FEATURES OF THE UK NATIONAL SPACE SUPPLY CHAIN AND OPPORTUNITIES FOR INTERNATIONAL COLLABORATION

Tucker R[(1)], Walley D[(2)], Perera-Webb A[(3)], Milyayev K[(3)]

[(1)] Red Kite Management Consulting, Abingdon, UK, robin.tucker@redkiteconsulting.uk
[(2)] Connected Economics, Callington, UK, dominic.walley@connectedeconomics.com
[(3)] Commercial Space Technologies, London, UK, cst@commercialspace.co.uk

ABSTRACT

In the wake of a newly released UK National Space Strategy (NSS) and a continued national ambition to grow the UK space industry, Satellite Applications Catapult commissioned a "UK Space Supply Chain" study from the companies contributing to this paper. Utilising a combination of regional space industry reports and the Catapult's UK Space Capabilities Catalogue (UKSCC), a taxonomic database of the UK space industry, the study assessed the current UK space sector supply chain, and considered how to develop a supply chain that will support a prosperous industry, the National Space Strategy and the wider economy. The results of this study revealed the UK has a robust and multifaceted space industry, proficient in addressing current upstream and downstream markets. The international situation for space is, however, rapidly changing, so the study has also generated recommendations to help better connect and enhance elements of the UK space supply chain to address future markets and societal demands. This paper condenses the findings of the abovementioned study and assesses opportunities for international collaboration.

1 INTRODUCTION

In reviewing the breadth of UK space capabilities, we found no major gaps except launch and emerging sectors. The UK space sector can bring together components and construct large or small satellites, operate complex satellite systems in space and on Earth, and develop applications in all major domains.

Currently, it appears dominated in income terms by downstream or applications businesses, which the Size & Health study [1] puts at 71% of sector income. However, the true picture is more nuanced. This is partly because Sky UK is shifting its services to terrestrial broadband and only spends a minority of its income in the space supply chain. It is also because applications have more potential for 'cascade' effects down the supply chain, this is diluted by the availability of free data (e.g. from Galileo and Copernicus satellites), and by much of their supply chain being from the general IT sector rather than the space sector. We estimate satellite manufacture to have about 45% greater cascade expenditure within the UK space industry per pound of income than non-Direct-to-Home (DTH) satellite applications (TV broadcasting).

The UK upstream sector has structural weaknesses, balanced with strengths.

- It is highly dependent on imports, for about 60% of its inputs – from tiny electronic components to large subsystems. The sector exports strongly as well, and the two are in approximate balance.
- There is only one UK 'large satellite' integrator, Airbus Defence and Space (DS). This limits competition for UK contracts, but helps the UK gain a role in ESA and large commercial contracts.
- It is underrepresented in 'Medium to Very Large companies' with 100+ employees, but has large numbers of smaller SMEs. It also has several 'outposts' of large foreign-owned groups that have expressed intention to expand (e.g. Lockheed Martin, Thales Alenia Space).

- Linked to this, there is limited ability in 'sub-system integration' – the key step between components and complete satellites – outside the major prime contractor.

Markets are shifting in a way that threatens some existing UK strengths and opens new opportunities.

The UK's strong GEO satcoms industry, and wider supply chain, is under threat from LEO constellations such as Starlink and Kuiper. This supply chain includes upstream (Airbus, Teledyne, Thales Alenia and other suppliers), service operators (Inmarsat, Intelsat, OneWeb, etc.), and ancillary services (finance, insurance, IT, legal, consulting). The threat comes from constellations with vertically integrated business models, manufacturing their own satellites and largely raising their own funds and self-insuring. There is some insulation due to UK-based OneWeb, but its supply chain is very international.

The major needs expressed by the supply chain across regions are for basic inputs. Skills were the most common concern, with some specific gaps, but basic STEM skills over the long-term being the biggest concern. Funding was an issue outside areas with strong funding networks. Where there was no existing space cluster, space companies wanted better awareness and coordination of the sector.

2 UK ADVANTAGES, DISADVANTAGES AND RECOMMENDATIONS

The 'cluster' approach works well, and the regional evidence shows different types of clusters helping firms to find opportunities, learn from each other, and share resources. As well as local contact, clusters also provide a focus for inter-regional contact, and they may help to offset some of the difficulties of the UK having a predominance of small businesses. Clusters are a vital part of the UK space ecosystem, but they need critical mass to be effective and should be developed strategically where there is sufficient space activity or potential, rather than everywhere (causing a dilution effect).

New space markets with large public benefit could be opened by public sector 'market creation'. In upstream, Space Environment Management can be kick-started by UK public procurement, but international regulation should be the objective. In downstream, there are many applications with a public benefit, for example Environment Act Biodiversity Net Gain monitoring, Road pricing, Health monitoring. For these, public procurement or regulation can play a key role. Because of the benefits, these markets can save public money and can even raise funds if the 'polluter pays'.

There are several emerging markets in the in-orbit sub-sector, including: satellite constellations (in all three main application areas), in-orbit servicing and manufacturing (IOSM), space-based solar power (SBSP), and launch vehicles, yielding an increasing level of space activity. These markets will require businesses with significant resource to exploit them, and the UK has some advantages and some disadvantages.

UK advantages:
- Airbus DS – part of a world-leading international space business
- Research, engineering, and creative 'problem-solving' skills
- Financial and professional services – London's expertise here has proved valuable before
- International partnerships and foreign investment – UK proven open for business.

UK disadvantages:
- Foreign partnerships/operations often mean invisible imports/outsourcing
- Lack of large suppliers beyond Airbus limits the opportunity to tackle large challenges.

Investing in these markets should bring good returns for the industry and the nation, but they will only grow to full maturity in the 2040s or beyond. By 2032, the ten-year timeline for this study, the UK's share of potential In-Orbit Servicing and Manufacturing markets is estimated to be £200-300m. To that we can add knock-on benefits to the supply chain of £100m, and a total impact of circa £180m for UK launch. In total, new markets will generate about £500-700m to add to the industry's income in 2032 – transformative for individual companies, but not for the overall size of the industry.

If the sector continues its long-term 7% growth rate (outside a DTH segment expected to shrink), it will reach £28bn income by 2032 (in 2019 prices) [1], and a more even mix between upstream and downstream. Achieving £40bn would require significant stimulus to develop large UK upstream and downstream space businesses, with actions along the lines described in recommendations 4, 5 and 6 (Table 1).

Overall, we see the 2020s as a time for strengthening the UK's capability base in preparation for a larger space economy. The 2030s will start to see a scale-up depending on technology readiness and investment. The 2040s should see a larger industry supporting more orbital activity.

Delivering this vision, in line with the National Space Strategy, requires an ecosystem of technology, regulation, services, and customers. The UK should not attempt to do everything, but to focus on the areas where it has most advantage. National effort should focus in three categories:

Ecosystem development	Technology development	Major programmes
Developing the capabilities and the 'environment' (skills access, regulation, etc.) of the supply chain. These are the focus of most of our recommendations. (Recommendations 1,3,4,5,6)	Enabling technologies for new and advancing space markets e.g., Optical communications, Mission simulation for IOSM, Robotic assembly for SBSP. Recommendation 2 covers technology development, and Recommendation 4 shows how it can be extended to develop capabilities as well.	Very large programmes requiring major investment & coordination, e.g. Space-based solar power, Launcher using SABRE engine. Major programmes are essentially a larger form of technology development and capability development, requiring greater investment over a longer period.

We make six recommendations for the UK space supply chain to support the National Space Strategy as shown in figure 1.

- One is an **Enabler**, which address the basic requirements of the sector.
- Two are **Capability Developers** – Existing activities to build capability in the space supply chain.
- Three are **Capability Multipliers** – New activities that could significantly increase the capabilities of the UK space sector, often with limited cost.

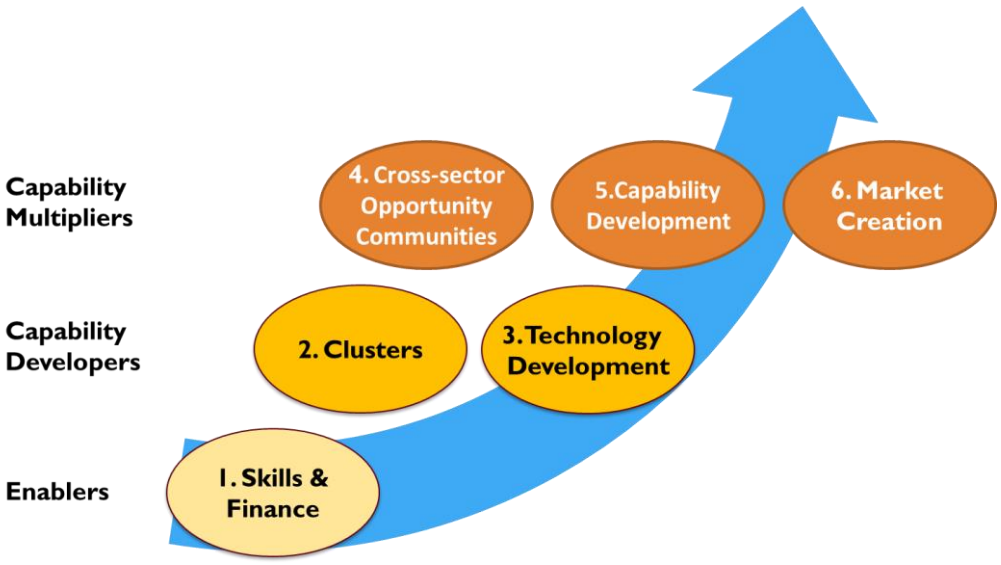

Figure 1. Six recommendations for the UK space supply chain

These recommendations are described in the table below.

Table 1. Recommendations for the UK Space Supply Chain

1: Skills and Finance	Improve access to skills and finance, with a plan that meets the growing needs of the sector.	The space sector is not alone in needing more people with STEM skills, but it can also help to inspire and train them.
2: Space Clusters	Continue space cluster development and creation.	Space clusters have been positive, but need critical mass. A strategic view should be developed of the areas with sufficient space activity or potential, and cluster creation and development continued on that basis, in addition reinforcing links between clusters.
3: Technology Development	Invest in technology development to accelerate progress, but aware of the dangers.	Investment in Research and Development for space has paid good return, and helping as many across the 'space proven' hurdle as possible should be a goal. However, it is important to know there is a realistic potential market and financial plan.
4: Cross-sector Opportunity Communities	Reach out to related sectors that can unlock big space opportunities.	The big opportunities in space will be best realised by supplementing the capabilities of the space sector with those of other sectors in which the UK has world-class skills, such as advanced manufacturing, communications (including optical and quantum), IT, robotics, and professional services.
5: Capability Development	Use programmes to improve UK industry capability, not just technology.	The programmes required for science missions and technology development can also address the UK's industry structure deficit. RFPs can include requests for UK and SME content and how these will be enhanced by the programme, developing a more capable UK industry.
6: Market Creation	Be proactive in market creation, using regulation and public procurement as tools.	Several opportunities for space are held back because the markets do not exist, but they could be created or catalysed by the public sector. This can save public money where space services save expense elsewhere, or even raise money e.g., through environmental regulations.

3 OPPORTUNITIES FOR INTERNATIONAL COLLABORATION

Key civil and defence capability priorities for the UK, as defined in NSS [2], are as follows:

- Satellite Communications: Global, secure, and resilient
- Earth Observation (EO) and Intelligence, Surveillance and Reconnaissance (ISR)
- Command-and-Control, and Space Capability Management
- Space Control
- Position, Navigation and Timing (PNT)
- Orbital Launch Capability
- In Orbit Servicing and Manufacturing (IOSM)
- Space Domain Awareness (SDA)

The Size and Health Survey [1] suggests that the UK imports and exports of the space sector are quite finely balanced with exports of around £5.8bn in 2018/19 (mostly to the rest of Europe) and imports of around £5.7bn. Trade surpluses tend to create jobs as foreign demand drives domestic firms to expand. The open international nature of much space activity means that markets are often globally competitive (e.g. satellite manufacturing), constraining the market power of individual UK firms.

OneWeb supply chain [3] can be mentioned. The OneWeb supply chain illustrates the range of supply chain activities and their international nature behind a UK-headquartered business.

OneWeb employs 229 people at the company headquartered in White City in London, as well as many more manufacturing satellites and user terminals, launching and operating satellites. When operational, OneWeb will also support jobs at telcos that resell OneWeb bandwidth and services. The supply chain impact of OneWeb in the UK will depend on how much of this supply chain is delivered domestically. Gen 1 satellites are currently being built by Airbus in Florida while South Korean company Intellian is the main partner for user terminals and a global network of ground stations is being built out. Key elements of the Gen 1 OneWeb supply chain comprise:

- Airbus which currently integrated the elements of the OneWeb satellites at its purpose-built facility in Florida, USA (although production may be moved to the UK)
- RUAG Space who make the satellite backbone in Florida, the satellite dispensers in Sweden, and the satellite insulation in Austria
- Teledyne who provide signal converters and filters from their facility in Shipley, Yorkshire
- MDA make the antenna systems in Montreal, Quebec
- Syrlinks who make transceiver in Rennes, France
- Sol Aero in Albuquerque, New Mexico (now owned by RocketLab) who make the solar panels
- SpaceTech, who make the solar array deployment mechanism in Immenstaad, Germany
- Star trackers are made by Sodern, a subsidiary of Ariane Group based in Paris
- NewSpace Systems in South Africa make the magnetic torquers
- Korean firm Intellian make the user terminals while Satixfy are developing terminals for aircraft and other mobile locations at their facility in Cheadle, Manchester
- Hughes Networks is developing much of the ground system hardware in Maryland, USA.

The results of our study suggest that the most efficient international collaboration relevant to all 8 abovementioned priorities will be in the areas of low-cost flat panel antennas, low-cost integrated circuits, encryption and security technologies for the use by the UK space upstream companies.

International support is also important for fundamental and applied research taking place in the UK – the funding through, for instance, ESA tenders and scientific discussions on development of In Orbit Servicing and Manufacturing and Space Based Solar Power (SBSP) [4]. IOSM and SBSP

include technologies for which UKSpace (the space trade association based at the Bordon Innovation Centre) pays special attention through respective committees.

Another aspect of international collaboration with the UK is in the migration of skilled workforce from continental Europe. Also, access of companies to such facilities as ESA Business Incubator Centre at Harwell plays a very positive role.

4 CONCLUSIONS

The results of the "UK Space Supply Chain" study allowed the authors to produce 6 recommendations: 1) Skills and Finance - Improve access to skills and finance, with a plan that meets the growing needs of the sector; 2) Space Clusters- Continue space cluster development and creation; 3) Technology Development - Invest in technology development to accelerate progress, but aware of the dangers; 4) Cross-sector Opportunity Communities Reach out to related sectors that can unlock big space opportunities; 5) Capability Development - Use programmes to improve UK industry capability, not just technology; 6) Market Creation - Be proactive in market creation, using regulation and public procurement as tools. The importance of international collaboration is also confirmed, namely in the development of novel market/technologies, funding and a skilled workforce.

5 REFERENCES

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