

THE WEST MIDLANDS SPACE CLUSTER DEVELOPMENT: BUSINESS CASE

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THE WEST MIDLANDS SPACE CLUSTER DEVELOPMENT: BUSINESS CASE

EXECUTIVE REPORT

MARCH 2021

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FOREWARD

In the last decade, space has transformed into one of the UK's fastest growing and most promising sectors. Trebling in size since 2010, the UK space industry now employs close to 42,000 people across the country and generates an income of nearly £15 billion every year. Space has the potential to drive growth and productivity across many areas of the wider UK economy, as a strategic 'enabler of growth in other sectors' (Gov.uk, 2015) and 'critical national infrastructure'. In response to this, the UK Space Agency '*Local Space Sector Cluster and Supply Chain Development*' Fund was established to develop the maturity of 'early-stage' local space clusters across the UK. This 'seed corn funding' focussed on providing evidence and analysis of local ecosystems in order to stimulate local advocacy and investment in Space and increase the uptake of space data and technologies. The 2020 funding was awarded to seven locations – including the West Midlands – to ensure space is a priority for regional economic growth and attract commercial investment from space companies to these areas.

The main outcome from this work is a proposed route to increase the maturity of the West Midlands space cluster. Our research has revealed the latent competitive advantages, through new combinations of assets, technologies, skills, knowledge, and expertise that are present in the West Midlands region now, as the building blocks of a future

West Midlands space cluster. We now have a deeper understanding of the foundations available for attracting further investment and talent to drive the evolution of this cluster, as part of a wider regional economic growth plan.

A unique strength for the future development of a West Midlands space cluster is our manufacturing sector (aerospace, automotive, and rail). The West Midlands is a globally significant sector for advanced manufacturing, assembling a critical mass of globally competitive business and high-tech Small Medium Enterprises (SME's) operating across a range of transport-related sectors, and in particular aerospace, automotive, and rail. Within the region we have strong supply-chains mobilised around key capabilities (such as engines, electromechanical systems etc). These industries (and in particular aerospace) share close similarities with space and thus demonstrate strong latent space potential. Furthermore, whilst the West Midlands is home to only a handful of downstream space application businesses, the region combines space application capabilities with important end-user sectors for space data/services, creating a powerful value-chain ecosystem for innovation, business growth, and end-user benefit. Our space application capabilities include data analytics, image analysis, artificial intelligence, machine learning, and gaming technologies. The West Midlands holds particular strengths in key user sectors that have the potential to benefit significantly from

space enabled data and services, including future transport (connected and autonomous vehicles, digital rail etc), modern services, health and life sciences (connected data driven services), and agriculture 4.0 (precision agriculture and autonomous farming systems). Combining satellite-enabled applications (including, ubiquitous connectivity, remote sensing, and precision navigation and time), space-enabled systems and services have the potential to transform these end-user sectors, addressing major industrial and societal challenges and driving innovation, competitiveness, and growth.

This is an important national initiative to both enhance the UK's position in the global space technology sector and promote regional growth. These will translate leading R&D into applied technologies and better job opportunities for the region as a whole. Exploration of the global space technology sector is especially welcome at this challenging time as we start plotting our region's economic recovery from the coronavirus pandemic.

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EXECUTIVE SUMMARY

IMPORTANCE OF SPACE: Space has become a critical infrastructure and dependency for governments, societies, and economies globally. Today, the space market is valued at over \$366 billion and is forecast to reach \$558 billion by 2026 [Bryce]. Globally¹, more than \$10 trillion of economic activity is reliant upon satellite services. Approximately 90% of modern military capabilities are dependent on space in some way. Most of the UN 'essential climate variables' are monitored by space-based systems, and all 17 UN Sustainable Development Goals benefit in some way from satellite-enabled services.

SPACE 2.0 (NEW SPACE): Over the last decade the global space industry has undergone a sustained period of change. Lower cost and more capable launch vehicles have significantly improved the accessibility of space. Lower cost ground antenna capable of satellite tracking have opened the market to low-earth-orbit (LEO) small- and cube- satellite constellations with ubiquitous performance, lower latency and data loss, greater resilience, and lower cost. Advanced digital coding systems are enabling use of new spectrum frequencies with ever increasing efficiencies. And new satellite production capabilities utilising advanced manufacturing processes are enabling satellites to be produced at volume on assembly lines at lower cost.

The pace of advancement is enabling the sector to look beyond traditional satellite capabilities (communications and connectivity, remote sensing and earth observation, and

precision navigation and timing) towards new space applications, such as in-orbit services (satellite servicing, upgrades, refuelling, and repositioning, debris removal, construction and manufacture, and reclaim/recycling or resources), space mining, space-based solar power, sub-orbit transport and space tourism, space habitats, and even our journey to Mars and beyond. The size and importance of the space sector is only set to increase in the coming years.

UK SPACE INDUSTRY AND STRATEGY: Space is a sector of strength for the UK within which we punch far beyond our weight. The sector² is valued at £14.8 billion with a 3.3% CAGR, representing 5.1% of the global market. Over £5.5 billion in export trade is made annually to Europe, North America, Asia, and Oceania. The sector directly employs approximately 42,000 people across 948 organisations with a 2.6x labour productivity compared to the UK average (high-value sector). Areas of existing strength include small satellite manufacture and downstream space applications. The UK seeks to build on these strengths through a bold and ambitious space strategy³. Key policy objectives are to:

- Secure 10% of the global Space market by 2030, growing our revenue from £14.8 billion to £40 billion,
- Double the value of GDP from industries supported by satellite services from £300 billion to £600 billion,
- Contribute £3 billion to the economy from increased investment in research, science, and innovation,

- Create an ecosystem attracting £3 billion in inward investment and £500 million per year equity investment,
- Stimulate up to £1 billion of private investments in UK Space infrastructure using smart government procurement,
- Generate additional £5 billion in export revenues,
- Attract and train up to 30,000 additional skilled people.

To realise these objects the UK is focusing national efforts on four sector priorities: 1) Connectivity Services (from autonomous vehicles to healthcare services), 2) Earth Information Services (leveraging new satellite capabilities to enable smarter services around the world), 3) In-Space Robotics (for in-orbit applications and services), and 4) low-cost launch capabilities. As part of this strategy, the governments ambition is to increase prosperity for all, creating opportunity in every part of the UK.

THE ROLE OF REGIONAL SPACE CLUSTERS: Through delivery of a locally led strategy focusing on the strengths and opportunities of the region, space clusters act to accelerate development of the thriving, resilient and well-connected ecosystem required by the UK to achieve its Space ambitions and deliver the Government's wider economic priorities. Regional Space Clusters are supported by the UK Space Agency and the Satellite Applications Catapult who operate co-ordinated programs to support the development of local Space ecosystems and provide targeted company support across the whole of the UK.

THE WEST MIDLANDS SPACE SECTOR: In 2018 the West Midlands space industry⁴ had a total income of £127 million, representing 0.85% of UK turnover, and comprising 74 companies who employed 1,170 people. GDP of regional end-user sectors reliant upon satellite data and services was estimated at 22.51 billion. This positions the West Midlands sixth within the regional table and significantly behind London, the South East, and the East of England. Most firms identified as engaging in space manufacturing activities (72%) with smaller shares for space applications (20%) and ancillary services (8%), reflective of the strong regional strengths within advanced manufacture.

However, the West Midlands holds significant latent space potential within:

- the upstream sector for space manufacture (materials, components, and assemblies), leveraging our nationally leading aerospace (automotive and rail) supply-chains,
- downstream space application sectors, leveraging our specialisms in computer and data sciences, and
- end-user sectors for future mobility (automotive and rail), modern services (business, professional, and financial service sectors), data driven health and life sciences, and agriculture.

UPSTREAM SECTOR – SPACE MANUFACTURING

SUPPLY CHAINS: Space manufacture is dominated by a handful of companies. To enter the market suppliers must engage with prime/OEM (or sub-system) manufacturers at an early stage in the design cycle (so that their offerings may be incorporated into the (sub-)system specifications) and demonstrate compliance with customer quality management systems and processes, a costly exercise for both the OEM and supplier. Due to the effort, cost, and risk of on-boarding new suppliers, manufacturers naturally gravitate towards their established suppliers, creating a barrier to entry and the perception of a closed supply chain.

On the other hand, whilst many suppliers have the capability to participate within the space manufacturing supply chain, they are deterred from doing so due to their limited awareness of the sector and the potential opportunities, low production volumes and bespoke nature, and the requirement for strict quality management systems and documentation.

A unique strength of the West-Midlands is our manufacturing sector (aerospace, automotive, and rail). Within the region we have strong supply-chains mobilised around key capabilities (such as engines, electromechanical systems etc). These industries (and in-particular aerospace) share close similarities with the space sector and thus demonstrate strong latent space potential.

To facilitate entry and growth of our manufacturing supply-chains within existing and future space value chains we have identified 3 'must-win' battles:

- 1) early engagement and collaboration with space primes/OEMs and sub-system manufacturers – *to unlock supply-chain opportunities,*
- 2) recognition, mobilisation, and alignment of regional supply-chain capabilities for space manufacture – *to mobilise and structure regional capabilities, and*
- 3) step-change enhancement of regional manufacturing offerings and capabilities, meeting existing and future unmet supply-chain needs – *to achieve international recognition and leadership in our target specialisms, facilitating customer engagement and take-up, and thereby driving penetration and growth within global markets.*

¹ Athena – A new approach to space

² Size and Health of the UK Space Industry 2018, London Economics, January 2019

³ www.spacepartnership.org.uk

⁴ <https://londonconomics.co.uk/blog/publication/size-and-health-of-the-uk-space-industry-2018/>

DOWNSTREAM SPACE APPLICATION AND USER

SECTORS: Combining ubiquitous connectivity, remote sensing, and precision navigation and timing, space enabled systems and services have the potential to transform end-user sectors, address major industrial and societal challenges, and drive innovation, competitiveness, and growth. The West Midlands holds key strengths in end-user sectors that have the potential to benefit significantly from space enabled data and services, including future transport (connected and autonomous vehicles and digital rail), modern services (insurance and property technology), health and life sciences (connected data driven healthcare services), and agriculture 4.0 (precision agriculture and autonomous farming systems).

However, space applications in these user sectors are currently limited by end-user awareness of space enabled capabilities, space application provider awareness of the unmet end-user needs and challenges, performance limitations of existing space capabilities, and accessibility and cost of space data. Furthermore, whilst the West Midlands holds strengths in the fields of computer and data sciences, there are relatively few businesses in the region operating within the space applications value-chain segment (primarily due to its emergent nature), limiting our innovation and growth potential.

Although challenges associated with performance, accessibility, and cost of space data are anticipated to reduce in time with growing UK (and international) space assets, these must be carefully aligned with use case requirements and roadmaps.

To facilitate growth of downstream space application and user sectors we have identified 3 'must win' battles:

- 1) engagement with key end-users to raise awareness, explore potential applications, and demonstrate the use and benefits of space enabled systems and services – *to stimulate market demand and enable the benefits of space to be realised,*
- 2) growth of space application start-up's (and pivots) – *to generate a regional capability to meet this demand and capture market share, and*
- 3) step-change enhancement of regional offerings and capabilities within our end-user market niches – *to achieve international recognition and leadership in our target specialisms, facilitating growth within global markets.*

Stimulation of end-user markets will be key to driving growth of the region's downstream capabilities and services.

OUR VISION AND STRATEGY: is a future where the West Midlands plays a pivotal role in the UK space industry:

- a globally leading supply-chain representing ~10% of UK space manufacture,
- a thriving downstream space applications sector representing ~10% of the UK market,
- achieving international recognition with strong export markets (>12.5% GDP)
- attracting new business to the region and significant inward investment (>£300 million),
- investing >£300 million in research and innovation,
- supporting growth in the region, with a target of £1.64 billion direct GDP growth, leading to an additional 3,000 new jobs,
- benefiting £40 billion+ of regional economic activity reliant upon satellite services, and
- providing high quality training (3,000+ additional skilled people / apprenticeships).

**GENERATING £1.64
BILLION GDP GROWTH,
CREATING 3,000+ NEW
JOBS, ATTRACTING 300
MILLION+ INWARD
INVESTMENT,
BENEFITING £40
BILLION+ REGIONAL
ECONOMIC.**

In line with the UK Space Agency Cluster Roadmap (figure 1), we will facilitate this vision through a West Midlands Space Cluster that seeks to:

- understand regional strengths and latent space potential (✓ – initiated),
- identify and explore space opportunities that leverage this potential (✓ – initiated),
- establish a locally-led space leadership group involving key stakeholders from government, industry, and research/ academia (✓ – initiated),
- define a space strategy that aligns with regional strengths and priorities (✓ – initiated),
- leverage/build anchor facilities within the region, that play a central role in supporting the cluster, raise the profile of the West Midlands space industry, and provide a focal point for activity,
- cluster regional stakeholders, assets, facilities, expertise, activities, and initiatives that have relevance to the space industry,
- coordinate cluster activities towards strategic policy objectives, including:
 - networking and awareness raising events and initiatives (involving key stakeholders),
 - establishment of working groups to inform and lead strategy and policy,
 - partnership and collaboration with strategic stakeholders that lie beyond the region,

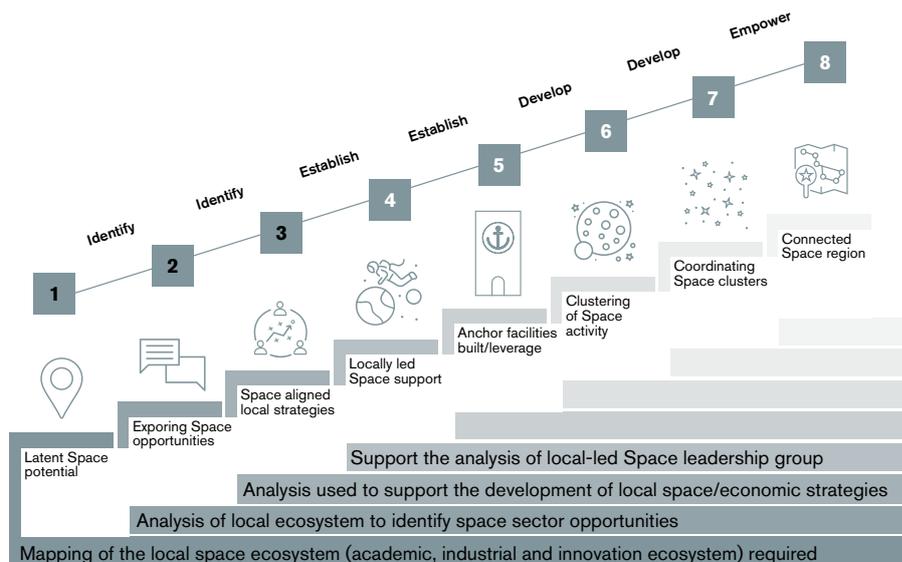


FIGURE 1. UK SPACE AGENCY SPACE CLUSTER ROADMAP

- mobilisation of business support services, access to skills training, and finance for research, innovation, and growth, and
- integrate and empower our space clusters within a connected region through structured programmes of activity.

Our first four steps along this roadmap have already been initiated as part of our UK Space Agency funded 'Local Space Sector Cluster and Supply Chain Development' project (identified with a '✓' in the bullet points above).

Co-ownership of the strategy by regional stakeholders will be essential for its success. It is envisaged that the Space Cluster will be initially launched and operated in collaboration with the Midlands Aerospace Alliance, an organisation already representing many of our key stakeholders, from a sector that draws many parallels with the space industry, that has direct experience in the clustering and coordination of sector specific activities, and already delivers a range of programmes supporting businesses to pivot into adjacent markets.

ALIGNMENT WITH REGIONAL PRIORITIES:

Our vision aligns closely with key regional priorities, and in particular:

- *The West Midlands Local Industrial Strategy* – building on the distinctive strengths of the region, including future mobility, data-driven health and life sciences, modern services, and globally competitive manufacturing supply chains,
- *The West Midlands Digital Roadmap* – providing ubiquitous digital connectivity and services supporting realisation of the strategies '5 Missions for 2021–2026',
- *The Made Smarter Programme* – supporting digitisation of the manufacturing sector, both directly through take-up of digital and advanced manufacturing technologies by the space industry, and indirectly through satellite connectivity services, and

West Midlands Space Market (Low-, High-, and Target Scenario Forecasts)

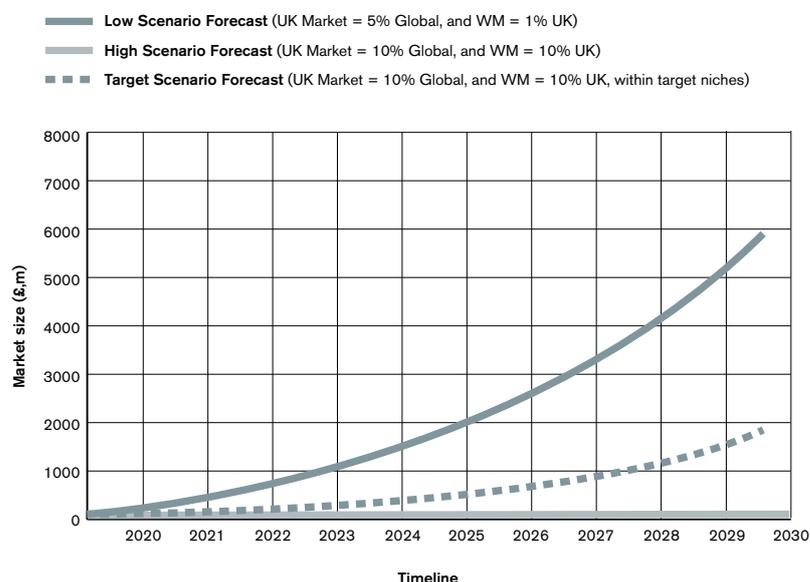


FIGURE 2. WEST MIDLANDS SPACE INDUSTRY (LOW TO HIGH SCENARIOS) [AUTHOR: ROB BEVAN]

- *The West Midlands Innovation Programme* – supporting development of an innovation ecosystem that fosters entrepreneurship, drives up levels of innovation, and supports exploitation of R&D within the space sector.

It is also anticipated that a strong space industry will attract the take-up of essentially needed STEM subjects and support the retention of such skills within the region.

POTENTIAL MARKET OPPORTUNITY: We have undertaken a top-level assessment of the potential addressable market for the West Midlands space sector (figure 2). Our baseline ('do nothing') scenario assumes that the UK retains a 5% share of the global market, and that the West Midlands retains a 1% share of the UK market. Within this scenario the West Midlands Space market would grow from £166 million (2020) to £287 million by 2030 at a CAGR of 5.6%. Our upper (high forecast) scenario assumes that the UK is able to achieve its growth target to 10% of the global market, and that the West Midlands is able to capture a 10% share of the UK market. Within this scenario the West Midlands Space market would grow from £166 million (2020) to £5.74 billion by 2030 at a CAGR of 42.48%.

We then estimated the potential addressable markets for our target niches, assuming a 10% share of both the forecasted UK space manufacturing (£323 million) and downstream space applications (£1.318 billion) sectors by

2030. We assessed the reasonableness of the downstream market by evaluating the potential space markets for each of our target end-user sectors (automotive, rail, modern services, health and life sciences, and agriculture).

We plotted the combined addressable market on our graph assuming constant growth. Within this scenario the West Midlands Space market would grow from £166 million (2020) to £1.64 billion by 2030 at a CAGR of 25.74%. This scenario falls well within the low to high scenario range and is thus believed to be realistic.

NEXT STEPS: Moving forward, one potential option is to 'do nothing'. Under this scenario, it is highly unlikely that the West Midlands share of the space market would increase beyond its existing position (~1% share of the UK market) and is in fact more likely to decrease as other regions rise to the opportunity. If we do not act quickly enough, it is also likely that we will lose any competitive advantage gained through our regional strengths and will move into a position of playing 'catch-up'.

A far better strategy is to take the initiative and gain competitive advantage and leadership through our strengths. Our action plan is centred on several core activities that provide a basis upon which the cluster will be built:

- *Action 1 – Implementation Strategy and Business Case:* to undertake a robust assessment of the opportunity, working

with key regional stakeholders, to lay the foundations and strategy for implementation,

- *Action 2 – Cluster Set-Up and Operation:* to establish the foundational components of the cluster and lead its continued development and growth, and
- *Action 3 – Thematic Leaders:* to recruit one or more thematic leaders who will act as cluster champions for specific priority areas and will proactively drive progress towards key policy objectives.

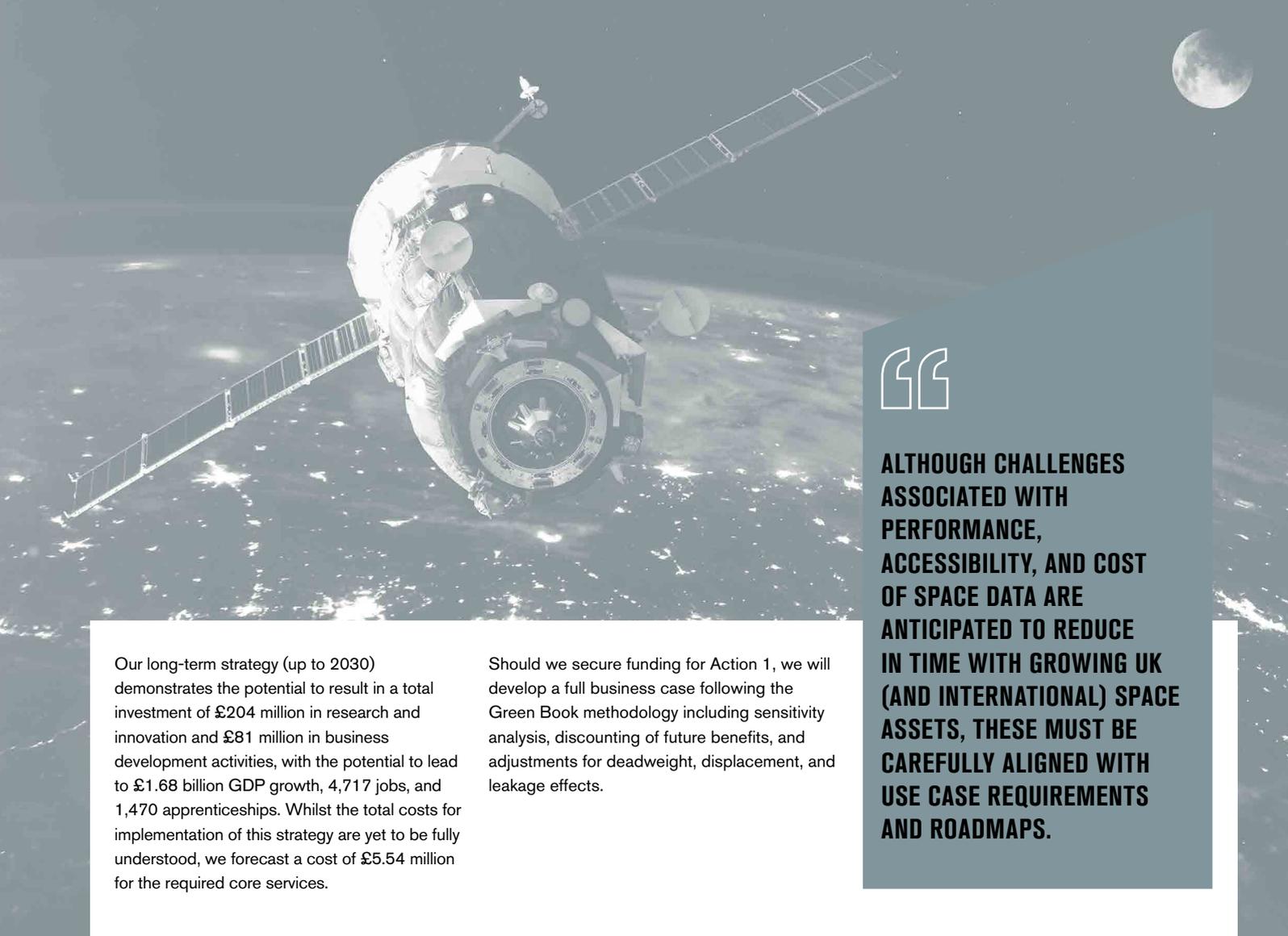
We have also identified a range of 'optional actions' that will facilitate, reinforce, and accelerate innovation and business development, and provide the necessary resources and capabilities to translate these opportunities into GDP growth and employment. These activities include Dedicated Innovation Consultancy Vouchers, Skills and Training, Space Incubator and Accelerator Programmes, Cluster Facilities (development support through to applied research), and Structure Programmes of Support targeting Strategic Policy Objectives. Our 'short-term' strategy over three and a half years has an estimated cost of £1,627,500 (Table 1) and is forecasted to result in a total investment of £54 million in research and innovation and £21 million business development activities, with the potential to lead to £442.5 million GDP growth, 1,246.5 jobs, and 420 apprenticeships (Table 2)

Table 1: Costs – Short-Term Space Cluster Development Strategy

| Activity | Year 1 | | | | Year 2 | | | | Year 3 | | | | Year 4 | | Estimate Cost |
|--|--------|----|----|----|--------|----|----|----|--------|----|----|----|--------|-------------------|-----------------------|
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | |
| Option 1: Strategy and Business Case | | | | | | | | | | | | | | | £75,000 |
| Option 2: Cluster Set-Up and Operation | | | | | | | | | | | | | | | £750,000 ¹ |
| Option 3: Thematic Leaders (x3) | | | | | | | | | | | | | | | £802,500 ² |
| Total Cost | | | | | | | | | | | | | | £1,627,000 | |

¹ assumes a cost of £250,000/year over three-years (see Table 7)

² assumes a cost of £133,750/year for three thematic leaders over 2-years (see Table 7)



Our long-term strategy (up to 2030) demonstrates the potential to result in a total investment of £204 million in research and innovation and £81 million in business development activities, with the potential to lead to £1.68 billion GDP growth, 4,717 jobs, and 1,470 apprenticeships. Whilst the total costs for implementation of this strategy are yet to be fully understood, we forecast a cost of £5.54 million for the required core services.

Should we secure funding for Action 1, we will develop a full business case following the Green Book methodology including sensitivity analysis, discounting of future benefits, and adjustments for deadweight, displacement, and leakage effects.



ALTHOUGH CHALLENGES ASSOCIATED WITH PERFORMANCE, ACCESSIBILITY, AND COST OF SPACE DATA ARE ANTICIPATED TO REDUCE IN TIME WITH GROWING UK (AND INTERNATIONAL) SPACE ASSETS, THESE MUST BE CAREFULLY ALIGNED WITH USE CASE REQUIREMENTS AND ROADMAPS.

Table 2: Benefits – Short-Term Space Cluster Development Strategy

| Activity | Duration (Years) | Research and Innovation | | | Business Development | | | Apprenticeships (skilled staff) ³ |
|---|------------------|-------------------------|---------------|--------------|----------------------|---------------|--------------|--|
| | | Investment £m | GDP Growth £m | Jobs | Investment £m | GDP Growth £m | Jobs | |
| Action 1: Strategy and Business Case | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Action 2: Cluster Set-Up and Operation ¹ | 3 | 12 | 87.6 | 249 | 3 | 6.9 | 19.5 | 90 |
| Action 3: Thematic Leaders (x3) ² | 2 | 42 | 306.6 | 864 | 18 | 41.4 | 114 | 330 |
| Total Benefit | | 54 | 394.2 | 1,113 | 21 | 48.3 | 133.5 | 420 |

¹ assumes the action will facilitate an investment of £4 million/year in research and innovation (leading to £29.2 million/year GDP growth and 83 new jobs/year) and £1 million/year investment in business development activities (leading to £2.3 million/year GDP growth and 6.5 new jobs/year) (see Table 7)

² assumes the action (per thematic leader) will facilitate an investment of £7 million/year in research and innovation (leading to £51.1 million/year GDP growth and 144 new jobs/year) and £3 million/year investment in business development activities (leading to £6.9 million/year GDP growth and 19 new jobs/year) (see Table 7)

³ assumes 1 apprentice/ skilled staff per ~£950,000 GDP growth (in line with our vision targets)

BACKGROUND AND MISSION STATEMENT

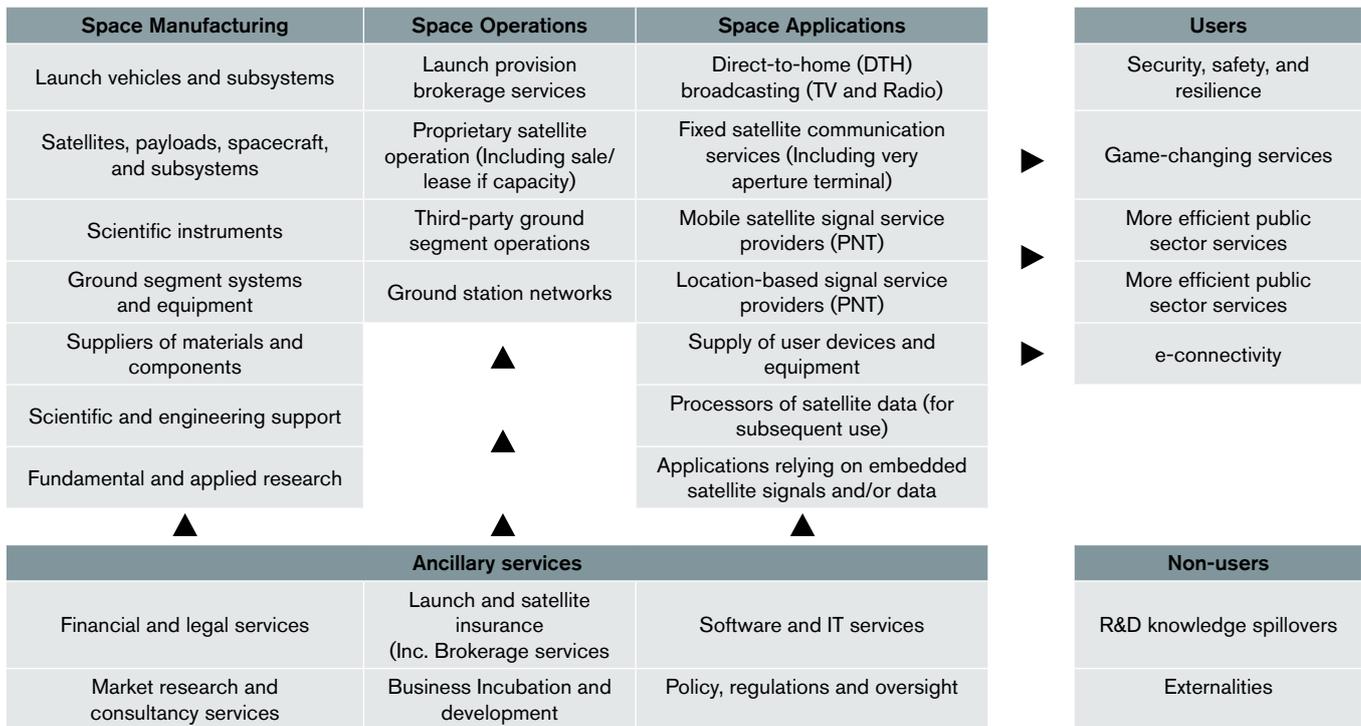


FIGURE 3. SPACE VALUE CHAIN (SOURCE: LONDON ECONOMICS REPORT)

IMPORTANCE OF THE GLOBAL SPACE INDUSTRY

Space is a major dependency of governments, societies, and economies globally⁴:

- >\$366 billion market value (2019) and forecast to reach \$558 billion by 2026,
- >\$5.7 billion raised by space start-ups during 2019,
- >\$10 trillion annual global economic activity is reliant upon satellite services,
- >6 billion GNSS⁵-enabled devices worldwide,
- ~53,000 merchant ships reliant upon satellite-based safety and communication services,
- Most of the 40 UN 'essential climate variables' are monitored by space-based systems,
- All 17 UN Sustainable Development Goals benefit meaningfully from space-enabled services,
- Identified as critical national infrastructure and a top ten risk by most developed nations,

- ~90% of modern military capabilities dependent on space in some way.
- The importance of space is only set to accelerate with an ever-increasing reliance upon a connected and informed society, an explosion in space-based opportunities, and enhanced accessibility of space.

THE SPACE INDUSTRY VALUE-CHAIN

The space value-chain is structured by:

- space manufacturing – design and manufacture of space components, subsystems, launch vehicles, satellites/ spacecraft, and infrastructure.
- space operations – launch and operation of satellites and spacecraft.
- space applications – applications of satellite/spacecraft signals, data, and services
- ancillary services – specialised services that support manufacture, operations, and applications.

- users – those not directly involved in space-related activities but are reliant upon satellite/space services.
- non-users – those who are not reliant upon space services but indirectly benefit (from space-related activities)

A picture of the space value-chain today is provided above (figure 3).

Space missions are typically financed by either (or both) commercial operators or government agencies. Satellite / spacecraft manufacture is traditionally subcontracted to 'prime' contractors who assume responsibility for manufacture working with a supply chain of subsystem, component, and material manufacturers. Satellite launch is typically contracted to a public or private organisation with launch capabilities, either as a primary or secondary payload. Launches typically carry multiple payloads (reaching more than 100 satellites for large launch vehicles). Some operators subcontract satellite operation and/ or spaceflight to third-party organisations.

NEW SPACE (SPACE 2.0) - THE EMERGING OPPORTUNITY

Over the last decade, the space industry has undergone a sustained period of change. Technological advancement has driven exponential growth in satellite/spacecraft performance, and new manufacturing, launch and operation capabilities, leading to the reconfiguration of value-chains and market disruption. The commercial space industry has been reinvented by new companies, such as SpaceX, Virgin Galactic, Blue Origin, One Web, Kymeta, and Planet, which in turn is driving change within the incumbents, such as Lockheed Martin, Airbus, Boeing, Northrop Gruman, and McDonald-Detwiler.

Key technologies that have driven change include:

- Lower cost and more capable launch vehicles/services, significantly improving the accessibility of space (democratisation of space).
- Lower cost ground antenna systems capable of satellite tracking, enabling commercial use/operation of new Low-Earth-Orbit (LEO) small- and cube-satellite constellations.
- Advanced digital coding systems, enabling enhanced transmission capabilities, use of new spectrum frequencies (Ka-, Q/V-, W-/E- bands), and improved efficiencies (~10-fold)⁶ in the use/reuse of available frequencies.

- New (small) satellite production capabilities (assembly lines), utilising advanced manufacturing processes (additive manufacturing), standardised components, and integrated quality testing; enabling faster and lower cost manufacture of satellites at higher volume.
- These drivers have led to greater diversity in launch and satellite/spacecraft systems with exponential growth in performance and functionality.

Space 2.0 encompasses both traditional and new/emerging space applications (figure 4).

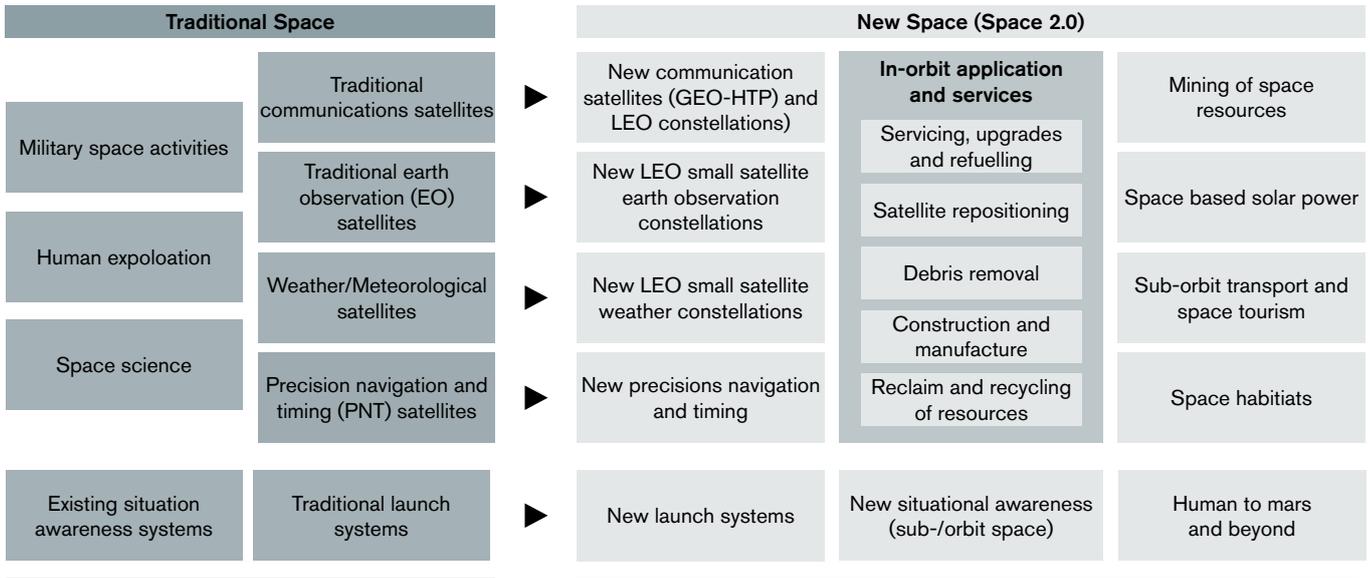


FIGURE 4. TRADITIONAL AND NEW SPACE APPLICATIONS (AUTHOR: ROB BEVAN)

⁴ Athena – A new approach to space

⁵ GNSS = Global Navigation Satellite Service

⁶ Space 2.0 – Revolutionary Advances in the Space Industry; Joseph N. Pelton (Springer)

THE TRADITIONAL SPACE SECTOR INCLUDES:

SPACE MANUFACTURING: includes the design and manufacture of space components, subsystems, launch vehicles, satellites/ spacecraft, and infrastructure. The sector is characterised by strict specifications, bespoke jobs, short production runs, labour intensive manual assembly, and extensive quality testing (often representing >50% of costs⁷). However, the sector is undergoing significant transformation towards greater vertical integration, volumetric production on assembly lines, standardisation of components, and greater use of advanced manufacturing technologies, including digital technologies for in-line inspection. These trends are significantly reducing the cost basis for space manufacture whilst increasing scalability.

LAUNCH SYSTEMS: within the last decade launch systems have undergone radical transformation. Whilst launch capabilities, diversity, and capacity have continued to increase, launch costs have fallen dramatically. Key innovations driving this trend include re-useable launch vehicles, low-cost (standardised) components and volumetric manufacture, smarter launch vehicles with greater autonomy over flight systems, and horizontal launch capabilities (from carrier planes).

SITUATIONAL AWARENESS: represents the monitoring of sub-orbital and orbital objects, debris, and space craft. Existing situational awareness systems utilise radar (and on-board GNSS systems) to track objectives >10cm in size (~22,000 in orbit today)⁸. With an exponential increase in the number of launches, satellites in orbit, and use of sub-space, there is a need for ever greater situational awareness, and capacity to track more objects down to a smaller size.

SATELLITE DATA AND SERVICES: provide the foundations for most space applications. These include:

1) Communication satellites: traditionally very large, powerful, and expensive satellites in geostationary orbit (GEO) communicating with millions of ground antennas with high data capacity/efficiency. Geostationary orbit eliminates the need for satellite tracking capabilities, thereby enabling very low cost,

small aperture ground antennas to be used. Key services include broadcasting of television and radio, telephone/mobile communications, and broadband connectivity. Technological advancements are driving communication satellites in two directions:

- **High-Throughput Satellites:** even larger satellites with huge antenna and solar panels (10kW+) and advanced digital coding systems, enabling an exponential increase in capability and efficiency, and thus continued improvements in cost efficiency.
- **Small satellite constellations:** a network of 60+ small- or cube- satellites that blanket the earth and collectively provide effective/ equivalent coverage. Such constellations are enabled by the emergence of low-cost ground antenna with satellite tracking capabilities, and low-cost volumetric small-/ cube- satellite production capabilities. Since low-earth orbit (LEO) satellites are ~40x closer to the earth, this enables reductions in both latency and loss of transmission data. Furthermore, small-/ cube- satellites may be designed to have a shorter operational life, enabling operators to embrace continuous technological advancements, and are inherently more resilient, as loss of an individual satellite does not result in loss of the entire service.

2) Earth Observation Satellites: encompass a broad suite of passive (natural reflection/ emission) and active (signal transmission/ reflection) sensing capabilities from satellites in geostationary, medium-, and low- earth orbit. Earth observation capabilities are experiencing rapid growth due to the emergence of lower cost, miniaturised, and more powerful sensing technologies (with lower power requirements) that enable:

- Ever increasing improvements in spatial (pixels/unit area), spectral (width, precision, and number of spectral bands measured), and temporal (frequency of measurement update) resolution; and
- Increased use of LEO small-/cube- satellite (constellations), that are less costly than large satellites, and place the satellite closer to earth for improved sensing and lower gain requirements (and smaller antenna).

Satellites are now able to observe objectives with a resolution <0.3 million⁸, utilising 100+ frequency bands with progression toward near real-time updates. An important component in the EO value-chain is data processing services. This includes pre-processing of raw sensing data to make it more accessible for use, data storage, and analysis of signal images/spectra. Advancements in machine learning and artificial intelligence play a particularly important role here.

3) Precision navigation and timing (PNT):

Also called global navigation satellite services (GNSS) or Global Positioning Satellites (GPS), utilise triangulation of timed signals from 3 geostationary satellites to provide high accuracy positioning. High accuracy is achieved via a time stamp provided by an on-board atomic clock. Accuracy can be further supplemented via signals from ground systems at precisely known locations. Standard positional accuracy (3D locational data) is to within a five mile radius; however, with advanced techniques this can be reduced to a few cm's accuracy⁸. Time accuracy is <40 nanoseconds.

CORE SATELLITE CAPABILITIES:

- Ubiquitous connectivity – high-performance connectivity regardless of location,
- Precision location, navigation, and timing,
- Earth observation – ever expanding suite of remote sensing data and services with enhanced spatial, spectral, and temporal resolution.

These combine to provide key enablers for an extremely diverse range of user applications and needs.

⁷ Feedback from interviews with companies involved in space manufacture

⁸ US Gov: www.gps.gov/systems/gps/performance/accuracy

⁹ www.reactionengines.co.uk/beyond-possible/sabre

UK SPACE INDUSTRY AND STRATEGY

Space is a sector of strength for the UK within which we punch far beyond our weight [data: London Economics]:

- £14.8 billion turnover (2016/17) with 3.3% CAGR, representing 5.1% global market share (Table 3),
- UK income is split between Space Manufacturing (13%), Space Operations (15%), Space Applications (69%), and Ancillary Services (3%),
- £5.5 billion in exports (2016/17) to Rest of Europe (54%), North America (16%), Asia and Oceania (14%), and Other (16%),
- Direct employment of 41,900 people, across 948 organisations, with ~39+ new entrants annually,
- 2.6x labour productivity compared to UK average (high value sector),
- £566 million R&D expenditure,
- £5.7 billion direct contribution to GDP (Gross Added Value),
- Enabler of >£300 billion GDP across end-user sectors.

ROLE OF REGIONAL CLUSTERS

The Government's ambition is to increase prosperity for all, creating opportunity in every part of the UK. Through delivery of a locally led strategy focusing on the strengths and opportunities of a particular region, space clusters act to accelerate development of

| Customer | | 2016/17 £m |
|---------------------------------|----------------|---------------|
| Commercial | Consumer (B2C) | 7,500 |
| | Business (B2B) | 4,670 |
| Defence/Military | | 1,276 |
| Other Civil Government | | 402 |
| European Space Agency (ESA) | Galileo | 190 |
| | EGNOS | 0.12 |
| | Copernicus | 34 |
| | Other | 264 |
| Research/Science Funding Bodies | | 174 |
| European Commission (EC) | H2020 | 15 |
| | Other | 133 |
| UK Space Agency | | 70 |
| Other Space Agency | | 60 |
| Undefined | | 3 |
| Total | | 14,792 |

the thriving, resilient and well-connected ecosystem that the UK requires to achieve its Space ambitions, realise the full economic potential of Space across the UK, and proactively deliver the Government's wider economic priorities.

Regional Space Clusters are assisted by the UK Space Agency and the Satellite Applications Catapult who operate co-

ordinated programs to support the development of local Space ecosystems and provide targeted company support across the whole of the UK. These programs help to establish local networks, facilities, support, advice, and resilience that raise awareness of Space sector opportunities and reduce barriers to entry and growth, creating stable and productive Space communities.

THE SPACE GROWTH PARTNERSHIP (SGP)

www.spacepartnership.org.uk is a strong and dynamic partnership between industry, government, and academia, created to secure the future growth and global success of the UK Space Sector. Involving key sector stakeholders, including the UK Space Agency (an executive government agency responsible for all strategic decisions on the UK civil space programme), the SGP has defined, and is responsible for implementing, the UK's Space strategy.

Strategic policy objectives identified by the SGP include:

- Secure 10% of the global Space market by 2030, growing our revenue from £14.8 billion to £40 billion,
- Double the value of GDP from industries supported by satellite services from £300 billion to £600 billion,
- Contribute £3 billion to the economy from increased investment in research, science and innovation,
- Create an ecosystem attracting £3 billion

- in inward investment and £500 million per year equity investment into the UK,
- Stimulate up to £1 billion of private investments in UK Space infrastructure using smart government procurement,
 - Generate additional £5 billion in export revenues,
 - Attract and train up to 30,000 additional skilled people.

Key areas of focus underpinning the **UK implementation and growth strategy** include:

- Combining our capabilities in Space data and artificial intelligence (AI) to drive productivity growth and connectivity in Space-enabled sectors of the UK and exports,
- Developing new global partnerships for science and exports to underpin new export campaigns and new opportunities 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,
- Expanding the sector's highly skilled workforce across the UK to deliver high productivity jobs in science and industry across the UK and inspire young people to

study Science, Technology, Engineering and Maths (STEM) subjects.

The strategy recommends focusing national effort on **four sector priorities**, building upon UK industrial and academic strengths:

- **Connectivity Services** – £40 billion forecast market. UK to capture an increased market share in the largest Space application focusing on opportunities from 5G around autonomous vehicles and Internet of Things,
- **Earth Information Services** – £20 billion forecast market. Delivering live and local data from new satellite capabilities to enable smarter services for citizens across the UK and around the world, building on the UK's leading Positioning, Timing and Navigation (PNT) and Earth Observation capabilities,
- **In-Space Robotics** – 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,
- **Low-Cost Access to Space** – Maximising the value of proposed UK Spaceports and launch from the UK, a £10 billion forecast market, making the UK a home for low-cost launch services.

WHERE WE ARE TODAY – REGIONAL LATENT SPACE POTENTIAL

THE WEST MIDLANDS – KEY REGIONAL FACTS

The 'West Midlands Combined Authority' includes the Black Country LEP, Coventry and Warwickshire LEP, and Greater Birmingham and Solihull LEP together with the following local authorities: Cannock Chase, North Warwickshire, Nuneaton and Bedworth, Redditch, Rugby, Shropshire, Stratford-on-Avon, Tamworth, Telford and Wrekin, and Warwickshire (see map below). The WMCA is an administrative body created in 2016 for the participating authorities to collaborate and take collective decisions to receive **additional powers and funding** from government. The WMCA's main **priority areas** are economic

growth, transport, housing, and skills and are led by Mayor Andy Street who was elected in 2017 on a three-year term (with the 2020 mayoral election postponed to 2021 due to COVID-19). Nevertheless, our study of space-related businesses and local universities did expand into the West Midlands region (known as a NUTS1 region for statistical purposes). This includes the Marches LEP and the shaded areas in the map below that are part of the various LEP's but not the WMCA. The West Midlands region is one of the largest conurbations outside London, its central location puts it at the heart of the UK's transport networks and international connections.



THE 2019 'WEST MIDLANDS LOCAL INDUSTRY STRATEGY' IDENTIFIED THE REGION AS: 'A DISTINCTIVE ECONOMY – CREATIVE AND INNOVATIVE, WITH GLOBAL SUPPLY CHAIN STRENGTHS, A DIVERSE AND YOUNG POPULATION, WELL CONNECTED, TRADING, AND ENTREPRENEURIAL.'



KEY REGIONAL FACTS:

- An economy deep rooted in innovation, with >70,000 people working in 14,000 tech and digital businesses (the largest regional cluster in the UK).
- World-class education system comprising 12 universities producing >55,000 graduates a year, of whom 30% are qualified in engineering, technology, science and maths related subjects.
- Centrally located with 90% of the UK population within four hours of travel.
- Largest financial and professional services sector outside of London.
- Highest number of people in the UK employed in advanced engineering and automotive sectors.
- Home to >10% of UK aviation sector.
- Diverse population comprising 190 nationalities.
- Home to the UK's first multi-city 5G test bed, supporting large scale trials for next generation technologies, such as connected and autonomous vehicles, medical and emergency services, construction, and industry 4.0.
- A centre for transport innovation, home to the UK's first Future Mobility Zone.

[data: West Midlands Growth Company]

This is underpinned by significant physical infrastructure associated with universities, industry, and public sector organisations that have invested across the West Midlands.

WEST MIDLANDS LOCAL INDUSTRY STRATEGY¹¹

The 2019 'West Midlands Local Industry Strategy' identified the region as: *'a distinctive economy – creative and innovative, with global supply chain strengths, a diverse and young population, well connected, trading, and entrepreneurial.'*

These market opportunities and sector strengths translate into strong latent space potential within both upstream and downstream value-chain sectors.

THE WEST MIDLANDS INNOVATION ECOSYSTEM

The West Midlands Science and Innovation Audit (2017)¹⁰ identified three core strengths within its innovation ecosystem:

- *A diverse, crosscutting research and innovation base* – comprising 12 universities (many consistently ranked in the top 20 nationally for the quality of their blue sky and applied research), two catapult centres (Manufacturing Technology Centre, and Energy Systems Catapult), 11+ science parks, 14+ incubators, and 10+ accelerators (the largest collection in the country)
- *An engine of private sector research and development* – with businesses across the West Midlands investing £2.3 billion+

annually in R&D (2016), making up 10% of all UK Business Enterprise expenditure on R&D (BERD) and the 4th highest region in the UK.

- *Home to dense innovation networks and clusters* – of original engineering manufacturers, universities, and firms in strategic sectors. These can be found across the region and include the Edgbaston's life sciences cluster, the area surrounding Birmingham Airport, the automotive and future mobility cluster around Coventry and Warwickshire, Digbeth and Leamington Spa's 'Silicon Spa' cluster of computer game companies, and Malvern's emerging cyber-security cluster.



IN 2018 THE WEST MIDLANDS SPACE INDUSTRY HAD A TOTAL INCOME OF £127 MILLION, REPRESENTING 0.85% OF UK TURNOVER, AND COMPRISING 74 COMPANIES WHO EMPLOYED 1,170 PEOPLE.

Identified regional **market opportunities** and **sector strengths** include:

| MAJOR NEW MARKET OPPORTUNITIES | | | |
|--|--|--|--|
| FUTURE OF MOBILITY | DATA DRIVEN HEALTH AND LIFE SCIENCES | CREATIVE CONTENT, TECHNIQUES AND TECHNOLOGIES | MODERN SERVICES |
| SECTOR STRENGTHS | | | |
| LOW CARBON TECHNOLOGY ENERGY AND CLEAN GROWTH | AEROSPACE PRECISION COMPONENT MANUFACTURING | LOGISTICS / TRANSPORT TECHNOLOGY FUTURE MOBILITY | METALS AND MATERIALS INNOVATIVE SUPPLY CHAINS |
| LIFE SCIENCES DEVICES, DIAGNOSTICS, REAL LIFE TESTING | PROFESSIONAL SKILLS SKILLS AND A FULL SERVICES SECTOR | RAIL DIGITAL RAIL, HIGH SPEED 2 | CONSTRUCTION OFFSITE MODERN MANUFACTURING, LAND REMEDIATION |
| CREATIVE GAMES, NEXT GENERATION CONTENT, PROCESS AND PRODUCT DESIGN AND DESIGNER MAKER | FOOD AND DRINK MACHINERY, FOOD AND FLUID CONTROL TECHNOLOGY, PHOTONICS R&D | AUTOMOTIVE BATTERY DEVELOPMENT, DRIVE TRAIN, CAV | TOURISM SHAKESPEARE'S ENGLAND, COMMONWEALTH GAMES, BUSINESS, CITY OF CULTURE |

¹⁰ www.wmca.org.uk/media/1682/west-midlands-sia-final-for-publication-21617.pdf

THE EXISTING WEST MIDLANDS SPACE INDUSTRY

In 2018 the West Midlands space industry had a total income of £127 million, representing 0.85% of UK turnover, and comprising 74 companies who employed 1,170 people. GDP of regional end-user sectors reliant upon satellite data and services was estimated at 22.51 billion (see Table 4). This positions the West Midlands within the middle of the regional table but significantly behind London, the South East, and the East of England.

Utilising Standard Industrial Classification Codes (30.3: Manufacture of air and spacecraft and related machinery; 33.16: Repair and maintenance of aircraft and spacecraft and 51.22: Space Transport) we analysed a recent online survey and identified 85 West Midlands companies, up by 11 (15%) since 2018. Our analysis found that most firms identified as engaging in space manufacturing activities (72%) with smaller shares for space applications

(20%) and ancillary services (8%), reflective of the regional strengths within advanced manufacture. Most companies (>65%) operated across more than one value chain sector.

Table 5 provides a summary of the regional space companies identified. Their location in the region is shown in figure 5.

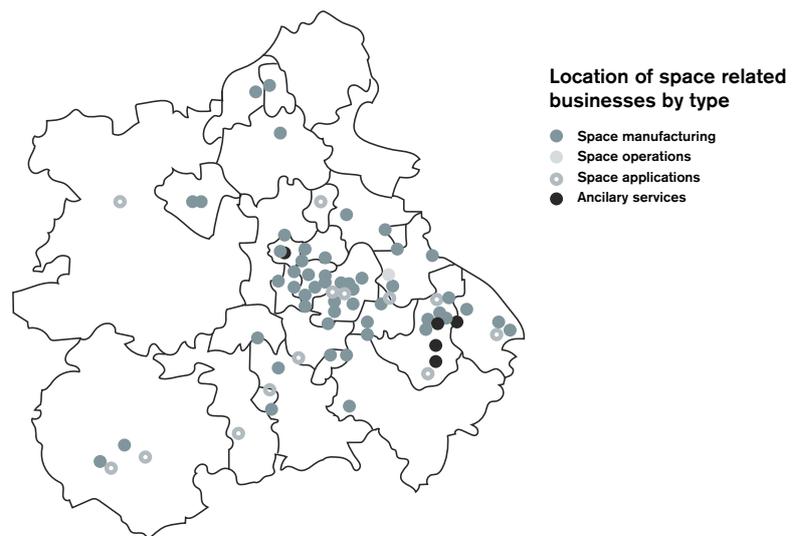


FIGURE 5. LOCATION OF EXISTING REGIONAL SPACE COMPANIES (AUTHOR: TASOS KITSOS)

Table 4 – UK Space Industry by Region, 2016/17 (Data: London Economics¹¹)

| Region | Number of Organisations | ... of whom have their headquarters in the region | Income (2016/17), £ million | % Share of UK Market (by turnover) | Employment (2016/17) | GDP of end-user sectors reliant upon satellite data and services, £ billion |
|--------------------------|-------------------------|---|-----------------------------|------------------------------------|----------------------|---|
| London | 218 | 172 | 9,484 | 64.16% | 12,286 | 69.73 |
| South East | 368 | 269 | 2,364 | 15.99% | 9,023 | 43.54 |
| East of England | 146 | 102 | 2,088 | 14.12% | 4,379 | 30.38 |
| South West | 173 | 99 | 184 | 1.24% | 1,333 | 21.99 |
| Scotland | 132 | 83 | 140 | 0.95% | 7,555 | 24.87 |
| West Midlands | 74 | 40 | 127 | 0.86% | 1,170 | 22.51 |
| Yorkshire and the Humber | 44 | 24 | 102 | 0.69% | 1,302 | 19.20 |
| East Midlands | 83 | 54 | 77 | 0.52% | 868 | 17.79 |
| North East | 34 | 22 | 75 | 0.51% | 907 | 6.39 |
| Wales | 47 | 27 | 67 | 0.45% | 517 | 8.14 |
| Northern Ireland | 26 | 15 | 40 | 0.27% | 145 | 8.69 |
| North West | 75 | 35 | 33 | 0.22% | 2,360 | 26.60 |
| Crown Dependencies | 4 | Redacted | Redacted | Redacted | Redacted | N/A |
| Total | 1,424 | 948 | 14,792 | | 41,929 | 299.83 |

¹¹ West Midlands Local Industrial Strategy

Table 5 – Key West Midlands Companies with Identified Space Activities

| | | |
|---|---|--|
| Collins Aerospace Plc <i>Actuation and Propeller Engineering</i> | Roxel (UK Rocket Motors) Ltd <i>Manufacture of solid fuel propulsion systems</i> | Precision Technologies International Ltd <i>Precision Machining – components</i> |
| Mackart Engineering Ltd <i>Additive Manufacturers (polymers/composites)</i> | Westley Group <i>Metals and Materials Supplier</i> | GKN Aerospace <i>Precision Machining – rockets and turbines</i> |
| The Motorsport Industry Association <i>Association</i> | Righton Blackburns <i>Metals and Materials Supplier</i> | MJ Sections Limited <i>Precision Machining – Sheet Fabrication</i> |
| Midlands Aerospace Alliance <i>Association</i> | Talisman Plastics <i>Metals and Materials Supplier</i> | PZA Systems Ltd <i>Satellite Telecommunications Consultancy</i> |
| SPACE Skills Alliance <i>Business services</i> | Titanium Industries UK Ltd <i>Metals and Materials Supplier</i> | ETL Systems Ltd <i>Satellite telecommunications equipment</i> |
| Geospatial Insight Ltd <i>Business Services using EO Data</i> | Meggitt (UK) Ltd <i>Precision Machining</i> | Global RadioData Communications Ltd <i>Satellite telecommunications equipment</i> |
| Energeo Ltd <i>Business Services using EO Data</i> | Nasmyth Coventry Ltd <i>Precision Machining</i> | Trakm8 Ltd <i>Satellite telecommunications equipment</i> |
| Erebus UK Ltd <i>Business Services using EO Data</i> | Momentum Engineering Ltd <i>Precision Machining</i> | IMR Technologies UK Ltd <i>Satellite telecommunications equipment</i> |
| Tekdata Ltd <i>Manufacture of cabling and interconnections</i> | A & M EDM Ltd <i>Precision Machining</i> | Mobell (Mobal) <i>Satellite telecommunications equipment</i> |
| Aras Software Ltd <i>Data processing and related activities</i> | Accura Engineering Ltd <i>Precision Machining</i> | Polar Electro <i>Satellite telecommunications equipment</i> |
| Mix Telematics Europe Ltd <i>Data processing and related activities</i> | Advanced Chemical Etching Limited <i>Precision Machining</i> | Spectra Group <i>Satellite telecommunications</i> |
| Amphenol Invotec Ltd <i>Printed Circuit Boards</i> | AE Aerospace Ltd <i>Precision Machining</i> | Speedcast <i>Satellite telecommunications</i> |
| TLM Laser Ltd <i>Laser Products</i> | ANT Industries <i>Precision Machining</i> | ACL Satellite Broadband <i>Satellite telecommunications</i> |
| InnoLas UK Ltd <i>Laser Products</i> | Arrowsmith Engineering Ltd <i>Precision Machining</i> | Borwell Ltd <i>Software Solutions</i> |
| Excel Precision (Birmingham) Ltd <i>Machine Tool Manufacturer</i> | Graves Aircraft Components Limited <i>Precision Machining</i> | Altair Engineering Ltd <i>Software Solutions</i> |
| Westley Engineering Ltd <i>Machine Tool Manufacturer</i> | JJ Churchill Ltd <i>Precision Machining</i> | AEON Engineering Ltd <i>Software Solutions</i> |
| Heller Machine Tools Ltd <i>Machine Tool Manufacturer</i> | Parker Precision Ltd <i>Precision Machining</i> | NewSPACE Systems Pty Ltd <i>Specialised design activities</i> |
| Yamazaki Mazak UK Ltd <i>Machine Tool Manufacturer</i> | Reginson Engineering Ltd <i>Precision Machining</i> | Teer Coatings Limited <i>Specialist coatings and equipment</i> |
| Cube Precision Engineering Ltd <i>Machine Tool Manufacturer</i> | Summit Engineering (Birmingham) Ltd <i>Precision Machining</i> | Indestructible Paint <i>Specialist paints and coatings</i> |
| Mettis Group Limited <i>Machining Forged Components</i> | Wyken Tools Ltd <i>Precision Machining</i> | Surface Finishing Engineering Limited <i>Turnkey Systems for Surface Treatment</i> |
| Mettis Aerospace Limited <i>Machining Forged Components</i> | Harris RCS <i>Precision Machining</i> | Technoset Ltd <i>Component cleaning and testing</i> |
| Mettis Aerospace (Holdings) Limited <i>Machining Forged Components</i> | Electro Discharge Ltd <i>Precision Machining</i> | Coventry University <i>University</i> |
| Bromford Industries Ltd <i>Precision Machining</i> | Columbia Precision Ltd <i>Precision Machining</i> | WUSAT University of Warwick <i>University</i> |
| Steatite Ltd <i>Batteries and communications</i> | Paragon Engineering & Logistics Ltd <i>Precision Machining</i> | MTC <i>University</i> |
| UTC Aerospace <i>Heat transfer and fluid management systems</i> | Burcas Ltd <i>Precision Machining</i> | University of Birmingham <i>University</i> |
| Air Liquide <i>Medical and industrial gases</i> | MGS Precision <i>Precision Machining</i> | University of Wolverhampton Science Park Ltd <i>University</i> |
| Buzzard Cameras Ltd <i>Imaging equipment for satellites/drones</i> | CCR (Wednesbury) Ltd <i>Precision Machining – Cold Rolled Rings</i> | University of Wolverhampton Science Park Ltd <i>University</i> |
| Novocomms Limited <i>Imaging equipment for satellites/drones</i> | Exactaform Cutting Tools Ltd <i>Precision Machining – Composites</i> | Energy Tubes Ltd <i>Manufacture of Welded Tube Products</i> |
| Staubli UK Ltd <i>Robotic systems</i> | D & S Engineering (Coventry) <i>Limited Precision Machining – Optics and Hydraulics</i> | |

LATENT POTENTIAL WITHIN UPSTREAM SPACE MANUFACTURE

The West Midlands is a globally significant sector for advanced manufacture, assembling a critical mass of internationally competitive businesses and high-tech SMEs operating across a range of market sectors, and in particular transport (aerospace, automotive, and rail), construction, food and drink, life sciences, and low carbon technology. Manufacturing represents 16% of regional output (£22.1 billion), with >300,000 jobs (10% regions work force) across more than 33,000 organisations¹².

Transport represents 36.4% of manufacturing output, with automotive dominating, accounting for ~£8 billion GVA. [MakeUK]. In particular, the Midlands hosts one of the world's major aerospace supply chain clusters, representing >20% of the UK aerospace industries (7% of Europe's, and 3% of the worlds) and >45,000 jobs (and >1200¹³ apprenticeships) across 300+ organisations (>160 in the West Midlands)^{[Data: Midlands Aerospace Alliance]¹⁴}, of whom half make sophisticated 'flying parts,' while the remainder make expert equipment for design, testing and manufacture, or supply specialist services. The West Midlands represents >10% of the sector turnover at ~£3.5 billion (~£1 billion GVA), with >90% exports [MAA].

Key clusters are those centred around:

- aircraft engine manufacture at Rolls-Royce in the East Midlands, and
- electro-mechanical systems for control of aircraft moving parts, located in the West Midlands and organised around Collins Aerospace, Rolls-Royce Control Systems, Meggitt, and Moog.

The aerospace sector draws many parallels with the space industry, working to strict and often bespoke specifications, requiring upfront investment with long lead times to a return, requiring extensive quality management testing and documentation, and operating within a complex regulatory and international trading environment. These capabilities and strengths provide a strong basis through which the West Midlands can capture share of the national and global space manufacturing market, and in particular the materials, components, and assemblies segment(s). These strengths/capabilities are not currently being leveraged resulting in lost opportunities.

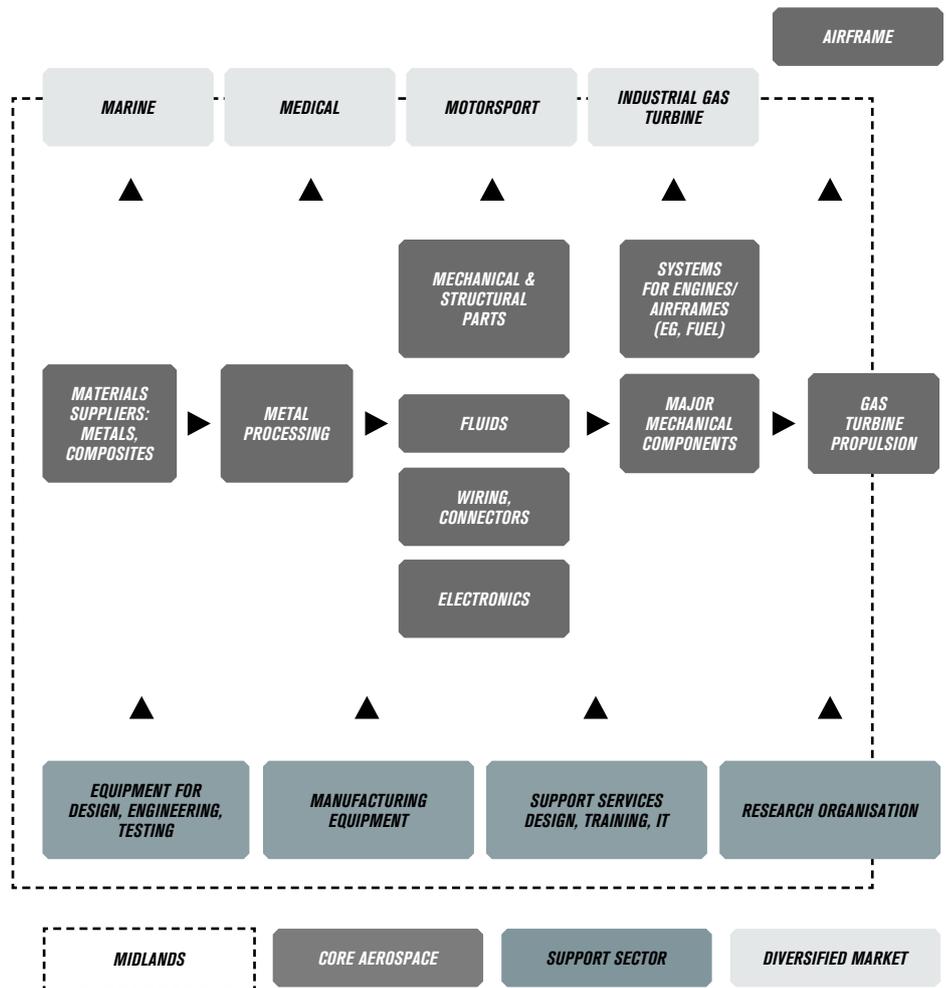


FIGURE 6. MIDLANDS AEROSPACE COMPETENCIES, AS DEFINED BY THE MIDLANDS AEROSPACE ALLIANCE

The West Midlands Aerospace Alliance identifies its regional competencies in figure 6.

The sector is supported by a **strong university base** (figure 7) offering courses, capabilities, and technologies with direct and/or latent upstream space potential:

- Ten of the 12 universities in the region offer 228 STEM courses relevant to the upstream space sector with 21,600 enrolments. Whilst ranking centrally within the UK for all STEM subjects, the West Midlands has the third highest enrolments for Engineering and Technology,
- The majority of universities have strong links to the aerospace sector and advanced manufacturing industry, and vast knowledge and capabilities in these fields,
- The larger universities (Birmingham, Warwick, Coventry) have an extensive history of working on upstream space research and close connections with key institutes such as the ESA, UK Space Agency etc.

¹² UK Manufacturing Facts 2020/21, Make UK

¹³ Assuming ~25% of total industry apprenticeships

¹⁴ www.midlandsaerospace.org.uk

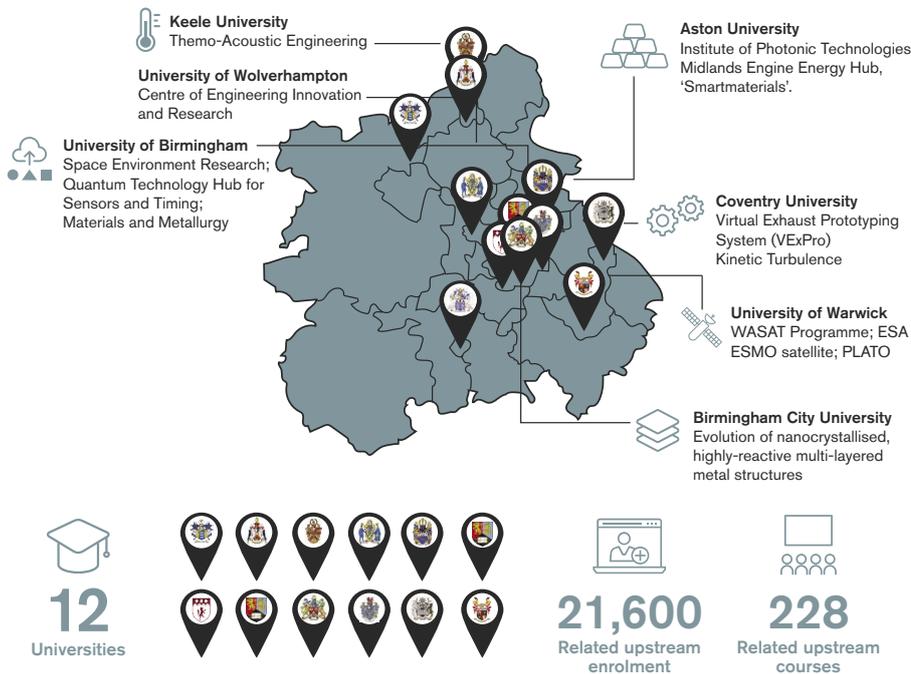


FIGURE 7. KEY UPSTREAM SPACE CAPABILITIES OF THE WEST MIDLANDS UNIVERSITIES (AUTHOR: ALICE PUGH)



THE WEST MIDLANDS IS A GLOBALLY SIGNIFICANT SECTOR FOR ADVANCED MANUFACTURE, ASSEMBLING A CRITICAL MASS OF INTERNATIONALLY COMPETITIVE BUSINESSES AND HIGH-TECH SMES OPERATING ACROSS A RANGE OF MARKET SECTORS, AND IN PARTICULAR TRANSPORT (AEROSPACE, AUTOMOTIVE, AND RAIL), CONSTRUCTION, FOOD AND DRINK, LIFE SCIENCES, AND LOW CARBON TECHNOLOGY.

EXAMPLES OF REGIONAL UPSTREAM RELATED PROJECTS

Keele:

- POLKA – hydrogen-fuelled combustion system (advanced simulation)

Birmingham:

- Lisa Pathfinder – first generation gravitational wave detector (phasemeter, optical bench)
- Photam – Equipment for 3D printing in space
- Impress – novel, higher-performance intermetallic alloys
- STE-QUEST – testing Einstein's equivalence principle using an atom interferometer and an atomic clock
- AMCASH – two-day technical interventions for SMEs (microscopy and materials characterisation, polymer science, computational modelling)
- Science2Industry – SME interventions to overcome product, process, or R&D-based technical challenges

Warwick:

- ESA ESMO Satellite – Moon Orbiter (electrical power supply system)
- WUSAT-3 – ongoing 4th year MEng project to develop a CubeSat

- PLATO – search for small, rocky exoplanets in the habitable zone of stars

Birmingham City:

- Evolution of nanocrystallised, highly-reactive multi-layered metal structures

Aston:

- Various projects spanning fibre gratings, optoelectronics, nonlinear photonics, fibre lasers, material processing, UV and femtosecond lasers, THz technology, and nano-photonics.

Coventry:

- Kinetic turbulence in magnetised plasmas
- VExPro – Virtual Exhaust Prototyping System

Wolverhampton:

- Various projects spanning advanced materials and composites, advanced manufacturing, structural mechanics, and vibro-acoustics



THE AEROSPACE SECTOR DRAWS MANY PARALLELS WITH THE SPACE INDUSTRY, WORKING TO STRICT AND OFTEN BESPOKE SPECIFICATIONS, REQUIRING UPFRONT INVESTMENT WITH LONG LEAD TIMES TO A RETURN, REQUIRING EXTENSIVE QUALITY MANAGEMENT TESTING AND DOCUMENTATION, AND OPERATING WITHIN A COMPLEX REGULATORY AND INTERNATIONAL TRADING ENVIRONMENT.

UPSTREAM SPACE MANUFACTURE SWOT ANALYSIS:

We have engaged with key stakeholders in the space manufacturing sector to understand our key strengths, weaknesses (and challenges), opportunities, and threats.

S

STRENGTHS

Key regional strengths for space manufacture include:

- A small network of supply chain companies who already provide materials and components to the space sector.
- An extensive manufacturing supply chain that could potentially 'pivot' into the space sector, with:
 - experience operating in the aerospace, automotive and rail sector(s) to stringent specifications and quality management controls, and complex regulatory and trading environment,
 - strong global exports and reputation,
 - existing offerings and capabilities directly suited to space manufacture (high performance materials, precision, advanced and smart manufacture etc).
- Active regional clustering within the manufacturing sector, including the Midlands aerospace alliance, Made in the Midlands, Make UK (Midlands) etc.
- High profile manufacturing research and innovation centres, including the Manufacturing Technology Centre (MTC); Warwick Manufacturing Group (WMG); and the High Temperature Research Centre (HTRC).

- Strong academic research capabilities.
- Strong regional business support capabilities:
 - IP management (essential for space due to the need for transparency),
 - Established network of West Midlands growth hubs – GBS, CW, Stoke & Staffs, BC, Marches, and Worcestershire.
- Strong manufacturing skills base and existing skills support:
 - Skills Factory – employer-led education and training designed to address shortfalls in key technical skills (eg, advanced manufacturing).
 - Elite Centre for Manufacturing Skills – demand-led apprenticeships and short-course training provision.
 - Advanced Manufacturing Training Centre (AMTC) – provision of advanced apprenticeship programmes in the field of advanced manufacturing.

These regional strengths are complemented by strong national drivers for OEM's (aerospace, defence, and space) to source more from within the UK.

W

WEAKNESSES

Key regional weakness and challenges to growth of space manufacture include:

- Lack of big company(s) or regional space assets within the West Midlands for supply chains and companies to cluster around and take a lead (as they do for the aerospace sector).
- Many manufacturing companies within the West Midlands reside within the 'long tail' (lower value) part of the value chain.
- Limited available skilled resource trained for space manufacture, and in particular 'Shopfloor' technicians/engineers for manufacture and assembly (driven in part by competition with other industries, such as automotive, aerospace etc).
- Lack of training programmes that specifically address this skill gap for space manufacture (or able to meet anticipated future demand).
- Many companies have limited awareness or understanding of:
 - What the space sector is, how it operates, who the key stakeholders are, how to get involved etc.
 - The relevance of their products and services to space.
 - Regulatory, certification, accreditation, or international trading (licensing) requirements and how to comply with these.
 - Existing and future programmes, opportunities, requirements, and challenges – Limited public awareness of space (2.0) and what the UK is doing in this sector.
- Poor engagement and transparency from OEMs/primes/subsystem manufacturers:
 - Value chains are 'closed' to those already involved and difficult to enter (due in part to the time, cost, and risk of on-boarding new suppliers) – suppliers find it difficult to raise their profile and 'get a foot in the door'.
- This creates barriers to early engagement of suppliers at the design stage (to get their materials and components designed into the specification), an essential requirement to becoming an eventual supplier.
- Poor awareness of academic specialisms, capabilities/facilities, and IP/technology leading to poor academic and industrial collaboration.
- Lack of specific business support within the West Midlands to facilitate access to or growth within space markets.
- Limited access to finance for: 1) early-stage research; and/or 2) upfront development costs; and specialist support to help with bids. Time to market is long (years). Required upfront investment with a long period to reward is a barrier for many companies.
- Traditionally, the space sector involves low production volumes, bespoke user requirements, with strict quality testing / documentation requirements. This may deter many suppliers from participating in the value-chain, especially suppliers who are geared to manufacture for high-volume markets.

O

OPPORTUNITIES

Key regional opportunities within the space manufacturing sector include:

- Transition towards low-cost volumetric production of launch vehicles and satellites utilising advanced manufacturing processes and more standardised components.
- Adoption of Industry 4.0 technologies for enhanced efficiencies, productivity, and quality management.
- Global recognition and leadership – rapid growth of both domestic and international space manufacturing markets through leveraging or pivoting existing strengths.

T

THREATS

Key threats to our regional space manufacturing sector include:

- Competition from domestic and global competitors seeking to achieve recognised leadership within our target niches.
- Competition from lower-wage economies who are increasingly able to meet quality, performance, and delivery requirements.
- Potential conflict / competition with other space clusters who seek growth within our target niches.

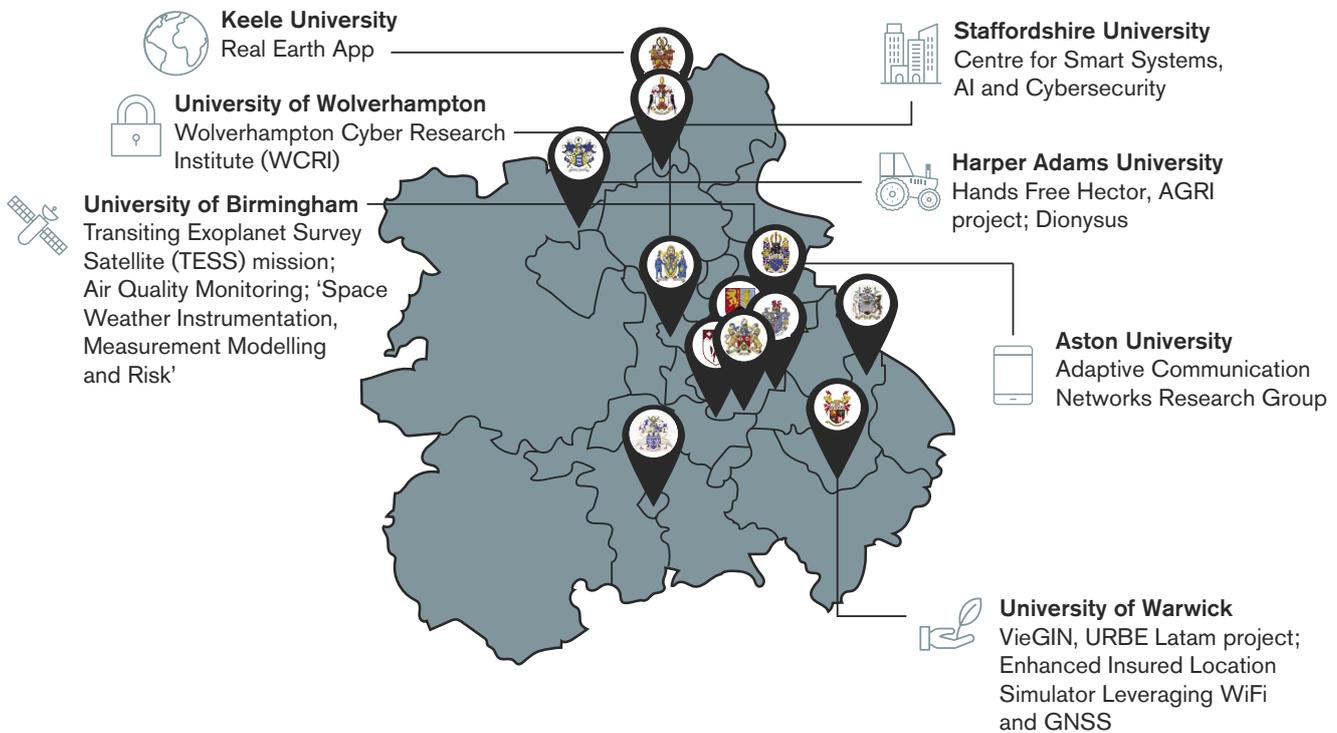


FIGURE 8. KEY DOWNSTREAM SPACE CAPABILITIES OF THE WEST MIDLANDS UNIVERSITIES (AUTHOR: ALICE PUGH)

LATENT POTENTIAL WITHIN DOWNSTREAM SPACE APPLICATIONS AND END-USER SECTORS

Whilst the West Midlands is home to a handful of downstream space application businesses, the region combines latent space application capabilities with important end-user sectors for space data/services, creating a powerful value-chain ecosystem for innovation, business growth, and end-user benefit. The region hosts more than 14,000¹⁵ Technology and Digital businesses (5% UK total), employing over 70,000 people, representing the UK's largest tech and digital sector outside of London. Many companies sit within existing clusters, such as Innovation Birmingham, the area of Digbeth and Leamington Spa (gaming technologies), Birmingham and Solihull (Data driven healthcare and technologies), and Malvern (cyber security). Over the period 2015–2025 the GVA from the West Midlands Tech and Digital sector is forecast to increase from £5.7 billion to more than £7 billion.

The **regional universities** (figure 8) demonstrate both existing and latent capabilities for downstream space applications. Key areas of strength relevant to space applications include: sensors and measurement (eg, Quantum Sensors and Timing – Birmingham), machine learning and artificial intelligence (eg, Warwick's Centre for applied artificial intelligence, and the Artificial Intelligence and Cybersecurity centre in Staffordshire), imagine analysis and visualisation, augmented and virtual reality, cloud computing (eg, Centre for Data Science – Coventry), big data and data analytics (eg, Warwick Data Science Institute, Data Analytics and AI Group – Birmingham City), cyber-security (eg, Centre for Cyber Security – Wolverhampton), Internet of Things (Emerging Device Technology Group – Birmingham), 5G and wireless technologies (eg, Adaptive Communications Networks Research Group – Aston), robotics and automation (Robotics – Birmingham), and blockchain.

Important end-user sectors of regional strength for space applications include transport (automotive and rail), modern services, health (and life sciences), and agriculture (see case studies 1–5).

¹⁵ 'Tech and Digital – Deep Dive Report' (2017), Regional Observatory & Birmingham City University

EXAMPLES OF REGIONAL DOWNSTREAM RELATED PROJECTS AND ACTIVITIES

Keele:

- Real Earth App – utilising satellite images to demonstrate earth ecosystems.

Birmingham:

- Launching Air Quality Monitoring into the 21st Century
- Space Weather Instrumentation, Measurement, Modelling and Risk
- Role of forest disturbances in the global biomass turnover and carbon sinks

Warwick:

- The Vegetable Genetic Improvement Network (VeGIN)
- URBE Latam project – protection from natural hazards
- Enhanced Assured Location Simulator Leveraging WiFi and GNSS Sensor Fusion'

Staffordshire:

- Centre for Smart Systems, AI and Cybersecurity

Harper Adams:

- Farming by Satellite Prize (2013, 2014)
- Hands Free Hectare – autonomous farming
- Dionysus – autonomous vineyard robot
- AGRI project – SME innovation support
- Synergy – innovative technologies to operate connected autonomous cars

Aston:

- Adaptive Communications Networks Research Group, including 4G/5G Mobile Cellular Systems and Technologies, and IoT Systems and Technologies

Wolverhampton:

- Wolverhampton Cyber research institute (WCRI)

Worcester:

- River science and unmanned aerial vehicle surveys



DOWNSTREAM SPACE APPLICATIONS SWOT ANALYSIS:

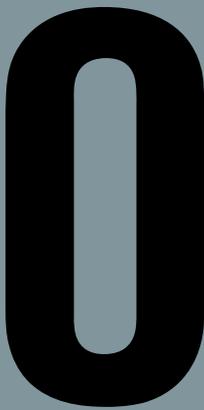
We have engaged with key stakeholders across the downstream space application sector to understand our regional strengths, weaknesses, opportunities, and threats.

STRENGTHS**Key regional strengths for space applications include:**

- UK's largest technology and digital sector outside London, representing 14,000+ businesses mobilised across existing industry clusters, such as Innovation Birmingham (tech and digital), Warwickshire 'Silicon Spa' (gaming technologies), Birmingham and Solihull (Data-driven healthcare and technologies), and Malvern (cyber security).
- Strong academic and research capabilities within key areas of enabling science and technology relevant to downstream space applications (from sensors to value-added data services).
- Existing government and regional authority engagement and capabilities:
 - West Midlands Office for data analytics (supporting policy and decision making).
 - West Midlands Police seen as national leaders in the use of data analytics, cloud computing, and digital transformation.
- High Potential Opportunity (HPO) schemes led by Department for International Trade to boost foreign direct investment (FDI) within areas relevant to downstream space applications.
- Strong regional value-chains for sectors relevant to downstream space applications, spanning customer/market demand through to solution provision, manufacturing and service supply-chains, business support etc.
- Established network of West Midlands growth hubs and broader business support services.
- West Midlands (multi-city) 5G testbed and future mobility zone with a broad portfolio of flagship applications and networks, including connected and autonomous vehicles, medical and emergency services, construction, and industry 4.0; providing an ideal ecosystem for the development, take-up, and testing of applications utilising space data and services.

WEAKNESSES**Key regional weakness and challenges to the growth of space applications include:**

- Limited existing regional industry for space applications.
- End-user awareness and understanding of space capabilities, applications, and benefits (art of the possible), creating barriers to user engagement and adoption.
- Access to and cost of space data and services, compounded by the lack of sovereign space capabilities.
- Concerns surrounding the privacy and (cyber) security of space data and services.
- Existing markets are small and niche, creating barriers to investment and growth. This is compounded by inferior public and private finance for space applications compared to competitors in Europe and the US.
- Whilst the region produces employees and graduates with the required skills for downstream space applications, these are increasingly being poached by companies outside the region (such as London) that can offer higher salaries (combined with remote working practices), creating a skills gap.
- Many existing projects are research driven and do not lead to a real commercial demand.



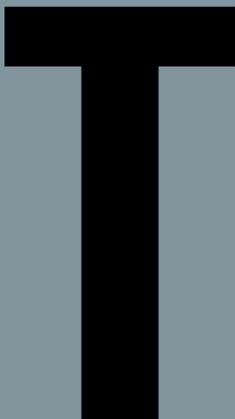
OPPORTUNITIES

Key regional opportunities within the space applications sector include:

- Regional strengths within key end-user sectors with high growth potential for space applications:
 - Automotive ('Connected and Autonomous Vehicles' and 'Road Traffic Management').
 - Rail ('Connectivity', 'Rail Traffic Management', and 'Infrastructure and Hazard Monitoring').
 - Modern Services ('Insurance Services' and 'Property Technology').
 - Health and Life Sciences (from '(Tele-/e-) healthcare services within remote locations', and 'Connectivity and navigation of emergency services', to 'Healthcare modelling and prediction' and 'Disease surveillance and control').
 - Agriculture (from 'Precision Farming' and 'Agricultural Logistics', to 'Connected and Autonomous Farm Machinery').

(see case studies 1–5)

- High potential for new business within downstream space application sectors, facilitated by established technology and digital industry base, combined within key research strengths within areas of enabling science and technology, and a strong innovation ecosystem.



THREATS

Key threats to our regional space applications sector include:

- Competition from outside the UK. We are still playing catch-up with European competitors who have access to better finance and assets.
- Cost of existing (space) data and services create barriers to the viability of many downstream applications.
- Lack of sovereign capabilities create a vulnerability to the access of data and services.
- Resilience of space assets to malicious attack leading to loss of essential space data.
- The capabilities, capacity, and/or reliability of space data and services (connectivity, PNT, EO), and/or sector skill base, does not grow with downstream needs and demand.

CASE STUDY 1

AUTOMOTIVE

AUTOMOTIVE SPACE APPLICATIONS

'Connected and autonomous vehicles' and 'Road Traffic Management' represent key future markets for satellite applications, combining satellite communications, PNT services, and earth observation, working in synergy with terrestrial communication (5G) infrastructure.

Applications¹⁶ for 'Connected and Autonomous Vehicles' include:

- *Vehicle-to-Vehicle (V2V) communications* – either directly or via a central control centre. V2V information can be integrated/fused with sensor, weather, or other data, and primarily acts to improve safety, reduce the risk of accidents, and improve traffic management.
- *Navigation and location-based services* – support autonomous vehicles and assisted driving, usage-based insurance schemes, automated road pricing and congestion charging, automated eCall distress signals, intelligent speed adaptation etc.
- *Autonomous vehicle operation* – providing the necessary connectivity (assurance), data (PNT and EO), and infrastructure to enabling autonomous operation of vehicles, for more efficient (reduced congestion), cost-effective, and inclusive transportation of goods and people.

Applications¹⁷ for 'Road Traffic Management' include:

- *Emissions / air quality monitoring* – especially for management of compliance with air quality limits. Here satellites enable local authorities to better focus their testing resources and manage traffic flow.
- *Asset surveillance and monitoring* – include potholes and other hazards, floods and landslides, damage to infrastructure etc. Satellites enable improved detection of problems, coordination of resources, and monitoring of progression/resolution.
- *Roadside communications* – including traffic management devices or systems, especially in remote locations.
- *Location-based services for road charging* – including road tolls and congestion charges, smart parking, remote driver monitoring (insurance, corporate responsibility) etc.
- *Emergency Services* – supporting navigation, secured connectivity, and management of emergency services, especially within remote locations.

THE WEST MIDLANDS AUTOMOTIVE SECTOR

The West Midlands is the UK's hub for the automotive industry¹⁸. The region:

- represents ~1/3 of UK annual automotive production (~600,000 vehicles) leveraging a strong integrated supply-chain of >430 businesses, representing ~1/5 of UK automotive companies.
- has 35 OEM brands (including Jaguar Land Rover, Aston Martin Lagonda, BMW, Tata Motors, Geeley Auto Group, London Electric Vehicle Company, and Changan), a majority of whom have their UK operations headquartered in the region, and >20 vehicle manufacturing sites.



- employs >46,000 people (30% UK sector total) and generates ~£3.2 billion GVA.
- key strengths in the emerging market of connected & autonomous vehicles and is set to become the UK's first (multi-city) Future Mobility Zone (and testbed for 5G), enabling large-scale testing.
- mobilises high profile research and innovation centres, including: *National Automotive Innovation Centre, Mira Technology Institute, Centre for Connected and Autonomous Automotive Research, National Transport Design Centre (NTDC), UK Mobility Data Institute, Manufacturing Technology Centre, and Warwick Manufacturing Group.*

The West Midlands thus provides a fertile ground for growth of space application businesses addressing the automotive sector.

| SWOT Analysis – Automotive Space Applications | |
|---|---|
| <p>STRENGTHS</p> <ul style="list-style-type: none"> ■ 35 automotive OEMs within the region ■ Connected supply-chain of > 1,300 companies ■ High profile automotive research and innovation centres ■ Significant scientific, technological, and innovation strengths in space related automotive applications ■ Key assets including the UK's first multi-city future mobility zone and 5G test bed | <p>WEAKNESSES</p> <ul style="list-style-type: none"> ■ Reliability of connectivity or access to space data (eg, impact of weather or terrain etc) ■ Capacity of existing space assets and cost of accessing data vs scale of demand and affordability ■ Cost of capital (antenna's) for space connectivity ■ Cost and complexity of integration with terrestrial infrastructure. |
| <p>OPPORTUNITIES</p> <ul style="list-style-type: none"> ■ Broad scope of (global) applications for which terrestrial infrastructure is unable to offer a complete solution ■ Drive within government and/or public authorities to move away from terrestrial infrastructure investments, better monitor traffic emissions, and transition towards smarter traffic management ■ Growth in automotive related IoT devices necessitating improved connectivity ■ Early-stage engagement to shape a future direction reliant upon satellites | <p>THREATS</p> <ul style="list-style-type: none"> ■ Alternative terrestrial solutions eventually offer a complete solution with improved performance, reliability and cost ■ Negative perception of or trust in satellite-based services by either the automotive sector or customers ■ Poor alignment/integration of satellite-based services with either automotive application needs or terrestrial infrastructure ■ Automotive OEMs are unable to agree upon standards |

¹⁶ Routes to market report. 06 – Satellite technologies for broadband to vehicles, Satellite Applications Catapult

¹⁷ Routes to market report. 27 – Satellite technologies for road traffic management, Satellite Applications Catapult

¹⁸ Welcome to the West Midlands: Automotive, West Midlands Growth Company

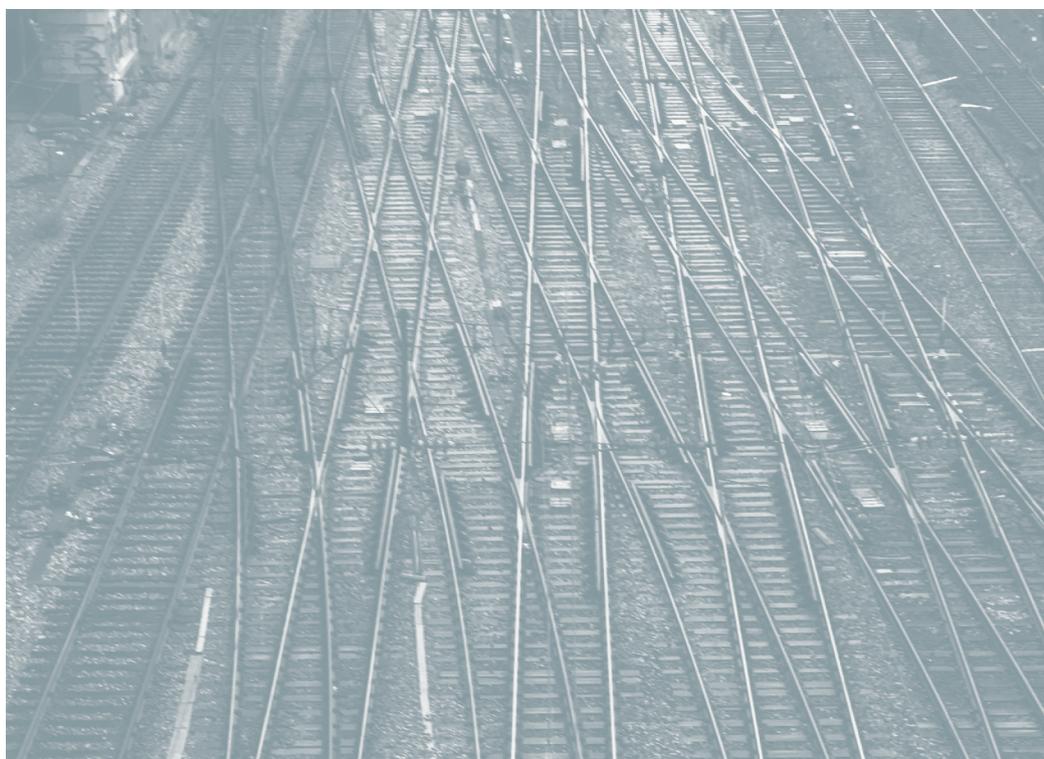
CASE STUDY 2

RAIL

RAIL¹⁹ SPACE APPLICATIONS

Digital Railway (UK) and European Rail Traffic Management (ERTMS) represents major sector drivers. Key space application areas supporting this vision include 'Broadband to Trains (connectivity)²⁰', 'Rail Traffic Management'²¹, and 'Infrastructure and Hazard Monitoring'.

- **Broadband to Trains (connectivity):** connectivity is important from both a passenger perspective and to enabling future digital rail services and management. Whilst rail operators are investing heavily in terrestrial-based connectivity services, such as WiFi, these are unable to provide a complete solution, especially within remote locations. Such lack of ICT infrastructure represents a major barrier to the advancement of digital rail. Satellite connectivity thus represents an important part of the solution, providing broader coverage, connectivity assurance/ resilience (back-up), and enhanced transmission speeds.
- **Rail Traffic Management:** utilising satellite PNT and connectivity capabilities to improve the robustness of digital signalling and train control systems, whilst reducing the need for trackside equipment
- **Infrastructure and Hazard Monitoring:** utilising PNT and earth observation capabilities (complementing existing terrestrial capabilities) to monitor infrastructure assets, and to detect hazards or risks on or alongside the track, such as landslides, floods, fallen objects, change of land use (adjacent to the track) etc. It is anticipated that satellite capabilities will help to maximise resource efficiencies (and reduce rail disruption) by identifying areas of concern for further investigation by rail maintenance teams.



THE WEST MIDLANDS RAIL SECTOR

The West Midlands lies at the heart of the UK rail infrastructure, key to the mobility of both people and freight. The region²²:

- accounts for ~£2 billion GVA and >40,000 jobs (~32% railway system, 43% rail supply sector, 3% station retailers and supply chain, and 22% induced impacts.
- whilst not hosting a rail OEM, the regions rail supply chains comprise key expertise in rolling stock design, development and manufacture, infrastructure and consultancy services, systems and signalling, and light and very light rail technologies.
- hosts key rail companies including construction specialists and consultancies (AECOM, TDA), international advisors

(Arup, WSP, Atkins), large rail engineering and technology firms (Alstom, Wabtec), and numerous high-tech SMEs.

- is home to numerous major rail investment projects, such as HS2 (~£5.1 billion) and the Midlands Metro Extension, providing numerous innovation and procurement opportunities.
- Mobilises high profile research and innovation centres, including: *Birmingham Centre for Rail Research and Education*, *UK Rail Research and Innovation Network*, *Centre of Excellence in Digital Systems*, *Quinton Rail Technology Centre (UK's leading facility for rail testing, trialling and product development)*, and *Very Light Rail Innovation Centre*

However, growth in population, freight, and demand for rail services, combined with an aging infrastructure, raises major challenges for our rail system. Digital rail seeks to apply digital technologies to reduce cost and unlock capacity, performance, and safety benefits. Space applications have the potential to make significant contributions to the digital rail strategy, ranging from digital signalling and traffic management, through to communications and infrastructure monitoring.

Home to many of the UKs leading centres for digital rail, the West Midlands is ideally positioned to capitalise and benefit from emerging space capabilities for the rail sector.

| SWOT Analysis – Rail Space Applications | |
|--|--|
| <p>STRENGTHS</p> <ul style="list-style-type: none"> ■ Major rail network operators located in the West Midlands (Network Rail and HS2) ■ High-profile research and innovation centres focused on rail ■ Specialist scientific, technological, and innovation strengths in digital rail solutions ■ West Midlands future mobility zone and 5G test bed to support demonstration projects | <p>WEAKNESSES</p> <ul style="list-style-type: none"> ■ Reliability of connectivity (eg, impact of weather or terrain etc). ■ Cost of access to data ■ Performance – ability of satellite based-data and services to meet rail application needs. ■ Integration of existing rail infrastructure. ■ Early stage. Space is yet to gain significant recognition or a coherent strategy for rail. |
| <p>OPPORTUNITIES</p> <ul style="list-style-type: none"> ■ Strong sector drivers and on-going activities towards digital rail solutions (connectivity, rail traffic management etc) ■ Need for more efficient and effective infrastructure and hazard monitoring, especially away from trackside) ■ Large scale investment / transformation projects providing immediate innovation and procurement opportunities | <p>THREATS</p> <ul style="list-style-type: none"> ■ Satellite solutions are unable to fully satisfy the unmet rail need ■ Terrestrial solutions improve to the extent that they meet the need and demand ■ Competition with rail solutions offered by non-UK suppliers ■ Negative perception or trust in satellite technologies by rail operators ■ Difficulty in achieving market penetration due to existing investments |

¹⁹ The Economic Impact Of UK Rail 2018

²⁰ Routes to market report. 05 – Satellite technologies for broadband to trains, Satellite Applications Catapult

²¹ Routes to market report. 26 – Satellite technologies for rail traffic management, Satellite Applications Catapult

²² West Midlands Combined Authority Rail Sector Action Plan (2019)

CASE STUDY 3

MODERN SERVICES

MODERN SERVICES SPACE APPLICATIONS

It is anticipated that initial space applications for modern professional services (within the West Midlands) will include:

Insurance Services: space applications for the insurance sector help to both better model and monitor risk (and customer compliance with insurance policies) and assess the impact of risks should they occur²³. Here, improved modelling and assessment not only enables more competitive insurance products, but also enables new business models to be considered (such as parametric insurance) and helps to address insurance fraud. Key insurance markets of interest include motor/transport, property and infrastructure, maritime, and agriculture.

Property Technology (or PropTech):

encompasses the application of information technology and platform economics to real estate markets, including cloud computing, artificial intelligence, big-data analytics, IoT etc. Important areas of application²⁴ include:

- Shared economy – shared use of services, goods, property, spaces or capital.
- Investment management – use of data to derive and distribute intelligence on the real estate market and properties.
- Property Insurance – management of risk and uncertainty (weather, operation and maintenance, security vulnerabilities, construction lifecycle etc.
- Urban planning – smart planning of towns and cities of the future, considering pollution, sustainability etc.

- Construction technology (ConTech) – used to innovate the way in which companies design, engineer and build structures.
- Smart Buildings – including security, eco-friendliness and building management.

Satellite-based services and devices have the potential to transform the Protech sector, enabling connectivity, data, insights, and services beyond those possible with terrestrial systems, such as connectivity to remote buildings and construction sites, routing and positioning systems for the construction industry, environment, pollution, and weather monitoring, analysis of building use, and risk analysis, to name but a few.

THE WEST MIDLANDS MODERN SERVICES SECTOR

The West Midlands is the largest professional service sector outside London, and the only other region will a 'full-service offering'.

The region:

- Has a total professional services GVA that is forecast to reach £50 billion by 2030 (4.72% CAGR)²⁵, accounting for a third of total regional output.
- Is home to ~48,000 companies employing 400,000 people (representing 1 in 5 jobs).
- Hosts many leading companies, including the new HSBC UK headquarters, the largest regional offices for each of the 'Big Four' (PwC, EY, Deloitte and KPMG), and the EU headquarters of the international law firm Gowling WLG.
- Hosts high-profile research centres in the field, such as the Advanced Services Group at Aston University.
- Has strengths in key enabling technologies, including machine learning and AI, cloud computing, cyber security, gaming technology, augmented/virtual reality etc.



The professional services sector is conservative in nature focusing on service delivery through proven methods. Innovation is typically driven through start-ups/spin-outs that are either quickly acquired by, or enter partnerships with, larger companies once proven.

The 'full-service offering' nature of the West Midlands professional services sector, combined with regional strengths in key enabling technologies, provides a unique opportunity for the West Midlands to achieve leadership in this field of space applications.

| SWOT Analysis – Modern Services Space Applications | |
|--|--|
| <p>STRENGTHS</p> <ul style="list-style-type: none"> ■ Largest professional services sector outside London (with a strong frontline workforce) ■ Internationally leading research centres in the field of professional service, including key enabling technologies ■ Home to many of the largest professional service sector companies and supporting a dynamic network of innovative SMEs ■ Key infrastructure assets include multi-city 5G test bed (demonstration projects) | <p>WEAKNESSES</p> <ul style="list-style-type: none"> ■ Conservative nature that is resistant to change / innovation unless proven. ■ Innovation functions are frequently dispersed across the UK (and even globally). ■ Companies have limited capital for innovation. There are limited drivers for change unless driven by the customers or new entrants. |
| <p>OPPORTUNITIES</p> <ul style="list-style-type: none"> ■ Broad range of opportunities with high growth potential. Key existing applications within insurance and property technology. ■ Competition combined with climate change is driving new business models reliant upon better modelling and analytics. ■ Proliferation of digital technologies associated with service sector is driving the need for enhanced connectivity. ■ Strong professional service sector and market within the region, creating an ideal eco-system for innovation and start-ups. | <p>THREATS</p> <ul style="list-style-type: none"> ■ Risk of businesses moving from the region (services can deliver to the region from any location). Need to establish incentives / dependencies that encourage businesses to stay. ■ Threat from non-UK suppliers (especially world-leading risk modelling companies located in the US). ■ Ability of competitors to quickly copy new service innovations. ■ Emerging technologies with the potential for market disruption (eg, AI). |

²³ Routes to market report. 18 – Satellite technologies for insurance services, Satellite Applications Catapult

²⁴ PropTech, ESA Business Applications

²⁵ West Midlands Industrial Strategy

CASE STUDY 4

HEALTH AND LIFE SCIENCES

HEALTH AND LIFE SCIENCE SPACE APPLICATIONS

Space has an important role to play in healthcare. It supports the delivery of healthcare services within remote locations and areas affected by natural disasters, patient monitoring (within the home) and assisted living, disease surveillance and control activities, navigation of emergency services, healthcare modelling and prediction (public health management), and health infrastructure and logistics, to name but a few applications.

THE WEST MIDLANDS HEALTH AND LIFE SCIENCE SECTOR

The West Midlands is nationally leading in key areas of health and life sciences, including devices, diagnostics, healthcare data sciences, and clinical testing. The region:

- has 400+ life science businesses with >11,000 employees, generating >£4 billion turnover²⁶.
- Nationally recognised strengths in healthcare data informatics and systems, digitisation of healthcare services, genomics medicine and diagnostics, medical technologies evaluation, and clinical trials.
- Clinical and academic centres of excellence including the Queen Elizabeth Hospital site, Birmingham Institute for Translational Medicine.
- Leads the Health Data Research UK Midlands Site, the Midlands and Wales Advanced Therapies Treatment Centre, and has four regional NHS England Global Digital Exemplars.

SWOT Analysis – Health and Life Science Space Applications

STRENGTHS

- Strong regional life science sector with 400+ businesses.
- Recognised national strengths areas relevant to space applications, including in healthcare data sciences and digitisation of healthcare services.
- Clinical and academic centres of excellence, including four regional NHS England Global Digital Exemplars.
- Strong innovation ecosystem, including translational partnerships and facilities.
- Unique infrastructure including multi-city 5G test bed (demonstration projects).

WEAKNESSES

- Reliability of connectivity and/or space-based services (due to weather or terrain).
- Cost of capital (antenna's) for space connectivity (affordability for implementation by healthcare providers).
- Complexity for the integration of services within healthcare systems, enabling access to patient data and ensuring compliance with privacy and security requirements).

OPPORTUNITIES

- Delivery tele-/e- healthcare services within remote locations – improving healthcare efficiencies, improving patient outcomes and convenience, and supporting assisted / independent living.
- Connectivity and navigation of emergency services.
- Healthcare modelling and prediction (public health management).
- Disease surveillance and control activities.
- Delivery of healthcare services within areas affected by natural disaster.

THREATS

- Risk averse nature of the healthcare sector deters adoption and use.
- Competition from global competitors.
- Rapid pace of healthcare innovation has the potential to disrupt the market.

- Strong innovation ecosystem, including translational partnerships and facilities, science parks, and business support services.
- Unique infrastructure assets, including multi-city 5G test bed supporting demonstration / delivery of healthcare projects relevant to space applications.

Building on our strong regional life sciences industry, strengths in health data sciences, digital healthcare services, translational medicine, and unique multi-city 5G infrastructure, the West Midlands is well positioned to capitalise on emerging space capabilities for healthcare.

²⁶ Welcome to the West Midlands: MedTech, West Midlands Growth Company

CASE STUDY 5

AGRICULTURE

AGRICULTURE SPACE APPLICATIONS

Within agriculture satellite applications contribute to sustainable intensification and food security in arable and livestock farming²⁷. Here connectivity, PNT, and EO services combine to improve detection and monitoring of crop productivity, enable early detection and monitoring of disease, enhance farm system management, and enable monitoring of farming practices at a regional and national level. This includes precision agriculture (variable application of technology and resources based on specific needs to improve yield and reduce environmental impact), agri-logistics (monitoring and management of farm assets, geo-traceability etc), and connected and autonomous farm machinery (tractor guidance, automatic steering etc).

The benefits of space applications within agriculture are primarily realised by large farms ('00's of hectares). Whilst UK farms are typically smaller (representing a relatively small domestic market), they represent an ideal market for developing and demonstrating technologies/ services that may then be sold to larger farms in the EU and US (existing markets) and developing nations (future markets).

THE WEST MIDLANDS AGRICULTURE SECTOR

The region has a total output of ~£2.3 billion (~8.5% UK output), across ~14,287 farms, employing 43,342 people²⁸. The largest contributors of value include milk (£409 million), poultry (£313 million), wheat (£186 million) and fruit (£168 million), collectively contributing ~46% of output.

Whilst the average farm size is small (~66ha, somewhat below the UK average of 86ha), large farms (>100 ha) represented >19%

| SWOT Analysis – Agriculture Space Applications | |
|--|---|
| <p>STRENGTHS</p> <ul style="list-style-type: none"> ■ Strong agricultural base of ~14,287 farms (>19% having >100ha). ■ Recognised by the Department for International Trade as a high potential opportunity for agritech investment. ■ UK leading research for agritech and precision farming (Harper-Adams University) with direct experience in satellite-based data and services. ■ Numerous leading agritech and food / beverage manufacturing businesses. | <p>WEAKNESSES</p> <ul style="list-style-type: none"> ■ Cost of equipment creates a barrier (deterrent) to adoption (long period to ROI) ■ Satellite data and services only have significant benefit for large farms. Since the majority of UK (regional) farms are small, this results in a small internal market. ■ The requirement for education and training to adopt satellite based-data and services creates a barrier to adoption. ■ Agricultural research is fragmented and lacks big data and analytical expertise. |
| <p>OPPORTUNITIES</p> <ul style="list-style-type: none"> ■ Broad range of opportunities for space applications, spanning precision farming through to agri-tech/logistics. ■ Emerging markets in Europe and US (for immediate exploitation), with potential high-growth markets in developing nations. ■ Enhanced regional farming productivity and sustainability whilst reducing costs. | <p>THREATS</p> <ul style="list-style-type: none"> ■ Negative perception by farmers who remain unconvinced by the benefits of the business case. ■ UK market is insufficient to support the growth of space application companies. ■ Competition from non-UK suppliers in the US and EU that have more established markets. |

(2,715) of total and accounted for >65% of farmed land, providing a significant regional market for satellite-based solutions.

In addition to a strong agricultural sector, the region also:

- includes one of the UKs leading universities in agritech research (Harper-Adams), pioneering schemes such as the world's first Hands-Free Hectare project. The university hosts the National Centre for Precision Farming, and the Midlands Agri-Tech Innovation Hub, and has extensive direct experience in the use of satellite-based technology, data, and

services for agriculture.

- is recognised as a high potential opportunity for agritech investments by the Department for International Trade.
- Hosts numerous leading agritech companies (including Kuhn, Saputo, UPL, Avara, and Earth Rover), and over 300 food and 100 beverage manufacturers.

Combining expertise in agritech and precision farming, with a strong agricultural base and industry, the West Midlands demonstrates significant potential for driving innovation and growth within space applications for agriculture.

²⁷ Routes to market report. 01 – Satellite technologies for agriculture & food security, Satellite Applications Catapult

²⁸ Defra Statistics: Agricultural Facts, England Regional Profiles, February 2020

CONCLUSION

Within the West Midlands we have identified latent space potential within:

- the upstream sector for space manufacture (materials, components, and assemblies), leveraging our nationally leading aerospace (automotive and rail) supply-chains,
- downstream space application sectors, leveraging our specialisms in computer and data sciences, and
- end-user sectors for future mobility (automotive, and rail), modern services (business, professional, and financial service sectors), data driven health and life sciences, and agriculture.

UPSTREAM SECTOR – SPACE MANUFACTURING SUPPLY CHAINS

Space manufacture is dominated by a handful of companies. To enter the market suppliers must engage with prime/OEM (or sub-system) manufacturers at an early stage in the design cycle (so that their offerings may be incorporated into the (sub-) system specifications) and demonstrate compliance with customer quality management systems and processes, a costly exercise for both the OEM (and sub-system) manufacturer and supplier. Due to the effort, cost, and risk of on-boarding new suppliers, manufacturers naturally gravitate towards their established suppliers, creating a barrier to entry and the perception of a closed supply chain.

On the other hand, whilst many suppliers have the capability to participate within the space manufacturing supply chain, they are deterred from doing so due to:

- limited awareness of what the space sector is, how it operates, who the key stakeholders are, or how to get involved,
- limited understanding of the relevance of their products and services to the space sector,
- low production volumes and bespoke nature, combined with strict quality management systems,
- limited availability of human resources skilled in the art of space manufacture,
- lack of training programmes that specifically address these skill gaps,
- poor awareness of academic specialisms and capabilities, leading to under-developed academic and industrial collaboration.

Furthermore, the region lacks large space primes/OEMs or regional space assets/facilities within the West Midlands for supply-chains and companies to cluster around and take a lead from (as they do for the aerospace sector).

A unique strength of the West-Midlands is our manufacturing sector (aerospace, automotive, and rail). Within the region we have strong supply-chains mobilised around key capabilities (such as engines, electromechanical systems etc). These industries (and in-particular aerospace) share close similarities with space and thus demonstrate strong latent space potential.

To facilitate entry and growth of our manufacturing supply-chains within existing and future space value chains we have identified 3 'must-win' battles:

- 1) early engagement and collaboration with space primes/OEMs and sub-system manufacturers – *to unlock supply-chain opportunities,*
- 2) recognition, mobilisation, and alignment of regional supply-chain capabilities for space manufacture – *to mobilise and structure regional capabilities, and*
- 3) step-change enhancement of regional manufacturing offerings and capabilities, meeting existing and future unmet supply-chain needs – *to achieve international recognition and leadership in our target specialisms, facilitating customer engagement and take-up, and thereby driving penetration and growth within global markets.*

DOWNSTREAM SPACE APPLICATION AND USER SECTORS

Combining ubiquitous connectivity, remote sensing, and precision navigation and timing, space enabled systems and services have the potential to transform end-user sectors, address major industrial and societal challenges, and drive innovation, competitiveness, and growth. The West Midlands holds key strengths in end-user sectors that have the potential to benefit significantly from space enabled data and services, including future transport (connected and autonomous vehicles and digital rail), modern services, health and life sciences (connected data driven services), and agriculture 4.0 (precision agriculture and autonomous farming systems).

However, space applications in these user sectors are currently limited by:

- the small size of the existing regional markets for space applications (creating barriers to investment and growth),
- end-user awareness and understanding of space capabilities, applications, and benefits (art of the possible), creating barriers to user engagement and adoption,
- performance limitations of existing space assets,
- access to and cost of space data and services, compounded by the lack of sovereign space capabilities,

- inferior public and private finance for space applications compared to competitors in Europe and the US,
- concerns surrounding the privacy and (cyber) security of space data and services,
- retention of skilled regional graduates and employees (many of whom are poached by companies outside the region), creating a skills gap.

Furthermore, whilst the West Midlands holds strengths in the fields of computer and data sciences, there are relatively few businesses in the region operating within the space applications value-chain segment (primarily due to its emergent nature), limiting our innovation and growth potential.

Although challenges associated with performance, accessibility, and cost of space data are anticipated to reduce in time with growing UK (and international) space assets, these must be carefully aligned with use case requirements and roadmaps.

To facilitate the growth of downstream space application and user sectors we have identified 3 'must win' battles:

- 1) engagement with key end-users to raise awareness, explore potential applications, and demonstrate the use and benefits of space enabled systems and services – *to stimulate market demand and enable the benefits of space to be realised,*
- 2) growth of space application start-up's (and pivots) – *to generate a regional capability to meet this demand and capture market share, and*
- 3) step-change enhancement of regional offerings and capabilities within our end-user market niches – *to achieve international recognition and leadership in our target specialisms, facilitating growth within global markets.*

Stimulation of end-user markets will be key to driving growth of the region's downstream capabilities and services.

WHERE DO WE WANT TO BE – A VISION OF THE FUTURE FOR THE WEST MIDLANDS

VISION

Our vision is a future where the West Midlands plays a pivotal role in the UK space industry:

- closely engaged with upstream space primes and subsystem system manufacturers, downstream space application markets, and broader national and international stakeholders.
- providing connected and globally leading supply-chain capabilities:
 - mobilised around well-defined areas of competency (mirroring those found within the regional aerospace sector),
 - leveraging our significant manufacturing base (aerospace, automotive, and rail) with high latent space manufacturing potential,
 - and competencies in advanced manufacturing and industry 4.0,
 - supporting the upstream manufacture of satellites, spacecraft, and launch vehicles,
 - and representing ~10% of the UK space manufacturing market by 2030 (£323 million GDP),
- realising a thriving downstream space applications sector:
 - comprising a balance of disruptive start-up business, and businesses that have either pivoted into, or have adopted, the use of space data and services,
 - leveraging our significant regional competencies in data and computer sciences,
 - to realise internationally competitive and disruptive space application products and services,
 - addressing important industrial, commercial, and societal challenges,
- within important end-user sectors of strength to the region (transport, modern professional services, health and life sciences, and agriculture),
- and representing ~10% of the UK space applications market by 2030 (£1.32 billion GDP),
- achieving international recognition for our capabilities with strong exports markets (>12.5%²⁹ GDP) for both upstream space manufacture and downstream space application services,
- attracting new business to the region and significant inward investment (£300 million by 2030),
- investing >£300 million in research and innovation by 2030,
- supporting growth in regional:
 - GDP, targeting ~£1.64 billion direct growth by 2030, with a further £40 billion+ of GDP reliant upon satellite services, and
 - Employment, targeting 3,000+ new jobs by 2030,
- providing high-quality training to support the regional (and UK) space industry (3,000+ additional skilled people by 2030).

STRATEGY

We will facilitate this vision through a West Midlands Space Cluster that seeks to:

- understand regional strengths and latent space potential,
- identify and explore space opportunities that leverage this potential,
- establish a locally-led space leadership group involving key stakeholders from government, industry, and research/academia,

- define a space strategy that aligns with regional strengths and priorities,
- leverage/build anchor facilities within the region, that play a central role in supporting the cluster, raise the profile of the West Midlands space industry, and provide a focal point for activity,
- cluster regional stakeholders, assets, facilities, expertise, activities, and initiatives that have relevance to the space industry,
- coordinate cluster activities towards strategic policy objectives, including:
 - networking and awareness raising events and initiatives (involving key stakeholders),
 - establishment of working groups to inform and lead strategy and policy,
 - partnership and collaboration with strategic stakeholders that lie beyond the region,
 - mobilisation of a business support services, access to skills training, and finance for research, innovation, and growth, and
- integrate and empower our space clusters within a connected region through structured programmes of activity.

IMPLEMENTATION

Co-ownership of our regional space strategy is essential. It is imperative that there is continued collaboration across our different stakeholder groups (building on our Space Leadership Group activities). The key stakeholders include businesses, universities, investors, local government bodies/agencies, and entrepreneurs/potential start-ups. The 'UK Space Agency Local Space Sector Cluster and Supply Chain Development Funding Call' for the region has been a partnership between the University of Birmingham, the West Midlands

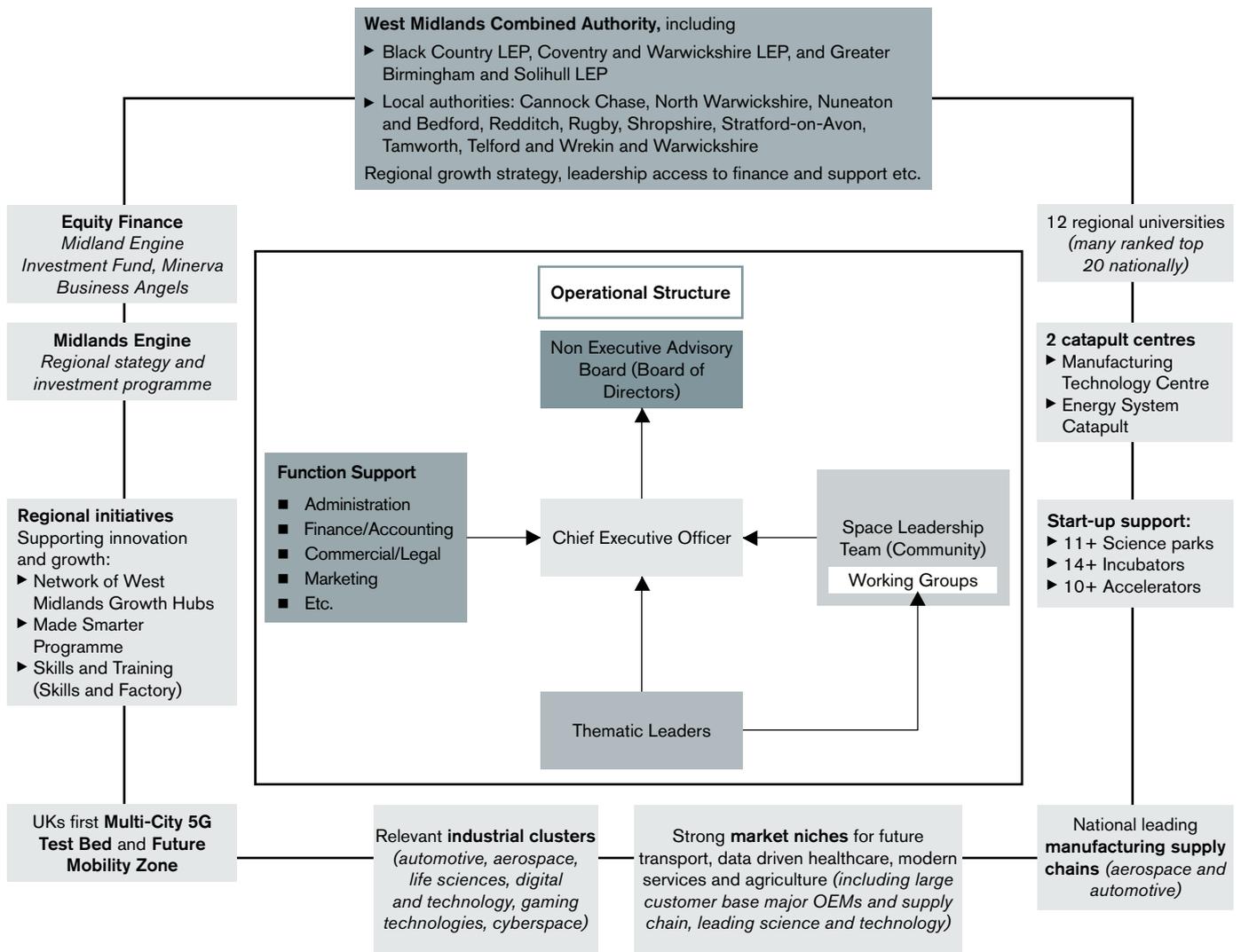


FIGURE 9. SPACE CLUSTER OPERATIONAL STRUCTURE AND POTENTIAL AVAILABLE RESOURCES

Combined Authority, Greater Birmingham and Solihull LEP, the Black Country LEP and Coventry and Warwickshire LEP. The local government partners will be invited to adopt the strategy going forward.

It is envisaged that the Space Cluster will initially be hosted by the Midlands Aerospace Alliance (MAA). The MAA is a regional association that:

- is an industry-led regional cluster body that also encompasses a wide range of regional stakeholders. Through its predominantly aerospace work, the MAA already mobilises many key regional and national stakeholders associated with upstream space manufacture,
- draws many parallels with the space sector, with direct experience in:
 - the clustering and coordination of sector specific activities and initiatives,
 - supporting businesses that operate within a heavily regulated and global sector,
- runs an existing 'cross sector pivot

programme' financed on a pilot basis by the West Midlands Combined Authority, is the industry delivery partner on a Midlands-wide ERDF programme with the University of Nottingham which can also facilitate and support aerospace companies to enter new markets (such as space),

- encompasses the required profile to draw the attention and engagement of key regional and national stakeholders,
- has an established management and operational structure that may be leveraged to efficiently support a new space cluster.

The cluster will:

- recruit a non-executive advisory board (Board of Directors), drawing experienced leaders from across our target value chains (and selected national space sector bodies), who will provide strategic planning and oversight of the cluster operations,
- recruit a chief executive officer who will establish the cluster foundations and lead its continued development and growth,

- recruit one or more thematic leaders who will lead specific priority areas within the cluster strategy,
- leverage professional functional support resources from the MAA, and
- mobilise a Space Leadership Team (community), comprising a diverse group of representatives from business, academia, local authorities, professional services, national space organisations etc, who will form a range of working groups addressing strategic priorities.

Wherever possible we will seek to leverage existing facilities, capabilities, and initiatives from within the region (figure 9), thereby maximising efficiency and ensuring cluster resources are focused on those activities that add the greatest value. We will also seek to establish strategic collaborations with other regional and national clusters/initiatives, and in particular the Leicester Space Park, other regional space clusters, UK Space Agency, and the Satellite Applications Catapult.

ALIGNMENT WITH THE NATIONAL SPACE STRATEGY

Our vision aligns closely with the UK National Space Strategy. We have identified **strategic policy objectives** that deliver against each of those identified within the national strategy. Our **strategy for implementation** aligns with key areas of the national implementation strategy:

- our downstream space applications sector will utilise regional data and computer science capabilities to drive competitiveness and growth,
- we seek to gain international leadership and recognition in our areas of specialism to underpin new global partnerships and export campaigns,
- we will leverage our nationally leading digital and technological capabilities combined with strong customer value-chains within key market niches (transport, health, modern services, and agriculture) to attract entrepreneurs and investors, and stimulate innovation, start-ups, and pivots,
- we will invest in education and training to create the next generation of space scientists, engineers, and business professionals, and enable future skill demands to be met.

Our strategy also aligns the four national **sector priorities**. We will leverage emerging (5G) *connectivity services*, and *advance earth information/observation services*, to address unmet needs and opportunities across our market niches. We will develop space manufacturing supply-chains, utilising *robotics and industry 4.0 technologies*, to support manufacture of *low-cost satellites and launch vehicles*.

ALIGNMENT WITH THE EMERGING 'NEW SPACE' (SPACE 2.0) MARKET

Our strategy primarily focuses on the development of capabilities and markets that align with the emerging 'New Space' (Space 2.0) opportunities, and in particular:

- development of manufacturing supply chains incorporating robotics and industry 4.0 technologies, targeting low-cost volumetric production with integrated quality management and component standardisation (towards low-cost satellites and launch vehicles),
- creation of new space application business combining Space 2.0 satellite capabilities (ubiquitous connectivity, enhanced remote sensing, and precision location and timing services) with emerging data and computer science technologies,
- creation of new markets in the areas of future transport, data driven healthcare, modern services, and agriculture, that utilise these second-generation space capabilities.

ALIGNMENT WITH REGIONAL PRIORITIES

Our vision aligns closely with key regional strategies and priorities:

1) West Midlands Local Industrial Strategy

The West Midlands Local Industrial Strategy (LIS) builds on the distinctive strengths of the region – future mobility, data-driven health and life sciences, modern services, and global competitive manufacturing supply chains. Its ambition is to 'drive growth by strengthening the foundations of productivity and take advantage of market driven opportunities in mobility, data-driven health and life sciences, modern services, creative, content techniques

and technologies'. The major market opportunities identified in the LIS, closely align with the end-use sectors for downstream space applications that have been identified.

Regional partners, including the region's Local Enterprise Partnerships, support the LIS: Black Country LEP, Coventry and Warwickshire LEP and Greater Birmingham and Solihull LEP. Each of these LEPs have growth strategies to help guide their investment and localised market opportunities.

2) Digital Roadmap

The West Midlands' Digital Roadmap highlights how digital connectivity is going to be vital to the region's economic bounce-back post-COVID-19. It is described as the 'golden thread that links all of our industries – Advanced manufacturing, automotive, life sciences, professional services, construction, low carbon, transport, healthcare, public services', as they are being transformed by the power of digital technologies. Satellite enabled applications are central to digital connectivity and therefore supporting the development of a West Midlands space cluster directly aligns with the 'Five Missions for 2021–2026' identified in the roadmap:

- 1) Securing access for everyone to digital opportunities, particularly those in poverty,
- 2) Sharing and using data to improve people's lives,
- 3) Becoming the UK's best-connected region,
- 4) Realising the potential of digital to transform our economy and build economic resilience, and
- 5) Using digital public services to build a fairer, greener, healthier region.

3) Made Smarter Programme

Connected to the digital roadmap is the Made Smarter Adoption programme, which supports the digitisation of Manufacturing. The programme provides expert support to companies to upskill and reach a higher digital readiness level, supporting the adoption of industrial digital technology. By supporting the adoption of industrial digital technology, such as robotics and automation, additive manufacturing or the Internet of Things, the programme will help level up regions by enabling manufacturers to increase their productivity, create high-skilled well-paid jobs and reduce their emissions. The key technologies associated with automation and the Internet of Things include satellite-enabled communications, global positioning satellites (GPS), and space-based sensors. To realise these digital opportunities, investments are to be made in artificial intelligence, machine learning and data analytics, technologies which satellite-enabled application companies depend on. Therefore, space technology will both be a contributor and beneficiary of the Made Smarter Programme.

4) West Midlands Innovation Framework (WMIF)

The West Midlands Innovation Framework (WMIF) seeks to 'develop and support an innovation ecosystem that fosters entrepreneurship, drives up levels of business innovation and the exploitation of research and development, targeting varying needs in different parts of the region'. A West Midlands Space Cluster aligns with the key pillars of the WMIF:

- Networks and linkages – joining-up, leveraging, and supporting existing business support networks and programmes (relevant to our regional space strategy),

- Investment programmes – mobilising a range of finance products/mechanism to support growth of the regional space sector,
- Intelligence – exploring the space industry ecosystem and identifying and filling gaps in the innovation and entrepreneurial capacity,
- Culture – building an innovation culture by facilitating and showcasing the importance and impact of the regional space industry.

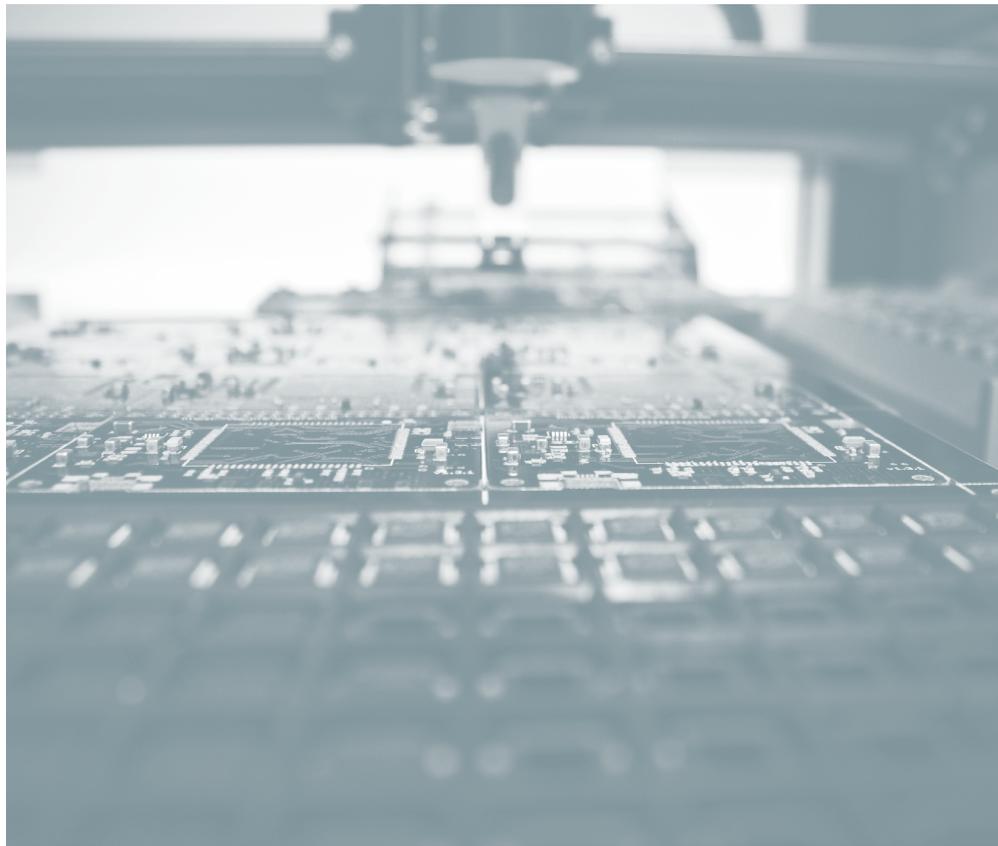
The cluster also supports a number of the 'must win' battles identified by the WMIF through the West Midlands Innovation Programme and the MIT REAP research:

- Coherent regional funding strategy (aligned to space),

- Coordinated business support (building on existing programmes),
- Digitisation of manufacturing (space supply chain),
- Showcasing the region.

In line with the WMIF strategy we will target:

- Innovation and business advancement with 'long-tail' supply chain firms with potential to supply to (and advance up the supply chain within) the emerging UK and global space industry,
- Innovation driven enterprises that are actively, or open to, exploring space opportunities,
- Start-up and scale-up firms that are experiencing high growth episodes.



HOW ARE WE GOING TO GET THERE – WEST MIDLANDS SPACE CLUSTER APPROACH

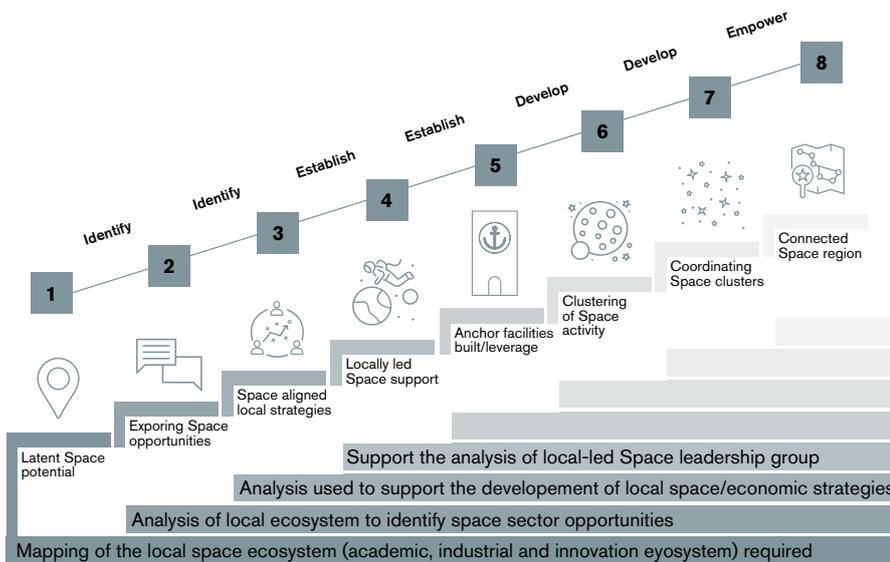


FIGURE 10. UK SPACE AGENCY SPACE CLUSTER ROADMAP

Our proposed approach follows the eight phases of the cluster roadmap (fig.10). Our initial work as part of the UKSA project has enabled us to initiate the first four phases. So far, we have:

- 1) Identified our core areas of strength in terms of latent space potential,
- 2) Identified key upstream and downstream opportunities to apply and develop this potential,
- 3) Developed a top-level regional space strategy, and
- 4) Established a locally-led Space Leadership Group, mobilising stakeholders from government, industry, and research/academia.

The next phases of activity are to:

- 5) Establish anchor facilities³⁰ at the heart of our cluster, leveraging key existing regional assets, and exploring the need for additional dedicated facilities,
- 6) Establish clusters of space activity around our regional strengths and opportunities,
- 7) Coordinate cluster activities towards defined strategic goals, and
- 8) Integrate and empower our clusters within a connected space region.

These activities are not sequential, but rather run concurrently to continuously build, reinforce, and develop a vibrant cluster of firms within the region.

ESTABLISHMENT OF ANCHOR FACILITIES

Will leverage/develop the supporting infrastructure needed by firms to enter, and grow within, the cluster of space related industries and services. Central to this infrastructure are anchor facilities that will provide focal points for cluster activity, essential services and support, and will help to raise the profile of the region, attracting interest and inward investment. We foresee three phases of development:

- Mobilisation of existing regional assets – to provide the foundations from which we may build the cluster infrastructure,
- Establishment of specialist support facilities – providing essential design, prototyping, and testing services aligned to our specific regional needs and interests, and
- Establishment of a public-private funded applied research and innovation centre – supporting longer-term development goals that enhance regional offerings and capabilities.

Existing regional assets will include:

- *Technology Parks (including business incubators and accelerator facilities)* – providing flexible property/office and value-added business support services to new start-up firms. They are predominantly physical workspaces providing facilities, lab space, and technical equipment. Examples in the West Midlands region include: Innovation Birmingham Campus, (Ignite Incubators) Warwick Science Park, and The Staffordshire Advanced Materials, Incubator and Accelerator Centre.
- *12 regional Universities* – providing centres of excellence for science and technology, and essential research and innovation

support services. Access to University facilities is important given the wealth of start-ups and tech companies within the region, most of whom don't have access to specialist facilities.

- **Research and Technological Organisations** – The Manufacturing Technology Centre (MTC), representing the 'High Value Manufacturing Catapult' on all space activities and providing a single point of entry for the sector. The MTC has developed relevant capabilities, has worked in the space sector for many years, and has recently (September 2020) accelerated its space sector effort identifying opportunities for development, application and commercialisation of technologies (inc. robotics) to support advancement in the space sector.

STAKEHOLDER FEEDBACK:

'One of the first things that stood out from our study was the quality of the facilities and volume of space relevant projects being undertaken across all regional universities – We've got an incredibly strong base here. For example, the University of Birmingham has around 8 programmes of activity including access to key facilities such as radiation testing.'

CLUSTERING OF SPACE ACTIVITIES

Focus will be given to linking the upstream and downstream sectors in the region, helping the cluster to grow as a whole. Activities considered will include:

- **Stakeholders** – across the space value-chain including upstream and downstream customers, supply-chain companies, providers of enabling technologies, academia and research organisations, government/regional agencies and partners, professional services, investors etc.

- **Projects and initiatives** – including existing space and related research projects, skills and training programmes, grant/equity/loan financing opportunities, business support initiatives (such as the 'Aerospace Unlocking Potential programme – supported by the ERDF), relevant working groups, platforms, and events etc.
- **Infrastructure and expertise** – including:
 - Relevant regional academic specialisms, facilities, and IP (eg, computer and data sciences etc),
 - Enabling technology providers, such as Industry 4.0 technologies, AI data analytics software, data centres etc.
 - Professional services, such as legal and IP services, standards and accreditation support etc.
- **Partnerships and collaboration** – collaborations with other clusters or organisations (inside and outside the region) for the exchange of information, networking, access to facilities, and collaborative activities, including:
 - *Space-related*: Space Park Leicester, Satellite Applications Catapult, UK Space Agency, Harwell and Westcott Space Clusters, Space Growth Partnership etc, and
 - *Non-space related*: such as the 'Cross-Industry Technology Exploitation in Clusters' run by the Midlands Aerospace Alliance, etc.

We foresee a close collaboration with Space Park Leicester, seeking to build synergistic capabilities that deliver value for stakeholders across the Midlands.

For **space manufacture**, we will seek to engage strongly with existing and future upstream customers. This is essential for ensuring supply chain capabilities and development focus are aligned with (and have access to) genuine upstream customer needs and demand (mirroring those found in the aerospace sector). Whilst there are several sub-system manufacturers located within the West Midlands, we will also seek to forge engagement with others (and space primes) outside of the region.

For **space applications**, focus will be given to engagement with downstream customers within our sectors of strength (stimulating and ensuring focus on genuine areas of demand) and enabling technology partners (such as data and computer sciences), ensuring the region has the necessary capabilities to respond to such opportunities and demand.

STAKEHOLDER FEEDBACK:

'We need to ensure that we align our existing capabilities (within the West Midlands) with the space opportunities, and in particular the aerospace sector that is so adjacent to the space sector. This has to form one of the bedrocks for what we do in the region and leverage into the space sector. Engagement here will help us to understand/learn about the next evolution of what is required by the space industry and primes.'

'We need to look at our supply chains, look at good companies in those supply chains, and build out.'

COORDINATION OF CLUSTERS

Will undertake activities to structure and coordinate progress towards our strategic goals. These will include:

Awareness raising and networking:

Awareness raising, knowledge exchange, and networking activities lie at the heart of the proposed cluster. This is particularly important for many of the members who are unfamiliar with the space market, and for driving engagement with the upstream space prime/subsystem manufacturers who are largely unfamiliar with our capabilities and unique service offerings, and downstream end-user customers who are often unfamiliar with space capabilities and uses.

³⁰ Anchor Facilities play a critical role in terms of coordination and support of economic activity. Key characteristics of anchor institutions include spatial immobility, embeddedness in the local (space) economy and community, and a large resource base that is manifested in local purchasing, employment and business support [UKCES].



A broad range of **awareness-raising** activities will be considered, including articles, reports, supplier catalogues and profiles, presentations, videos, and seminars. These will be stored/available via the cluster website and will be promoted across a broad range of dissemination and communication channels.

We will leverage our partnerships and collaborations to ensure transparency across value-chains and to ensure that our members have access to the most up-to-date information. For example, the UK Space Agency runs 'space 101' training. There are also numerous awareness-raising courses run by the Satellite Applications Catapult.

We will seek to raise awareness concerning:

- the emerging Space 2.0 market, how it operates, and who the stakeholders are,
- the existing and anticipated future programmes/missions, opportunities, and challenges,
- how companies can get involved and manage the regulatory, compliance, and (international) trading requirements,
- the capabilities/facilities, specialisms, and IP/technology of regional academic, RTO, and enabling technology partners,
- available business support services and finance opportunities, and
- the profile, capabilities, and unique product/service offerings of regional manufacturers (suppliers) to upstream primes/OEM and sub-system manufacturers

STAKEHOLDER FEEDBACK:

'As part of the awareness-raising, we need to very clearly define what we mean by the "West Midlands" Space Cluster'.

'One of the big challenges is getting companies who are technically using space data, but don't realise that they're space companies. We need to talk about "space enabled" companies rather than space companies per se'.

'From a LEP perspective we need to identify the opportunities for businesses to market and promote within the region. We need a compelling story to tell our business bases. A joined-up narrative developed and shared by all key actors'.

'What awareness raising activities have worked well in other space clusters? What insights can we learn from those that have already done it... recognising that things may work differently in our region'.

'Involvement of a broad and diverse space advocacy group (from academia, industry, government etc). This enables space to be championed across the value-chain and a range sectors'.

'From experience, those that have strong industrial/business engagement have worked very well'.

The innovation culture in the west midlands is supported by a variety of networks, most notably those managed by the Innovation Alliance West Midlands who provide networks to promote innovation activity in a variety of sectors and promote innovations regionally. Crucially, there are a number of space-related networking groups that already exist in the region, including the 'Midlands Aerospace Alliance', 'R&R space', the 'West Midlands branch of the British Interplanetary Society', and 'Midlands Innovation'. These groups collectively promote engagement and interest with space technology in the West Midlands and funding could be directed towards furthering their reach.

STAKEHOLDER FEEDBACK:

'Just because you have both upstream and downstream – it does not mean they will talk to each other. It was quite a difficult thing to make that connection between the upstream and the downstream when it comes to actual customers... the upstream sell to huge companies or governments... and the downstream sells to a myriad of commercial customers'.

'We have an opportunity to create a shared/collaborative culture, where like-minded businesses can come together, allowing mutually beneficial relationship creation.'

'Companies follow companies. It is about raising awareness to identify companies that are doing something exciting and all that is about facilitating local active networking'.

'Many companies using space data do not think of themselves as "space" companies – we sell ourselves as basically providing information'.

'Early engagement of suppliers with OEMs/ primes is key. Early engagement at the innovation/R&D level, when technologies are being developed, enables trust to be built, which in-turn facilitates entry to supply chains. ie, route in through R&D projects, recognising that it will take years to become an eventual supplier (new business)'

'There also needs to be awareness-raising amongst investors and local government stakeholders, since when you use the word space, most people think of NASA and the big, shiny, multi-million-pound opportunities that go on. There is "knowledge brokering", which needs to happen across the whole business community, as well as the university community. We need to engage with stakeholders and almost go back to basics. Awareness-raising is important because industry frequently needs to start from square one when entering stakeholder discussions. It would help greatly if stakeholders already had an understanding about space'.

'Facilitating networking across our regional academic partners for joint ESA and UK Space Agency bids – there is a lot of building blocks that if we can start to stack them up at a technical level, we can really start to build our offer and credibility'.

'The academic expertise is really diverse. We've got some fantastic specialisms. And actually, we could use this to start to tease out some of that very diverse expertise that we have here'.

'Public awareness is crucial if we want this to develop. Universities have an important role to play in this. Warwick is building a three-unit CubeSat, designed to go to the International Space Station to be in low Earth orbit'.

'How can key research groups join together for the common good of the WM Space Cluster aspirations. Warwick University has strengths in future materials and manufacturing and already closely works with Leicester. They are part of the Midlands Innovation Group, which also includes Birmingham. So there is the opportunity to strengthen that activity'.

'The Universities could act as a safe space/ forum where people are free to discuss the problems they are facing and shared objectives. They could host an annual conference, which facilitates confidential meetings between firms and potential investors. This could include student competitions'.

STAKEHOLDER FEEDBACK:

'Within universities, there are people next door to each other, who are not quite sure what each other is doing. We need to try to shine a light on this and uncover where all these fantastic opportunities could be and what people are doing in terms of the research. There are going to be masses of early career researcher, across all the universities in the region. But unless we can shine a light and uncover what they're doing, then those opportunities will not be commercially viable.'

'How can we ensure there is greater tech-transfer/spinouts from these universities? We need to put in place an applied funding stream to encourage near-to-market innovations within universities with the ambition that they will be measured, not by publications but being measured by the number of spinouts.'

'We have to avoid being "ivory towers", and make sure that what we develop is fit for purpose for the local space industry. The role of universities is important, but universities tend to be too blue skies. So there needs to be a national reorientation of certain University activities, so it becomes more practical.'

'We are not matching research and industry together. We are doing it with other sectors like automotive, but we are not doing it with space. We need to widen our matching between employers and the graduates, which would help with that graduate retention piece.'

A key aspect to raising awareness will be **networking events**. These events are essential for:

- engaging with regional members to understand their needs and interests, and offer, or signpost to, appropriate support,
- forging engagement and early collaboration between:
 - regional manufacturing companies and upstream customers, and in particular upstream technical teams that are at the design stage, enabling regional supplier capabilities to be designed into emerging systems (thereby securing later procurement contracts),
 - regional space application companies and downstream end-use customers, ensuring innovation and business growth are aligned closely with real customer needs and demand.
- open access to, and collaboration with, clusters and organisations beyond our membership, and in particular Space Park Leicester, the Harwell and Westcott Space Clusters, the Satellite Applications Catapult (and associated regional centres of excellence), and the UK Space Agency.

We will draw on recent innovations in holding networking events including blending in person and remote access events to increase accessibility and attendance as well as providing in person events that use well proven methodologies to support knowledge exchange and networking.

Working Groups (WGs):

WGs will provide an important vehicle for: 1) exploring specific subject areas and foresight mapping, 2) identifying and proposing solutions to key sector challenges, 3) strategizing and informing policy, 4) mobilising advocates, and 5) lobbying decision makers. They will draw on diverse groups of experts to address defined goals/challenges, typically meeting monthly and led by a WG Leader who will be responsible for managing the group and driving the agenda, chairing meetings, and reporting.

Demonstrator Projects:

Specific projects will be selected to showcase:

- how West Midlands companies can pivot into and/or grow within the space manufacturing sector, and
- the (latent) space capabilities of the West Midlands region.

These projects will reinforce awareness raising activities, provide practical examples of achievements and progress made, and attract further interest and investment into the region.

STAKEHOLDER FEEDBACK:

'A good example of an awareness raising event would be 'TechSevern' on Innovative Healthcare: <http://techsevern.com/news/tech-severn-hailed-as-huge-success/>. The event brought together stakeholders working in the sensing and healthcare sectors to identify potential innovations for assisted living and home care technologies.'

'Farmers are quite hard to sell to. They are resistant to change and don't necessarily believe everything they're told. So when we're trying to sell new technology, it's important to be able to demonstrate efficacy. So for us, it's important to have prototypes using satellite data, evidencing that it's worth the investment.'

BUSINESS SUPPORT FRAMEWORK

Will develop and deliver a broad framework of business support services. Wherever possible, we will seek to leverage existing infrastructure, programmes, and expertise. The business support framework will include:

- *Business Engagement* – will provide a central contact point for engagement. The team will engage with existing and/or potential members to raise awareness, understand the businesses needs and interests, and signpost to opportunities and support both within and outside the cluster.

- *Business Incubation Space* – will seek to provide access to business incubation space near to key assets, leveraging existing regional science and business parks. These will provide hubs through which businesses may network and access facilities and support.
- *Accelerator programmes* – in the short-term we will seek to leverage the wealth of accelerator programmes that are already available across the region. However, in the longer-term, we would like to develop accelerator programmes tailored to the specific needs of the region, and in particular: 1) supply-chain manufacture for space, and 2) space applications for future transport, modern professional services, health, and agriculture.
- *Workshops and consultancy* – will provide workshops and expert consultancy services to help members to advance their innovation or business growth projects. Services will include access to support for required space standards and accreditation. Whilst the cluster will seek to develop key competencies within our areas of strategic interest, it is envisaged that these services will initially be provided using external experts. It is anticipated that consultancy services will be financed by individual members.
- *Coaching and facilitation* – will provide 1-2-1 support for companies wishing to pivot into, or seek new growth opportunities within, the emerging space market. Coaching programmes will consider both peer-to-peer based support, through to more intensive programmes of support delivered by external expert coaches.

Whilst the business support services will be open to all types of company, we will ensure a focus on those companies with greatest growth potential, including: 1) businesses with the potential to pivot and prosper within space markets; 2) innovation driven enterprises that are actively, or open to, exploring space opportunities; and 3) start-up and scale-up firms that are experiencing growth episodes.

STAKEHOLDER FEEDBACK:

'We could develop diversification vouchers that support everyday innovation; helping companies to identify the right consultant. Could be relatively small – £5,000 – similar to an innovation voucher that gets companies to think through opportunities.'

'Different kinds of R&D investments are needed. Eg, it is more difficult for start-ups in the upstream sector than the downstream.'

'We need support for companies that have the capabilities and opportunities to pivot into Space. The majority of companies would not have an awareness of the supply chain, digital solutions relevant to space, etc. The majority of companies in the West Midlands would not profile themselves as space industry companies at all. Awareness-raising is needed around supply chains / digital solutions.'

'We need to understand what level of risk is involved in moving into the Space sector at different points in time? Is it better to move early? Or is it better to get involved in a smaller way over the longer-term?'

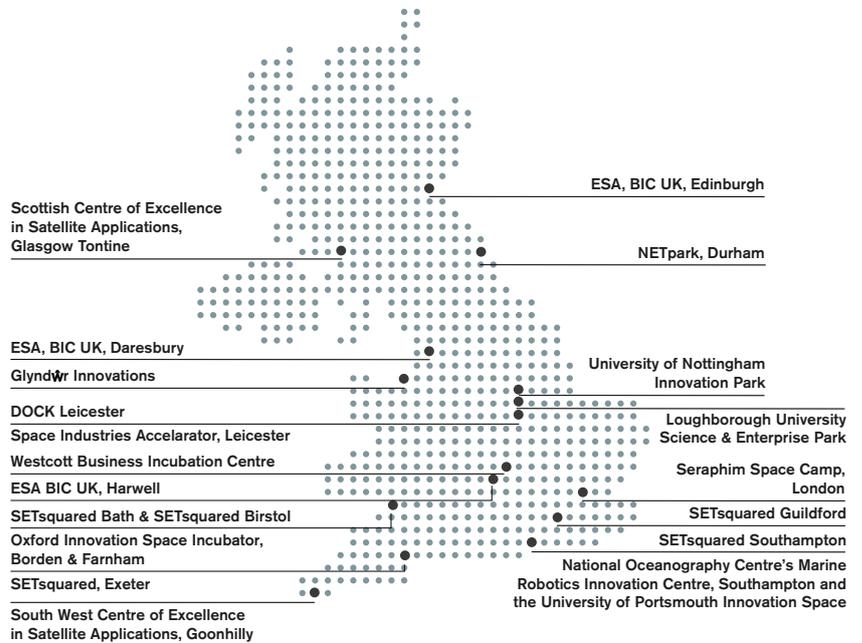


FIGURE 11. UK SPACE INCUBATOR NETWORK MEMBERS

SPACE INCUBATOR NETWORK

www.setsquared.co.uk/uk-space-incubator-network/

The UK Space Incubator Network comprises a growing number of incubators dedicated to identifying and accelerating the growth of start-up and scale-ups that are leveraging space technology as a critical asset in their businesses. The network aims to share best practice and

engage in collective action where it is more effective than operating individually. Centres provide a mixture of office space, business support, networking and events, and access to specialist facilities and funding. Figure 11 provides a map of existing network members. There are currently no members located within the West Midlands, creating an important gap within the regional business support landscape for emerging space industries.

SKILLS

Will ensure that the West Midlands space sector has access to, and is able to retain, the necessary people and skills to meet existing and future demand. We will seek to:

- Facilitate graduate engagement with regional space employers, driving understanding and enthusiasm for the sector,
- Assess the existing and anticipated future regional skill requirements and resources to identify key gaps, and

- Engage with higher-education and regional skills/training providers to develop appropriate training solutions to fill these gaps (considering graduate, apprenticeship, and targeted professional development courses).

In developing the skills programme(s) we will not only consider how to achieve the skill requirements, but also how to retain these skills within the West Midlands (through improvements in opportunity, the workplace

environment, and pay). Working in partnership with organisations such as 'STEM Learning' is also essential for developing interest in the space sector amongst young people and providing them with the appropriate skills. STEM Learning is the UK's largest provider of education and careers support in science, technology, engineering and mathematics (STEM) and has a dedicated Regional Network Lead. This will help to create a future talent-pool within the West Midlands that is interested in working in either the upstream or downstream space sector.

FINANCE

We will work with existing public and private sector funders to identify how existing **grant, equity, and loan finance options for research and innovation**, and business growth can be accessed by – and in some cases tailored to – firms and entrepreneurs in the sector. This will involve identifying any specific market failures or barriers to firms in the sector accessing appropriate finance and making firms aware of alternative options that may be more appropriate to their needs. Proposed activities include signposting to existing finance options, holding events for potential investors seeking potential opportunities as well as working closely with the British Business Bank, equity finance ventures, investment banks, and regional/national agencies, to source or influence new finance options.

SATELLITE FINANCE NETWORK

<http://satellitelifinancenetwork.org/>

The Satellite Finance Network represents individuals and organisations from the finance, legal, insurance, government and space technology and applications communities, from start-ups and small companies to industry leaders, with a common interest in delivering satellite and space-enabled projects to domestic and export markets around the world. Services of the network include:

- Facilitating and attracting investment (Connecting industry players (particularly SMEs) with the financial community; Matching industry players with the right investors),
- Identifying regulatory barriers and other impediments to growth (Working to create a 'space friendly' and competitive regulatory environment for the UK; Offering solutions, where they exist, to industry players; Encouraging and supporting exporters in areas of finance and regulation),
- Promoting business opportunities between companies.

We will engage with the Satellite Finance Network to help mobilise (access to) finance to support regional activities.

STAKEHOLDER FEEDBACK:

'The biggest problem is actually investment – there needs to somehow be access to a pot of money, or a way to get shareholders really interested, in order to grow that area.'

'The "elephant in the room" is of course funding. It is very difficult to get funding for collaboration or the development of new space projects from the academic side. The Space Agency only funds things which are already existing and proven... the late stages. So, when it is at the earlier stages in the pipeline, which academia is involved with, I haven't seen any funding streams for that yet.'

'Support is needed with investing in R&D – including product services and everyday innovation.'

'There is money in the region, it's just making it easier to access.'

'There may be a route to linking space with other policy initiatives, such as decarbonisation and sustainability for food production.'

Strategic Programmes:

Through the actions of our working groups and leadership board, a suite of strategic programmes will be identified with the necessary critical mass of activity to effect change and realise strategic policy goals. Through these strategic programmes we seek to:

- achieve a step-change advancement in technology, capability, and competitiveness within our target specialisms and market niches,
- leading to international recognition and leadership,
- driving the necessary growth to achieve our ambitious targets for the sector.

This may involve placing a space sector wrapper around existing national generic business support programmes as well as developing targeted projects for the sector, including support via information-guidance-brokerage of external advice, tax credits, soft loans, grants for research and innovation projects, skills/training, entering new markets, access to expertise and generic business support, regulatory compliance, and investment.

Programme goals, activities, and resources will be defined by the thematic working groups and approved by the leadership team. Whenever possible we will seek to leverage existing assets and resources. Where necessary, additional resources/finance will be sought.



INTEGRATION AND EMPOWERMENT OF CLUSTERS

We will collaborate with other Centres of Excellence, such as Harwell and Leicester space park, building on their existing strengths and sharing our own. The West Midlands' central location will help build these cross-cluster networks.

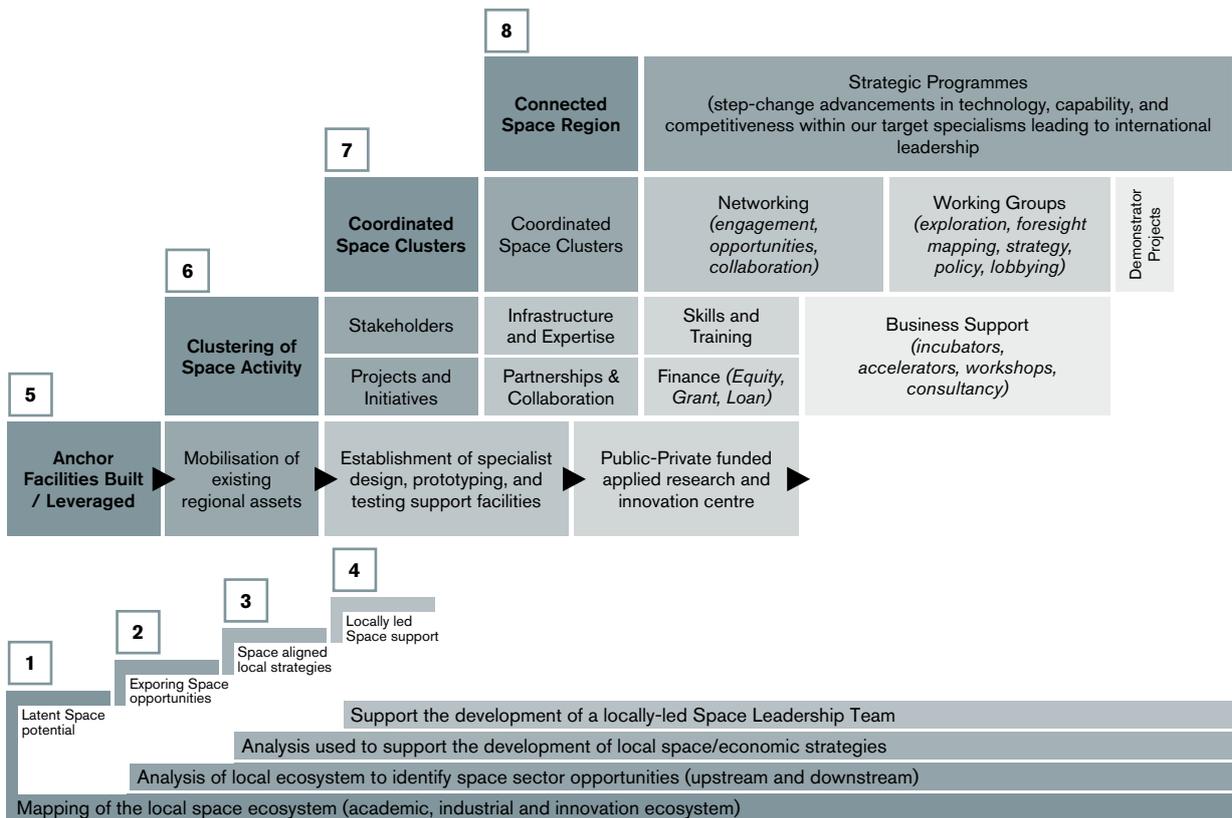
This will be supported by the Space Leadership Team and Advisory Board that will include representatives of OEMs, suppliers and professional services, local government and academia. These bodies will provide both a voice to the sector and will oversee activities to integrate and empower our cluster, driving long term competitive growth for the region. These activities will include:

THE INNOVATION CULTURE IN THE WEST MIDLANDS IS SUPPORTED BY A VARIETY OF NETWORKS, MOST NOTABLY THOSE MANAGED BY THE INNOVATION ALLIANCE WEST MIDLANDS WHO PROVIDE NETWORKS TO PROMOTE INNOVATION ACTIVITY IN A VARIETY OF SECTORS AND PROMOTE INNOVATIONS REGIONALLY.

WEST MIDLANDS SPACE CLUSTER (OVERVIEW)

A VISION OF THE WEST MIDLANDS SPACE INDUSTRY (BY 2030)

- a globally leading supply-chain representing ~10% of UK space manufacturing,
- a thriving downstream space applications sector representing ~10% of the UK market,
- achieving international recognition with strong exports markets (>12.5% GDP)
- attracting new business to the region and significant inward investment (>£300 million),
- investing >£300 million in research and innovation,
- supporting growth in the region, targeting:
 - £1.64 billion direct GDP growth
 - a further £40 billion+ of GDP reliant upon satellite services
 - >3,000 new jobs
- providing high quality training (3,000+ additional skilled people / apprenticeships)



| Must-Win' Battles (Outcomes) | | | |
|---|---|--------------------------|------------|
| UPSTREAM – SPACE MANUFACTURE 1) early engagement and collaboration with space primes/OEMs and sub-system manufacturers, 2) recognition, mobilisation, and alignment of regional supply-chain capabilities for space manufacture, and 3) step-change enhancement of regional manufacturing offerings and capabilities, meeting existing and future unmet supply-chain needs. | DOWNSTREAM – SPACE APPLICATIONS 1) engagement with key end-users to raise awareness, explore potential applications, and demonstrate the use and benefits of space enabled systems and services, 2) growth of space application start-up's (and pivots), and 3) step-change enhancement of regional offerings and capabilities within our end-user market niches. | | Automotive |
| | Modern Professional Services | Health and Life Sciences | Rail |
| | Agriculture | | |

POTENTIAL MARKET OPPORTUNITY AND IMPACT

The **global space industry** is valued at £315 billion (\$366 billion in 2019) and is forecast to reach £480 billion (\$558 billion) by 2026 at a CAGR of 5.6%³¹. Value-chain sectors of greatest relevance to the West Midlands include Upstream Space Manufacture (primarily materials, components, and assemblies) and Downstream Space Applications (primarily within automotive, rail, modern professional services, health and wellbeing, and agriculture).

SPACE MANUFACTURE

The global market for manufacture of satellites and launch vehicles is estimated at £19.97 billion, comprising manufacture of satellites (~£14.22 billion) and launch vehicles (~£5.60 billion)³¹. The market is forecast to grow at an ~5% CAGR through to 2030, reaching ~£32.29 billion. The US leads the market holding an ~30% market share, closely followed by China (24%). Other notable markets include Europe, Japan, Canada, and India. Drivers for market growth include the rise of small-/cube-sat constellations, sustained reductions in launch costs alongside continued improvements in launch capabilities (improving the accessibility of space), and the proliferation of downstream space applications (demand for space data and services).

UK Position: whilst the UK upstream space manufacturing sector is comparatively small, it is internationally leading in the manufacture of small satellites. Combined with recent investments in space manufacture (and test centres), and launch capabilities (including

the novel SABRE engine, spaceports etc), and our globally leading aerospace sector, the UK is well positioned to capture an increased share of the future upstream market for space manufacture.

We have undertaken an assessment (figure 12) of the UK and West Midlands market potential within the global satellite and launch vehicle manufacturing sector, assuming:

- an initial UK market share of ~5% (~£950 million),
- an initial West Midlands market share equal to ~1% of the UK market (~£9.5 million), primarily for the supply of materials, components, and assemblies,
- the UK is able to achieve a 10% share

ASSUMING MARKET GROWTH PREDICTIONS, WE FORECAST UK AND WEST MIDLANDS GROWTH POTENTIAL OF UP TO £3.23 BILLION AND £323 MILLION (RESPECTIVELY) BY 2030.

of the global market by 2030 with linear growth,

- the West Midlands is able to achieve a 10% share of the UK market (*mirroring that for the aerospace sector*) by 2030 with linear growth.

| Satellite and Launch Vehicle Manufacturing Market | | | |
|--|-----------|-----------|-----------|
| | 2020 | 2025 | 2030 |
| Market Value (£m) | 19,818.00 | 25,302.00 | 32,293.00 |
| UK Market Share (5% baseline) | 990.90 | 1,265.10 | 1,614.65 |
| UK Market Share (% growth) | 5% | 7.50% | 10% |
| UK Market Share (growth, \$ million) | 990.90 | 1,897.65 | 3,229.30 |
| West Midlands Share of UK Market (1% baseline) | 9.91 | 18.98 | 32.29 |
| West Midlands Share of UK Market (growth) | 1% | 5% | 10% |
| West Midlands Share of UK Market (growth, £ million) | 9.91 | 94.88 | 322.93 |

FIGURE 12. ASSESSMENT OF POTENTIAL MARKETS FOR MANUFACTURE OF SATELLITES AND LAUNCH VEHICLE (AUTHOR: ROB BEVAN)

³¹ Main trends and challenges in the space sector, June 2019, pwc

³² Bryce – The 2019 Global Space Economy at a Glance

³³ Global Satellite Communication (SATCOM) Market Research Report (February 2021), Market Research Future



Our estimates are in-line with the assessments of the 2018 London Economics report.

SPACE APPLICATIONS

Downstream satellite applications dominate the space market, with direct-to-home (DTH) broadcasting accounting for >£86 billion market share. However, DTH broadcasting is a mature market (in decline). The strongest future growth potential is anticipated to result from: 1) Ubiquitous connectivity services, 2) Location-based-signal services, and 3) Remote sensing / earth observation data and services.

COMMUNICATION AND BROADBAND SERVICES

The global satellite communication market is valued at £19.37 billion³² (£15.24 billion Fixed Satellite Services, £2.41 billion broadband, and ~£1.72 billion Mobile Satellite Services) and is forecast to grow at a 8.4% CAGR³³ (£47.03 billion by 2030), driven by increased demand for satellite-based services for sectors such as transport (inflight connectivity, maritime broadband, etc), connectivity for rural areas, IoT and machine-to-machine communication, cloud computing, online gaming, and growth of the telecommunication sector. Important future drivers for growth will include autonomous vehicles, rail traffic management and communications, modern professional and healthcare services in remote locations, precision agriculture etc. It is anticipated that demand could rise by many orders of magnitude by 2030 [Satellite Catapult / Ofcom]. Growth is supported by advancements in satellite technology. Commercial satellite operators are investing greatly in the development of new GEO satellites with enhanced capabilities (from 260 Gbps in

2019 to 1,000 Gbps in 2020) through novel frequency reuse and spot beam technologies. Others (eg, OneWeb) are investing in new high-throughput satellites in LEO / MEO to provide high-speed broadband services with low-latency levels. Prominent players in the commercial satellite market are Lockheed Martin Corporation, Space Systems/Loral, LLC, Airbus SE (and Surrey Satellite), The Boeing Company, and Thales Group.

UK Position: whilst the UK has a relatively small share of the upstream markets for data provision, it has a disproportionate share of downstream sectors, including terminals, modems, data processing and software services etc. Through investment in major international programmes (OneWeb), our capabilities for satellite manufacture and launch, and continued leadership in end-user applications, devices and services, the UK has the potential to significantly increase its share of the global satellite communication market.

LOCATION-BASED-SIGNAL SERVICES

The global market for location-based services (LBS) and Real-Time Location Systems (RTLs) is valued at £15.32 billion (2020) and is forecast to reach £33.75 billion by 2025 at a 17.1% CAGR³⁴ (and £74.30 billion by 2030). Key drivers for growth include: 1) Growth in number and diversity of applications utilising geospatial data, 2) The proliferation of location-based apps amongst consumers, 3) Increased adoption by industry, and 4) Growing demand for marketing based on geospatial location. Real time location data enables important applications, such as asset tracking, mapping and navigation, marketing and

advertising, and location-based services, for key sector verticals including transport and logistics (including autonomous vehicles), retail, government, manufacturing, tourism and hospitality, healthcare and life-sciences, media and entertainment, energy and utilities, finance and insurance, disaster and natural resource management etc. Important companies include ALE International, Teldio Corporation, Cisco Systems Inc., Creativity Software Ltd., DigitalGlobe Inc. (Maxar Technologies), Ericsson Inc., IndoorAtlas Ltd, Esri Technologies Ltd., Communications Inc., Google LLC, HERE Global B.V., HPE Aruba Inc., IBM Corporation, Intel Corporation, Microsoft Corporation, Qualcomm Technologies Inc., and TeleMapics LLC

UK Position: whilst the UK does not currently have sovereign PNT satellite assets, we have developed key capabilities and strengths in the use of such data for a broad range of application sectors, ranging from consumer apps through to industry, agriculture, health and life sciences, transport etc. The UK is well positioned to build on these strengths.

³⁴ Location-Based Services (LBS) and Real-Time Location Systems (RTLs) Market by Component (Platform, Services and Hardware), Location Type (Indoor and Outdoor), Application, Vertical, Region - Global Forecast to 2025, Markets and Markets

REMOTE SENSING / EARTH OBSERVATION DATA AND SERVICES

The global market for commercial **Earth Observation** data and services (excluding upstream activities) is estimated at ~£3.96 billion (£1.38 billion data and £2.58 billion value added services) and is forecast to reach £7.32 billion – £10.55 billion by 2030 at a CAGR of 5.69% – 10.3%^{35 36}. Growth is driven by the emergence of new (and expansion of existing) end-user applications enabled by continued enhancements in EO spatial, spectral, and temporal resolution. To date, more than 50 companies have announced their intention to launch earth observation satellites, the majority small-/cube-sat constellations (representing >1,800 satellites and an investment of >\$800 million), primarily competing for lower resolution but higher revisit rate data. These satellites will significantly enhance data availability/accessibility and place pressure on pricing.

The existing market is dominated by security, defence, and military applications (~33%), followed by agriculture (~9%), emergency services (~7%), environmental monitoring (~6%), and a diverse range of other applications (figure 13)³⁷.

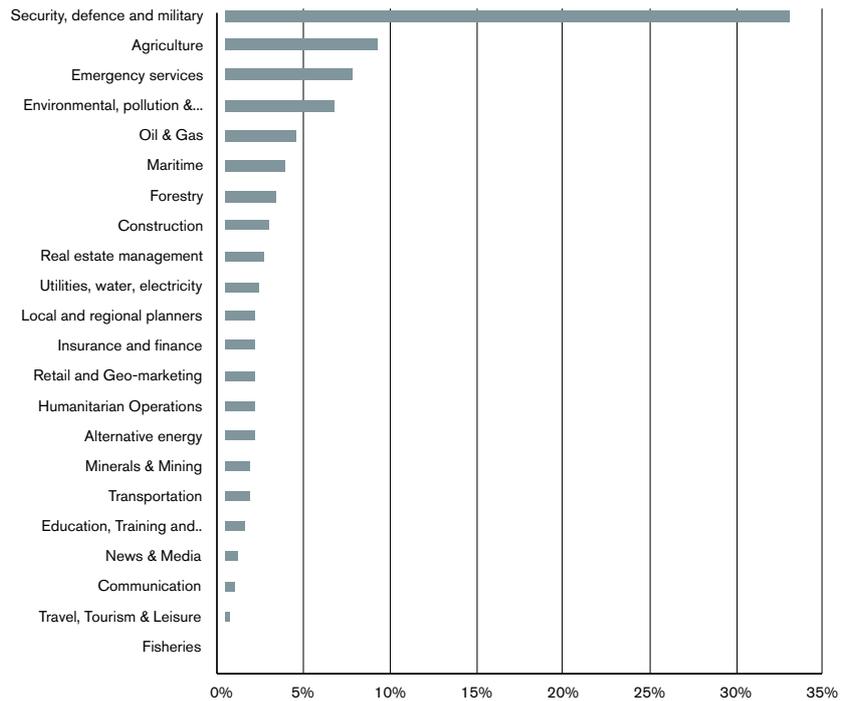


FIGURE 13. MARKET SHARE FOR EARTH OBSERVATION APPLICATIONS (SOURCE: EARSC REPORT³⁸)

A majority of the market is held by north America (~40%), Europe (26%), and Asia (21%). Key market players include Airbus Defence and Space, Ball Aerospace & Technologies Corp, Boeing Company, DigitalGlobe, Esri, ImageSat International N.V., Maxar Technologies Ltd, Mitsubishi Electric Group, Planet Labs Inc, Satellite Imaging Corp, Thales Group, and UrtheCast.

UK Position: Whilst the UK is currently the fourth largest market within Europe (11.9%) (figure 14), behind France (24.3%), Italy (23.7%), and Germany (11.9%), our market is experiencing rapid growth (6.5% CAGR), compared to -1% – 0.3% for France, Italy and Germany³⁸. In particular, the UK shows particular strengths / growth within disruptive NewSpace (Space 2.0) EO applications (utilising data from emerging satellite constellations combined with cloud computing, big data, AI, virtual/augmented reality technologies), representing 17.9% European market share, second only to Germany (figure 15). Our strengths in small-/cube- satellite manufacture combined with key enabling technologies (such as AI, data sciences etc) ideally position the UK to drive areas of leadership in the EO sector.

³⁵ Earth observation data and services market, Euroconsult

³⁶ StrategyR – Satellite remote sensing – Global market trajectory and analysis

³⁷ A survey into the state and health of the European EO services industry, EARSC with the support of ESA

³⁸ The state of commercial earth observation, Size & Growth across ESA member states, London Economics

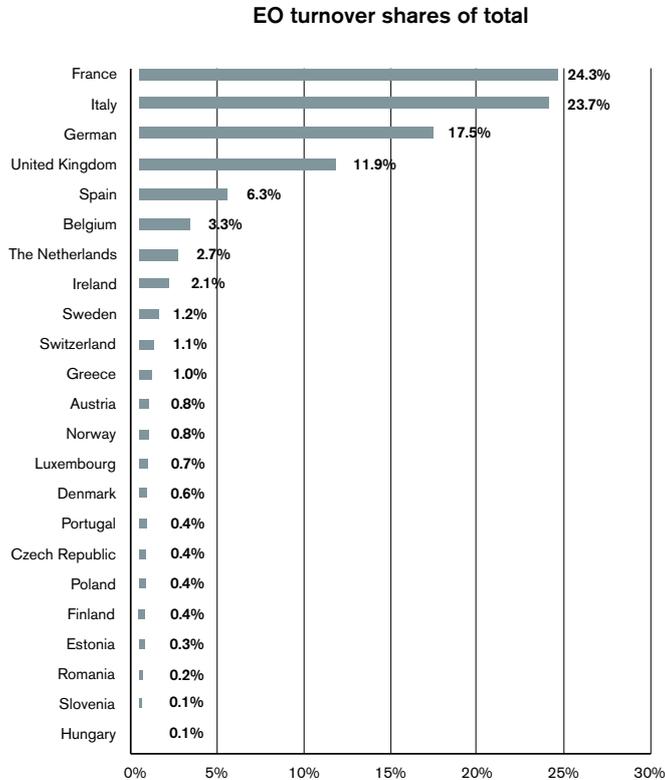


FIGURE 14. EUROPEAN MARKET SHARE BY NATION (SOURCE: LONDON ECONOMICS⁴⁰)

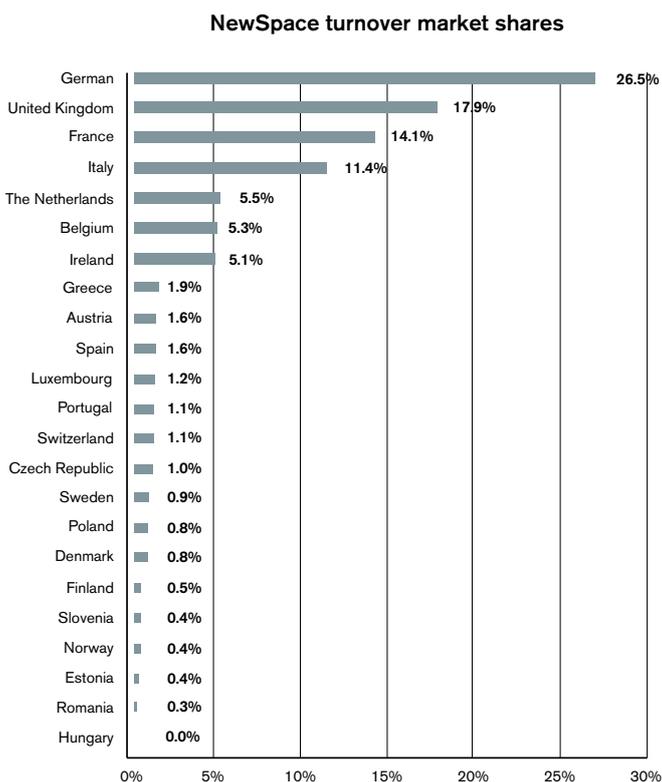


FIGURE 15. NEWSPACE EUROPEAN MARKET SHARE (SOURCE: LONDON ECONOMICS⁴⁰)



THE GLOBAL SPACE INDUSTRY IS VALUED AT £315 BILLION (\$366 BILLION IN 2019) AND IS FORECAST TO REACH £480 BILLION (\$558 BILLION) BY 2026 AT A CAGR OF 5.6%⁶. VALUE-CHAIN SECTORS OF GREATEST RELEVANCE TO THE WEST MIDLANDS INCLUDE UPSTREAM SPACE MANUFACTURE (PRIMARILY MATERIALS, COMPONENTS, AND ASSEMBLIES) AND DOWNSTREAM SPACE APPLICATIONS (PRIMARILY WITHIN AUTOMOTIVE, RAIL, MODERN PROFESSIONAL SERVICES, HEALTH AND WELLBEING, AND AGRICULTURE).

TOP-DOWN ASSESSMENT OF THE MARKET POTENTIAL FOR SPACE APPLICATIONS

We have undertaken a top-down assessment of the market potential for the UK and West-Midlands within the future Satellite Communications (figure 16, Table 1), Location Based Services (figure 16, Table 2), and Earth Observation (figure 16, Table 3), assuming:

- An initial market share of 5% and 1% for the UK and West Midlands (respectively),
- The UK is able to achieve a 10% share of the global market by 2030 with linear growth,
- The West Midlands is able to achieve a 10% share of the UK market by 2030 with linear growth.

We believe a 10% share of the UK market is realistic as this represents only a marginal increase beyond the West Midlands total share of the UK market (~7.5%) and is in line with our existing markets of strength, which range from ~8.5% for agriculture, ~10% for aerospace, to ~30% for automotive.

We estimate an existing UK and West Midlands market share for these downstream space applications of £1.93 billion and £19.33 million (respectively), roughly in-line the assessments of the 2018 London Economics report.

ASSUMING MARKET GROWTH PREDICTIONS, WE FORECAST UK AND WEST MIDLANDS GROWTH POTENTIAL OF UP TO £13.19 BILLION AND £1.32 BILLION (RESPECTIVELY) BY 2030 FOR THESE TARGET MARKETS.

| Table 1 – Satellite Communication Market | | | |
|--|-----------|-----------|------------|
| | 2020 | 2025 | 2030 |
| Market Value (£ million) | 19,370.00 | 28,996.00 | 47,032.00 |
| UK Market Share (5% baseline) | 968.50 | 1,449.80 | 2,351.60 |
| UK Market Share (% growth) | 5% | 7.50% | 10% |
| UK Market Share (growth, £ million) | 968.50 | 2,174.70 | 4,703.20 |
| West Midlands Share of UK Market (1% baseline) | 9.69 | 2,174.70 | 4,703.20 |
| West Midlands Share of UK Market (growth) | 1% | 5% | 10% |
| West Midlands Share of UK Market (growth, £ million) | 9.69 | 108.74 | 470.32 |
| Table 2 – Location Based Services Market | | | |
| | 2020 | 2025 | 2030 |
| Market Value (£ million) | 15,324.00 | 33,741.00 | 74,293.00 |
| UK Market Share (5% baseline) | 766.20 | 1,687.05 | 3,714.65 |
| UK Market Share (% growth) | 5% | 7.50% | 10% |
| UK Market Share (growth, £ million) | 766.20 | 2,530.58 | 7,429.30 |
| West Midlands Share of UK Market (1% baseline) | 7.66 | 25.31 | 74.29 |
| West Midlands Share of UK Market (growth) | 1% | 5% | 10% |
| West Midlands Share of UK Market (growth, £ million) | 7.66 | 126.53 | 742.93 |
| Table 3 – Earth Observation Market | | | |
| | 2020 | 2025 | 2030 |
| Market Value (£ million) | 3,960.00 | 6,267.00 | 10,555.00 |
| UK Market Share (5% baseline) | 198.00 | 323.35 | 527.75 |
| UK Market Share (% growth) | 5% | 7.50% | 10% |
| UK Market Share (growth, £ million) | 198.00 | 485.03 | 1,055.50 |
| West Midlands Share of UK Market (1% baseline) | 1.98 | 4.85 | 10.56 |
| West Midlands Share of UK Market (growth) | 1% | 5% | 10% |
| West Midlands Share of UK Market (growth, £ million) | 1.98 | 24.25 | 105.55 |
| Table 4 – Combined Space Applications Markets | | | |
| | 2020 | 2025 | 2030 |
| Market Value (£ million) | 38,654.00 | 69,204.00 | 131,880.00 |
| UK Market Share (5% baseline) | 1,932.70 | 3,460.20 | 6,594.00 |
| UK Market Share (% growth) | | | |
| UK Market Share (growth, £ million) | 1,932.70 | 5,190.30 | 13,188.00 |
| West Midlands Share of UK Market (1% baseline) | 19.33 | 51.90 | 131.88 |
| West Midlands Share of UK Market (growth) | | | |
| West Midlands Share of UK Market (growth, £ million) | 19.33 | 259.52 | 1,318.80 |

FIGURE 16. TOP-DOWN ASSESSMENT OF UK AND WEST MIDLANDS SPACE APPLICATION MARKETS (AUTHOR: ROB BEVAN)

BOTTOM-UP ASSESSMENT OF THE MARKET POTENTIAL FOR SPACE APPLICATIONS

We believe this growth potential can be realised through our core areas of application strength:

Automotive: Important satellite applications for the automotive sector include 'Connected and Autonomous Vehicles' (vehicle-to-vehicle communications, navigation and location-based services, and autonomous vehicle operation), and 'Road Traffic Management' (emissions/air quality monitoring, asset surveillance and monitoring, roadside communications, location-based services for road charging, and emergency services). Key activities for UK companies include mobile broadband solutions, resell of PNT services (and integration into OEM manufacture), manufacture of flat panel antenna, systems integration (hardware and software), value added data processing, and direct traffic management services.

The Satellite Applications Catapult has undertaken an assessment^{18,19} of the potential market for these opportunities. We have supplemented this analysis with additional market data (figure 17, Tables 1 and 2).

WHILST THESE FORECASTS INCLUDE BOTH SPACE APPLICATIONS AND END-USER COMPANIES, THEY CLEARLY HIGHLIGHT THE SIGNIFICANT (£500 MILLION+) MARKET POTENTIAL FOR THE WEST MIDLANDS SPACE INDUSTRY WITHIN THIS SECTOR, ESPECIALLY CONCERNING CONNECTED AND AUTONOMOUS VEHICLES.

RAIL

Digital Railway (UK) and European Rail Traffic Management (ERTMS) represents major sector drivers. Space application areas supporting this vision include 'Broadband to Trains (connectivity)', 'Rail Traffic Management', and 'Infrastructure Management'. Key activities for UK space companies include mobile broadband solutions, resell of PNT services, manufacture of flat panel antenna, value added data processing (and earth observation services), infrastructure and hazard monitoring solutions, etc.

| Table 1 – Space Markets for Connected and Autonomous Vehicles | | | | |
|---|-----------------|------------------|------------------|--------|
| | 2020 | 2025 | 2030 | CAGR |
| Vehicle-to-vehicle communications (£ million) | 169.77 | 216.45 | 276.26 | 4.90% |
| Location-based services / Navigation systems (£ million) | 75.62 | 121.68 | 195.79 | 10.00% |
| Connected and autonomous vehicles (£ million) | 8,928.00 | 21,171.13 | 53,377.00 | 19.58% |
| Total (£m) | 9,173.39 | 22,171.13 | 53,849.05 | |
| West Midlands Share of UK Market (1% baseline) | 91.73 | 221.71 | 538.49 | |
| West Midlands Share of UK Market (growth) | 1% | 5% | 10% | |
| West Midlands Share of UK Market (growth, £ million) | 91.73 | 1,108.56 | 5,384.91 | |

| Table 2 – Space Markets for Road Traffic Management | | | | |
|---|--------------|--------------|--------------|-------|
| | 2020* | 2025 | 2030 | CAGR |
| Emissions / air quality monitoring (£ million) | 4.30 | 6.04 | 8.47 | 7.00% |
| Asset surveillance and monitoring (£ million) | 21.52 | 30.18 | 42.34 | 7.00% |
| Roadside communications (£ million) | 6.89 | 9.66 | 13.55 | 7.00% |
| Location-based services for road charging (£ million) | 12.91 | 18.11 | 25.41 | 7.00% |
| Emergency Services (£ million) | 4.30 | 6.04 | 8.47 | 7.00% |
| Total (£ million) | 49.92 | 70.03 | 98.24 | |
| West Midlands Share of UK Market (1% baseline) | 0.50 | 0.70 | 0.98 | |
| West Midlands Share of UK Market (growth) | 1% | 5% | 10% | |
| West Midlands Share of UK Market (growth, £ million) | 0.50 | 3.50 | 9.82 | |

* Market figures estimated from Satellite Applications Catapult market report

FIGURE 17. POTENTIAL MARKETS FOR AUTOMOTIVE SPACE APPLICATIONS

Whilst it is difficult to assess the direct market for space applications within the rail sector, we are able to understand the scale of the opportunity from the size and growth of key railway markets:

- Global Smart Railways (including connectivity and networking) valued at £17.65 billion (2019) and forecast to reach £33.58 billion by 2024 at a CAGR of 13.7%³⁹. Europe holds a 54.5% share of this market [Market Research Europe], with the UK playing a pivotal role.
- Global Railway Signalling Systems valued at £8.33 billion and forecast to reach £18.86 billion by 2028 at a CAGR of 9.5%⁴⁰.
- Global Rail Asset Management valued at £8.09 billion and forecast to grow to £10.85 billion by 2025 at a CAGR of 5.9%⁴¹.

IT IS NOT UNREASONABLE TO ASSUME THAT SPACE APPLICATIONS (AND SPACE ENABLED SOLUTIONS) COULD REPRESENT A £1 BILLION+ OPPORTUNITY FOR THE UK AND £100 MILLION+ OPPORTUNITY FOR THE WEST MIDLANDS.

MODERN (PROFESSIONAL) SERVICES

It is anticipated that initial key space applications for modern professional services (within the West Midlands) will include 'Insurance Services' and 'Property Technology'.

WHILST IT IS DIFFICULT TO ESTIMATE THE DIRECT SPACE APPLICATIONS MARKET FOR INSURANCE AND PROPTech, WE KNOW THAT UP TO ~21% OF EARTH OBSERVATION ACTIVITIES ARE ASSOCIATED WITH THESE ACTIVITIES (SEE FIGURE 13, PAGE 63), INCLUDING ENVIRONMENT, POLLUTION AND CLIMATE MONITORING, INSURANCE AND FINANCE, CONSTRUCTION, REAL-ESTATE MANAGEMENT, AND LOCAL AND REGIONAL PLANNING, REPRESENTING A UK MARKET OF >£220 MILLION BY 2030 (>£22.04 MILLION IN THE WEST MIDLANDS). THIS ESTIMATE EXCLUDES SATELLITE COMMUNICATION AND PNT SERVICES THAT CAN BE EXPECTED TO MORE THAN TRIPLE THESE FORECASTS (>£660 MILLION AND £66 MILLION FOR THE UK AND WEST MIDLANDS RESPECTIVELY). THESE FIGURES ALSO EXCLUDE DOWNSTREAM APPLICATIONS ENABLED BY SUCH SATELLITE SERVICES THAT MIGHT BE EXPECTED TO INCREASE THE MARKET VALUE BY 10-FOLD.

HEALTH AND WELLBEING

Space applications for health support the delivery of healthcare services within remote locations and areas affected by natural disasters, patient monitoring (within the home) and assisted living, disease surveillance and control activities, navigation of emergency services, healthcare modelling and prediction (public health management), and health infrastructure and logistics, to name but a few applications.

WHILST WE ARE YET TO CALCULATE THE VALUE OF THE SPECIFIC SPACE APPLICATION MARKET FOR HEALTH, IT IS NOT DIFFICULT TO APPRECIATE THAT THE POTENTIAL MARKETS FOR GROWTH ARE VERY LARGE. FOR EXAMPLE, TELEHEALTH/TELEMEDICINE ALONE REPRESENTS A £33.32 BILLION GLOBAL MARKET FORECASTED TO REACH £165.04 BILLION BY 2025 AT A CAGR OF 37.7%⁴². IT IS NOT UNREASONABLE TO ASSUME THAT BY 2030 SPACE APPLICATIONS FOR HEALTHCARE WILL REPRESENT A MARKET FOR THE UK AND WEST MIDLANDS OF £1 BILLION+ AND £100 MILLION+ (RESPECTIVELY).

AGRICULTURE

Within agriculture satellite applications contribute to sustainable intensification and food security in arable and livestock farming. Whilst UK farms are typically smaller than those found in the US or many mainland European nations (representing a relatively small domestic market), they represent an ideal market for developing and demonstrating technologies/services that may then be sold to larger farms in the EU and US (existing markets) and developing nations (future markets).

AGRICULTURE REPRESENTS AN ESTABLISHED MARKET FOR SPACE APPLICATIONS. THE GLOBAL MARKET FOR PRECISION AGRICULTURE ALONE IS ESTIMATED AT £6.03 BILLION (2020) AND FORECAST TO REACH £11.02 BILLION BY 2025 AT A CAGR OF 12.7%⁴³, WITH EARTH OBSERVATION SERVICES REPRESENTING A >£344 MILLION MARKET SHARE (FIGURE 13). IT IS NOT UNREASONABLE TO ASSUME THAT BY 2030 SPACE APPLICATIONS FOR AGRICULTURE WILL REPRESENT A MARKET FOR THE UK AND WEST MIDLANDS OF £1 BILLION+ AND £100 MILLION+ (RESPECTIVELY).



GROWTH IS SUPPORTED BY ADVANCEMENTS IN SATELLITE TECHNOLOGY. COMMERCIAL SATELLITE OPERATORS ARE INVESTING GREATLY IN THE DEVELOPMENT OF NEW GEO SATELLITES WITH ENHANCED CAPABILITIES (FROM 260 GBPS IN 2019 TO 1,000 GBPS IN 2020) THROUGH NOVEL FREQUENCY REUSE AND SPOT BEAM TECHNOLOGIES.

³⁹ Smart Railways Market by Solution (Rail Asset Management & Maintenance, Operation & Control, PIS, Communication & Networking, Security & Safety, and Rail Analytics) and Service (Professional and Managed), and Region – Global Forecast to 2024, Research and Markets

⁴⁰ Railway Signalling Systems Market Size, Market Share, Application Analysis, Regional Outlook, Growth Trends, Key Players, Competitive Strategies and Forecasts, 2020 To 2028, Research and Markets

⁴¹ Rail Asset Management Market by Offering (Solutions (Condition Monitoring, Predictive Maintenance, Security, Asset Planning & Scheduling) and Services), Application (Rolling Stock and Infrastructure), Deployment Mode, and Region - Global Forecast to 2025, Markets and Markets

⁴² Telehealth/Telemedicine Market by Component, Application, Hardware, End-User, Delivery – Global Forecast to 2025, Markets and Markets

⁴³ Precision Farming Market by Technology, Application, Offering and Geography – Global Forecast to 2025, Markets and Markets

POTENTIAL MARKET GROWTH SCENARIOS FOR THE UK AND WEST MIDLANDS

We have forecasted the UK and West Midlands space markets utilising low to high ambition scenarios (figures 18, 19, and 20).

For the global space market (line 1) we have assumed an existing market value of £332,743,000 with a CAGR of 5.6%⁶.

For the UK market (figure 18, lines 2–4) our range includes:

- A low value scenario, assuming the UK maintains a flat 5% share of the global space market. This scenario would see the UK market grow to £28.69 billion by 2030 (5.6% CAGR) and represents our baseline, and
- A target (higher value) scenario whereby the UK is able to capture a 10% share of the global market by 2030, in line with strategic policy objectives. This scenario would see the UK market grow to £57.38 billion by 2030 (13.18% CAGR).

| Forecasted Global, UK and West Midlands Markets (including Low-, High- and Target-Scenario Forecasts) – £ millions | | | | | | | | | | | | | | | |
|--|------------|-----|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| | Scenario | No. | | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | CAGR |
| | | 1 | Global Space Market | 332,743 | 351,377 | 371,054 | 391,833 | 413,775 | 436,947 | 461,416 | 487,255 | 514,541 | 543,356 | 573,784 | 5.60% |
| UK Market | Low V High | 2 | Low Scenario Forecast (UK Market = 5% Global) | 16,637 | 17,569 | 18,553 | 19,592 | 20,689 | 21,847 | 23,071 | 24,363 | 25,727 | 27,168 | 28,689 | 5.60% |
| | | 3 | UK Space Market (% growth) | 5% | 5.5% | 6% | 6.5% | 7% | 7.5% | 8% | 8.5% | 9% | 9.5% | 10% | |
| | | 4 | Target Scenario Forecast (UK Market = 10% Global) | 16,637 | 19,326 | 22,263 | 25,469 | 28,964 | 32,771 | 36,913 | 41,417 | 46,309 | 51,619 | 57,378 | 13.18% |
| | | | | | | | | | | | | | | | |
| West Midlands Market | Low V High | 5 | Low Scenario Forecast (UK Market = 5% Global and WM = 1% UK) | 166 | 176 | 186 | 196 | 207 | 218 | 231 | 244 | 257 | 272 | 287 | 5.60% |
| | | 6 | WM Space Market (% growth) | 1% | 1% | 2% | 3% | 4% | 5% | 6% | 7% | 8% | 9% | 10% | |
| | | 7 | High Scenario Forecast (UK Market = 10% Global and WM = 10% UK) | 166 | 193 | 445 | 764 | 1,159 | 1,639 | 2,215 | 2,899 | 3,705 | 4,646 | 5,738 | 42.48% |
| | Targeted | 8 | Targeted Scenario Forecast (UK Market = 10% Global within target niches) | 166 | 209 | 262 | 330 | 415 | 522 | 656 | 825 | 1,037 | 1,304 | 1,640 | 25.74% |

FIGURE 18. FORECASTED GLOBAL, UK AND WEST MIDLANDS SPACE INDUSTRY MARKETS (LOW TO HIGH SCENARIOS) [AUTHOR: ROB BEVAN]

Figure 19 shows the range of these two scenarios.

For the West Midlands market we first defined our upper and lower ranges (figure 18, lines 5–7, and figure 20). These include:

- a baseline (low forecast) scenario assuming that the UK retains a 5% share of the global market, and that the West Midlands retains a 1% share of the UK market. Within this scenario the West Midlands Space market would grow from £166 million (2020) to £287 million by 2030 at a CAGR of 5.6%.
- an upper (high forecast) scenario assuming that the UK is able to achieve its growth target to 10% of the global market, and that the West Midlands is able to capture a 10% share of the UK market. Within this scenario the West Midlands Space market would grow from £166 million (2020) to £5.74 billion by 2030 at a CAGR of 42.48%.

WE THEN PLOTTED GROWTH TOWARDS REALISATION OF THE COMBINED MARKET POTENTIAL FOR OUR TARGET NICHE MARKETS (SPACE MANUFACTURE AND SPACE APPLICATIONS) ASSUMING CONSTANT GROWTH (FIGURE 18, LINE 8, AND FIGURE 20). WITHIN THIS SCENARIO THE WEST MIDLANDS SPACE MARKET WOULD GROW FROM £166 MILLION (2020) TO £1.64 BILLION BY 2030 AT A CAGR OF 25.74%. THIS SCENARIO FALLS WELL WITHIN THE LOW TO HIGH SCENARIO RANGE AND IS THUS BELIEVED TO BE REALISTIC.

UK Space Industry (Low- and Target Scenario Forecasts)

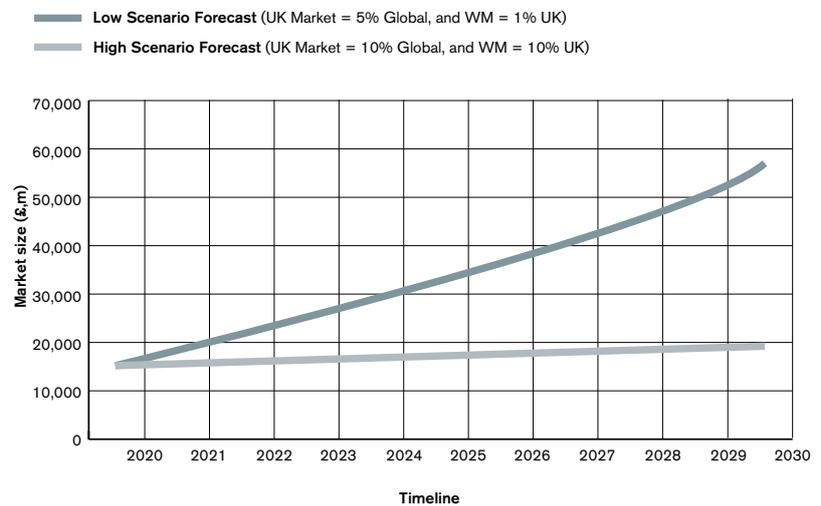


FIGURE 19. UK SPACE INDUSTRY (LOW TO HIGH SCENARIOS) [AUTHOR: ROB BEVAN]

West Midlands Space Market (Low-, High-, and Target Scenario Forecasts)

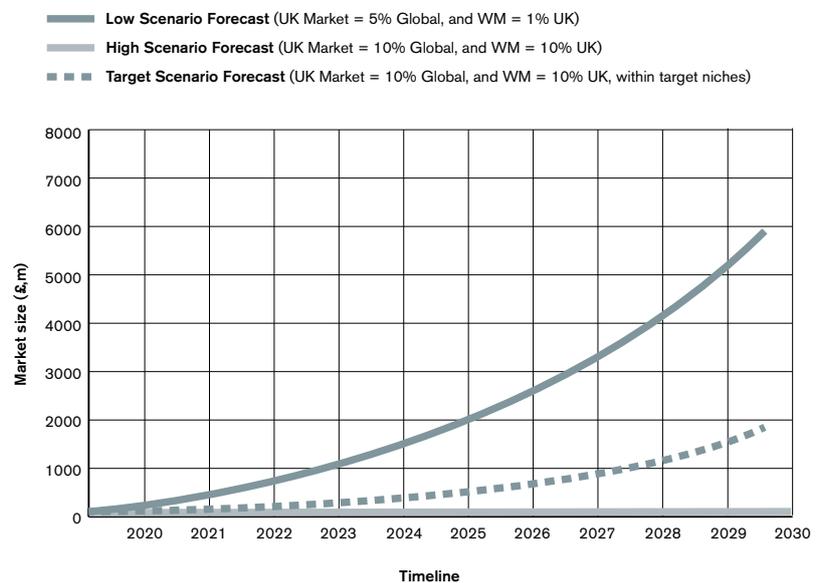


FIGURE 20. WEST MIDLANDS SPACE INDUSTRY (LOW TO HIGH SCENARIOS) [AUTHOR: ROB BEVAN]

NEXT STEPS

Do Nothing: Moving forward, one potential option is to 'do nothing'. Under this scenario, it is highly unlikely that the West Midlands share of the space market would increase beyond its existing position (~1% share of the UK market) and is in fact more likely to decrease as other regions rise to the opportunity. If we do not act quickly enough, it is also likely that we will lose any competitive advantage gained through our regional strengths and will move into a position of playing 'catch-up'.

Action Plan: A far better strategy is to take the initiative and gain competitive advantage and leadership through our strengths. We have identified both 'core-' and 'optional-' actions towards the development of a West Midlands Space Cluster.

'Core Actions' provide the basis upon which the cluster will be built and include:

- Action 1 – Implementation Strategy and Business Case
- Action 2 – Cluster Set-Up and Operation
- Action 3 – Thematic Leaders

Action 1 – Implementation Strategy and Business Case. Will lay the foundation and strategy for implementation of a regional space cluster. Within the scope of our initial UKSA project we mobilised regional (and national) stakeholders; identified our regional strengths with latent space potential; understood how these align with opportunities presented by the emerging space industry; explored the challenges and barriers to addressing these opportunities; defined a vision for the future West Midlands space industry; and identified key actions to the realisation of this vision. These activities have resulted in a top-level strategy and business case that enables the opportunity in the West Midlands to be understood.

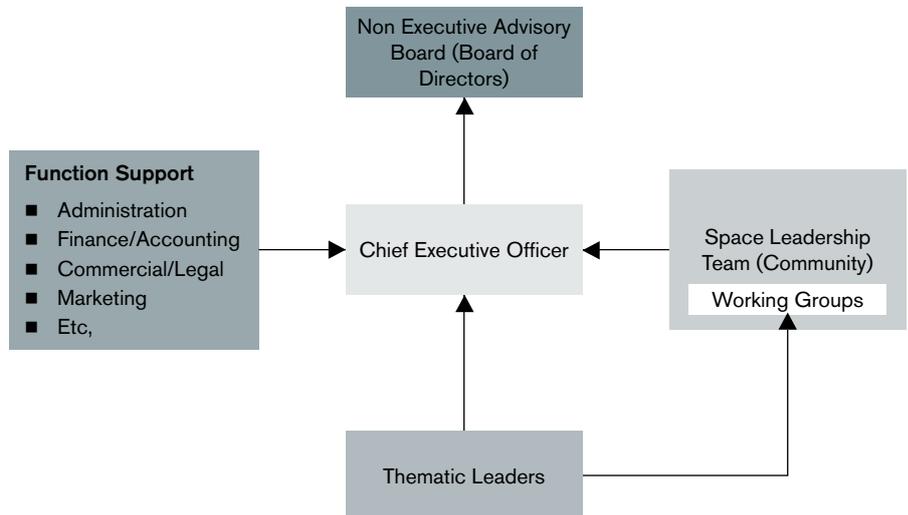


FIGURE 21. SPACE CLUSTER OPERATIONAL STRUCTURE

We believe the next step in our journey is to undertake a more robust assessment of the opportunity, working with key regional stakeholders, to define a detailed strategy and business case for implementation. This will ensure that the cluster has the optimum focus and approach prior to launch. Activities will include a detailed assessment of the identified upstream and downstream opportunities (including a West Midlands Space Directory), target policy objectives, cluster approach, plan for implementation, management and operational structure, actions and costings, business case etc. This business case will be used to secure investment from both public and private sector organisations.

Action 2 – Cluster Set-Up and Operation. We will recruit a cluster CEO to establish the foundational components of the cluster and lead its continued development and growth. This will include establishment of the operational and management structures and procedures (figure 21), identification and leverage of regional assets, anchor institutions and facilities, clustering of key stakeholders and space activities, definition of the cluster policy objectives and strategy, establishment of working groups around key policy objectives/thematic areas, and implementation of networking and awareness raising events, including signposting to existing opportunities and support.



Action 3 – Thematic Leaders. Will recruit one or more thematic leaders who will act as cluster champions for specific priority areas and will proactively drive progress towards achievement of key policy objectives. We envisage three thematic leaders, one who will lead the upstream space manufacturing priority area, and two who will lead the downstream space application priority areas. The thematic leaders will report into the cluster CEO. Thematic leaders will be responsible for mobilising key stakeholders and activities, leading thematic working groups, driving the strategy and agenda, leveraging available resources and support, and defining structured programmes of support around specific policy objectives.

In Table 6, we identify how these actions support delivery of the cluster roadmap.

We have also identified a range of ‘**optional actions**’ that will facilitate, reinforce, and accelerate realisation of our policy objectives and maximise impact, that will be investigated further under option 1. These include:

■ **Optional Action 1 – Dedicated Innovation Consultancy Vouchers:** that provide direct funding to companies to help them explore space-related opportunities and address specific challenges or barriers to progressing their business idea. They are aimed at businesses that traditionally focus on other (non-space) advanced manufacturing sectors, such as aerospace, automotive and energy. Working with the Manufacturing Technology Centre and Midlands Aerospace Alliance, we have been able to identify that these businesses have a ‘high-potential’ to pivot/diversify into the space sector. The purpose of the vouchers is to help business owners develop a clearer understanding of the potential of a business idea or innovation

and to produce an action plan that recipients can use with potential investors (or make the case internally for investment where a business is considering pivoting towards the sector). This will allow them to unlock further R&I and/or business development investment either through internal funding and or external private and public funding (eg, UK Space Agency, ESA, Innovate UK, Horizon Europe etc) ultimately leading to business growth. Vouchers will also be used to facilitate collaboration between cluster members.

- **Optional Action 2 – Skills and Training:** providing dedicated space related skills and training meeting specific identified needs not currently addressed by existing initiatives. This might include:
- the development of internships within local companies for undergraduates and postgraduates to improve retention of STEM graduates within the region as well as improve the employability and entry into work of graduates from the region’s universities. There are existing models for delivering these kinds of internships that could be adapted with support of sector champions,
 - Technical and degree apprenticeships,
 - Outreach activities to schools and colleges in the region building existing schemes such as Aim Higher that also provide opportunities for disadvantaged and underrepresented groups,
 - Apprenticeships for older workers displaced by economic shocks in the region that have potential transferable skills,
 - Working with university and colleges to develop modules around the opportunities in the sector, and
 - Identification and provision of training in advanced level skills.

■ **Optional Action 3 – Space Incubator / Accelerator:** access to dedicated incubator space and/or accelerator programmes to increase the number and growth of space start-ups and/or pivots.

■ **Optional Action 4 – Cluster Facilities:** investment in dedicated cluster facilities and equipment needed to address regional research and innovation weaknesses/needs and to drive international recognition and leadership within our target niches. In the short-term we envisage a centre providing dedicated design, prototyping, and testing support for upstream manufacture, and downstream and end-user applications. In the medium- to long-term we envisage a public-private applied research and innovation centre.

■ **Optional Action 5 – Structured Programmes:** investment in structured programmes of activity targeting realisation of strategic policy objectives (typically defined by the thematic leaders and their working groups).

In Table 6 we outline how these optional actions support delivery of the cluster roadmap.

A summary of the core and optional actions and their associated teams, goals, outcomes, and ‘rough order of magnitude’ (ROM) costs is shown in Table 7 (pages 64–67).

COST-BENEFIT ANALYSIS (SHORT- AND LONG- TERM)

Our short-term strategy assumes implementation of all three core services:

| Activity | Year 1 | | | | Year 2 | | | | Year 3 | | | | Year 4 | | Estimate Cost |
|--|--------|----|----|----|--------|----|----|----|--------|----|----|----|--------|-------------------|-----------------------|
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | |
| Option 1: Strategy and Business Case | | | | | | | | | | | | | | | £75,000 |
| Option 2: Cluster Set-Up and Operation | | | | | | | | | | | | | | | £750,000 ¹ |
| Option 3: Thematic Leaders (x3) | | | | | | | | | | | | | | | £802,500 ² |
| Total Cost | | | | | | | | | | | | | | £1,627,500 | |

¹ assumes a cost of £250,000/year over three years (see Table 7)

² assumes a cost of £133,750/year for three thematic leaders over two years (see Table 7)

Our short-term strategy has a **3.5-year cost of £1,627,500**.

Anticipated benefits to result from these activities include:

| Activity | Duration (Years) | Research and Innovation | | | Business Development | | | Apprenticeships (skilled staff) ³ |
|---|------------------|-------------------------|----------------------|--------------|----------------------|----------------------|--------------|--|
| | | Investment £ million | GDP Growth £ million | Jobs | Investment £ million | GDP Growth £ million | Jobs | |
| Action 1: Strategy and Business Case | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Action 2: Cluster Set-Up and Operation ¹ | 3 | 12 | 87.6 | 249 | 3 | 6.9 | 19.5 | 90 |
| Action 3: Thematic Leaders (x3) ² | 2 | 42 | 306.6 | 864 | 18 | 41.4 | 114 | 330 |
| Total Benefit | | 54 | 394.2 | 1,113 | 21 | 48.3 | 133.5 | 420 |

¹ assumes the action will facilitate an investment of £4 million/year in research and innovation (leading to £29.2 million/year GDP growth and 83 new jobs/year) and £1 million/year investment in business development activities (leading to £2.3 million/year GDP growth and 6.5 new jobs/year) (see Table 7)

² assumes the action (per thematic leader) will facilitate an investment of £7 million/year in research and innovation (leading to £51.1 million/year GDP growth and 144 new jobs/year) and £3 million/year investment in business development activities (leading to £6.9 million/year GDP growth and 19 new jobs/year) (see Table 7)

³ assumes 1 apprentice/ skilled staff per ~£950,000 GDP growth (in line with our vision targets)

Our short-term strategy has a **3.5-year cost of £1,627,500**.

Anticipated benefits to result from these activities include:

| Activity | Duration (years) | Cost £ | Research and Innovation | | | Business Development | | | Apprenticeships (skilled staff) |
|---|------------------|---------------|-------------------------|----------------------|--------------|----------------------|----------------------|--------------|---------------------------------|
| | | | Investment £ million | GDP Growth £ million | Jobs | Investment £ million | GDP Growth £ million | Jobs | |
| Option 1: Strategy and Business Case ¹ | 0.5 | £75K | 0 | 0 | 0 | 0 | 0 | 0 | |
| Option 2: Cluster Set-Up and Operation ¹ | 9 | £2.25m | 36 | 262.8 | 747 | 9 | 20.7 | 58.5 | |
| Option 3: Thematic Leaders (x3) ¹ | 8 | £3.21m | 168 | 1,226.4 | 3,456 | 72 | 165.6 | 456 | |
| Total | | £5.54m | 204 | 1,489.2 | 4,203 | 81 | 186.3 | 514.5 | |

¹ assumes annual cost and benefit (investment, GDP, and job) estimates outlined in Tables 7 and 8.



However, to realise these benefits we must ensure the **necessary resources and capabilities to translate R&I and BD investments into GDP growth and employment**. To mobilise such resources and capabilities, we anticipate further investments in initiatives such as dedicated innovation vouchers, skills and training, incubator facilities, accelerator programmes, dedicated research and innovation facilities, and structure support programmes (options 4–8). We are still to understand the scope and scale of these costs, however it is not unreasonable to assume that these could amount to £50 million+.

Our short-term strategy is forecast to result in a total investment of £54 million in research and innovation and £21 million business development activities, with the potential to lead to £442.5 million GDP growth, 1,246.5 jobs, and 390 apprenticeships.

Our long-term strategy is forecast to result in a total investment of £204 million in research and innovation and £81 million business development activities, with the potential to lead to £1.68 billion GDP growth, 4,717 jobs, and 1,470 apprenticeships.

TABLE 6: HOW OUR ACTION PLAN ALIGNS WITH AND WILL LEAD TO THE IMPLEMENTATION OF THE CLUSTER ROADMAP

| Cluster Roadmap Step | Work to date | Implementation Strategy and Business Case |
|--|---|---|
| Latent Space Potential | Top-level assessment identifying core competencies and strengths with latent space potential. | Detailed assessment and mapping of regional competencies and strengths with latent space potential. |
| Exploring Space Opportunities | Top-level assessment identifying key space value-chain and market segments of strength to the West Midlands. | Detailed assessment of our target value-chain and market niches to understand, map, and prioritise the specific opportunities of greatest relevance to the West Midlands. |
| Space Aligned Local Strategies | Definition of a top-level West Midlands space vision, strategy, and business case. | Definition of a detailed West Midlands vision, strategy, top-level roadmap, and business case. |
| Locally Led Space Support | Mobilisation of regional stakeholders within a broad Space Leadership Team. | Mobilisation of key stakeholders within the Space Leadership team to help guide assessment of the regional latent potential and opportunities, and development of the cluster strategy. |
| Anchor Facilities Built / Leveraged | Identification and initial engagement with key regional anchor facilities. | Engagement with key regional anchor facilities to understand their capabilities and potential role within the space cluster |
| Clustering of Space Activity | Identification of regional space related activities. | Engagement with regional space related activities to evaluate and understand their potential role and value. |
| Coordinated Space Clusters | Engagement and workshops with key stakeholders to define vision, challenges, and strategy. | Structured engagement and workshops with key stakeholders within each value-chain and market segment to further define the cluster vision, strategy, and roadmap. |
| Connected Space Region | Initial engagement with key national organisations and other regional clusters to better understand the UK landscape. | Engagement with national organisations and other regional clusters to evaluate and understand how the West Midlands could add value as part of a connected UK space landscape. |

| Cluster Set-Up and Operation | Thematic Leaders | Optional Actions |
|---|---|--|
| Continued assessment to identify and understand specific regional competencies and strengths, and the potential and requirements to pivot these into space applications. | Continued assessment of the latent space potential within each value-chain and market niche. | |
| Continued assessment of value-chain and market segments to identify and assess potential space opportunities of relevance to the West Midlands. | Continued assessment of space opportunities within each value-chain and market niche. | |
| Continued refinement and definition of the cluster vision and strategy. | Continued refinement and definition of the vision, strategy, and detailed roadmap for each target market niche. | |
| Recruitment of high-profile stakeholders within a core leadership team, responsible for overseeing and supporting the cluster strategy and implementation. Continued mobilisation of a broader regional stakeholder grouping. | Recruitment of high-profile stakeholders to the leadership team meeting the needs of the target market niches. | |
| Mobilisation of existing regional anchor facilities within the cluster network and activities. | Engagement with anchor facilities to support the development of facilities, activities, and services to meet the needs of specific market niches (policy goals). | Build of specialist support facilities and/or an applied research and innovation centre. |
| Mobilisation of regional stakeholders and space related projects, initiatives, infrastructure, expertise, and partnerships. | In-depth assessment and mobilisation of stakeholders and activities around defined market niches. | A range of dedicated activities to reinforce and accelerate realisation of policy objectives and to maximise impact. |
| Regular networking and awareness raising events and activities. Engagement with upstream and downstream customers. Mobilisation of working groups around defined goals and priorities. | Coordination and management of events, working groups, and activities within specific market niches towards defined policy goals. | Activities and resources to support the coordination of cluster activities. |
| Engagement with national organisations and other regional clusters to further understand and establish a connected UK space landscape. | Coordination of strategic programmes addressing defined policy goals. Coordination of activities with national and organisations and those in other regions, towards common goals in our defined market niches. | Structured strategic programmes mobilising a critical mass of activity and support to achieve defined policy objectives. |

RELATIONSHIP OF THESE ACTIONS TO THE 'MUST WIN' BATTLES AND 'REGIONAL POLICY OBJECTIVES'

Our 'core actions' seek to establish the cluster's operational structure, mobilise and coordinate key regional stakeholders and activities, and define and implement the cluster policy objectives and strategy. These actions primarily leverage resources and activities that are already available within the region.

The 'optional actions' on the other hand, primarily seek to provide new facilities, services, and resources that are not already within the region, to ensure the successful achievement of our research and innovation goals, that research and innovation potential is translated into economic and societal impact, and that we are able to realise international recognition and leadership within our chosen areas of specialism.

It can therefore be understood that, whilst our 'core actions' will enable the cluster to engage with upstream/downstream customers, mobilise and align our capabilities, initiate research and innovation projects, and establish new business start-ups (our first two must win battles for each sector); this potential will only convincingly be translated in recognised international leadership (our third must win battle for each sectors) and our target regional policy objective impacts through the mobilisation of our 'optional actions'.

TABLE 7: CLUSTER OPTIONS, OUTCOMES AND ROM COSTS

| Option | Team | Goals |
|---|---|---|
| <p>Action 1: Implementation Strategy and Business Case</p> | <ul style="list-style-type: none"> ■ Interim Cluster Lead/Consultant | <ul style="list-style-type: none"> ■ Assessment of specific upstream and downstream opportunities ■ Detailed cluster strategy and plan ■ Detailed business case ■ West Midlands Space Directory ■ Definition of operational structure ■ Mobilisation of non-executive advisory board ■ Detailed assessment of costings and options |
| <p>Action 2: Cluster Set-Up and Operation</p> | <ul style="list-style-type: none"> ■ Non-executive advisory board (key opinion/industry leaders) ■ Cluster CEO ■ Functional support services | <p>Will establish the foundational components of the cluster and lead its continued development and growth.</p> <ul style="list-style-type: none"> ■ Establishment of the cluster operational structure ■ Establishment of anchor facilities (leveraging existing regional assets) ■ Clustering of key stakeholders, projects, and initiatives ■ Establishment of key partnerships and collaborations (access to knowledge, networks, resources, and facilities) ■ Organisation and implementation of awareness raising and networking activities ■ Signposting of members to opportunities and support ■ Definition of a cluster vision, policy objectives, and strategy ■ Establishment of key working groups |
| <p>Action 3: Thematic Leaders</p> | <ul style="list-style-type: none"> ■ Thematic Leader ■ Functional support services | <p>Will lead specific priority areas within the cluster strategy. We envisage ~three thematic leads, spanning our target upstream and downstream priorities, reporting to the cluster CEO.</p> <ul style="list-style-type: none"> ■ Detailed assessment of thematic area capabilities, strengths, and opportunities ■ Define and drive implementation of a thematic area strategy and action plan ■ Proactive clustering, awareness raising, networking, and partnering around defined policy objectives ■ Leveraging of existing and or creation of new initiatives and services to support implementation of the strategy and action plan |

¹ Assuming an industry standard 7.3-fold GDP growth return for investment in research and innovation activities

² Assuming an industry standard 2.3-fold GDP growth return for investment in business development activities

| Top Level Outcomes (KPIs) | Justification of Outcomes | Rough Order of Magnitude Costs |
|--|---|---|
| <ul style="list-style-type: none"> ■ Cluster strategy and business case facilitating subsequent investment | | <p>ROM Cost = £75,000 (over six months)</p> |
| <ul style="list-style-type: none"> ■ Establishment of the West Midlands Space Cluster (management, facilities, members, and activities) ■ Facilitation of activities resulting in: <ul style="list-style-type: none"> □ £4 million+ R&I investment □ £1 million+ investment in business development ■ Leading to: <ul style="list-style-type: none"> □ £31.5 million GDP growth, and □ 89.5 jobs ■ 30+ space related apprenticeships | <ul style="list-style-type: none"> ■ £4 million investment in research and innovation with potential to result in £29.2 million GDP growth (and 83 jobs), assuming: <ul style="list-style-type: none"> □ 12 events per year, with 40+ attendees per event, leading to 40+ potential collaborations and 4+ projects, with an average value of £1 million/project, and □ 7.3-fold¹ GDP ROI for investment in R&I and £353K GDP/job³ ■ £1 million investment in business development activities with potential to result in £2.3 million GDP growth (and ~6.5 jobs), assuming: <ul style="list-style-type: none"> □ 10+ business support interventions (~1/ month), leading to ~£100,000 further investment in business development activities, with a 2.3-fold² GDP ROI (and £353,000 GDP/job³) ■ >30+ space related apprenticeships⁴ | <p>ROM Cost = £250,000 / year</p> <ul style="list-style-type: none"> ■ Non-executive advisory board = £20,000 (expenses) ■ CEO (1 FTE) = £87,500 (£70,000 salary + 25% overhead) ■ Support staff (1FTE) = £62,500 (average 50,000 salary + 25% overhead) □ Administration (0.5 FTE) □ Accounting (0.1 FTE) □ Marketing (0.3 FTE) □ Commercial/legal (0.1 FTE) ■ Office rent and rates = ~£10,000 ■ Travel = £15,000 ■ Networking Events = £25,000 ■ Annual Conference = £15,000 ■ Marketing = £10,000 ■ Other = £5,000 <p>While there is the possibility that some intuitions and OEMs may provide funding and support through benefit in kind initially for a secretariat and staff representatives on the Board, some public funding will be needed.</p> |
| <ul style="list-style-type: none"> ■ Establishment of thematic area strategy and plan ■ Facilitation of activities resulting in: <ul style="list-style-type: none"> □ £7 million+ R&I investment □ £3 million+ investment in business development ■ Leading to: <ul style="list-style-type: none"> □ £58 million GDP growth, and □ 163 jobs ■ 50+ space related apprenticeships | <ul style="list-style-type: none"> ■ £7 million investment in research and innovation with potential to result in £51.1 million GDP growth (and 144 jobs), assuming: <ul style="list-style-type: none"> □ 7+ collaborations with an average value of £1 million/project, and □ 7.3-fold¹ GDP ROI for investment in R&I and £353,000 GDP/job³ ■ £3 million investment in business development activities with potential to result in £6.9 million GDP growth (and 19 jobs), assuming: <ul style="list-style-type: none"> □ 30+ business support interventions (2+ /month), leading to ~£100,000 further investment in business development activities, with a 2.3-fold² GDP ROI (and £353,000 GDP/job) ■ >50+ space related apprenticeships⁴ | <p>ROM Cost = £133,7500 / per thematic leader / year</p> <ul style="list-style-type: none"> ■ Thematic Leader (1 FTE) = £62,500 (£50,000 salary + 25% overhead) ■ Support staff (0.5FTE) = £31,250 (average 50,000 salary + 25% overhead) □ Administration (0.2 FTE) □ Marketing (0.2 FTE) □ Commercial/legal (0.1 FTE) ■ Office rent and rates = ~£2,500 (extra) ■ Travel = £7,500 ■ Working Group Meetings and Events = £15,000 ■ Marketing = £10,000 ■ Other = £5,000 |

³ Employment growth forecast based on average sector turnover per employee (£14.8 billion turnover divided by 41,900 employees = av. £353K turnover per employee).

⁴ Assuming ~£1 million GDP growth per apprentice, in-line with the UK strategy (£25 billion GDP growth with 30,000 additional skilled people = 1 skilled person per £833K GDP growth).

TABLE 7: CLUSTER OPTIONS, OUTCOMES AND ROM COSTS [CONTINUED]

| Option | Team | Goals |
|--|---|--|
| <p>Optional Action 1: Dedicated Innovation Vouchers</p> | <ul style="list-style-type: none"> ■ Scheme Coordinator and Administration ■ Applicant Assessment and Award Committee ■ Auditors | <ul style="list-style-type: none"> ■ To provide innovation vouchers that facilitate investment in R&I and/or business development activities ■ Building on successes achieved by the Harwell cluster, vouchers may also be considered to stimulate collaboration between cluster members |
| <p>Optional Action 2: Skills and Training</p> | <p>To be defined</p> | <ul style="list-style-type: none"> ■ To provide specific dedicated space related skills and training, meeting identified needs not addressed by existing initiatives |
| <p>Optional Action 3: Space Incubator / Accelerator</p> | <ul style="list-style-type: none"> ■ Incubator Manager ■ Support Staff ■ Existing West Midlands science park(s) | <ul style="list-style-type: none"> ■ Co-location and networking of space start-ups ■ Access to specialist skills, resources, and support |
| <p>Optional Action 4: Cluster Facilities</p> | <p>To be defined</p> | <ul style="list-style-type: none"> ■ Dedicated cluster facilities to support design, prototyping and testing for Upstream space manufacture, Downstream space applications, and/or End-user applications, and/or ■ Public-private funded applied research and innovation centre |
| <p>Optional Action 5: Structured Programmes</p> | <p>To be defined</p> | <ul style="list-style-type: none"> ■ Structured programmes of dedicated activity targeting realisation of strategic policy objectives, considering: Research and innovation projects, Skills and training, Business support, Access to finance etc, |

| Top Level Outcomes (KPIs) | Justification of Outcomes | Rough Order of Magnitude Costs |
|--|--|--|
| <ul style="list-style-type: none"> ■ Facilitation of activities resulting in: <ul style="list-style-type: none"> □ £15 million+ R&I and/or business development investment ■ Leading to: <ul style="list-style-type: none"> □ Between £36.5 million and £108 million GDP growth, and □ 201 jobs | <ul style="list-style-type: none"> ■ a scheme value with funds of £1 million that provides 100 vouchers with worth £10K to local businesses to buy access to know how and advice and develop a value proposition for new service or product related to the space sector. ■ Using a top-down approach the scheme would generate between £2.3 million and £7.4 million of additional GVA. ■ For some businesses, the vouchers may result in companies not progressing poor business ideas. If 20 companies avoided investing £50,000 in an unviable idea the scheme would release potential savings of £1 million. ■ If 40 companies secure funding of £250,000 to take forward their ideas that be equivalent to £10 million additional investment in R&D providing a further potential £23 million to £74 million GVA uplift. ■ If 5 companies secure investment over the period of the scheme that would add a further £11.25 million to £37 million. ■ Potential jobs created at 13.4 jobs per £1 million R&I spend equates to 201 jobs. | <p>ROM Cost = £1.25 million (over three years)</p> |
| <ul style="list-style-type: none"> ■ Facilitate start-ups, pivots, and business growth | <p>To be defined</p> | <p>ROM Cost = to be defined</p> |
| <ul style="list-style-type: none"> ■ Accelerate number and growth of space start-ups and pivots | <p>To be defined</p> | <p>ROM Cost = to be defined</p> |
| <ul style="list-style-type: none"> ■ Access to specialist research and innovation facilities configured to support regional priorities and projects ■ Creation of science and technology supporting regional policy objectives and projects | <p>To be defined</p> | <p>ROM Cost = to be defined</p> |
| <ul style="list-style-type: none"> ■ Realisation of strategic policy objectives ■ Driving innovation and change | <p>To be defined</p> | <p>ROM Cost = to be defined</p> |

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