

Prosperity from space

A global partnership strategy for the UK



Cover image: Britain by night from the International Space Station during Expedition 27 in 2011, copyright Paolo Nespoli / European Space Agency

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Orbital Intelligence, Airbus, Teledyne e2V, ViaSat, CGI, University of Leicester, National Centre for Earth Observation, Earth-I, Satellite Applications Catapult, Airbus, Telespazio VEGA, In-Space Missions Ltd., Avanti, Inmarsat, Methera, Hughes, Reaction Engines, Lockheed Martin, BAE Systems, GMV, Thales Alenia Space, Microcross Components, MDA, Astroscale, OneWeb, the Satellite Finance Network, Bird & Bird, SSTL, Elecnor Deimos, EarthSense Systems, The National Space Academy, ESA(ECSAT), Surrey Satellite Technology Ltd., 4Links Ltd., Blue Abyss, QinetiQ, Honeywell, Intelsat, Bluestone



Innovate UK



**Department for
International Trade**

Foreword

Space is changing. Almost every week we seem to watch breathless as a new breakthrough hits our screens or marvel at the information relayed from constellations of satellites strung around the globe.

The UK continues to punch above its weight in this New Space revolution. Our small and nano satellite manufacturers, instrument makers, data scientists and satellite operators are leading the way. Building on our world class science base; international collaborations via ESA and elsewhere; and strong institutions such as the UK Space Agency and the Satellite Applications Catapult, the sector is bringing the benefits of Space to all of us here on Earth. Whether we are finding our way around, being entertained, communicating on the move; protecting our planet or protecting our borders; or driving productivity in Sectors across the UK economy, Space technology is silently delivering for us all-wherever we live and whatever our role in society.



This Industry-led Sector Strategy sets out the ambition of the companies, institutions, academics and entrepreneurs of the UK's Space Sector to work with Government to ensure the UK continues to lead the way. We aim to build and finance great UK businesses, attract inward investment, deliver breakthrough research and create high productivity jobs across the UK. We will launch Satellites and Space missions from the UK and improve productivity, communications and security nationwide.

Those benefits in themselves justify continued co-investment between Government and Industry. Add to that the unique role Space plays in inspiring the young scientists and engineers who will drive our future economy, and its ability to remind the world of the leading role the UK plays in all advanced technologies, and the case is compelling.










We look forward to working with you all to deliver a prosperous, forward looking UK, based on out of this world Space technology.

Andy Green

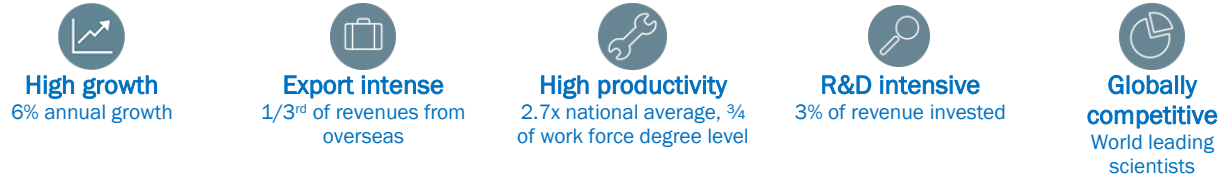
Chair of the Space Sector Council

President of UKspace

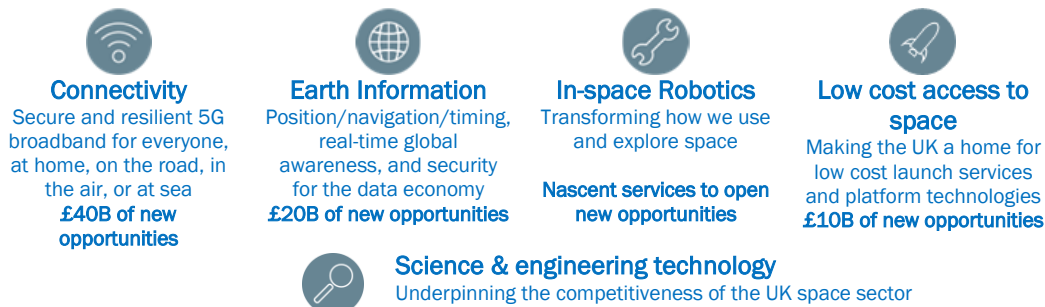
Table of contents

	Summary of our strategy and sector deal proposition	6
	Build on our success together	14
	Create a National Space Programme	18
	Create the business environment for success	27
	Invest in our people and places	35
	Continue to drive growth from ESA, Eumetsat and EU programmes	42
	Delivering on the promise	44
	Financing a Sector Deal	49
	Annex: Market Challenge Teams	52

STRONG FOUNDATIONS



BUILDING ON OUR STRENGTHS



Contributing solutions for :

The AI and data driven economy

The future of mobility

Clean growth

Aging society

DELIVERING OUR PROMISE





Summary of our strategy and sector deal proposition

A sector with strong foundations

The UK space sector has trebled in size since 2000 and decisive steps have been taken since 2010 to raise the UK's share of the expanding global space economy from 6.5% to 10% by 2030. Space data supports 14% of GDP and continues to grow.



High growth
6% annual growth



Export intense
1/3rd of revenues from overseas



High productivity
2.7x national average, ¾ of work force degree level



R&D intensive
3% of revenue invested



Globally competitive
World leading scientists

Time to build on our success

The global space market is undergoing a revolution. Commercial organisations, working closely with governments, have plans to monitor the planet day and night, provide broadband to even the remotest spots on earth, mine asteroids, and colonise Mars. The UK punches above its weight in space and space services underpin industries representing £250B of annual UK economic activity [1]. As the economy becomes increasingly digitalized this dependency will only increase. Key trends include:

- ✂ The market is undergoing an inflection and the space sector rapidly changing due to a commercial revolution as the demand for data and connectivity grows exponentially
- ✂ Although competitive, the sector needs to 'up its game' to compete in global markets against increasingly aggressive competition
- ✂ Private capital is emerging as a 'game changer'
- ✂ The role of Government will change as sector commercialises:
 - Regulating for new commercial activities in space
 - Using smart procurement to incentivise entrepreneurs to invest (e.g. US has built a fully commercial launch programme from such incentives although the US Government remains the anchor customer)
- ✂ Increasingly significant involvement of UK businesses in EU operational space programmes makes it crucial that industry secures either access to these programmes or identifies commercial and industrial opportunities to address shortfalls in activity

Our response builds on and delivers the Space Innovation and Growth Strategy (IGS) developed by the sector since 2009 [2] :

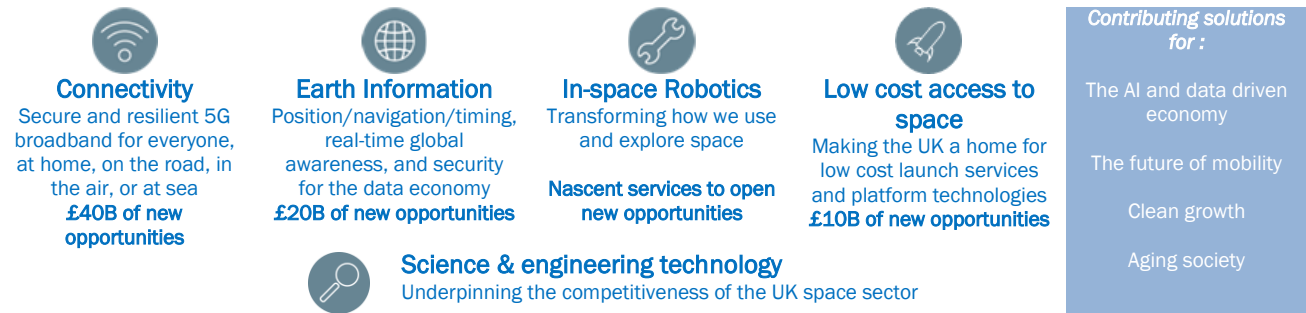
- ✂ Driving into the £75bn in new global market opportunities identified
- ✂ Taking advantage of commercialisation by moving quickly to a new eco system
- ✂ Increasing space connectivity to deliver the access needed for ubiquitous, resilient and on-the-move connections demanded by enterprise and consumers
- ✂ Scaling up the use of space data across the economy by using AI and improving analytics
- ✂ Securing the bridgehead into new commercial launch, constellations and robotics services
- ✂ Participating in 'next generation' exploration missions, e.g. navigation, communications and robotics for commercial missions to the Moon

A strategic **Space Growth Partnership** ('SGP') comprising industry, academia and Government will achieve our 10% target of the Global space economy by:

- ✂ **Developing new Global Partnerships for science and exports** to underpin new export campaigns and new markets for UK excellence in space science and missions
- ✂ **Making the UK a hub for new commercial space services** that attracts new entrepreneurs, stimulates the development of innovative products and increases investment for SMEs and start-ups
- ✂ **Using Space Data and AI to drive productivity growth** in space-enabled sectors of the UK and overseas economies

Building on the UK's strengths and entering new markets

Based on an assessment of the strengths of the UK sector and market analysis including £75B of future market opportunities, we have identified 5 key areas to drive forward under our strategy which also support the delivery of solutions to the Grand Challenges identified in the Government's Industrial Strategy. Our strategic priorities align with a portfolio of over 40 industrially led initiatives accompanying the strategy and shaping the delivery plan.



A strategy anchored in a sector deal

Our strategy is ambitious, but achievable with the help of the Government's Industrial Strategy.

We will deliver growth in these areas through 4 four strategic actions, illustrated in Figure 1:

- (1) create a **National Space Programme**
- (2) **create the business environment for success;**
- (3) **invest in people and places** to deliver high productivity jobs in science and industry across the UK and inspire young people to study STEM subjects; and
- (4) continue to drive **growth from** our investment in ESA and **European Programmes**.

This will provide the basis to raise sector growth from 6% to 9% each year needed to secure the 10% target share of the global space economy by 2030

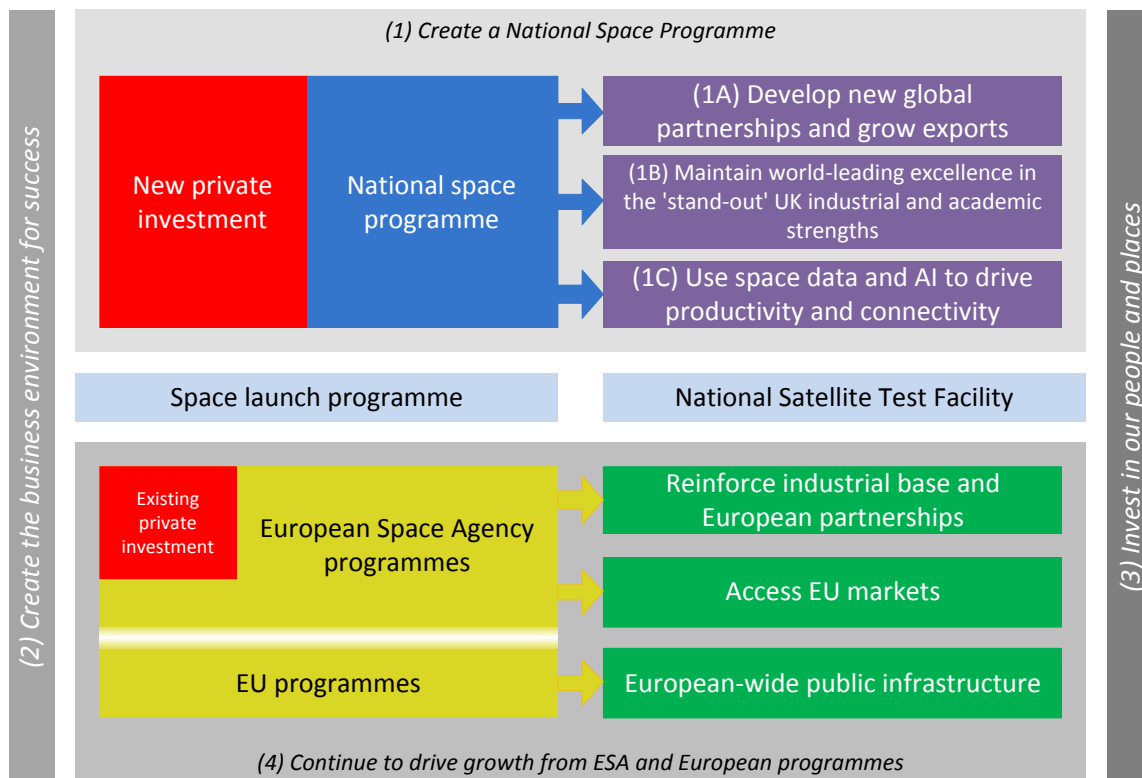


Figure 1. Our strategy creates new activities required to accelerate growth, whilst securing the fundamentals in the European programmes

(1) Create a National Space Programme

The UK has a unique space programme based on partnering and co-funding. The industry is R&D intensive (3.0% of revenue in 2015 [1]) and business has indicated it is ready to invest more in the UK. However, accelerating growth, and responding to the market tipping point, requires a predictable background for investors to develop technology ready for a global market. We therefore propose [the creation of a National Space Programme](#) starting with an additional investment of £600M in UK space research and innovation over the first 5 years, with £320M from industry and £280M from the Government, **starting with a wave 3 bid to the Industrial Strategy Challenge Fund (ISCF)**. Industry has already come forward with a portfolio of outline business propositions with a combined pledge of private capital subject to detailed business case development and enabling actions. The proposed programme would be complementary to our ESA subscription, described in (4), and, although it would not be as large as other European countries', it would enable the UK to compete due to co-funding and a market oriented approach. The programme will have 3 key components:

(1A) Build new global partnerships and exports

Building non-EU exports is a key challenge set by the Government. Market analysis indicates there are new global opportunities worth at least £75B per annum. Our strategy to access these markets is based on a partnership between industry and Government to build trusted international relationships. At the same time, space businesses are highly mobile and ambitious. This presents the challenge of retaining companies in the UK but also creates the opportunity to attract new investment. We will use our partnership to develop [Space Is GREAT export campaigns in targeted space markets, as well as conduct joint science and innovation based missions. We propose that the National Space Programme includes a dedicated budget for bi-lateral and cooperative missions with international partners to open new export opportunities. We will establish a Space Trade and Exports Group and deliver an UK Space Trade and Exports Strategy in 2018.](#)

(1B) Maintain world-leading excellence in the 'stand-out' UK industrial and academic strengths

We will focus the National Space Programme on the industrial and academic strengths identified above to de-risk new technology to be a first-mover in new commercial markets and strengthen science funding. [\(1B\) Guided by market analysis and reviews of industrial priorities carried out by the SGP, we propose to focus the National Space Programme on 5 key areas: Connectivity, Earth Information Services, In-space Robotics, Low cost access to space, and Science & Engineering Technology.](#) Table 1 highlights detailed actions under each area and also illustrates the mapping to the Grand Challenges.

(1C) Use Space Data and AI to drive Productivity in Sectors across the UK Economy

Space is an underpinning technology which supports productivity in all sectors. Space data and AI create exciting new opportunities for sectors across the UK. Work has begun in areas as diverse as agriculture, autonomous vehicles and mining. We propose to [\(1C\) establish cross-sector teams to develop these opportunities across the UK economy in the National Space Programme](#), building on the key areas identified. By continuing to expand its take-up, we aim to double the value of GDP from industries supported by space data from £250B to £500B.

(2) Create the business environment for success

The UK retains a great reputation for an open and stable legal and economic framework, with good tax and incentive arrangements. Many countries, such as the Netherlands, Luxembourg and Canada, are now stepping up to attract the wave of new investment in space and we have to act now to stay in a leading position. We recommend that [the UK should look to form partnerships on exciting services and capabilities with similarly ambitious nations, as well as continuing to improve its business environment, specifically around access to finance and regulation.](#) To support the new wave of private investment we therefore propose to [\(2A\) improve the entrepreneurial pathway and access to finance.](#) Furthermore, we will need to create competitive support and incentive arrangements to continue to attract the best in the space business. [\(2B\) A cross-Government working group should be set-up to secure high value inward investment,](#) including leveraging the National Space Programme. For Exporters to succeed they need support from a Government in clear and transparent export licensing and financing. By acting as an entrepreneurial investor or anchor/reference customer the Government can give the UK first mover advantage, drive improvements in public service delivery and security. We propose to attract commercial investment to create space infrastructure by [\(2C\) demonstrating how smart Government procurement can be deployed to stimulate commercial investment in UK infrastructure giving the UK first mover advantage and empowering UKSA to become a procurement agency for the rest of Government,](#) for example a pan Government earth information service or broadband for underserved communities.

It is also important to develop domestic and international regulation by streamlining the UK regulatory environment recognising issues raised by new technology and the increasingly competitive international landscape. We propose to deliver [\(2D\) a global, competitive and progressive regulatory regime supported by a dedicated and adequately resourced team.](#)

(3) Invest in our people and places

The growth will require a new generation of scientists and engineers requiring training programmes to match the sector's needs. We will create a skills programme to **(3A) attract and train up to 30,000 additional skilled people by 2030. (3B) We will actively encourage diversity and inclusion in our workforce to ensure fresh ideas and innovation. (3C) We will showcase exciting scientific achievements in space and undertake 1,000,000 interactions per annum with young people to inspire the take up of STEM careers benefiting all high tech sectors in the UK.**

Place is at the heart of our strategy: our Earth Information and Connectivity priorities deliver across the country, bridging digital divides, whilst our Launch priority will seek to accelerate the development of a domestic supply chain supporting the UK's investment in a new spaceport. Growth in space businesses will mostly come from services and applications, and this presents an opportunity to fully engage all regions of the UK as space underpins and increases the productivity of more and more economic activity. A regional strategy encompassing local productivity uplift, training and support to new business is a core part of the strategy. We welcome the Government's initiatives to spread industrial benefit across the UK and **(3D) we will work with LEPs and DAs to develop locally-led regional technology hubs creating a Coast-to-Coast Space Spine across the country.**

(4) Continue to drive growth from ESA, Eumetsat and EU programmes

Our strategy will build upon the bedrock of our relationship with the European Space Agency (ESA). The National Space Programme will be complementary to ESA and a dialogue will be created to take advantage of both approaches. **(4A) We recommend to continue to enhance the relationship with ESA and Eumetsat maintaining at least the current level of investment.** UK companies also play a significant role in EU programmes, such as Copernicus and Galileo, giving industrial critical mass and access to essential European markets, as recognized in the current Government position [29,30]. They also support the critical UK Space Science base. We therefore support the Government's goal to seek to negotiate an ambitious future partnership with the EU and **(4B) recommend that a future UK/EU partnership covers all current and future EU space programmes, or identifies commercial and industrial opportunities to address shortfalls in activity**

Delivering on the promise

We have the basis of a detailed delivery plan, leveraging existing organizations, focusing on our objectives:



Reach 10% of the global space market by 2030, from £13.7B to £40B revenue



30,000 new high-skilled jobs across the UK



Double value of GDP from industries supported by space data to £500B



Attract £500m of equity investment per annum

Achieving these goals requires accelerating the sector growth rate from 6.5% towards 9% per annum. Delivering the recommendations to achieve this will be the responsibility of an SGP Programme Board governed by a Space Sector Council representing industry, academia and Government. The SGP Programme Board will advise on the implementation of the National Space Programme and be supported by an SGP Delivery Team for day-to-day tasks, including the formation of Market Challenge Teams to create pursuit plans for the key growth markets. This will be done by **establishing a Space Sector Deal leveraging the existing Space Growth Partnership.**

Contributing to delivering wider Industrial Strategy

In developing our strategy we have taken care to ensure that we achieve and serve the objectives of the Government's Industrial Strategy. We welcome the publication of the White Paper in November 2017 and our priorities align well with the *foundations of Industrial Strategy*, as shown in Table 1:

Ideas: The space sector is already R&D intensive (3% of revenues spent on R&D). Our proposal will further grow this and focus on turning ideas, supported by market analysis, into commercial success. A stable National Space Programme and smart Government procurement will allow innovative ideas to flourish and scale globally. We include both funding for science-led development of exciting new space technologies in institutions across the UK as well as international collaborations leading to new export opportunities. We have also included two important features: firstly a market-led cross-sector approach to generating and incubating new ideas in the coming years, and secondly the support mechanisms for companies of all sizes to build business around these ideas.

People: Our proposal will generate 30 000 highly paid jobs across the UK and will develop the necessary training schemes to provide the required skills. Space attracts students towards STEM subjects and we will reinforce this both by actively reaching out to students across the UK as well as developing national initiatives which will excite the public. We will raise our game in developing a more diverse workforce from all backgrounds.

Infrastructure: Space is already recognized as critical national infrastructure [7] particularly for communications and Positioning, Navigation and Timing (PNT). Our proposal will provide investment into a new generation of UK infrastructure. With our cross-sector proposals we will contribute to the upgrading and securing of the entirety of UK infrastructure such as trains and roads. Enabling 5G infrastructure for the whole UK, crucial to future productivity, is a key feature. The development of UK launch infrastructure and the National Satellite Test Facility will provide fertile ground for new and existing companies.

Business environment: Our strategy is designed to create the best business environment for space including regulation and finance. A Sector Deal will drive long-term investment by existing and new companies into the UK, including anchoring multinationals in the UK. Our proposals include scale-up support for SMEs and improved access to the large sums of equity finance globally available for space. We have developed a plan to significantly increase space exports from the UK with a range of new approaches.

Place: At the heart of our strategy is spreading the benefits across the UK. Our priorities for Earth Information and Connectivity will contribute to the digitization of the entire country whereas supply chain development supporting the UKLaunch initiative will deliver inspirational new jobs in Scotland or Wales. We will work to develop clusters and hubs across the UK focussing on R&D and training to localize the services we're developing.

Our strategy will also contribute to the *Grand Challenges* identified in the Industrial Strategy white paper:



Growing the AI & Data Driven Economy

Data refinery for EO data
10-fold increase in space communications capacity
Remote sensors IoT connectivity



Shaping the Future of Mobility

Develop connectivity services for connected and autonomous vehicles
Use Earth Information for infrastructure planning/protection



Clean Growth

Build on the UK's expertise in environmental analytics and bring it closer to business decision planning
Improved space based navigation supporting low carbon transport



Ageing Society

Telemedicine for remote locations
Location services for assisted living

National Space Programme priorities

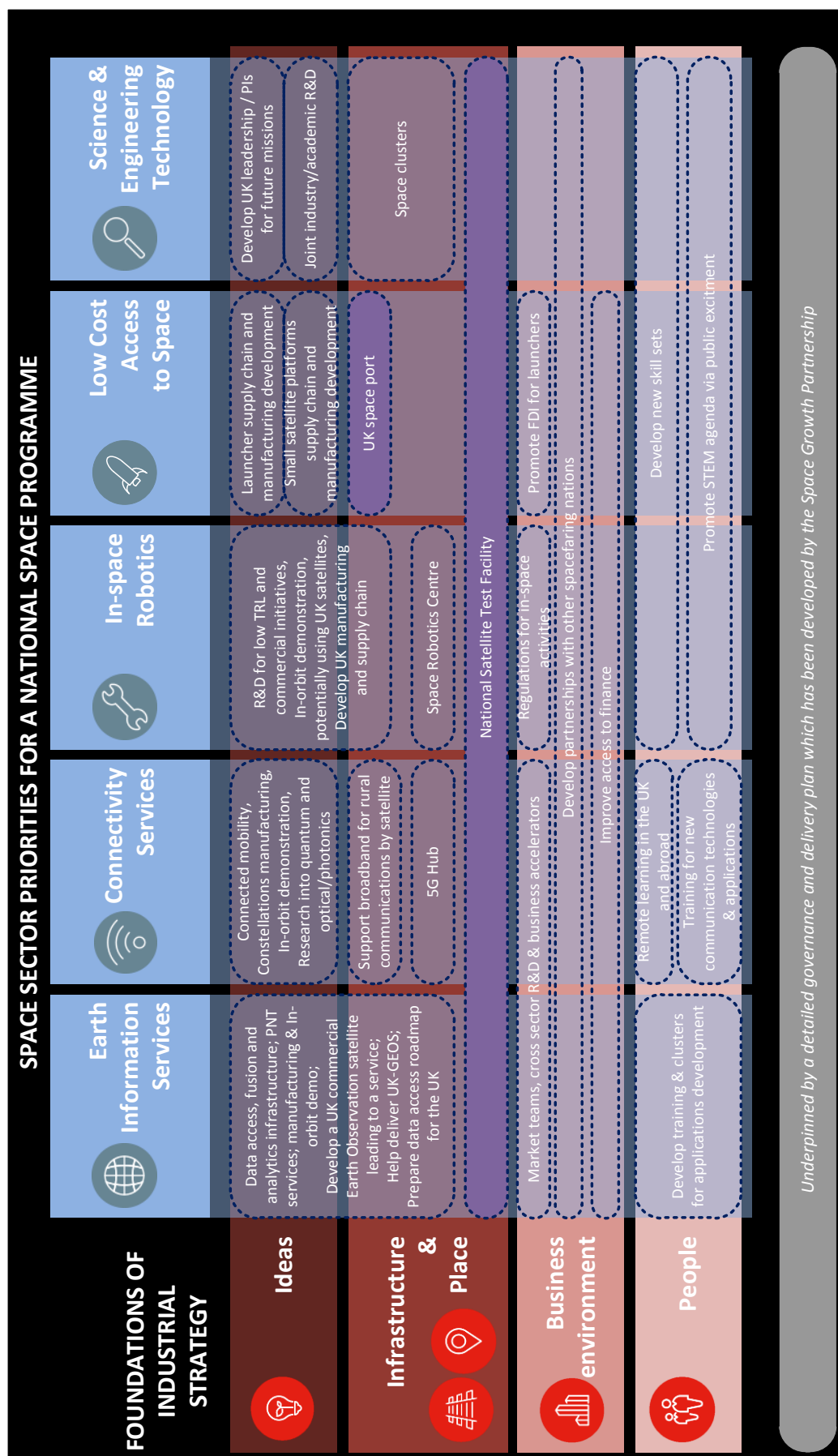


Table 1. Our National Space Programme priorities to accelerate growth have been developed by cross sector consultation and align well with the Government's foundations of Industrial Strategy. (UK space port and NSTF already announced.)



Figure 2. Demonstrating confidence in the sector, the UK Government announced the creation of the National Satellite Test Facility in July 2017 (courtesy RAL)



Figure 3. Our strategy includes accelerating development of the domestic supply chain to support the UK's investment in a new spaceport (image courtesy Machrihanish Airbase Community Company, MACC – one of the candidates)

Summary of actions

In developing our strategy we have identified actions which Industry and academia commit to taking forward. In addition there are actions which require additional investment or Government support to achieving our aims. We propose that these reciprocal activities form the basis for a **Space Sector Deal**.

Industry and academia commitments	Actions requested of Government
<ol style="list-style-type: none"> 1. Industry has put forward over 40 initiatives against which it would pledge £320M subject to business case. 2. Industry has developed two illustrative propositions, based on novel business models, stimulating up to £1B of industry investment in UK space infrastructure. 3. Industry has seconded personnel to support development of the regulatory environment. 4a. Industry will take the lead in running export forums to target priority export markets, seconding personnel to investigate new markets, and support DIT in concluding new trade deals with and beyond Europe. 4b. Industry will lead a Trade and Exports Group to develop a strategy to increase exports. 5. Industry, including the Satellite Applications Catapult, will lead the Market Challenge Teams to identify and develop novel opportunities. 6. Industry and academia will collaborate with local agencies to establish a network of space technology and application hubs across the country. 7. Industry and academia have led the creation of the Space Growth Partnership, developed this strategy, and will lead the delivery. 8. Industry will lead the Satellite Finance Network and work with Government and the financial sector to enhance the flow of private finance for space ventures. 9a. Industry will take the lead in investing in and developing the skills base and driving increases in diversity and inclusion. 9b. Industry will work with Government to promote space to 1,000,000 students per annum. 9c. Industry will work with Government to generate 30,000 new high quality jobs. 10a. Industry and academia will work together to advance the UK's space technology base for the future and to increase the value to the UK from its investment in ESA Programmes. 10b. Industry will work to increase the number of high growth SMEs in ESA and EU programmes. 10c. Industry will support accelerators to support the growth of new space ventures and ambitious SMEs. 	<ol style="list-style-type: none"> 1. Create the National Space Programme with £280m funding over 5 years for technology, science and new applications. 2. Engage with the sector to determine how it can act as an anchor customer to incentivise commercial investments in, for example, real-time satellite imagery services and capacity for rural and mobile broadband. 3. Continue to develop a competitive regulatory and licensing environment, with an adequately resourced team, that provides the basis for inward investors and entrepreneurs to invest in UK-based businesses. 4. Develop <i>Space is GREAT</i> export campaigns including Department for International Trade to create High Value Campaigns in the largest global space export markets. 5. Use its convening power to bring together customers and suppliers in space-enabled sectors of the economy to develop jointly managed sector productivity and investment plans. 6. Work with the sector and Space Growth Partnership as it develops its regional hubs and skills initiatives to ensure that National schemes can be accessed by the sector as needed to drive initiatives. 7. Announce Space Growth Partnership empowered and resourced to deliver deal. 8. Implement the recommendations of the recent Patient Capital and SBRI Reviews concerning Access to finance. Help facilitate closer coupling of the finance sector with space by supporting and helping to expand the work of the Satellite Finance Network. Support proposals to enhance business training of entrepreneurs in the sector and acceleration and scale up of their new ventures. 9. Work with the sector to ensure barrier free access to skilled European and other overseas personnel, with mutual recognition of professional qualifications and unimpeded mobility to conduct the sector's work across international boundaries. 10. Continue to invest in ESA and Eumetsat at current levels and retain access to EU programmes (building on from the Government's Brexit position paper [10]), or equivalents.



Build on our success together

Since the Innovation and Growth Strategy (IGS) was published in 2010 [2] and updated in 2014 [45] the sector has undergone major changes. We now have a **UK Space Agency (UKSA)** whilst Harwell has become the UK's *space gateway* hosting the Satellite Applications Catapult, European Space Agency (ESA) Centre for Satellite Applications and Telecommunications (ECSAT), a new RALspace facility, and the new National Satellite Test Facility (NSTF). The UK has also participated in amazing missions, including visiting an comet (Rosetta), demonstrating technology for a gravity wave observatory (Lisa Pathfinder) and Tim Peake's visit to the International Space Station. No other sector has the same mix of commercial business and public interest.

Important initiatives have also been started. The NovaSAR space radar and SABRE rocket engine developments have seen co-investment from industry and Government. The Satellite Finance Network (SFN) has provided a route for SMEs to reach out to investors whilst Seraphim Capital has become the world's first venture fund dedicated to financing the growth of companies operating in the space ecosystem.

Importantly the UK launched a National Space Policy [7] which recognized the strategic importance of space, the criticality of looking after the space environment, the growth of the space sector, and committed to cooperating internationally for the responsible use of space. This policy sets out important commitments by Government which have helped give confidence to business whilst providing the framework for building the UK's position as a space-faring nation. Most recently a *Space Industry Bill* is paving the way for space flight from the UK.

Space has become increasingly important to modern Britain. This trend is set to continue as societies in the developed and developing worlds rely increasingly on space based assets as one of the critical infrastructures to meet the needs of an estimated population of 9 billion in 2050.

UK National Space Policy [7]

Structural changes, increased commitment to ESA, and introduction of co-investment programmes are to be applauded but we cannot be complacent. Several of the most important recommendations of the IGS and update in 2014 [6] have not been implemented, particularly the National Space Growth Programme and Bi-lateral Projects. These were clearly identified as key mechanisms to achieve the long-term growth and they remain more relevant than ever. Indeed the House of Commons Science and Technology Committee [8] highlighted that whilst progress had been made, there was more work to do including "...an expanded National Space Programme, alongside its contribution to the European Space Agency" and setting out how the National Space Policy [7] objectives will be delivered. Industry has clearly indicated that it would be ready to invest in the UK if this approach was followed.

The sector believes that the Government's Industrial Strategy is well timed to address the opportunities and challenges in the space sector and recommend that our collaboration is crystalized into a Space Growth Partnership between industry, academia and Government as part of a Sector Deal for Space.

Working with other sectors

The Government's industrial strategy provides a platform for us to work with other sectors which could benefit from, or contribute to, space. **We will develop joint cross-sector R&D topics and export opportunities** and initial discussions have already started, as shown below:



MARINE SECTOR	AGRI-TECH SECTOR	OTHER SECTORS
  <p>"Marine South East engages with SMEs in the marine industry and is a stakeholder in the Maritime Sector Deal. Space derived services such as satellite communications, global positioning and navigation as well as maritime situational awareness are vital elements of a safe and productive marine industry. As such, the maritime sector believes collaborating with the space industry to produce successful sector deals will be an important aspect in creating prosperity and growth in our respective industries". Dr Jonathan Williams, CEO Marine South East Ltd</p>	<p>"Engagement with the Agrimetrics centre will ensure an integrated approach between the organisations that source and add value to satellite derived data with the community benefiting from the agricultural big data. Working in partnership with all of the UK agricultural centres of excellence – Agrimetrics; Centre for Crop Health and Protection (CHAP); Centre for Innovation Excellence in Livestock (CIEL); Agricultural Engineering Precision Innovation Centre (Agri-EPI) and other organisations, the AgriTech Market Challenge Team will have access to the extensive network of agricultural stakeholders that form a route to market for satellite derived agritech services." Ian Cox, from Innovate UK</p>	<p>Discussions have begun with the Rail Sector who are keen to come together to explore a jointly managed research and product demonstration programme that leads to benefits in both sectors. This could potentially be in the areas of efficient rail operations, protecting the rail infrastructure and improving the passenger experience. As part of Industrial Strategy, both sectors intend to drive preparatory activity forward in the next few months.</p> <p>Discussions have also begun with the Defence Growth Partnership to collaborate on joint projects, for example on persistent surveillance.</p>



Figure 4. ECSAT (European Centre for Space Applications and Telecommunications) and Harwell personnel raise the flag at ESA's new home in the UK, an outcome of the IGS (courtesy ESA)



Figure 5. Launch on India's PSLV for 2 small satellites built by SSTL, including one for UK start-up Earth-i – our strategy will aim to support similarly innovative and ambitious companies (courtesy SpaceNews.com)

Market and investment trends in the space economy

With average year-on-year growth rates of 8.1% since 1999/00 (compared to just 1.6% over the same period for the wider UK economy), the size of the UK space industry has been measured at £13.7B in 2015, a 6.5% share of the global space economy [1]. The positive benefit is ubiquitous; space services have been estimated to support industries contributing 14% of the UK's entire non-financial economic output, equating to £250B. Sector productivity is twice the UK average at £140,000 value-added per employee, it invested £415M in R&D in 2014/2015 and 36.4% of turnover is generated from abroad.

Space is integrated in everyday life. Everyone uses satellite navigation which has also enabled a range of new businesses, especially through mobile phones. Commercial services such as satellite telecommunications provides connectivity on-the-move and to rural locations where other solutions are prohibitively expensive. These services will become more ubiquitous and critical as the economy becomes digitalized and new autonomous technologies become commonplace. It is the cross-sector potential of space which makes it a unique economic enabler. As the integration of space services gathers pace we have now set a target of increasing their take up across the UK economy, so that by 2030 space will support industries representing £500B of UK non-financial business economy GDP (+4.7% per year).

6.5%

UK share of
global market
(2015)

The UK is a hotbed of leading innovators. Inmarsat is one of the biggest satellite communications companies in the world and is in the process of becoming a leader in providing internet to passenger aircraft. Airbus is a leader in satellite manufacturing, image intelligence and secure communications services with 25% of the global telecoms satellite market and 15% of the commercial satellite imagery market. Surrey Satellite Technology Ltd. is the world leading small-satellite provider, recently building three 1m resolution optical satellites with the capacity leased to a Chinese operator in an innovative services export. ClydeSpace have been developing their position as one of the most innovative players in the nano-satellite industry and have won orders from around the world. The supply chain is well established with companies like Teledyne e2v and Honeywell attracting significant inward investment. Reaction Engines are developing air breathing rocket engine technology with game-changing potential to reduce the future cost of access to space. Companies like Ecometrica and EarthSense Systems are developing exciting new geospatial technologies for environmental management which are already leading to exports.

£400B

Global space
market in 2030

The global space market is forecast to grow by 80% to 2030, primarily by increased uptake of commercial services. Our analysis of this data, summarized in Table 2, confirms that the greatest growth is due to the application of space services in the wider economy, but this growth is driven by the introduction of **new technologies making services cheaper and more effective**. Therefore Consumer TV/radio and PNT/GNSS data-services will be driven by the other sub-sectors, *as long as this focus includes a business-oriented approach ensuring that the market challenges and opportunities are properly addressed*. We intend to do this by

establishing Market Challenge Teams in the key growth areas to ensure connectivity across value chains.




Sub-sector	Global market size 2015	2015 UK sector size	Forecast global growth rate	Key trends	Strategic priority
Telecoms Services	\$39B (12%)	£2.6B	+7%	Strong growth in fixed and mobile networks, integration in 5G	 Connectivity: Secure and resilient 5G broadband for everyone, at home, on the road, in the air, or at sea
Consumer TV & radio / equipment	\$101B (32%)	£8.6B	+5%	Growth in consumption in non-Western markets	
GNSS Data Services	\$48B (15%)	£0.6B	+8%	Increasing use of location-based apps	 Earth Information: Position/navigation/timing (PNT), real-time global awareness, and security for the data economy
GNSS Devices	\$35B (11%)	£0.9B	+2%	Growth in lower cost devices and chip sets	
Commercial Earth Observation Services	\$3B (1%)	£0.1B	+7%	Growth in value added services	
Satellite & Ground seg. / Manuf. & launch	\$16B (5%)	£0.8	-2%	Emergence of low cost satellites and launchers	 Low cost access to space & In-space robotics: Accessing new opportunities
Non-commercial Gov & Military	\$77 (24%)	£0.0 (N/A)	+2%	Linked to global defence spending	

Table 2. Detailed understanding of market structure by sub-sector (here in 2015) and forecast growth rates / key trends will be used to target the most promising opportunities for the UK sector

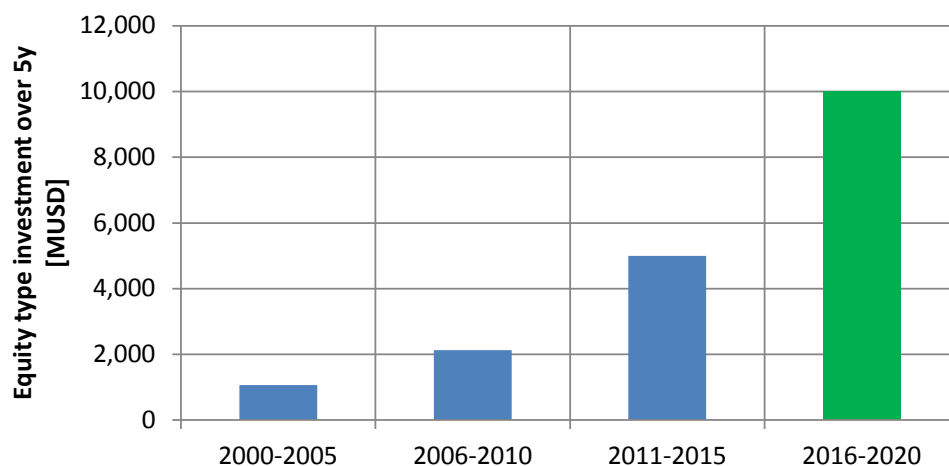


Figure 6. Global private equity investment is rising exponentially (forecast for 2015-2020) after [3]; we intend to bring this investment to benefit the whole UK

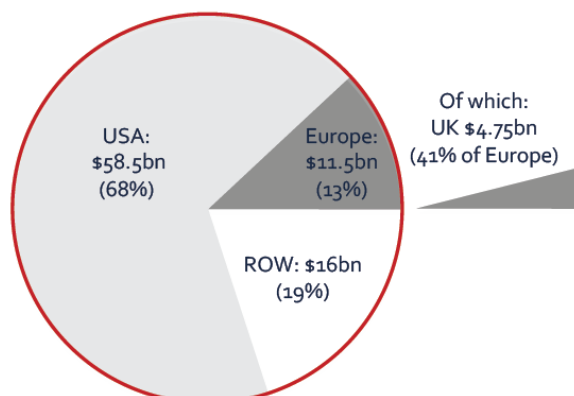
Since 2010 the sector's target has been to capture 10% of this fast growing opportunity [2]. During this time we have seen an unprecedented acceleration in global investment and novel business concepts, as shown in Figure 6. Driven by major investors realizing that space has the capability to produce global scale businesses private equity investment (non-debt) has risen exponentially due to concepts like massive constellations of small satellites in low earth orbit to provide global broadband connectivity. These new entrants have access to large quantities of patient capital and the mentality of moving quickly and decisively (this is not a problem unique to the space sector as noted in the Patient Capital Review [36]). The USA leads the way in this wave of investment, with 63% of investors into space companies and 40% of satellites. This presents an opportunity and a challenge: significant new global opportunities are emerging whilst the competition is becoming stiffer. **The challenge is how to stimulate investment into UK businesses and draw global businesses to the UK?**

The Government's proposed Industrial Strategy is well timed to respond to this tipping-point and accelerate growth towards the 9% per annum required to reach the 2030 ambition. Market analysis is revealing the next wave of opportunity and businesses are indicating where they would like to invest. The window-of-opportunity for the UK to capture this investment will be determined by our ability to quickly secure first-mover advantage in emerging opportunities. The current UK approach of working with industry to co-invest providing de-risking and anchoring in the UK is working but needs to be scaled up and made more predictable. UK regulations need to move quickly to adapt to new business models and new opportunities. The Government should also seek to use space services to achieve its security and prosperity goals, such as bridging the digital divide. This would protect the UK's lead in areas of competitive advantage (described below in section 1B), and position the UK to capture future space trends and opportunities. It would also help to make the UK the best place to grow existing and new space businesses.

£75B

annual revenue identified in new opportunities from market analysis

2014 Global VC (all sectors) : \$86bn



Space Industry Global VC in 2015

≈ \$1.8bn (with annual variations)
≈ 2.1% of annual global investment

In perspective:
Worldwide GDP ≈ \$74tr
Space economy ≈ \$260m revenue ≈ GVA
Space economy ≈ 0.35% of global economy

Figure 7. The approximate scale of VC funding for space in the overall VC context shows the high relative interest in space VC

1 Create a National Space Programme

£3B

Additional economic contribution from increased research, science and innovation by 2030

The UK's space sector is R&D intensive (3.0% of revenue invested in 2015 [1]), and already above the Government's target of 2.4%. Yet with private investment rapidly increasing around the world the UK has the opportunity to attract more investment by continuing to develop the National Space Programme alongside our partnerships with Europe. This is recognized elsewhere in Europe as France, Germany, Spain and Italy all also have significant national programmes [5] which, accumulated over the long term, have resulted in the development of a wider range of advanced products and skills. This makes it increasingly difficult for the UK to compete, particularly at a time of rapid industrial change and was recognized in the House of Commons Science and Technology Committee's report [8]: "To place the UK space sector on a stronger footing globally we recommend that the UK Space Agency pursues an expanded National Space Programme, alongside its contribution to the European Space Agency."

The UK programme has increased over recent years and supported some exciting and highly visible developments. A co-investment approach has been taken on the SABRE air-breathing rocket engine development with Reaction Engines and the NovaSAR space radar with SSTL and Airbus both delivering game-changing technologies. A small but important National Space Technology Programme (NSTP) has also been created. While effective, these approaches have been uncoordinated. Giving confidence to industry that these types of programme will continue and be expanded to meet the growth challenge is important to attract the long-term investment which is available both from existing industries and companies wanting to come to the UK. In building the strategy business identified more than 40 areas where it would be willing to invest should the national programme be continued and scaled-up.

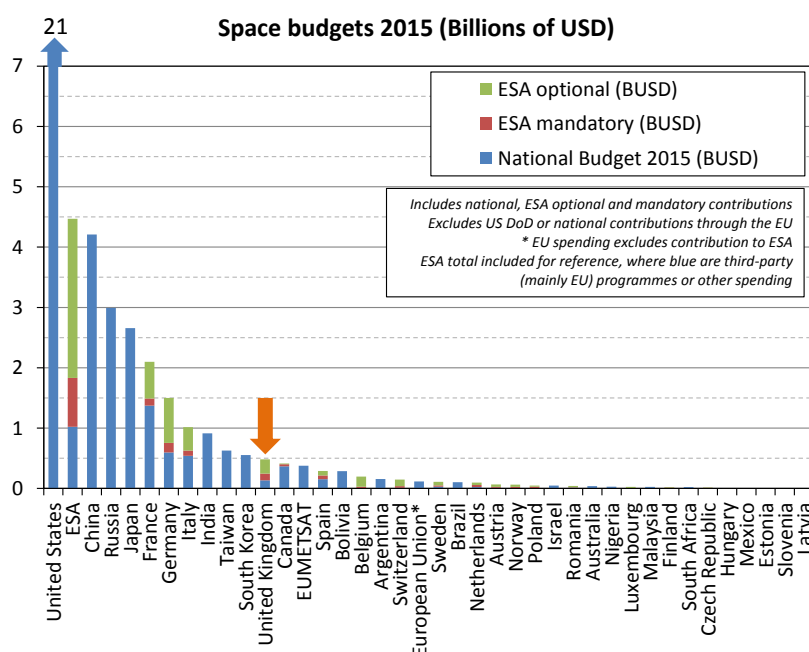


Figure 8. Space budgets in 2015 for selected space faring nations, including ESA mandatory and optional contributions but excluding MOD/DOD budgets (source: The Space Report, 2016 [5] and ESA Annual Report 2015 [13])

In 2015 UK invested less than other comparable European nations, South Korea and Taiwan.

Note that this does not include increased ESA subscriptions announced by the UK at CMIN16 nor recent increases in other space budgets.

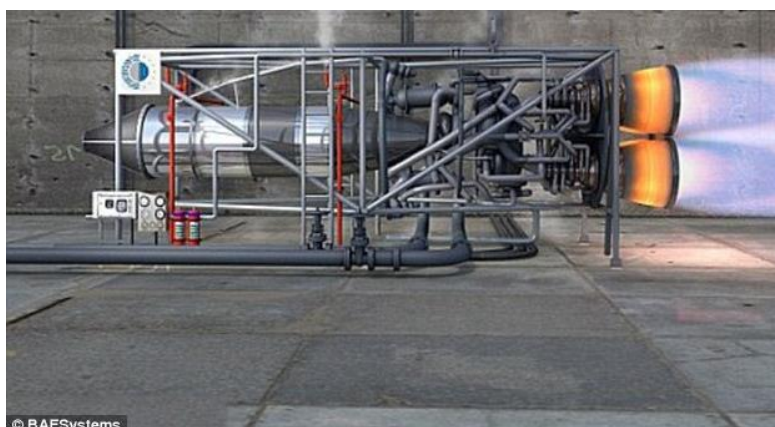


Figure 9. Reaction Engines are developing the revolutionary SABRE engine (pictured here in a computer simulation of the planned test, courtesy BAE Systems) which has been supported by the UK Space Agency. A National Space Programme will provide a stable environment for similarly exciting future investments.

Meeting this challenge requires a broad-based approach *fully leveraging our existing and future investment in ESA* and adding a national approach to help the UK sector to respond rapidly and form new partnerships in the most dynamic growth markets around the world. We therefore propose the formalization of the existing approach into a National Space Programme to:

- ✦ Regularly carryout market analysis and explore industrial R&D priorities to robustly identify and develop new growth opportunities, helping to guide the UK response to achieve these.
- ✦ Establish Market Challenge Teams, led by the Satellite Applications Catapult (see Annex: Market Challenge Teams) to explore new markets and develop cross-sector R&D propositions.
- ✦ Collaborate on R&D, innovation and cost reduction in manufacture, in-orbit demonstration, launch and in-orbit operations, involving academia and leveraging the National Space Technology Strategy (NSTS) to accelerate the capabilities of the UK sector
- ✦ Leverage Government funding to attract the increasingly dominant amount of private investment now flowing into the space sector, developing new commercial services, giving the UK competitive advantage in key future markets.
- ✦ Create an accelerator, e-space business skills programme and expanded Satellite Finance Network (SFN) for innovative and ambitious start up and scale up businesses to attract £500M per annum in private investment by 2030.
- ✦ Ensure that all UK businesses have access to cutting edge facilities such as the National Satellite Test Facility being developed at the Rutherford Appleton Laboratory (RAL) in Harwell.
- ✦ Work with the Defence Growth Partnership (DGP) in the context of the Defence Industrial Policy [34] to develop joint *export-ready* and *international-by-design* offers.

A formal National Space Programme in the UK would not be like other nations, it would follow the Government's existing approach by seeking to co-invest in the next wave of growth opportunities. The programme will build upon two investments already announced in 2017:

- ✦ £99m to RAL for the National Space Integration and Test Facility at Harwell:
 - benefits the entire sector providing a one-stop-shop for satellite assembly and testing
 - draws dynamic new companies to rapidly invest into the UK
 - stimulates a new generation of space companies in the Harwell space gateway
- ✦ £50m to UKSA for Launch facilities across the UK:
 - designed to position the UK as a leader in launching smallsats into orbit both for scientific research and technology demonstration purposes and as part of moves to establish mega-constellations for future communications and observing purposes
 - attracting inward investing upstream businesses to locate in the UK and create a new UK supply-chain in launcher technology and launch services

Part of the National Space Programme will also be to demonstrate how the entire UK can benefit from space infrastructure and smart Government procurement in advanced capabilities such as Earth Information Services, superfast satellite broadband for rural communities to bridge the digital divide (as is being done in France [14]) and future resilient Positioning, Navigation and Timing (PNT) capabilities.

We therefore propose **the creation of a National Space Programme** investing an additional £600M in UK space research and innovation with £320M from industry and £280M from the Government. The National Space Programme will have 3 key components:

- (1A) Build new global partnerships and exports : making the UK a global partner and supplier of choice
- (1B) Develop new commercial space services : making the UK a global leader
- (1C) Use Space Data and AI to drive Productivity across the UK Economy and benefiting all sectors

CASE STUDY



Based in Surrey, SSTL built the world's first disaster monitoring constellation on behalf of a 5-nation consortium (launched 2003). With its new series of low-cost, rapid build products, SSTL sees significant and immediate opportunity for delivering the constellations of the future.

(1A) New global partnerships and exports

Most nations are now either exploiting space or building their domestic capability to create regional advantage. This creates a complex interweaving of commercial, civil and military interests expressed through different national approaches to technology, regulation, and imports. As the UK domestic market constitutes only around 2.5% of the global market, mastering this complexity and increasing exports is essential to accelerate growth towards the 9% per annum required to reach the 2030 target. Indeed, despite the European market continuing to grow, the markets with the highest predicted growth rates are in Latin America, Africa and the Middle East. The approach must therefore seek to simultaneously increase our market share in large, mature markets whilst building new business in more rapidly growing economies.

£5B

**Additional revenue
per annum
targeted from
exports by 2030**

The UK has been successful with overseas sales increasing from 31.0% in 2012/13 to 36.4% in 2014/15 (33.5% excluding ESA/EC) [1]. Building on this experience, the Space Growth Partnership has been analysing global opportunities, including creating an Exports Working Group, surveys and working in-country. This has revealed the scale of the export opportunity as well as providing the basis for a country-by-country export strategy. It is estimated that 38% of the global market is accessible to UK companies. However, given the complex nature of international buyers and market access barriers this ambition can only be realized in a partnership approach. In particular, to access the main commercial opportunities it will be necessary to build trust in customer countries that the UK is not seeking to displace local industry. A range of approaches needs to be applied ranging from R&D collaboration, local partnerships, as well as direct exports promotion. This also brings exciting opportunities to attract new technologies and companies into the UK as part of a comprehensive strategy to develop the UK as a global innovation hub.

To access the opportunities we are developing 3 High Value Export Campaigns, led by the Department of International Trade (DIT) and supported by UKSA, to run over 5 years, aiming for a total of £1B additional export revenues. Priority countries have been identified and further analysis is planned. These campaigns should cover not just export promotion but inform innovation activities to ensure that the right products and services are developed. Links should also be made to in-orbit demonstrators to prove the benefits of UK technology. **To support this we will develop Space Is GREAT export campaigns in targeted space markets, as well as conduct joint science and innovation based missions.**

The highest value exports are still likely to come from larger economies, even though these may also be those with mature domestic markets and businesses. However in fast growing developing economies the challenge is different. Many of these nations are either seeking services, rather than space specific solutions, whereas those which are interested in space often do it to develop indigenous industry. In this case the UK can be viewed as a threat which might displace local industry. In addition, the opportunities often start small since the take up of space services is immature. In these cases it is again important to build local relationships to establish trust. R&D relationships are still useful, but equally important is the need to simultaneously mature the use of space solutions by public bodies and consumers. Therefore, **we will develop a country-by-country strategy for the fastest growing markets tailoring the UK offering, including working with DSO.**

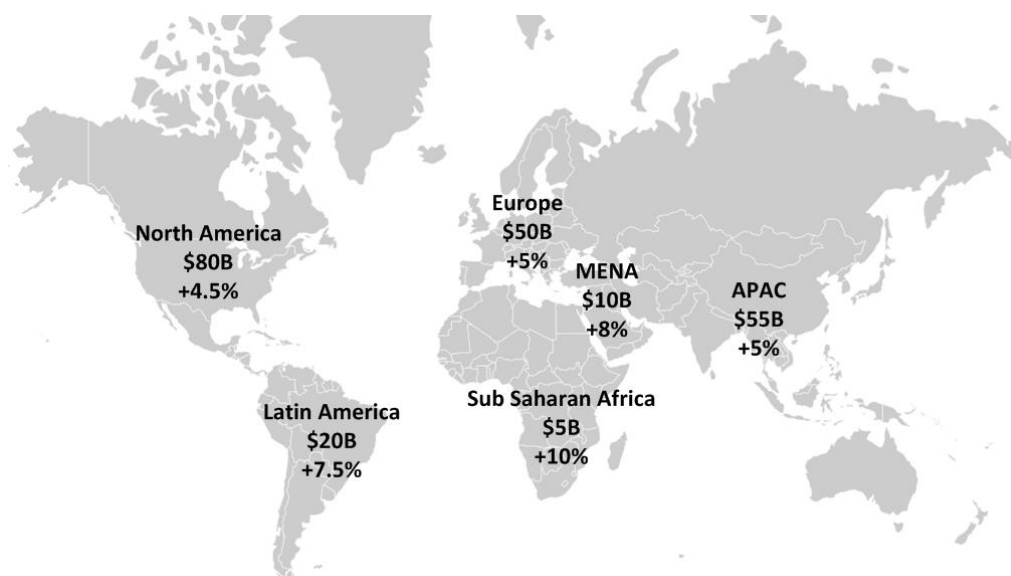
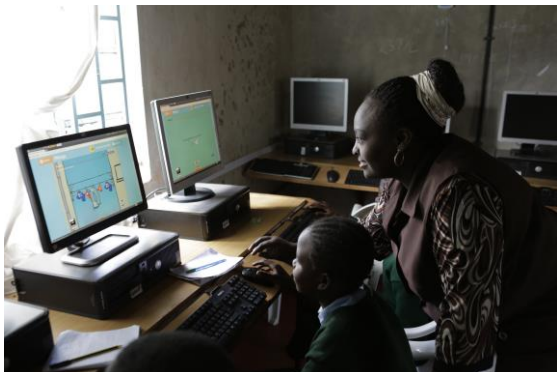


Figure 10. Knowledge of current market sizes (commercial, excluding teleports) and forecast growth rates, forecast in this chart to 2023, allows the UK to target the best opportunities around the world

CASE STUDY



Avanti Communications has used its satellite broadband service to support education programmes in East Africa through iMlango funded by DFID and iKnowledge funded by UKSA / International Partnership Programme. Avanti has won follow-on contracts under a plan to connect 10,000 schools in Kenya.

But our quest for international partnerships goes far beyond exports, helping to deliver services where the impact is far more valuable than revenue alone. Because of its global reach, space technology can make delivering services to remote and rural areas cost effective and sustainable. Recently, the UK Space Agency has established the International Partnership Programme (IPP), a five year, £152M programme, supported by DFID, which uses space sector expertise and capability to provide sustainable, economic and societal benefit to undeveloped nations and developing economies. This programme has been used to realise important change and deliver benefits to emerging economies, including:

- ✂ eLearning enabled by satellite connectivity for more than 300 schools in Tanzania
- ✂ extending health services to remote areas of Nigeria
- ✂ reducing poverty and deforestation in Peru
- ✂ increasing food security by reducing losses from pest outbreaks in Ghana, Zambia and Kenya

IPP is focussed on delivering measurable outcomes in a digital world, with the bi-product that it supports exports by showcasing space capabilities and raising the profile of UK companies with overseas customers. As the initial IPP-funded projects begin to bear fruit, **we recommend that consideration is given to extending the existing International Partnership Programme.**

Overall the diverse nature of space, able to deliver both high value exports and aid solutions, presents an ideal opportunity to build trusting relationships around the world, helping to build **Global Britain**. Doing this will require the UK to step-up its world-wide engagement realizing that for most countries there is strong interaction between Government and industry so that developing joint R&D projects is a key mechanism to building the trusted relationships for export. For example, running a joint space mission can develop a business relationship between supplier and prime contractor, whilst building confidence in the UK products and services. We have surveyed 5 other nations (France, Germany, USA, China, India) and found that they have all successfully built-up export businesses from these initial joint R&D projects. The opportunity therefore exists for the UK to copy this approach but leveraging its worldwide reputation for applications and services to become a sought-after partner for the next wave of space developments. This could be done through a cooperative missions programme seeking to develop relationships with both established and emerging space nations, projecting UK industrial capability, co-developing services/applications and delivering overall economic impact. Specific opportunities in mature markets include Space Weather Monitoring, Machine-to-machine communications, Space Debris Removal, Synthetic Aperture Radar, and Disaster Relief. In addition these opportunities should include an element of science and engineering R&D which helps to cement the partnership as well as looking at areas of UK strength, for example helping countries to deliver their ambitions for space exploration. **We therefore propose that the National Space Programme includes a dedicated budget for bi-lateral and cooperative missions with international partners to open new export opportunities.**

Britain leads the world in humanitarian response; digital technology helps us focus our aid where the need is greatest. Satellite data is helping us to trigger digitally-enabled payments before the worst effects of drought are felt by those who are most vulnerable, providing lifesaving support.

DFID Digital Strategy [29]

Finally, delivering the above will only be possible with a comprehensive Exports Strategy distilled into country and region specific strategies and roadmaps. This strategy will need adequate resourcing from the stakeholders across industry and Government. We have started discussions with other sectors, such as defence, rail and marine, on how our respective export strategies could complement one another. **We will therefore establish a Space Trade and Exports Group and deliver an UK Space Trade and Exports Strategy in 2018.**

(1B) Maintain world-leading excellence in the ‘stand-out’ UK industrial and academic strengths

The UK has world-leading space capabilities in Earth Observation and Telecommunications extending across industry and the research base. For example, in Earth Information the UK has NERC Research Centres, the Rutherford Appleton Laboratory, the Met Office, NPL, National Centre for Earth Observation, and many Universities as well as some key companies; UK scientists lead 2 of the next 4 EO Explorers to be launched. UK scientists working with industry have been responsible for the success of Envisat to Copernicus, to the value of high quality data, to the creation of new SMEs like EarthSense and Rezatec (and indeed SSTL originally); through the Met Office for the instrument requirements, data products and services from Eumetsat. It's no accident that ECMWF leads 2 of the Copernicus Services. The strength of the UK lies in harnessing this environment. The National Space Programme has the objective of building upon these strengths to de-risk new technology to be a first-mover in new commercial markets. As described above two approaches will be taken to help guide the priorities: market analysis and review of industrial R&D priorities, as well as Market Challenge Teams.

We have already started analysing markets and working with industry to identify their priorities. Over the last year we have identified that exciting market opportunities exist in :

- ✂ **Connectivity** : representing the majority of the sector in the UK and expected to grow at 7%, the UK can take a leadership role in ubiquitous connectivity and transitioning to 5G.
- ✂ **Earth Information** : covering positioning/navigation/timing from space (e.g. PNT/GNSS) as well as Earth Observation and other geo-spatial technologies significant opportunities exist to drive new growth from fusion of space-based and terrestrial data sources.
- ✂ **In-space robotics** : an emerging opportunity to develop new capabilities for manufacturing in space as well as servicing existing space assets where the UK could become a leader.
- ✂ **Low cost access to space** : supporting the recently announced investment in UK launch to develop supply chains and continue to keep the UK a leader in low-cost satellite platforms.

The National Space Programme therefore exists to accelerate UK growth in these areas as well as to provide an unpinning Science and Technology component to develop and mature new technologies which will enable the UK to become a leader in these markets.

We envision that the National Space Programme will operate a number of competitive open calls to allow businesses of all sizes and types to contribute to the UK's future success.

In addition, the Market Challenge Teams will be established to identify and analyse the best routes to accessing new markets, including in sectors not already using space services. They will be used to guide the focus of the National Space Programme to provide the essential feedback for growth including understanding the international context and opportunities for partnerships. The primary purpose of the Market Challenge Teams is to enable UK space businesses to work in a structured fashion with customers, wider industry experts, Government and academics to access new business opportunities that would otherwise be highly unlikely to be developed in the UK. In practice the Market Challenge Teams will operate in the pre-competitive phase of developing markets and addressing barriers to growth. They will not seek to engage in or influence individual contracts between customers and suppliers or the operation of competitive markets after companies are in a position to contract with customers.

Guided by market analysis and reviews of industrial priorities carried out by the SGP, we propose to focus the National Space Programme on 5 key areas: Connectivity, Earth Information Services, In-space Robotics, Low cost access to space, and Science & Engineering Technology.




Sub-sector	UK share of global market 2015	Forecast global growth rate	Challenges facing the UK sector	Strategic priority
Telecoms Services	10%	+7%	Rise of mega constellations; slow-down in traditional markets	 Connectivity: Secure and resilient 5G broadband for everyone, at home, on the road, in the air, or at sea
Consumer TV & radio / equipment	13%	+5%	Increase of Over-The-Top / IPTV in western countries & difficulty of accessing foreign markets	
GNSS Data Services	2%	+8%	Dominance of US companies in mobile applications	 Earth Information: Position/navigation/timing (PNT), real-time global awareness, and security for the data economy
GNSS Devices	4%	+2%	Low manufacturing in the UK	
Commercial Earth Observation Services	7%	+7%	Small domestic market compared to strong government support abroad	
Satellite & Ground seg. / Manuf. & launch	7%	-2%	Small domestic market, challenges of Brexit	 Low cost access to space & In-space robotics: Accessing new opportunities
Non-commercial Gov & Military	N/A	+2%	Export to foreign governments often depends on G2G activity	

Table 3. We have tailored our priorities to the UK's strengths and the challenges facing the sector, illustrated here.



National Space Programme Priorities: Connectivity Services

The ambition: Capture an increased market share in the largest space application focussing on the opportunities from 5G around autonomous vehicles and the Internet-of-Things (IoT).

The situation: Connectivity is the largest source of revenues for the space industry generating \$18B p.a. for satellite operators with 8% CAGR. However the industry is undergoing a seismic shift with the advent of new technologies, business models and the preparation for unprecedented levels of global ubiquitous connectivity. For example, Inmarsat is developing an in-flight connectivity solution whereas OneWeb is developing a global constellation of small satellites for non-stop internet access. Indeed, "according to Morgan Stanley global mobile data traffic is set to grow about 200 times over the next 20 years – the vast majority of which will be needed for autonomous vehicles... about 10% will require satellite-based systems" [12].

The plan:

- 1) develop a strategy to enable ubiquitous connectivity from satellites in the UK and evaluate the economic impact
- 2) develop a mechanism to encourage operators to provide sufficient capacity over the UK with 100% coverage to support the growth in new applications, household and mobile connectivity
- 3) develop and implement a strategy for space and terrestrial players to work together, ensuring satellite services are designed into the specification of future 5G network



National Space Programme Priorities Earth Information Services

The ambition: Delivering live & local data from new satellite capabilities, to enable smarter services worth more than £10bn, for citizens across the UK and around the world, building on the UK's leading Positioning/Navigation/Timing (PNT) and Earth Observation capabilities. Enhance defence and security capabilities and grow export potential.

The situation: Information about the earth and our relationship with it support a range of applications from climate decision making to turn-by-turn satellite navigation. Decision making will only become more reliant on this wave of data as the economy become more digitalized and new uses are discovered for combinations of data, including terrestrial and airborne sources (e.g. drones). This presents opportunities to optimize business, increase productivity, deliver better public services, and protect our environment. PNT/GNSS is already one of the largest parts of the UK space sector (26% of revenue) whereas Earth Observation, despite its relatively small revenue (1%) makes the difference in a wide range of Government applications and increasingly in commercial services. Building on the recent review of PNT [35] and the UKSA EO Strategy [11] we will aim to accelerate growth and attract private investment, as well as examine the issue of national resilience. The approach covers the whole value chain, recognizing that critical mass and attracting scale-up investment can only be achieved by a significant and orchestrated effort with UK-specific expertise and data resources. A final opportunity is the interest in EI technologies within the evolving Defence Sector Deal and we will work together with the Defence Growth Partnership to boost the UK offering and capability.

The plan: Under a wave 3 bid to the ISCF

- 1) develop a UK data refinery and exchange as national capability (incorporating different data sources), helping companies develop their products and fully capitalize on the UK's world-leading AI, data mining and algorithm expertise;
- 2) co-fund in-orbit demonstration of new sensors and technologies;
- 3) demonstrate how sovereign UK infrastructure can deliver UK-centric services, supporting economic growth, resilience and security, as well as creating exportable products and services
- 4) establish cross-sector market-led R&D to diffuse benefits across industry sectors leading to the delivery of smarter services.



National Space Programme Priorities In-Space Robotics

The ambition: Develop and demonstrate technology and services allowing the UK to take a leading role in future in-orbit robotics businesses, including satellite servicing and in-orbit manufacturing.

The situation: Forecasts from SA Catapult studies and 20 expert market consultants show an accessible market of over \$500m for in-orbit servicing, in-orbit manufacturing and debris mitigation, with the UK potentially able to populate the full value chain. The initial commercial targets for application are maintenance and life-extension services for telecoms satellites and servicing future mega-constellations in Low Earth Orbit; however there are also multiple other reasons for addressing these challenges for the longer term, including removal of hazards to operations in space and future exploration missions. The opportunity to capitalise on these technologies in space has not yet been fully grasped by any one nation; Canada, Japan and the United States are the current front-runners and Germany also is interested, but apart from the resupply and servicing of the ISS, all are still in the early stages of looking at developing the next generation of automated capabilities in space.

The plan:

- 1) Develop R&D to develop new technologies and skills
 - 2) co-fund demonstration missions for new products and offerings from the UK
 - 3) develop the accompanying regulatory framework to enable operations from the UK
- (Image copyright Effective Space Solutions)



National Space Programme Priorities Low cost access to space

The ambition: Unlock new growth opportunities by capturing a share of the growing small satellite business including small platforms and low cost launchers.

The situation: Small satellites are continuously growing in capability and forming the basis for large new constellations to provide global capability. The UK has leading capability in small satellites and future growth can be stimulated by developing and introducing new miniaturized technologies. However it is recognized that a major limitation for small satellites is the inability to reliably secure correspondingly low cost launch services. Around the world there are many initiatives to develop low cost launchers and the UK has developed a plan to attract this business to the UK with a spaceport programme.

Government investments include a National Space Technology Programme (NSTP) projects, a National Space Propulsion Facility at Westcott, £60m of Government support to the revolutionary SABRE engine being developed by Reaction Engines, and £50m announced for UK launch supply chain and facility development.

The National Space Programme can support this programme by helping UK companies to enter the supply chain for these vehicles and benefit not just from launches in the UK but also the global market.

The plan: UKSA has developed the LaunchUK plan to capture market share and establish one or more spaceport facilities in the UK. Alongside this development the National Space Programme should:

- 1) Deliver new UK products or services to take part in the global value chain arising from UK spaceports and launch services, building on the £50M funding separately to UKSA as part of the Industrial Strategy to stimulate rapid development of the launch vehicle and spaceports themselves.
- 2) Develop new miniaturized technologies to improve the capabilities of small satellites

(Image copyright UKSA)



National Space Programme Priorities Science and Engineering Technology

The ambition: To foster new connectivity between sector companies and applied science and engineering technology research in academia.

The situation: The opportunity is to bring academic expertise to bear on areas of scientific and engineering technology challenge facing industry as it gears up to develop new capabilities needed to deliver the advances envisaged by the UK's National Space Technology Roadmap and beyond.

The plan:

- 1) invite industry to articulate a series of challenges and problems for which it requires solutions in the medium to long term. Academia will be invited to articulate its research programmes and future plans.
- 2) Develop collaborative research teams to come together to address common interests, apply for funding and form consortia, which may include multiple industrial and academic partners according to the nature of the activity and other sources of funding that can be accessed.
- 3) priority missions to be UK firsts in space with joint academic-industry missions being one part.
- 4) competitive regional bids for space hubs involving academia and industry (see 3D).
- 5) joined up skills programme with hubs linked to undergraduate, Masters and UKRI PhD hubs (see 3A).

(Image copyright STFC)

(1C) Use space data and AI to drive productivity

Aside from driving revenues within the sector, space data has a variety of valuable applications driving productivity gains across the economy, with the earth information provided by satellite imagery and GNSS positioning, navigation and timing (PNT) combining with terrestrial observations to form the vast geospatial data market which is “priceless, but [worth] trillions” [37], and forecast to grow at a rate of 17% per year [38]. In a report for Google, Oxera Consulting defined these geospatial services as providers of “satellite imagery, digital maps, satellite positioning signals, and navigation devices”, highlighting the reliance of geospatial services on space data and the space industry value chain, before going on to state that these services “make an important contribution to future productivity. The efficiency gains created are helping to facilitate economic activity and generate additional consumer welfare”.

A particularly important source of space data is PNT, for example used in applications such as SatNav, which is considered to be part of Critical National Infrastructure [7]. Indeed, the recent Blackett review [35] highlighted the need for improving the resilience of PNT and that “...growing demand for time and geo-location create opportunities for the UK to leverage its academic and industrial expertise in these areas.” We agree with this analysis since guaranteeing the flow of this data is important to encouraging its take-up.

Productivity benefits resulting from intelligent analysis of space data have already been demonstrated and recorded in the agricultural sector, with an economic impact study finding that the most important benefits of space data to the agricultural industry were productivity related [39]. Our strategy will create similar productivity benefits in other sectors, with this space sector deal poised to create more valuable space data, to encourage analysis of space data in a more efficient manner (through a data refinery and AI interrogation techniques), and to work with other sectors to increase the adoption of space data. Examples of these productivity benefits we can expect to come to fruition in other sectors with the adoption of space data combined with AI include:

- ✦ Maritime and shipping – efficiency in bulk shipping with improved communications, tracking, and routing;
- ✦ Aviation – improved Air Traffic Management with intelligent flight tracking; space data-derived analysis of environmental factors such as volcanic ash to inform aircraft routing and improve aircraft maintenance;
- ✦ Automotive – a blend of roadside sensors, GNSS signals, and communications will optimise traffic flow, reducing emissions, congestion, and enabling better road management.
- ✦ Rail – space data will allow for more efficient management of rail networks through using PNT and satellite communications to provide real-time track and embankment monitoring on-board trains, and using Earth Information data to provide indicators of subsidence or land movement which may inhibit critical railway infrastructure.

Artificial Intelligence (AI) and digital innovation has been highlighted in the Government’s Industrial Strategy as one of the four Grand Challenges, and as a cross-cutting technology in at least three of the five foundations of productivity upon which the Industrial Strategy is based [40]. With AI technology capable of “transforming the productivity and GDP potential of the UK landscape” [41], its application to the already valuable geospatial datasets derived from space data will transform the productivity and value-added potential of the space data services landscape. The proposed creation of an Earth Information data refinery to improve the analysis-readiness of data, set technical standards, and increase the ease of access to space data will allow for continued development and refinement of AI techniques. This matches the recommendations made to Government by the Alan Turing Institute that in order to continue developing AI capabilities in the UK the ease of access to large datasets needs to be improved.

Finally, a new wave of space data is anticipated from satellite communications constellations providing space data to enable narrowband Internet of Things (IoT) connectivity. This provides another use case for the necessary fusion of AI and space data to support our digital economy. We will seek to explore this opportunity and how all sectors can benefit.

With the potential for AI to unlock what HM Government describe as “huge amounts of value ... [in] new services made possible by geospatial information”, **we propose to (1C) establish cross-sector teams to develop these opportunities across the UK economy in the National Space Programme. In partnership with other sectors, we will develop joint propositions to integrate space data and AI into existing services and supply chains, with the initial focus on initiatives within the Maritime, Defence, and Agri-Tech sector deals.** Continuing to expand the use of space data will support companies across the economy with revenues of £500B in 2030, doubling from £250B in 2015. An ISCF proposal has been submitted to drive forward greater use of data [44].

CASE STUDY



Bird.i is a UK startup applying artificial intelligence to satellite imagery aggregated from multiple sources to provide new insights to construction companies. This allows owners of construction sites to remotely track progress and development, leading to efficiency savings in being able to access real-time information.

2 Create the business environment for success

Since the dawn of the space age nations have attempted to combine the dual-use of space for economic growth and strategic benefit, and policies continue to evolve rapidly. The UK has developed a partnership approach reflected in the Innovation and Growth Strategy (IGS) and the business environment has continued to be attractive to existing and new companies based on:

1. Long term Government support to the sector anchored in the UK Space Agency
2. World leading Space companies and Universities
3. Its flexible labour market
4. A supportive licensing and registering approach
5. Targeted support for the downstream sector via the Space Applications Catapult (and ESA Business Apps)
6. An attractive corporation tax rate and 10% tax on UK developed IP sales

Since then other countries have taken note and are moving rapidly to further commercialize their approach to space and industrial base. Notable recent developments include:

- ✂ USA: Exhibits a proud history of commercialization of space, combining Government initiatives with private finance. Large Government contracts, most prominently for launch services, have been used to stimulate investors leading to globally disruptive companies like SpaceX (>50% of launches are for the US Government). Two-thirds of investors in start-up space are from the US [22]. Recently corporation tax was lowered to 21%.
- ✂ France: Already a leader in the commercialization of space (e.g. the SPOT satellites or Ariane), the Centre national des Etudes Spatial (CNES) has reorganized with the agency with a new Directorate of Innovation, Applications and Science (DIA) planning to develop applications as part of its contract with the Government [15]. Example new initiatives include working with SNCF on rail innovations and an agreement with Geoflex to exploit Precise Point Positioning to create a future “national champion”. Team France is also now a major NewSpace actor working together with industry and leveraging funding from ESA and the PIA (Future Investment Programme). The Aerospace Valley in Toulouse aims to create 35 000-40 000 new jobs by 2025.
- ✂ Luxembourg: Already a leader in satellite communications services (thanks to the PPP in 1985 which led to SES), keen to attract foreign companies and aiming to play a leading role in the exploration and utilization of space resources (spaceresources.lu initiative). Able to provide funding through LuxIMPULSE and has committed €200M in funding for early-stage space ventures [20]. The first European country to offer a legal framework on the exploration and use of space resources [17]. LuxGovSat created as a new venture between the Government and SES for governmental satellite communications.
- ✂ China: Already a global leader in space, China is now home to several ambitious new firms in areas such as launch (e.g. LandSpace and OneSpace) and earth observation (e.g. 21AT). A major factor has been deregulation, allowing private companies to build and launch satellites. China now seeks to capture 10% of the global space market by 2020 [21].
- ✂ India: With the PSLV vehicle already a workhorse for small satellite launch, India is seeking to become a major international player by further commercializing its industry. For example, future navigation satellites will be built by private industry [19] whilst PSLV will be privatized by 2020 [18]. ISRO is also setting up a centre for entrepreneurs in Hyderabad making available raw data for future applications.
- ✂ Netherlands: The Dutch equivalent to the Department for International Trade (NFIA) is actively encouraging FDI from space-related companies into the Netherlands. Already hosts the main office of O3b and some smaller players and recently changed their legislation to regulate cubesats.
- ✂ Canada: Revenues in the Canadian space in 2015 totalled \$5.3B with a growth rate of 0.4% from 2010 (broader GDP multiplier of 1.86). Larger companies have been rapidly changing (Honeywell releasing 49% of staff in Cambridge, Ontario) partly due to the downturn in geostationary communications satellites and a lack of Government contracts [23]. On the other hand Canadian start-ups such as Urthecast, ExactEarth and Kepler Communications have been making headlines.

Countries which have recently championed economic development through space, and entrepreneurial space applications, include countries such as Portugal, New Zealand, UAE, Australia, Bolivia, Korea, Poland, Azerbaijan, and Bahrain. Many of these countries have already indicated their willingness to work with the UK and UKSA have signed MOUs with over 16 countries providing the frameworks for future cooperation.

Against the increasing global interest in space we recommend that **the UK should look to form partnerships on exciting services and capabilities with similarly ambitious nations, as well as continuing to improve its business environment, specifically around access to finance and regulation.**

(2A) Improve the entrepreneurial pathway & access to finance

With the rapid commercialization of space there is a growing interest amongst private sector financiers in the space sector. The UK is seen as an attractive investment location and is second only to the US, having 15% of all non-US investors that have invested in space. However, feedback shows that the quantity of high quality and mature propositions is currently insufficient and that there is insufficient capital, particularly for companies requiring more than £5m in equity investment [36]. For the UK to fully capitalize on the sector's growth will require the strengthening of the entrepreneurial pathway:

- ✂ Current support through general purpose incubators/accelerators has to date not provided the quality and volume of investable propositions required to reach the sector's growth targets. The ESA Business Incubation Centre in Harwell operates as part of a European network and UKSA have made modest funding available to fifteen general purpose incubators to encourage them to accommodate space ventures.
- ✂ In terms of dedicated mentoring from the sector, there is only the UK Satellite Finance Network (SFN) which, on a modest scale, with help from the Catapult and supported by volunteers who understand both space and finance, helps to prepare new space-based ventures and broker contacts for them to sources of advice and finance.
- ✂ Recently, space-specific venture capital funds have appeared (such as Seraphim), but significantly more funding capacity at both early stage and to drive scale-up will be needed to feed the growth ambitions of the sector.

In order to increase the volume of investible propositions in the UK we recommend that this pathway is strengthened by providing experiential learning in a best-in-class intensive business acceleration environment, driven by practising entrepreneurs and investors, and including brokering to multiple potential suppliers of appropriate forms of finance. It includes three specifics:

1. An 'e-space' business training programme for aspiring new and existing growth businesses coupled with an ideas stimulation environment for development of concepts, to be piloted in Harwell and potentially rolled out also in the Midlands and possibly Scotland.
2. A new intensive business accelerator for start-ups and early growth companies using space capabilities, following best-in-class business accelerator practice. Graduates from the accelerator will locate back to local incubators.
3. An expanded Satellite Finance Network, facilitated in response to demand for a commercially independent service to broker between the sector and financiers and to offer impartial advice and signposting to individuals and companies seeking all forms and scales of finance for space-related ventures. Its goal will be to expand its network to both financiers and industry and to upscale its capacity to respond to requests for assistance in a timely manner. It is planned to deliver this service, and to guarantee its impartiality and independence, using a purpose configured company limited by guarantee.

Given that appropriate confidence and momentum can be established in this manner, patterns of investment and growth in other high-tech sectors indicate that it should then be possible to raise the current annual average of £65m in private sector equity risk venture finance going into space to £500m per annum by 2030.

To support the new wave of private investment we therefore propose to **improve the entrepreneurial pathway and access to finance**. We also support the recommendations of the Patient Capital Review [36].

Case study



Seraphim is the world's first venture fund dedicated to financing the growth of companies operating in the Space ecosystem. Backed by major companies including SES, Airbus and Telespazio, Seraphim has already invested in a range of exciting companies. With £70M under management investments are typically at Series A (product and some market validation) and between £1M and £3M.

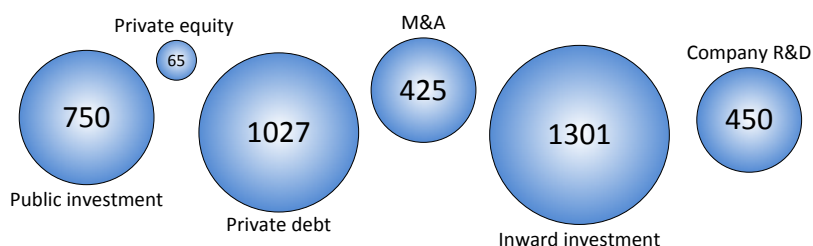


Figure 11. UK investment in space 2015-2016 between public and private funding, totalling £4B (public investment includes ESA and EU programmes)

(2B) Encouraging inward investment

Foreign Direct Investment is a fundamental part of the UK space industry growth story. A look at the big players in the UK space industry quickly reveals the extent to which overseas investment has helped drive domestic growth (e.g. Airbus, Thales Alenia Space, ViaSat, EchoStar/Hughes, Deimos, Teledyne, Honeywell). Inward investment has also made a significant contribution to the growth of the thriving Harwell Campus, where a third of the space companies based there have located from overseas. Government and industry recognise that attracting global space businesses to the UK is a key part of achieving the growth ambition. The Space Growth Partnership has created a high level of engagement between the space industry, UK Space Agency and Department of International Trade (DIT), the Government's lead department for attracting new, high value foreign direct investment into the UK.

£3B

**Additional revenue
per annum
targeted from
inward investment
by 2030**

Feedback from existing investors emphasizes the importance of having long term support to the sector from the Government and a shared ambition. Combined with a highly skilled workforce, flexible labour market and attractive tax regime the UK is a good place to run a space business. The introduction of the Satellite Applications Catapult has been highly successful at increasing the engagement of services companies in non-traditional space areas. Examples of the significant Foreign Direct Investment (FDI), impact achieved are:

- ✂ DIT presently runs two inward investment campaigns which specifically target (i) the US and (ii) the Mediterranean Region. In 2016, DIT supported investment projects leveraged an estimated £1B in new investment activity. A similar amount of non-DIT supported investment over the same period has also been identified.
- ✂ Established foreign owned companies increased their investment in the UK by over £1B (estimated) in 2015/16.

DIT has been successfully building a pipeline of investment projects over the past 3 years, and the number of investors seeking to locate their activities and operations in the UK is growing. There is evidence to show the level of investment has the potential to grow significantly by attracting new disruptive commercial businesses and business models. In addition existing foreign owned and multi-national businesses have indicated their willingness to increase their investment in the UK. Given this potential to attract investment and deepen international partnerships it is logical to develop a strategic approach with the following aspects:

- ✂ Setting targets for inward investment : additional revenues of £3B are targeted from inward investment
- ✂ Targeting ministerial and senior civil servant engagement : establishing a powerful UK presence on the international stage
- ✂ Marketing the UK as an investment location and a global hub for space innovation : working with Harwell and the proposed regional clusters to attract businesses
- ✂ Working with the sector to develop high profile, ambitious initiatives : building on the experience of the Launchers initiative to accelerate investment
- ✂ Increase DIT and UKSA teams and structures to support and help land this new investment into the UK : ensuring entry into the UK is as smooth as possible
- ✂ Adequately resourcing and coordinating investment support : connecting businesses to the support offered by the UK from both the public sector and private investors (e.g. via the Satellite Finance Network)
- ✂ Ensuring that the UK has a global, competitive and progressive regulatory regime : maximizing the attractiveness of operation in the UK, particularly in emerging technologies & services
- ✂ Establish the International Space Trade Programme : deepening our partnerships around the world and allowing the UK to build bi-directional trade and investment relationships
- ✂ Ability to attract overseas entrepreneurs to set-up in the UK : working with the entrepreneurial initiatives to engage with businesses of any size or maturity

Within the strategy some clear recommendations have been established which are well suited to be addressed in the Industrial Strategy:

1. Establish a cross-Government team, led by DIT, with increased staffing:

The appetite for investment in the UK is increasing and the opportunity will make a significant contribution to delivering the sector's growth target. We recommend a scaled-up UK offer and a holistic approach engaging all stakeholders to land the opportunities.

2. Attracting disruptors/new business models: The UK can offer an attractive proposition to the industry's new disruptors. These organisations at the forefront of technology development and new business models offer significant rewards for business and the UK. If the UK's ambitions to be a world leading space nation are to be realised, it must engage positively with these companies. This means recognising rewards may also come with some up front risk, and displaying flexibility when existing levels of support do not cater for novel proposals. We recommend that Government should be willing to demonstrate this flexibility when there is a clear business case that can deliver real economic benefits matching the level of ambition in the sector.

3. Investment targets: DIT should target 20 new Space FDI companies/opportunities per year by 2020, which will result in an additional estimated investment in the UK of £1B by 2020, with the potential for the actual figure to be significantly more than this in future years.

4. Targeted Ministerial and senior civil servant engagement : use senior officials within DIT and OGDs to open doors for DIT overseas teams, targeting specific companies or individuals/entrepreneurs that we want to attract to or grow in the UK.

5. Marketing: DIT needs to work with UKspace, InnovateUK and UKSA to develop new marketing collateral that promotes Space UK as a place for FDI and enabling regulation and takes additional benefit from any high profile space publicity/marketing activity such as the upcoming spaceport announcements or confirmation of an Industrial Strategy Space Sector deal.

6. Programme of high profile ambitious initiatives: The launchers and spaceport initiative has demonstrated that ambitious announcements, supported by modest public funding can potentially leverage major new investment activity. This has created a model that could be a good fit for addressing other challenges and where attracting new FDI is an essential component (e.g. growth of UK regional space clusters or opening up new markets such as in-orbit servicing and active space debris removal).

We propose to establish a cross Government team to secure high value inward investment and leveraging the National Space Programme.

CASE STUDY



Deimos Space UK was founded in 2013 to develop new technologies at the Harwell Space Cluster. It works on space science, navigation, earth observation and space situational awareness. Already based in multiple European countries Deimos chose the UK because of its long term strategic approach, contribution to the European Space Agency, skills base, and export networks. It plans to grow by more than 50% in the next 3 years.

(2C) Use smart Government procurement to give the UK first mover advantage

As one of the most digitally advanced governments in the world [31], the UK Government is a purchaser of space services and technology from commercial organizations through a number of different routes, including:

- ✂ The MOD is a direct procurer of defence/military satellite communications services under a PFI contract as well as a procurer of commercial satellite imagery.
- ✂ Numerous departments, including DFID, Home Office and FCO, directly or indirectly procure commercial satellite communications services for applications such as disaster response and emergency services.
- ✂ DEFRA procures satellite imagery and data.
- ✂ The UK procures Copernicus and Galileo (GNSS/PNT) capability via the EU.
- ✂ The UK space agency procures capability via direct contracts (for example recently for MicroCarb AIT).
- ✂ A range of contracts through the “Space for Smarter Government” Programme (SSGP).

All of these contracts are competitively procured from UK and international companies. With the global headquarters or European base of 5 major satellite communications providers (Inmarsat, Avanti, Intelsat, OneWeb, Airbus) and 4 satellite prime contractors (Airbus, SSTL, ClydeSpace, Thales Alenia Space), the UK has one of the most competitive and mature commercial markets in the world, ensuring that a large part of Government spending remains in the UK and achieves excellent value for money. By committing to accelerate the pace and scale of transformation [31] the Government has an opportunity to take advantage of space to continue to build more secure, resilient and capable services.

As an executive agency UKSA is well placed to drive the use of space by Government and act as a centralized procurement entity for transformative capabilities, especially in areas which are yet to fully benefit from space. A good example here is the Emergency Services Network (ENS) contract won by EE in December 2015 where Avanti will provide “carrier grade” cellular backhaul by satellite to over 900 fixed and portable base-stations in the UK using the HYLAS-1 and HYLAS-2 satellites.

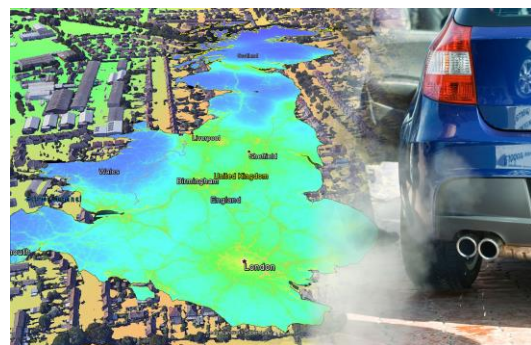
The benefits of this approach will be immediate and significant:

- ✂ Foster innovation to support economic growth
- ✂ Help spending departments increase their cost effectiveness and meet other policy objectives
- ✂ Attract investment by companies into the UK, driving future exports
- ✂ Streamlining of purchasing of space data, for example of satellite imagery, across Government

The main mechanisms which could support these aims are:

- ✂ SBRI: A cross sector mechanism but relatively small programme in the UK space sector, SBRI, which is well suited to SMEs, has mainly been used by the *Space for Smarter Government Programme*. This has led to a number of well-received projects but suffers from typical problems for SBRI, as highlighted by the *Connell Review* [25]: *The main weakness in SBRI highlighted in company feedback was the weak pull through to public sector procurement; the final operational testing and adoption stages of the SBRI process remain problematic across many departments. This partly reflects the lack of phase 2 product development contracts, and low levels of funding in many SBRI programmes.*
 - We agree with the conclusions and recommendations of the Connell Review when applied to Space, particularly the need for “Phase 3” trial deployments and evaluations.

CASE STUDY



With SSGP support, EarthSense Systems has published MappAir® – the first high resolution nationwide map of air pollution. Combining data from satellites and its own air quality monitoring sensors together with open source data. Initially available for the whole of the UK at 100 metre resolution, MappAir® shows how air pollution, specifically nitrogen dioxide, changes across the country and within towns and cities. With SSGP support EarthSense have been able to not only create MappAir®, but also investigate how it can be used to help inform the smart city agenda in terms of insight into air pollution, health and societal impacts and mitigation strategies.

- Furthermore we highlight the recommendation that “Competitions should be focused as much as possible on topics where UK SMEs and new ventures in large companies potentially have important contributions to make”. For Space we recognize that the UK will never be the leader in all aspects and, as highlighted by our National Space Programme priorities, we should focus on what we are good at, and where UK companies believe that they have something great to offer.
- ✂ PFI/PPP¹: The nature of space is that projects are often designed to deliver capability at the cutting edge of science and technology. This implies that projects can often be expensive and have significant risk. RFI/PPP models have been proven to be effective in the space industry by strongly incentivising industry to take responsibility for technical risks leading to better value for money and on-time-deliveries. Several countries have taken up this model, including Germany (TerraSAR) and Japan (DSN). On the other hand, having pioneered the use of PFI, and developed revisions such as PFI2, the UK now appears to be moving away from this approach both generally and with respect to space.
 - We recommend that Government continues the use of PFI when there is a compelling business case.
 - In moving to a direct procurement model we strongly recommend that Government establishes an adequate basis for evaluation and the necessary technical competences in the relevant departments.
- ✂ Service regulation and voucher schemes: another approach to encouraging business investment is the stimulation of demand by regulation or by providing customers with vouchers. A particular example here is the Broadband Connection Voucher scheme which made a big difference to 42,500 small firms and had an economic benefit of £8 for every £1 spent [33].
 - Rapid improvements in satellite broadband capability mean that rural users could see significant benefits by moving to satellite broadband. We recommend that the possibility for such a scheme is investigated, based on vouchers or some other measure to give companies the confidence to invest in UK capability.
- ✂ Better coordination between departments and novel organizations such as the Geospatial Data Commission and UK Government Earth Observation Service (UK-GEOS). These efforts need to be delivered effectively and aligned with industry, particularly towards future export goals.

The UK could also benefit from evaluating new infrastructure needs such as for Earth Information and also for on-going services such as PNT. Many of these will have strongly positive benefits across the economy and drive future exports. We agree that the Government should always seek competition and strategic choice (as emphasized in the recent Defence Industrial Policy [34], for example) and have demonstrated that this can be obtained alongside thriving and globally competitive UK industrial sectors. As part of this strategy industry has developed two specific examples (Earth Information and Connectivity) which could lead to £1B of private investment in UK infrastructure. We recommend that Government seeks a dialogue with industry on how to best develop these capabilities to provide business with the confidence to invest in the UK.

£1B

**Potential new
private
investment in UK
infrastructure**

Therefore, we propose to attract commercial investment to build space infrastructure by **demonstrating how smart Government procurement can be deployed to stimulate commercial investment in UK infrastructure giving the UK first mover advantage and empowering UKSA to become a procurement agency for the rest of Government**, for example a pan Government earth information service or broadband for underserved communities.

¹ Note: PPPs are used in the ESA ARTES programme to describe co-investment in new business R&D. Since this approach is not directly related to Government procurement we address ESA ARTES in section (4).

(2D) Deliver effective regulation in a commercial age

Space activities are regulated at national and international level. The operation of technology in space, including satellites, the launch of objects into space and most other space activities are strategic and subject to international treaties, which are flowed down into national laws and regulation. Transmissions to and from satellites are coordinated internationally and also require territorial licensing and may be subject to lawful intercept and other requirements. Satellite imagery can be subject to export control, data privacy and data policies. Businesses operating in these areas recognize the importance of regulation in meeting international commitments and ensuring trust in, and the credibility of, national regulatory systems. Companies look across the world for the most enabling and supportive regulatory environment, and transparent and credible licensing regimes. Regulatory considerations are second only to tax considerations and opportunities to secure state and private funding in driving companies' decisions about where to establish and grow their businesses.

There are many, particularly new, commercial opportunities which require: (i) the modernization or re-interpretation of existing regulation and licensing processes; (ii) the introduction of new regulation allowing new activities, such as launch opportunities; and (iii) the development of entirely new international regulation or codes of conduct: recognising existing international law, regulation and guidelines and influencing the development of such, for example in relation to in-orbit servicing and active debris removal.

Development of enabling and progressive (transparent, objective and proportionate) regulation gives clarity to companies and investors. The UK is not alone in seeking to grow its space sector and regulation is a key area where states are competing to encourage space-related foreign inward investment or encourage the growth of their national space industry. These include Estonia, Finland, Hungary, Greece, Portugal, Indonesia, New Zealand and the UAE. Other states are looking to upgrade their regulations to encourage growth and attract investment such as Luxembourg, Australia and Japan.

Against this increasingly competitive state environment it is therefore important that the UK has a regulatory environment that:

- ✂ enables innovation in, and the development and growth of, UK companies
- ✂ encourages investment, including foreign investment
- ✂ is internationally competitive
- ✂ is seen internationally to be promoting responsible use of the space environment

In the framework of the Space Growth Partnership the stakeholder community has established a number of areas where the UK can increase its competitiveness and stimulate the growth of existing and new businesses.

Existing satellites must be licensed by the UK Government via the UK Space Agency. This licensing process can introduce important burdens for businesses, particularly:

- ✂ **Insurance:** Third party liability (TPL) insurance cover is a requirement of the UKSA (and other regulators) to obtain a launch and/or operations licence. TPL insurance premiums can represent a significant financial burden to businesses, especially for operators of small satellites and constellations. Government should review, consult on and implement new models of TPL insurance requirements with objective and measurable risk metrics for smallsats /cubesats and constellations based on insurance market practice. Different models should be considered based on assessment of risk.
- ✂ **Liability:** The sector welcomes the Space Industry Act. Government should provide clarity as to the implementation of a liability cap in this legislation, and consult with industry on its planned policy and use of a liability cap for in-orbit operations and launches. The use of a cap will allow operators to insure against such liability.
- ✂ **Licensing process:** Licensing can be a complex process, even for satellites which are copies of proven designs. Government should transition to and implement its streamlined "traffic light approach" operationally by the end of Q1 2018, with appropriate guidance on the process published on the UKSA website and the streamlining of data requests for repeat missions. More generally, Government should review its licensing application process and practice (including speed and clarity of the process), and in particular for new technologies such as constellations, in-orbit servicing operations and domestic and overseas launches, and consider the structure, clarity and context of the application form and the licensing procedure on an on-going basis.

The UKSA should ensure that its licensing process is robust but flexible enough to cover different types of missions, and ensure that it has considered best practice from other jurisdictions (particularly taking into account any information which may have been shared by industry). This may include applying group licensing approvals, and group licensing application procedures (for example limited to a range of standard in-orbit

missions such as constellations where the satellites are identical and launched on the same launcher, with the individual space objects noted separately on one application form and separate licences granted to them).

- ✂ **Fees:** Government should review cost recovery in relation to licensing fees. The recovery of costs should be governed by applicable law and Treasury guidance and should be proportionate, reasonable and transparent. Government should also review the fees for different and innovative technologies such as constellations and in-orbit servicing, spaceports and launches and consult on changes to such fees. Any overpayment of fees should also be able to be recovered by operators and future payments reassessed.

Similarly, satellite operators must also file through the International Telecommunication Union (ITU) to gain international recognition for the orbital parameters of their satellite/constellation and the frequencies which they plan to use. Ofcom is the UK administration which processes the filings through the ITU on behalf of UK-registered companies. Ofcom also provides licences for the use of Earth Stations in the UK.

The Earth's orbit and the spectrum used by space operators are highly valuable resources. Therefore, all stakeholders appreciate the importance of preserving access to space and participating with our international partners in international measure to protect it and ensure sustainable use of the space environment. This includes the ability to monitor the space environment and identify threats to space assets. To this end we recommend:

- ✂ **Compliance and Enforcement:** Government should consider models for monitoring and reporting compliance with licence conditions, and in particular different models for different technologies, orbits and operations. Government should develop a long term risk assessment tool to analyse the long term risk profile of missions.
- ✂ **Creating an effective regulatory environment for new space technologies:** Government should research the risks and consider the most effective regulatory and international policy framework associated with new technologies such as mega constellations and in-orbit servicing. Government should use this work to develop an effective regulatory environment for such new technologies and seek to encourage the development of one within international fora. Industry should engage effectively with the Government in exchanging information, practical examples and future proposals for the use of such new space technologies and in creating an effective regulatory environment.
- ✂ **Space Surveillance and Tracking (SST): Environmental Sustainability and Space Debris Guidelines:** Industry should work closely with Government to develop requirements for SST, including in relation to the evolution of the UK Space Operations Centre (SpOC) and the sharing of SST data sets. Industry and Government should continue their work within international fora such as the Inter Agency Debris Committee (IADC), International Standards Organization (ISO), UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) and ensure the widespread implementation of these and other guidelines.

Beyond the general issues of reaching space and maintaining access to it, the growth of space businesses relies on the ability to distribute Earth information acquired by satellites and provide telecommunications services.

Earth Observation (EO) is a fast growing area (approx. 10% growth rate) and Government should propose and engage with industry on the drafting of an EO data framework for high resolution images derived from space, balancing commercial objectives and appropriate security constraints.

Access to Spectrum – Telecommunications is the largest application of space technology by revenue and is rapidly growing with the development of worldwide broadband internet systems. Industry and Ofcom should engage on, and Ofcom should evaluate, evidence-based spectrum requirements of industry to enable this growth. Ofcom should consider evidence from industry, as to whether changes to the Ofcom Procedures for the Management of Satellite Filings would be beneficial for UK industry and enable growth.

Ofcom should engage with industry to understand the evolving nature of space technology and services to ensure that the UK regulatory process is fit for purpose. Ofcom should continue to work with UK industry to understand how, proposed, changes to the ITU Radio Regulations may benefit or impact UK industry. This is important in the preparation leading up to WRC-19 in relation to securing sufficient and sustainable spectrum for satellite telecommunications and EO, and to ensure the protection of existing uses of satellite spectrum for telecommunications, EO and Earth stations, for example of Earth exploration satellite systems (EESS), and data relay satellite systems.

More generally, a deeper engagement strategy should be established between the Government, Ofcom and industry. Ofcom should continue to represent the interests of the UK, including the UK industry, in European and international fora, after effective consultation with industry. Industry must therefore engage with the Government and Ofcom to articulate its requirements and provide evidence based information. This should include working together to identify further opportunities for the UK to grow through effective regulation.

UK Government should deliver a global, competitive and progressive regulatory regime supported by a dedicated and adequately resourced team.

3 Invest in our people and places

(3A) Skills for a high productivity industry

In order to support its annual growth, arising from a combination of both organic growth already being experienced in the sector and the additional stimulus from the Sector Deal, the sector will need to recruit and train an additional 30,000 employees in addition to the 38,500 directly employed in 2015. This is a conservative estimate. The number of skilled posts the sector needs to fill may be much higher than this driven by the eventual revenues of the sector by 2030, the need to replace those leaving the sector and possible changes in employment driven by the ever closer relationship between space applications companies and the sectors where those applications themselves will be used.

To do this, the space sector will need to do its utmost to retain skilled professionals, attract graduates and post graduates from UK universities, diversify its workforce, be permitted to recruit and retain skilled overseas workers at numbers similar to today² and provide continuous professional training for employees in the sector and those joining from other sectors. It will need to consider an increased role for apprenticeships in the space sector. This activity will take place across the country as new centres of excellence build, including all-new market activities such as the UK Spaceport. In addition the sector intends to work with the Government to ensure mutual recognition of professional qualifications across international boundaries.

The nature of space manufacturing, science, engineering and operations does mean that a high proportion of skilled workers in these areas are required to have space-specific knowledge and skills. These workers will need to be skilled in mathematics, physical sciences and engineering but equally important will be the growth of a workforce with experience and talent in business development, entrepreneurship, data analytics and marketing/communication skills.

We are now living in an era when moving across several sectors during a career is rapidly becoming the norm rather than the exception, presenting fertile opportunities for us to create new structures in order to accelerate the growth of the space sector's capabilities and performance. A focus on increasing retraining opportunities, maximising staff retention and actively encouraging significantly increased levels of diversity in our workforce are strategic and operational imperatives for us to embed in our prioritisation if we are to achieve our ambition of securing 10% of the projected £400B global market by 2030.

So we will focus on supporting and growing the existing successful skills development programmes such as the Space Internship Network (SpiN), and support the development of expansion of new skills development programmes in a range of areas from business development to entrepreneurship.

To drive forward the sector's skills agenda we will appoint a senior industrialist to lead a new space sector skills & diversity programme, reporting to the Space Sector Council, to ensure we are providing the coordination across industry, universities and Government to give us the best chances of recruiting the talent we need and training them effectively. Specific measures comprise:

- ✦ We will expand the number of available internship opportunities for current undergraduates through programmes like the Space Internship Network (SpiN), which provides short-term projects (typically of eight weeks duration) to offer individuals the opportunity to gain new skills and an insight into the space business, and other UK/International internship/summer school opportunities to 300 places per year.
- ✦ We will maximise training opportunities for existing staff through both traditional training routes (Masters/Continual Professional Development), for example degree apprenticeships. By working proactively with academic, business and technical training partners, we will increase the supply of professional development, Masters and technical training programmes through sponsorship and support for content development, potentially including light-touch accreditations.
- ✦ We will support the specific needs of the space sector by providing routes, linked to appropriate training, from other sectors and disciplines, including non-STEM subjects, which will allow workers to move across sector boundaries.
- ✦ We will support the development of critical business/leadership skills during Higher Education courses through partnership, content development and industrial placements.
- ✦ We will maximise on the opportunities for disruptive business innovation through the development of an Institute for Space Entrepreneurship, including improving the UK's ability to commercialize new ideas and R&D.

² 11% of the sector's employees are highly skilled foreign nationals.

- ✂ Knowledge Transfer Partnerships will be fostered and proactively highlighted, strengthening university/industry collaboration and taking advantage of the additional £30m announced in the Industrial Strategy. In tandem the 'e-space' scheme will be utilised, strengthening the ability of start-ups to "spin-out" and scale-up."
- ✂ We will more effectively cross-link to other sectors which increasingly are providing the business market opportunities for existing and new space-derived services - to enable maximal flow of skilled and new entrants into space sector from "non-traditional" sources and also to enhance space services capability to new markets
- ✂ We will work to significantly enhance Space Sector Careers awareness and opportunities – using STEM Ambassadors and academic/training partners to create new platforms focused on maximising the ability of and flow rates into space sector employment
- ✂ Establish a 'UK national graduate scheme' using ESA ARTES funding to create an annual programme of graduate placements related to the high growth potential areas in the space industry, including commercial applications of Telecoms, navigation and Earth observation. UK graduates would be placed either with ESA in relevant departments, or directly with businesses, for a period of between 1 and 2 years. We would target 50 graduates per annum who would, after their placements, come back to the UK, improving the pool of UK nationals with relevant space experience.

We recommend establishing a people and skills programme to attract and train up to 30,000 additional skilled people by 2030.

(3B) Diversifying our workforce

Rapid social change alongside an increasing depth of academic and industrial research tell us that – beyond simply being the right thing to do – diversity and inclusion are good for business, good for society and create better teams that deliver productivity. In fact, the research indicates that diversity & inclusion are more important to business growth than we might have imagined, with a robust correlation between highly innovative, diverse companies and success at capturing new markets as well as improving market share (Center for Talent Innovation study sponsored by Bloomberg, Bristol-Myers Squibb, Cisco, Deutsche Bank, EY, Siemens, Time Warner).

Furthermore, 90% of CEOs agree that promoting diversity & inclusion is critical for attracting talent (18th Annual CEO Survey, PwC 2015). We recognise that this principle holds true for the space sector as well, where a high performing workforce is critical to our success.

Both historically and today, the space sector suffers from a significant diversity gap; add this to the sector's aging workforce – for example, 70% of NASA's workforce in 2011 was aged 40-60 – and we are facing a significant risk. By the same token, we have an opportunity for the UK to build a diverse, inclusive sector that leads the world and attracts talent.

The space sector has also grown significantly over the past 5-10 years but was recruiting new talent at minimal levels before and into that period, creating significant risk for growing the sector according to our ambitious target.

Given this context, we intend to address diversity and inclusion head on in our sector. What do we mean by diversity & inclusion?

- ✂ Diversity: involves traits that people are born with (e.g., age, gender, ethnicity, disability and sexual orientation) or have acquired (e.g. experience abroad and professional background).
- ✂ Inclusion: involves empowerment and equal treatment for people of all backgrounds, personality types, marital status, socioeconomic status, etc.

We recognise that this is a difficult issue to tackle for many reasons and we do not purport to have all the answers; however, by making it a central tenet of the space growth partnership and the national programme we can drive future action plans that will encourage progress in this area.

As part of our plan for achieving diversity and inclusivity, we also aim to identify and exploit mechanisms for enabling people to contribute to and benefit from the sector, including those from different socioeconomic classes.

Over the next four years:

- ✂ We will focus on this important issue from day one of our sector deal whilst recognising that there is no 'quick fix' for achieving diversity & inclusion.
- ✂ We will review the best practices of other UK and international initiatives for achieving diversity & inclusion across the workforce.
- ✂ We will build diversity & inclusion into each of our initiatives for developing the skills base and inspiring future generations.
- ✂ We will ensure that the UK Space Sector Council and the Space Growth Partnership will include a 'Change Champion'.
- ✂ We will host an international summit on diversity in space, inviting space and diversity experts from around the world to explore strategies for addressing our particular sector challenges.

We recommend using the space sector deal as an opportunity to demonstrate global leadership in achieving a more diverse workforce and inclusive environment that attracts the best and brightest from around the world.

CASE STUDY



The Women in Aerospace UK group was formed in 2016. The current aim of the group is to bring together the UK Space Community in support of a more diverse and equal workforce. The group will initially focus on three areas: De-mystifying Unconscious Bias; Networking/Mentoring; Creating a Network of Experts.

(3C) Inspiring future generations

Across the entire spectrum of space science, from “looking out there” (astronomy), “going out there” (exploration) and “looking back here” (satellite applications), the discoveries made, journeys undertaken and services provided from space have transformed our understanding of the Universe, raised our aspirations for exploration and adventure and revolutionised our 21st- Century way of life through global telecommunications, navigation- enabled smartphone apps, satellite broadband and Earth Observation capabilities. Perhaps more than any other topic, space captures the imagination, instils wonderment, and inspires the next generation of scientists and engineers. As a rapidly growing sector it also offers the opportunity to inspire new generations of entrepreneurs and innovators.

When the European Space Agency (ESA) Rosetta mission completed its 12-year, 6 billion kilometre odyssey to rendezvous with and land on the nucleus of the tiny Comet Churyumov-Gerasimenko in 2014, it lifted UK space science onto the front pages of newspapers across Europe. The enormity of the achievement was one which people in the street could visualise. The saga of the lander kept the project in the public eye over an extended period and the TV publicity surrounding it gave the Space Scientists supporting the programme the opportunity to demonstrate their genuine excitement both in the project and in science as a career.

Principia - the education programme conducted by British ESA astronaut Tim Peake during his six-month mission on board the International Space Station - included primary school science activities, on-orbit coding opportunities and orbital demonstrations of fundamental physics and chemistry concepts. Nearly a million UK students engaged as virtual participants in his mission through these activities and Tim’s next spaceflight opportunity – probably by 2021 - will build further on this legacy, highlighting the science educational opportunities of Earth Observation and satellite applications.

UK-involved missions scheduled for launch in the next four years include the James Webb Space Telescope (the successor to Hubble), ESA’s Bepi-Colombo mission to Mercury, ESA’s Solar Orbiter and the ExoMars rover in 2020 which will put a British-built rover onto the surface of the Red Planet. The rover in particular is a challenge that all can understand and the availability now of demonstration hardware will be exploited to the full to engage with the young over an extended period. These forthcoming UK space missions present further, rich opportunities for educational inspiration in a world which is increasingly digitalized, interconnected and in which UK innovation can help solve societal challenges from the local to global.

But inspiration alone is not enough.

For our sector to reach its full potential by 2030, we need a future workforce including up to 30000 new talented individuals, with a range of skillsets and from a diversity of backgrounds – and right now, that future workforce is in primary or secondary schools.

We need to make them aware of opportunities in the space sector that they- and their families - may not even realise exist; we need to help them navigate to reach these potential careers goals; and we need to support them in their understanding of the critical enabling curriculum subjects they will need in order to do so.

So, working with UK Space Agency and other partners, we will implement a multi-layered space education development strategy, involving students, teachers, careers advisors and industry/academia - supporting and growing those programmes which are already making significant headway in these areas and introducing new innovative methodologies to engage young people, their teachers, families and communities in outreach and education.

Over the next four years:

- ✦ A cohort of new STEM Ambassadors recruited from across the space sector will deliver up to 30,000 new engagements with groups of young people reaching up to 1 million young people – acting as direct role models and mentors for the next generation of UK space professionals.

CASE STUDY



The National Space Academy, led by the National Space Centre, uses inspirational contexts from across space science to boost student attainment, enhance teacher effective and to provide careers support for secondary schools and colleges across the UK. Its 35-strong team includes some of the UK’s best current science teachers working with current UK space sector scientists and engineers to deliver intensive curriculum-focused masterclasses for students and teachers. Each year more than 6000 students and 1000 teachers participate in its UK programmes, whilst overseas the Academy has led, on behalf of HMG, international programmes for the European Space Agency, China National Space Administration and UAE Space Agency.

- ✦ We will work with the UK Space Agency, industry and academia to grow existing successful national programmes of space education for students and teachers such as the National Space Academy and ESERO-UK – to directly work with tens of thousands of school students and STEM/geography/humanities teachers each year.
- ✦ We will work with Universities and Government to support the expansion of existing space-focused summer school and out-of-term extended programmes for school students
- ✦ We will work in partnership with industry, Government and careers professionals to create effective careers information platforms enabling young people, their teachers and families to better understand the opportunities for them in our sector.
- ✦ We will support the existing space-focused science education centres such as the National Space Centre and new Airbus STEM Centre and the wider UK Association of Science and Discovery Centres (ASDC) network of over 60 science centres to potentially reach millions of family visitors each year- informing them further on space science, supporting wider space outreach programmes and further engaging the diverse range of stakeholders we need in order for our sector to reach its full employability potential.

We will showcase exciting scientific achievements in space and undertake 1,000,000 interactions per annum with young people to inspire the take up of STEM careers benefiting all high tech sectors in the UK.

Case study: Airbus Foundation Discovery Space



*Airbus Defence and Space, in partnership with North Herts College and North Herts LEP, have opened a £3.2M facility in Stevenage to enhance STEM uptake in general and build the next generation of space scientists, technicians and engineers. Together they have grasped the unparalleled opportunity offered by the Mars Rover Programme. Positioned with its windows looking directing out across a simulated Mars landscape, the **Airbus Foundation Discovery Space** centre for science, technology engineering and maths will welcome 27,000 students in the next five years. North Herts College will run a STEM education programme at the centre, working with Airbus Defence and Space's engineers and technicians. There will be a series of interactive exhibits as well the chance to see the 30m x 13m test area in action, with prototype rovers negotiating the simulated Martian landscape. Outreach activities for schools and a dedicated website and social media campaign are also planned.*

(3D) Spread the benefits around the UK

Space is an underpinning technology which benefits everyone in the UK, however we know that there is more it can offer. Two of our priorities address this : *Earth Information* has the ability to deliver services and applications across the UK whereas our priority around *Connectivity* is about enabling everyone, and especially those outside big towns and cities, to benefit from always-on broadband internet. In addition, our priority for UK Launch services offers exciting opportunities for regions to attract inward investment as well as stimulate local economies. **Therefore “Place” isn’t just a consideration for our strategy, it is at its very heart.** So these transformative services will simply not exist without adequate localization and the local resources to train the people needed. In return, communities will receive services boosting local productivity and quality of life. A number of projects have already been funded through the Space for Smarter Government and ESA Integrated Applications Programmes. We recommend that these continue to push for regional benefits and that the National Space Programme also provides a complimentary boost to local applications.

The industry itself is weighted towards the south east but is rapidly expanding throughout the UK. Centres of excellence are emerging in Scotland (e.g. the world’s leading CubeSat manufacturer, CydeSpace), Wales (e.g. the processing and archiving centre for Copernicus operated by Airbus), and Northern Ireland (e.g. the new Thales Alenia Space Electric Propulsion Integration Centre in Belfast), but there is much more opportunity for expansion if the right conditions can be put in place. Places such as Leicester, Guildford, Cornwall, Portsmouth, and Hertfordshire are developing local strategies and mature proposals, such as the *Leicester Space Park* and *Portsmouth 5G Centre*. These will build on the work started in developing the Harwell Space Gateway in Oxfordshire and the Regional Centres of Excellence developed by the Satellite Applications Catapult. Our strategy will help to develop these proposals further so that they are investment-ready and also so that they develop together to make the best of existing and future collaboration opportunities.

A key part of our strategy will also be to engage local industry and SMEs through industry-led accelerators. One template for this is the Airbus *Endeavour* initiative with the Welsh Government which aims to accelerate the Welsh economy by helping to fund the development of early stage research to the point where commercial value can be realised. Another potential initiative is proposed by Inmarsat in partnership with Leeds university. We will explore if such programmes can be scaled up across the UK.

Attractive places to locate are also important incentives for FDI to come to the UK. Attractiveness is strongly affected by factors such as the visibility of clusters of skills, research, facilities, room for business expansion and possibilities to connect to cross-sectoral capabilities. The Harwell cluster, as an example, has demonstrated success both as a place to seed and cultivate new home-grown companies and also as a UK destination for multi-nationals and an attractor for FDI. Therefore this strategy will build on strengths, focusing on building more clusters of resource and capability across the country in a network to complement Harwell. We will work with the emerging clusters to integrate them into our FDI offer and help them to develop the best offer towards the global market.

Finally, we recognise the opportunity to create local Industrial Strategies recommended by the Government. Space strategies have been developed within Northern Ireland [42] and Wales [43]. The SGP plans to support all devolved administrations (as well as the LEPs) to continue to develop their own approaches to capturing the benefits of space.

To enable the growth envisaged by the strategy industry and academia will work with LEPs and DAs to develop locally-led regional technology hubs creating a Coast to Coast Space Spine across the country. These hubs will focus R&D, training, skills development/education for current and future sector workforce and wider STEM outreach.

CASE STUDY



In the SatCare project ambulances in rural Scotland will be equipped with satellite-connected video and ultrasound capabilities in a project between NHS Highland and the Scottish Ambulance Service, ESA and ViaSat. This will help provide better care during long journeys in rural areas leading to better patient outcomes.

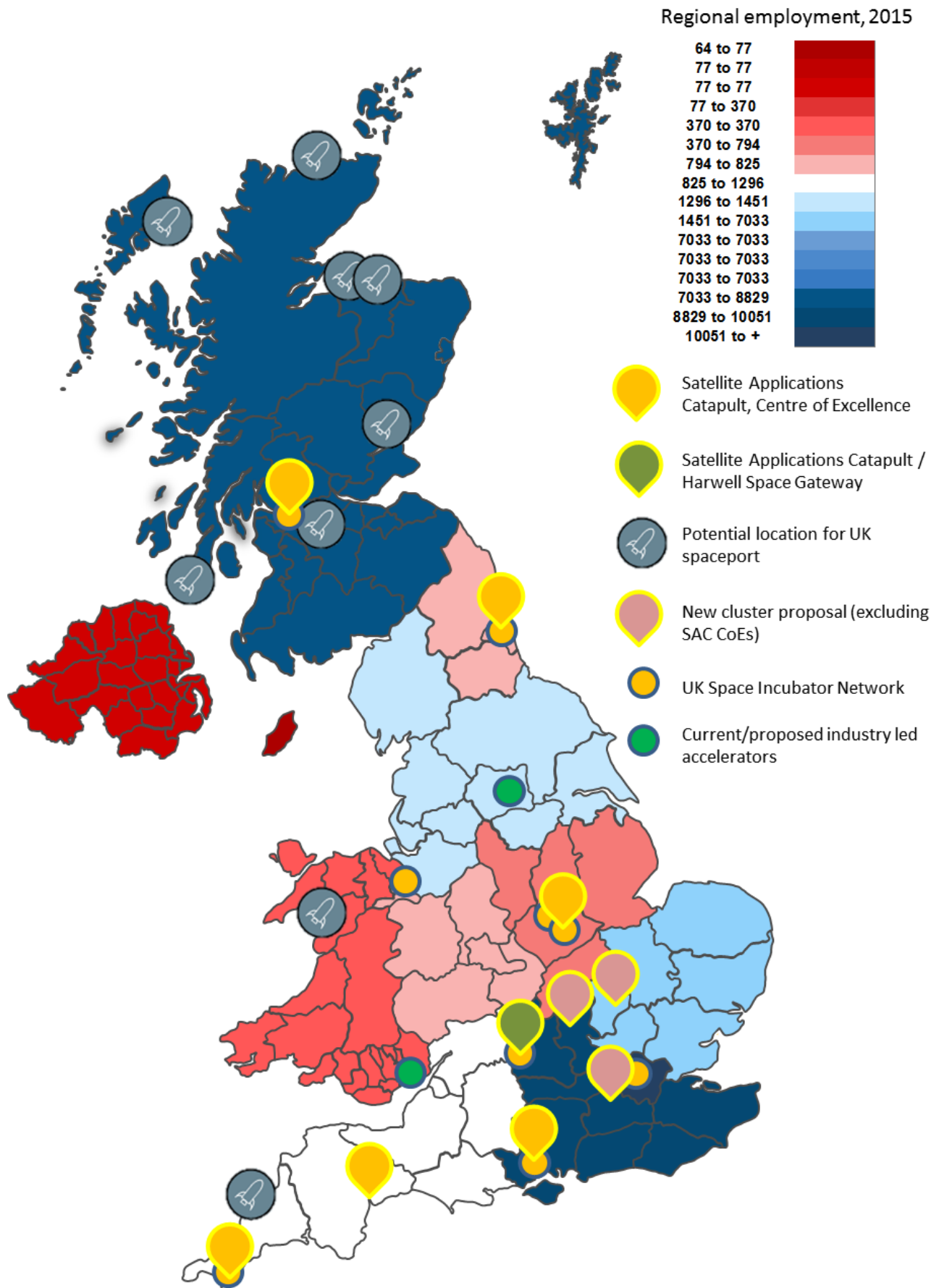


Figure 13. Place is at the heart of our strategy and we are developing ideas for driving regional growth across the key priorities identified

4 Continue to drive growth from ESA, Eumetsat and EU programmes

(4A) Increasing benefits from ESA and Eumetsat

Historically the UK has chosen to deliver space programmes through partnerships with the European Space Agency (which is separate from the EU), Eumetsat, and the European Commission. This has allowed the UK to very sensibly leverage its contribution to make amazing and historic achievements, far in excess of what would be possible on our own. On the 13th October 2017, for example, all UK news outlets covered the launch of the Sentinel-5 Precursor spacecraft, built in Stevenage. Such missions give a very public endorsement to statements that the UK remains on the world stage.

Crucial to maintaining the UK's global position and industrial base, ESA programmes deliver value-for-money and access to the European market. A recent literature review [24] indicates that returns from ESA membership can be estimated as “£3-£4 (direct) plus £6-£12 (spillover) per £1 of public investment”. ESA science missions allow exploration of our universe and understanding of the key issues facing our global environment.

ESA also funds a number of commercially focussed programmes, like the Advanced Research in Telecommunications Systems (ARTES) programme, helping companies in the UK developed new technologies. New programmes such as PIONEER are being developed to allow new business models and the UK is already being successful at accessing these, for example the first Space Mission Provider was the Harwell based company Open Cosmos (contract signed May 2017 at the UK Space Conference).

In developing our strategy we have reviewed the relative merits of both ESA and National Programmes, taking into account lessons learnt from other European countries. The entire space sector believes that the relationship with ESA is a key component of our strategy going forward and that our investment should be maintained. A dialogue has already been established with ESA to take advantage of the complementary advantages of ESA and National delivery mechanisms, as indicated in Table 4. We will also consider that in some cases an ESA project supported by dedicated national projects can provide an excellent mechanism for establishing UK opportunities and growth in large programmes. Examples could include developing an SME to feed into programmes delivered by primes in other ESA member states, or developing UK based services relying on ESA infrastructure. Specific examples currently under discussion include 5G and Satellite Based Quantum Key Distribution (SB-QKD). These could cross between ESA and a National Space Programme since following the last ESA Ministerial, the UK became the largest contributor to ESA's ARTES programme, which stimulates innovation and economic return from the commercial satellite communications market. Opportunities for developing optimized approaches and streamlining the process will be explored.

ESA Funding	National Funding
<ul style="list-style-type: none"> • Pan-European or global scale projects that benefit from international collaboration. • Innovation or products that require or benefit from ESA accreditation or ESA technical expertise. • Programmes giving UK companies access to European customers • Influence, know-how and access to the €4bn annual ESA R&D programme. • Projects where a European supply chain is required or highly desirable for UK to access relevant technology • Projects that companies want to take forward on multiple European sites • Collaboration with best science groups in Europe. 	<ul style="list-style-type: none"> • Purely national interest, benefit or priority. • Bi or multi-lateral international partnerships that do not involve ESA. • National exploitation of technology spun-out of the €4bn pa ESA R&D programme. • Increased R&D and preparatory research nationally enables the UK to secure better value and access from ESA mandatory programmes • Fast track space qualification of novel space technology to open up new global markets

Table 4. Our complementary ESA/national approach

Another key aspect of ESA funding is that some EU programmes use a combination of EU and ESA investments (particularly in the early phases), so the UK's new partnership with the EU needs to include consideration not only of how best to continue the UK's involvement in these existing programmes but also the impact on the ESA programmes. In addition, current uncertainty about UK participation in future EU programmes such as Govsatcom and SESAR may lead to difficulty in securing the early contracts with ESA that will help UK companies to win large future contracts.

Finally, the UK is a member of Eumetsat which is also separate from the EU and maintains a close relationship with ESA. We do not expect this to change.

We recommend to continue to enhance the relationship with ESA and Eumetsat maintaining at least the current level of investment.

(4B) Continuing to benefit from EU programmes

EU programmes provide European-scale public infrastructure which individual countries might struggle to afford by themselves, including:

- ✂ Copernicus : providing global environmental monitoring
- ✂ Galileo (GNSS/PNT) : providing improved satellite-based navigation with European autonomy
- ✂ SST : a new programme providing Space Surveillance and Tracking

As highlighted by the Government's Brexit position paper [10] these also provide important commercial opportunities for UK companies. Historically the UK does very well in these projects with 20% workshare compared to a 14% budget contribution. For example the UK runs the Copernicus data processing centre in Wales and acts as provider for several key services, including Security and Climate. The UK has also been influential, particularly in the security aspects of Galileo. With this investment already sunk, companies and Government are now beginning to rely on these missions for data and services. Whilst access to Copernicus and Galileo may still be possible after Brexit, we may lose access to advanced and security features, as well as the ability to influence the next phases of development.

Beyond the current programmes the EU is increasingly ambitious for space, with key future activities including:

- ✂ SESAR : Single European Sky ATM Research
- ✂ GovSatCom : providing Government communications
- ✂ The follow-on R&D programme to Horizon 2020

In our current position the UK can help to influence these programmes which will provide major opportunities for companies in the coming years.

Overall, therefore, British scientists and companies are so deeply embedded in EU programmes that they completely underpin the sector. A recent survey of 56 companies showed that Europe was the sector's biggest market. Furthermore, although we are not leaving ESA, the future relationship between EC and ESA will become tighter and therefore the UK needs to retain influence. **Access to European markets and programmes is also an essential factor in existing businesses investment in the UK.**

On the other hand, if the participation in EC programmes needs to change (as a result of the negotiations to leave the EU), then appropriate measures should be put in place to mitigate the resulting impacts on UK industry and society, as well as reaffirm the relationship with our European partners. Despite the importance of our European partnerships, especially to accessing the commercial European market, they are not designed to build the sorts of new relationships that the UK seeks to build around the world.

We therefore support the Government's goal to seek to negotiate an ambitious future partnership with the EU and recommend that a future UK/EU partnership covers all current and future EU space programmes, or identifies commercial and industrial opportunities to address shortfalls in activity.

CASE STUDY: Sentinel-5 Precursor



Launched in October 2017, Sentinel-5P is a state-of-the-art ESA satellite in collaboration with the Dutch Ministry of Economic Affairs. Built by Airbus in Stevenage, it will produce daily global maps of high altitude chemistry and pollution to be used for improving air quality predictions for European citizens as well as understanding climate change.



Delivering on the promise

The foundation for this strategy is the work carried out between 2009 and today by stakeholders in the space sector from industry, Government and academia. Between 2009 and 2012 this collaboration gave rise to an Innovation and Growth Strategy (IGS) for the Space Sector. Significant achievements include:

- ✂ A new National Space Policy from Government [7]
- ✂ Formation of the UK Space Agency
- ✂ Creation of the new Satellite Applications Catapult Centre at Harwell
- ✂ Increased UK investment in the European Space Agency's programmes and the location of ESA's new European Centre for Space Applications and Telecommunications (ECSAT) at Harwell
- ✂ Local centres of excellence in several of the UK's regions and local space strategies in Devolved Administrations and elsewhere around the country
- ✂ The Space4Climate collaboration between industry, Government and academia
- ✂ The Satellite Finance Network to bring industry and financiers closer together

With the above preparatory steps completed and the sector still demonstrating above average growth of 6% per annum, a review of progress and future opportunities was undertaken in 2013.

The IGS was configured around the space sector's ambition to increase the UK's share of the global space market by 50% between 2009 and 2030 [2]. The 2013 review [45] showed that more would need to be done on a number of fronts in order to reach the goal of attaining the target 10% share of the global market for the UK by 2030. In 2015 the decision was taken to tighten management of the collaboration and to concentrate on key actions underpinning future growth.

The areas identified for concerted action were: as represented in the chart below. The main work streams were complimented by consultations with industry and the other stakeholders to solicit ideas for specific industrial and other initiatives aimed at contributing to enhanced growth, UK infrastructure provision, exports and inward investment.

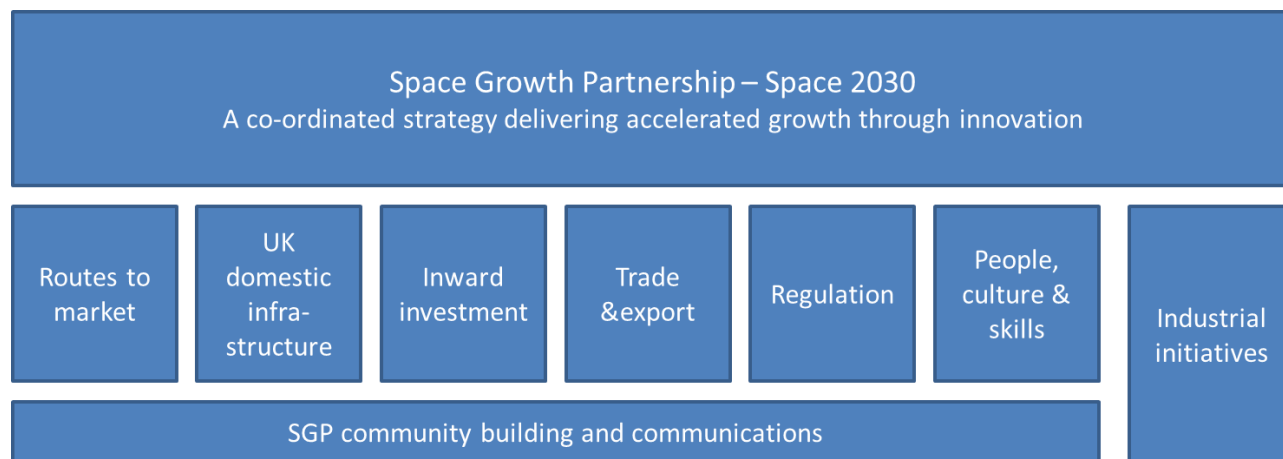


Figure 14. The Space Growth Partnership has evolved from the IGS to deliver the 2030 ambition

These activities involved over 100 people undertaking multiple consultations and studies, resourced and funded by the stakeholders working in collaboration. Engagements with Government, industry and academia made use of:

- ✂ The Council, Executive and dedicated Committees of UKspace, including its SME Forum and European Affairs Group
- ✂ Market focused workshops organised by the Catapult and KTN
- ✂ Dedicated export forums organised by industry
- ✂ Multiple smaller consultative activities on topics such as :
 - Access to Finance (industry lead)
 - Liaison with defence interests (industry lead)
 - Procurement (industry lead)

- Regional growth strategies (UKSA lead)
- Regulation (industry lead)
- Inward Investment (DIT lead)
- People, Culture and Skills (UKSA and academic lead)
- Academic engagement

The principal stakeholders took the decision to form a Space Growth Partnership (SGP) to pursue an agreed *Statement of Aims* and to act as a delivery vehicle for the IGS. Latterly the SGP has worked to align its envisaged programme with the Government's Industrial Strategy and the recent guidelines set out for Sector Deals. Outcomes from this work so far have included:

- ✂ 35 commissioned market reports
- ✂ Reports and recommendations for each of the six work-streams
- ✂ 40 proposals for collaborative initiatives from industry and the SA Catapult

These documents can be found in the SGP programme library (see document tree in Figure 15).

Key actions are reflected at high level in the Executive Summary and previous sections of this document. There are further detailed actions recommended in the Work Stream Reports listed in the document tree represented below. The documents to go into the two hashed boxes on funding allocation and corresponding detail for delivery planning purposes will be finalised once the deal has been struck.

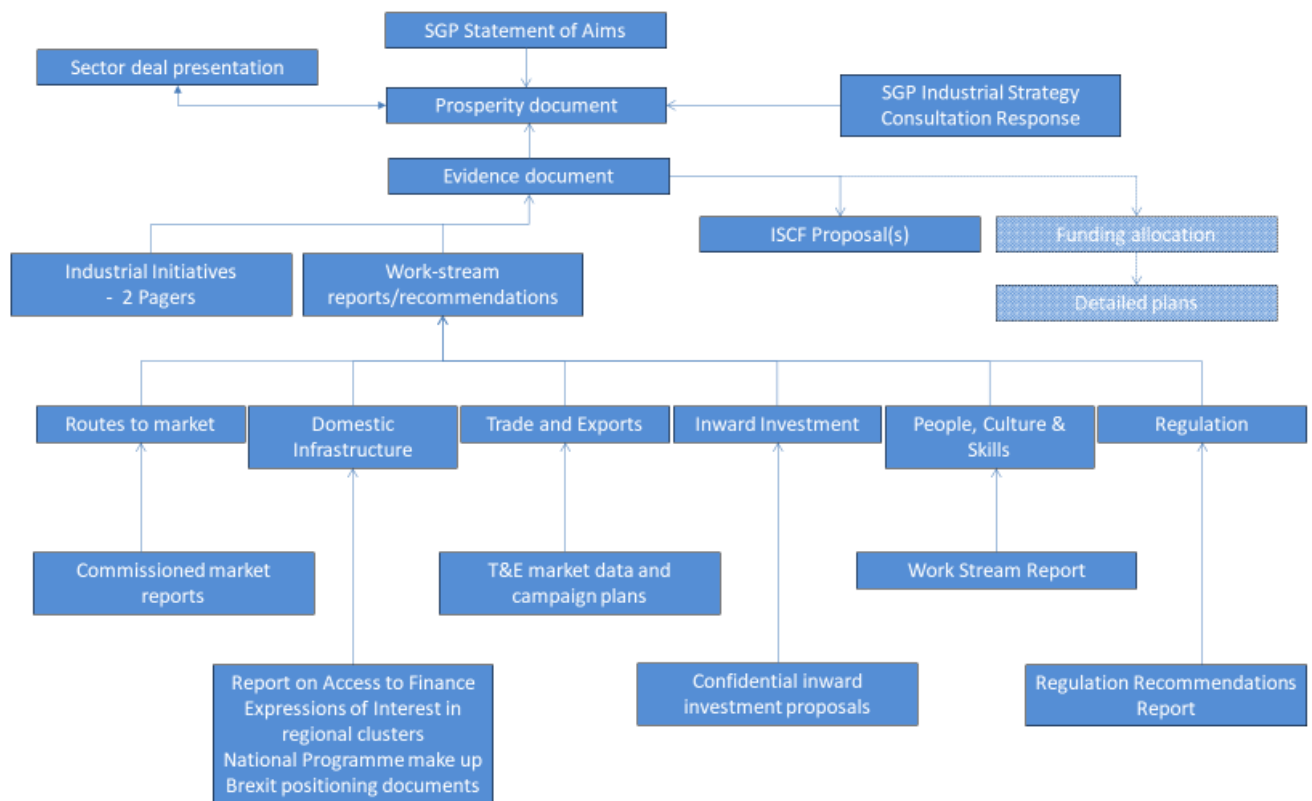


Figure 15. The strategy is supported by a depth of analysis and supporting evidence

Within this framework we have formulated the proposed Sector Deal to align this collaborative enterprise with the goals of the Government's Industrial Strategy, to be delivered in accordance with the following governance and implementation plan.

Our plan to achieve the 2030 targets

The Space Growth Partnership brings together the stakeholders and it is establishing three levels of control as seen below:

- ✂ A **Space Sector Council** (SSC) to provide high-level governance. The Space Sector Council is already established and has superseded the Space Leadership Council which had been in operation since the IGS in 2010. Its members are CEOs of the sector's leading companies, the CEOs or Directors of Government departments and leading academics. The Chairperson is Andy Green.
- ✂ An SGP **Programme Board** reporting directly to the Space Sector Council is being organised. The core members of the board will be senior representatives of the key budget holders for the various initiatives/programmes. These are currently envisaged to be InnovateUK, UK Space Agency, Satellite Applications Catapult, Department of International Trade and UKspace. Individual Programme Board members will be accountable for delivery of those elements of the Sector Deal managed by his/her own organisation.
- ✂ The Programme Board will be supported by an SGP **Delivery Team** which will include many of the existing preparation team thus maintaining essential continuity but whose size and composition will be negotiated with the budget holders on agreement of the sector deal. Recognising the need for effective delivery, the sector is ready to formalize these structures so they can be fully established before commencement of a Space Sector Deal. This is based on clear, largely single point, accountability for delivery of each element of the sector deal linked to the ownership of budgets and manpower resources. Each organization would be expected to use its own delivery mechanisms but work together in the partnership to ensure coordination and maximized effectiveness.

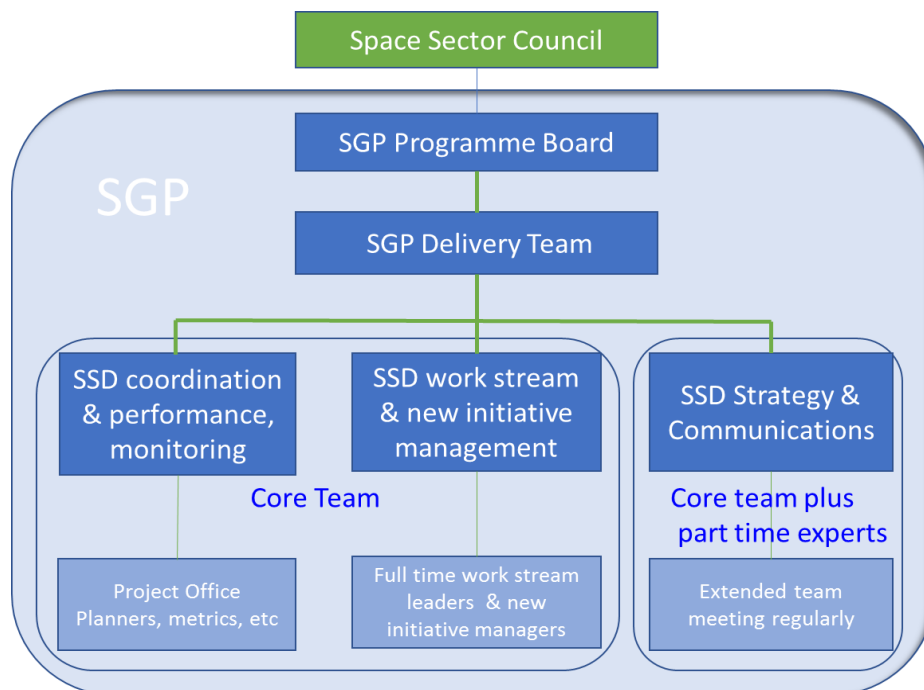


Figure 16. Proposed SGP structure

The SSC will meet quarterly and the programme board will meet monthly, except at the start of the activities when more frequent meetings may be necessary. The delivery team will have full time and part time members and will look to utilise (not duplicate) the existing delivery teams whether in Government or private institutions.

The SGP are currently evolving to set in place the structure for the Governance, Implementation and Delivery. The following table illustrates the activities both completed and planned.

Date	Activity
August 16	Start to form SGP following decision of Space Leadership Council
December 16	Start to gather market data
January 17	InnovateUK agree to fund market studies by SAC
February 17	Agree statement of aims for the Space Growth Partnership
March 17	Market reports start to arrive
April 17	Request industry initiatives
May 17	Initial 40 industry initiatives received
June	Initiatives grouped into work-streams and decision to hold workshops made
July	Workshops held
September 17	Work-stream outputs received
Oct 17	Hold first Space Sector Council meeting
17 th Jan 18	Space Sector Council endorses sector deal submission
2 nd Mar 18	<i>Prosperity from Space</i> submitted
Mar 18	Space Sector Council meets to agree formation of SGP Programme and Delivery teams
Mar 18	Kick-off pilot Market Challenge Teams: Agri-Tech and Transport
Mar – April 18	If selected as candidate sector, negotiation with BEIS
April 18	Confirm SGP programme board and hold first meeting
May 18	Negotiate SGP delivery team make-up with constituent bodies
May 18	Confirm planning and kick-off sector deal activities
May 18	Kick-off Market Challenge Teams
May 18	2nd SGP Programme board and agree preparation phase for National Space Programme and work-stream activities
June 18	Presentations across the UK to industry/academia on sector deal
June 18	<i>SGP programme board monthly review</i>
June 18	Form work-streams to develop initiatives
June 18	Space Sector Council meeting. Review SGP programme output.
July 18	Match 40+ industrial initiatives against National Space Programme preparation phase outcome
July 18	Deliver Export Strategy
July 18	<i>SGP programme board monthly review</i>
July – Sept 18	Hold Market Challenge Team Workshops
Aug – Nov 18	Call for new industrial initiatives
Sept 18	<i>SGP programme board monthly review</i>
Sept – Dec 18	Review initiatives from MCTs and industry
Oct 18	<i>SGP programme board monthly review</i>
Nov 18	Kick-off first industrial projects
Nov 18	<i>SGP programme board monthly review</i>
Nov 18	<i>Space Sector Council meeting.</i> Review SGP programme output.
Dec 18	Issue <i>Opportunity Unlock Plans</i> from pilot Market Challenge Teams
Jan 19	<i>SGP programme board monthly review</i>
Jan – Mar 19	Hold Market Challenge Team Workshops
Feb 19	<i>SGP programme board monthly review</i>
Feb – Mar 19	Review initiatives from MCTs and industry
Feb 19	<i>Space Sector Council meeting.</i> Review SGP programme output.

Industry continues to invest

Evidence that UK industry is ready to make significant investments in the UK can be drawn from recent examples:

- ✂ **OneWeb** is investing in a new Corporate Headquarters, Network Operations Centre (NOC) and Satellite Operations Centre (SOC) in the UK.
- ✂ **Airbus** has invested with the Hertfordshire LEP in a new STEM centre in Stevenage based on the Mars Rover development and has invested in the NovaSAR (radar) and S-1 (optical) satellites to be launched in 2018.
- ✂ **Thales Alenia Space** has made a major investment in Belfast with the opening of a new electric Space Propulsion Integration Centre.
- ✂ **SatixFy** has invested in a new company in Manchester and opening a Joint Venture in Farnborough with ST Electronics.
- ✂ **Earth-i** has contracted Surrey Satellite Technology Ltd. for a new rapid revisit optical satellite constellation.
- ✂ **Inmarsat** has contracted for 2 sixth-generation telecommunications satellites which will be built by Airbus.
- ✂ **Avanti** has invested in the Hylas-4 satellite in March 2018 as well as the Hylas-3 payload in a joint venture with the European Space Agency, due for launch in 2019.
- ✂ Having founded in Denver, **Orbital Micro Systems** announced in December 2017 that it was relocating to Harwell to take advantage of the UK's unique In-Orbit Demonstration programme. OMS plans a constellation of 40 cubesats to provide highly accurate weather forecasts to users who need them, such as airlines.
- ✂ The **University of Leicester** is investing in *Space Park Leicester*, an ambitious initiative to develop a global hub and collaborative community based on space and space-enabled technologies .

By working together to finance the sector deal the outcomes can be achieved in partnership.



Financing a Sector Deal

Space is an R&D intensive sector

The space sector is R&D intensive and uses Government co-investment to produce world-leading innovation, de-risk novel technology that can be commercialised and drive university and industry partnerships in fundamental research. The sector has a science and engineering base that, although strong, relies on investment to maintain its international competitiveness. To most nations, Space is a strategic capability and, for this reason, many retain comprehensive support environments to protect national interests. This is an important factor that faces the UK's industry when competing in export markets even with commercial products. The sector does, of course, provide the majority investment in research itself, with companies investing £415M in research and innovation in 2015, 8% of the sectors Gross Value Added. The wider picture of private and public support in the sector in 2015 is presented in Figure 18.

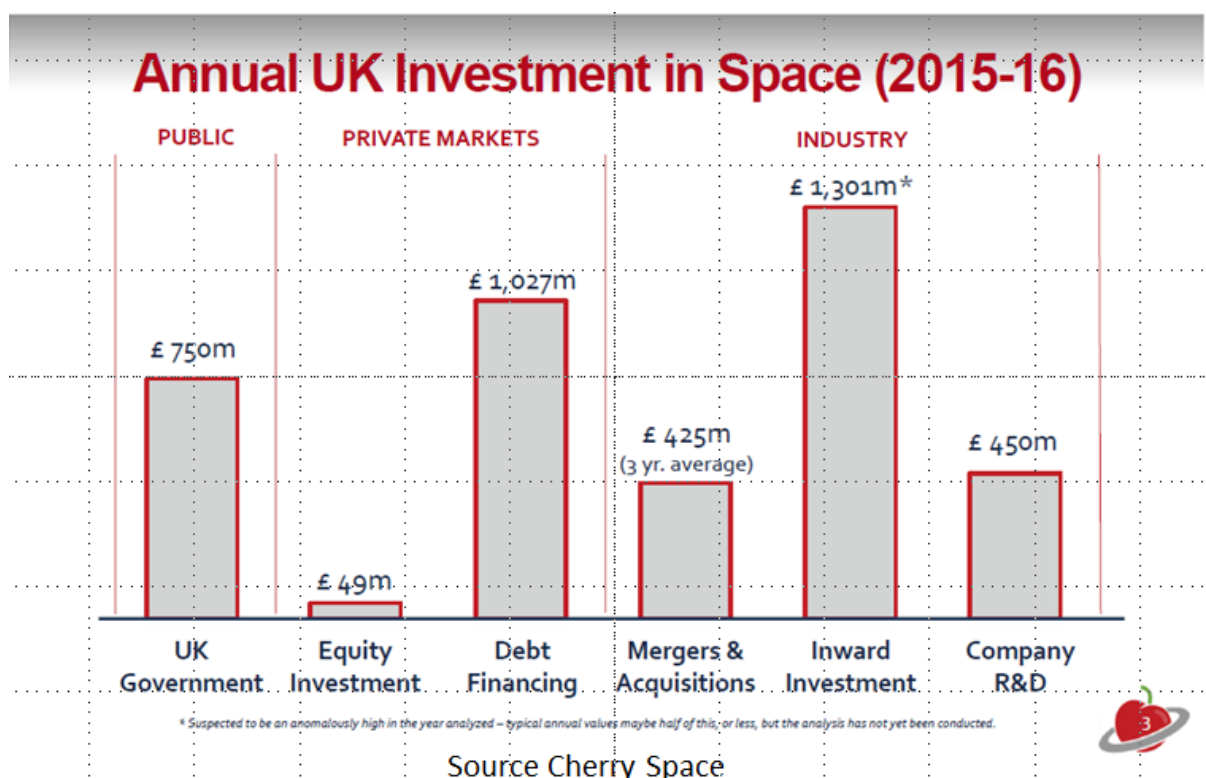


Figure 18. Annual UK investment in space is dominated by industry and private markets providing a spring board for a National Space Programme to drive growth in new opportunities

The sector already enjoys public support

The UK space sector acknowledges the public sector support it receives from Government. A critical component of this support is the £300M per annum provided to the European Space Agency by the UK, which funds the UK's involvement in major space science and exploration missions and research programmes in satellite telecommunications, Earth observation and applications. The UK's long-term membership of ESA has underpinned the international competitiveness of the sector. The sector is united in recommending that this support continues at the same level into the future.

The UK also has a National programme of support. The International Partnership Programme has been established in the UK Space Agency to drive projects in countries eligible for Official Development Assistance support. These projects have stimulated in-country social and economic benefits for its citizens based on using space infrastructure and data to deliver this impact. This is regarded as an important programme by the space sector, delivering transformative benefits to recipients while exercising UK capabilities. The sector strongly welcomes Government's decision to turn this into a £150M programme over 5 years. Such funding cannot, however, be used to develop broader international partnerships with other space faring nations given the restrictions on the use of ODA funds.

The publication of Industrial Strategy highlighted the £99m provided from the Industrial Strategy Challenge Fund for the National Satellite Test Centre and £50m from UKRI for the UK's spaceport and satellite launch programme. These are important mixed capital and research investments that build future national facilities for UK and overseas customers. It is important that we build on these facilities by investing in the research, innovation and supply chains that will maximise their use and value to the UK.

In addition to the above projects, the UK has taken forward a series of research and innovation projects on a national basis, including the NovaSAR Space Radar, SABRE hybrid air-breathing rocket engine and a modest national space science programme. In addition, space benefits from innovation not aimed at directly at space capabilities (but from which space can still lever benefit) and European research programmes. We estimate that they are worth between £30M and £50M per year depending on exactly what is included in this sum. However, a strategic, rather than ad hoc, approach to constructing public support for space programmes is likely to achieve more for less. This is one of the reasons the sector is proposing a National Space Programme.

National Space Programme

The sector is proposing that the UK launches a National Space Programme to invest an additional £600M in UK research and innovation over and above existing funding. The NSP would be launched with £320M pledged by industry and £280M from Government, subject to business case. The initial NSP would run for 5 years, climbing to a Government investment of £70M per annum by 2021/22 and stabilising at this level thereafter. Industry match-funding would follow the same profile.

Within the Sector Deal, the National programme would be deployed to stimulate additional UK investment in research and innovation including:

- ✂ increasing productivity in space-enable markets using AI and space data
- ✂ strengthening world-leading excellence in 'Stand-out' UK industrial and university capabilities that we can deploy in new applications and commercial services
- ✂ funding bi-lateral science and innovation with Global space nations to underpin new trade partnerships
- ✂ maximising the long-run science benefits to the UK

The sector envisages that around £45M per annum could be earmarked for driving research and innovation in space data, applications and commercial services; £15M per annum for bi-lateral programmes and £10M per annum to strengthen science. The exact split would depend on priorities and business cases for support. The Space Growth Partnership stands ready to help develop business cases for envelope programmes and priorities for the National Programme. For example, as part of the Sector Deal proposal process, in 2017, the sector has identified a potential £2.5B of industry investment in new projects that can be secured by £700M in Government co-investment. We are therefore confident that a competitive approach to taking forward individual programmes within the National Programme would be over-subscribed and hence yield high value programmes.

The NSP focus on commercial services can also be used to demonstrate how smart Government procurement can be deployed to stimulate commercial investment in UK space infrastructure. De-risking novel technology with industry provides companies to develop a first mover advantage in overseas markets. It will also help spread the benefits of the space sector across the UK by supporting activities in regional centres specialising in unique space capabilities and better encouraging local partnerships between industry and academia. An obvious example here is maximise the local benefits of the UK spaceport by stimulating investment in new launch system value chains, logistics and small satellite platforms.

Wider benefits of National Space Programme

Historically our primary activity has been through European programmes because our investment is relatively small compared to major space nations and it has enabled the UK to take forward research at viable scale with European partners. The UK's relative position on ESA and National investments is presented in the OECD's analysis below. The ESA funding provided enables the UK to punch above its weight. Although the funding from France and Germany is self-evidently larger than the UK, the fact that these nations support the Ariane launcher development (which excludes the UK entirely) and that the UK makes a reduced contribution to the International Space Station enables the UK to be the lead nation in ESA's commercially important satellite telecommunications and Earth observation programmes.

However, by not investing in National programmes, the UK is not able to take forward opportunities in a sector that is becoming more international and commercial, nor is it able to maximise the benefits from its existing investments in ESA. This is the change required.

Space spending by nation, 2015 (\$m)

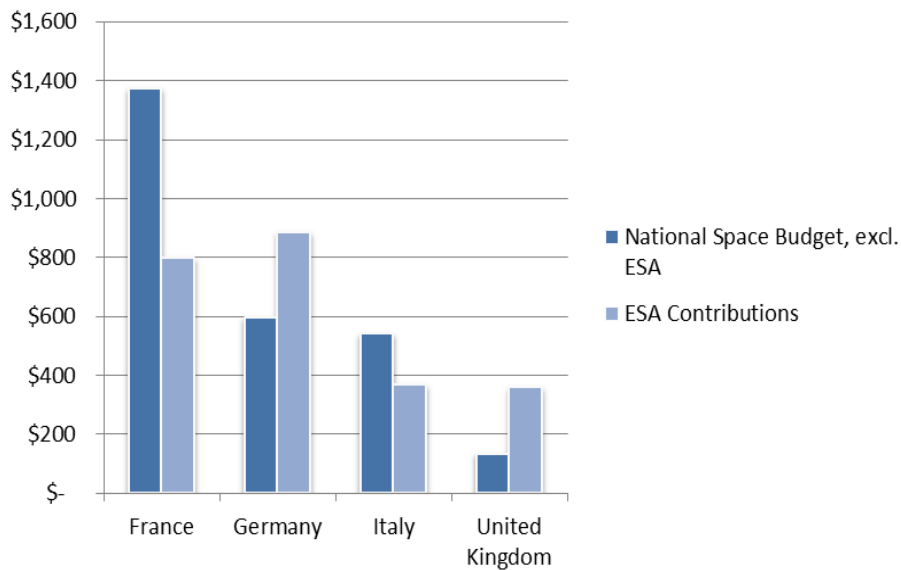


Figure 19. Focus on space spending by comparable European nations

Within a sector deal, a National Space Programme can be organised to:

- ✂ open new opportunities for global bi-lateral partnerships programmes that are currently not possible, such as with the US, Japan, India, Australia and Canada.
- ✂ make our investments go further by increasing industry investment and spurring competition for the best programmes in a predictable way: giving companies the confidence to plan for long-term UK R&D and phase the delivery of complex, long-run, projects to reduce risk to everyone and enable more projects in any one year to go forward
- ✂ retain best practice and IP within the UK, rather than sharing our commercial knowledge with competitors, particularly when an agile response will give us a first-mover advantage
- ✂ support UK National priorities as and when we need to
- ✂ improve the UK offer compared to other nations for companies looking to relocate to the UK by providing an option to a fast-track national programme as well as European mechanisms, maximising the leverage of a favourable business environment (e.g. tax, skills, regulatory environment)
- ✂ give universities and science a real opportunity in the UK to maximise their capabilities in advance of competing for work in ESA science and exploration programmes and be first in space with projects that showcase UK space science and engineering excellence

Next steps

The sector intends to support a bid into the Industrial Strategy Challenge fund for £85M to take forward the structural reform and innovation in data analytics and access to data needed to promote the use of geospatial data in the UK. This will include the use of AI to better analyse data and improved connectivity in areas such as the Internet of Things.

The sector then intends to request that Government provide £195M to the UK Space Agency to create the other elements of the National Space Programme. The sector would be keen to plan on initial investments in 2019/20, rising to and stabilising at £70M per year by 2021/22. As shown above, industry and academia are already making a series of significant investments in the UK.



Annex: Market Challenge Teams

The space sector recognises that the greatest benefit from the evolving space technologies is derived from working in close partnership and collaboration with organisations in the non-space sector, responding to stakeholder needs, identifying and resolving some of their most important challenges. Examples of important challenges to be addressed by collaboration between the space sector and stakeholders in other areas of society include improving efficiency of agriculture or providing ubiquitous, reliable connectivity for citizens everywhere, such as travelling on trains.

To this end, the space sector is establishing “Market Challenge Teams” to enable interested groups to identify and analyse the important issues that can be resolved by the application of space derived solutions. Previous work by bodies such as the Satellite Applications Catapult and the Knowledge Transfer Network have provided targeted collaboration projects. and laid the foundations for the approach.

It is one of the important purposes of the Market Challenge Teams to identify new challenges and opportunities and to scale up the development of solutions and make them readily available to the broadest market. Collaborating closely with challenge stakeholders will ensure the solutions are well suited for the end user environment and can be industrialised, enabling the collaborators to benefit from market exploitation. This approach will support strong market growth in the space sector and enable it to achieve the commercial targets laid out in the Industrial Strategy.

Developing Market Challenge Teams will create positive change in the space sector. Specialists from the space sector will inform stakeholders in the challenge community of the latest advances in the use of satellite derived services. Stakeholders will have a clear understanding of the potential for using space capabilities. In addition, organisations in the space sector will be stimulated to develop solutions informed by the experts in the challenge community.

Engagement with existing end user communities such as the Centres for Agricultural Innovation in the above example, will be strengthened by the Market Challenge Teams, ensuring support from the space sector is readily available to develop well considered solutions to the end users challenges.

The Market Challenge Teams will accelerate sector growth by grasping new opportunities that are deemed to be over-and-above those taken forward as organic growth of the space sector. This will need a different approach – accessing these opportunities by definition will not be ‘business as usual’ – market barriers are likely to be higher, activity will need to be more broadly planned and coordinated, and actors may need to demonstrate a greater appetite for risk.

The primary purpose of the Market Challenge Teams is to enable UK space businesses to work in a structured fashion with customers, wider industry experts, Government and academics to access new business opportunities that would otherwise be highly unlikely to be developed in the UK.

In practice the Market Challenge Teams will operate in the pre-competitive phase of developing markets and addressing barriers to growth. They will not seek to engage in or influence individual contracts between customers and suppliers or the operation of competitive markets after companies are in a position to contract with customers.

The approach is to build on existing groups, associations and activities where appropriate. There are a number of relevant organisations and committees in the UK that will add great value. Several that would be expected to play key roles are the Trade Associations, KTN and the Satellite Applications Catapult. The Catapult already has a proven record of performing excellent, similar work in a number of areas such as fisheries, blue light services and mining. Market Challenge Teams will build on these and broaden them to identified market opportunities with an emphasis on:

- ✂ Large, high growth activities
- ✂ Markets yet to be created and shaped, longer-term results
- ✂ Close to market, quick wins inhibited by technical or regulatory barriers
- ✂ Existing opportunities already served by competitor countries
- ✂ New, uncertain wild cards
- ✂ Disruptive innovation

The key is that Market Challenge Teams are flexible, results oriented, and address untapped potential where collaborative effort is needed to address barriers.

Selecting the target markets

The space industry, Satellite Applications Catapult, KTN, UK Space Agency and UKspace continually gather market information to understand the challenges of the non-space sector. In addition Innovate UK funded a broad ranging analysis of 35 Routes to Market which in turn have identified over 60 opportunities in a range of sectors from space launch to insurance services and from environmental monitoring to new communications for transport.

Based on inputs from across a wide range of commercial and social sectors it is planned to initially establish eight Market Challenge Teams to demonstrate the value of this approach.

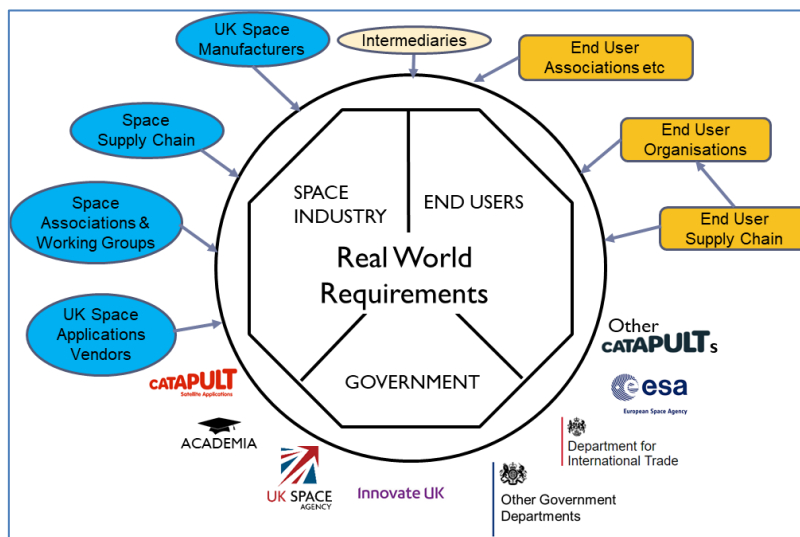


Figure 20. Market Challenge Teams can include a diverse range of members

Suggestions for the initial Market Challenge Teams include; Transport (e.g. Intelligent Transport Systems for road, rail, air and maritime); Climate, Environment and Resources; Security, Resilience and Defence; More Efficient Government; Professional Services (e.g. insurance, finance); Consumer Services (Improving the lives of citizens); Access to Space (UK Launch, in orbit servicing and demonstrations); Science (Connecting UK scientists with UK industry).

The Market Challenge Teams will be dynamic, identifying real world challenges and opportunities lead by stakeholders from the end user community. Once opportunities are identified the Market Challenge Team will progress opportunity pursuit activities at its discretion. This is likely to focus on one or several opportunities in parallel often across a number of sub-groups and markets.

An important feature of the process is that opportunities are investigated in enough depth that all the issues are identified to allow the challenge to be addressed and turned into an opportunity. Solutions may be based on removing technical, regulatory, business model or market access barriers leading to robust, scalable and repeatable products and services.

The diagram below illustrates how challenges and opportunities are identified by the Team and through a process of focused meetings and workshops, appropriate stakeholders along the value chain highlight blockers to the opportunity. Outline solutions are developed that will find real world applications. The output from this activity is to create a vehicle such as competition or possibly to let a contract that will lead to the development of marketable solution.

The Market Challenge Teams will also use information developed as part of the National Space Technology Strategy to identify appropriate technologies under development that could be a component of innovative solutions for the challenge stakeholders.

This approach allows opportunities identified and shaped by end users and potential members of their supply chain to pursue solutions that can be funded through the National Space Programme as well as other sources of funding such as ESA, Innovate UK, the UK Space Agency or Private Venture Capital. Outputs from the process will inform further potential projects and can be cycled through the Market Challenge Teams to create further opportunities for future consideration

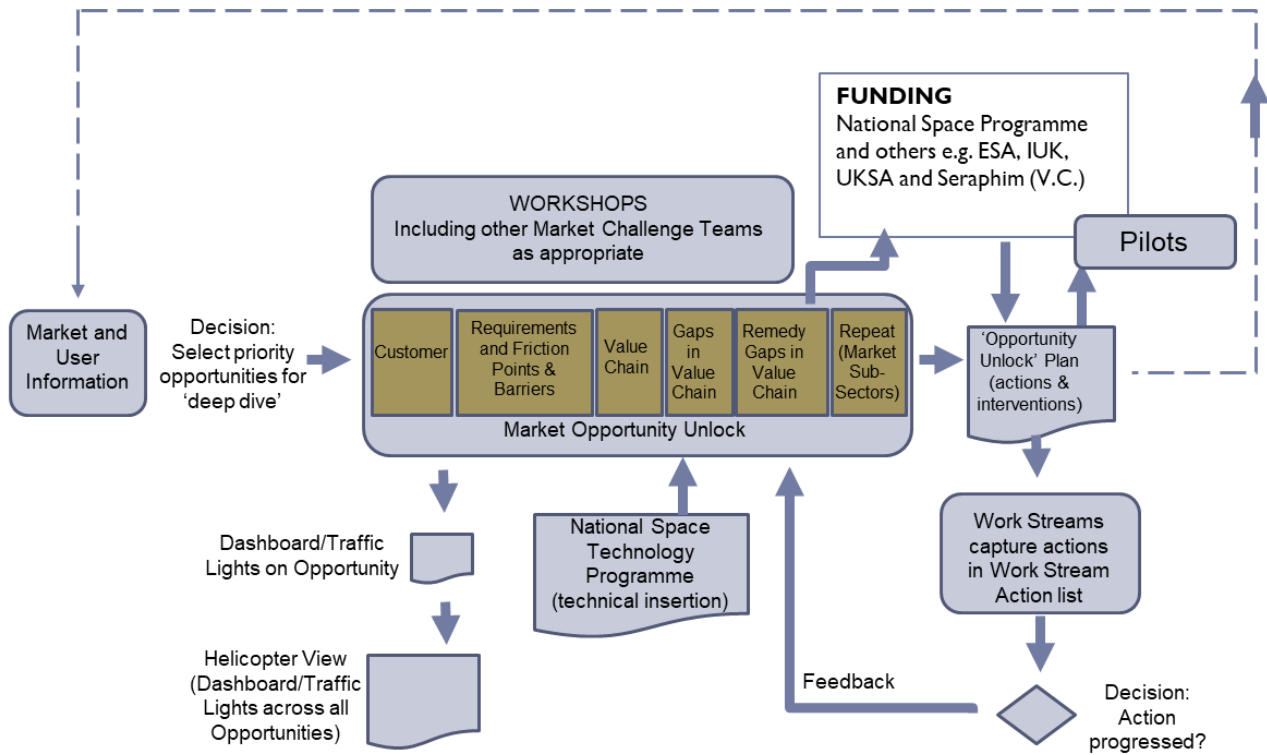


Figure 21. Market Challenge Teams enable suppliers and end users to cooperate in developing opportunities

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