



European Space Policy Institute

Commercial Space Exploration

Potential contributions of private actors to
space exploration programmes

Executive Summary

Prepared by the
European Space Policy Institute

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Toward a Paradigm Shift?

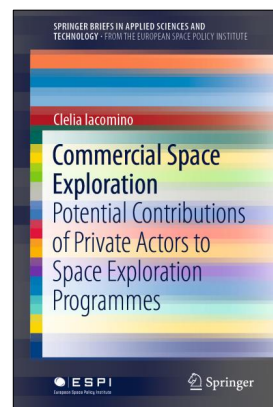
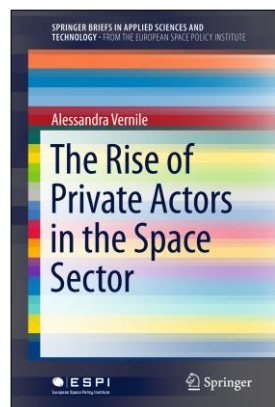
Despite multiple attempts to foster a cross-fertilisation with commercial activities,¹ outer space exploration and Human spaceflight, two domains intrinsically related, remain essentially funded and led by governments through national and international programmes. The substantial cost of space exploration missions and lack of business case (so far) limited the emergence of commercial leadership in this field. As a consequence, and despite a strong political will, the involvement of commercial actors in space exploration programmes remained limited, in general, to the role of contractors.

This situation evolved to some extent with the retirement of the Space Shuttle and the introduction of the Commercial Orbital Transportation Services (COTS) programme. Driven by the objective to improve cost-effectiveness and share development and operations risks with private partners, NASA implemented an innovative procurement scheme based on competitive, performance-based, fixed-price milestones.² The financial and operational success of this programme marked an important milestone in the evolution of the relationship between government and industry, demonstrating that more ambitious partnerships between public and private actors could yield great benefits. Fostering the involvement of commercial actors in public programmes is nowadays a dominant consideration of governments and agencies who are increasingly eager to explore new mechanisms and take advantage of commercial contributions to achieve challenging space exploration goals.

The growing opportunity of a more prominent contribution of commercial actors to space exploration also lies in the so-called "New Space" ecosystem, a business-driven dynamic of the space sector which is characterised by a substantial increase of private investment and commercial endeavours seeking to develop disruptive industrial and business concepts to address new markets. In this ecosystem, space exploration and Human spaceflight have become domains of interest for private companies, entrepreneurs and investors, eager to conduct business in these fields.

This general context creates programmatic opportunities and strategic challenges for space agencies, opening the way to a (possible) paradigm shift in the approach to space exploration in the future.

As a follow-up of ESPI first study on "[The rise of private actors in the space sector](#)", which looked into the overall New Space sectoral dynamics, this new study investigates in more details related trends in the space exploration and Human spaceflight domain. The book, available for purchase on [Springer website](#), provides an overview of the current space exploration geopolitical, commercial and programmatic environment to identify elements that would drive, or prevent, a more prominent contribution of private actors to space exploration and to analyze the conditions, mechanisms and expected impacts/benefits of successful contributions.



1 Note: These attempts were primarily related to the objective to use human spaceflight and space exploration systems for commercial purpose (e.g. use of the Space Shuttle as commercial orbiter and for in-orbit servicing, commercial use of space stations for technology developments or orbital tourism).

2 National Aeronautics and Space Administration (2014). *Commercial Orbital Transportation Services*. Retrieved from <https://www.nasa.gov/sites/default/files/files/SP-2014-617.pdf>

Space Exploration Programmes: New Ambitions, New Ways

New impetus in space exploration ambitions

Recent years have been marked by a new impetus in international space exploration plans.

A first important step was made by the current U.S. administration with the signature of NASA's Transition Authorization Act by President Donald Trump in March 2017. The document underlined a strong willingness of the U.S. to engage more actively in human space exploration with the development of a gateway in cis-lunar orbit as the next programmatic step to prepare the journey to Mars. This objective was later confirmed by the adoption of the Space Policy Directive 1 "Reinvigorating America's Human Space Exploration Program" calling for a return to the Moon in cooperation with international and commercial partners under a (renewed) American leadership. More recently, in March 2019, NASA was requested by the National Space Council to accelerate its initial programmatic roadmaps to return to the Moon by 2024, giving way to a revision (not yet settled) of the required budget.

This ambitious goal also gave way to a debate on the future of the ISS in light of the difficulty for the U.S. administration to support both programmes simultaneously. Among different options, a transfer of the station to the private sector appears to be the solution preferred by the current administration and some initial steps were made in this direction (i.e. commercial studies and consultations). The question of the future of the ISS faces major programmatic, political, legal, technical and even diplomatic issues and will not be easily settled. In the meantime, the station should provide an ideal testbed for new public-private partnerships and commercial endeavours.

These Moon exploration plans gained an international dimension with the signature of several joint statements between NASA and other space agencies (including with ESA in March 2019). These recent developments suggest that the current vision provides a fertile environment for international partners to contemplate a financially and technically conceivable contribution to the programme, in line with their own objectives. Such international dimension is a crucial feature to translate the U.S.-led vision into a tangible programme. The experience of the ISS programme showed that, beyond the value of burden-sharing for joint benefits, a cooperation framework with collective commitments is essential to ensure long-term stability in a changing political environment.

Even though no agreement has been reached yet, space agencies are now engaging more proactively in strategic and programmatic reflexions and options are shaping up. The book offers an overview of the current state of affairs, including public space exploration strategies and programmes in the World. Of course, space exploration programmes go far beyond large international programmes and count with multiple robotic missions addressing different scientific objectives. However, the book shows that larger and longer endeavours offer a more solid foundation for commercial contributions.

A more prominent role for private industry and commercial solutions

Governments seek to give a more prominent role to the private sector for mutual benefits.

Space agencies and other public institutions are actively seeking new ways to work with the private sector for the implementation of their space programmes. They aim to leverage joint investments, risk sharing schemes and more efficient arrangements to better achieve public objectives while supporting sectoral growth and innovation more effectively.

Updated in January 2018, the Global Exploration Roadmap explicitly underlines that "growing capability and interest from the private sector indicate a future for collaboration not only among international space agencies, but also with private entities pursuing their own goals and objectives".³ This objective is not new and multiple initiatives already took place, in particular in the frame of the ISS programme. In this respect, the Commercial Orbital Transportation Services (COTS) programme has been a stepping stone with widely-recognized results in the improvement of cost-effectiveness and schedule management as well as in the stimulation of private development of commercial space transportation systems. In the wake of this success, and with the objective to further revisit public-private relationships and explore new mechanisms to stimulate business development, NASA

³ ISECG (2018). The Global Exploration Roadmap. Available online at <http://www.globalspaceexploration.org>

launched various initiatives such as the Lunar Cargo Transportation and Landing by Soft Touchdown (Lunar CATALYST) initiative, the Commercial Lunar Payload Services (CPLS) programme or the Next Space Technologies for Exploration Partnerships (NextSTEP) among others. The Agency also revealed, in May 2019, a new plan to stimulate the commercial use of the ISS including a policy to allow new commercial activities on the station and transport of private astronauts, a pricing for cargo transfer and on-board services and new options to attach commercial modules.

These different initiatives and plans are part of an overall change of paradigm at NASA, summarised in the following table:

Program Characteristic	Early Space Age Approach	Commercial – Oriented Approach
Owner	NASA	Industry
Contract Fee-Type	Cost Plus	Fixed Price
Contract Management	Prime Contractor	Public-Private Partnership
Customer(s)	NASA	Government and Non- government
Funding for Capability Demonstration	NASA procures capability	NASA provides investment via milestone payments
NASA’s Role in Capability Development	NASA defines “what” and “how”	NASA defines “what” industry defines “how”
Requirements Definition	NASA defines detailed requirements	NASA defines top-level capabilities needed
Cost Structure	NASA incurs total cost	NASA and Industry share cost

Table 1: Change of paradigm at NASA. Source: NASA.⁴

As a pioneer in developing commercial space activities, Europe has long taken full stock of the importance of better integrating the commercial component in its space exploration ambitions. In this frame, ESA and national agencies are actively exploring new ways to work with industry and foster business growth and innovation through different policies and instruments.

As part of its Space 4.0 vision, ESA aims to pursue a consistent and forward-looking space exploration programme designed to “further stimulate commercial partnerships with industrial entities.”⁵ David Parker, ESA Director of Human Spaceflight and Robotic Exploration, commented that “commercial partnership will play a growing role in the exciting ESA vision for space exploration and [...] ESA intends to stimulate private sector engagement in space exploration and foster innovative and inspiring approaches for ISS services and utilization and future ESA missions.”⁶ In this field, a recent outstanding ESA initiative is the launch of a Call for Ideas (CFI), establishing a process to launch strategic partnerships with the private sector and positioning ESA as a business partner and sponsor of selected commercial initiatives for space exploration and exploitation of the ISS.

The materialization of a full-fledged programme incorporating international and commercial contributions as it is contemplated today still faces major hurdles including the definition of a technical and programmatic architecture meeting the objectives of diverse partners as well as the release of appropriate funds. From this standpoint, finding the right match between institutional and commercial objectives will be a critical challenge. Notwithstanding the current landscape, marked by consistent efforts from public agents to foster the emergence, and use, of commercial solutions certainly offers an interesting momentum for the development of space exploration-related business.

4 Martin, G. (2017). *NewSpace: The Emerging Commercial Space Industry ISU MSS 2017*. Retrieved from NASA: <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170001766.pdf>

5 ESA (2016). *ESA Council meeting held at ministerial level on 1 and 2 December 2016 Resolutions and main decisions*. Retrieved from ESA: <http://esamultimedia.esa.int/docs/corporate/For Public Release CM-16 Resolutions and Decisions.pdf>

6 Ibid

“New” Space Exploration

In a recent study, ESPI investigated the New Space evolution and examined the various interrelated trends comprising this emerging business-driven shift.⁷ As a result, ESPI defined New Space as “a disruptive sectorial dynamic featuring various end-to-end efficiency-driven concepts driving the space sector towards a more business- and service-oriented step”. ESPI research underlined that endeavors and practices in the space sector have tangibly evolved over the last decade and continue to do so at a remarkably fast pace.

ESPI isolated six trends which, together, characterize the New Space phenomenon:

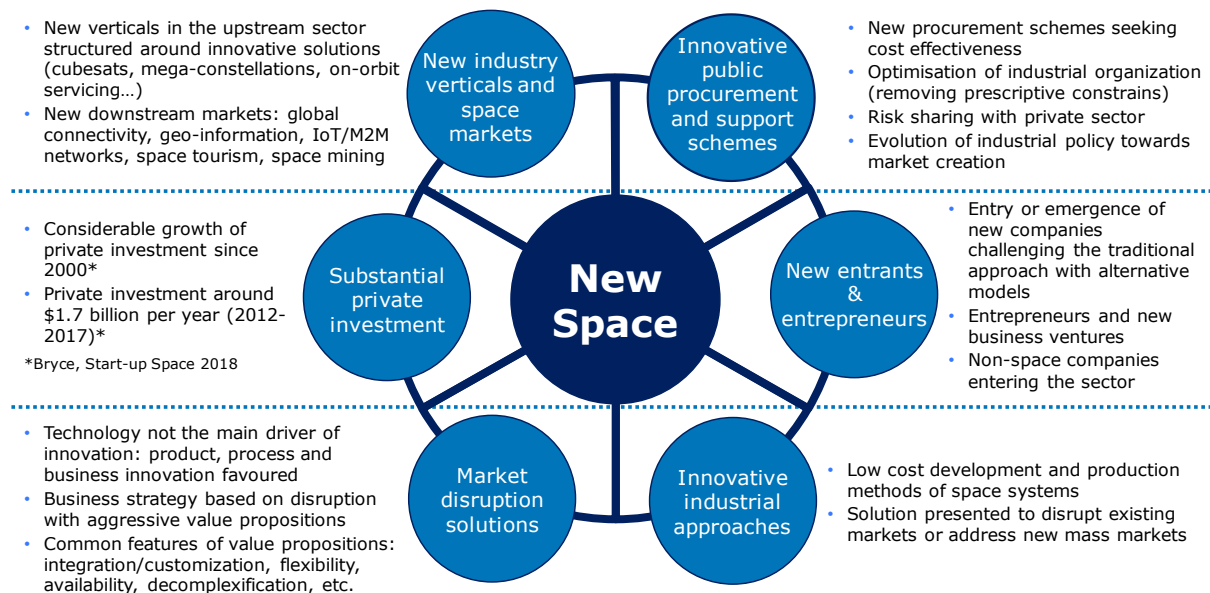


Figure 1: Key trends driving the New Space sectorial dynamic.

Together, these interrelated trends are driving a profound paradigm shift in the space sector leading to new opportunities for commercial space ventures and private contributions to public space programmes in various space fields including, in particular, space exploration and Human Spaceflight. As a matter of fact, these two domains have been substantially impacted by the New Space evolution with outstanding achievements of public strategies and the emergence of various private endeavors pursuing the goal to conduct business in these fields.

Although some studies have investigated these trends in the space sector at large, a consolidated assessment in the space exploration domain has not yet been conducted. The book showcases multiple new business ventures and investment operations showing how space exploration became a domain of interest for private companies, entrepreneurs and investors, eager to engage in commercial endeavors and conduct business in these fields.

Company	Key info	Investment	Description
SpaceIL Israel	<ul style="list-style-type: none"> Start-up developing unmanned spacecraft to the Moon Founded in occasion of the Google Lunar X Prize in 2007 In 2019, SpaceIL’s lunar lander Beresheet was the first-ever private mission to the Moon but failed to land. 	\$22.4 million	Private investments from business angels (in particular Morris Kahn) complement public investments from the Israel Ministry of Science and Technology.
Moon Express United States	<ul style="list-style-type: none"> Start-up providing lunar transportation and services to government and commercial customers. In 2018, ME signed an MoU with the Canadian Space Agency to 	\$65.5 million	A total of 22 investors over six funding rounds. Minerva Capital Group is the leading investor with \$12.5 million.

⁷ Vernile, A. (2017). *The Rise of Private Actos in the Space Sector*. ESPI: Springer.

	use Moon Express lunar orbiter and lander system for CSA payloads.		
Goonhilly United Kingdom	<ul style="list-style-type: none"> Start-up seeking to develop and expand Deep Space Communications. In 2018, GES signed a partnership with ESA to develop Commercial Lunar Mission Support Services. 	€26.7 million	Two funding rounds from English investors. The first has been announced in 2014 as a funding round from a VC firm while the second recorded in 2018 is from a business angel.
PTScientists Germany	<ul style="list-style-type: none"> Start-up developing a spacecraft capable of delivering two rovers, or up to 100 kg of payload, to the lunar surface. PTS signed a contract for ESA's planned in-situ resource use (ISRU) mission and will provide the lunar lander that will analyze the regolith for future utilization. 	Undisclosed	Undisclosed
Deep Space Industries United States/Luxembourg	<ul style="list-style-type: none"> Start-up developing technologies to facilitate access to deep-space and exploit space resources. DSI targeted to launch a private deep space mission in 2020 (Explorer spacecraft). Plans were likely revised after DSI was acquired by Bradford Space in 2018 for an undisclosed amount. 	\$3.5 million	Serie A funding round to support the development of a deep space exploration platform.
Astrobotic United States	<ul style="list-style-type: none"> Development of space robotic technology for lunar and planetary missions. NASA awarded Astrobotics 2 contracts for developing technologies for the Peregrine Lunar Lander. 	\$12.5 million	Public and private investments over three different rounds.
ispace Japan/Luxembourg	<ul style="list-style-type: none"> Company developing robotic spacecraft technologies to discover, map, and use the natural resources on the Moon. Ispace Hakuto team participated to the Google Lunar X Prize The company signed up for two launches in 2020 and 2021 	\$90.0 million	iSpace has been particularly successful in raising money. Development Bank of Japan has been the leading investor.

Table 2: Selected examples of businesses and private investments in space exploration

The book covers many examples in the United States, Europe and other countries such as Space Adventures, Axiom Space, Bigelow Aerospace, Space Application Services, OffWorld, Made In Space... and outlines a thriving private ecosystem, despite high technical and business risks. The recent bankruptcy of some ventures does not seem to significantly impact this trend yet.

The book underlines that space exploration private endeavours are not necessarily start-ups and recalls that a number of well-established players are also developing new commercial concepts. It is also important to stress that a different innovation dynamic is unfolding, based on product, process and business innovation rather than technology development.

Growing opportunities for commercial contributions to space exploration

As highlighted by Mr. Gonzalez, advisor to EC director for EU Satellite Navigation Programmes, in his report on commercial space, "space commercialisation results from the convergence of a bottom-up trend driven by a growing accessibility of space technology and a determined top-down policy to encourage a more market-oriented approach to space activities."⁸ Information and data compiled in ESPI book provide clear evidence of a growing convergence between such top-down policy effort and bottom-up trend in the space exploration sector.

From a policy perspective, various objectives (i.e. optimisation of programme cost-effectiveness, research of innovative concepts, support to industry development and competitiveness, contribution to economic growth) triggered a desire to foster the development of commercial space activities, including in the space exploration domain. Governments set up determined and audacious public strategies toward this goal with the underlying objectives to 1) enhance the capacity of space agencies to share risks and costs with the private industry and 2) boost innovation and market development. This ambition has been translated into new approaches to public procurement and support to research as part of an industrial policy giving more room to business considerations. The book shows that the willingness to reap benefit from a development of commercial space exploration and from a more prominent role of private industry in public programmes is a dominant consideration in the United States and Europe, the two leaders in commercial space, and provides multiple examples of new public instruments implemented on each side of the Atlantic.

From a commercial perspective, space exploration has become a domain of interest for private companies, entrepreneurs and investors, eager to engage in new, potentially rewarding, endeavours. As a result, a tangible business-driven dynamic is developing and the space exploration sector is progressively driven toward a more commercially-oriented step. Embedded within the broader New Space context, this trend is characterised by:

- Multiple commercial endeavours from well-established players and new entrants including non-space companies and start-ups. The book proposes to organise the various models adopted by these commercial space exploration endeavours (e.g. value proposition, target market(s), cost structure, revenue streams, industrial partners) into four categories:
 - *Visionaries*: Companies targeting a very long-term and highly ambitious commercial objective in space exploration (e.g. mining of asteroids or celestial bodies, private settlements). These companies usually implement a step-wise approach based on an incremental technology development process;
 - *Support service providers*: Companies offering commercial solutions that can support other private endeavors or be integrated into public exploration programmes (e.g. transportation, engineering, robotics, 3D printing, in-orbit servicing, and assembly);
 - *Business opportunity seekers*: Companies leveraging opportunities created by public space exploration programmes for a commercial purpose (e.g. commercial utilization of the ISS);
 - *Autonomous exploration-related businesses*: Companies whose business model is based on solutions developed independently from public institutions and addressing mainly commercial markets (e.g. private space transportation and station for tourism or research). For these companies, public demand can be an important complement but does not constitute a pillar of business development.

Boundaries between these categories are thin and companies may adopt multiple business profiles and/or pivot throughout their development.

- Innovative approaches to meet business requirements and commercial objectives including new concepts and methods such as, industrial organisation optimisation, partnerships with other industries, supply chain rationalization and vertical integration, miniaturization and simplification (e.g. use of cubesats, proven technologies re-use), automation and digitization, standardized

⁸ González, A. (2017). *A Snapshot of Commercial Space*. CSTPR white Paper. Retrieved from http://sciencepolicy.colorado.edu/admin/publication_files/white_papers/2017.01.pdf

architectures or use of COTS among others. These new approaches give way to an alternative innovation dynamic where all components of innovation (i.e. technology, product, business model and process) are integrated.

- Growing private investment in commercial ventures in the space exploration domain. A consolidated assessment of global private investment in the space exploration domain has not yet been conducted, however, the book provides multiple examples of multi-million investment deals and demonstrates that space exploration has become a domain of interest for investors, eager to engage in risky yet potentially highly rewarding operations.

Eventually, the growing opportunities for more significant commercial contributions to space exploration can only be the outcome of two complementary forces: a determined and long-standing effort from public actors and a favourable business dynamic in the private sector.



From “stimulating” to “leveraging” commercial contributions

The public objective to support commercial space exploration and leverage more significant private contributions (i.e. risks, costs and benefits sharing) ultimately aims to 1) improve public programmes effectiveness and efficiency and/or 2) transfer selected activities to the private sector (e.g. ISS operations) to free some budget and refocus on new missions. From this standpoint, various success stories demonstrated that more ambitious public-private partnerships can support such objectives provided that a number of conditions are met (Figure 13):

Conditions	Potential benefits
<ul style="list-style-type: none"> • Maturity of partners: suitable skills and experience to manage respective responsibilities • Improved Value for Money: improved economy, efficiency, effectiveness in comparison to traditional procurement • Appropriate financial management: capacity to mitigate overprice (e.g. through open and fair competition) and budget overrun (e.g. financial management throughout the project lifecycle, up to decommissioning) • Appropriate risk management: allocation of risks to the party best able to manage them and capacity of partners to manage respective risks • Adjustment of project management best practices: flexibility of partners to agree on adapted decision frameworks, shared responsibilities, project specifications, certification processes, industrial policy/setup • Complementarity and/or alignment of partners’ objectives: public programme objectives meeting business needs and vice versa • Resources availability and readiness: the capacity of partners to mobilize required human, technical, financial resources • Commitment term in line with partners’ requirements: PPP duration allowing partners to achieve their objectives, including return on investment • Favourable external economic and commercial conditions: the capacity for private partners to achieve a profitable business case (e.g. interested customers, adequate demand) • Compliance with international and European rules and standards: compliance of the partnership with international treaties, applicable legal and regulatory regimes as well as relevant standards 	<p>Common benefits</p> <ul style="list-style-type: none"> • Shared costs in view of meeting budget constraints or reaching the financial conditions to achieve programmatic/ business objectives • Shared risks and transfer to the party best able to manage them • Shared benefits in line with respective public and private objectives as described below: <p>Public sector benefits</p> <ul style="list-style-type: none"> • Improved efficiency and effectiveness through incentives to achieve objectives on time and on resource • Development of industrial capabilities based on complementary public and private investment • Support to innovation and competitiveness by granting more flexibility to the private sector to pursue alternative routes (e.g. business- or process-driven innovation) • Other strategic benefits (e.g. job creation, economic growth, societal and environmental challenges) <p>Private sector benefits</p> <ul style="list-style-type: none"> • Additional revenues and profit (as a direct result of the PPP or through access to new revenue streams) • Competitive advantage gained as a result of a variety of positive direct or indirect PPP impacts (e.g. experience gain, new competencies, customer acquisition...) • New competences and capabilities that can be leveraged on other verticals and markets • Technical and business innovation creating potential differentiators for industry value proposition and/or business setup

Table 3: Conditions and potential benefits of a successful PPP

Among these conditions, the capacity of the private sector to develop a profitable and sustainable business addressing, at least partially, private markets, remains a key challenge for many commercial ventures in the space exploration sector. Indeed, a vast majority of them is still at early stages of development and, even though there is confidence in the existence of business opportunities, the profitability and sustainability of the business models proposed by these companies as well as their capacity to address new sizeable private markets have yet to be demonstrated.

The public sector has an important role to play to accompany commercial endeavours emerging today toward a fully viable stage.

From this perspective, the report shows that the combination of public policies and favourable business trends is instrumental; especially in the space exploration domain where the objective to stimulate and leverage commercial solutions has become a central goal for institutions and where public support, through its various forms, (e.g. loans and subsidies, R&D funding, public demand,

legal and regulatory framework adaptation) remains essential for the private sector to develop a profitable and sustainable business model. Ultimately, the capacity of public actors to successfully leverage commercial contributions to space exploration and reap associated benefits can only be the outcome of two complementary engagements:

- **On the “offer” side**, the public sector must act as a business catalyst to support the development of commercial solutions by the private industry and facilitate early business development;
- **On the “demand” side**, the public sector must act as an anchor customer to integrate commercial solutions from the private industry and support business profitability and sustainability,

The report shows that European public actors, and in particular ESA, have already made a tremendous effort on the offer side (i.e. support the emergence of commercial solutions) with the introduction of new successful instruments to support commercially-driven innovation (e.g. business incubation, grand challenge, investment easing) and to facilitate the emergence of new private solutions (e.g. calls for ideas, strategic partnerships). This effort is already yielding concrete results with several new projects and ventures having arisen in, or migrated to, Europe.

There is, however, a growing need to address, as a second step, the demand side (i.e. integrate these commercial contributions) and more specifically to position public actors as anchor customers of commercial solutions developed by the private industry. Such anchor customer approach, which builds on complementarity between public and private partners objectives (i.e. public programmes and business goals), seeks “to procure sufficient quantities of a commercial space product or service needed to meet Government mission requirements so that a commercial venture is made viable.”⁹ In addition to the level of demand, the duration of the agreement also plays an essential role to provide the commercial partner with the necessary business stability to withstand temporary problems, build investors’ confidence or explore new concepts or markets.

ESA has made initial steps towards a demand-driven support to commercial development with the signature of a collaboration agreement with Surrey Satellite Technology Ltd (SSTL) and Goonhilly Earth Station (GES) for Commercial Lunar Mission Support Services. Building on return on experience and lessons learnt, such approach could be used for other Agency needs.

The complementarity of offer- and demand-oriented initiatives is best illustrated by the recent NASA’s CATALYST and CPLS programmes. CATALYST encouraged and facilitated the development of U.S. commercial robotic lunar cargo delivery capabilities (i.e. offer) and was followed-up by the CLPS programme to purchase private transportation services to the lunar surface using fixed priced contracts (i.e. demand). On one hand, CATALYST has been instrumental to support the emergence of various private solutions able to compete for subsequent CLPS contracts. On the other hand, it is the fixed priced contracts, which integrate selected offers into NASA lunar plans, that will allow the agency to actually leverage these private solutions. These two initiatives are the “offer” and “demand” components of an approach serving a single public objective.

As underlined in the list of conditions for successful public-private partnerships, the integration of commercial contributions will also inevitably raise the need to adapt agencies’ practices to set up adapted financial and risk management schemes especially with commercial solutions used as critical capabilities. Indeed, should current trends progress towards a fully sustainable model where public programmes would make steady use of commercial solutions, including for critical know-how, a situation of mutual reliance between public and private sectors would develop, exposing public programmes to commercial risks. Such situation should be properly anticipated and managed.

Way forward

Commercial potential of new concepts

A number of promising solutions are now emerging from the cloud of commercial space exploration endeavours. Among the ventures and projects launched recently by the private industry, those falling in the categories of “*support services providers*” and “*business opportunity seekers*” stand out as the most promising in the short-term to contribute to space exploration programmes (i.e. value for money, risk sharing, innovation) and meet the conditions of success mentioned above.

With regards to support services provision, various new concepts, which will be at the heart of future space exploration programmes, offer an interesting potential to develop a more demand-driven approach to public-private partnerships based on 1) repeatable standard service purchase, 2) complementarity of public and private objectives, 3) development of market opportunities, and 4) fair industry competition. These promising support service concepts include, among others:

- In-orbit operations, manufacturing and assembly;
- In-Situ Resource Utilization (incl. resource exploration, mining and processing);
- Station and base operations;
- Transportation and payload hosting;

As pointed out previously, the implementation of more ambitious public-private partnerships for the development and provision of these new services will require agencies to adapt their approach including industrial policy and procurement rules. The key challenge for agencies will be find the right balance between their inclination toward top-down control over the development and distribution of space capabilities and the necessary loosening of this control to meet business requirements.

The role of private actors in the post-ISS era

The considerations mentioned above are expected to take on their full meaning in the post-ISS era. In particular, the Lunar Gateway plans will require a great deal of transportation and in-orbit/in-situ operations and assembly which will provide a fertile ground for the delivery of services by the private industry. To prepare for such era of space exploration and Human spaceflight programmes building more extensively and prominently on partnerships between public and private actors, the ISS provides an essential test-bed.

The private sector has been expected to develop business cases for the utilization of the ISS since the inception of the programme. This old promise materialized only partially and commercial activities remained, first and foremost, valuable complementary contributions. Nevertheless, with the declared objective to transfer ISS operations to the private industry and end direct funding to the programme by 2025 to free budget for the Lunar Gateway, the current U.S. administration seems confident that, in the current ecosystem, the station has the potential to fulfil this long-awaited goal.

The U.S. administration contemplates a two steps approach on the offer & demand model described previously:

- First, to stimulate the emergence of an offer by 2025 and facilitate business development, the U.S. Budget allocated \$150 million “to encourage development of capabilities that the private sector and NASA can use”¹⁰;
- Then, to leverage the complementarity between public and private objectives (i.e. cost savings for the public sector and business profitability and sustainability for the private industry), NASA would become a customer of solutions offered by the station for its low Earth orbit research and technology demonstration requirements.

Beyond the objective to phase out of the programme to refocus on the Moon, a progressive transfer of ISS operations to the private sector would also pave the way towards public-private partnerships for the post-ISS era and in particular the Lunar Gateway programme that is planned to integrate more ambitious partnerships with the private industry. The proposal to transfer the ISS to the private

¹⁰ Budget of the U.S. Government, Fiscal Year 2019

sector is audacious and will likely face multiple political, diplomatic, legal, technical, industrial, operational and commercial challenges. Notwithstanding, this proposal allows to project the challenges ahead of space agencies on the difficult road toward more significant commercial contributions to space exploration.

This scenario would require to discuss the conditions for European industry to participate, through competition or industry-to-industry cooperation frameworks, to a commercialisation of the station either as a partner for commercial operations or as a customer/user of the station. Such discussion, which should account for existing and upcoming partnerships with the European private sector for the ISS exploitation, should be supported by a consultation to assess industry's interest and by an examination of the conditions to be met for a European participation including the need to setup appropriate arrangements with the United States. A policy in this sense should also anticipate necessary activities (e.g. R&D, demonstration, qualification...) to support the emergence of European champions.



Commercial Space Exploration

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