting from technology that has already been vastly tested to provide connectivity in the most demanding environments on the ground. **GAMALINK** also delivers accurate position determination based on GPS, which provides absolute position and timing information that may be used to achieve synchronization between satellites.
- **Mass:** 3U (3.6 Kg)

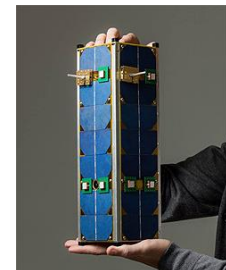


GAMASAT 1 (QB50 PT01)

Description

**TO BE launched
from ISS**

- **Organisation:** University of Porto
- **Partners:** Tekever
- **Mission objectives:** It is a part of the QB50 constellation to gather science data in the upper layers of the troposphere in the altitude range from 350 km down to 200 km. The QB50 project, which will demonstrate the possibility of launching a network of 50 CubeSats built by Universities Teams all over the world as a primary payload on a low-cost launch vehicle to perform first-class science in the largely unexplored lower thermosphere. GAMANET's enabling device is **GAMALINK**, an advanced communications platform relying on the flexibility of Software-Defined Radio. Present on every GAMANET node, whether a CubeSat or a Ground Station, GAMALINK empowers the formation of mobile wireless ad hoc networks in space. GAMALINK also delivers accurate position determination based on GPS, which provides absolute position and timing information that may be used to achieve synchronisation between satellites.
- **Primary payload:** FIPEX (Flux- Φ -Probe Experiment) of TU Dresden
- **Mass:** 3U (4 Kg)

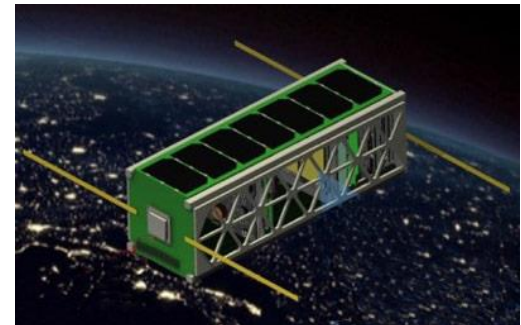


LinkSat

Description

TO BE launched

- **Organisation:** University of Buffalo
- **Partners:** -
- **Mission objectives:** Technology demonstration to fly a **software defined radio (SDR)** payload in order to characterize the background radio noise on commonly used CubeSat bands. It will sample each RF band throughout the orbit to develop a temporal and spatial map of the RF noise environment. It is part of NASA ELaNa programme.
- **Mass:** -



Sources

- <http://space.skyrocket.de/index.html>
- <http://www.nanosats.eu/>