



Executive Summary

Evolution of the Role of Space Agencies

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SPACE AGENCIES RESPONDING TO A NEW SITUATION

In the first sixty years of the space age, space agencies have undoubtedly been instrumental in shaping and driving the evolution of the sector, fostering and sustaining the development of private industry from its inception. Acting according to their mandate, these institutional bodies have ultimately achieved outstanding success in unlocking the potential of outer space for the economy and society as can be seen today, through initiatives, collaborations and ever more ambitious programmes across the whole spectrum of what today constitutes modern space activities. Furthermore, in Europe, this has been achieved under very effective economic conditions, as Europe has spent overall a fraction of the space budgets of other major space powers.

Indeed, through a long, cumulative process that took place over the past decades, what began during the cold war as daring space research and technology development programmes – the burden of which was fully borne by the public side – have ultimately spawned entirely new markets and privately-led entities, both in the upstream and in the downstream. From telecommunications and Earth observation, to space transportation and navigation, the value of the global space economy – and the share of private participation in it – is ever increasing. The space sector has moved away from the initial “experimental” framework, to a full operational setup (“commodity”).

In light of this, it can even be argued that in advanced spacefaring nations, one of the “historic” missions that has guided agencies from the outset – that is, fostering the creation and development of a sound space industry – has successfully reached its initial objective.

A new trend for public space agencies’ approaches, which will end up characterising the current space age, was initiated in the late 2000s. One of the origins of this new trend can be traced back to a unique conjunction of factors initially occurring in the U.S., the first of which is the retirement of the Space Shuttle programme and the pressing need to recover independent U.S. manned access to space, and to the ISS in particular. Notably, this urgent technical and political necessity came at a time when the global financial crisis of 2007-2008 hit the world’s economies, leading soon to substantial budgetary constraints for public bodies, including space agencies, and tightened conditions for the timely achievement of the aforementioned objective in the traditional, cost-plus fashion.

The new approach endeavoured first by NASA was thus one of increased reliance on the private/commercial sector to fulfil some of the agency’s purposes and goals, substantially changing the main way in which the world’s most prominent space agency conducts its space transportation and human spaceflight procurement programme vis-à-vis industry. At the basis of the new approach lie shared costs and risks between the public agency and industry, as well as a transfer of control of key programme characteristics from the former to the latter. From a purely contractual and procedural point of view, the main feature of this new approach lies in the implementation of various public-private partnerships schemes and models, in the perspective of long-term public commitment to the procurement of services offered by private operators (i.e. a growing “anchor customer” role for public bodies).

Even more fundamental, it can be argued that if such a change in approach was possible (and successful), it is ultimately due to the comprehensive maturity reached by the space industry. This factor eventually enabled companies to have a greater degree of autonomy in developing and conducting space activities, becoming a more independent – and capable – partner to the public side. Naturally, it must always be recognised that such maturity builds upon the cumulative past interaction between private and public

actors (namely, public investments), and, in many instances, also on technological developments originally mostly handled by the public sector.¹

This recent trend, i.e. of an increased commercialisation of space activities, progressive shift of risk and responsibility to industry, and procurement of off-the-shelf services,² has also spread to Europe. Recognising the potential and opportunities of this approach, European space agencies, ESA as well as national ones, have explored in recent years new ways of partnering with industry, albeit naturally in a different manner than the U.S. model. In particular, the European satcom sector has witnessed the highest number of successful PPPs-like arrangements so far (e.g. the pioneering PFI model of the Skynet 5 programme devised in the UK in the 1990s, and the multiple ESA PPP satcom initiatives in the 2000s previously described). More recently, also in space transportation and space exploration, the blueprints of this approach have been or are in the process of being implemented in a number of European programmes. For example, the Ariane 6 programme is a major attempt to achieve an adequate compromise in the relationship between ESA and the European space transportation industry: a higher degree of design autonomy and responsibility for development and industrial setup was given to the private sector, while the programme remains fully backed by public funding.



This on-going commercial dynamic and trend undoubtedly exhibits a number of benefits to be reaped by the public as well as by the private side, as demonstrated by the recent successful examples in the U.S. and, to some extent, in Europe. Yet, as outlined by the CNES President Jean-Yves Le Gall, the so-called New Space dynamic should not be considered as a revolution in the space sector *per se*, but rather as a sectorial evolution responding to a change in the broader industrial and economic paradigm well beyond the space sector, often dubbed as the fourth industrial revolution.³

¹ An example is represented by the fact that some technology initially developed by NASA for the Apollo programme and for VTVL vehicles prototypes in the 1980s, is employed in today's privately-developed American space launchers.

² In other words, shifting from the status of "almighty customer" to "simple consumer".

³ Le Gall, J-Y. "Les Enjeux Stratégiques Spatiaux du XXI^e Siecle". Réalités Industrielles, pp 17-20. May 2019.

In light of this background, this ESPI report investigates the evolution of the customer-provider relationship between space agencies and the private sector, focusing on the European setting, in particular by:

- Analysing the historical mandate, role and models of selected space agencies, identifying core tasks and responsibilities, and describing typical mechanisms of interaction with the private sector;
- Outlining the characteristics of the “New Space” dynamic and Space 4.0 concept for the evolving “spacescape” of the 2010s;
- Highlighting emerging models and approaches between space agencies and private entities; identifying the merits and limits of such models of interaction and their applicability in the spectrum of space activities;
- Elaborating on how space agencies in the European context could benefit from the sectoral evolution by revisiting and possibly expanding their traditional roles.

MERITS, LIMITS AND BENEFITS OF PROCUREMENT MODELS

Traditional public procurement has been a staple of the space sector since its inception, enabling countries to kick-start, develop and sustain their own space industry in such a successful way that ultimately led to the achievements of the space era. In light of the analysis conducted in this study as well as interviews with experts from public agencies and private companies, the report identifies and discusses some key merits of traditional procurement, while also pointing out a number of inherent constraints.

Traditional Procurement	
Merits	<ul style="list-style-type: none"> • Capabilities development: effective, and even fundamental, for high-risk technological development • Appropriate for the initial (or sustained) development of systems and infrastructures for public good and societal benefit • Straightforward to decide and implement, with a cohesive and unified overview from overall strategy to design • Enabling step for long-term market creation
Limits	<ul style="list-style-type: none"> • Risks and costs incurred entirely supported by the public side • Not market-focused in the short- and medium-term • Relationship between agency and industry can be inelastic • Might entail inefficiencies inherent to the necessary public scrutiny and oversight of public investments

Public-private partnership models – PPPs, in their various forms – have recently been preferred to traditional procurement in several space programmes over the last decade, including in Europe. They obviously offer distinct advantages, in particular in terms of the commitment of the private sector. However, they also come along with a number of limits, and a number of conditions affecting both partners have to be met for these schemes to be successful and achieve a balanced win-win outcome between both partners.

PPPs	Private Partner	Public Partner
<p>Merits</p>	<ul style="list-style-type: none"> • More autonomy and freedom of action for technical management • Return on investment and market potential • Gain intellectual property associated with innovation and R&D • Gain competitive advantage 	<ul style="list-style-type: none"> • Timeliness, efficiency and flexibility of programme development • Transfer of risk to the private sector • Spin-in from non-space domains technologies • Reduced upfront costs • Allow a reallocation of public agencies' focus and resources
<p>Limits</p>	<ul style="list-style-type: none"> • Require a well-developed industrial base, able to sustain risk and to commit to the long term • Possibly complex to establish: require careful alignment of goals, agreement on timelines and governance, clarification on ownership, access, decision and control 	<ul style="list-style-type: none"> • Increased risk to be sustained • Not easy to balance risk and reward

With regard to the PPPs schemes, two major considerations emerge from the analysis:

- First, it is important to highlight that **PPP models are not intended to nor will replace traditional procurement** in a number of areas and domains, for example in early-stage R&D, technology maturation and space science – notably, where there is hardly a possibility for commercial market development, in general or in the short/medium-term.
- Second, a number of **clear conditions have to be set, and pre-requisites have to be met** for PPP models to have a successful outcome. This includes considerations regarding public interest, delimitation of responsibilities, private capability to assess and sustain risk, as well as external factors such as market maturity and uptake, etc.

This being said, the above-mentioned approach – which entails a transfer of risk from the public to the private side in exchange for a greater degree of decisional and design autonomy, long-term commitments and investments, as well as avenues for profits on the commercial market, among other key elements – can lead to a number of upturns for the public side:

- First and foremost, when properly implemented, **increased timeliness and cost-efficiency of space developments management** as compared to traditional procurement, taking advantage of available industrial skills. In these instances, private companies must obviously follow a different logic (market- and competition-driven, and pressured to generate revenue) than in the traditional cost-plus approach. Naturally, cost-plus approaches still retain their value when addressing high-risk technological development.

- Second, the public-private synergy will **continue to efficiently foster and nurture the development of industrial capabilities** as well as industry's **outward competitiveness** and overall sectorial innovation – with the added benefit of technological spin-in from non-space domains.
- Moreover, by placing a lesser burden on the institutional side, focusing on formulation of user needs rather than technical requirements, and reducing micro-management of procurement, space agencies could put **increased emphasis and resources in undertaking what no other entity is clearly able to do**: dealing with and sustaining the high costs and risks of **early-stage technology development and trailblazing space programmes**.⁴

As for the private sector, the benefits of a well-structured and arranged public-private partnership scheme are manifold. In particular, these include long-term stability and predictability of business, either as a direct result of the PPP itself, or ideally through access to new revenue streams and markets; increased competitive advantage including acquisition of new intellectual property rights (IPRs) for technologies and capabilities; and ultimately increased technical and business innovation.

It is safe to say that this trend is poised to continue in the future. As its underlying enabling factor is the maturation of the space industry in more and more space domains, and overall forecasts indicate that the space sector will continue growing in the future (in the number of public and private actors, programmes, size of budgets, overall economic value, etc.),⁵ likewise the level of capabilities – and, conceivably, appetite for and fitness to sustain risk – of the global space industry will grow accordingly, particularly in the most advanced spacefaring nations.

Moreover, new opportunities and perspectives will foreseeably open up over the next decade. There are several new domains of space activities that could potentially serve as proving grounds for an enhanced and evolved approach of space agencies and governments in procuring programmes. The new areas can be either entirely new and global, such as the emerging in-orbit servicing domain (a broad term that includes satellite life extension and refuelling, tugging, maintenance, inspection, debris removal, even manufacturing),⁶ but also regional initiatives within the boundaries of consolidated space domains, such as the upcoming European GovSatCom and Space Situational Awareness (SSA) programmes, and most likely the development of Space Traffic Management (STM) capabilities and associated regulation in the near future.

In these areas, new procurement approaches and partnerships from the public actor, building on the successful examples of the past (e.g. satcom, remote sensing) and lessons learned, could result in delivering effective space programmes and services. Looking ahead, as the commercialisation of space will undoubtedly progress in the next few years, more space domains might become a commodity for the delivery of everyday services to citizens. In the longer run, it is not far-fetched to envision space agencies procuring from industry systems and services in the most advanced space domains in a turn-key fashion.

⁴ Such activity remains, also according to the opinion expressed by some of the stakeholders interviewed for this report, at the core of a space agency's role. This is in line with the view that the governments' role is to be primarily active in those areas of public social, scientific, strategic and economic interest where the private sector is either not willing, able, or even advisable to operate by itself.

⁵ While the fundamentals of the global space sector are certainly solid and there is a huge potential for growth both in developing and established spacefaring nations, such growth would take place provided that limited space resources already strained today (orbits, frequencies, etc.) as well as the overall space environment will be managed in a sustainable way.

⁶ A word of caution is due regarding the business case for provision of in-orbit services. As of the time of writing, such business case isn't entirely clear nor proven yet.

THE CHALLENGE OF BALANCING RISK-SHARING, CONTROL AND REWARD

In the traditional procurement model, the public partner within a contractual agreement bears most of the technological risks associated to the development phase. The private partner in this sense incurs very little of these risks. For the development of major public infrastructure this model is most often used and appropriate for several reasons:

- First, because it is well adapted to the management of high-risk developments in cases in which the technology has not reached a sufficient level of readiness, and in particular for large scale projects. There, the public actor is more likely than the private actor to bear potential delays and cost overruns, sometimes deliberately overlooked to achieve political or strategic imperatives.
- Second, because the amount of risk incurred is not always proportionate to the potential profits and thus is obviously not appealing to private actors if they fail to identify sound market or business perspectives.

While this has been the case for technological systems during their initial development stages, early in the emergence of these technologies, the techniques and processes for many systems, e.g. telecommunications and space transportation, have matured over the decades. This maturation has gradually provided industry with the capacity to technically manage in full autonomy the development of complex space systems, which was the privilege of governmental actors in the early days. As a consequence, PPPs have become increasingly relevant, particularly for large-scale infrastructures offering both public interest and commercial viability. In such situations, the private partner can reasonably trade between a higher degree of technological risk during the development phases and stable long-term business perspectives for the delivery of commercial services. This makes the downstream sector a key enabler in such arrangements, shifting the stakes away from design and manufacturing, which used to be the primary focus of agencies and public actors at large.

In the broader economic sense, it should be seen as a positive sign of maturity of the space sector as a whole that private actors are now gaining autonomy, as in other long-established industrial domains. It is actually in the very nature of the private sector to take development and exploitation risks to make profits. One of the outcomes of the recent development of the space economy is to make this rule applicable across the board of the space domain as has long been the case in more traditional areas of the economy. However, the space sector keeps a number of specificities, which still prevent it from a fully standardized market economy.

One of them is the continued strong degree of involvement of major governmental actors worldwide in the sector. As a consequence, it is thus highly regulated and economic considerations have not been a historical driver for the development of regulations, mostly driven by strategic considerations.

A second one is the difficulty of making a clear assessment of the risks, for multiple reasons:

- The highly critical phase of the launch;
- The specific relation to reliability given the impossibility (so far) to perform maintenance and repair operations in orbit;
- The duration of the return on investment cycles, sometimes over 10 years, in high-tech related areas likely to evolve at a fast pace;
- The absence of progressivity in the investment, which requires full deployment before getting a chance to make the reality check of the business case;
- The strategic will of many countries to obtain autonomous capacities of access and operations in space, which prevents a pure "demand and supply" model, inevitably resulting in endemic global over-capacity.

Such a high level of risk or uncertainty should be balanced by very high profit perspectives, which have happened in just a few cases in the short history of space business. However, the trend seems to be today towards a bolder approach to space and a strong belief in promising long-term growth.

However, one condition that will remain applicable is the fact that private actors can only take assessable risks. This issue of “assessing the risk” is particularly critical in the setting up of PPP schemes. In light of this, proper framework conditions should be set up, to give industry the means to assess such risks before they are requested to commit. Clear assessments of this matter before the establishment of a PPP are indispensable to avoid arbitration between the two partners at later stages, possibly leading to increased – and unforeseen – public funding expenditure in order to still complete the programme.

As previously said, from the industrial perspective, higher risks can be sustained provided they are properly rewarded. This should primarily lead to higher payment from the public partner, especially as compared to traditional procurement schemes, although spread over the full duration of the programme. However, if public partners are generally open to transferring more risks to industry, the fact that to achieve so entails increased overall costs is generally not so broadly accepted. Alternatively, the increased risks could be offset by the prospects of profits to be made on the commercial markets (either still partially sustained by public demand or on a purely competitive basis). A third, potentially non-negligible, incentive and reward could lie with the IPR management, provided that companies can reap the benefits of subsequent commercial exploitation of patents and inventions developed during the PPP.

Arguably, one of the main issues related to the transfer of risk from public to private partners in space PPPs is the transfer of decisional control that it implies. Transferring risk and control coincide for a number of interlinked reasons. Primarily, a partner expects a greater deal of control once it takes upon itself more responsibility and risk – it is somewhat obvious that should a partner have more of a burden in both risk and responsibility, then they ought to be able to have a larger extent of autonomy in how they uphold their end of the partnership. Whether a company is willing to take on such risk or not will depend on its perception of the sustainability and potential rewards associated with the venture. It is reasonable to grant a mature industry the core endogenous roles over which they can have direct control (i.e. development processes, operations), however factors that are beyond their reach (i.e. broader financial and regulatory fluctuations) should be supported and facilitated by the public side.

Lastly, another concern with such transfers concerns the traditional mission objective of space agencies as developers, equipped with a decades-long strong and unique workforce and culture of engineering expertise. Space agencies are accustomed to retaining the know-how and knowledge to conduct space projects, outlining exactly the “what”, and almost entirely the “how” of each programme conducted in traditional procurement of the past decades. From this perspective, giving up – partially or totally – control of the “how”, as PPP arrangements suggest, is a major step for the agencies’ long-established way of managing activities. Provided it is desirable, it would thus represent a cultural shift of paradigm, highly challenging and most likely irreversible.

RETHINKING CUSTOMER-PROVIDER RELATIONSHIP BETWEEN AGENCIES AND INDUSTRY

The on-going dynamic provides many opportunities for institutional bodies such as space agencies, which will require a great deal of behavioural changes to update their institutional toolbox, particularly regarding procurement.⁷ Such a step is probably welcome and necessary, since a conceivable risk for established agencies is that not partaking in, or disregarding, this sectorial evolution might result in a reduction of their relevance and role.

This would particularly imply revisiting and rethinking the long-standing customer-provider relationship between agencies and the private sector, as stressed by a number of Heads of Agencies. In a recent interview, the CNES President Jean-Yves Le Gall remarked that *“La quatrième révolution industrielle [...] a touché le secteur spatial comme l’ont été tous les autres secteurs technologiques. Face à ce défi, le spatial doit, en France, repenser son partenariat public-privé.”*⁸ The ESA Director General, Jan Woerner, observed that *“These [Space 4.0 / New Space] challenges require a new understanding of the role of ESA and the way we carry out and support space activities. Concerning the instruments used to conduct space activities, new methods – including public private partnerships – are to some extent being used already. In addition, turnkey project and multi-partner open concepts may be considered. This diversity of instruments brings with it a diversity of roles which may include traditional agency, partner, broker, enabler or facilitator.”*⁹

It is thus clear that the role of space agencies in the new “spacescape” will continue to remain essential, particularly since, as further noted by the CNES President, public investment will remain largely dominant in the space sector in the coming years.¹⁰ Furthermore, the core tasks and missions of space agencies extend across and beyond the increasingly commercial dynamic,¹¹ so they will not be diminished or outpaced by this trend, but instead augmented by it, opening up new possibilities of partnerships and innovative relationships even beyond PPP models. Finally, as further demonstrated by the recent creation of new agencies in several countries, the space agency as an institutional body will retain a central, conceivably strengthened role in managing the public-private spacescape of the coming decades – also in supporting development of regulations.¹² Notably, the announced European Union Agency for the Space Programme will not make an exception, as it will be born well within the new trend, and will be mandated to manage deployment and exploitation of space infrastructures – a less challenging and more favourable task than that occupied by long-established agencies.

⁷ It must be stressed once again that space agencies have naturally evolved over the course of the past decades, alongside the evolution of the space sector. The new dynamics of the 2010s represents another turning point – and opportunity – for institutional bodies to reassess and enhance their roles.

⁸ Le Gall, J-Y. “Les Enjeux Stratégiques Spatiaux du XXI^e Siècle”. *Annales des Mines - Réalités Industrielles*, pg. 20. May 2019.

⁹ Woerner, J. “Looking Ahead”. ESA Website. Web: <http://blogs.esa.int/janwoerner/2018/07/27/looking-ahead/>.

¹⁰ Le Gall, J-Y. “Les Enjeux Stratégiques Spatiaux du XXI^e Siècle”. *Annales des Mines - Réalités Industrielles*, pg. 20. May 2019.

¹¹ Another example is the responsibility of countries regarding space activities with respect to international treaties. For example, with regard to the Outer Space Treaty and the Liability Convention, as described by ESA: *“[...] for each and every object sent into space, there should be at least one State identified which bears international responsibility and liability, regardless of whether the State itself (i.e. the government) is at the origin of the launch or a natural person (citizens of that State for example) or juridical person (economic operators for example) under its jurisdiction.”*

¹² Notably, the new space agencies that are being founded worldwide and within Europe mostly have set as their primary objective to better link and serve their national strategies and interests vis-à-vis the expanding commercial sector. This is achieved mostly by providing support to the local companies in terms of access to finance, national and international tenders and the definition of clear space regulations, thus acting more as business-enabling platforms rather than direct public procurement or research-oriented bodies.

As outlined in the report, the core tasks of space agencies comprise three top-level areas: proposal of a space policy, its implementation, and national and international representation.¹³ As the focus of this study is the private-public relationship, its recommendations are particularly related to the space policy implementation core-area. One of the key research questions then pertains as to how space agencies can adjust and enhance their modus operandi to fully and comprehensively benefit from the overall sectorial evolution, and continue fulfilling their missions and goals in an optimal fashion. A second question is then how to help ensuring that even a mature industry is motivated and willing to negotiate the increased risk entailed in space PPPs-like arrangements, furthermore helping to build up or consolidate the confidence of private investors.

Following the analysis conducted in this report and interviews with European stakeholders, some considerations for enhancing the role of space agencies with regard their customer-provider relationship with industry are as follows:

1. **Formalise space agencies' mission to assess public users' needs, but also aggregating them to facilitate market uptake.** As the space sector has become largely a transverse infrastructure, whose services are now deeply embedded in various economic domains which are in turn becoming increasingly dependent on it, the expanded mission for agencies will be to aggregate user needs including from a broader number of actors from the public and private non-space domains, such as transportation, agriculture, environment, security and so on.
2. **Shift toward a role of "procurement of services" in those domains where feasible,** building on the lessons learned from successful PPPs, and – where suitable – initiate, regulate, evaluate and supervise PPP-like arrangements relying extensively on industrial competition for the delivery of proposals. This expanded role would entail agencies acquiring additional competencies, know-how and business-type expertise, in particular with regard to understanding market assessment and cost projections, business risks, and so on – so to act as efficient evaluators and supervisors of future potential partnerships.
3. **Ensure proper technical oversight** over development, deployment and exploitation of space programmes under PPP models. Strong in their own internal and long-standing technical expertise, agencies would act as a counter-balance (also "counter-expertise") to assess and oversee the proper course of technical development according to the initial objectives and conditions set. This indispensable oversight should obviously not lead agencies to interfere with development decisions that are the responsibility of the private partner. For this, further strengthening of their own technical know-how is fundamental to ensuring the fulfilment of agency missions.
4. **Foster the appropriate industrial and procurement policy** to continue to maintain a healthy degree of domestic industrial competition and thus ensure outward competitiveness of the whole industrial component.
5. One major reward and incentive for the private side to undertake PPPs is the profits to be reaped on the commercial market following such partnership. Notably, in the space sector the market is often sustained by a sizable public demand. To close the circle, **public entities at large (not just space agencies) should – wherever and if feasible and appropriate – take the role of anchor customers for systems and services,** in those domains that include a public good component, ultimately to reap the benefits of available capacities that meet their needs, and to ensure the long-term economic sustainability of the ventures on top of the commercial market.

¹³ With caveats for ESA which for example does not have responsibilities in proposing a space policy, nor supporting national security programmes.

6. Moreover, in the European context, agreement between all major institutional entities on a broad and clearly stated **preference for European industry** for institutional programmes, for the procurement of space-based systems or services, could be beneficial and instrumental to further support the strengthening of the whole sector vis-à-vis increasingly competitive international markets. Indeed, the emergence of a strong(er) public demand in the European spacescape is a condition for building up domestic demand, which in turn is a necessary condition for the stability and predictability of the whole sector. In principle, ESA has already been applying such a clause, as stated in its Convention,¹⁴ but in many instances some national space agencies, or the European Commission, have not comprehensively adopted this approach. The preference clause – which has been under discussion among European stakeholders for at least two decades – has both merits and limits,¹⁵ and obviously requires that European stakeholders converge on the principle of its relevance, and also set up the appropriate legal instruments to implement it. This is a major challenge in the EU framework, which doesn't favour such a principle in its overall regulatory and legal corpus, and which might not be able to agree on specific regulations applicable only to the space sector.
7. A key appealing factor for industry is IP ownership. Whereas in most traditional public procurement IPRs typically remain with the public partner, PPP models usually envisage that **the ownership of the developed system and its related technologies are shared with the private partner, or assigned to them in an exclusive way**. This can act as an additional and potentially strong incentive for companies as they will be able to further leverage and develop these technologies on their own also beyond the completion of the partnership. However, in the European context, there is a stark difference in management of IPRs between ESA programmes (retained by the private partner) and the European Commission (partially retained by the public partner), and therefore **reaching a Europe-wide consensus on such a crucial aspect remains challenging**. This will need to be fully addressed in the setting up of the implementing rules of the European Defence Fund, which might involve space-related activities.
8. **Clear regulatory frameworks and improved access to finance and capitals** – an area in which not just space agencies but broader government and financial institutions have a role to play – will be instrumental in setting a level and stimulating playing field for private companies. Moreover, this would increase investor confidence in space ventures.

CONCLUSION

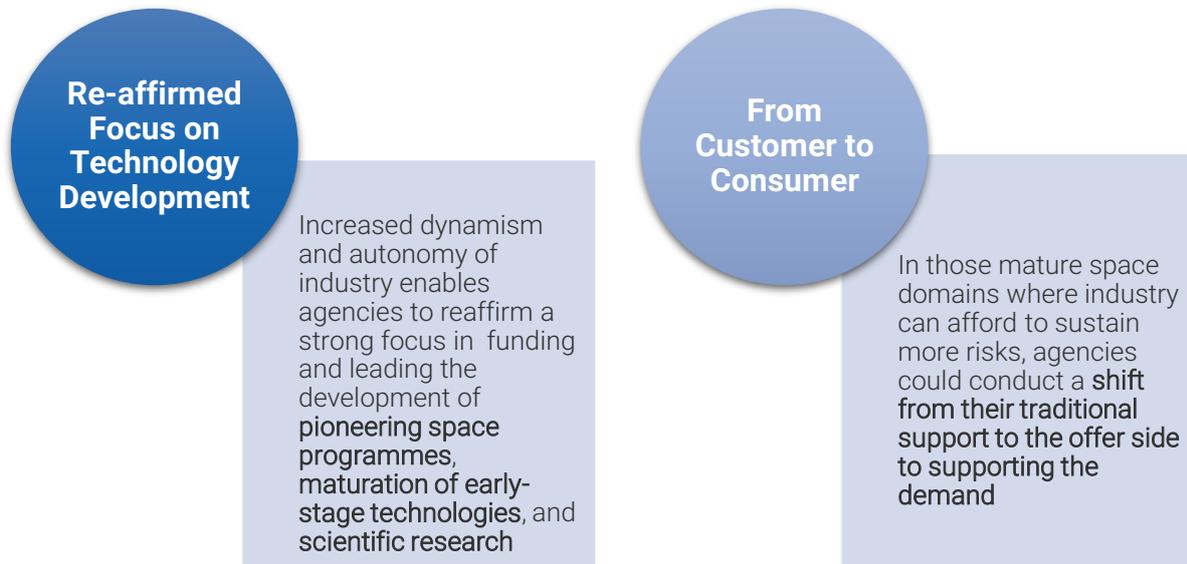
In conclusion, the consequences of fully embracing the trend of commercialisation of space in the European spacescape would ultimately be to expand the role of agencies at the two opposite sides of the spectrum of their mission.

From one side, increased dynamism and autonomy of industry would enable agencies to enter into more PPP-like models where applicable, so to reallocate precious resources to reaffirm a strong focus on their unique and irreplaceable role – that is, in funding and leading the development of cutting-edge programmes, maturation of early-stage technologies, scientific research (including human and robotic space exploration), and similar non-commodity parts of the space sector.

¹⁴ See Art. II, Annex V of the ESA Convention. Notably, this provision is not legally binding for ESA, and furthermore the Convention enables the ESA Council to decide whether and to what extent ESA can deviate from this preference. See: von der Dunk, F. "European space law" in von der Dunk, F. (Ed) "Handbook of Space Law", pg. 221. Edward Elgar Publishing, 2015.

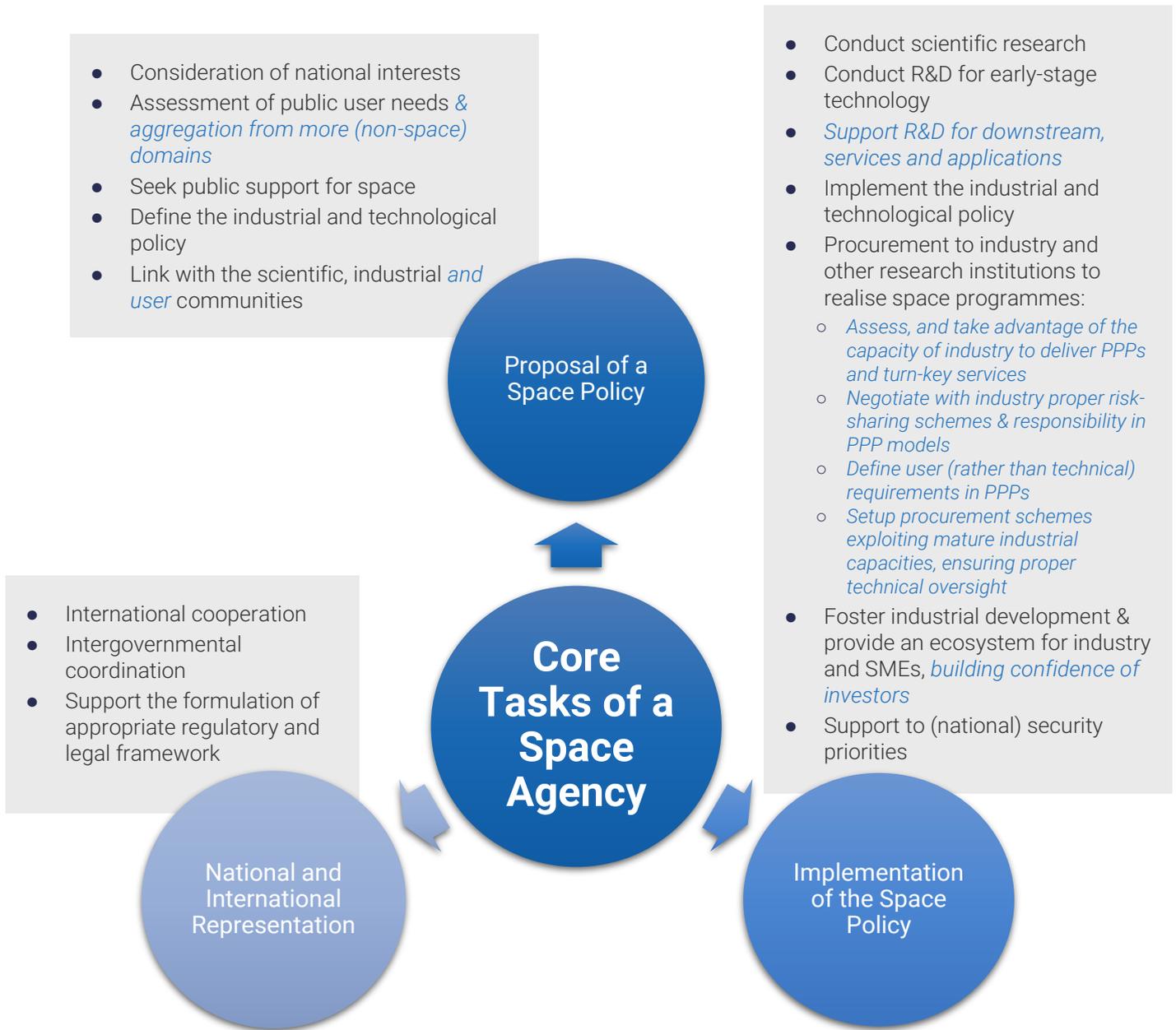
¹⁵ In the launch service market, see for example: Aliberti, M. and Tugnoli, M. "The European Launchers Between Commerce and Geopolitics", pg. 79. ESPI Report 56, ESPI, Vienna, 2016. Web: <https://espi.or.at/publications/espi-public-reports/send/2-public-espi-reports/10-the-european-launchers-between-commerce-and-geopolitics>.

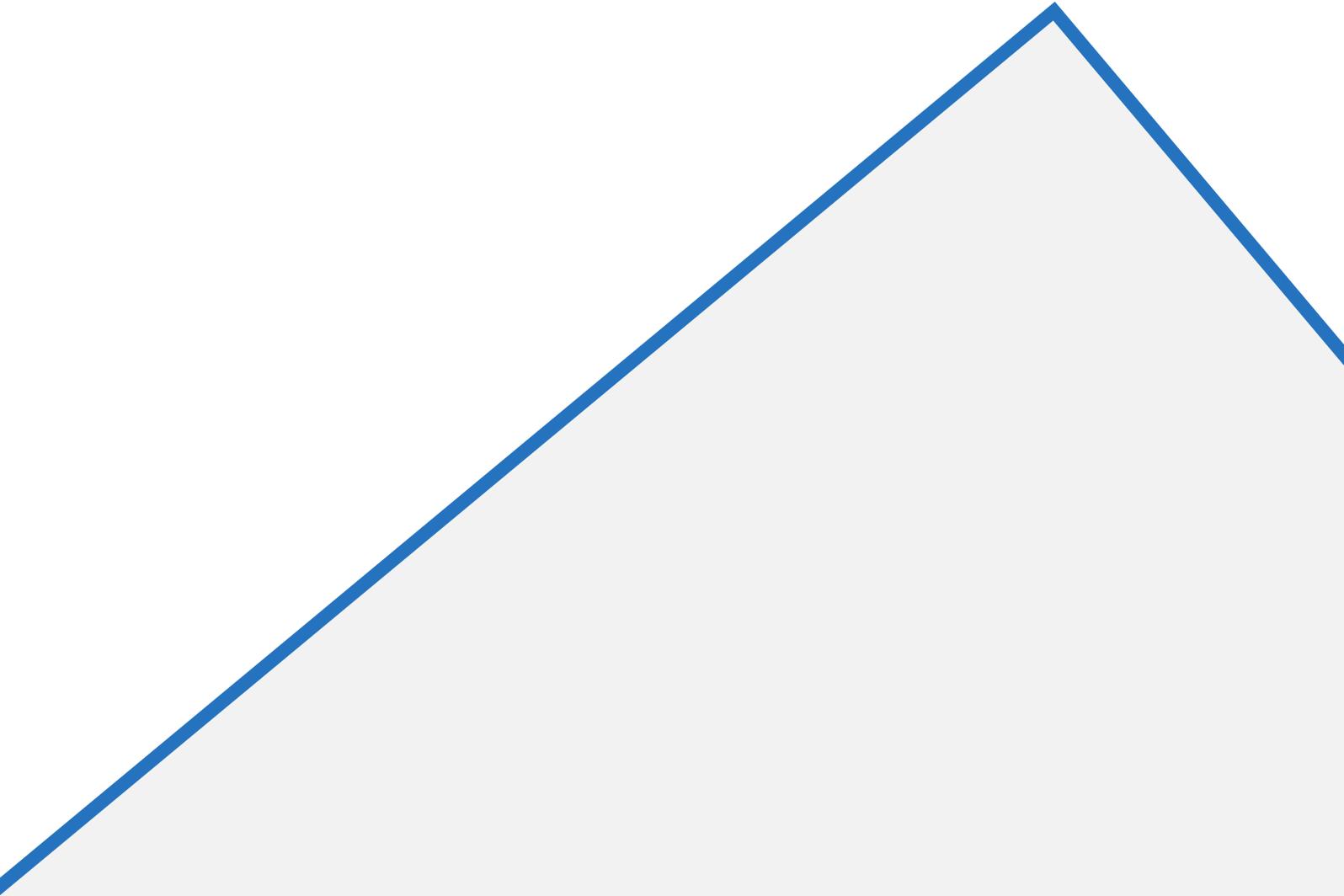
On the other side, in those mature space domains where industry can afford to sustain more risks, agencies could shift from their traditional support to the offer side to supporting the demand side. In other words, agencies would shift from a *customer* to a *consumer* status. In a sense, the various policy measures put in place in the U.S. over the past decade all point towards repositioning the public sector towards actively supporting the demand for space systems and applications.



From a practical standpoint, such a shift in the role of agencies would particularly entail organising, pooling, and aggregating the demand (and thus user needs) of an increasing number of entities, particularly non-space public actors and institutions. By increasing the integration of the national (or regional) space ecosystem, from start-ups to SMEs to large companies, and extending beyond the traditional, top-down boundaries of the space domain, agencies would then effectively act as the authoritative focal point for space in a transversal fashion across all sectors of economic activities.

Recalling the core tasks and responsibilities of space agencies as identified in the research, the figure below summarises the findings of this study with regard to the evolution of the roles of space agencies in the customer-provider relationship, highlighting historic (in black) and potential new tasks and areas of responsibilities (in blue).





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