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GARAI Mission: two Microsatellites embarking four Imagers for multispectral submetric Earth Observation serving critical applications.

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ABSTRACT

SATLANTIS MICROSATS SA and OHB Sweden are finalizing 2 micro satellites together under the project name GARAI, first launch scheduled in October 2024. This paper will present the current status of the High-Resolution Multispectral satellite and the services it will enable.

Each satellite will embark two binocular imagers from the iSIM family, iSIM-90 and iSIM-170, combining high resolution images and videos with swath values up to 13 km and multispectrality, with a total of 14 different filters split between the four optical channels covering SWIR spectra, VIS Polarimetry, and PAN + VNIR spectra.

The GARAI mission incorporates OHB Sweden's flight proven InnoSat micro satellite platform together with SATLANTIS iSIM technology. InnoSat has proven itself worthy in various missions from commercial (GMS-T, 2021, ADIS, 2025), scientific (MATS, 2022) to institutional (AWS,2024 and EIS, 2025). iSIM technology has been demonstrated through past missions such as IOD (2020), CASPR (2021), ARMSAT-1 (2022), MANTIS (2023), GEI-SAT (2023), HORACIO (2024).

The iSIM technology is based on diffraction-limited set of telescopes with high-precision, robust and light mechanical structure, high performance electronic control system and image processing unit including the proprietary Ultra High-Resolution algorithms for the maximization of spatial resolution, brightness, and contrast.

The GARAI satellites will weight around 100 kg including around 30 kg of payload and feature Earth Observation state of art technology such as:

- High data rate through a high-speed X-band link capable to downlink payload data at > 500 Mb/s.

- A high slew-rate mode for tracking of linear profiles such as borders, coastlines, or pipelines, resulting in maximum efficiency for data capture around the globe. This uses a Chebyshev polynomial based guidance mode accounting for the satellite agility where the onboard controller has been tuned for the particular use case and mission parameters. The guidance is generated with flight dynamics tools that transform the desired observable paths on earth into suitable

actuation profiles on-board. The heritage onboard guidance block dates from OHB Sweden's ODIN satellite, launched in 2001 and still in operation after 23 years!

- High delta-V propulsion system for station keeping capabilities, collision avoidance and orbit transfer to accommodate a wide variety of mission profiles, and active atmospheric reentry.

- An optical bench with a vibration isolation solution and high thermal stability through its own dedicated thermal control system accommodating both payloads and star trackers minimizing thermoelastic misalignments for precise pointing and geolocation.

SATLANTIS will operate the satellite using its own Mission Control Center and Software integrated with the Mission Control Software "RAMSES" from OHB Sweden and will process the data at SATLANTIS Data-Hub. GARAI will serve a broad range of applications, from methane emissions detection (SWIR) of high accuracy through removal of aerosols (Polarimetry) with geolocation and quantification of the leaks simultaneous to visible observation of the scene (VNIR), to civil applications requiring high-resolution imagery and videos (VNIR) in combination with agile operations (high slew-rate and tracking of linear profiles) such as defense and security e.g., surveillance of critical infrastructure, borders, coasts, providing a leading market solution of Earth Observation satellites around 100 kg.

INTRODUCTION

The GARAI satellites, GARAI-A and GARAI-B, are the next generation of satellites in SATLANTIS's strategic roadmap, aimed at establishing a unique satellite solution, providing High-Resolution, multispectral and polarimetry imagery + video products with multiple applications for the Earth Observation (EO) market. GARAI-A is scheduled for launch in October 2024, followed by GARAI-B in June 2025. Both satellites will be deployed into a sun-synchronous low Earth orbit, as part of SpaceX Transporter missions.

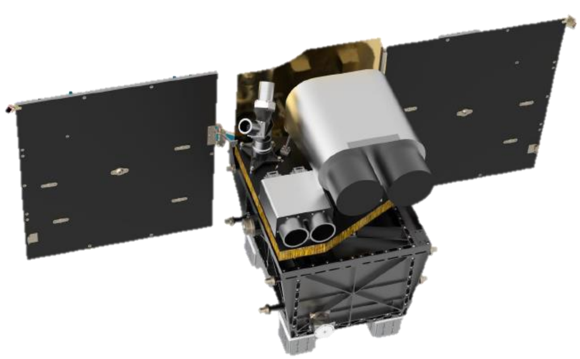

Figure 1. GARAI spacecraft render. Featuring OHB Sweden Microsatellite platform and SATLANTIS payload.

WHO IS BEHIND GARAI'S SPACECRAFT?

SATLANTIS MICROSATS S.A.

SATLANTIS is a leading Space technology company providing solutions for Earth Observation and Universe Exploration, built around their high-resolution optical payloads for small satellites.

SATLANTIS' EO solutions offer comprehensive and simultaneous coverage across PAN, RGB, NIR, and SWIR spectral ranges, plus TIR capabilities, alongside video and polarimetry.

Covering the entire value chain, SATLANTIS not only offers EO optical payloads but full satellite solutions, to address challenges in various sectors for clients worldwide: environment (detection of methane emissions), security (coastal, maritime and borders surveillance), energy infrastructures (monitoring of plants and pipelines), among others, via an offering encompassing hardware, software, and services, fully customizable to the users' needs.

In 2020 and 2021 the company demonstrated the high resolution of iSIM-170 onboard the International Space Station (ISS) in its first IOD missions, and a report by Euroconsult positions SATLANTIS among the best global providers of small satellites optical payloads. After that, it launched its first complete satellite solutions for EO in May 2022 following two more in June 2023 and March 2024.

SATLANTIS was founded in 2013 and is headquartered in Bilbao, Spain, where its production facilities are located. It has a subsidiary in Gainesville (Florida, US) within the Innovation Hub; SuperSharp in Cambridge (UK), a company specialized in thermal infrared payloads for Earth Observation satellites, and a French office in Bidart.

OHB Sweden

OHB Sweden is a renowned space technology company specializing in the development and manufacture of advanced satellite systems and its subsystems. The company offers innovative solutions for a wide range of space applications, including Earth Observation, telecommunications, and scientific missions. OHB Sweden's expertise encompasses the design, integration, and testing of satellite platforms, with a strong emphasis on reliability and performance.

OHB Sweden's comprehensive approach covers the entire value chain, from initial concept design to the delivery of fully operational satellite systems. Their services include mission analysis, system engineering, payload integration, and in-orbit operations, ensuring tailored solutions to meet the specific needs of their clients across various sectors, including environmental protection, security, and resource management.

Their InnoSat microsatellite platform provided for this mission delivers the heritage, high performance and versatility required for this mission.

OHB Sweden was founded in 2010, emanating from the satellite department of Swedish Space Corporation with satellite design experience since the 1980s, and is now a part of the OHB SE group, one of Europe's leading space enterprises. The company has a rich history of successful missions and collaborations with major space agencies and national space organizations. OHB Sweden continues to drive innovation in space technology, supporting both commercial and scientific endeavors with their state-of-the-art satellite systems and expertise.

MISSION TECHNOLOGICAL OBJECTIVES

The main technological objective of the GARAI satellites is to combine the InnoSat platform capabilities, along with the iSIM imager technology, for a multipurpose EO mission that offers widest range of state-of-the-art observation capabilities and techniques, alongside the automation of the satellite tasking requests through SATLANTIS Mission Control Software (MCS) and the RAMSES software suite from OHB, and advanced image processing techniques and data-hub infrastructure to maximize satellite's resources and broaden the spectrum of analysis ready imagery products.

Imagery products and application examples

For each satellite there are 4 different optical channels, each one equipped with its own detector and filter combination to enable multiple ways to understand light. With a continuous acquisition time of 15 minutes, in each orbit it can cover up to 80.000 km^2 of territory, and the payload can produce various multispectral products in Panchromatic, VNIR and SWIR spectral bands, achieving 1 m or better resolution after applying SATLANTIS proprietary image processing algorithms (disclaimer: no AI involved).

Multispectral High Resolution VNIR capability (Image + Video)

Environmental monitoring, VNIR data can contribute to monitor changes in vegetation (e.g., forests), land, and water bodies, and thus helping monitorization of biodiversity and protection from ecological degradation which can represent hazards. In addition to natural or climate change-related phenomena, besides it can be used to monitor and detect human (illegal) activity causing threats to environmental ecosystems.

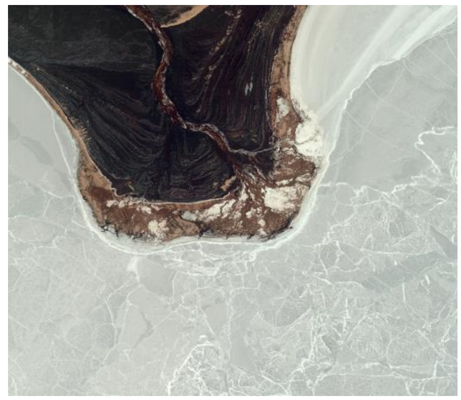

Figure 2. Athabasca Sand Dunes Provincial Park in Canada. Image taken with an iSIM-90 imager onboard a 16U-CubeSat platform.

Disaster Monitoring, high spatial resolution in VNIR spectrum contributes to disasters management and response. Satellite imagery is considered crucial to the management of disasters and emergencies, supporting the preparedness, response, and recovery efforts.

Land cover: VNIR data can support land monitoring, with applications like urban planning.

Figure 3. Urban area over Spain. Image taken with an iSIM-90 imager onboard a 16U-CubeSat platform.

Security and Defence, with the imagery data of high spatial resolution is possible to perform surveillance of strategic areas and infrastructures, including detection of illicit and/or threatening activities carried out within the areas of interest and their surroundings.

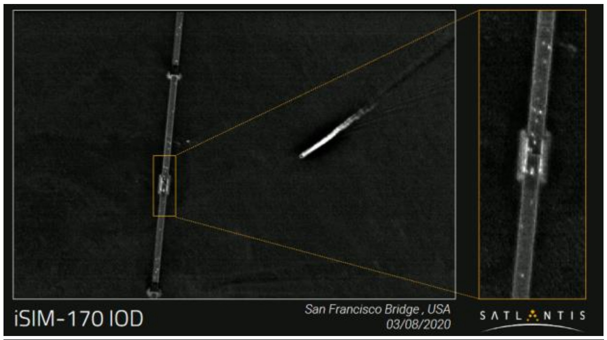

Figure 4. San Francisco Bridge, USA. Image taken with an iSIM-170 imager onboard ISS.

Multispectral SWIR capability

Green-House Gases Monitoring, thanks to Satlantis' expertise in Methane Emissions Detection and Quantification, and to the specific SWIR spectral bands embarked in this mission, the GARAI satellites can contribute to the fight against Climate Change. CH_4 (i.e., methane) has up to 84 times more heat retention capacity than carbon dioxide (CO_2) molecules. The same SWIR bands might also be used to contribute to CO_2 detection. Due to the recently adopted regulations regarding CH_4 monitoring, the Oil & Gas industry is required to adopt different measurement methods (including satellites) to certify their good conduct.

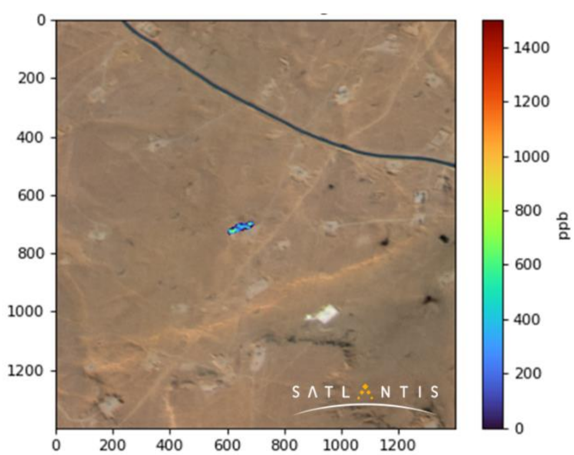

Figure 5. Example of detection and quantification of methane emissions in Algeria dessert. Performed by an iSIM-90 imager onboard a 16U-CubeSat platform.

Precision Agriculture to increase the crop management efficiency and adjust it to fields spatial variations, including factors such as temperature and precipitations variation, plant diseases prevention, branding and market positioning or regulation. Specifically, SWIR spectral bands are sensitive to water content of soil and plants, the presence of lignin from dead vegetation, and the content of hydrous minerals.

Figure 6. Example of different products for precision agriculture. Performed by an iSIM-90 imager onboard a 16U-CubeSat platform.

Marine Environment, SWIR bands can support the monitorization of marine ecosystems, for instance by using them in combination with Floating Debris Indexes (FDI) and Floating Algae Indexes (FAI) to assist algae and plastic detention processes and enhance the marine environment preservation. In addition, SWIR bands can contribute to suspended particulate matter (SPM) concentration monitoring in sea ecosystems.

Figure 7. Fields next to the coast in Bongeen, Australia. Performed by an iSIM-90 imager onboard a 16U-CubeSat platform.

Mineral Determination and Mapping, high spatial resolution SWIR images contribute to material composition detection, allowing mineral patterns mapping and indexes that are not achievable using current multispectral technology. Thus, SWIR bands represent a powerful tool for mining and geologic remote sensing applications.

Polarimetry

Object detection and classification: polarimetry can be used to detect and classify objects based on their unique polarimetric properties, allowing for better object identification and more accurate target detection.

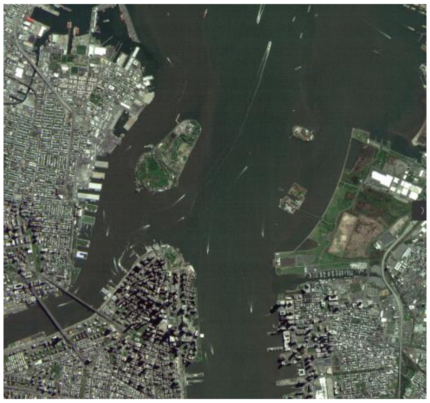

Figure 8. Upper Bay New York, USA. Image taken with an iSIM-90 imager onboard a 16U-CubeSat platform.

Characterisation of the Earth's surface: polarimetry can provide valuable information on the composition and structure of the Earth's surface, allowing for better characterisation of materials and more accurate identification of changes in it.

Pollution detection: polarimetry can be used to detect and characterise pollution in bodies of water and in the atmosphere, allowing better monitoring of the environment and faster response to emergency situations.

Figure 9. Industrial port in Europe. Image taken with an iSIM-90 imager onboard a 16U-CubeSat platform.

Vegetation observation: polarimetry can provide valuable information on the structure and health of vegetation, allowing for better monitoring of natural resources and more accurate identification of land-use changes.

In summary, polarimetry in optical sensors offers a wide range of differential applications that can significantly improve the accuracy and efficiency of observations and measurements made by remote sensing systems.

Observation modes

Platform agility and imager technology make possible to acquire and process images using multiple observation strategies.

"Push-frame" or Scanning observation mode.

Is the baseline mode, which consists of acquiring 2D consecutive images at high FPS while the satellite moves along its orbit, with a fixed pointing.

The instrument FOV along and across track corresponds to the two dimensions of the detector area array projected on the Earth's surface, with the longer side of the swath oriented perpendicularly to the direction of movement to maximize the total scanned area during acquisitions.

The channels on the payload imager are parallel to each other, configured to observe the same area on ground. Thus, each channel can be used to acquire images of the same area on ground but at different spectral ranges.

During an image acquisition operation, images are taken at a high frame rate and at short exposure times with respect to the satellite motion to ensure no blurring during movement along the orbit, and a sequence of images with a common area of overlap.

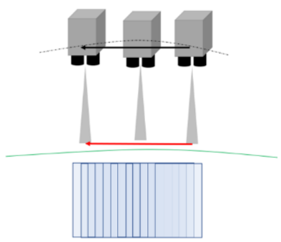

Figure 10. Scanning acquisition mode representation. The imager is pointing at a fixed off-Nadir angle while acquiring at high FPS.

The overlapping regions will be used to combine images with SATLANTIS' Ultra-High Resolution (UHR) algorithm that to improve the spatial resolution.

Backscanning observation mode

This mode aims to achieve a reduction of the platform ground velocity, by constantly adjusting the platform attitude towards the target while moving along the orbit during the acquisition period. This ground velocity reduction allows greater exposure times which results in a drastic increase in SNR of the acquired images. This mode is particularly interesting when acquiring targets within low solar elevation angles or for applications where high SNR is required.

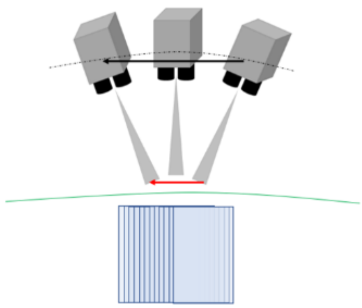

Figure 11. Backscanning acquisition mode representation. The imager adjusts its pointing to reduce the sensor ground velocity while acquiring at higher exposure time.

Non-linear tracking observation mode:

The platform can be commanded to follow linear targets like roads, country borders, pipeline infrastructure or coast features thanks to its onboard controller and agility capabilities.

This observation mode allows to efficiently cover linear targets that otherwise will need multiple satellite observations to be covered entirely, besides, it can be used to acquire multiple scattered single targets.

Figure 12. Non-linear tracking acquisition simulation over the Portugal coast.

Staring observation/video mode:

This mode allows to take a Panchromatic Fixed Video of a target for up to 90 (s), which provides a temporal context to the observation for identification of velocities, trajectories, fluxes…etc. For instance, an acquisition in Staring mode of an airport will probably show planes taking-off or landing during the acquisition time, or an observation of the roadways will show the traffic flux. The spacecraft will be pointing at the same geographic coordinate during the acquisition operation.

Swath-augmentation mode:

The spacecraft agility capabilities can be used to command maneuvers that extend the final imagery product swath by performing parallel sweeps of a specific geographic area during the acquisition period. This mode can efficiently cover targets that extend the instrument swath in a single orbit.

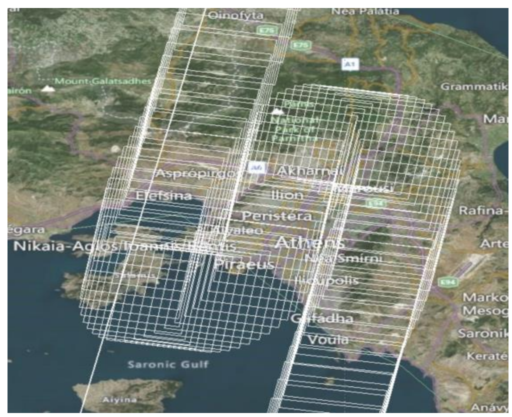

Figure 13. Swath-Extension simulation. The satellite performs various parallel tracks over the target when passing over it.

Mission Control software and satellite tasking automation

SATLANTIS proprietary Mission Control Software (MCS) is conceived as a tool to automate the daily satellite tasking which otherwise would require extensive 24/7 full-time dedication of satellite operators.

Through automatization, satellite operations are controlled and tasked in an orbit-by-orbit basis, where, after a successful contact with the platform, the MCS gathers the necessary information like platform and payload telemetries, imagery products that have been downloaded and newly acquired, and remaining operations (amongst other data) to plan for the next available contacts.

Figure 14. Visualization of platform and payload telemetry database.

Once it has the necessary data, it calculates possible operation schedules based on a pre-defined database of targets which contains, information regarding each target priority, successful coverage already performed, cloud prediction, pointing and illumination constrains and more. Then, a mission-customized algorithm determines the most efficient operation schedule from all those possible, to optimize operations.

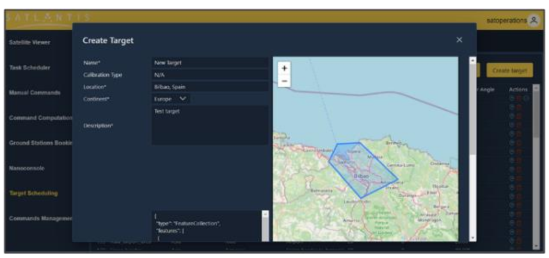

Figure 15. Interface to add a new target to the MCS target pool.

Finally, it generates the commands to perform the selected operations, integrates these with periodic housekeeping tasks (including imagery and TM data download) and automatically schedules its upload for the next available pass. In parallel, the MCS has automatically scheduled a given number of passes per day within the global network of antennas available based on a set of constraints and priorities (elevations, masks, etc.) and executes the scheduled tasks during these.

This procedure maximizes the use of satellite resources and mission performance, with minimum human resources needed on-ground during nominal operation. The MCS performs autonomous process and review of telemetries and generates warnings and alerts visible for the operators to take action when needed. This way, satellite operations can be performed with minimum human intervention.

The MCS automated operations are guided by several configuration parameters which satellite operators can adjust at any time. In addition, the MCS also allows for manual control of the satellite in the form of manual command inputs either in real-time during a communication window i.e., when passing over a ground-station, or scheduled some time in advance, offering full satellite control to the operators.

Some other features of Satlantis MCS are:

- Compatible to multi-satellites, multi-constellations model
- Earth Observation oriented
- Task automation: manual, semi-automatic or automatic operations
- User-Friendly web-based interface
- REST API for software interconnectivity.
- Continuous improvement through own operator's experience
- User authorization management
- On site or remote access (cloud based)

Figure 16. MCS main screen. The satellite position activated targets and ground stations active are represented. Satellite can be propagated back and forward manually.

A relevant feature is that the MCS is scalable and mission agnostic i.e., it can be used for different satellites in different (or not) missions simultaneously. Essentially, the MCS can be called multiple times for multiple satellites, and according to a unique satellite identification number, access specific configuration parameters and command lists. At the same time, different satellites can share a common acquisition database, such that the observations of all are coordinated to fill-in the gap of imagery needs and effectively operate as a unified constellation.

For GARAI mission, Satlantis MCS will integrate "RAMSES" Mission Control Software from OHB Sweden to bring the expertise and functionalities to reliably monitor and control the platform and combine them with the payload tasking automation capabilities mentioned above.

Image Processing and Data Hub unit

After TT&C and Payload data is downloaded through the Ground Station Network and is received by SATLANTIS MCS, Payload data is parsed and delivered to the Processing Unit for the generation of the mission analysis ready data and stored in the Data Hub unit.

Image Processing Unit

The Processing Unit is an infrastructure that combines cloud and local computation resources at scale to automatically processed all the received data by using the mission processing pipeline. The next figure represents an example mission processing pipeline deployed on the Processing Unit.

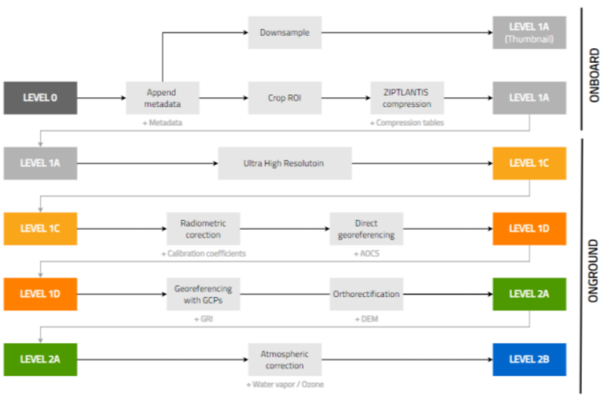

Figure 17. Data Processing pipeline schematic.

Level 0 – raw data generated by the Payload. This data is not downloaded to ground.

Level 1A – raw data cropped for each spectral band. This data products are generated onboard and download to ground.

Level 1A Thumbnails – low resolution image previews of the Level 1A data products downloaded to ground and used for the selection of downloaded data after its previsualization. The purposed of the L1A Thumbnails is to discard undesired data (e.g., from acquisition over fully cloudy areas) to use the download times more efficiently, reducing time and costs.

Level 1C – data generated by SATLANTIS Ultra High-Resolution algorithms that, by the registration, alignment and co-adding of overlapped 2D frames acquired by the payload allows to produced output data products. In this step, dark, flat, gamma and sensor geometric corrections are also applied.

Level 1D – multi-band mosaic that is georeferenced and radiometrically corrected to top-of-atmosphere (TOA) radiance. During this steps Rational Polynomial Coefficients (RPCs) are computed and data is resampled and projected to WSG84 ellipsoid.

Level 2A – orthorectification of the L1D product by using a global Digital Elevation Model (DEM). In this step geometric refinement coefficients are also computed to the RPCs by using a Ground Reference Image (GRI) to extract Ground Control Point (GCPs) to improve geolocation accuracy.

Level 2B – L2A data radiometrically corrected to BOA reflectance (Atmospheric Correction).

The Processing Unit is in charge of orchestrating the image processing pipeline and delivering the generated products to the mission data archive systematically and automatically.

Data Hub unit

The Data Hub is the Payload Data Ground Segment of the mission. It is a cloud infrastructure based on microservices which main function is to handle the massive amount of data generated by an Earth Observation mission, archiving, and cataloguing all the mission datasets in an organized and efficient manner.

The Data Hub is design to be deployed in an Amazon Web Services (AWS) cloud environment. Its architecture is shown below.

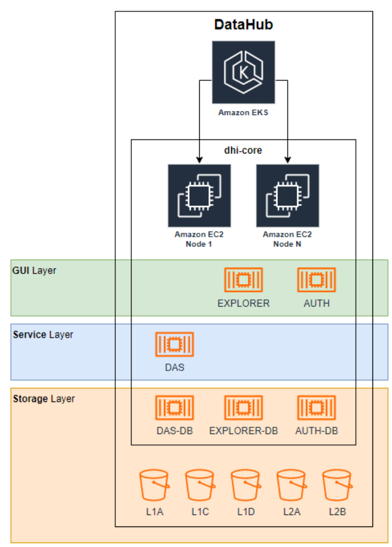

Figure 18. Data Hub structure.

The Data Hub is comprised by three different systems.

The Data Archive System (DAS) is in charge of archiving of all the mission datasets. The DAS is responsible of the archive management, with the ingestion and registration of new received and generated products in the appropriate structure, and the retrieval of the requested products from the archive.

Customer's DAS will play the role of main mission data archive. The archive structure is organized, as baseline, by mission, dataset, and date, but additional parameters can be added by the Customer to have a more customized data access and discovery. The DAS relies on cloud object storage services, AWS Simple Storage Service (S3).

The Authentication and Authorization System (AUTH2) is in charge of the control of user and user group roles and permission to the different Data Hub Clients (Graphic User Interfaces) and resources (Datasets). Additionally, the AUTH2 is used for the synchronization and check of the datasets present in the Data Hub. The Data Hub provides a Graphic User Interface (GUI) from where the system can be easily controlled.

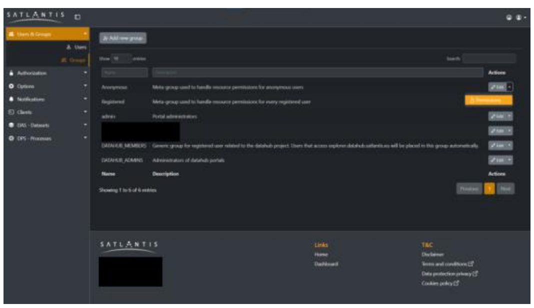

Figure 19. Screenshot of the Data Hub AUTH2 system GUI

The Explorer is the GUI used for the data access, discovery, and request. It has a catalogue design, from where any user (data administrator or data end users) can access the dataset to which the Data Hub administrators have previously granted access permissions.

The Explorer allows to search from products by dataset, period of interest, area of interest, and other additional product dependent constraints (name, sensor incident/azimuth angle, solar incident/azimuth angle, cloud cover percentage, etc.). It allows the previsualization the products with the download of image quick look or the projection of these is the map, and also the review of metadata field summary and details, with a dedicated metadata window pop-up.

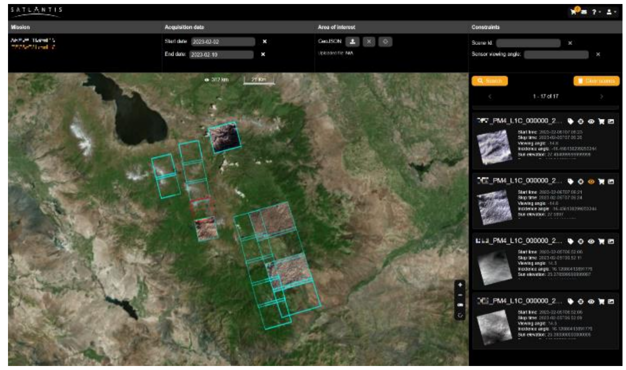

Figure 20. Screenshot of the Data Hub Explorer GUI.

PAYLOAD OVERVIEW

Each GARAI satellite payload features an aluminum honeycomb optical bench that holds two different iSIM imagers; iSIM-90 and iSIM-170, along with the star tracker head assembly and a shock absorption system. This configuration ensures precise geolocation and minimizes the impact of launch vibrations in the instruments to ensure reliable data collection. The total payload assembly has an approximate mass of 30 kg.

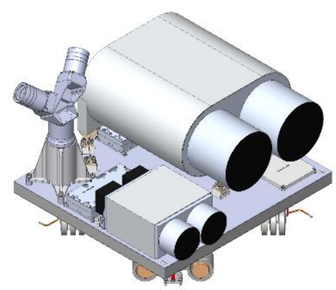

Figure 21. GARAI Satellite payload render.

iSIM stands for "integrated Standard Imager for Microsatellites". Both, iSIM-90 and iSIM-170 imagers, consists of a combination of technologies including optics, mechanics, electronics, and processing algorithms to achieve a high spatial resolution and allow significant cost reduction compared with traditional imaging systems of similar performance. These characteristics are the result of combining a very compact and straightforward optomechanical design, with the latest advances in electronics (detectors and processors), the use of COTS components (radiation-tolerant in LEO), and the incorporation of advanced manufacturing procedures. iSIM technology can be divided into two main subsystems: the Optomechanical Subsystem and the Electronics and Control Subsystem (ECS).

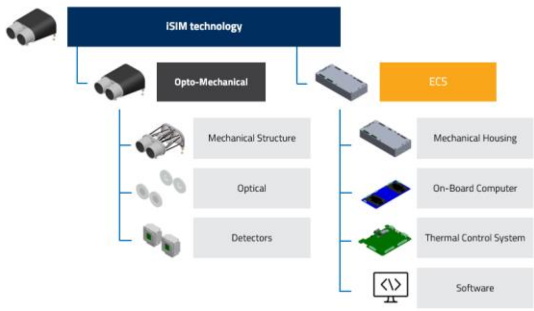

Figure 22. iSIM imager subsystem breakdown.

iSIM imager optomechanical subsystem

The Optomechanical Subsystem of each imager has a binocular design with two optical channels that corresponds to a modified Maksutov-Cassegrain design that provides diffraction-limited images. Each optical channel is formed by multiple optical elements. External and internal baffles are included to improve the optical quality by reducing straylight.

The mechanical structure design is a high precision, robust and light alloy structure with carbon fiber struts that support the optical system and detectors.

The mechanical interface between the optomechanical structure and the satellite platform is formed by the three titanium blades that create a three-point isostatic interface. The configuration guarantees thermo-structural stability preventing induced stresses due to temperature variations, providing the required stiffness to survive operational and launch environments.

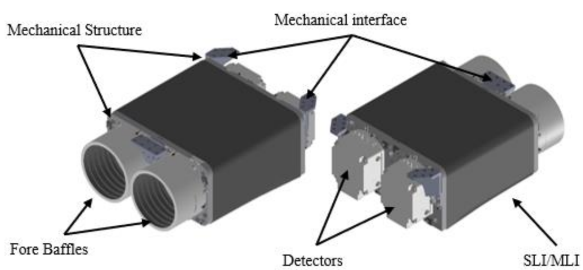

Figure 23. iSIM-90 imager render.

Payload electronics and control subsystems (ECS)

The ECS is composed by the Central Processing Unit and the Thermal Control Unit (TCS). The payload has 2 fully redundant onboard computers, FPGAs, and power domains, with the supervisor being designed with full capabilities for fault detection and power cycle.

The CPU HW unit consists of a compact 2U-formfactor board designed with cold redundancy, using separated cores and memories that make it robust to radiation effects. This PCB contains the control and processing SWs of the ECS, in charge of payload control, management, operations, image storage, compression and processing, and communication and transmission with the satellite platform.

To support the acquisition and image processing, the CPU design also provides high-speed processing based on FPGAs and GPUs.

The active TCS HW unit consists of a compact 1U-formfactor board. This board contains the SW for temperature monitorization and control of the payload. For temperature monitorization and temperature control this PCB is connected to temperature sensors and heaters, respectively, that are distributed throughout the mechanical structure of the payload.

In terms of software, the ECS is responsible the following capabilities:

- Payload monitoring (Telemetry and Telecommand).
- Payload-to-Satellite bus communications and data transmission.
- Image detector commanding and monitoring.
- Active Thermal Control monitoring and commanding.
- Image storage.
- Image compression. configurable for factors between x2 and x6.
- Smart Image Processing Algorithm.
- In-orbit software upgradeability.

The electrical and data handling interfaces consist of a harness to provide power to the payload and for transmission and reception of TT&C and Science Data. The next figure highlights the TT&C data transmission interfaces and the Science data transmission.

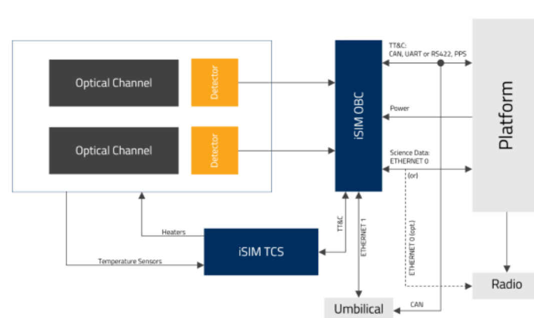

Figure 24. Functional block diagram showing external interfaces with satellite platform.

For temperature management, temperature setpoints are defined according to the operational temperatures of the corresponding payload units and, therefore, can be adjusted to meet the operational requirements needed for a specific unit and task. The setpoints are provided by the CPU to the TCS.

Figure 25. iSIM imager ECS unit.

GARAI iSIM-170 imager characteristics

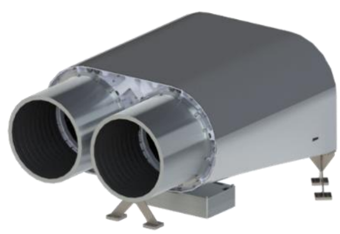

Figure 26. iSIM-170 imager render.

Table 1: GARAI iSIM-170 imager characteristics specifications table.

	PAN+VNIR
Physical	
Mass (kg)	< 15
Volume Optomechanics (mm3) (1)	605 x 473 x 311
Volume Electronics (mm3) (1)	209 x 96 x 46
Imaging	
Resolution (m) (2)	1 m or better
Swath (km) (2)	7.5
Spectral range (nm)	450 - 900
Multispectral bands	PAN & VNIR
(1) All dimensions include margins. (2) At 500 km reference altitude after processing.	

GARAI iSIM-90 imager characteristics

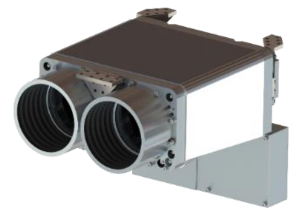

Figure 27. iSIM-90 imager render.

Table 2: GARAI iSIM-90 imager characteristics specifications table.

	VNIR [Polarimetry] + SWIR channel
Physical	
Mass (kg)	< 4
Volume Optomechanics (mm3) (1)	324.8 x 219 x 115
Volume Electronics (mm3) (1)	209 x 96 x 46
Imaging	
GSD (m) (2)	SWIR 6,45 [m], Polarimetry: 3.5 [m]
Swath (km) (2)	SWIR: 8,3 km, Polarimetry: 13 km
Spectral range	400 - 900
Multispectral bands	SWIR Polarimetric VNIR 450-900 (nm)
(1) All dimensions include margins. (2) At 500 km reference altitude after processing.	

PLATFORM OVERVIEW

General architecture

GARAI satellite bus is based on the InnoSat micro satellite platform. With a total platform mass around 80 kg, the main structure follows a rectangular prism concept using honeycomb aluminum panels.

The top deck of the platform is used as the payload interface while in the bottom the structure is reinforced to hold the FEEP base thrusters and the launcher deployment mechanism.

The platform features two deployable solar array wings on the platform sides that are hold down in the stowed configuration by non-pyrotechnic mechanism.

The platform is designed for an in-orbit lifetime of 5 years.

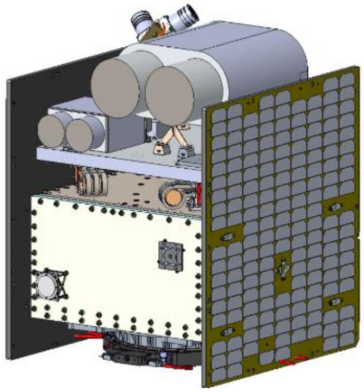

Figure 28. GARAI satellite render in stowed position.

Communications

The Telemetry Tracking and Command (TT&C) subsystem ensures the smooth operation and control of the satellite throughout the mission. Its main purpose is the collect and transmit data on the satellite's health, status, and performance back to ground operations and receive and execute commands from ground control to adjust the satellite configurations.

The architecture of this subsystem relies on a S-band transceiver with two antennas placed in a Nadir-Zenith configuration. The Nadir antenna is used in nominal operations, while both would be used to increase the probability of a successful communication link in case the platform enters Safe Mode and its tumbling.

In addition, an X-band transmitter with a download rate of 580 Mbps is directly connected to the payload so a high volume of imagery data could be downloaded in each contact with ground station, thus reducing the total latency of the final products.

Communication with the platform and Payload Data is encrypted thorough an CCSDS compatible authentication and encryption solution using AES-256 encryption algorithm.

Thermal control

The platform uses a combination of MLI, radiative surfaces and heaters to maintain operational temperatures during the mission.

Besides, the platform provides multiple safe heater lines to protect the payload maintaining acceptable survival temperatures while the satellite is in Safe Mode and the Payload TCS is disabled.

AOCS

The AOCS system achieves 3 axis stabilization through 4 hot redundant reaction wheels and a set of 3 magnetorquers for angular momentum dumping and safe mode coarse pointing. Other sensors like star trackers, sun sensors and gyroscopes are used in combination to achieve precise spacecraft pointing.

To perform all the observation modes required for this mission it uses a high slew-rate mode based on Chebyshev polynomial guidance mode accounting for the satellite agility where the onboard controller has been tuned for the particular use case and mission parameters. The guidance is generated with flight dynamics tools that transform the desired observable paths on earth into suitable actuation profiles on-board.

Propulsion

The propulsion system in GARAIs satellite features two FEEP based thrusters in cold redundancy, designed with large propellant margins to account for the mission propulsion needs during the satellite lifecycle.

The propulsion maneuvers considered include; initial orbit transfer maneuver from the launcher orbit injection and slight inclination correction, orbit maintenance, Collision Avoidance Maneuvers (CAM) and End of Life disposal in compliance with the <5-year Reentry rule.

References

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