NEW SPACE PORTUGAL CONSTELLATION

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ABSTRACT

The New Space Portugal Constellation initiative features the development of a constellation of Earth Observation satellites to seamlessly integrate GEOSAT's operations. This initiative is fully aligned with Portugal Space 2030 strategy that has among its priorities the development of space capabilities to establish Portugal as a recognized authority in the Space-Climate-Ocean interactions. The New Space Portugal Constellation features an end-to-end system with two sub-constellations, one with 16 HR satellites, for the acquisition of actionable data from fast developing events, and another, with 3 VHR satellites, capable of capturing images with resolution up to 40 cm/pixel with daily revisit. These two constellations will share the same ground and data infrastructure, for coordinated acquisitions followed by seamless post-processing and integration. This infrastructure will also serve as a one-stop shop for customers and users from various market segments that will access both imagery and value-added products leveraged from artificial intelligence techniques and partners expert networks.

1. INTRODUCTION

Since the 1960s, the Space sector has been an engine of scientific exploration and knowledge, as well as a source of cutting-edge technologies and innovation, with increasing diffusion to other economic sectors. A significant portion of the services considered essential to our society today (e.g. weather forecasting, global communication, television broadcasts, precision navigation) would not be possible without satellite technologies. Although the Space sector has leveraged several scientific advances of great importance (e.g. discovery of the hole in the ozone layer) and has diffused its innovation to other sectors (e.g. application of Space instrumentation in medical radiology), this sector has suffered from a significant risk aversion, due to the high costs of access to space and the impossibility to maintain/repair satellites after the launch. Historically, governments, Space agencies and public entities have assumed a leading role in the Space sector, both as funders of institutional Research and Development (R&D), as well as by becoming clients of the outcome products and services. Recently, the traditional Space industry and the government Agencies have been stimulated to rethink the future strategy of this sector. The accelerated technological developments, together with the perception of possible commercial returns (initially anchored in the satellite communications segment), as well as the innovations proposed by entrepreneurs from other sectors (such as the digital economy), shook the status quo. The "New Space" approach has encouraged the emergence of new actors (mainly from the information technology sector) and a greater focus on the "commercialization" of Space. The New Space Portugal Constellation initiative addresses this new "economic" mindset as it proposes the development of two new Earth Observation satellite constellations focused on providing commercial services to clients. The present document begins with the context that originated this initiative, with

the presentation of the proposed system and followed by a breakdown of the possible products may result as the outcome of the initiative.

2. CONTEXT

The New Space Portugal initiative stems from the convergence between public policies and private commercial strategies that can be summarized in two main events:

Creation of the Portuguese Space Agency and Portugal Space 2030 strategy

In 2018, Portugal defined its national research, innovation and growth strategy for Space, entitled Portugal Space 2030, targeting the development of Space capabilities to establish Portugal as a globally recognized authority in Space-Climate-Ocean interactions with a focus on the Atlantic and its socio-economic exploitation. The strategy presented 3 axes, concerning the exploitation of Space-based data to foster new markets and highly skilled jobs (Axis 1), the development and deployment of space systems (Axis 2); and capacity-building targeting sustainability of sustainability of infrastructures, services and space applications (Axis 3).

Within Axis 2, the priority areas include:

- "Development and construction of the next generation of satellites […]";
- "Deployment of large inter-connected satellite constellations for multiple and integrated applications, in domains such as Earth observation […]";
- "Hosting strategic ground-based infrastructures that enable the operation of current and future spacecrafts […]".

Following the announcement of this strategy, Portugal Space, the Portuguese Space Agency, has been announcing the fostering of a new constellation for Earth Observation (dubbed the Atlantic Constellation) as one of the national Space priorities.

Creation of GEOSAT

GEOSAT was incorporated in Portugal in 2021, to acquire the EO assets of the Urthecast group in Spain, and become the first Portuguese satellite operator, one of two very high-resolution EO satellite operators in Europe and the only EO optical satellite operator in the Iberian Peninsula. This capability allows the company to be uniquely positioned to lead an initiative as the one proposed. Furthermore, GEOSAT's existing satellites will be replaced in the years to come, with business continuity to be ensured from the next generation of satellites that will expand current capabilities.

3. SYSTEM CONCEPT

To sustainably observe and monitor disperse and vast territories and provide a global insight of different phenomena with high observation frequency, it is essential to use a Constellation of Space assets, operating in a coordinated manner. In fact, the need of constant monitoring of our planet and the subsequent benefits from that observation to our society are continuously being recognized.

One of the most relevant contributions arises from climate change, since the constant monitoring of essential variables (such as ocean temperature and colour), with high spatial and temporal resolution, has allowed the development of more reliable models which, in turn, support an improvement on climate's predictability and evolution, including the occurrence of extreme events [1,2]. The

generated knowledge contributes to the necessary capacity of governments, societies, and scientific stakeholders to put in place interventional strategies and priorities, as well as to establish well prepared responses and contingency plans for catastrophic events [3].

For commercial purposes, the applicability of EO data with high temporal and spatial resolutions, allied to predictive models, can contribute to improve the knowledge of species distribution in the Ocean [4] or even evaluate soil conditions, allowing to follow crops' evolution throughout different seasons [5]. Thus, high volume and high quality EO information has the potential to contribute to the sustainability and growth of several sectors, such as fishing, fish farming, agriculture, tourism, insurance companies, national security authorities (and many more), enabling these stakeholders to have high value-added information and ultimately contributing to increase their competitiveness.

The New Space Portugal initiative will be an end-to-end system that cover all aspects of the value chain from the upstream segment to the downstream segment as presented in Figure 1 and described below.

Figure 1 - New Space Portugal artistic view

Space segment

In order to be able to collect different types of data and serve the needs of multiple customers/users, two sub-constellations have been defined in the New Space Portugal initiative that will have a collaborative operation, performing coordinated acquisitions and be seamlessly integrated in the same ground/data platform, creating an effective Atlantic Constellation. The first sub-constellation feature 3 satellites equipped with VHR imagers that will reach a resolution of about 50 cm and up to 40 cm after post-processing. To increase and complement the services provided by the VHR constellation, a HR constellation is also being prepared. This HR constellation will have 16 satellites in 4 different SSO planes to allow for 3h revisit and 1h latency from acquisition to delivery over interest areas. In terms of payloads these include, for example, optical sensors, covering the RGB, panchromatic and near-infrared bands, which will feature state-of-the-art specifications. The expected resolutions for these sensors are of the order of 5 m for the Multispectral (MS) camera and 30 m to 50 m for the Hyperspectral (HS) one.

Ground/data segment

Within the Digital Planet framework, a single data infrastructure to serve both sub-constellations will be developed as a basis for a hybrid architecture (local servers and cloud services), which allows applications and components to interoperate. Briefly, the main development objectives are:

- **Centralisation** – Content from multiple data sources will be gathered and processed using Big Data analytics and research techniques. New multilingual interrogation and federated mechanisms will also be developed, allowing querying diverse data source models, maximising fresh data, and avoiding, as much as possible, the need for Extract, Transform, and Load processes for data ingestion, whilst enabling to optimise response time and minimising the need for data transfer;
- **Data harmonisation, enrichment and resources management** – The acquired data can be received by extracting metadata, enabling conversion, optimisation, aggregation, harmonisation and indexing and image processing of different data formats, ensuring resources storage optimisation, taking advantage of diverse techniques such as de-duplication;
- **Security** – By implementing private computing techniques on public, shared, or third-party infrastructures, appropriate security levels will also be allocated, allowing specific data accessible to specific user groups;
- **Cost-benefit ratio** – An optimisation of data access speed will be developed, using indexing mechanisms suitable for the various typologies and preparing the contents of the databases to the request and reducing the costs of preparing for initial processing as needed;
- **Flexibility** – Users will have fast and secure access from anywhere, increasing data consumption;
- **Knowledge Distribution** – With a wide range of information available it is expected that the distribution of information and knowledge will trigger the resolution of innovation challenges for the different identified stakeholders and other relevant entities. Transactional semantics will also be offered for querying and integrating data;
- **Resilience** – Fault tolerance mechanisms will be studied and developed, allowing the definition of different types of guarantees and policies, weighing the impact on performance and usage of computational/storage resources with the intrinsic or extrinsic value associated with each data set.

4. PRODUCTS

At a global scale, the EO segment provides a plethora of applications to several clients in a multitude of markets, namely: defence; emergency management and humanitarian aid; precision agriculture and forestry; fisheries and aquaculture; climate and meteorology services; energy and natural resources; biodiversity, ecosystems and natural capital monitoring; public and private management of maritime, aviation, rail and automotive infrastructures; insurance and finance services; urban development and cultural heritage; among other blue economy and Space services. All EO markets are characterized by the generation of value-added information based on satellite data, most times combined with in-situ data. Moreover, the EO markets can also be classified according to data revenue, which can be categorized as a financial transaction between an EO data provider and a user (either a service provider or an end-user). Even though data and service revenues are set to double over the next decade (from roughly 2.8 B€ to over 5.5 B€, the number of real actors with commercial activities is very small [6].

In terms of actual products, few entities worldwide are working with very high-resolution images (sub-metric pixel resolution scale). The bulk of the sales of these companies results from multi-annual and recurring contracts, in which their products are based on 3 large groups: ortho-rectified images; 3D elevation maps and models; complex information products. In this context, New Space Portugal will also be focused on the development of Downstream applications driving new services, more

complex and higher value-added products integrated in a single platform and readily available to end-users through specifically designed tools for different verticals. Value-added activities will be divided into 4 main fields: maritime observation, terrestrial observation, security, emergency management and defence (depicted in Figure 2). In particular, the services developed will regularly and systematically provide information (through observation or forecasting tools) to support applications in various domains other than Space, with a potential impact on the daily activities of organisations and companies (and society), such as:

• Defence – maritime surveillance, costal surveillance, maritime traffic control;
• Emergency Management – management and warning of natural disasters, including forest fires;
• Maritime Observation – observation of essential variables, variability and dynamics of ecosystems, climate forecasts;
• Terrestrial Observation – Soil geographic information and its variations, vegetation status, forest registration and management, water resources management, agriculture, nature conservation.
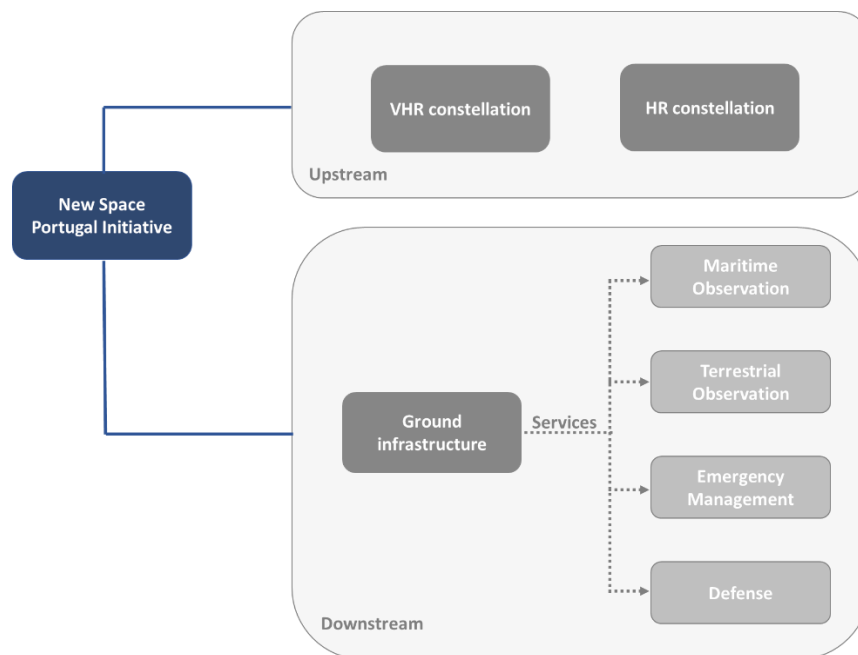

Figure 2 - Major development areas within New Space Portugal initiative

5. CONCLUSION

The new Space Portugal Constellation initiative features two new Earth Observation satellite constellations, which focus on providing commercial services to clients. It results from the convergence between two main events: i) Creation of the Portuguese Space Agency and Portugal Space 2030 strategy and ii) Creation of GEOSAT:

i) Targets the development of Space capabilities, as a mean to position Portugal as a recognized authority in Space-Climate-Oceans interactions.

ii) Incorporated in 2021, GEOSAT is exceptionally placed to lead this initiative given its experience in the EO sector and its need to prepare the next generation of satellites for replacing the one's it currently operates.

This initiative aims at the development of an end to-end-system, covering all aspects of the value chain, from the upstream segment to the downstream segment. For this purpose, two sub-constellations have been defined: the first sub-constellation features 3 satellites equipped with VHR

imagers that will reach a native resolution of about 50 cm and up to 40 cm after post-processing. The second, a HR sub constellation, features 16 satellites in 4 different SSO planes to allow for 3h revisit and 1h latency from acquisition to delivery over interest areas.

Both constellations will be managed through a collaborative operation, performing coordinated acquisition, and be seamlessly integrated in the same downstream platform. For this, a single data infrastructure is planned to create an effective single Atlantic Constellation. Regarding products and services, this initiative is expected to have a positive impact on the day-to-day activities across multiple sectors: Defence; Emergency Management; Maritime Observation and Terrestrial Observation. It is expected that the high volume and high quality EO information resulting from this initiative, will promote a sustainable growth of several sectors, by making accessible high value-added information that ease the work of its users and costumers.

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