+Space in Portugal and Europe with ESA

The Strategy for the Portuguese participation in the
2019 ESA´s Ministerial Meeting, "Space19+"
and the articulation of national/EU/ESA/business funding sources, with a clear diversification strategy for investment in space under an integrated and holistic approach

Prepared by *Portugal Space (the Portuguese Space Agency)* in collaboration with the Office of the *Minister for Science, Technology and Higher Education*

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Executive Summary

Fostering space economy and innovation in Portugal requires diversifying and articulating funding sources and this document sets the target of attracting **2500 million Euros for 2020-2030** with a 50/50 balance between public and private sectors, including national and European, public and private sources in space-related activities in Portugal, according to:

- **public sector**: about 1240 M€ which includes FCT, ESA, and EU and assumes that the EU finances around half of the total, the other 50% being financed by companies involved in addition to 50% through Joint Undertakings and public markets; and
- **private sector**: about 1260M€ which includes investments made by companies and commercial markets.

This target considers increasing by a factor of 10 the overall level of investment in space in Portugal until 2030, including the following main challenges:

- Increase the annual outcome of space related activities in Portugal to about 500 million Euros by 2030;
- Create and promote about one thousand skilled jobs in Portugal in the period 2020-2030;
- Attract major players to operate in Portugal and promote new entrepreneurial projects to help promote new high-added-value activities;
- Strengthen space research in close cooperation among academia, scientists, the public administration and, above all, the business sector, together with the development of new skills and the advanced training of qualified human resources.

The successful ESA Ministerial Meeting, Space19+ (November 27-28, 2019), and the related discussions and approval of the ESA budget for 2020-24, together with the ongoing preparation of the financial perspectives for Europe for 2021-27, including the preparation of the next European framework program for research and innovation and the European Structural and Investment Funds (ESIF), as well as the emerging forms of fundraising in Europe (including Joint Undertakings, JUs), represent a new opportunity and a great challenge for Portugal to take the next step and, building on what has been achieved so far, develop new ambitions in specific space fields and related applications in non-space sectors.

Following the development, and current process of implementation of the national strategy for space, "Portugal Space 2030", fields of focus are: Earth Observation, Space Safety, Space Transportation, and Telecommunications, including related downstream activities, working towards the vision for Portugal – an Atlantic nation, with a rich and global maritime tradition – to be recognised, by 2030, as a global authority in the science and economics of Space-Earth-Climate-Oceans interactions for the benefit of society and economy.

It is in this context that this document approaches "Democratization of Space" in terms of the full integration of space into economy and society in a sustainable manner, both environmental as well as economic, and therefore a growth of the sector beyond public sector funding on which is has mostly relied thus far. Space19+ was a major milestone for Portugal on the way to this challenging target.

The 22 ESA Member States endorsed the most ambitious plan in the history of ESA, accounting for 14.4 billion euros over five years. The Portuguese contribution has also increased significantly from 73 million euro subscribed in 2016 to 102 million for the next years. In a time in which Space is no longer seen as a way for countries to show off their technological prowess and sovereignty, but rather as an added value to society and a competitive advantage for industries and economy, ESA's Council at Ministerial Level, Space19+, came to an end this Thursday, with the approval of the most ambitious plan to date for the future of the European Space Agency and the whole European space sector.
The current document, which is split into three parts, presents the overall implementation strategy for "Portugal Space 2030" and describes the main decision elements for Space19+, including:

- Part I presents the Portuguese context in which the ESA Ministerial Meeting has taking place and describes the strategic approach both from a content as well as from a funding point of view with the aim of implementing an evolution in the space strategy from one driven by technology capacity building to one driven by programmatic aims in the various fields of interest and of implementing this evolution not only in the frame of ESA but closely articulated with the national and European frameworks available through public and private funding instruments;

- Part II provides a summary of the Portuguese approach to the ESA co-presidency for the next three years, 2020-2023;

- Part III provides a summary of the main decision of Space19+ as well as the corresponding financial elements.

The document includes a set of Annexes that provide background information such as: i) a high level summary of the main objective of the Portuguese space strategy, "Portugal Space 2030"; ii) an overview of the developments in Portugal in space over the last two years; iii) a financial overview of the past 20 years of Portuguese involvement in ESA; and iv) a summary of the programmatic approach followed in deriving the subscriptions at the ESA Ministerial Meeting, Space 19+.

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Part I: Implementing the strategy "Portugal Space 2030"

1. Democratisation of Space - Space as a Common Good

Space should be considered as a common good, to be associated with our institutions and collective ambitions, as clearly considered in "Portugal Space 2030". Space provides the infrastructure for personal mobility, communication for work or when on vacation, weather forecasting, precision farming to maximise crop harvesting and crop rotation, banking transactions, management of precious resources such as potable water, monitoring of forest fires, archaeological investigations…, scientific knowledge and the dream of expanding the reach of humanity. These and many more activities rely today on space data and the infrastructure to generate this data and enable its use.

Beyond being a growing sector, space is a sector that supports and enables the success and competitiveness of many other sectors. More can be done and the potential is far from being fully exploited. The possibilities are beyond what we can imagine today. These have spurred the emergence of a buoyant new space sector and actors aiming to exploit these opportunities, changing the environment for space activities in general.

The relevance of Space is based on the alignment of the space agenda with major trends and drivers that will determine the evolution of our society. One vivid example is climate change: it is clear that climate change will have wide scale impacts on natural and human systems that are important to be monitored. Unprecedented changes in our society add to the complexity of this issue. In this context, the space sector provides an essential tool to: monitor the weather and enable accurate forecasting; to assess climate change impacts and vulnerabilities; and to support information-based decision making on mitigation and adaptation policies and measures. Global challenges are not limited to climate change and space should likewise be used to address migration, resource management, health, among others.

Space and the development of the technologies that are associated with or derived from it, are now recognised as a **driver of innovation**, as well as a way to attract youngsters and world talent, by several nations, representing an imperative for the promotion of **social and economic progress and for international safety and security**. In fact, the safety, security and well-being of our society are increasingly dependent on information and services provided from Space and it is important to point out the increasing **impact of space systems on many sectors.**

The sectors that can profit from space-based solutions are **agriculture, fisheries, infrastructure, urban development** (including land register, land usage and urban mobility), **transportation, maritime, shipping, communication, tourism, banking, defence and security, and even the public health sector and epidemic monitoring**, amongst others**.**

It is in this context that we talk about <u>Democratisation of Space</u> to mean the full integration of space into economy and society in a sustainable manner, both environmental as well as economic, and therefore a growth of the sector beyond public sector funding on which is has mostly relied thus far.

Indeed, beyond any technological development, the first breakthrough in space was the recognition that space was more than just a way to demonstrate national pride and superiority, but that space can actively, through data and its derived information, help tackle global challenges and solve problems of users and thus contribute significantly to economic growth.

The next breakthrough will come when it will be widely recognised that space is not just a passive provider of information, but that space activities can go **from observation to action**. From observing natural catastrophes and supporting aid efforts, to predicting them and avoiding loss of human life. From observing the effects of climate change, to working against the contribution of man to climate change and the environment in general by optimising travel routes for low fuel consumption, to supporting the optimisation of alternative green energy sources, to the use of space technologies for production of energy. From observing the effects of space weather on assets in space and on ground, to preventing the consequences of events such as the Carignton event of 1859 or the March 1989 geomagnetic storm which caused multi-billion-euro damages to entire nations. From observing the multiplication of space debris, to avoiding collisions from happening and actively addressing the safety of the space operating environment and further enabling manufacturing and recycling in space integrating Space in the economic sphere of influence of the Earth.

2. A strategy for attracting and enlarging investments in space: diversification and articulation of funding sources and the role of Portugal Space

The aim and mandate of the Portuguese Space Agency, "Portugal Space" (founded in 2019) is to foster space economy and innovation in Portugal, with the target of increasing by a factor of 10 the overall level of investment in space in Portugal until 2030. This target includes the following main challenges:

- Increase the annual outcome of space related activities in Portugal to about 500 million Euros by 2030;
- Create and promote about one thousand skilled jobs in Portugal in the period 2020-2030;
- Attract major players to operate in Portugal and promote new entrepreneurial projects to help promote new high-added-value activities;
- Strengthen space research in close cooperation among academia, scientists, the public administration and, above all, the business sector, together with the development of new skills and the advanced training of qualified human resources.

This set of targets and challenges require and represent a major collective effort to guarantee the following processes of diversifying and articulating the attraction of funding sources:

1. **Global investment level**: An overall level of national and European, public and private, investment in space related activities of **2500 million Euro for 2020-2030**;
2. **Portuguese Public Investment** including both **ESA** and **FCT** funding, where:
    a. **ESA**: An overall level of national investment in ESA of **250 million euros for 2020-2030 (including about 120 million euros in 2020-2025)**, with

the related return in procurement activities to main stakeholders operating in Portugal in close articulation with other national and, above all, European funding sources;

b. FCT: national competitive programs for research and advanced training, including an expected public investment of about 245 millions euros in the coming decade under the following items:
    i. Advanced training, through doctoral fellowships;
    ii. Scientific employment, through doctoral research contracts;
    iii. Research and academic careers, through invited chairs;
    iv. R&D projects;
    v. Research Institutions, Associate Labs and Collaborative Labs, through basic and programmatic funding;
    vi. International cooperation in science and technology (S&T);
c. Overall, the **Portuguese Public Investment,** including both **ESA** and **FCT** funding, should be used in close articulation with other national and, above all, European funding sources in a way to guarantee **a "multiplication factor" of 5 regarding the impact of public resources in the capacity to raise other sources of funding** for space related activities in Portugal;

3. **Beyond Portuguese Public Investment**: the challenge of better using the national investment in ESA to help raise other sources of funding for space related activities in Portugal requires a correct articulation of the national participation in the various ESA programs with the following sources of funding:
    a. Horizon Europe (HE), following the experience with H2020 and the past European framework programs for research and innovation, under the coordination of EC-DGRTD, including:
        i. Advanced training and scientific employment, through doctoral research contracts to be established under Marie Curie Fellowships and ERC Grants;
        ii. Collaborative R&D projects, involving European networks;
        iii. Research Missions, including above all those in non-space sectors that require space driven data;
        iv. Partnerships, mainly in aerospace;
        v. International cooperation in aerospace;
    b. European Space program (ESP), for 2021-2027, under the coordination of a new EC-DG Space and Defence Industries, to be created by the EC, including:
        i. Collaborative innovation projects, involving European networks;
        ii. Navigation and Earth Observation main programs;
        iii. Transportation, through the development of micro launchers;
        iv. Access to space, through a future generation of space ports, including the potential funding of Azores ISLP;
    c. Digital Europe Program (DEP), for 2021-2027, under coordination of EC-DG Connect, including:
        i. Collaborative innovation projects, involving European networks;
        ii. Navigation and Earth Observation main programs;
        iii. Integration of space data and AI for the digitalization of non space sectors;
    d. European Defence funds, under the coordination of a new EC-DG Space and Defence Industries, to be created by the EC, in close articulation with the Portuguese Ministry of Defence, including:
        i. Collaborative defence related projects, involving European networks;
        ii. Navigation and Earth Observation activities for security and defence;

iii. Integration of space data and AI for the digitalization of defence and security sectors;

e. European Structural and Investment Funds (ESIF) and, above all, the design and implementation of the program PT2030 (2021-2027), following the experience of the implementation of PT2020 (2014-2020), which includes national and regional, to be coordinated by the Portuguese Ministers of Planning and Territorial Cohesion, respectively, and involving the national agencies ANI (innovation) and AICEP; (foreign trade) , including:
   i. Advanced training, through doctoral fellowships;
   ii. Skilled employment;
   iii. R&D and innovation projects, including "mobilizing projects";
   iv. Interface and Innovation Institutions, including Associate Labs, Collaborative Labs and technology centres, through basic and programmatic funding;
f. Emerging forms of fund raising and investment in Europe (including the Joint Undertakings, JUs), under development by the European Commission;
g. Markets, considering public markets/procurement and commercial/business expenditure by private firms, including foreign firms operating in Portugal and Portuguese firms, as space is expected to connect more strongly to other sectors and with companies actively looking for technology transfer and spin-offs. Hybrid business models are expected to be developed beyond the pure upstream and downstream markets. The development of business is expected mostly for Earth observation, navigation and telecommunications, with the Space Safety and Security markets also developing in the near future to be very significant ones beyond current expectations;
h. Other sources of funding, including venture and investment funds.

Table 1 provides a brief summary of main targets for the coming decade, which should be considered as a guide for the positioning of PT Space, including for the definition of the way Portugal will contribute in the various ESA programs for 2020-2024.

The table proposes a **balance of funding for 2020-2030** according to:

- public sector: about 1240 M€ which includes FCT, ESA, and EU and assumes that the EU finances around half of the total, the other 50% being financed by companies involved in addition to 50% through Joint Undertakings and public markets; and
- private sector: about 1260M€ which includes investments made by companies and commercial markets.

Further assumptions behind the numbers in Table 1 are as follows:

1. FCT – scientific research related to space science and other planetary bodies, space weather, physics of the atmosphere, Earth observation and GNSS science, quantum and encrypted communication, and propulsion physics;
2. EU H2020-HE – technology R&D around topics of future business fields, i.e. space weather and space debris, applications, and transportation, with some general technology development;
3. European Space Programme, ESP – Earth observation in Copernicus and with third party missions contributing to Copernicus, Govsatcom, Galileo;
4. Digital Europe Programme, DEP – big data and AI around both EO data as well as space science missions and activities (ground and space);
5. European Defence funds – SST, space weather for GNSS purposes, EO data for defence purposes and safe and secure communications;

6. Markets – with respect to commercial activities the highest multiplication factor is for telecom and navigation followed by Earth observation as well as the emerging market of space safety (with larger potential in the second half of the decade and following decade); and new joint ventures, including Public Private Partnerships (PPPs) with national and international funding sources and investments funds, including transatlantic initiatives and the investment of European Agencies, such as EMSA, GSA, and defence related agencies, as well as non-space funding sources (agriculture funds, city councils, maritime agencies, defence authorities).

Table 1: Summary of main funding targets for space activities in Portugal over the next decade, 2020-2030 (in M€)

PT Space Strategy 2020-2030 (November 2019)		**Portuguese Public Investment**		**European Competitive Funds** (centralised mgt, by EC)				**ESIF - EU structural funds**	Potential **JUs** (EC and national)	**Markets**		**GLOBAL (million Euros)**
		FCT - Portuguese S&T Foundation	ESA - European Space Agency	European Space Programme, ESP	EC H2020-Horizon Europe	Digital Europe Programme, DEP	European Defence funds	ESIF: PT2020-PT2030	Emerging forms funding in Europe (Joint Undertakings)	Commercial	PT and EU public markets and procurement	
Science and Basic Activities (incl. Prodex)	9%	100	100			10			25			**235**
Space Exploration	1%	20	5							5	5	**35**
Space Safety	13%	20	23	50	25	5	20	50	15	80	30	**318**
Earth Observation	35%	55	55	100	40	20	35	120	35	300	110	**870**
Telecomms	24%	30	37	70	40	10	20	60	30	250	50	**597**
Navigation	9%	20	10	40	15	10	10	20	5	80	20	**230**
Transportation	7%		10	20	20			30	5	50	30	**165**
Technology	2%		10	20	5				5		10	**50**
Global (million Euros)	**100%**	**245**	**250**	**300**	**145**	**55**	**85**	**280**	**120**	**765**	**255**	**2500**
		495		**585**				**280**	**120**	**1020**		**2500**
% global		10%	10%	12%	6%	2%	3%	11%	5%	31%	10%	**100%**
		20%		23%				11%	5%	41%		**100%**

To achieve these targets requires carefully selected priorities, namely for the Portuguese position at Space 19+, as well as a careful positioning of the Portuguese Space Agency

(Portugal Space) in close articulation with FCT, ANI, AICEP and, above all, business industry.

Part II: Portugal in ESA and the France-Portugal Co-Presidency

1. France-Portugal Co-Presidency of ESA Council, 2020-23

The interest of France and Portugal to take over the ESA presidency after Spain is to commit to do the utmost in order to keep pursuing a consistent and ambitious European Space Policy, with ESA at its core.

The process: engaging Member States and other stakeholders

In order to help achieving these goals, France and Portugal will propose to the ESA Council the implementation of annual Meetings of the Ministers, to improve the process of "stock taking" and a close interaction with Member States as "shareholders" of ESA. At the same time, France and Portugal propose to guarantee the budgets for a period of 5 years (as the logic of the mandatory programme) in order to allow more strategic space activities.

It is foreseen to establish a real **co-presidency for the next 3 years among the two member states,** with an up-front agreement of who is chairing what subject **according to the four programmatic pillars of ESA**.

Space19+, in Seville, will approve an ambitious portfolio of space programmes and will address the challenges linked to the sector. It is critically important that:

- **All ESA Member States are seriously engaged in taking stock of space activities** in a continuous way and **strengthen the role of ESA in Europe in close articulation with the European Commission**;
- In addition, all ESA Member States should work with ESA to take the necessary steps towards **modernising ESA´s industrial policy** and guarantee the Agency evolves in a way to match a constantly changing environment, changing markets and a fast rate of digital transformation of our societies.

The content: forward looking

The main issues to be promoted in association with the ESA co-presidency are as follows:

- **Facilitate major initiatives currently developed at ESA across all its four main programmatic pillars** – Science and Exploration, Safety and Security, Applications, and Enabling and Support;
- **Strengthen the contribution of space in emerging opportunities such as modern 5G communications**, which should consider fund raising beyond public sector funding**;**
- **Stimulate links between space and non-space across Europe** (industry, agro-businesses, climate, city councils, among others; involving politics, academia, research entities), through the promotion of:
    - a proactive and positive approach to addressing global challenges and contributing to UN Sustainable development goals;

  - the diversification and new businesses opportunities in "New Space", Earth Observation areas, data processing, digital transformation and Artificial Intelligence, as well as related needs for mini- and micro-launchers and the democratization of the access to space;
  - growth of human capital.
- **Strengthen the downstream and transfer activities** by establishing a organizational gateway across and possibly on the level of the directorates.
- **Strengthen the role of Member States as "shareholders" of ESA** to foster Space-related entrepreneurship and economic growth in Europe, together with a clear orientation to benefit European actors at large, including citizens, scientific organizations and industry;
- **Strengthen a coherent European space policy including EU-ESA relationship**, in particular:
  - Optimizing ESA-EU relation, especially ESA-GSA-successor through structured links;
  - Revive the EU Space Council;
  - Broaden the European participation to all European States to strengthen the overall European competitiveness on a global scale;
- **Develop ESA further as a lean and agile New Space Agency**, which acts as an agency, broker, facilitator, enabler and mediator as it leverages its unique industrial policy and implements different and new instruments tailored to the activity type;

In addition, throughout the co-presidency, **space diplomacy** will help foster Government-Industry dialogues on "**More Space for a better Europe with ESA – boosting the European entrepreneurial space landscape**"

The preparation of these dialogues requires the involvement of all stakeholders, especially industry and entrepreneurs, so that a strong partnership may be built to boost new competitive services to address emerging needs across all our economies and societies. The aim is to engage industry and business leaders in a series of dialogues together with ambassadors, national delegates, space agencies and experts on topics of importance for the future of Europe and the European Space Agency, ESA, and centered on job creation.

A constantly evolving relationship between governments and industry, which ranges from government leadership to governments merely acting as catalysts, is fundamental in securing a vibrant and diverse space ecosystem fully interconnected to its users.

Details concerning the distribution of the different programmes within the pillars are to be discussed. Together, France and Portugal, in close collaboration with ESA, will prepare by January 2020 a plan for:
- a series of events to raise space awareness across Europe and abroad;
- a series of events for fund raising in collaboration with known venture capitalists – European and global;
- interaction with other entities worldwide;

Questions to be addressed include the following:
- Earth Observation, Telecommunication and Navigation and their contribution to addressing, preparing for and forward-looking advancement in the energy sector, in food, water, resource and waste management;

- Downstream and transfer gateway;
- Space as a Sector:
    - Satellite Manufacturing, e.g. Industry 4.0, e.g. Telecommunications, facing significant hurdles and where the window of opportunity is open now and only now for European industry to take up leadership in 5G and in optical communication and secured communication for diverse European users; and incentivizing to moving toward a captive market of scale and well as a more vibrant commercial market;
    - Space Transportation, where in addition to facing current challenges by delivering and increasing competitiveness, the aim should also be to democratize the access to space.

Shared responsibilities among the FR-PT co-presidency

Portugal will take the main responsibility to push forward:

- ESA-EU-MS relations;
- ESA Next Generation;
- Ensuring the sustainability of Space as a Sector: Space Transportation

and proposes that France take the main responsibility to push forward:

- Space4Globe: Applications of space to addressing UN SDGs and global challenges, tying in with initiatives such as Space Climate Observatory under French leadership;
- Ensuring the sustainability of Space as a Sector: Satellite Manufacturing;

Part III: Portugal in ESA and the Space19+ Ministerial Meeting

1. The Portuguese participation in Space19+: Programmatic Decisions

In the frame of ESA´s Space19+, 27th and 28th November in Seville, **Portugal increased in the annual subscription to ESA by about 20%, with a global subscription for the next five years to 102 million euros** under the following approach:

1. **Strengthen the Portuguese and European technology innovation and scientific leadership** by investing into an increase of the early technology development activities and the scientific programme – including missions such as LISA, the Comet Interceptor, Ariel, Athena – in which both Portuguese industry and research institutions can play a stronger role *(Strengthen the access of Portuguese entities to early technology development and space science activities while at the same time strengthening Europe in the global context both as a leader and a valuable partner, by enhancing scientific leadership and exploration reach and by continuing to inspire generations – young and old)* **as well as enabling and supporting dedicated technology development activities of Portuguese entities** [Programme(s): Mandatory Activities, GSTP]*;*

2. Commit to **lead the effort of democratisation of access to space data** through, primarily:
   (a) making the **first steps towards the dedicated development of a private-sector driven Earth Observation constellation of small satellites and associated downstream applications focused on the socio-economic development of the Atlantic** (a "Blue World") including investigating into related aspects, such as **Arctic Weather** and contributing to the strategic goals of partner countries [Programme(s): FutureEO and Incubed+]; and

   (b) investing into the **development of downstream applications and services connecting space to non-space sectors** and engaging into new business models [Programme(s): Telecommunication and Integrated Applicaions, ARTES];

3. Commit itself to **lead the effort of democratisation of access to space** through, primarily:
   (a) the **support of industry-led public-private-partnership developments for a spaceport and microlauncher to be launched from the Azores for small satellites** [Programme(s): Commercial Space Transportation Services] in complementarity to **supporting the fly-European policy** and contributing to the success and competitiveness of European launchers in the making [Programmes(s): FLPP and Ariane 6, Vega C and P120C competitiveness improvements]; and

   (b) supporting the success of **Space Rider** by targeting, above all, the vehicle's exploitation by bringing in non-space sectors such as the pharma industry **to foster research and development of products in a microgravity**

environment, thus leading space into a new era of commercialisation [Programmes(s): Space Rider].

4. **Reinforce space as a fundamental infrastructure** that serves economic growth (in-space and on Earth) and that needs to be evolved and protected by deciding to **co-lead in active debris removal/in-orbit servicing – enabling a world 1st, European leadership and competitive advantage in one of the largest future markets in space** (under the theme of "**clean Oceans with clean Space"**) as well as supporting the first steps towards an operational **Space Weather System** [Programme(s): Space Safety];

5. Trigger the use of space in the telecommunications sectors by larger telecommunications operators in the country to address European and Portuguese needs allowing us **lead in new topics such as encrypted quantum, optical communication, and 5G** [Programme(s): Telecommunications and Integrated Applications, ARTES];

6. **Reinforce Europe and the successful ESA-EU partnership** to the benefit of Portuguese and European society, economy, and autonomy by securing the continuity and evolution of the Copernicus Space Component [Programme(s): Copernicus Space Component] and supporting the development of a new ESA-EU partnership in Space Safety and Security;

Table 2 below summarises the subscriptions at the ESA Ministerial Meeting in 2017, CM16 and the subscriptions at Space19+, and reflects the current understanding of the space sector and should be updated dynamically as new elements arise. Figures 1 and 2 depict the subscriptions to Space19+ as per the table below.

Table 2: CM16 and Space19+ subscriptions

(Amounts in M€)

TOTAL OVERVIEW by DOMAIN	**PT CM16 (M€, 2016 ec / cec)**	**PT Space19+**
Earth Observation	5.5	15
Telecommunication – Artes*	7.25	12.5
Space Transportation	2	3.5
Space Exploration	1.4	1.5
Navigation	1	1.5
Space Safety	0.55	13.3
Technology**	8.5	2
Prodex	0.75	3
Basic Activities***	13.48	47.4
Scientific Programmes***	30.55	
CSG***	2.71	3
TOTAL (M€)	**73.69**	**102.7**

*ANACOM
** IAPMEI - SME and Innovation Development Institute
*** Mandatory Activities, decided on a 3 years + 2 years basis, i.e. the numbers reported are for a period of 5 years, whereas optional programme subscriptions are variable and depend on the specific activities and vary between 3 to 5 years.

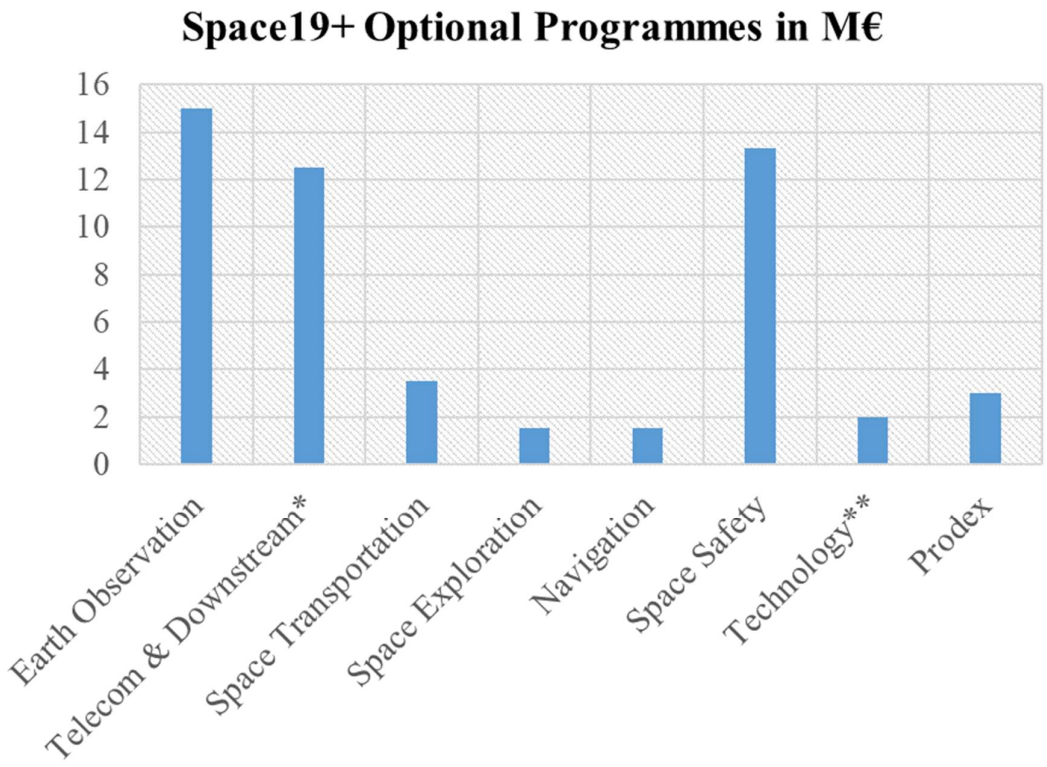

Figure 1: Space19+ Optional Programme Subscriptions in M€

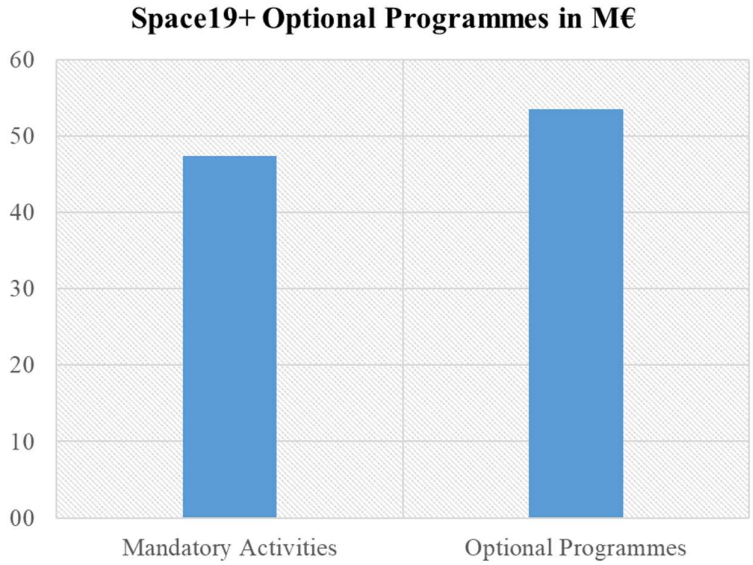

Figure 2: Space19+ subscription distribution between optional and mandatory

Annexes

Annex 1: Portugal Space 2030 Strategy

Guiding Principles

The Portuguese strategy in terms of investments must therefore be based on the following principles:

1. balance consolidating and continuation of acquired and proven competences with investments in new fields of growth and new markets;
2. develop subsystem and system competence to increase the Portuguese presence along the whole value chain, implement Portuguese goals in a European frame and strengthen the European space-based economy across all nations;
3. stimulate user uptake – commercial and institutional – by addressing user needs and including the user in the strategic definition process;
4. concentrate main efforts in a few strategic fields and support other fields by opening opportunities to businesses which may profit from space/non-space sector interactions and synergies;
5. build strong international partnerships and implement concrete projects in the frame of these partnerships;
6. build synergies between national-ESA-EU funding for space and other sectors; and
7. increase the science output in all fields.

Objectives for the timeframe 2020-2025

In order to successfully implement the Portugal Space 2030 Strategy and achieve the above objectives, in line with Joint Statement the following major objectives are set for Portugal to achieve during the years 2020-2025 through targeted subscriptions made at the ESA Ministerial, Space19+, in November 2019:

- develop subsystem and system competence through concrete projects and products working with international partners in the field of Applications and specifically Earth observation;

- contribute to European leadership in space-based solutions through the diversification of the fleet of satellites and high-altitude platforms available to end-users to develop applications and services by developing small systems to complement large ones whilst contributing to large systems;

- establish an open space port in the Azores contributing to the democratisation of access to space and to the competitiveness of European access to space for a wide range of payloads;

- support end-users in integrating space in solutions to their specific problems;

- strengthen scientific leadership and visibility, by enabling the scientific community to lead in key fields in science in and from space;

- enable the future via early elements of the seamless grid of innovation with the motto: failure is just a data point (i.e. experience and failure are hard but good teachers).

- develop, preserve and disseminate knowledge, competences, and skills for capacity building and sustainable growth, inspiring and promoting creativity with the motto: free and open access

Portugal Space 2030: priority goals

Having recognised the potential of space, Portugal has developed a 2030 Strategy which defines four priority goals:

- **Objective 1: Promote economic growth and the creation of skilled jobs** in Portugal by promoting space-related markets, namely through market uptake and exploitation of satellite data and signals cutting across multiple activity sectors and addressing societal challenges, including in agriculture, fisheries & ocean and climate monitoring; in monitoring infrastructures, in urban development, in defence and home security, and in the public health sector;

- **Objective 2: Foster the generation of satellite data through new space technologies and space-related infrastructures in Portugal**, leveraging international scientific and technological cooperation and turning Portugal into a stronger player in the space sector, with emphasis on new space industries (i.e. "New Space").

- **Objective 3: Contribute to the development of the country and to the strengthening of diplomatic relations and international scientific cooperation**, taking into account the advantages of Portugal's geo-strategic position for the Space sector, and also with a view to sharing the return of space activities with countries and not yet developed capacities in the space domain, with emphasis on Portuguese-speaking countries;

- **Objective 4: Ensure the development and evolution of the legal, financial, institutional, cultural/educational internationalization frameworks capable** of boosting the development of the space sector in Portugal through national initiatives and international cooperation for the next decade.

These objectives are framed by the goals and objectives for space activities in Europe for the years to come, provided by the 2016 ESA-EU Joint Statement setting out the "Shared vision and goals for the future of Europe in space":

- Foster a globally competitive European space sector, by supporting research innovation, entrepreneurship for growth and jobs across all Member States, and seizing larger shares of global markets;
- Maximise the integration of space into European society and economy, by […] strengthening synergies between civilian and security activities in the field of navigation, communication and observation, including through monitoring borders, land and maritime security conditions;

- Ensure European autonomy in accessing and using space in a safe and secure environment, and in particular consolidate and protect infrastructures, including against cyber threats;

The joint statement further recognises that “these are underpinned and possible only through excellence in science and technology expressed through an environment of outstanding education and skills and a thorough knowledge base.”

Annex 2: The last two years: space in Portugal, 2018-2019 - Main actions undertaken in Portugal

The gradual recognition of the Space sector that emerges in Portugal has been the target of recent public policies and strategies of strengthening scientific diplomacy and international scientific and technological cooperation, based on 5 lines of action, as briefly described in the following paragraphs.

1. First, the "Portugal Space 2030" strategy, approved by the Government in February 2018 with the ambition of multiplying by ten the volume of activities in Portugal in the area of Space, naturally within the scope and in articulation with the "Innovation Strategy for Portugal 2018-2030, which aims to "effectively converge to Europe by 2030 and achieve R & D investment of 3% of GDP", creating about 25,000 skilled jobs in the period 2018-2030. The need to stimulate new markets, public and private partnerships in Portugal in the international context implies the development in Portugal of pilot projects of international relevance and a demonstrative context in diverse sectors, including agriculture, fisheries, monitoring of major infrastructure, urban development, defense and security.

   The implementation of the "Portugal Space 2030" strategy includes three complementary instruments, as follows: i) A new legal regime through the "Space Law" approved in 2018; ii) The creation of a space agency, "Portugal Space" (www.ptspace.pt), installed in March 2019 ; and iii) Ongoing development of a foreign direct investment attraction strategy.

   In particular, the "New Space Industries" sector considers a new wave of actors and business models in the international space sector characterized by the capacity to attract private financing, in view of predominantly commercial markets and in need of communication and information systems based on mega-constellations of micro and nanosatellite. New Space opens up new opportunities for Portugal, as well as other small and medium-sized countries, namely at the level of production and use of data, based on specific technological platforms dedicated to Earth observation for social and economic activities, and at generation level of data and infrastructures. It includes the need and challenge of developing and producing satellites, mainly micro and nano-satellites, and the development of mega-constellations, with developments expected to democratize access to low-altitude orbits (LEO) and synchronized with the sun (ie, Sun Synchronized Orbits, SSO).

2. Second, the development and promotion of the "Atlantic Interactions" agenda and the Atlantic International Research Center - AIR Center, in the form of an innovative network institution driven by an international R & D cooperation program to strengthen knowledge on space-climate-ocean interactions through North-South / South-North cooperation. It includes the installation of an Earth observation center on Terceira Island, in conjunction with ESA and in the form of an ESA_Lab@Azores.

3. Third, the launch of the "Azores International Satellite Launch Program - Azores ISLP" (www.azoresislp.pt) and the procedures for the installation and operation of a space infrastructure for the launch of mini and micro satellites in

the Autonomous Region of the Azores. Its location on European Union territory in the Schengen Area, as close to Continental Europe as it is to the American continent and with extensive ocean cover over 1500 km in any direction, offers absolutely unique advantages for the promotion and development of "New Space" in Europe. It builds on the ongoing reinforcement of ground stations for satellite monitoring and stimulates a new challenge for Europe at large in terms of the need to consider and stimulate a new generation of launchers in terms of safety and environmental impact, as well as ensuring the unprecedented worldwide installation of a space port open to all international actors and operators. In other words, the installation of a new generation of environmentally sustainable and safe satellite launcher services, open to the world, can create a new positioning of Portugal and Europe at the world level.

Increasing international competition in this context has emerged rapidly, requiring a new strategy in the process of valuing the positioning of Atlantic and the real opportunities that Azores have in this area. Portugal's positioning of the Atlantic is thus critical and opens new opportunities in the international context. It facilitates, in particular, the installation of observation and measurement infrastructures in a spectrum not reachable or replicable in any other country, which represents an effective comparative advantage.

4. Fourth, the promotion of Portugal in the world through the reinforcement of international partnerships through the "Go Portugal - Global Science and Technology Partnerships Portugal" Program. The international prestige already achieved demands that Portugal, in the near future, position itself as a knowledge driven economy, with the capacity to take on the new challenges at the frontiers of the production and diffusion of knowledge. It is under this context that Space plays an absolutely fundamental role. This is, moreover, imperative for a country that seeks to affirm itself in the international scenario for science and innovation.

   Activities under development include: the expansion of the MIT-Portugal Program and the UT Austin-Portugal Program with a specific re-orientation for space research and innovation; a formal agreement for a specific partnership with the Chinese Academy of Sciences, CAS, for micro satellite development, through the installation in Portugal of “STARlab” in close cooperation with business companies operating in Portugal.

5. Fifthly, the promotion of the "PERIN-Portugal in Europe Research and Innovation Network", aimed at guaranteeing an effective convergence strategy for the “Europe of Knowledge” by 2030 and facilitating the implementation of the "Innovation Strategy for Portugal 2018-2030", through a joint and profound debate throughout the country and in priority areas for the promotion of research and development (R&D) activities, including health, artificial intelligence, production and agri-food technologies.

   In this context, the PERIN 2019 "+ Science, + Europe" journeys were held between March and April 2019, with the intention to reinforce and double Portugal’s participation in the next European Research and Innovation Framework Program (i.e., "Horizon Europe") and related programs relevant to

research and innovation activities (i.e., the European Space Program and the "Europa Digital", among others).

This is how the national agenda "Portugal Space 2030" mobilizes various sectors of society for Space, as valued as a common good, fostering new opportunities for institutional, industrial and international cooperation and contributing to the development of innovative and competitive technologies in the international market.

Annex 3: 20 years of Portugal at ESA, 1999-2019

Portugal joined ESA on the 14th of November 2000, making it the 15th of now 22 Member States. Since its ascension to ESA, Portugal has seen an increase in capacity building activities in the space sector and hence an increase in competence of Portuguese industry thanks to dedicated initiatives which the European Space Agency has for new Member States.

Portugal is however, still far from exploiting its potential in space. In the frame of ESA, Portugal sees an uneven distribution between the mandatory and optional programmes when compared to other Member States.

Figure A1 below gives and overview of the ratio between optional programme and mandatory subscriptions levels of Member States at CM16.

Successful Member States such as Germany, France, the United Kingdom, Italy have a relationship of 2:1 and above between the optional to mandatory activities today.

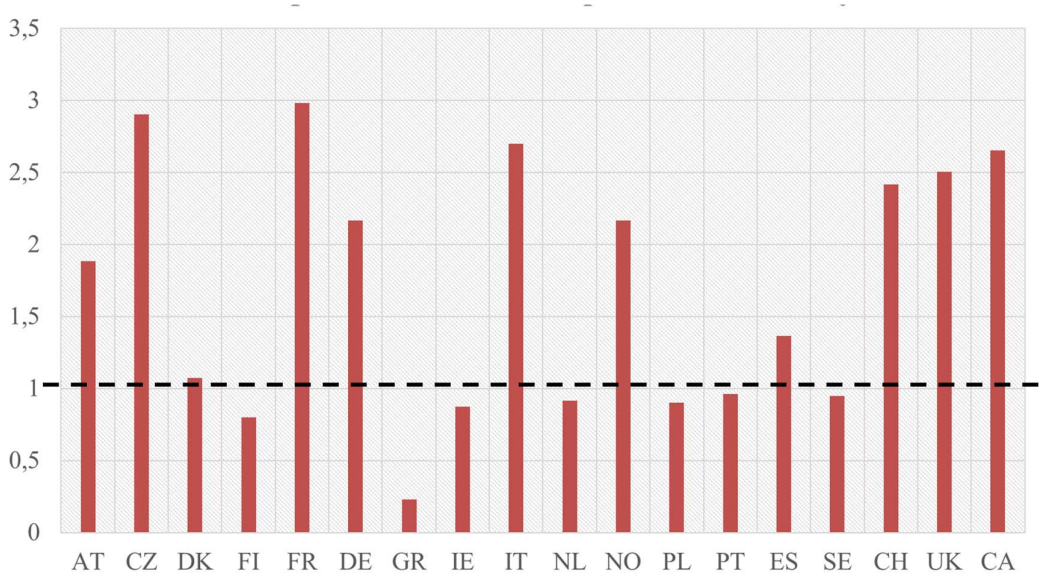

Figure A1: Ratio of Optional to Mandatory Subscriptions at CM16 for different Member States (on a 3-year basis)

The figure above does not include Luxemburg which has a ratio of 21.

Portugal's investments are at a ratio of 0.9:1 and shows that Portugal has significant room from improvement in going from basic research and early technology development and capacity building to developing systems and using these systems to provide solutions (downstream) for end-users. Figure A2 depicts the Portuguese contribution to ESA over the period 2000-2019.

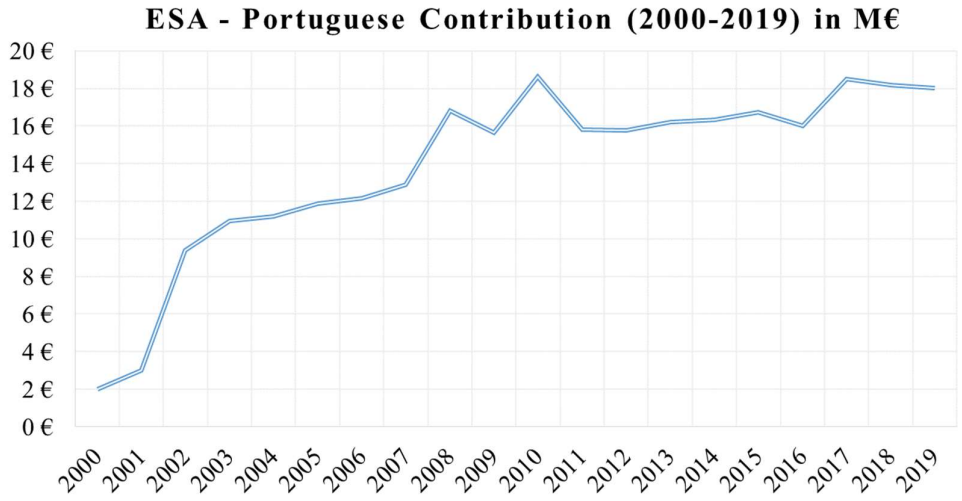

Figure A2: Portuguese Contribution to ESA during the period 2000-2019 in M€ and c.e.c.

The figure shows an increase over the initial period with an increased contribution at the occasion of the ESA Ministerial Meeting of 2016. The ambition to strengthen the space sector will be continued with a proposed increase of 20% in the Portuguese contribution at the ESA Ministerial Meeting of 2019, Seville, to achieve about 20 million per year during coming years.

It is however clear that the Portuguese contribution is not expected to have a large increase in coming years and, therefore, it is mandatory to have a much better articulation with other national and EU funding sources, as well as private business investments (see Part I of this document).

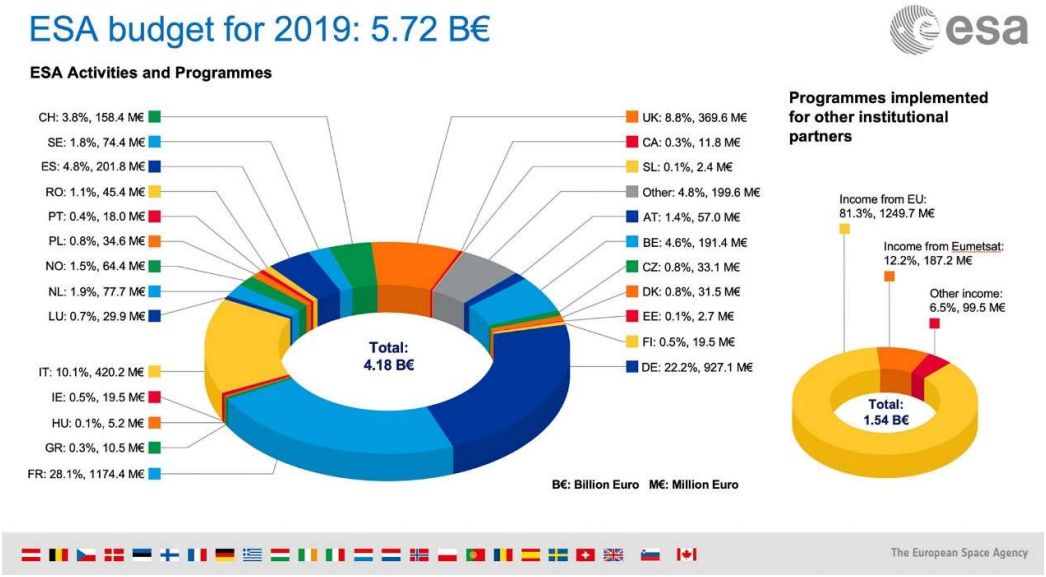

Figure A3: Distribution of Contributions to ESA per Member State for the year 2019

Figure A3 depicts the percentage distribution of contributions per Member State for the year 2019. Space activities in Portugal account for an annual outcome of about 40 to 50 millions Euro, while they represent about 600 million Euro in smaller countries such as Norway. In Spain, space sector is about 200 M€/year (and growing) in the frame of ESA alone.

These figures show an enormous potential for Portugal to grow a space economy and to attempt to multiply current outcome by 10 times in the coming decade, aiming to achieve an overall annual outcome of 500 million euros by 2030.

This requires a clear strategy to raise and attact about 2500 million euros in the coming decade, 2020-2030, as explained in this document and make use of an integrated and holistic approach, together with a strategy to diversify and articulate funding sources and investment funds.

Annex 4: ESA´s Space 19+ Ministerial Summit

The European Space Agency is presenting its programmatic content organised according to four main programmatic pillars and including the downstream as follows:

- **Space Science and Exploration**
- **Safety and Security**, with Space Safety, Safety and Security Applications, and Cybersecurity
- **Applications**, with Earth observation, Telecommunications, and Navigation
- **Enabling and Support**, with Space Transportation, Technology, Operations

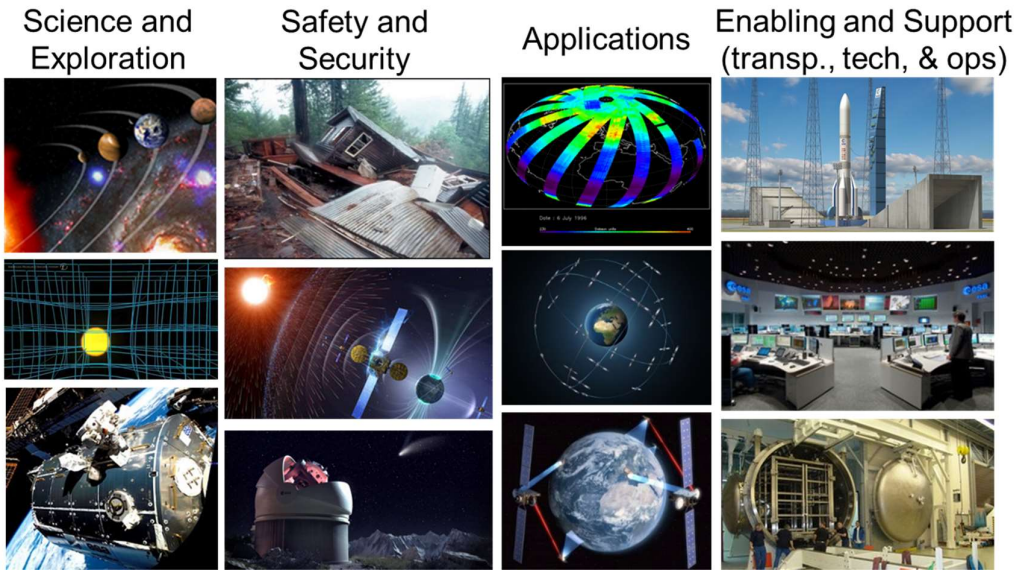

Figure A4: Four Programmatic Pillars

provides a summary of the main decision of Space19+ as well as the corresponding financial elements. Space19+ Programmatic approach

Mandatory Programme

Portugal should support these objectives and implement concrete actions for their implementation. Examples of specific elements are:

- Stimulate the development of new ideas addressing specific user-needs to be submitted to ESA to address for example: forest fires, autonomous shipping and optimised shipping routes, and the development of green energy sources. Technology development is to be favoured over studies.
- Stimulate the growth of the centres of scientific excellence across the country, bringing these together with other centres worldwide and closer to industry to develop cutting edge sensor technologies and digital/IT competences, making of Portugal a centre of excellence in topics of unquestioned future significance;
- Stimulate the use of ESA installations by Portuguese institutions; and

- Stimulate new partnerships between universities across Portugal and industrial and international entities.

Optional Programmes

Science and Exploration

Stock Taking

Portugal contributes to the European Exploration Envelope Programme, with a view of receiving 1.5 M€ worth of industrial contracts for Portuguese industry for some technology elements.

This funding amount is not enough for Portugal to develop significant expertise or contribute in a significant manner to the hardware of any individual mission.

Like space science mission (such as Rosetta), exploration activities are important in inspiring the younger generations and Portugal should not neglect this dimension of space activities to attract young people to study STE(A)M and aim for high-qualification jobs.

Way Forward

A new age of exploration is at its verge with new and renewed destinations. The next big breakthrough in exploration is expected through the commercialisation (at least partial) of activities and as well as a broader interaction not limited to a selected few partners as is the case today on the International Space Station.

The use of microgravity for the development of pharma products or specialised manufacturing process are only some of the commercialisation activities that might see an increase in the coming years.

Robotic activities and specifically activities associated with in-situ resource utilisation and in-space manufacturing will be the next technological breakthroughs in space – with all aspects such as power or AI will be enablers.

In view of the limited capacity to lead large exploration missions, Portugal should:

- grasp opportunities to strengthen acquired competences;

but complemented with:

- strengthening of the scientific “mining” of exploration activities;
- stimulating commercial activities built on synergies between space and non-space sectors such as sea/deep-sea sectors or Earth mining sectors;
- raising awareness of commercial opportunities for end-users and facilitate their entrance in the space landscape;
- invest in in-situ resource utilisation and in-space manufacturing opportunities

Space Safety and Security

General

Space Safety and Security are of civilian, governmental and defence relevance and Portugal must position itself now and in doing so: strengthen its infrastructure resilience; become an early entrant in new markets of huge proportion; and strengthen Europe as a whole.

Space Safety and Security is the next big topic in space and on Earth and early positioning in this field and associated markets will ensure leadership and economic growth.

The European Space Agency is the only agency worldwide that has made the first steps towards tackling safety and security is all its breadth. This is a unique opportunity that should not be missed. The overarching aim of the activities is: "*A resilient society capable of identifying and addressing hazards and threats originating in space, of fully exploiting space to counteract Earthly threats (human-made and natural) and of fully benefitting from space activities being cyber resilient."*

National and EU activities will be fully complementary to support users of the following sectors: defence, energy, air, government communications, …

Indeed, current developments worldwide have put an increased focus on safety and security aspects – from migration to autonomous shipping, to air traffic management, search and rescue and border control. The expectation is that the public sector be at the forefront of many of these activities with, however, private entities involved in this field both as users as well as investors. The public sector engagement will be paramount, with consequences of commercial importance. The increased reliance of other sectors on space assets and services for their own success and competitiveness magnifies the incumbent need to address threats (man-made or natural) originating in space which endanger critical assets in space and on Earth or even threat humankind – space debris and clean space, planetary defence, space weather (Space Safety). Worldwide, the public sector is expected to lead these efforts. Likewise, the expectation is that the public sector will take the necessary steps to enable commercial aspects and future markets associated with Space Safety (such as service provision and in-orbit servicing). Failing to do so will cripple the future competitiveness of industry.

Cyber resilience is already and will continue to be a concern. The global security framework is evolving. Cyber-attacks and accidents can target individuals, companies and public institutions/services (e.g. energy grids, financial markets, unmanned vehicles etc.), but also democracies. Space systems are a central link in this new intertwined safety and security continuum. The cyber security market totalled USD 101 billion in 2017, of which 90% were of a civilian and commercial nature. The civil segment increased by 12% in 2018, and 4% in defence. The compound annual growth rate of the global cyber security market is expected to be of 8.5% until 2022. Investing specifically in the cyber security of space infrastructure (ground and space segments) is of critical importance to the further growth and competitiveness of European space industry. Safety and security of space assets and activities will be an ever-increasing priority as space becomes more strongly integrated in all other sectors – both of public as well as of private relevance. Public entities will be judged on their ability to counter cyberthreats and private entities' survival will depend on their cyber resilience capabilities.

Space can contribute to the field of Safety and Security by investing in its own safety and security as well as in providing new services for the safety and security of others.

Awareness and readiness to react to emerging needs and markets will be key to success for the public and private space sector alike. Timeliness to implement will make the difference between make or break.

Space Weather (SWE)

Moderate space weather events happen frequently during every 11-year solar cycle. Strong events causing substantial impacts on the infrastructure take place in the average once per cycle. During the last solar cycle, several fast coronal mass ejections from the Sun barely missed the Earth. Warning systems and mitigation activities yield multiple benefits:

- **Social:** They can mitigate disruption or damage to critical systems on which society continuously relies, such as navigation and telecom satellites, electric power grids and terrestrial radio communication systems. Even routine solar activity can have a significant and costly effect on satellites and sensitive infrastructure on ground.
- **Economic:** The socio-economic cost of moderate space weather events over a period of 15 years could be up to 13000 M€. The socio-economic cost of a single extreme event is estimated to become up to 30000 M€ after 2030, when many commercial applications, including aviation, are dependent on satellite based navigation and telecommunication services. Although we cannot prevent space weather, costly ground infrastructure and satellites – and the critical services they provide – can be protected.
- **Geopolitical:** Loss of critical infrastructure and services could disrupt economic activity and daily life across Europe and worldwide, leading to serious upheaval.
- **Scientific:** Improve our understanding of the Sun-Earth system and its many interactions leading to space weather effects on Earth and other planets. Solar- and Heliophysics and space weather forecasting go hand in hand.

Europe needs to ensure the supply of timely, accurate and actionable information on Space Weather to build a reliable early warning system and develop responses to solar events.

Activities in this area will empower institutional, industrial and governmental users, by supporting a wide range of sectors to mitigate the effects of space weather on their systems, by producing robust data for owners/operators of satellites and infrastructure on the ground, and by putting in place a long-term maintenance and enhancement plan. Examples of potential users include:

- Institutional users: specialised agencies ensuring the safety of flight operations, such as the UN's International Civil Aviation Organization (ICAO) or Eurocontrol;
- Governmental users: securing public health, safety and security by providing early warnings that help protect governmental satellite navigation, communication and data relay systems by issuing timely warnings, and manage the threat of large-scale blackouts;
- Industry: apart from the space industry (e.g. satellite designers/operators, launch service operators, satellite navigation service providers), potential users include

commercial aviation companies, air traffic control (NAV specifically), power grid operators, and road and maritime transport providers.

Space Debris and Clean Space

There are more than 750 000 pieces of debris in orbit with a size larger than 1 cm, which are all potentially mission-ending. Of the 4500 satellites that are currently in orbit, only 1500 are active. Daily collision avoidance manoeuvres are required to avoid catastrophic events from happening that can result in cascading effects. ESA alone receives a few hundred collision alerts in a day for its fleet, with a single collision event in 2009 having doubled its avoidance efforts. There is one major uncontrolled re-entry event every week amounting to 100t in a year.

This makes the benefits of space debris mitigation and clean space activities manifold:

- **Social:** Unchecked growth in space debris could make specific orbits unusable, such as those used by vital climate, Earth observation and telecom satellites, permanently and catastrophically limiting critical services on which society relies. At the same time, collision avoidance warnings will enable satellite operators to take protective measures. The drive for sustainability and the protection of the environment is a value also shared by many in Europe, especially the youth.
- **Economic:** The destruction of individual satellites or permanent loss of specific orbits due to unchecked debris growth would have devastating global effects. For Europe this could mean the loss of economic activity in space which are directly worth over 8 000 M€. In addition, global satellite operators today spend 15 M€ annually on debris impact avoidance manoeuvres. With the increase of space activities so will this number increase if nothing is done. Developing technologies to automate collision warnings provide highly accurate orbit data and mitigate debris and investing into the removal of debris can create a variety of jobs and business opportunities for European industry including supporting the new market of space servicing. Furthermore the next breakthrough in space will be in-space production/manufacturing/recycling and capabilities for tackling debris are the same as those needed for in-orbit servicing and manufacturing.
- **Geopolitical:** Space is an enabler for the global economy and any loss of free and open use of space due to uncontrolled debris growth would undermine international economic stability, and by extension, endanger international public order.
- **Scientific:** Safeguarding our space assets against the risk of debris requires studying debris causation, and developing new statistical models, technologies, techniques and systems. Innovative technological solutions need to be studied to evolve satellites so that they do not become debris and removing debris requires a step forward in technical solution for close proximity operations.

Accurate, timely and comprehensive situational awareness is instrumental for the protection and safe operation of all critical European (and indeed global) space infrastructure.

Activities in this area will empower institutional, industrial and governmental users, by supporting sustainable space traffic management including monitoring, risk assessments and reduction, in-orbit servicing and debris mitigation, as well as designing to decrease environmental impacts, reduce the production of space debris and deorbiting large pieces of space debris. Examples of potential users include:

- Institutional and governmental users: Data processing, cataloguing and automation tools and software enabling timelier, more actionable information, and improving the ability of ESA, national space agencies and institutional partners to protect satellite fleets; and
- Industry: European industry can gain long-term competitive advantage by developing technologies and platforms that are effectively compliant with debris mitigation regulation. Precursors for active debris removal can build new European industrial capabilities needed to perform in-orbit servicing.

Stock taking

Portugal has so far not taken real interest in the safety and security dimension of space with only very limited investments going towards the topic of planetary defence and some activities linked to services developed in the frame of Copernicus.

In the frame of the EU, Portugal is part of the SST consortium.

Way forward

A strengthening of this field is a must in the field of both in safety and security IN and FROM space. Space Weather will become as common place as Earth weather forecasts and in-space manufacturing will extend the economic sphere of influence of nations to space for those nations that will invest in this field early. Furthermore, safety and security applications will be required by the public and private sector alike.

Space Safety and Security will result in operational systems for Europe of equal importance as Copernicus and Galileo and investments in this field will lead to a high return of investments when these operational systems will be in place. The expectation is that this will happen in the next 10 years with investments required in both the upstream as well as the downstream.

Portugal should:

- support the whole Space Safety and Security field as a unique opportunity for Europe;
- Develop specific space weather capabilities, scientific as well as industrial;
- Raise awareness of the consequences of space weather on all fields/sectors: from defence, to power grids, to health, communication and more;
- Contribute to the forecasting and now casting of space weather by contributing to the large pre-operational missions and with the development of small satellites to monitor space weather impacts on the Earth's atmosphere and Earth vicinity;
- Contribute to address the topic of space debris through tracking but by also addressing active debris removal and by that develop in-orbit

servicing/manufacturing capabilities which is the next frontier of space activities and markets;

- Act as a promoter of awareness and responsible action both towards Portuguese speaking countries and new space actors working together with ESA , the EU as well as other entities such as the Secure World Foundation and in the frame of the UN;
- Contribute to a global effort to address threats from asteroids and at the same time strengthen the scientific community around the topic linking it also to in-situ resource utilisation;
- Engage users across the country to develop safety and security related "intelligence" and services. Examples are:
    - Within the areas of radiation protection and nuclear safety, it would be interesting to stimulate the following:
        - Identify, characterize and evaluate the technical and commercial feasibility of space services to support NRBQ (Nuclear Radiological, Biological and Chemical) operations, namely the development of communication modules responsible for the implementation of a high-level communication system bandwidth and low latency to transmit both control information and CBRN sensor data in real time through a robust space-based communication network, improving quality and operational response;
    - In terms of climate monitoring and meteorological forecasting, the fact that the space sector provides essential tools for adaptation and mitigation to climate change, namely at the level of:
        - Knowledge of the territory and support to the evaluation of sectoral impacts and vulnerabilities;
        - Identification of vulnerable zones and sectors;
        - Monitoring of impacts (e.g. effects of droughts and floods, coastal erosion, etc.);
        - Support for informed decision-making, both in policy-making and in support of actors implementing adaptation measures (eg intelligent irrigation systems, design of flood protection systems, etc.);

<u>Applications: Earth Observation, Telecommunications, and Navigation</u>

General

The field of applications is certainly the one that brings, today, the most immediate return on investment through the development of space-based downstream services to address urban development, the needs of fisheries, shipping routes, agricultural needs, civil services and protection, search and rescue, and more.

In the field of telecommunications, the following major developments within 2020-2025 will require dedicated efforts:

- Market: With a digital economy requiring an all-pervasive connectivity, there are new opportunities for satcom, to become part of the global telecommunication's 'fabric'. This requires close-to-market support to the integration of space-based communications into terrestrial networks, in

particular with the emergence of next generation mobile networks, 5G. The established space industry needs to be more than ever sustained in this endeavour of transformation and new players especially SMEs need to be supported in entering the Space business

- Societal: New societal challenges are emerging, in particular regarding the safety and security of European citizens (see next pillar).
- Technological: 30 years after fibre-based terrestrial networks lay the foundation of the Internet, optical communication technologies in space are expected to achieve major impacts on the satcom sector in the next decade. Through disruptive technology developments Member States industries need to derive the necessary knowhow to fuel their competitiveness in the next generation solutions. This requires leadership in the introduction of comprehensive support on high risk optical technologies.

The public sector will also continue to be a key player in the field of satnav and more broadly for Positioning Navigation and Timing (PNT) technologies and services. All efforts of the EU, ESA, and at national level are of relevance and, in combination, will support the growth of a wide variety of business opportunities. The PNT domain allows to develop economic activities, particularly in the downstream innovation markets. Investment in innovation and competitiveness into PNT concepts, technologies and services is essential for European industrial stakeholders to hold their place and seize market opportunities as they arise. These investments are also fundamental to follow and anticipate the evolution of technical needs in order to offer attractive space solutions for the future.

The expectation will be that investments contribute to further increase European industry's innovation and competitiveness, addressing the end-to-end PNT value chain with a view to enhance Member States' industrial capabilities. In view of the highly competitive and rapidly evolving global market for satnav and PNT, these enhanced capabilities will enable new applications but will also help adequately address evolving and increasing requirements, such as increase resilience and robustness of PNT solutions.

The creation of new markets that will contribute to enlarging Europe's captive market will simultaneously support its competitive edge, its economic success, its stability, and its autonomy in the pillars of Applications and Enabling and Support (specifically autonomous access to space). Public sector investments in strategic partnership with the private sector will be a must as many new opportunities present themselves.

Stock taking

Portugal has invested in the past mostly in Earth observation, contributing successfully to the development of large satellites through equipment and subcomponents.

The DGT is one of the few entities in the Public Administration with a solid experience in Earth Observation, already using, in an operational maner, products derived from satellite images in the process of production of soil occupation cartography (COS). The COS follows open data policies and has a transversal use in the Central and Local Public Administration. The DGT is currently in a paradigm shift in the monitoring of soil occupation, and is developing methodologies for COS thematic enrichment based on attributes derived from satellite images (eg irrigated and non-irrigated areas, density of

the built-up tissue, density of forest cover, forest areas with shallow cuts). On the other hand, and considering that the COS has a scheduled period of 3 years, the DGT is also developing methodologies for the creation of annual soil occupation products based on satellite images. These developments have been made in the context of projects funded by various programs funded by the FCT, European Commission, ESA and Environmental Fund, and funding is now needed to develop a unique and structured program to add, consolidate and operationalize the developments that have been carried out in DGT.

Together with the IPMA, DGT coordinates the IPSentinel platform that provides satellite images of the Copernicus Program (i.e. Sentinels) to Portugal. (https://ipsentinel.pt).

This platform was built with EEA Grants funding and based on technology developed by ESA, constituting a Collaborative Solo Segment (CollGS) of the Copernicus Program. The portal has been in operation since April 2017 and has about 500 registered users. However, it does not currently have specific funding for its maintenance. For more details on the framework, architecture, functionalities and statistics of the IPSentinel infrastructure publication: http://revistamapping.com/wp-content/uploads/2018/03/Revista-MAPPING-187_A3.pdf

The interest in developing the sector of telecommunications and PNT has been very modest, with however industrial interest and expertise growing over the past years driven from an increased demand from all other sectors.

The business incubation centre established (ESA BIC in Coimbra) has been recognised as a new unique model of success within the ESA framework.

Way forward

The transformation of the telecommunication sector through 5G and optical communication is underway, and the Portuguese supply chain and operators should drive the transformation.

Tackling climate change is a societal and economic priority that Portugal should support both a supplier as well as system integrator, and as user as well as provider of solutions. Space-based data and information can complement in-situ gathered information to provide services to address many areas, assisting Portugal to reach 2050 carbon neutrality compromise.

Portugal's participation in ESA should be defined based on the interests and priorities of all actors related to space, not forgetting the potential Public Administration entities users of products derived from space technologies, namely Earth Observation. Only by involving the end users can it be ensured that the investment in ESA materializes in real benefits for the Public Administration. ESA's Earth Observation programs should enable to:

1. to develop and implement a national soil occupation monitoring program that will benefit the entire Public Administration.

2. to reinforce and maintain, together with IPMA, the IPSentinel platform, optimizing the availability of satellite images to the entire Public Administration.

With the goal of for example:

- Provision of satellite-related services, which support an entire infrastructure linked to digital communications, allowing for resource efficiency improvements (eg mobility, increased agricultural productivity, resource management such as potable water, monitoring of forest fires, … water resources, floods, water availability,…control of volumes raised by agriculture and the issue of transboundary basins, in particular the Guadiana basin…);
- Contribute to Portugal's commitment to achieving carbon neutrality by 2050, facilitating its implementation.

Portugal should therefore:

- Contribute to the next generation Copernicus and FutureEO programmes to maintain and further develop its thus-far acquire competence
- Develop subsystem and system competence through concrete projects which are user driven and/or industry proposed in co-funded schemes in as much as possible (InCubed+) and through that contribute to European leadership in space-based solutions through the diversification of the fleet of satellites available to end-users to develop applications and services by developing small systems to complement large ones whilst contributing to large systems;
- Lead and foster “Blue Worlds” activities and initiatives with a special focus on the Atlantic but in close collaboration with European and non-European countries to address water bodies and their understanding and sustainable socio-economic development and exploitation;
- Support end-users (in integrating space in solutions to their specific problems) through the amplification of the BIC/Incubator concept to centres across the nation;
- Invest in a new generation of services based on Earth observation systems as well as PNT.

<u>Enabling and Support: Technology and Space Transportation</u>

Stock taking

Portugal has thus far invested mostly in capacity building and technology development and this has allowed to achieve the current status.
Activities related to space transportation have been dedicated to Space Rider to allow microgravity research.

Way forward

Developing new basic ideas and investing in technological development is at the base of any sector. Technology development should aim at early demonstration and validation in orbit to allow early adoption of innovative ideas.

Democratisation of access to space is a key enabler and Portugal should strengthen initiatives started at a national level with international partnerships.

Portugal should therefore:

- Invest in developing and testing of basic ideas and early in-orbit validation and demonstration to quicker times to market;
- Engage in international partnerships to guarantee the success of the spaceport initiative and to support the democratisation of space through the development of a microlauncher with a Portuguese contribution in both the space and ground segments;
- Support the development of Space Rider and foremost its exploitation in view of the contribution it will bring to the use of space for microgravity research and product development as well in view of the economic growth of the region of the Azores as well its synergetic elements to the spaceport initiative;
- Contribute to the increased competitiveness of the existing family of launchers in an industry driven approach rather than government pushed;
- Act as a catalyst for an industrial restructuring in the domain of space transportation in line with decisions made in 2014 to hand over the governance to industry.