

INNOVATIVE PUBLIC PROCUREMENT IN SPACE – PHASE 1 SUMMARY REPORT



Foreword



We are at a seminal moment in the UK and indeed global space industry. The opportunity for space to play a key role in mitigating climate change and our technological future is upon us. To achieve that requires strategy, policy, regulatory clarity, and investment to match.

As the space sector evolves with major advances in launch, spacecraft design and data handling capability, so too does the market and the financial landscape in which we operate. Combining our UK experience and ingenuity will position us for continued leadership in Newspace and a key partner in large international programmes. This report examines how innovative public procurement can be used as a vital new tool to fuel this growth.

Following the Space Growth Partnership's Prosperity from Space report in 2018, which recommended further investigation of innovative procurement options for the UK space sector, the Partnership commissioned an independent study in late 2020. This report today:

- Reviews UK and international approaches to space sector growth;
- identifies innovative procurement models with the potential to make the UK more competitive internationally; and,
- recommends working up case studies to underpin recommendations for how innovative procurement models could be practically implemented in the UK.

The report is backed by extensive market and stakeholder research, with this phase one report summarising the research and procurement options identified. The innovative procurement models set out in this report sets the stage for Government as a beneficiary of services in a way that unleashes increased private investment into the UK space sector and drives innovation and export growth.

The final results of the study are expected later this year. The results will include worked examples and recommendations for adopting new processes for selected procurements in the UK.

On behalf of the Space Growth Partnership, I would like to thank BryceTech for undertaking this study and their thorough analysis of the market. Their analysis sheds light on gaps and opportunities in the UK and presents well-founded approaches for maintaining a competitive edge.

Will Whitehorn

President of UKspace

Executive Summary

Innovative procurement approaches will enable the UK to fully realise opportunities created by the transforming global space economy, and are particularly aligned with the post-Brexit government initiative to improve public procurement

Dramatic transformation of global space economy creates new opportunities

The nearly \$400B space economy—which supports trillions of broader economic output—is in a period of transformation driven by new launch services, satellites, products, and data applications. Space is attracting billions in annual institutional investment and corporate capital commitments, expanding R&D, and fostering partnerships among the largest companies in the world. More than 300 space start-ups have been funded, and the market cap of space companies that have become publicly listed in the last eight quarters exceeds \$20B. Space increasingly serves as an economic and defence policy focus for nations of all sizes, with government space budgets growing nearly 50% over the last decade. Today, space is creating new markets and shaping international relationships. Demand for space-related products and services encompasses fields from manufacturing to AI, autonomy, and data analytics.

Innovative procurement can help UK unlock space prosperity and security

Based on an analysis of space trends, assessment of progress against policies, and interviews with nearly 40 global business and government leaders, as Phase 1 of a study conducted for the Space Growth Partnership (SGP), Bryce identified current challenges to space procurement and developed recommendations to incorporate innovative procurement (Phase 2 of the study will identify specific mechanisms and characterise a pilot programme). The requirement for this study originated from Space Growth Partnership working groups. Space ventures can be capital-intensive, with long return periods, and often require unique advanced technologies, contributing to perceptions of risk, and sometimes impeding financing through traditional approaches. To ensure critical space capabilities are available to meet future UK needs, innovative government procurement can help address technical, cost, and commercial risks, provide investor confidence, and accelerate technology development and adoption.

Benefits of innovative procurement to UK government

Innovative procurement of space products and services will allow the UK government to leverage the current influx of commercial space investment and business activity. The prosperity and security benefits to the UK of innovative space procurement include:

Leveraging Investment, Reducing Costs

- ✓ Stimulating increased inward investment and VC investment generally by helping to commercially de-risk new businesses/capabilities
- ✓ Reducing costs of achieving national space goals by enabling the government to co-invest and risk-share with industry, including to support R&D investment growth
- ✓ Eliminating duplication and waste in space acquisitions
- ✓ Delivering value for money for the UK taxpayer by sharing the costs of creating new space infrastructure with other customers

Increasing UK Space Power

- ✓ Expanding UK space capabilities, delivering enhanced consumer telecom, improved national defence, and the many other space applications that result in space being considered critical national infrastructure
- ✓ New desirable capabilities to meet broader government objectives, such as data analytics combined with satellite imagery for public sector needs
- ✓ Improving capacity and resilience of the UK space and advanced technology supply chain
- ✓ Enhancing UK soft power and alliances through shared use of space capabilities

Driving Economic Growth and Exports

- ✓ Stimulating exports by validating UK space products and services through UK government use of those products and services
- ✓ Increasing competitiveness of space products/services, providing more options for government buyers
- ✓ High-value job creation throughout the space supply chain, which ranges from manufacturing to AI, robotics, autonomy, and quantum applications in the futures

Recommendations

Act as an anchor tenant for space firms that offer products and services relevant to government needs.

Anchor tenancy, or guaranteed government business, contributes to commercial success by providing predictable revenue, validating operational concepts, and reducing future uncertainty. This is attractive to both investors and customers. Anchor tenancy has been a particularly important approach to encouraging the private sector to invest in space-based capabilities. For example, NASA's procurement as an anchor customer of Commercial Crew and Cargo Transportation services led to billions of dollars of additional private investment and helped grow the US market share and capabilities for commercial launch services, while saving the US government billions relative to traditional procurement. NOAA has also played an important role in supporting earth observation companies, Spire and GeoOptics, by incorporating their weather mapping capabilities into operational weather forecasting through multi-million-dollar indefinite delivery-indefinite quantity contracts and supporting the development of emerging solutions. Anchor tenancy can be instrumental in helping to evolve an emerging market to a sustainable one.

Develop strategic public-private partnerships. Public-private partnerships feature co-investment, whether direct or in-kind, by government and typically one or more firms, to share costs and risks in developing new capabilities. For example, the Arctic Satellite Broadband Mission (ASBM) led by the Norwegian military partnered to share satellite payload space with the US DoD and Inmarsat to support development costs, making the system feasible within Norway's available budget. Public-private partnership success is dependent on execution as well as alignment with national goals.

Consider direct investment to ensure UK access to unique capabilities or to accelerate the availability of products/services that meet clear needs. Directly investing in targeted opportunities provides capital and also creates confidence for investors, strategic partners, and customers. As an example of meeting government needs, In-Q-Tel, a US government-funded investor, is widely viewed as a success. In-Q-Tel participation signals government is a potential customer and also government's confidence in a business's technology and business plan. As an example of gaining access to unique capability, the UK investment in OneWeb has attracted private investment from Bharti and other investors and is likely critical in securing \$1B in additional funding needed to complete the Gen 1 constellation, though no specific government use cases has been definitised. Investors interviewed by BryceTech commented that government investment should ideally occur only alongside commercial investors.

Ensure export finance support is flexible to changing market needs and levels of financing requirements, while being attractive to private co-investors. Commercially appealing, scaled, export finance support can play a critical role in plugging gaps in available commercial lending and position UK industry competitively in international markets. Export finance allows government to provide a meaningful commitment and competitive advantage to industry without the risk profile of ownership, providing the patient capital often required by space projects with uncertain and lengthy return profiles. For example, the French export credit agency, Coface, provided an attractive financing package that ultimately led to Iridium choosing Europe's Thales Alenia Space over Lockheed Martin for its \$3B constellation, supporting job creation, and capability development. The opportunity exists for the UK to evolve export finance from a traditional focus on large-scale, often satellite-focused, transactions to more flexible financial structures, available to wider sections of UK industry, focused on targeted market opportunities or strategic capability development.

Support innovative procurement with appropriate resourcing and clarity about future plans. The UK should consider matching the spending of peer nations to improve competitive edge and take full advantage of innovative procurement, ESA membership, and drive growth. France, Germany, and Italy spend about 0.05%+ of GDP while the UK spends half that amount. Moreover, a substantial portion of peer nations' spend is on national space programmes, separate to their ESA contribution. It will also be important to communicate future government plans and improving predictability of funding to increase today's investment and align industry capabilities to national objectives.

Introduction

Space capabilities enable global communication and transportation, enhance major industries, and underpin national defence in the UK and its allies. Use of space systems – satellites, launch services, and platforms in orbit— is growing worldwide, creating new markets and shaping international relationships. The UK is a global space actor today, with capabilities in a range of areas and increased focus on space as a driver for economic growth, evidenced through its recent \$500M investment in satellite constellation, OneWeb. The UK also boasts core strengths in satellite manufacturing, downstream applications, academia, regulation, and operations of assets, alongside ongoing development of domestic launch capability. However, space opportunities are not being fully exploited, with a relatively small space budget, fragmented ecosystem, and challenged relationship with the European Space Agency (ESA) leaving the UK at an overall competitive disadvantage, particularly in a post-Brexit, post-COVID era.

To capitalize on emerging opportunities, the UK needs new models and approaches to support the growth of its world-class space capability and economy, as well as to maintain national security. Government decisions about what to fund, what to acquire, and how to conduct its space activities—reflecting the range of government procurement approaches—are critical to the future of space in the UK. Industry-friendly policies, balanced with national security and safety considerations, and budgets comparable to peer nations, can benefit the economy, military, and civil space programs. These alternative models can attract additional private investment, increase the impact of significant capital investments by the private sector, and provide innovative ways of engaging with industry. The study identified and assessed a wide range of specific procurement mechanisms to achieve these objectives; the most highly ranked for unique space challenges—such as leveraging commercial investment and achieving long term national capability—include anchor tenancy, public-private partnerships, targeted government investment, and export finance support.

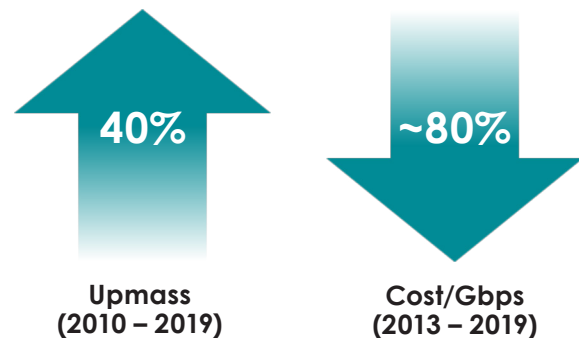
SGP has commissioned this report to better understand innovative public procurement approaches and the extent to which they deliver value for space activities. Bryce Space and Technology Ltd has conducted the study on which this report is based. The requirement for this study originated from Space Growth Partnership working groups. Phase 1 of this study provides an overview of space market conditions and identifies whether and how innovative public procurement can contribute to space sector growth, characterizing government action that can stimulate private investment, highlighting successes and failures and comparisons across sectors/nations. This report summarises the Phase 1 findings and provides the evidence base for recommendations related to innovative procurement. Phase 2 of this study will result in suggested specific procurement mechanisms and a proposed pilot programme.

Global Space Context

The nearly \$400B space economy—which supports trillions of broader economic output—is in a period of transformation driven by new launch services, satellites, products, and data applications. Space is attracting billions in annual institutional investment and corporate capital commitments, expanding R&D, and fostering partnerships among the largest companies in the world. Underpinning these trends are decreasing costs and increased capabilities for launch and space hardware.

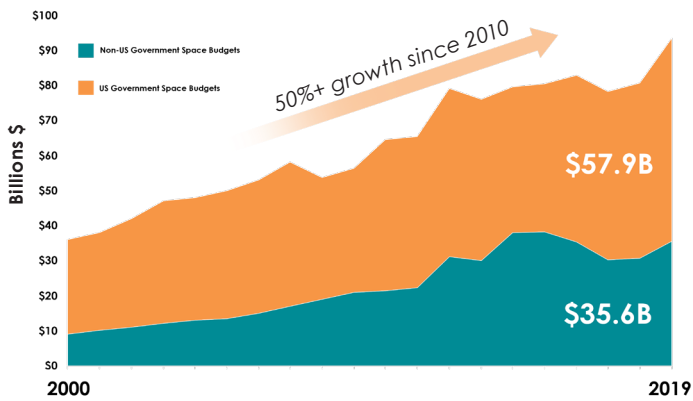
New commercial entrants seek to deliver satellite services like telecommunications, imagery, navigation, weather forecasts, and data analytics, as well as in-space capabilities such as additive manufacturing, on-orbit

Increased productivity and decreased unit costs.



servicing, and human spaceflight. Space increasingly serves as an economic and defence policy focus for nations of all sizes. Today, space is creating new markets and shaping international relationships.

Government space budgets have increased 50% over the last decade. Source: BryceTech.



Rising government budgets

Governments have a multi-decade legacy of relying on industry to implement national space programmes. Today, governments are increasingly partnering with companies in new ways to develop and take advantage of commercial space capabilities. Government space budgets represent 25% of the global space economy and have grown by nearly 50% since 2010. The US space budget is the world's largest, representing 60% of the total in 2019. Non-US government budgets grew from 25% of the total in 2000 to 38% in 2019. Four nations (considering Europe as a single entity—the USA, Europe, China, and Russia) represent 90% of total space budgets in 2019.

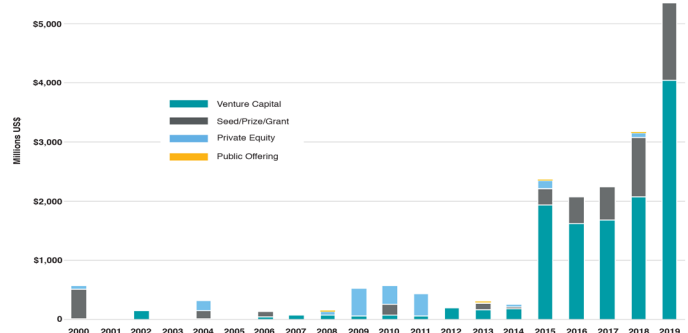
Continued growth in space capabilities has been further catalyzed by record start-up space investment (investments in companies that began as angel- and venture capital-backed start-ups) in recent years, with annual investment in space start-ups tripling over the past five years and reaching a record high of \$7B+ in 2020, concentrated in launch, satellite, and downstream data application markets. Space and terrestrial technology leaders are positioning to capitalize on maturing space markets, with Amazon and SpaceX saying this will invest over \$10B each in satellite communications constellation development, and both AWS and Microsoft having established space divisions for cloud data storage and processing.

Dramatic growth in start-up space investment and billion-dollar valuations

Increasing M&A and exit opportunities have the potential to sustain investor appetite. For example, Voyager Space Holdings and Redwire made multiple acquisitions in the past 12 months. Alongside this, there has been an increase in special purpose acquisition companies (SPACs) targeting the space industry, providing further growth capital for space companies and exit opportunities for investors. More than 300 space start-ups have been funded, and the market cap of space companies that have become publicly listed in the last eight quarters exceeds \$20B. Mutual funds, technology-focused exchange traded funds (existing and new), and other vehicles are enabling investment in diversified portfolios, while retail investor appetite for hyper-growth stocks is at an all-time high.

Investment in commercial space has surged in the past decade. Source: BryceTech.

Dramatic growth in start-up space investment



Stats on SPAC Transactions

11

Space Transactions

\$23B

Market Value

UK Space Context and Challenges

The UK has identified space as a growth driver, with the sector demonstrating consistent strength including under challenging global circumstances, growing during the financial crisis and showing resilience throughout the ongoing COVID-19 pandemic.

UK is attractively positioned to capture new markets, enhance international position

Demand for space-related products and services encompasses fields from manufacturing to AI, autonomy, and robotics to telecommunications, mapping, and data analytics—as well as growing space defence markets. Enhanced participation in the global space economy can generate UK exports, energise industry, strengthen defence alliances, and drive job creation. The UK is well-positioned, as an attractive place to do business, with advanced technology, industry, and academic capabilities, as well as national security relationships with the US, other Five Eyes nations, Europe, and Japan. The UK can take advantage of its strengths to target opportunities, support growth of its space economy, and drive further private investment into capabilities that also support government (civil and defence) needs.

The UK has sought to drive economic growth through space activities for more than a decade. The Space Innovation and Growth Strategy (IGS) was conceived to create a partnership between industry, government, and academia to develop, grow, and exploit new space-related opportunities. It culminated in the publication of a 2010 report with 16 recommendations in support of its stated target to establish the UK as a leading space nation and grow its share of the global space economy to 10%. The UK Space Innovation and Growth Strategy report was updated in 2015, maintaining the target of capturing 10% of the global space market and includes 10 new recommendations.

Today, the UK space economy comprises over 5.1% of the global space economy in 2018/19, with total income of £16.4B, more than 45,000 employees, and supports £360B of wider UK GDP, according to the 2020 *Size and Health Report* published by UKSA. The UK's unique business, academic, R&D environments, and Five Eyes position are attractive to global firms. This is evidenced by the UK being second only to the US in terms of start-up space investment, with \$3.4B (\$7.4B with OneWeb) invested across dozens of UK space start-ups. The UK has over 100 investors who have invested in start-up space companies.

Success has been mixed, UK will be challenged to meet 10% of space economy goal

The UK is not reaching its potential and taking advantage of its strengths to the fullest extent possible.

Interview insights from nearly 40 interviews with government, investors, and industry, including both large and small firms, identified opportunities for the UK to perform better in its space activities. The lack of a national programme with meaningful and predictable funding has been cited as impacting national competitiveness. Interviewees also identified the need for a strategy that incorporates government as an anchor customer, aligning national interests and the broader prosperity agenda. Government as a customer was identified as an important tool in building confidence among other potential customers/stakeholders. Interviewees also stressed the need for greater alignment and understanding of space across government, increased agility to attract providers, and support for flight heritage development through demonstrator missions. Another relevant factor cited in interviews was the defence agendas of Germany and France, that directly support wider industrial competitiveness and enable capability development transfer for civil/ESA programmes. Interviewees also identified the need to balance risk of failure with expectation of results over long timeframes, leveraging private sector engagement to support investment appraisal, with adoption rather than technology often being key to innovation. The potential for a challenging post-Brexit UK-ESA-EU relationship and evidence of skills gaps were also identified as key causes for concern that need addressing.

How the UK has performed against its space targets.

2010 IGS Recommendation	Achieved
Define and implement a National Space Policy	●
Establish National Executive Space Agency (UKESA)	●
Establish a National Space Technology Strategy (NSTS)	●
Provide more capital guarantees/anchor tenancy agreements	●
Procure EO data service for Public Sector needs and export	●
Strategy to secure leadership in climate-change monitoring	●
Develop space-enabled services as complementary infrastructure	●
Use low-carbon characteristics of space broadband/cast services	●
Establish senior-level government panel to ensure strategic view	●
Lead in promoting use of mobile satellite-based services	●
Take full account of wider value of space-enabled services when engaged in space-related regulatory activities	●
Support in championing STEM initiatives in schools, universities, and businesses	●
Initiate and lead 3+ space exploration/science missions by 2030	●
Establish a hub and spoke network to link UK centres of excellence	●
Doubling UK spend in real terms over next 10 years	●
Establish a Space Leadership Council	●

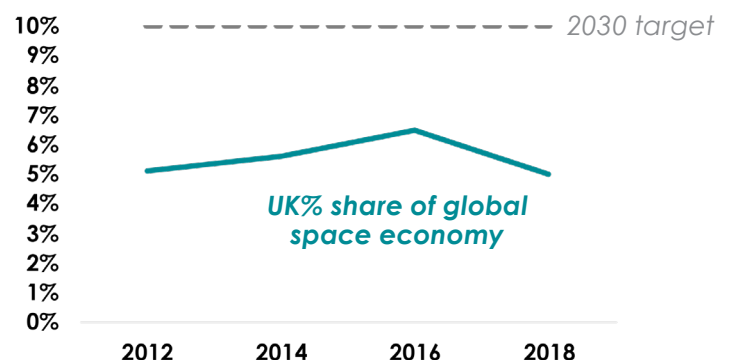
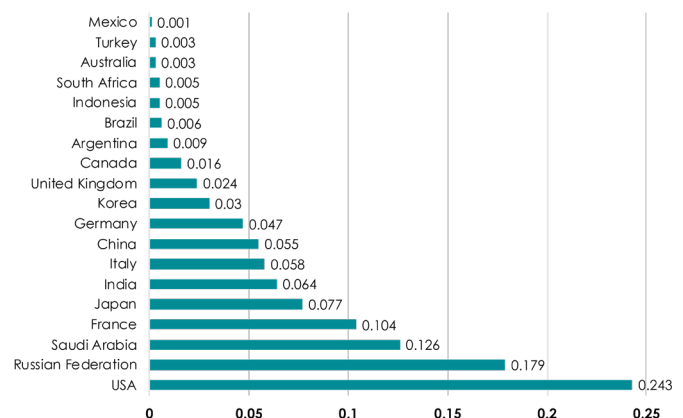
The UK spends the least on space among peer nations, which severely undermines its core competitiveness with peer space nations such as France, Germany, and Italy. More broadly, UK R&D funding is far below the OECD average, though the UK has set a target to meet and exceed this level in the coming decade, which will likely need to take the form of public and private investment.

The UK's share of the global space economy reached a peak of 6.5% in 2016 and has consistently remained around 5%. The UK will likely be challenged to meet its target of capturing 10% of the global space economy by 2030.

A disjointed, sometimes hesitant approach to dealing with the ESA and the lack of a substantial national space programme also negatively impact the UK's return on its ESA investment, which constituted about 75% of the UK's civil space budget in 2019. France, Germany, and Italy have intentional strategies and large national space programmes that support and strengthen capability development, increase heritage, and better position companies in those countries to win ESA contracts. In addition, peer nations (particularly Germany and France) ensure

2015 IGS Recommendation	Achieved
Address high-value market opportunities by developing and implementing growth roadmaps	●
Increase use of space applications and infrastructure meet UK's security and defence needs	●
Further develop analysis of the economic impact of the space sector	●
Promote relevant regulatory and spectrum regimes to maximise UK business growth	●
Implement the European Space Engagement Plan	●
Drive UK exports	●
Capture high-value opportunities through increased investment in National Space Growth Programme	●
Encourage space-related businesses, especially SMEs, to maximise opportunities for growth	●
Grow regional space clusters, including Harwell	●
Ensure skills are in place for the UK to develop space related opportunities	●

The UK spends about half of peer nation spending on space. Source: OECD.



Recommendation	Comment	Themes for Improvement
Provide more capital guarantees/anchor tenancy agreements	Limited evidence of UK providing capital guarantees/anchor tenancy agreements	Match spending with peer nations. Integrate space procurements across government to enable agility, reduce waste, and increase effectiveness
Procure EO data service for Public Sector needs and export	Space for Smarter Governance Programme not providing an effective, mission-oriented capability for certain end-users within government. Non-expert users seek answers associated with EO data analysis for specific applications	Leverage industrial capabilities. Potential need for operational acquisition of data analytics capabilities
Use low-carbon characteristics of broadband/cast services	Minimal historical evidence of space broadband/cast services being leveraged by government, potential exists through Project Gigabit	Improve coordination. Need for further interpretation, discussion to ensure alignment between UK Net Zero targets and UK capability provision, development
Doubling UK spend in real terms over next 10 years	UK spends the least on space compared to peer countries	Match spending with peer nations, improve ESA dynamics, decrease fragmentation of space policy, and greater integration of cross-governmental organisations with existing defence architecture
Address high-value market opportunities by developing growth roadmaps	Limited coordination on roadmaps to target high-value opportunities	Leverage industrial capabilities, international partnerships, improve coordination. Unique space capability acquisition, development. Need for cohesion across civil/defence to leverage dual-use capabilities
Drive UK exports	Export target of £25B by 2030 unlikely to be met based on current trends	Improve coordination, communicate future government plans, improve predictability of funding
Capture high-value opportunities through increased investment in National Space Growth Programme	Current national space innovation programme cited as not fit for purpose with limiting structural flexibility, challenging contractually, and difficult to spend project budgets in prescribed (multi-month, rather than multi-year) timelines	Match spending with peer nations. Need for larger scale, better structured national space programme, accelerate efforts to identify and replace investments in EU-funded activities (where appropriate) and large programmes such as UK GNSS
Ensure skills are in place for the UK to develop space-related opportunities	There is evidence of a UK skills gap in space particularly for technical skills, including in public sector	Develop shared training. Need to ensure Brexit-related disruption doesn't stymie skills availability. Accelerate provision of training-support entry routes post-A-level. Increase funding to develop technical skills, especially software development

competitive pressure is applied to larger prime contractors through appropriate incentive structures, including requiring a minimum funding allocation to SMEs (e.g., 25% in Germany) for ESA mandatory programmes. The UK also has a lower threshold of co-funding for some important programmes; 50% co-funding is provided by the UK government, compared to 70% co-funding provided by some other nations, thereby making it more challenging for UK companies to commit to competitive levels of co-funding under ESA programmes. The lack of a clear, intentional strategy for the UK's relationship with ESA undermines the UK's return on investment. Moreover, increasing EU participation in ESA may limit UK influence.

BryceTech assessed recommendations from both the 2010 and 2015 IGS reports (as summarised below). The UK has achieved success and made progress in a number of areas such as previously defining and implementing a national space policy, establishing a national executive space agency (UKSA), establishing a hub and spoke network to link UK centres of excellence (Satellite Applications Catapult), and seen growth in regional space clusters such as Harwell.

The goals the UK has not met include doubling space spending, increasing anchor tenancy agreements/capital guarantees, procuring space services for UK public sector needs, driving UK exports,

capturing high value opportunities through a substantial national space programme, and ensuring workforce skills development. These areas for improvement are summarised in the table.

Challenges to Government Procurement

Since exiting the EU, the UK government has proposed to streamline the multiple frameworks of procurement regulations into a single, uniform set of rules for all contract awards, supplementing this with relevant sector-specific rules (e.g., in defence or utilities sectors), and includes:

- Transparency throughout the commercial lifecycle (from planning through to completion)
- Requiring all contracting authorities to implement the Open Contracting Data Standard and to publish contract amendment notices

- Inclusion of 'crisis' as a new ground on which limited tendering can be used
- Reforming the process for challenging procurement decisions
- Achieving value for money is anticipated to remain focused on securing the best mix of quality and effectiveness, while ensuring social value is included when drafting contract terms and evaluating tenders.

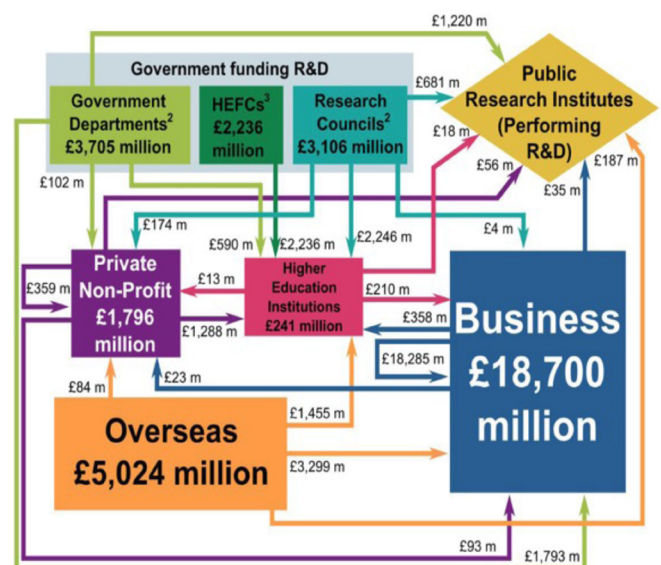
Existing rules are being overhauled and replaced with three procedures (among other changes):

- Flexible procedure giving buyers freedom to negotiate and innovate optimally
- Open procedure for simpler, 'off the shelf' competitions
- Limited tendering procedure for buyers to use in certain circumstances (e.g., crisis/extreme urgency)

These changes provide a unique opportunity to intentionally leverage innovative procurement mechanisms to drive economic growth through a simplified regulatory regime. Having the right regulation in place has the potential to improve outcomes for government buyers, increase transparency for potential suppliers, and catalyse economic growth.

Procurements are typically designed to ensure fairness, compliance, and competitiveness. Serving those objectives can be a challenge particularly for space activities where the high barriers to entry result in a limited competitive environment. This can come in multiple forms such as an industrial base that does not have multiple companies providing a complete product or where there is only one supplier providing components/subsystems. The US, for example, has historically awarded contracts or provided support to certain companies to ensure assurance of a given capability (e.g., ULA received a \$1B annual contract to provide assured access for national security launch). Choices about procurement approaches, contracts, and types of awards need to consider the ability to meet national goals and balance government as a major customer with being one customer among many.

Business funded more than half of total R&D expenditure in the UK. Source: Office for National Statistics (2019).



According to the Office for National Statistics, current total R&D expenditure in the UK was £34.8B equating to 1.69% of GDP in 2017 and far below the OECD average of 2.4% of GDP. More than half of the total (£18.7B) was funded by UK businesses, with government funding 20% (£6.8B), and approximately £5B (14%) stemming from overseas investment.

Through transparency and predictability of funding and the use of innovative procurement mechanisms, government can provide the impetus for increased business investment in R&D, thereby reducing the government's R&D funding burden, particularly for capital-intensive sectors.

Space ventures are often capital-intensive and high risk, with long return periods, and requiring unique advanced technologies. These factors contribute to perceptions of risk and sometimes impede financing through traditional approaches. In addition, it is generally accepted that in an advanced technology industry such as space, there is an ongoing, critical role for government to assist in reducing technology risk, especially at low levels of technology maturity and the need for access to space in order to test/demonstrate capability. As technologies mature, they are more likely to attract commercial R&D funding to move them up technology readiness levels and onto the

path to commercial viability. Facilitating new capabilities and growth of new companies comes with a degree of business risk, so government is, by definition, accepting a level of risk as a result of these procurement activities.

A key issue for companies is the generation of demand—the investment required by a company to create an operational service can be quite high and typically only justifiable for a sufficient volume of users of that service and/or one or more large customers that can substantially contribute to capability development. This creates a large commercial risk and can undermine competitiveness, particularly in relation to countries that actively procure services/products, support capability development, and help offset some of that risk. Early-stage companies may also run the risk of over-reliance on government grants, as opposed to using them as an effective tool to drive growth. Venture investors are particularly attracted to companies with viable ability to scale and potential for sustained, high quality sources of revenue. Government revenue that is designed to reduce technology risk (typically one-off) or to demonstrate capability is important and provides the credibility, influence, and impact of government backing. Furthermore, innovative procurement can play a key role in supporting the business cases of companies through the predictable, high-quality nature of this type of customer. Attracting large amounts of risk capital can support capability development, attract further inward investment, and drive exports.

Innovative space procurement can have the dual effect of attracting increased private investment and meaningfully contributing to the UK's commitment of increasing R&D expenditure, particularly given the R&D intensity of the sector. Innovative procurement can help address technical and commercial risks, provide investor confidence, accelerate technology development and adoption, and ensure critical space capabilities are available to meet future UK needs and drive economic growth. Furthermore, innovative procurement can support bilateral programmes with countries outside Europe, an important factor in a post-Brexit environment.

Innovative Procurement to Drive Investment, Grow Markets

Innovative procurement approaches have been leveraged by leading space nations to support capability development, while taking advantage of and supporting the growth of private investment. The US, for example, has multiple long running and well-funded programmes, as well as contracting mechanisms across civil, defence, and commercial markets. Increasingly, the US seeks to apply commercial capabilities to meet changing requirements, to take advantage of innovation, and to reduce costs. China has multiple high-risk/high-reward initiatives underway, additional programmes planned, and has overtaken the UK in recent years with the second highest investment in space start-ups behind the US. The EU continues to play a leading role and is among the top four in terms of spend on space, including flagship space-focused programmes such as Galileo and Horizon Europe, alongside its ESA funding, future EU Agency for the Space Programme (EUSPA), as well as plans underway for a new broadband constellation and a new venture investment initiative called Cassini.

BryceTech analysed international government actions that attracted private investment, including successes and failures, identifying comparisons and specific contracting mechanisms across a range of circumstances for implementing policy and delivering capabilities through government-industry activities.

Government actions aligned with private investment

Intentional government action, such as anchor tenancy, public-private partnerships, direct and targeted funding, and export financing, can directly support economic growth and stimulate further private investment while achieving national space goals. Multiple international government examples were identified where government action aligned with private investment. For example, the US government has addressed defence objectives for responsive launch as well as the need to transport cargo and astronauts to the International Space Station through

innovative commercial procurements. NOAA assessed the potential for radio occultation data provided by private companies through initial R&D funding as part of its Commercial Weather Data Pilot, which concluded in a report that stated, “the commercial sector is capable of providing the quality of data needed to help support NOAA’s operational weather forecasting needs”. In 2020, NOAA awarded its first contracts as a key anchor customer to purchase radio occultation data for operational use from commercial satellite operators Spire and GeoOptics. The table shows the combination of mechanisms and the private investment that was leveraged in these and other programmes.








In some cases, government action also led to unexpected outcomes, ranging from loss of investment to changes and realignment of approaches. For example, the Luxembourg government had to write-off a €12M investment in Planetary Resources, a company with goals of mining asteroids, after the company went through financial difficulties.

Multiple case studies, shown in the table, also provided a representative view of government action leading to additional private investment. These support mechanisms are leading to increased private investment, either as a direct result or an indirect stimulant, driven by the credibility, influence, and impact of government backing. Several examples are described on the next page.

Examples of innovative government space procurement actions.

Example	Government Support	Private Investment
NASA US DoD/SpaceX	Anchor tenancy, R&D funding, direct funding	Substantial (\$10s of billions)
Norway/Polar Satellite Procurement	Public-private partnership, Targeted investment	Moderate (<\$1B)
US DoD/Rocket Lab	Targeted investment, early-stage R&D investment	Substantial (>\$1B)
ESA/Airbus Digital Processor Payloads	Public-private partnership, R&D funding	Moderate (<\$1B)
MoD/SkyNet 5 PFI	Public-private partnership	Substantial (>\$1B)
NOAA/Spire and GeoOptics	Anchor tenancy, R&D funding	Moderate (<\$1B)
UK MoD/Airbus Zephyr	R&D funding	Moderate (<\$1B)
DARPA/ForAllSecure	Anchor tenancy, prize funding	Minimal (early-stage start-up)
Coface financing/Iridium NEXT	Export financing	Substantial (>\$1B)

Case studies of government action aligning with increased private investment.

UK Case Studies		Goonhilly government investment led to private investment, development of new capabilities	<i>£8.4M investment from Local Enterprise Partnership to £24M private investment from billionaire</i>
		Isotropic Systems collaboration with US DoD led to substantial investment raise	<i>Awarded US Defense Innovation Unit contract, UK grant funding, subsequently raised \$42M</i>
		Rezatec ARTES funding led to new multi-million-pound revenue stream	<i>Received £720K ARTES funding for M3i demonstration project, subsequently raised £5M Series B round</i>
		Oxford Space Systems’ ARTES funding led to new products, attracted private financings	<i>Undertaken multiple ESA ARTES projects and successfully raised over £12M in private capital</i>
Non-UK Case Studies		Astroscale awarded government space debris contract, raised new financing round	<i>Awarded multi-million-dollar contract to inspect launcher upper stage, subsequently raised \$51M</i>
		Axiom Space attracted commercial investment as well as government contract award	<i>Awarded a \$140M NASA contract, subsequently raised \$130M Series B round</i>
		US national policy led to significant international contracts for Maxar	<i>US government policy change and contract awards led to Maxar expanding its international sales</i>
		Orbit Fab’s successful in-orbit demo led to greater private investment	<i>\$3M contract award from the US Air Force, helped raise millions from private investors</i>

Local government investment in Goonhilly led to private investment and development of new capabilities. An £8.4M investment from the Cornwall & Isles of Scilly Local Enterprise Partnership into Cornwall-based Goonhilly, a leading provider of satellite ground station capabilities led to a £24M in private investment by billionaire Peter Hargreaves, enabling Goonhilly to triple its workforce, diversify into multiple revenue streams across supercomputing platforms, datacentre, AI and ML, and super cooled quantum computing. According to Goonhilly CEO, Ian Jones, government acting as an anchor customer would lead to the company becoming one of the large space companies in the UK. *Government support: Local government direct investment.*

Isotropic Systems collaboration with US DoD led to a substantial investment round and growth capital. Isotropic Systems is a privately funded company founded in 2013 and based in Reading that is developing user terminals to support multiple user links over multiple frequency bands. The company has been working with SES to demonstrate its terminals and conducted a test with the US Army in 2020. The company also won a US Defense Innovation Unit contract to trial optical beamforming technology for naval communications. The company recently won a UKSA grant for commercialisation of next-generation ground antenna and successfully raised \$42M from existing and new corporate and venture capital investors, resulting in over \$60M total fundraising since being founded. *Government support: US DoD as trial customer, UKSA grant funding.*

Astroscale awarded government space debris contract and signal potential as a customer, supported new financing round. Astroscale is a privately funded in-space services and debris removal company founded in 2013 and based in Tokyo, Japan with offices in the US and UK. In 2020, JAXA awarded Astroscale with a contract to send a spacecraft to inspect a discarded Japanese upper stage, the first step toward a debris-removal mission. The mission is Phase 1 of JAXA's Commercial Removal of Debris Demonstration (CRD2) and is targeted for launch in 2023. A follow-on contract would involve Astroscale deorbiting this upper stage by a specific date. Astroscale recently raised \$51M from private investors bringing total investment raised to over \$190M. *Government support: government as anchor customer.*

Axiom attracted commercial investment following government contract award. NASA's support of the commercialisation of the low Earth orbit environment has facilitated substantial private investment, including a \$130M investment in Axiom soon after it was awarded a \$140M NASA contract, with further plans underway through NASA's Commercial LEO Development programme. *Government support: government as anchor customer.*

Benefits of Innovative Procurement to UK Government

Innovative procurement of space products and services will allow the UK government to leverage the current influx of commercial space investment and business activity. The prosperity and security benefits to the UK of innovative space procurement include:

Leveraging Investment, Reducing Costs

- Stimulating increased inward investment and VC investment generally by helping to commercially de-risk new businesses/capabilities
- Reducing costs of achieving national space goals by enabling the government to co-invest and risk-share with industry, including to support R&D investment growth
- Eliminating duplication and waste in space acquisitions
- Delivering value for money for the UK taxpayer by sharing the costs of creating new space infrastructure with other customers

Increasing UK Space Power

- Expanding UK space capabilities, delivering enhanced consumer telecom, improved national defence, and the many other space applications that result in space being considered critical national infrastructure
- New desirable capabilities to meet broader government objectives, such as data analytics combined with satellite imagery for public sector needs
- Improving capacity and resilience of the UK space and advanced technology supply chain
- Enhancing UK soft power and alliances through shared use of space capabilities

Driving Economic Growth and Exports

- Stimulating exports by validating UK space products and services through UK government use of those products and services
- Increasing competitiveness of space products/services, providing more options for government buyers
- High-value job creation throughout the space supply chain, which ranges from manufacturing to AI, robotics, autonomy, and quantum applications in the futures

Recommendations for Enhanced UK Outcomes

Based on an analysis of space trends, assessment of progress against policies, and interviews with nearly 40 global business and government leaders, BryceTech has developed strategic recommendations that incorporate innovative procurement into UK space activities. Procurement models with the highest potential of supporting UK space sector growth were identified and ranked based on analysis of prior successful international programmes and attractiveness to investors, and considering interview insights (as shown in the table). The recommendations focus on four models that were identified as the most attractive to investors: anchor tenancy, public-private partnership, targeted investment, and export finance support, and are underpinned by a fifth recommendation addressing overarching issues. The UK is not using all available levers as effectively as other leading space nations do and the approaches identified can augment existing structures and help stimulate innovation.

Procurement models to support UK space sector growth.

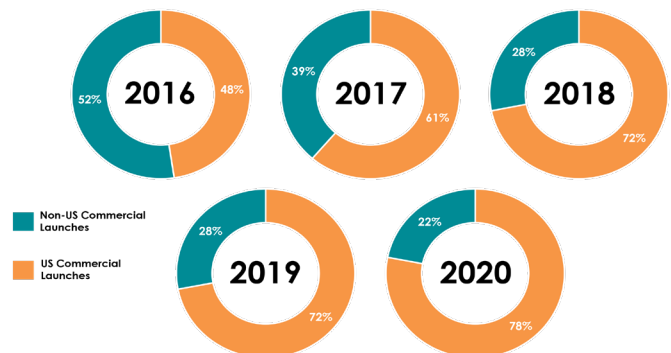
Procurement Model	Attractiveness to Investors	Comment
Anchor tenancy	Very High	Cited most often by investors as a specific, highly credible approach to supporting sector growth, spurring industrial investment, and attracting private investment
Public-private partnership	High	Multiple successful examples (including UK Skynet PFI), though success dependent on execution, alignment with national goals
Targeted investment	High	Commercial stakeholder involvement cited as crucial for ensuring successful outcomes, adding credibility to investment appraisal, and increasing attractiveness for further financing
Export finance support	High	Potential for increased investment when leveraged appropriately, need for stronger risk appetite (esp. for <£100m funding needs)
R&D funding	Medium	Strategic alignment, complementary industry-academia engagement, and substantial funding (>£1m) aligned with broader procurement strategy can increase potential for successful outcomes
Grant funding	Medium/Low	Important tool that should continue to be leveraged for early-stage tech development. Limited attractiveness to investors, particularly for small grant sizes and companies that become overly dependent on grant funding

The recommendations seek to draw on government-wide approaches to procurement that foster international relationships, attract investment, expand markets, and increase soft power. Adopting the right procurement mechanisms in the right way will improve outcomes, reduce waste, and deliver UK space success, while also developing new ways of engaging with industry. Based on Phase 1 analysis of the wide range of available approaches, Phase 2 of this study will result in suggested specific procurement mechanisms and a proposed pilot programme.

Act as an anchor tenant for space firms that offer products and services relevant to government needs

Anchor tenancy, or guaranteed government business, contributes to business success by providing predictable revenue, validating operational concepts, and reducing future uncertainty. This is attractive to both investors and customers. Anchor tenancy has been a particularly important approach to encouraging the private sector to invest in space-based capabilities. For example, NASA's use of procurements and space act agreements as an anchor customer of Commercial Crew and Cargo Transportation services led to billions of dollars of additional private investment and helped grow the US market share for commercial launch services, while saving the US government billions relative to traditional procurement. NOAA has also played an important role in supporting earth observation companies, Spire and GeoOptics, by incorporating their weather mapping capabilities into operational weather forecasting through multi-million-dollar indefinite delivery-indefinite quantity contracts and supporting the development of emerging solutions. Anchor tenancy can be instrumental in helping to evolve an emerging market to a sustainable one. Anchor tenancy has also been referenced as a suitable approach since the 2010 IGS and was recently highlighted in the Prosperity from Space report released by the Space Growth Partnership in 2018.

Innovative procurement approaches helped grow the US market share for commercial launch services. Source: BryceTech.



This mechanism has been cited most often by investors as a specific, highly credible approach to supporting sector growth, spurring industrial investment, and attracting private investment. It is particularly suitable for capabilities of strategic importance that do not require significant maturation of technologies. This mechanism can be implemented by developing a framework that ensures competitiveness, transparency, and effective government insight into capabilities. Capabilities that have other likely customers beyond the UK government are particularly relevant for this type of procurement. This should ideally be leveraged alongside early-stage R&D, targeted investment, and public-private partnerships to foster innovation and support technology maturation.

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Develop strategic public-private partnerships

Public-private partnerships feature co-investment, whether direct or in-kind, by government and typically one or more firms, to share costs and risks in developing new capabilities. For example, the Arctic Satellite Broadband Mission (ASBM) led by the Norwegian military partnered to share satellite payload space with the US DoD and Inmarsat to support development costs, making the system feasible within Norway's available budget. SpaceX and ULA were both awarded multi-billion-dollar, multi-year National Security Space Launch (NSSL) contracts by the US DoD, as part of a highly competitive process to select providers of assured launch capability for military missions. Public-private partnership success is dependent on execution as well as alignment with national goals.

This mechanism is particularly suitable for capabilities of strategic importance that require significant technology development. This will likely require an approach that involves substantial government oversight and partners that have strong alignment with national goals. This type of procurement is likely to be leveraged on a stand-alone basis for large programmes that require substantial government and industry investment to support technology maturation and capability development. For example, this mechanism could be used to establish a testbed for demonstrating the application of commercial capabilities to military needs, to reduce risk and uncertainty and facilitate use by the US, and other allies. UK has a unique opportunity to serve as a testbed to demonstrate that desirable capabilities can operate successfully within UK military and intelligence operational parameters, and by intentional extension, those of the US and other key allies. This can create a path that allows the UK to provide unique and important capability while contributing to UK economic prosperity. Such a testbed programme could work with companies to facilitate compliance with security requirements and retire both security and performance risks.

Spotlight: In-Q-Tel Model Viewed Favourably by Investors

- In-Q-Tel's (IQT) mission is to identify and invest in companies developing cutting-edge technologies that serve US national security interests
- Invested \$100s of millions in over 200 companies and represents government interests in investment community by making investments in firms whose products or services address a specific government need
- Widely respected by investors as judges of capability. Their involvement has helped draw in co-investors and additional private capital
- IQT also buys products/services as an initial customer, with requests for specific features to meet national security needs

Consider direct investment to ensure UK access to unique capabilities or to accelerate the availability of products/services that meet clear needs

Directly investing in targeted opportunities provides capital and also creates confidence for investors, strategic partners, and customers. As an example of meeting government needs, In-Q-Tel, a US government-funded investor, is widely viewed as a success. In-Q-Tel participation signals government is a potential customer and also government's confidence in a business's technology and business plan. As an example of gaining access to unique capability, the UK investment in OneWeb has attracted private investment from Bharti and other investors and is likely critical in securing \$1B in additional funding needed to complete the Gen 1 constellation, though no specific government use cases has been definitised.

The UK benefits from the extensive space capabilities of its closest allies, notably the US, other Five Eyes nations (Canada, Australia, New Zealand), and Europe. While the UK is generally viewed positively as a space partner, it does not deliver any major space capabilities that are uniquely relied on by other nations. To strengthen existing partnerships and enable new coalitions, UK space programmes should include the development of unique capabilities of value to its allies. Without the ability to make important contributions, the UK risks its strong position as a favoured space partner, when coalitions are absolutely necessary for future national security.

This mechanism should ideally be developed with a clear rationale for investing that maps directly to national goals and aligns with commercial opportunities. A number of investors commented that government investment alongside commercial investors can be crucial for ensuring successful outcomes by adding credibility to investment appraisal, and increasing attractiveness for further financing.

Ensure export finance support is flexible to changing market needs and levels of financing requirements, while being attractive to private co-investors

Commercially appealing, scaled, export finance support can play a critical role in plugging gaps in available commercial lending and position UK industry competitively in international markets. Export finance allows government to provide a meaningful commitment and competitive advantage to industry without the risk profile of ownership, providing the patient capital often required by space projects with uncertain and lengthy return profiles. For example, the French export credit agency, Coface, provided an attractive financing package that ultimately led to Iridium choosing Europe's Thales Alenia Space over Lockheed Martin for its \$3B constellation, supporting job creation, and capability development. The opportunity exists for the UK to evolve export finance from a traditional focus on large-scale, often satellite-focused, transactions to more flexible financial structures, available to wider sections of UK industry, focused on targeted market opportunities or strategic capability development. Export finance is crucial for a lot of markets and is even more crucial in a COVID-impacted world where some companies are cash-limited and the internal appetite to self-fund is vastly reduced.

This mechanism should be developed to optimise risk taking for different levels of financing needs, with lower financing needs having lower associated risk thresholds. Export financing could be better used to support co-investment in the \$10-100M range with a higher risk appetite than for larger, more expensive investments. This more flexible approach has the potential to increase commercial activity and provide greater opportunities for sector growth.

Support innovative procurement with appropriate resourcing and clarity about future plans

The UK should consider matching the spending of peer nations to improve competitive edge and take full advantage of innovative procurement, ESA membership, and drive growth. France, Germany, and Italy spend about 0.05%+ of GDP while the UK spends half that amount. Moreover, a substantial portion of peer nations' spend is on national space programmes, separate to their ESA contribution. This disproportionate spending has an adverse impact on UK competitiveness and enables peer nations to support and strengthen capability development, increase heritage, and better position companies to win ESA contracts.

It will also be important to communicate future government plans and improve predictability of funding to increase today's investment and align industry capabilities to national objectives. When government reduces future uncertainty about its intent as customer and as regulator, outcomes tend to improve. Businesses can plan and develop future capabilities to meet long-term government needs, improving both business outcomes and government mission results. Uncertainty about government intent chills investment; investors see risks in unanticipated regulatory action and shifting government priorities. France, Germany, USA, and others are seen as providing more clarity on future government intent, facilitating efficient decision-making by businesses in those nations. Without transparency about future intent, the UK is forgoing these benefits; with transparency, for the same future budget, the nation realises benefits now, before future spending occurs. Transparency to facilitate industrial investment and supporting sector growth can come in the form of predictable, consistent, multi-year (3+ years) funding, regulatory consistency and predictability, and characterisation of longer-term intent regarding government acquisition of space products and services.

UK civil and defence space organisations—as well as industry—face a challenge in building space-specific expertise, in the areas of technology, policy, and economics, as they grow. UKSA has added close to 150 staff since 2015. The recent integrated defence review prioritised more than £6.6B for research and development allocated over the next four years and specifically outlined space as a priority area, with the standing up of the UK's Space Command, alongside the Space Directorate. This growth and increased focus on space creates an opportunity for cost-effective shared education and training that will, first, help build critical expertise in the changing technology areas shaping space activities, such as robotics, machine learning and artificial intelligence, advanced materials, and autonomy, and, second, to build shared perspective and interagency relationships in the UK space enterprise to facilitate programme planning and effective policy.

The UK is taking action to better integrate space decision-making through the recent establishment of a National Space Council chaired by the PM, as well as the ongoing civil/defence national space strategy; a key next step will be building and maintaining institutional structures for integrated decision making. Aligning critical UK supply chains with domestic needs, using the right procurement mechanisms for SMEs, and leveraging national consortia will support the development of resilient and expanded capability, including attracting investment by new industrial partners. A key element of this will be to develop an appropriately organised inventory of UK capability that is mapped to national requirements, as well as ongoing interaction with industry through industry days, skills training opportunities, and transparent communication of opportunities to UK entities.

About BryceTech

BryceTech is an analytic consulting firm serving government and commercial clients. Bryce provides unique, integrated expertise on the space economy.

Bryce's expertise includes market analytics, technology readiness, cybersecurity, policy and economics, and strategy. Many authoritative data sets characterizing the space industry and sub-segments were originated by our analysts. We understand the interplay of national security, civil, and commercial space programs, capabilities, and markets.

Find out more at: brycetech.com