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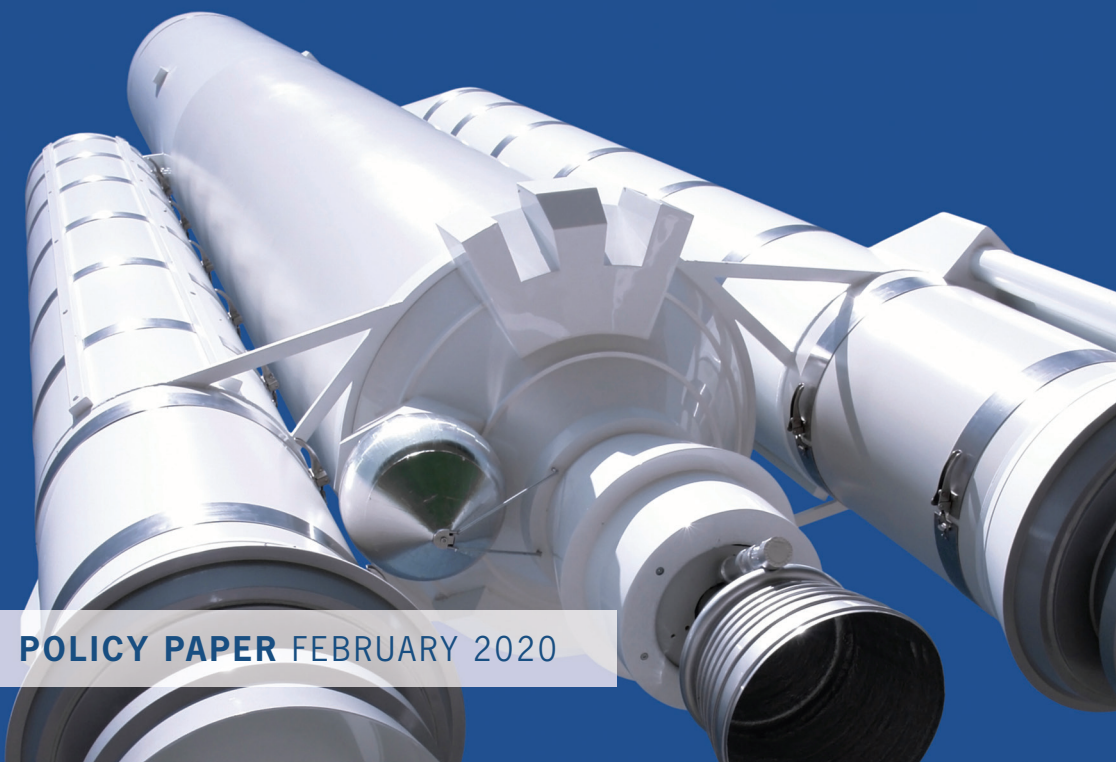
Space:
Will Europe Awaken?



POLICY PAPER FEBRUARY 2020

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There is no desire more natural
than the desire for knowledge

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INTRODUCTION

The past few months have seen important events unfold for Europe in space: in November of 2019, the European Space Agency (ESA) Council in Sevilla resulted in a significant increase of its space budget and in new projects. Then on 22 January 2020, Thierry Breton, the EU commissioner for Internal Market in charge of the defence industry and space (DEFIS), delivered a key speech announcing new ambitions for the EU in space, ranging from governance, budget to space programs.

Following the 2017 report entitled "Space: Will Europe Strike Back?", Institut Montaigne has continued its study of risks and opportunities for Europe in relation to space affairs. In February 2019, it held a Franco-German seminar on space issues to explore new routes for additional European cooperation in that field.

In this context, this policy paper, prepared by three European experts, aims first at outlining recent trends and issues around space affairs (1). Then we describe Europe's current position with a strong focus on the European Union (2). Finally, we outline five concrete proposals aimed at giving a new impulse to the EU's space program (3).

EXECUTIVE SUMMARY

A FAST-CHANGING LANDSCAPE.

A fast-changing landscape: to be heard on the international stage, Europe needs to have a leading role in space. Space has become a geostrategic issue and an expression of both hard and soft power, politically and economically. As dependence on satellites increases (satellite navigation, imaging, telecommunications, etc.), the need to protect these infrastructures becomes more critical. On an economic level, Earth orbit is the new frontier of Big Data. It is only logical that digital behemoths, both American and Chinese, are investing billions of dollars in new projects such as building constellations of thousands of satellites to provide new connectivity services worldwide.

Overall, private companies play an increasingly important role in space. For example, Jeff Bezos, founder and CEO of Amazon, personally invests approximately one billion dollars per year in Blue Origin, his aerospace company. This is as much as the French total annual space budget (1.3 € billion). Amazon plans to invest several billion dollars in a constellation to provide broadband internet. SpaceX, the well-known space company created by Elon Musk, has become one of the main driving forces of the space sector globally. Even in China, many space start-ups have emerged. In Europe, the landscape is already changing as private companies adapt to this new reality.

Europe's structural limits are being tested: in this "New Space" context, Europe has managed to build strong positions in several key aspects of space, from science and exploration to business applications. ESA, an intergovernmental body separate from the EU, has been instrumental in that regard. The EU, for its part, can be proud of its achievements, starting with its two leading programs, Galileo and Copernicus. However, the EU cannot rest on its laurels, as shown for instance by the outage of Galileo in July 2019. These two programs still need to be successfully completed in the context of the upcoming 2021-2027 Multiannual Financial Framework (MFF) to make sure Europe actually reaps the benefits of these investments. European space governance (particularly the connection with ESA) remains partly inadequate and needs to be improved, if not deeply transformed.

Lacking its own GAFA ecosystem, the European space program must compensate, and this requires becoming much more open to "non-space" for new projects and new sources of financing. The European space industry must be firmly defended and supported, but must also bear more responsibility and risks. This includes new entrants (especially start-ups) even though confrontations between legacy players and these new players must be avoided.

The EU must have a stronger voice than it does today on new issues in space (safe management of Earth orbit, economic utilization of celestial bodies, etc.). Europe has the responsibility of bringing its values of peace and cooperation for the determination of future regulations. In short, the EU now has the responsibility to reach for the stars.

Five concrete measures: to move toward these goals, concrete measures should be taken covering the various aspects of space affairs (strategic independence, technological and industrial leadership, geopolitical positioning). While many proposals can be contemplated, this policy paper is limited to just five measures that could be initiated as soon as 2020, with reasonable budgets. They take into account political acceptance among Member States, as well as financial realism:

1. Ensure Europe's autonomy in Space Traffic Management by developing EU capabilities for detection (ground-based radars and telescopes as well as space-based solutions) and computing, jointly with ESA and Member States. Such measure has been proposed by key stakeholders, but the real challenge is now to determine rapidly the next steps and implement them. This will help ensure Europe's voice is heard and its role as a guardian of Earth orbit is secured, before others establish new rules.

2. Adopt an innovative approach in terms of public space procurement. We propose creating a commercial services procurement unit within the future EU agency for the space program. The EU should, when relevant, support the development of commercial services (in particular, imagery and telecommunications) by European companies, and do so by becoming an anchor customer rather than an owner of satellites.

3. Decide in 2020 on a European strategy regarding broadband constellations. These projects bear significant uncertainties, but they are set to become a deciding factor for the future development of space as well as for telecommunications and Big Data. Europe cannot afford to wait to see if they succeed. The EU Commission should take the lead in designing a policy which could include specific regulations as well as the analysis of the need to develop a European capability in this field.

4. Ensure Europe's leadership in small satellites by providing free access to orbit for in-orbit technology validation. This aims at simultaneously developing launch capabilities for these satellites (small launchers, or rideshares using larger launchers), as well as supporting the development and commercial success of small satellite technologies.

5. Give the EU a political role in international space affairs, with an immediate focus on ensuring Europe has a role to play in, and benefits from, the ongoing push to develop activities in the space between Earth orbit and the Moon (so-called "cislunar space"). A potential concrete measure would be landing a probe on the surface of the Moon, by 2023, with a scientific and also commercial goal, which could include a demonstration of Moon resource utilization technology. This could send a strong symbolic message and push European established players as well as start-ups to take on the challenge.

I

THE INTERNATIONAL CONTEXT: A COMPLETE TRANSFORMATION OF SPACE AFFAIRS LED BY TECH COMPANIES AND CHINA'S AMBITIONS

I.1. Digital Technology, the Fuel of "New Space"

Space has become a central element of society. This has been the case for a long time for weather forecast and telecommunications. But this has become more obvious with the rise of applications using satellite positioning systems (for instance the GPS or Galileo) and, more recently, space imaging services, both for defence purposes and new industries (pipeline surveillance or agriculture, for example). In the defence field, the United States and France recently announced the establishment of armed forces focused on space. Against that background, the EU has identified the benefits the economy and society can draw from space services. This a major focus of its space strategy established in 2016.[1]

However, European actors tend to underestimate the role played by Tech giants and its consequences for the European space program.

Space, the new frontier of Tech giants: space is no longer just an issue of independent access to Earth's orbit, civil and military observation, scientific prestige, or control of the technological building blocks of nuclear deterrence. The acceleration of investments points to a world where being at the forefront of space powers is an essential prerequisite of sovereignty but also of prosperity, especially in terms of Big Data. Private investments are made by the digital industry and the main reason for this is that Earth orbit is a very good (or even in some cases, only[2]) medium for gathering and transmitting information, from imagery to internet data. Looking only at the GAFA (Google, Apple, Facebook, Amazon), we observe the following:

1 https://ec.europa.eu/growth/sectors/space_en
2 For instance in regions where ground infrastructures cannot be built economically.

- Google (along with a fund) has invested almost 1 billion dollars in SpaceX in 2015[3] and has made other significant investments in Earth observation (Planet). Its interest in SpaceX is linked to the Starlink internet constellation project, currently under development (see below).
- Facebook also has projects related to connectivity[4] and has financed satellites and associated technologies (high-altitude drones and balloons, telecommunication satellites, etc.).
- Apple also has been reported to work on satellite-related technologies. It has hired experienced people from the space industry to this end.[5]
- Amazon is perhaps the GAFA company most invested in space. Jeff Bezos, founder and CEO of Amazon, invests approximately one billion dollars a year of his personal wealth in Blue Origin, his launcher company. Amazon itself plans to invest several billion dollars in a constellation called "Kuiper" to provide broadband internet (see below). Finally, Amazon is currently extending its cloud services (AWS) to include space data.1 Space is thus going to play a key role for the group.

The impact of tech giants in space is also visible in China: for instance, Tencent has invested in Satellogic, an Argentinian start-up developing an Earth observation constellation.[7]

Constellations linked to connectivity: new projects are being developed and are being deployed (Oneweb and Starlink). They differ from existing satellites due to the number of satellites (several hundreds, even thousands) and the intention of providing connectivity to the entire planet, for broadband but also "Internet of Things" (IoT). While these projects will not replace ground infrastructure, they may capture a significant market share if they succeed, potentially weakening existing European telecommunications companies. Regarding broadband, the profitability of these constellations is hotly debated. They bring new issues and risks, in particular regarding the risks of collisions in space. Although European companies participate in such constellations (Airbus in Oneweb, for example), they are not directly associated with either the financial results or the data flows and services. These will be controlled mainly by entities in the US (Starlink and Kuiper) and Japan (Oneweb, through Softbank). The US' Department of Defence has expressed support for these initiatives and has already awarded a 28 USD million contract to Starlink for connectivity tests with US Air Force aircrafts.[8]

3 https://www.nytimes.com/2015/01/21/technology/google-makes-1-billion-investment-in-spacex.html
4 According to some reports, Facebook has recently set up a dedicated subsidiary which has filed an application before the FCC for satellite spectrum rights. https://spectrum.ieee.org/tech-talk/aerospace/satellites/facebook-may-have-secret-plans-to-launch-a-internet-satellite
5 https://www.bloomberg.com/news/articles/2019-12-20/apple-has-top-secret-team-working-on-internet-satellites
6 https://aws.amazon.com/fr/ground-station/
7 https://www.ft.com/content/fad2aa74-d2c3-11e9-8367-807ebd53ab77
8 https://spacenews.com/air-force-enthusiastic-about-commercial-leo-broadband-after-successful-tests/

It is worth noting that China is also contemplating launching similar projects, potentially with cooperation from Russia.[9] CASIC, a major State-owned aerospace company, is testing and will soon be deploying Hongyun, a LEO broadband constellation. There are also private constellation projects, the biggest being Galaxy Space. This start-up has financial backing from the 5G, IoT Chinese giant Xiaomi.[10]

The impact of Big Space Data: the ability to observe, gather, and process data from space will become a factor of competitiveness for companies, just as digital services offered today by GAFA or BATX[11]are essential today. Already, information gathered from space plays a key role in industries as diverse as energy and agriculture. The uptake by non-space business is set to increase further. However, only companies able to process space data and transform it into actionable intelligence will create significant value and profit.

With respect to observation capabilities and related data flows, it is common knowledge that American companies make significant use of the free access allowed to European space data. For example, data gathered by Copernicus satellites is systematically downloaded and stored by US entities (such as Google) and are integrated into their own services.

Europe has not been able to develop a world-class digital player, and this is a problem in the field of space as well. European private companies outside the space industry do not make investments comparable to those made by GAFA. This deprives the European space industry of an important source of investment (at a time when government investment is already weaker in that area) and also from important customers.[12] This also deprives the space industry of sources of technological innovation. The role of EU Member States and the EU is thus all the more important.

9 https://financialobserver.eu/cse-and-cis/russian-chinese-satellite-delivered-internet/
10 http://www.yinhe.ht/indexEn.html
11 Baidu, Alibaba, Tencent, and Xiaomi: the Chinese equivalent of GAFAM [Google, Amazon, Facebook, Apple, Microsoft]. They also invest in space (particularly Tencent and Xiaomi).
12 Digital players may become key customers for space internet services.

I.2. The Chinese-American Rivalry Now Extends to Space

China is the second determinant factor: by significantly increasing its ambitions and investments, it pushes the Americans to increase theirs, followed by other emerging powers.

The renewed ambition of the United States: government investment is increasing. NASA's budget rose by 2 $ billion in 2018, reaching 21 $ billion. Such increase is more than the total budget of the CNES, or one third of the current budget of the ESA. New initiatives have been taken under President Trump, with three presidential "space policy directives" (SPD 1 to 3) in one year. This strategy of predominance is bearing fruit. New ambitions for the Moon announced by Vice-President Pence (landing a human on the Moon by 2024 through the Artemis program) are clear signs of these renewed ambitions.

China has similar ambitions, although following a different model more adapted to its political and economic governance: significant and growing government budgets, well-trained engineers, and the personal involvement of new Chinese wealthy individuals and companies have already allowed the country to catch up in satellite technology and launchers. China even surpasses the West in some areas (e.g. in the field of quantum telecommunications[13] from space). China's space ambitions are clearly part of the "New Silk Road" project and the country is already quickly capturing market share in emerging countries (partly to the disadvantage of European companies). China indeed has quickly caught up with the US and Europe in terms of telecommunications satellites and proposes "packages" (satellite, launch and satellite operation in orbit) to more and more countries, sometimes in exchange of preferential rights to the country's resources. Further, the country has announced ambitious space exploration goals for the Moon and Mars. It will shortly launch its new space station, which it will also use as a soft power tool.

India is following suit, with less financial means but with equal determination: significant events in 2019 include India's failed attempt to land on the Moon, its announced project to send Indians to orbit autonomously and a satellite destruction test. Russia remains a significant player but is, to some extent, falling behind due, in particular, to a smaller, less data-driven economy.

13 It has been reported that China has taken a strong lead in quantum telecommunications, both from Space and on the ground. There have been proposals recently regarding a LEO constellation that could form the backbone of the quantum internet architecture.

II

EUROPE IN SPACE: A SIGNIFICANT BUT INCREASINGLY THREATENED POSITION

II.1. Europe in space faces risks on all fronts

European positions have been hard won over the last thirty years. They are challenged by the acceleration of the United States and China. This can be seen in several regards:

Public space budgets: they reflect Europe's current organisation in space, separated in three main levels. These levels are:

- The European Space Agency (ESA), with a combined budget of 5.72 € billion for 2019, coming from contributions by Member States and by the EU. The 2019 ministerial meeting in Sevilla has seen a major increase in national contributions;[14]
- The EU space budget which amounted to 1.55 € billion for 2018.[15] The proposed budget for the 2021-2027 period (while subject to confirmation) would see a marked increase (16 € billion over seven years versus 11 for the previous period);[16]
- The national space budgets (mainly of France, Germany, Italy and the UK) represent collectively (excluding contributions to ESA) around 2 € to 3 € billion.

Even if the three levels are combined, the total European space budget is unlikely to exceed *circa* 10 € billion annually over the coming years. This amounts to approximately 20-25 % of the annual American space budget. The Chinese budget is not officially known but is considered today to be equivalent to that of Europe, or even higher. It is in any case rapidly increasing and can benefit from lower costs (especially in terms of labor costs).

In a structurally constrained budgetary context, the effectiveness (or "value for money") of European space spending will be crucial in the coming years.

14 http://www.esa.int/About_Us/Corporate_news/ESA_ministers_commit_to_biggest_ever_budget
15 According to Eurospace.
16 The proposed distribution is as follows: 9.7 billion for Galileo (and EGNOS, the ground segment); 5.8 billion for Copernicus; 500 million for the independence of space surveillance or SSA and to Govsatcom (the satellite-secured government telecommunications system).

The space industry and the role of the private sector

- Europe has made only a limited bet on new satellite constellations,[17] small satellites (more compact and cheaper than existing satellites) and new orbital services.[18] Europe also struggles to fully embrace the trend towards an emerging "Big Data in space".
- Due primarily to a weaker government demand compared to its competitors, the European space industry is heavily dependent on its ability to secure export contracts. Market shares are challenged by competition from the US, and increasingly from China starting in emerging markets. The place of European launchers (Ariane 5 and starting in 2020, Ariane 6; the small launcher Vega) is threatened by the Americans and the Chinese. Europe has lost significant market shares and has not been able to keep up, especially from a technological and industrial standpoint, with players such as SpaceX. Satellite manufacturers are under pressure due to the trend towards smaller, less expensive satellites, many of which are assembled in large constellations (see above).[19] Such trend implies series production capability for satellite, which Europe has yet to build. Finally, the vast majority of private investments are generated by, and intended for American space start-ups.[20] One important factor for start-ups in the US is the ability to benefit from support and contracts from institutions related to defence and security (DoD, US Air Force, National Reconnaissance Office, etc.) as well as NASA, which does not hesitate to strongly support small emerging companies.
- Europe has managed to develop and attract some of the largest telecommunication satellites operators, such as Eutelsat and SES. It gives the continent a strong position in a sector which accounts today for the majority of the space economy. However, this position is poised to be challenged, in particular in the context of the proposed broadband constellations.

Preserving and developing the European space industry is essential. Traditional players (Airbus, Thalès Alenia Space, OHB, Arianespace, etc.) must be supported and transformed, while also supporting new start-ups. These new entrants can attract new private investments and new talents and thus stimulate the economic structure of the European space industry.

17 These projects of constellations of thousands of satellites are intended to provide telecommunications services. Airbus plays a role in the satellite internet project of the company Oneweb by providing satellites (although they are built in Florida).
18 These new services are intended to extend the lifespan of satellites, detecting and eliminating space debris.
19 For example, 450 jobs may be eliminated at the Franco-Italian company Thalès Alenia Space (TAS).
20 See for instance the Bryce report "Update on Investment in Commercial Space Ventures 2019". https://brycetech.com/reports.html

Current European Union Programs

- **Galileo:** the outage of July 2019 reflects the fact that the system is still in the learning phase. This however justifies an in-depth analysis of the current flaws in space governance (see below). The seriousness of this incident should not be ignored since without the ability of GPS to ensure the continuity of geolocation services, the impact on the European economy and on human safety could have been very serious. The credibility of the system in the opinion of operators (both governmental and private entities) has been damaged.
- **Copernicus:** this system for observing the earth is an unquestionable scientific success (especially for studying climate change) and gives Europe real "soft power" in international relations (as emphasized by its unprecedented coverage of the fires in Siberia and in the Amazon, in summer 2019). On the contrary, Europe's project of developing a private ecosystem built on the utilization of data from the Copernicus system has so far been unsuccessful despite the Commission's initiatives (particularly the five DIAS bringing together various European actors).[21]
- **GOVSATCOM:** aunched by the Commission in December 2013, its purpose is to give the EU governmental satellite communication capabilities by 2020, providing secure satellite communications services to the countries, organisations, and operators of vital importance to the Union. Its development is underway but remains dependent on allocation of sufficient resources in the EU budget.

Leading EU programs are unquestionable successes for the European Union, but the EU cannot rest on its laurels. There is still much to accomplish in order to justify the investments made in these programs. The planned budget increase – which still awaits confirmation – for the 2021-2027 MFF should be an opportunity to set high expectations in this regard. It is also necessary to think of new initiatives (see section 3 below).

21 To facilitate and standardize access to data, the Commission financed five cloud-based platforms offering centralized access to data from Copernicus as well as the necessary processing tools. These platforms are known as DIAS (Data and Information Access Services). So far, efficient and user-friendly 3rd party APIs have not been provided by the DIAS. This should be a first-order priority.

II.2. Governance

Relationship with ESA: European space governance (EU, ESA, Member States) remains far from perfect, as shown by the difficult negotiations with the ESA on the new space regulation (which has not yet been officially adopted) and also by Galileo's recent breakdown (see above). Creating a "European Union Agency for the space program" faces strong resistance from ESA, which underlines the risk of duplication and interfaces between the two entities.

Moreover, the importance of the main countries financing ESA must not overshadow the contribution of other Member States willing to develop their national space industries. However, it is important to avoid a situation where each ESA member tries to develop its own national actors.

These issues particularly complex and is a source of heated debate, especially in the Member States. Some are in favor of bringing the EU/ESA closer together, but such direction is likely to be perceived by others as weakening ESA.

In addition, Franco-German space collaboration continues to lack new shared projects and long-term strategic vision, despite the promising announcements made at the Franco-German ministerial council in Meseberg in the summer of 2018. Recent declarations in Toulouse in October 2019 do not significantly change this landscape, except for the mention of a potential *"common robotic mission to the Moon, launched by Ariane 6 and involving also elements of artificial intelligence"*.[22]

Independence: the EU Commission should be cautious with the risk of conflicts of interest involving certain non-European actors. Cases of European civil servants hired by these actors, while maintaining privileged access to the Commission, have been reported.

Brexit: the United Kingdom has decided to abandon Galileo's military capabilities (public regulated service, or PRS) after the country withdraws from the EU. It remains a member of the ESA but has announced new national ambitions (increasing the national agency's budget, creating a national spaceport, etc.). The goal should be to maintain close cooperation – especially in the field of satellites, where the British have a strong expertise – in order to avoid the UK becoming too close to other non-European actors.

22 https://www.elysee.fr/admin/upload/default/0001/06/b6d6d489f677358036fcc00c43d51f7a4213b233.pdf

In the short-term, the primary objective is to implement progress allowed by the new EU space regulation and to confirm the proposed space budget for the upcoming MFF. However, it is necessary to start designing the next stages of the European space governance without delay, especially regarding coordination between the EU and ESA. The role of national space agencies in the architecture should also be part of discussions.

With limited financial means compared to our competitors, governance must be all the more efficient, while guaranteeing the coherence of the European space program.

III

FIVE CONCRETE STEPS

In its 2017 report, Institut Montaigne made eight proposals for a new European space policy, covering particularly access to space (including innovation and European preference), the need to commit to new EU space projects, as well as the use of innovative methods to stimulate the rise of new actors.

This policy paper offers new proposals taking into consideration developments that have occurred in the last two years as well as the results of the common work of this paper's three authors. The proposals are also the result of discussions with many European actors in the space sector, both private and public, including large companies as well as start-ups.

III.1. Make the EU independent in terms of space traffic management (STM)

The Current Situation and Need

SSA (Space Situational Awareness) means being able to understand what is happening in orbit, to identify collision risks, and to detect the approach of unfriendly objects. Having adequate SSA is required to design appropriate practices, standards and regulations for ensuring safe, efficient and competitive use of Earth's orbits and beyond: This is Space Traffic Management, or STM. The EU has already identified SSA as an issue of community interest: since 2014,[23] a system called EU SST[24] has been in place with the support of several Member States.

This is a major issue for the EU, if only because of the need to protect its own satellites linked to Galileo and Copernicus. However, recent scenarios involving potential collisions between space objects (active or inactive satellites, debris) have become more frequent.[25] The announcement of the launch of thousands of new satellites makes it even more urgent not only to define new management regulations in orbit (which are

23 https://eur-lex.europa.eu/legal-content/FR/TXT/HTML/?uri=CELEX:32014D0541&from=EN#d1e714-227-1
24 EU SST means "Space Surveillance & Tracking (SST)"
25 As shown for instance with the avoidance manoeuver between an ESA satellite and a SpaceX satellite in 2019, which showed the weaknesses in the overall STM system.

today generally lacking), but also for the EU to have the technical capability to conduct its own space surveillance.

It should be noted that SSA and STM are fields where autonomy cannot be achieved without cooperation. Indeed, in many cases, the detection and safety of one's space assets require cooperation and communication with other actors. However, today, the Member States' capabilities are too weak, and Europe is thus greatly reliant on the capabilities and information made available by the US Air Force, which has far better technical capabilities in this area and regularly invests in improving them. The EU thus has no guarantee of having access to the necessary information.

Further, such SSA capabilities are essential for the EU to have a role in STM. They are in particular required for the EU to be consulted and heard when new regulations are established. It is important to note that setting a new STM framework is the objective set out by President Trump's Space Policy Directive No. 3 of June 2018.[26]

Finally, increasing Europe's capabilities and influence in the STM field is also critical if the EU is to take advantage of the new services and markets that SSA will create. In addition to detection and collision risk prediction, orbit management services such as active debris removal (ADR) will require appropriate SSA capabilities and may eventually become a key part of STM. In that regard, ESA has agreed in Sevilla on a dedicated mission called "ClearSpace-1" building on the success of the RemoveDebris mission conducted in 2018, which will continue building European capabilities. However, start-ups are already emerging, such as Japan's Astroscale which has already raised more than 100 $ million and has received in January 2020 a 4.5 $ million grant from the Japanese government. Companies and countries well-placed in this field will be well-placed to benefit from the demand created by future STM regulations regarding debris.[27] Europe should be at the forefront of this new chapter in space, which could start unfolding very fast as collision risks increase.

Today, the Commission's proposal for the 2021-2027 MFF is 500 € million (over a seven-year period, or approximately 70 $ million per year) for SSA *and* Govsatcom, with the distribution still unknown between the two programs. The outgoing Parliament has proposed doing more but it will be up to the new Parliament to decide. However, to date, STM plans, budgets and governance remain uncertain and insufficient. This should change fast.

26 https://www.whitehouse.gov/presidential-actions/space-policy-directive-3-national-space-traffic-management-policy/
27 https://spacewatch.global/2020/01/japans-astroscale-receives-4-5-million-grant-from-tokyo-government-for-commercial-space-debris-removal/

The Proposed Measure and Financing

The EU has authority, and is legitimate, to make SST & SSA a new EU space program in its own right, alongside Galileo (and EGNOS), Copernicus, and Govsatcom. This SST & SSA program could be a tangible sign that the EU is taking new initiatives and is not limiting itself to existing programs. This would be a strong message that the Union, and with it the Member States, intend to continue building its space capabilities.

This initiative involves creating, along the model of Galileo and Copernicus, its own capabilities (particularly radar and observation telescopes but also computing systems) in addition to the existing capabilities of the Member States, with whom coordination will be needed. To respond to the sensitive nature of the collected data, and on the model of Galileo, a secure system could be added to a general civil catalog listing space objects in real time. This catalog would be public and open in particular to civil space operators on a global scale. The opening of the catalog to the international community would create a "soft power" effect, as is the case with Copernicus in terms of observation. It would give the EU a powerful voice in negotiating new orbital regulations. The European Space Policy Institute (ESPI), a think-tank backed by numerous public and private stakeholders, has outlined what roles the EU, ESA and EU Member States need to fulfill for such a system.[28]

Significant technical and political work is required to define the technical capabilities needed for Europe to have sufficient autonomy and competitiveness. It is clear however that creating capabilities (for example, effective radar) requires a real financial and organisational investment, which is significantly higher than what is actually anticipated in the 2021-2027 MFF. In terms of financing, there are two possible options: increase the overall space budget, or, if this is not possible, optimize the anticipated budget by taking advantage of the rapid decrease in prices for certain equipment and products.

PPP-based approaches should also be contemplated to leverage STM services the European private sector will be able to provide. The EU would need to act as an "anchor customer" for emerging private capabilities.

28 "Towards a European Approach to Space Traffic Management", ESPI Report 71 - published: January 2020. Available here: https://espi.or.at/publications/espi-public-reports.

III.2. Adopt an innovative approach in terms of public space procurement

In December 2017, Institut Montaigne emphasizes in its propositions the need to promote the entry of new private actors in Europe, through innovative public-private partnerships similar to those used by NASA for accessing ISS and the development of moon-related capabilities. Institut Montaigne argued that such partnerships would maximize the efficiency of additional public investments made by the EU. To date, in the absence of a new flagship program that could justify such a PPP approach, such schemes have not yet been used.

In this policy paper, we propose using other innovative approaches aimed inter alia at boosting the efficiency of Europe's public spending.

The Current Situation and Need

European nations are investing in space technology through the EU Space Programme[29] primarily for the Copernicus Earth Observation satellites and Galileo navigation satellites, and through Horizon 2020 for research[30], EUMETSAT and ESA for meteorology[31], ESA for several space components including launchers, telecommunications, science & exploration and space technology development[32], and also through national space programs.

In the US, NASA directs public funds for buying performance from commercial service providers, seeding multiple competing developments and acting as a significant anchor customer[33]. In several areas, NASA has succeeded in stimulating a space economy to mature enough to attract significant commercial venture capital investments.[34] 2018 was a record year for venture investment into space with total investment increasing by 29% from 2017, and US companies collecting 64% of the $3.2 billion invested compared to European companies' 18%. While the data from China is more sketchy, significant investments during 2018 in Chinese companies such as LandSpace and OneSpace suggest that the Chinese space program is fueling similar rapid development in the Chinese space economy.

29 http://europa.eu/rapid/press-release_IP-18-4022_en.htm
30 https://ec.europa.eu/programmes/horizon2020/en/h2020-section/space
31 https://www.eumetsat.int/website/home/AboutUs/index.html
32 https://www.esa.int/About_Us/Welcome_to_ESA/Funding
33 https://www.cnbc.com/2018/11/29/nasa-picks-9-companies-to-compete-for-lunar-transportation-contracts.html
34 https://spacenews.com/space-startup-investments-continued-to-rise-in-2018/

In Europe, the existing public funding has failed to stimulate equally significant private space sector renewal and development[35]. While some actors (both large and small) have embraced the "New Space" movement, the majority of the European space economy consists of the few large scale integrators and their subcontracting chains whose primary business is delivering traditional solutions to the slow-moving institutional buyers and the incumbent satellite communications companies whose business is threatened by the new, smaller and cheaper satellite technology. A handful of start-ups are developing new technologies as cost effective solutions for business needs, but there is a dearth of funding to mature and scale their solutions. Most start-ups currently buy their launch services from the US, India or China, signaling the lack of sufficiently available solutions in Europe (see our proposal below).

We have a systemic challenge. To address this systemic challenge, we need to change both how the public funding is applied, and to reduce the fragmentation of the European commercial space activities.

If we wish to compete with the large economic areas of the US and China, we need to properly leverage our domestic economic potential. A small country such as Finland or Denmark is not enough of a market to establish any significant growth industry, although it can be an effective test lab and trial market. France or Germany are significantly larger but are still small markets compared to the US or China. Europe as a whole is an economic area of 500 million people and home to some of the world's most advanced industries. When we direct European companies to serve the European market, they have a sufficient domestic market to enable growth into global powerhouses. This requires pooling our resources to generate European-domestic anchor customers and market demand, and to direct development into the strategic directions we want European industry to be able to compete in.

Failure to develop such logic would result in diminished innovation and competitiveness. Worse, successful space start-ups are at risk of being lured to the US or China by easier business and financing opportunities if there is not a sufficient business incentive for those companies to stay in Europe.

The Proposed Measure and Financing

Shifting the procurement logic: in order to stimulate a viable space economy in Europe, we need to go from buying traditional space assets to be managed by the

35 https://www.eib.org/attachments/thematic/future_of_european_space_sector_en.pdf

upcoming EU Space Agency, to buying performance (services, data, etc.) from commercial actors, utilizing competitive tendering processes, to stimulate companies to come up with and develop better solutions they can then offer commercially. In order to leverage the best skills and technology available in Europe and boost the industry across the whole region, we need to execute this tendering at the European level, not just within nation states. With the EU and maybe also ESA acting as anchor customers, the matured solutions can have a calculable return on investment (ROI) timeframe and thus become relevant also for commercial venture capital. This results in new jobs, innovation, and a healthy ecosystem that is less structurally dependent on the public procurement chain after the initial stimulation period. This proposal is consistent with the new EU space regulation, as well as ESPI recommendations.[36]

Leveraging the EU Space Program, starting with Copernicus: when looking at the European space portfolio, Galileo and EGNOS are clearly strategic public infrastructure and should be managed as such. Any SSA/SST solutions dealing with traffic management and safety should be considered the same (see our proposal above).

On the other hand, Copernicus, Europe's Earth observation program, consists of technologies (mainly, satellites) and solutions that can be developed individually, could certainly be improved upon if private sector innovation is more stimulated, and could be an effective vehicle for innovative tendering – as already suggested in the EU Space Program for 2021-2027. Today, the EU and ESA procure satellites from manufacturers (and thus jointly decide the operational needs and the technical characteristics) and then operate them through ESA and contractors. Such need to buy and own satellites is less relevant today as private companies become able to build the satellites themselves and offer services on the market. When such services are available, it is more flexible and cheaper for the EU to buy the services (imagery, etc.). Naturally, European companies would be preferred compared to non-EU competitors.

Another potentially effective vehicle for innovative tendering would be the GOVSATCOM program – instead of building a public infrastructure communications system, becoming an anchor customer could pull in European telecom excellence to consider development of commercial solutions that could serve customers globally.

Creating a Commercial Space unit within the EU Space Agency: what we are missing today is a focused effort and a concrete plan for stimulating commercial space activity through entire value streams, and a commercial space agency function

36 Evolution of the role of space agencies, ESPI, October 2019. https://espi.or.at/publications/espi-public-reports/category/2-public-espi-reports

to make it happen. This function could be a Commercial Space unit within the EU Space Agency. It could use for example 10% of the planned Copernicus and GOVSATCOM budgets for innovative tendering for purchasing performance for those systems, and act as the anchor customer for innovative companies, including start-ups.

This Commercial Space unit could also be responsible for other key aspects relating to commercial space. First, it could be in charge of promoting space towards "non-space", i.e. engaging with companies and institutions which are not aware of the benefits that space services and products can bring.

Second, on a more technical level, the unit could be in charge of the development and promotion of standards for the space system and for space-terrestrial system interfaces. This would concern not only manufacturing standards (e.g. for satellites) but also telecommunications-related standards.

It is worth noting that Europe has traditionally been a leader in interconnected communications systems thanks to our drive for standardization. GSM, 3G, LTE and now 5G standardization have traditionally been a strong field of influence for European companies and institutions and they have generated prosperity and global market leaders in Europe.

Now, non-European companies (including space companies) are actively developing proprietary solutions. The systems under development will not integrate seamlessly to terrestrial communications networks – they will likely compete with, not complement, existing services. From a European perspective, it would be logical to leverage our strong competence in telecommunications and standardization also in the new space communications market. More generally, it is critical to consider the numerous synergies between space-based telecommunications and other "big data" issues, including regarding 5G and quantum telecommunications.

This means both creating standards and requiring standards compliant solutions as the end customer, for example in the GOVSATCOM program. Standards compliance should also mean that satellite communications would complement, and not compete with terrestrial telecommunications systems, by extending the range and resilience of the existing networks. ESA is already working on such issues but only if the EU brings its political weight behind such initiatives can Europe hope to play a role on these key issues for connectivity.

In short, the proposed measure would not require additional budget (although dedicated staff would be required) but rather a rethinking the EU's role, moving from its position as an owner of assets relying on ESA for implementation, towards a new role as a political player, smart promoter and buyer of commercial services.

III.3. Decide in 2020 on a European strategy regarding broadband constellations

The Current Situation and Need

As mentioned in Section 1. constellations and in particular broadband constellations are set to become a deciding factor for the future development of space. This results from their sheer size (hundreds, and potentially thousands of satellites) and from their potential role as a key element in the global internet infrastructure. Irrespective of their eventual success or failure, constellations are now a reality and will raise new issues in terms of space safety and Space Traffic Management.

Today constellations target mainly niche sectors and areas such as the arctic region, the finance industry, the maritime and the aviation industries. That said, it is very possible that at least some of these constellations will eventually become direct competitors of more traditional telecommunications players in particular if they decide, and successfully manage, to target consumers directly. This could include households, starting with underserved consumers located in areas where broadband, or geostationary satellites, are not economically viable. If the technical characteristics and the economies of scale improve sufficiently, it cannot be excluded that constellations operators eventually provide internet access directly to the mass market. They may become key to the large-scale deployment of connected objects such as cars, aircrafts, drones.

Should this scenario unfold, the consequences would not be limited to the telecommunication and big data sectors. In the space sector, the deployment and operation of constellation would significantly reinforce the players involved, both in the field of launchers (increased launch demand, increased technological advances as a result etc.) and for satellite (manufacturing processes, satellite technology).

There are arguably many uncertainties regarding constellation projects, and it is not yet clear whether the proposed business plans may actually deliver the revenues and capabilities contemplated by developers and financial supporters.

In any case, the authors of this paper consider that the EU cannot remain passive in light of the potentially massive, far-reaching consequences of large constellations. Europe as a whole cannot simply wait to see whether these projects succeed, because it might be too late by then to avoid a US and Chinese monopoly on space-based internet capabilities. The precedent of what happened on the ground (digital services and infrastructure) should be clear enough in that respect.

The Proposed Measure and Financing

No conclusion on this key issue may be reached before key European public and private stakeholders have actively and thoroughly analyzed the current prospects and implications of constellations. One of the key questions that must be answered is the opportunity of having a European space-based broadband capacity. Another key question is whether the EU should have a dedicated policy regarding the authorisation and surveillance of constellations.

Regarding a potential European-controlled capability, it may be noted that it would allow Europe not to rely entirely on non-European capabilities, including for defence and security players (as noted above, the American DoD is a supporter and future client of US constellations). It would also give Europe some weight on future negotiations of international regulations and/or standards related to such constellations, for instance regarding Space Traffic Management (see above).

Being a commercial venture, such capability should in any case involve relevant business players (aerospace companies, satellite operators, telecommunication companies, but also potential customers such as the automotive industry). A PPP approach, although potentially complex, could be contemplated.

Such analysis of Europe's position on constellations should be conducted under the authority of the EU Commission but should also involve other key European public (including Member States) and private (including citizens and relevant NGOs) stakeholders. The timing is critical given the pace at which other constellations are being developed and deployed. It would be advisable to reach conclusions no later than the summer of 2020 in order to be in a position to take action in the course of this year.

III.4. Make Europe a leader in "smallsats" while developing capabilities for launching these satellites

The Current Situation and Need

"Smallsats" are a major development in the space industry, one that is only beginning. The consulting firm Euroconsult anticipates that 8,500 satellites will be launched in the next ten years, with 80% of these part of constellations (see above, section 1). This creates new problems (collision risks, debris management, etc.) but also opportunities. For example, orbital services are appearing (satellite surveillance, propulsion systems, de-orbiting systems, etc.) along with "micro-launchers" specifically designed for this type of satellites (there are dozens of projects of this type, with the most advanced coming from the US and especially China)[37].

For now, Europe has largely missed the shift to these smallsats and microlaunchers. Both its businesses and its public institutions lag far behind their American competitors in terms of the number of smallsats in orbit.[38] However, Europe has interesting capabilities as well as promising start-ups. Europe is trying to catch up and there are strong players: for instance, Airbus is participating in the Oneweb venture and has developed new capabilities to building smaller, cheaper, telecommunications satellites; several start-ups manufacture, sell and have launched smallsats (e.g. Danish GomSpace; Dutch ISIS); and other start-ups develop new technologies associated with smallsats (e.g. French Thrustme, for electrical propulsion).

In this respect, the possibility of validating technologies and prototypes in orbit is essential in order for Europe to establish itself in the international market, but this opportunity is sorely lacking today on the European stage. Such capability is crucial (including in terms of credibility) to then sell products to clients. For instance, if a company developing new electrical propulsion technology wants to test its product in orbit, it eventually needs to find a launch opportunity to evidence the capabilities it will be selling to its customers.

Today, the programs of the ESA and the Commission are too patchy and too poorly financed, especially when compared to the efforts of NASA or the Chinese authorities.

37 So far, only a handful of companies have succeeded in developing and operating a new rocket: The US company RocketLab with Electron, and very recently Chinese start-up iSpace with a successful orbital launch of its Hyperbola-1 launcher (https://techcrunch.com/2019/07/25/ispace-becomes-the-first-private-chinese-company-to-launch-satellites-to-orbit/).

38 US players (public and private) account for the large majority of launched smallsats. On the commercial side, Bryce found that in the last seven years, 663 commercial smallsats were launched, with the rate of deployment accelerating sharply in the last two years; Over half were manufactured by the US remote sensing start-up Planet; Over 80% were manufactured by US companies; Planet and Spire account for about two-thirds of smallsats.

ESA has also launched an initiative called "CubeSat Systems Unit" in April 2019: it aims at working with European companies to develop low-cost technology-testing.[39] This comes on top of ESA missions already funded under the In-Orbit Demonstration part of the General Support Technology Programme (GSTP).[40] The EU Commission has funded projects, for instance the QB50 project.[41] The EU Commission also has developed several initiatives, and in particular the H2020-based IOD/IOV program jointly with ESA. This has led to booking rideshares services from Arianespace's Vega launcher (the launch should occur in the course of 2020).

However, the industry needs more frequent, systematic and simple access to IOD/IOV opportunities, using European capabilities. The only alternative at the moment for industry players is to look for non-European partners and launchers.

Concerning small launchers, current launchers (Ariane, Vega) still offer too little capability (frequency, dedicated orbit, etc.) to have access to orbit, which pushes European operators to turn to other operators. Micro-launcher projects have been announced in Europe (Arianeworks in France, OHB in Germany, PLD Space in Spain, etc.), but, without support, these developments remain uncertain because the market is fragile. Finally, in terms of defence and security, the capability of rapidly deploying "replacement" constellations in case of accident or aggression is seen by space nations (especially the US) as essential for ensuring the credibility of space assets and thus of military systems. Europe is currently unable to do this.

The Proposed Measure and Financing

As part of its space budget, the Commission would finance regular, free (or subsidized) access to orbit for testing and approving technologies related to smallsats, thus offering real predictability for European businesses and public institutions.

The program would thus "kill two birds with one stone": by granting decisive aid to help European technologies emerge onto the global market, the Commission would also help to develop European capabilities for launching smallsats, thus stimulating innovation and jobs. Once a strong competitive European sector has emerged for smallsats launch capabilities, the measure could eventually be discontinued.

39 https://www.esa.int/Our_Activities/Space_Engineering_Technology/ESA_s_CubeSat_central_for_smaller_missions_into_space
40 http://www.esa.int/Our_Activities/Space_Engineering_Technology/Technology_CubeSats
41 https://cordis.europa.eu/project/rcn/102061/factsheet/en

As a basis for discussion, the mechanism would have the following characteristics:

- **Open to European companies, universities and NGOs**
The goal is to promote the European sector and rules must be designed so that only technologies and products developed on European soil are eligible;

- **One launch opportunity at least per quarte** (i.e. four opportunities a year).
This gives visibility to players on the availability and timeline. They would have confidence that a launch opportunity will be available when they are themselves ready to fly;

- The level of **financial support would be adjusted depending on the type of player.**
For instance, larger companies with sufficient funding could be given a discount. Typically, for start-ups the services could be free (including insurance costs);

- The service would **use European launchers only, as soon as they are available.**
Today, only Vega offers dedicated rideshare opportunities through its Small Spacecraft Mission Service (SSMS) service. However, it is unlikely that Vega can meet the demand, in terms of volume (which hopefully will grow in the coming years) and flexibility (launch date, orbital requirements, etc.). Further, having only one European solution is by nature risky should the launcher not be available for a period of time.

Thus, the goal would be to use non-European launchers but only as long as there is no European solution available, which should be the case around 2021. Afterwards, only European launchers would be eligible.

As more European smallsats launch capability becomes available in the 2020s, competition between launch operators would allow for better pricing and adaptability;

- **The EU Commission should use established European launch brokers to implement the service.**
Such brokers (such as the Dutch company ISIS) are used to proposing launch services and are better placed to implement the scheme. The EU Commission's role would be limited to designing the rules, monitoring the scheme and providing the financing.

The budget for such a measure can be estimated as 10 to 20 million euros per year in order to perform approximately two to four flights per year.[42] This figure remains very

42 The amount of the annual budget would depend mostly on the volume to be launched. To give an example, US launch company Rocketlab's Electron rocket currently costs around 6 million USD to launch and cheaper small launchers are expected on the market, including in Europe. Also, the dedicated broker could buy slots on different launchers as well as use rideshare and piggyback options, thus maximising the efficiency of the spending.

limited compared to other European Union space programs but would have significant visibility for the EU (especially at the time of the launch).

III.5. Give the EU a political role in international space affairs, with an immediate focus on the Moon

The Current Situation and Need

The further development of the future space economy is not limited to earth's orbit and activities focused on earth. Today, space nations and entrepreneurs are engaged in a new exploration phase and tomorrow, will make utilization of, or even occupy space resources available on celestial bodies. The Moon is the focus of many missions and plans for permanent settlements have been announced by the US (Artemis program; SpaceX' own plans). China, in contrast, wants to utilize the space-based economy for its national long-term wealth creation. This also applies to cislunar space (space between Earth orbit and the Moon).

While the media attention is mainly focused on US plans to go back to the Moon, China has drawn long-term plans and the rationale for a Moon settlement and cislunar economy, the next step after its planned space station in Earth orbit. For instance, the head of its lunar exploration program emphasized that *"the universe is an ocean, the Moon is the Diaoyu Islands, Mars is Huangyan Island* [contested islands in the China sea]. *If we don't go there now even though we're capable of doing so, then we will be blamed by our descendants. If others go there, then they will take over, and you won't be able to go even if you want to. This is reason enough."*[43]

The impact of such projects should not be underestimated. Nations and their respective entrepreneurs, which establish a presence in space and on the surface of celestial bodies will create, either in fact or in law, the applicable regulations and industry standards. They will be the ones creating new partnership schemes, financing models, interfaces and scalable industrial processes, allowing them to establish and sustain a dominant role in this future in-space economy. The risk is currently very high

43 These remarks were reportedly made by Ye Pejian answering a reporter at the Chinese Communist Party's annual plenary sessions in 2017. Source: https://www.thedailybeast.com/chinas-looming-land-grab-in-outer-space?ref=scroll

that the EU is absent from this new space-based economy, with potentially serious consequences on Earth itself. The "Moon Village" project put forth by the management of ESA, while ambitious in its goal to avoid rivalry and promote cooperation, remains so far unfunded and a long-term prospect.

From a political standpoint, the EU is the right level for taking a political stance regarding not only new issues such as Space Traffic Management, collision and debris risks, etc. (see Proposal 1 above), but also regarding celestial bodies, including the Moon. Under the 1975 Convention (Article II), ESA is limited to peaceful purposes and is focused on space research and technology and their space applications. Its missions and its governance structurally limit its ability to adopt strong "political" positions on these issues.

The EU has not yet entirely taken on the quite extensive authority given to it by Article 189 of the TFEU: *"1. In order to promote scientific and technical progress, industrial competitiveness, and the implementation of its policies, the Union develops a European space policy. To this end, it can promote common initiatives, support technological research and development, and coordinate the necessary efforts for the exploration and utilization of space. (…)."* This does not mean the EU replacing Member States (especially France, Germany, and Italy) on subjects viewed as related to sovereignty, but to acknowledge that the EU must take positions, in its own name, on new space issues.

The EU must therefore – alongside Member States – be present as a political entity on important issues and discussions relating to exploration/utilization of celestial bodies, starting with the Moon and cislunar space.

For the EU, the opportunity to have automated and human resources in the Earth-Moon system will soon become a question of sovereignty. Faced with the nationalist thinking of the US, China, and India, the EU cannot be absent from these developments. Ultimately, these issues are closely linked with the economic significance of space, both in earth's orbit (surveillance, connectivity, and Big Data) and beyond, as well as with the soft power (international prestige, power to inspire younger generations, etc.) that space exploration brings.

Proposed Measure

At this stage, in order to regain European visibility and thought leadership, initiatives could be proposed, particularly to strengthen the role of the EU in international space fora, both public and private, concerning the development of regulations, treaties, policies but also industry standards and new partnership models. In addition to staking out

these positions publicly, the EU should also consider the opportunity to actively support the development of industrial and commercial projects connected with the Moon.

Until today, the only large facility in space, with an estimated cost of $150 billion, construction time of 13 years and an annual operating cost around $2.9 billion, is the International Space Station (ISS). It has been financed, built and maintained through a public-private partnership scheme, in which scientific research, geopolitical soft-power demonstration and international collaboration has been the inherited logic. NASA just recently initiated the transition of this research lab towards a commercial and industrial facility.

The next step proposed by the US Government and NASA is the Lunar Gateway project, a space station positioned in Moon orbit, intended to serve as the successor to the ISS for lunar exploration and preparing the next steps toward Mars. However, the sustainability of such a program may be questioned, as it is greatly dependent on American political risks and is in increasing competition with new private actors such as SpaceX. Europe (including ESA) should be cautious not to commit too much of its limited resources to this project.

An alternative proposal could combine (i) concrete, experimental projects directed at the Moon surface (which can build upon what is currently proposed at ESA level[44], with additional support and an emphasis on speed) and (ii) a more long-term goal involving entrepreneurial ventures, supporting further exploration and presence (including through human presence).

From Europe to the Moon: three examples of concrete actions

First, in the near-term, the EU could back (along with interested Member States) a mission to have a European presence on the Moon as soon as possible. The strategic goal beside technological capability demonstration would be to show that Europe aims to be part of any initiative to develop new space legislation or rules regarding the Moon and beyond, with the aim of promoting European values in a potentially increasingly competitive lunar environment.

To do so, Europe could back a mission to place a lander on the lunar surface within, for instance, three years. This is an aggressive timeline given current European lunar capabilities, but there is no doubt that this is feasible. A science experiment could be part of this project, with the goal of exciting the imagination of Europeans (this was the

44 See in particular the recently announced ESA strategy for science at the Moon (https://sci.esa.int/documents/34161/35992/1567260389633-SA_Strategy_for_Science_at_the_Moon.pdf).

case with China's attempt at growing cotton on the Moon surface). This could involve, for instance, testing ESA's recently developed experiment to extract oxygen from simulated Moon dust.[45] Another, even more ambitious option, would be to develop a commercial end to end space resource utilization value chain approach and place on that lander a technology demonstration project.

Second, Europe should develop specific capabilities it could use as a leverage in its cooperation with other space Nations in the cislunar space. An example of this approach would be to develop European in-orbit services and shuttling capabilities in the cislunar space. Europe would purchase cargo transportation services from Earth orbit to the lunar environment. Another example could be the support of the creation of a cislunar data cloud network, which would leverage artificial intelligence and quantum encryption for safe communication and bandwidth provision. Additional capabilities to leverage the EU's position could include in-situ-resource utilization. A secondary goal would be proposing such services to other Nations and/or companies.

European industry and entrepreneurs should be supported in the development of such technologically highly advanced capabilities, competitive services and products. This could be done by the active involvement of several European agencies, acting (initially) as the anchor customer. A coherent approach focused on innovation and competition would enable new markets to form and grow and these players to create new private-public partnerships, which can be inspired from NASA's initiatives for ISS cargo and crew (COTS and Commercial Crew programs).

Third, Europe should leverage non-space industrial capabilities for the Moon exploration effort, create links between industries and foster cross-sector innovation. Companies like Air Liquide, Audi, Vodafone, Toyota, Bridgestone, Caterpillar, Foster + Partners are already working on concepts for lunar and terrestrial applications. Caterpillar for example is collaborating with NASA to help advance the construction technology needed to create 3D printed habitat structures for the Moon and Toyota together with JAXA are working on a hydrogen-powered rover to help explore the surface of the Moon.

Permanent presence on the Moon by 2040 will require critical infrastructure elements in areas related to energy, mobility, transportation, production, communication, food, health, water and habitation. European companies should be encouraged and enabled to develop together with space industry partners solutions which would advance capabilities for Lunar exploration and Earth application.

45 https://www.esa.int/Enabling_Support/Space_Engineering_Technology/ESA_opens_oxygen_plant_making_air_out_of_moondust

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THERE IS NO DESIRE MORE NATURAL THAN THE DESIRE FOR KNOWLEDGE

Space: Will Europe Awaken?

To be heard on the international stage, Europe needs to have a leading role in space. Space has become a geostrategic issue and an expression of both hard and soft power, politically and economically. As dependence on satellites increases (Satellite navigation, imaging, telecommunications, etc.), the need to protect these infrastructures becomes more critical. On an economic level, Earth orbit is the new frontier of Big Data. It is only logical that digital behemoths, both American and Chinese, are investing billions of dollars in new projects such as building constellations of thousands of satellites to provide new connectivity services worldwide.

In this "New Space" context, Europe has managed to build strong positions in several key aspects of space, from science and exploration to business applications. Overall, private companies play an increasingly important role in space. Lacking its own GAFA ecosystem, the European space program must compensate and this requires becoming much more open to "non-space" for new projects and new sources of financing. The European space industry must be firmly defended and supported, but must also bear more responsibility and risks. Europe has the responsibility of bringing its values of peace and cooperation for the determination of future regulations.

In short, the EU now has the responsibility to reach for the stars. To move toward these goals, concrete measures should be taken covering the various aspects of space affairs: strategic independence, technological and industrial leadership, geopolitical positioning. While many proposals can be contemplated, this policy paper is limited to five measures that could be initiated as soon as 2020, with reasonable budgets and a strong European ambition.

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