

## **Upstream Space: A Galaxy of Capability**

An Audit of Upstream Space Capability in The Oxfordshire-Cambridgeshire-MK-Herts Corridor; M3 Corridor & Solent; Greater East Midlands; Scotland; Wales; and Northern Ireland.

A Science and Innovation Audit Report sponsored by the Department  
for Business, Energy & Industrial Strategy

**SUMMARY REPORT**

**2018**

## 1. Introduction

The UK has a rich and proud heritage in the global space sector. Since the 1950's UK has been an integral part of both the economic and scientific growth in space systems and space applications. From the early days of experimental satellite manufacture, UK is now producing the heart and essential systems for 25% of the worlds telecommunications satellites in what is now a mature commercial market. UK has contributed significantly as a member state within the European Space Agency, to space science, space exploration and earth observation missions, and is now a trusted prime contractor for global flagship missions such as Exomars Rover, Solar Orbiter and Biomass.

The UK has also embarked on unique and breathtaking adventures of our own, such as the iconic Black Arrow rocket, which flew successfully in 1971, to the Beagle 2, which landed on the surface of Mars in 2004. The re-invigoration of a National programme supporting future 'UK-own' and bilateral opportunities is a cornerstone of the recently submitted Space Sector Deal proposal.

Over the years the UK has had an extraordinary cornucopia of capability, demonstrating world-class expertise in a broad spectrum of fields at every step of the upstream space value chain, that process that designs, tests, manufactures and launches satellites and spacecraft, and then is able to operate them from Earth. However, in order to realise this, investments of time, effort and finance must be made across the UK's excellent industrial and academic base to ensure that these exciting developments keep pace with our competitors internationally and are effectively aligned so as to offer a sleek, coordinated suite of services and capability to our investors, users and partners.

This audit has, for the first time, brought together stakeholders from across the parts of the United Kingdom with significant critical masses of upstream-space activity to focus on their strengths in and understand where investment and effort may fortify and prepare these assets for the future.

It is worth recognising that this audit is not intended at this stage to be a comprehensive national audit and is broadly confined to the geographic regions represented in the Consortium. It is therefore also recognised that key competencies within some areas are not currently included, but that future maintenance and development of this audit will expand both its geographic and technical scope.

### 1.1. SKY HIGH ASPIRATIONS

Since 2000, the UK space sector has trebled in size, and grown at a rate of 8.1%, five times greater than the UK wider economy over the same period, while productivity is over three times the national sector average. Yet this is only the beginning.

In 2010, the Innovation & Growth Strategy (IGS) for Space outlined a challenging and inspirational target of growing the UK's share of the estimated £400 billion<sup>1</sup> global space market by 2030 from 6.5% to 10%. Space already is a UK success story; a strong presence in global commercial markets, a powerhouse of innovation, a bastion of engineering and scientific excellence, and can boast a world-class, highly productive workforce across many areas. As a result, the space sector supports 14% of

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<sup>1</sup> Space IGS Update, July 2015, <http://www.ukspace.org/wp-content/uploads/2015/07/Space-IGS-Report-Update-July-2015.pdf>

UK GDP, some £250billion<sup>2</sup>, which the Space Growth Partnership aims to double to £500billion, attract £3billion of inward investment, and provide 100,000 new jobs.

To achieve the IGS targets, we must build on the sector's core strengths and established market position, and in addition encourage companies to pursue new commercial opportunities from the UK, which offers an excellent location for space launch into in-demand polar orbits, with a world-leading satellite industry, and reputation for regulatory excellence. While the space industry in the UK is booming, much more needs to be done at pace to capture this intended market share.

The decision to leave the EU creates a particular need for agility. The UK must develop new and enduring international partnerships, while retaining the industrial corporates already embedded within the UK. We must also stimulate investment into UK businesses and attract new inward investment. The focus on facilities, innovation and skills to support rapid, volume production of mid-weight satellites in particular, is highly relevant. This in the context of Newspace trends towards constellations of smaller satellites, UK Launch status & the associated need to develop a robust supply chain, Brexit resilience and specifically the potential requirement to respond to the EU's potential abrogation of the UK's involvement in the Galileo Programme.

The Science & Innovation Audit for Upstream Space will be aligned with the Sector Deal for Space to act as a call to investors to recognise the strength and depth that the UK Upstream Space sector offers – in particular in the context of the highly dynamic and growing space market where industrial and market position will become established in the next few years.

## **1.2. BENEFITS OF UPSTREAM SPACE**

Market forecasts indicate that downstream applications will be the major source of economic growth in the space sector in the coming years<sup>3</sup>. However, strong presence in the upstream sector is essential to secure a 'virtuous circle' of capability across the value chain. The detailed knowledge and competence that comes from upstream engagement underpins the development of standards and operations that are the basis of downstream end user applications.

For example, mastering the technology for space-based digital payloads allows a direct understanding of satellite operator needs for power and bandwidth flexibility, and being able to optimise this in an upstream design solution can prove decisive in a global competitive environment. Similarly, radar system competence is directly relevant to support delivery user applications related to surveillance, climate change and flood management.

The UK is a thought leader in downstream space-based applications, and it has a strong established upstream and emerging innovative capability. Continuing efforts to maintain and build this 'virtuous circle' in the UK will help to grow market position in the face of increasing global competition.

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<sup>2</sup> Satellite Applications Catapult Press Release, 11 May 2018

<sup>3</sup> <https://www.gov.uk/government/publications/space-growth-action-plan>

Upstream Space delivers a range of services to both public and private customers and users, bringing scientific and economic benefits and providing critical information to the security, meteorological and environmental sectors.

It provides infrastructure on which modern society depends. From multinational businesses such as Sky and Uber, to local farmers who use satellite data to help manage their crops, the products of upstream space have been developed and exploited to create capabilities that have become a part of everyday life. This will only increase as our understanding of how to use space data improves, enabling us to face ever more complex challenges, both on Earth and beyond.

In the science and planetary exploration domain, Upstream Space is what enables scientific investigation and pioneering. The engineering and manufacturing capabilities that have supported missions such as Rosetta, Mars Express, and Lisa Pathfinder have ensured that the science instruments are delivered safely into space, provided with resources to allow experiments and investigations to continue in the harshest of environments throughout the satellites' lifetime. Having major roles for this kind of mission in the UK allows close links to UK scientists, development of the UK supply chain and the ability to inspire young people through outreach and public media. Finally, upstream space has an almost unique ability to excite and inspire young people – our next generation of scientists and engineers not just in the space sector but across the whole UK economy.

**WHAT IS UPSTREAM AND DOWNSTREAM SPACE?**

The space sector is divided into two complementary segments. The segment that makes and sends objects (satellites, probes, spacecraft and rovers) into space is conventionally called "Upstream". The segment that uses these objects to deliver products and services on Earth for largely commercial (but also environmental and scientific) exploitation, such as telecoms, is called "Downstream". The upstream segment overwhelmingly consists of space manufacturing: the design, manufacture of spacecraft, payloads, systems, subsystems, and components, and the infrastructure required to launch and operate them from Earth. This Science & Innovation Audit focuses on that Upstream Segment.

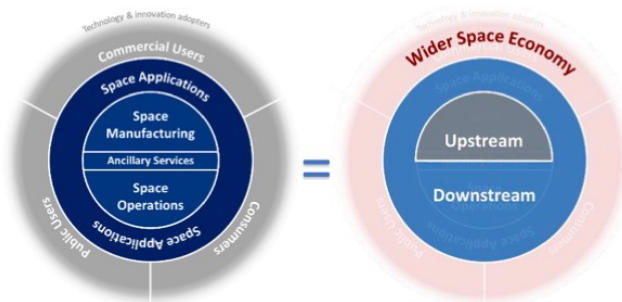


Image 1: where upstream and downstream sit in the wider space economy. Image credit: London Economics.

### The Upstream Space SIA Regions

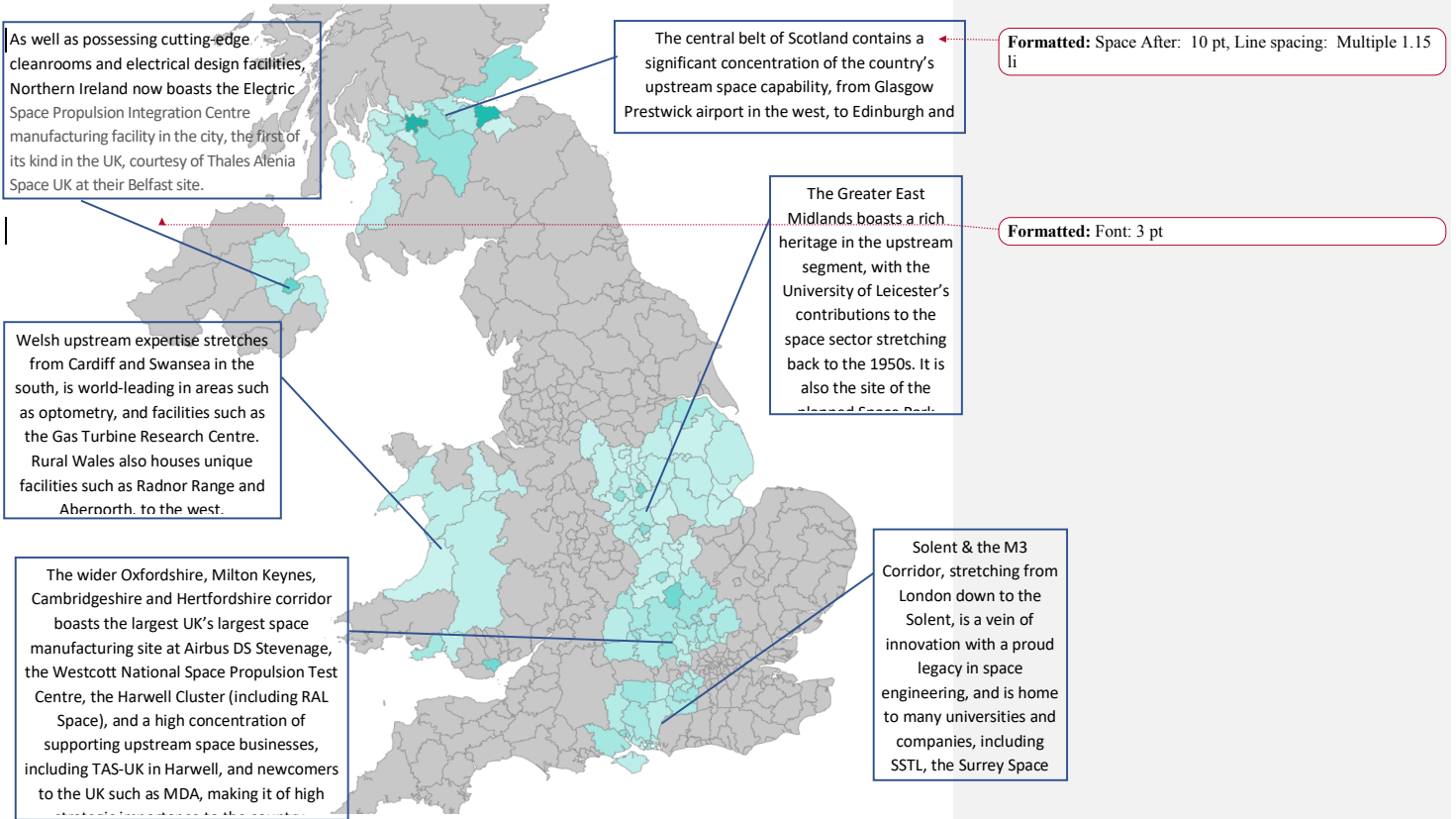


Image 2: Map of the UK, highlighting the regions making up the audited area for the Upstream Space Science & Innovation Audit. It is anticipated that, in future iterations of this report, the geographic breadth of the report will increase to provide a truly national picture of upstream space in the UK.

## 2. Our Hypothesis

Upstream Space is a maturing sector which is operating at levels of productivity higher than national average and generating substantive economic value as well as significant contributions to scientific and educational endeavour. The sector is facing a very dynamic market with high potential for growth and a complex external environment in the context of Brexit, global commercial competition and changing European institutional landscape.

As private sector companies continue to gather a foothold in growing upstream markets such as satellite launching, and emerging future markets such as exploration, construction, infrastructure assembly and mining, there is a unique opportunity for engineers, researchers, businesses and investors to get in on the ground floor.

The UK upstream sector has major assets that can contribute towards future success, relying also on cutting edge innovation, business entrepreneurship, export support, skills development and targeted investment to maximise potential of the collective UK effort. The Space Growth Partnership, in its Prosperity from Space strategy, has published proposals aimed at focusing the next steps to build future success. It is an extremely research-heavy sector at the cutting edge of the scientific and engineering arena. It returns value not only to the scientific community, but also economically, and is one of the very few sectors that continually and effortlessly captures the imagination of the public.

### **Harnessing diversity**

The upstream space value chain across the UK has a wide range of diverse capabilities, all of which contribute to a thriving current industry base and help prepare for the future.

The UK Space Landscape created by the InnovateUK-funded Knowledge Transfer Network (<http://space.ktnlandscapes.com/>) reflects the following space manufacturing ecosystem:

- 1 complete space systems manufacturing organisation
- 40 companies involved with satellite and payloads manufacture
- 29 companies involved with launch vehicles and subsystems
- 19 ground systems and equipment suppliers
- 109 suppliers of materials and components
- 13 scientific and engineering support companies
- 4 providers of scientific instruments

The recent joint working within the Space Growth Partnership has resulted in a number of recommendations encapsulated in their "Prosperity from Space"<sup>4</sup> strategy document including a National Space programme which would complement the European institutional investment and further stimulate the upstream sector.

Whilst it is still expected that institutional investment will remain important to the sector as it continues to mature over the coming years, there is clearly increasing appetite for private sector investment in space. This is coming for example from 'new space' entrepreneurs and venture

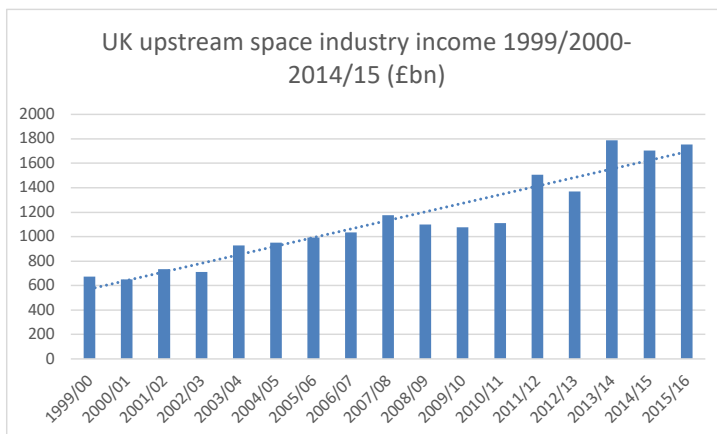
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<sup>4</sup> [http://www.ukspace.org/wp-content/uploads/2018/05/Prosperity-from-Space-strategy\\_2May2018.pdf](http://www.ukspace.org/wp-content/uploads/2018/05/Prosperity-from-Space-strategy_2May2018.pdf)

capitalists interested in the future commercialisation of space infrastructure, operations and services. The development of an attractive regulatory regime in UK to encourage inward investment has been a recent focus – efforts in this direction should be maintained to keep UK competitive advantage vs other space nations.

We therefore believe that every effort should be made to:

- Showcase the economic benefits of Upstream Space to potential inward investors
- Increase investment from both private and public sources to protect new infrastructure, such as test centres and spaceports, and to enable the fundamental and applied R&D activities to continue to thrive
- Continue to build connectivity and mutual support across the whole UK upstream sector, including established global players and the wider 'UK Nationwide Cluster'
- Yet ensure activity at these individual, regional clusters, is doubled down and retains focus. Clusters grow organically, quickly and attract inward investment more effectively.
- Maintain R&D intensity through a dedicated and stable funding base for space manufacturing and ground segmentation technologies, and create the conditions in which companies are able to confidently re-invest in R&D.
- Support the UK's shaping of new markets through improved awareness raising of emerging technologies that will plug the gaps in the UK's value chain and drive down satellite manufacture costs to drive down the cost of downstream services
- Develop unique, strategic, industrially-focused infrastructure, such as the LOCAS (Low-Cost Access To Space) facility, with the potential to anchor business investment, and accelerate UK technical and manufacturing / production capability for 'newspace' markets.



### 3. UK Regional Strengths

The UK's greatest strengths are quite simple: the excellence of its workforce, and the excellence and intensity of its research base, and the breadth of industrial capability.

Upstream Space boasts a highly qualified, highly productive workforce in all geographic regions, and is the highest qualified of all sectors in England and Wales<sup>5</sup>. Productivity also is well above the national average. As this full audit focuses on a select few geographical regions, here we offer a summary of their main strengths and concentrations of activities in Upstream Space.

#### The Greater East Midlands

The Greater East Midlands has a cluster of nationally important space activity. The University of Leicester enjoys worldwide recognition for its international research in space science, planetary exploration and earth observation science. **Space Park Leicester** is being developed as a science and innovation hub. The **University of Nottingham** is a world leader in space-based applications of position, navigation and timing, and hosts the UK national centre of excellence for GNSS. The **National Space Centre** in Leicester is a £60m science visitor centre attracting over 200,000 visitors annually, with over 10,000 students and their science teachers participating in the National Space Academy programmes and other space education initiatives (some of which are globally exported). GEM is also home to Space @ **OU** (Milton Keynes) with the **Centre for Electronic Imaging** (detector for Gaia, Euclid, JUICE), and the proposed **Blue Abyss** test and training centre for commercial aquatic and space research.

#### Hertfordshire

Hertfordshire has been part of upstream space since the 1960's when the British Blue Streak rocket was built by Hawker Siddeley Dynamics. The company has evolved into **Airbus Defence and Space** (Airbus DS), housed in the same buildings, and today Airbus DS teams focus on the design and manufacture of advanced satellites and systems for telecommunications, earth observation, and navigation and science programmes. Airbus DS builds a quarter of the world's telecommunications satellites and leads flagship ESA projects such as the ExoMars Rover, Solar Orbiter and Biomass. They also support the UK's military satellite communications services to the UK armed forces, including mobile voice, video, internet and broadcast communications. Delivered through the Skynet 5 constellation, these services also meet the needs of other military and government users like NATO. There are over 1200 employees in Stevenage, with more across the UK.

Oxfordshire also boasts one of the most concentrated clusters of upstream space activity in the UK. At **Harwell**, the **Rutherford Appleton Laboratory's Space Science** group (RAL Space) employs around 200 staff working on world-leading research and technology development, space test facilities, instrument and mission design, and studies of science and technology requirements for new missions. RAL Space has been involved in over 200 space missions. The site also hosts the **Satellite**

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<sup>5</sup> See Chapter 2.5, Full Report



**Applications Catapult**, as well as a growing industrial base, including sites for **Thales Alenia Space UK, MDA UK, GMV UK, Neptec**, and many more businesses within the supply chain.

In the M3 Corridor running to the Solent, Portsmouth supports a high-tech defence and advanced manufacturing cluster in aerospace and space, including companies such as **Airbus DS, BAE Systems, GE Aviation Systems** and **QinetiQ**. The Airbus site in Portsmouth employs over 1000 people and specialises in digital payloads for telecommunication satellites, as well as instruments for spacecraft including low-cost radars. The northern end of the corridor also supports **SSTL, Surrey Space Centre** at the **University of Surrey**, and start-ups such as **Earth-I**.

In the space industry, **Scotland's** central belt undertakes more upstream space activity by volume of craft than other parts of the UK, and Glasgow alone builds more satellites than any other European City<sup>6</sup> thanks to local activities of **Clyde Space** and **Spire**. With respect to the upstream sector, Scotland is home to 23% of the industry in space manufacturing, compared to 17%. The UK space industry has strong presence in Scotland with 18% of the UK space industry workforce based there. It is further supported by the reputable research expertise, with Scotland being ranked as number 1 in the World University Rankings for space sciences. Scottish industry has set out its aspiration to rapidly expand to become a £4 billion industry by 2030 and play host to at least one UK Spaceport, an ambition which was confirmed at the 2018 Farnborough Airshow, where Government Industrial Strategy funding was confirmed for the development of a vertical launch spaceport in Sutherland, on the north coast of Scotland, by **Lockheed Martin**.

## 4. Opportunities and Threats

The UK's Upstream space sector is highly productive, commercially and scientifically successful and highly innovative; as such, the space sector plays well as a growth opportunity within the UK Government's Industrial strategy. There are a number of opportunities that UK Government, industry, academics and investors can take hold of, but also various risks that must be mitigated by close collaboration and alignment.

### Opportunity 1: The Sector Deal

The recently announced Sector Deal proposes to align strategic approaches to addressing needs in the areas of R&D, industrial growth, skills and workforce development, and regulations. The upstream space sector needs to remain alert as the UK Government agrees a number of sector deals across the UK economy as the technology crossovers between sectors may provide future opportunities.

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<sup>6</sup> [www.scotsman.com/future-scotland/tech/glasgow-builds-more-satellites-than-any-other-european-city-1-4354219](http://www.scotsman.com/future-scotland/tech/glasgow-builds-more-satellites-than-any-other-european-city-1-4354219)

### **Opportunity 2: A Growing Workforce**

Space-related science & engineering courses yield great economic benefits by preparing the future generation of engineers for the rigours of industrial work. However, leakage to other sectors exacerbates an existing skills shortage. The Space Growth Partnership is formulating proposals to address this skills gap, including industry supporting one million engagements per year with young people at all levels to inspire and encourage them to consider careers in STEM.

### **Opportunity 3: Growth Potential**

Upstream Space in the UK is set to grow and grow quickly due to a combination of new technologies, the completion of an end-to-end value chain within the UK, and greater access to space for customers and operators. There is a unique opportunity for investors to get on board on the ground floor, as startups and established businesses look to enter and broaden their market share in satellites, launchers and ground segmentation markets.

### **Opportunity 4: R&D Excellence**

The UK's Research Base for Upstream Space is uniformly excellent, with some of the world's best-ranked universities. If the requisite funding for future programmes of industrial and space science research is secured, the UK will be able to leverage its excellent research base for long-term benefits. With alternative models of R&D, such as Strategic Research Clusters and ARTES, continuing to be supported, industry can be supporting into researching areas they otherwise might not.

### **Risk 1: Regulations**

The UK does well in UK and European markets, but with the exception of large multinationals, penetration of non-European overseas markets could be improved. Regulators and insurers can help businesses to overcome barriers to entering the market by working closely with Government and industry.

### **Risk 2: Research Funding Gap**

Upstream Space outperforms the rest of the UK when it comes to accessing UK funding, leading and participating in research projects. However, the majority of fundamental and applied research funding for upstream space has come from the EU over the last decade, and Brexit represents a very real and imminent threat to sources of R&D funding for UK academic and industrial researchers. With negotiations for FP9 underway, certainty is crucial if the R&D intensity is to be successfully maintained.

### **Risk 3: Fragmentation**

Because the UK has no centralised research capability in the vein of France, Germany or Italy, we have the benefit of protecting key assets from the vicissitudes of the market, whilst ensuring that technological and political strengths are more closely aligned, allowing for some very long-term investment decisions to be protected from the political winds. Recent investment decisions pertaining to the **National Satellite Test Centre**, and the **National Space Propulsion Test Centre** at Westcott suggest that the UK is taking some steps in the direction of its European counterparts. Building upon this, long term planning and support for UK launch infrastructure, and ground segmentation infrastructure, such as space gateways, control stations and VSATs, is seen as crucial in order to ensure that current UK aspirations and activities provide world-class space services and products for generations.

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