COUNCIL FOR SCIENCE AND TECHNOLOGY

Priorities for Strengthening the UK's Sovereign Space Capability

October 2023

COUNCIL FOR SCIENCE AND TECHNOLOGY

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Chancellor of the Exchequer
11 Downing Street
London SW1A 2AA
'Sent by email only'

Secretary of State for Science, Innovation and Technology
100 Parliament Street
London SW1A 2BQ
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05 October 2023

Dear Chancellor, Secretary of State:

PRIORITIES FOR STRENGTHENING THE UK'S SOVEREIGN SPACE CAPABILITY

Capability in space-based technologies is increasingly critical to a prosperous economy, national security, resilience, and sustainability. The UK relies on space day-to-day for navigation services, weather forecasting, communication, defence, surveillance, among other uses. The spill-over benefits from space technologies are similarly extensive, impacting sectors such as agriculture, transport, healthcare, and construction[1,2].

Space is also a major contributor to the UK's economy and productivity. Annually, the space sector is worth over £17.5 billion, while space-based satellites underpin £370 billion of wider economic activity[3]. With the global space market forecast to grow to £1 trillion by 2030[4], this presents a clear opportunity for the UK to build sovereign capability and to capture more global market share.

In an increasingly competitive geopolitical environment, governments worldwide are rapidly building sovereign space capabilities for global power, influence, and prestige. This means that the next decade of space investment will dramatically shape the global landscape, and the UK's

1 UK Space Agency (2022) Returns and Benefits from Public Space Investments 2021. Available at: https://www.gov.uk/government/publications/returns-and-benefits-from-public-space-investments-2021/returns-and-benefits-from-public-space-investments-2021
2 Government Office for Science (2018) Satellite-derived time and position: Blackett review. Available at: https://www.gov.uk/government/publications/satellite-derived-time-and-position-blackett-review
3 UK Space Agency (2023) Size & Health of the UK Space Industry 2022. Available at: https://www.gov.uk/government/publications/the-size-and-health-of-the-uk-space-industry-2022/size-health-of-the-uk-space-industry-2022
4 Bank of America (2023) The new space era: Expansion of the space economy. Available at: https://business.bofa.com/en-us/content/bank-of-america-institute/transformation/expansion-of-the-space-economy-january-2023.html

position within it. It is vital that we act now to secure and build on our own sovereign space capabilities. In doing so, we will ensure both our competitive global edge and reinforce our national resilience.

The current landscape for space-based technology is rapidly changing and requires significant investment. These are dynamics that must be recognised when deciding the UK's ambitions and future direction. The USA is currently the biggest investor in national space capability, while China, Japan, France, Russia, and Germany all have national programmes more than twice as large as the UK's[5]. Newer entrants such as the UAE and India have recently demonstrated willingness to invest in becoming space powers. Longer-term, we believe that UK government investment should at least match that of other similar-sized economies, such as France, whose current government investment is approximately three times that of the UK's[6].

The recent re-establishment of the National Space Council and publication of the National Space Strategy in Action report[7] are positive steps for signalling the government's ambition for the UK space sector. The capabilities recognised in the National Space Strategy are important and there are significant interdependencies between them. However, many of the capabilities identified require long-term, consistent investment, which is a challenge within the confines of comparatively much shorter-term, periodic spending reviews.

Furthermore, we believe that prioritisation of investment in the capabilities laid out in the National Space Strategy should be explicitly determined on the basis of **(a) growing economic opportunities, (b) enhancing our national resilience,** and **(c) ensuring our national security.** Recognition of these multiple objectives of space investment will enable the UK to contribute constructively to its international space partnerships, while simultaneously building an appropriate level of sovereign capability. On these principles, we believe there are at least **four areas** in which the UK should initially prioritise for investment to build sovereign capability:

1. Position, Navigation, and Timing (PNT)

The European Union, Russia, China, India, Japan, and USA own and operate sovereign PNT systems. PNT, specifically highly-accurate timing, is integral to the operation of all 13 Critical National Infrastructure (CNI) sectors[8]. To mitigate the extensive social and economic impacts arising from a loss of PNT, **the UK should develop a spectrum of sovereign-owned technologies which augment or supplement our access to Global Navigation Satellite Systems, as well as discrete terrestrial technologies to provide back-up timing and positioning capability that do not rely on space-based systems.** We recommend the government prioritises investing in advanced timing technologies, particularly atomic clocks. This should include both terrestrial and space-based clocks, such as those deployed in geosynchronous equatorial orbits (GEO). Additionally, we suggest exploring the possibility of supporting these technologies in low Earth orbit (LEO) or as hosted payloads on LEO and medium Earth orbit (MEO) communications constellations.

5 Statista (2023) Government space program spending of the leading countries in the world 2020-2022. Available at: https://www.statista.com/statistics/745717/global-governmental-spending-on-space-programs-leading-countries/

6 OECD (2019) The Space Economy in Figures: How Space Contributes to the Global Economy. Available at: https://doi.org/10.1787/c5996201-en.

7 National Space Strategy in Action (2023) Available at: https://www.gov.uk/government/publications/national-space-strategy-in-action

8 National Protective Security Authority (2023) Critical National Infrastructure. Available at: https://www.npsa.gov.uk/critical-national-infrastructure-0

The UK should work with partners, and help enable industry, to investigate, invest in, and develop other technologies to maintain accurate timing and positioning in the event of denial of space by accidental or hostile action. These technologies could include, but are not limited to, smart antennas, quantum-enabled navigation, sources to continue localised broadcasting of position information, and technologies to detect the source of interference to PNT. These measures would help to ensure access to robust PNT services during times of threat to space-based infrastructure. The development of the National Timing Centre (hosted by the National Physical Laboratory) is an opportunity to build our own cutting-edge capabilities so that the UK can provide secure, resilient, and terrestrial Timing Signals domestically that do not solely rely on space-based systems.

2. Earth Observation (EO)

The UK has world-leading capabilities in the application and processing of satellite-derived EO data, with over 160 EO companies operating in the UK (the largest number in any European country)[9]. However, the UK is mostly dependent on receiving data from foreign-owned satellites. As such, the UK has little ability to secure its access to data if the satellites owned and operated by other countries are disrupted by space debris, natural phenomena, or hostile action. Given this reliance, **the UK should strengthen its commitment to partnerships with trusted allies in the design, manufacture, delivery, and operation of next-generation EO platforms.** This includes through capitalising on the UK's association to Copernicus.

For civilian and defence applications, **government should aim to further strengthen UK sovereign capability in advanced EO analysis services (both UK in-orbit data sources and the associated ground station segments).** Government should continue to leverage the UK's growing strengths in the provision of end-to-end EO application services and in Artificial Intelligence (AI) applications. This should include investment to develop capability in the application of AI to space sensor products, new sensing technologies, multiple sensor correlation, and correlation of space-based data with other sources. Combining the UK's expertise in small satellites, EO, AI, and data analysis will also help government achieve its intention to use EO technologies to meet net zero ambitions as set out in the National Space Strategy's ten-point plan.

3. Space Energy and Resources

Government should prioritise investment in exploiting intrinsically safe nuclear reactors, nuclear fuels, nuclear batteries, and in the long term, solar farms and novel power transmission methods through space. Building on the UK's leadership in nuclear energy technologies, there is a window of opportunity for the UK to leverage its early competitive advantage in applying this to space-based applications. The technologies underpinning space-based power have the potential to provide both power to ground infrastructure (for fixed and deployable requirements) and power to satellites in orbit, based on the Moon, or other planets. This would help to ensure resilient and efficient sources of energy for future space missions, meet the high energy demands of novel space technology, and may offer significant

9 London Economics (2020) The State of Commercial Earth Observation – May 2020. Available at: https://londoneconomics.co.uk/blog/publication/the-state-of-commercial-earth-observation/

translational benefits to terrestrial-based power applications[10,11]. This technology could meet economic and national security goals and provide global recognition of the UK as a leading nation in space power.

4. Space Domain Awareness (SDA)

Space domain awareness is key to understanding and protecting our space-based assets from the threats of hostile orbiting spacecraft, space debris, and space weather. It is also critical for maintaining national security, allowing the UK to identify and attribute space activity to other nations, including potential attacks on our own space-enabled CNI. The UK works closely with allies to monitor the space domain and protect our assets, including the significant radar capabilities provided by the joint US-UK enterprise at RAF Fylingdales[12].

The development of a greater and more diverse sovereign capability in this area will help to reinforce these services at a time when space becomes an increasingly congested domain[13]. Although NATO has increased strategic coordination and collaboration for space surveillance and tracking, NATO and its individual states have different priorities. NATO cooperation also relies on the capabilities provided by its members. We believe that the UK should develop sovereign SDA capabilities to support its ambitions in space and to contribute to collaboration with allies. **We recommend that government increases its investment in platform technologies to track and analyse space-based objects (including space debris) for the purposes of space safety, international coordination in the use of space, and for national security. This should include investment in research to understand the effects of space weather and measures to monitor it.** We also recommend that government considers whether any of these capabilities, particularly those with dual-use applications, may unlock additional benefits upon further investment.

Given the current economic climate, we have identified four capability areas where we believe an increase in resource could have disproportionate national impacts. However, we also support the long-term ambitions and additional capabilities identified in the National Space Strategy. Government should continue to work with industry to leverage private sector investment in these areas. The priorities identified in this letter should be considered in line with the government's ongoing analysis and broader engagement across the space sector. This includes government's current engagement on sovereign launch capability.

For our advice to be implemented, government will need to work closely with industry to address the growing skills gaps in the space sector. 52% of UK space sector organisations are currently facing skills shortages[14], both at technician and degree levels, across areas including software engineering, radio frequency engineering, data, AI, and machine learning. As the space sector's requirements mirror the growing demand for skills in AI and advanced manufacturing, investing

10 National Nuclear Laboratory (2019) UK scientists generate electricity from rare element to power future space missions. Available at: https://www.nnl.co.uk/2019/05/uk-scientists-generate-electricity-from-rare-element-to-power-future-space-missions/

11 UK Space Agency (2023) UK Space Agency backs Rolls-Royce nuclear power for Moon exploration. Available at: https://www.gov.uk/government/news/uk-space-agency-backs-rolls-royce-nuclear-power-for-moon-exploration

12 Royal Air Force (2023) RAF Fylingdales. Available at: https://www.raf.mod.uk/our-organisation/stations/raf-fylingdales/

13 Royal United Services Institute (2020) Space as an Operational Domain: What Next for NATO? Available at: https://rusi.org/explore-our-research/publications/rusi-newsbrief/space-operational-domain-what-next-nato

14 UK Space Agency (2023) Space Sector Skills Survey: Research Report. Available at: https://www.gov.uk/government/news/uk-space-sector-has-sights-set-on-artificial-intelligence-and-machine-learning-professionals

in skills will not only benefit the space industry but also make a meaningful contribution to our national workforce.

In conclusion, investing in the UK's sovereign space capability at the next spending review, and longer-term, will send a positive signal. Importantly, this investment will also help the UK to build strong partnerships with allies to ensure resilient access to critical space infrastructure beyond our sovereign capabilities.

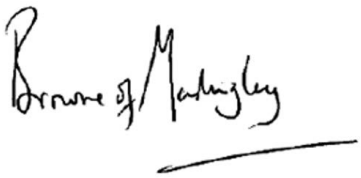
We would be delighted to discuss our advice in more detail with you and your Ministerial colleagues.

We are grateful to Professor Max Lu (President and Vice-Chancellor, University of Surrey) for leading the development of this advice, with support from Paul Stein (Chairman, Rolls-Royce SMR Limited), Professor Jim Hall (University of Oxford), Professor Fiona Murray (Professor and Associate Dean, Massachusetts Institute of Technology), Professor Keith Ridgway (Senior Executive, University of Strathclyde), and Professor Brooke Rogers (Professor and Vice-Dean People and Planning (SSPP), King's College London). We also thank policy teams across government who helped to inform our work.

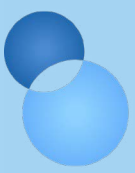
This letter is copied to the Prime Minister and members of the National Space Council.

Yours sincerely,

Dame Angela McLean
Co-chair



Lord Browne of Madingley
Co-chair



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