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The Integrated Review and UK Spacepower: The Search for Strategy

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Abstract

This paper examines the role of spacepower and space policy in the midst of the Integrated Review, a nascent Defence Space Strategy, and organisational shifts in the UK space sector. After outlining the nature of British spacepower as an inherently dependent, integrated, and allied form of power for the UK, the paper puts forward recommendations for the British state. Whilst the British state cannot aspire for a large degree of strategic autonomy in space, it can aspire for more operational independence with targeted investments that may make a difference in acute crises and conflicts. In particular, the paper encourages the consideration of communications systems, intelligence, surveillance, and reconnaissance satellites, and space domain awareness infrastructure, as strategically useful and feasible space investments for enhancing core military and intelligence capabilities on Earth. In addition, spacepower must be dovetailed to prevailing terrestrial political priorities and a clear defence strategy which should outline core combat capabilities and therefore a clear 'need' for specific space systems to meet. The MoD must also respond to the reality of the proliferation of military spacepower among potentially adversarial states and the threats they pose to terrestrial military forces and likely combat missions. Whether the new Space Directorate and a possible UK Space Command at the Ministry of Defence will help address these remains to be seen, but they are positive moves if the UK wishes to develop a more space-centric military culture and cadre of space specialists. Finally, the National Space Council has an important role to play in coordinating space activity across the state, but it is faces a very difficult challenge given the diverse range of activities across multiple space sectors, and it must therefore be aware of the limitations of a 'one space policy fits all' approach.

Introduction: Key Questions and Recommendations

Increased policy interest in British spacepower is happening within a tempestuous political context and at a time where space technology continues to spread to more actors, including those that might potentially be hostile towards the UK. It no surprise therefore that the delayed Integrated Review is claimed to be the first UK defence review to pay specific attention to spacepower. The maturation and proliferation of spacepower is not the only headwind UK space strategy and the Integrated Review must deal with. The political-economic rupture of Brexit cuts across the space-industrial base and European astropolitics; continuing ecological deterioration places increased demands on space-based monitoring systems and exacerbates insecurity on Earth; and the Covid-19 pandemic has decimated budgets and may trigger structural economic change. There has never been a greater need for a clear space-centric perspective on what spacepower can and should offer for defence policy, security, and wider political goals today, but that perspective needs a clear British defence strategy on Earth to outline priority tasks that space infrastructure can hope to meet. The new Director of Space role at the Ministry of Defence (MoD) is an encouraging sign of effort to congeal and increase the prestige of a defence space perspective in Whitehall. It is one of several moving parts ongoing in UK space policy and strategy-making: the Cabinet Office and other departments have significant roles to play in managing and coordinating British space activities across the military, industrial, diplomatic, and research and development sectors.

The new UK National Space Council (NSpC) seems to have its work cut out in managing and co-ordinating the space portfolio across the British state. Meanwhile, the MoD should be grappling with the pressing strategic questions of:

- How to respond to the increase in the operational and tactical military uses of spacepower by other terrestrial military forces, both allied and potentially hostile?
- How to respond to the proliferation of anti-satellite or counterspace capabilities among potentially hostile military forces?
- What do allies provide in space that Britain cannot do without, but can continue to rely on and therefore do not need to replace with 'sovereign' projects? And vice versa.
- How to build the competencies and what form of organisation best meets Britain's capabilities, resources, and objectives in space?

One constant of British spacepower is that it is defined by its dependencies on and integration with allied states and commercial providers. Britain cannot by itself afford to do everything that the demands of spacepower places on modern military forces, in part due to the historical neglect and lack of interest in developing sovereign military space capabilities. British spacepower as a whole sits between its military and intelligence integration with the United States and Five Eyes on the one hand, and industrial and scientific space integration with Europe at both the European Space Agency (ESA) and the European Union (EU). This 'binary' geostrategic context conditions any British ambition in space as the UK already has many 'path dependencies' and entrenched ways of accessing spacepower through its allies rather than pursuing fully independent means. As spacepower became more important for imposing dispersion and decreasing the necessity of mass to create the effects of concentration on the battlefield,[1] the UK became more dependent on its allies for spacepower services in turn. Today, that dispersing influence of spacepower can be created by possible adversaries through the spread of precision-strike technologies and allowing the military forces of Russia and China to shoot what they can see. When both sides can use spacepower in terrestrial force enhancement in such a way, the attractiveness of mass deployments of forces returns, and units become more vulnerable to precision munitions, which also rely on space systems to function. Therefore, spacepower has become a very important part of tactical military power over the last few decades with more forces dependent on it and more states seeking to deny its use.

In this context, it may be a case that increased British interest in military spacepower is 'better late than never'. In the last ten years spacepower can be argued to have 'come of age' in Whitehall.[2] The MoD has released two air and space power joint doctrines, a military primer, a pamphlet on the Defence Space Strategy, created the new role of Director of Space, and looks set to create a UK Space Command.[3] As seen below, there have been some experimental prototype satellites flown in recent years. This is a significant uptick in activity for the MoD in space, but it is building on existing activities. Britain possesses the sovereign *Skynet* military and intelligence satellite communication system, though its daily operation has been 'outsourced' to Airbus. Additionally, the contribution of the RAF Fylingdales radar to the American ballistic missile early warning and Space Surveillance Network and the Space Operations Centre at RAF High Wycombe are significant space duties for the MoD. Furthermore, UK military officers enjoy a highly integrated role in the United States' military space formations and UK intelligence agencies have a close working relationship with US space-related intelligence organisations. The formation of the UK Space Agency in 2010 congealed industrial, commercial, and scientific efforts and was a significant statement of intent from the UK Government on ambitions in the global space economy.

It is not immediately obvious what sort of space capabilities are best if Britain is to acquire new systems. Many significant military space actors have pooled their efforts to create shared strategic space capabilities such as space launch so that precious resources can be diverted towards other applications of satellite technologies and more pressing terrestrial requirements and capability gaps. Britain is a typical European military space actor in that regard, having entrenched reliable allied relationships in space which provides access to, for example, space launch, space tracking, intelligence, and Global Navigation Satellite Systems (GNSS) for military purposes.[4] In the 1960s, the UK decided to invest in an expensive British capability rather than buy cheap from the Americans by building in the *Skynet* communications constellation.[5] Yet Britain's abortive Intermediate Range Ballistic Missile (IRBM) and Space Launch Vehicle (SLV) efforts – *Blue Streak* and *Black Knight/Arrow* respectively – were tied with the *Atlas*, *Skybolt*, and *Polaris* programmes in the United States and were eventually cancelled due to the vulnerabilities of IRBMs for a UK nuclear weapons capability.[6] Crucially, the UK could rely on the United States to launch its military satellites into orbit and became more confident in its reliance on the USA for space access and intelligence, whilst also becoming a founding member of ESA.[7] The political-military dilemmas and economic trade-offs of relying on and cooperating with trusted allies versus funding sovereign capabilities are not entirely new for British spacepower.

Below, I argue that the most promising and cost effective space capabilities for public investment for defence and intelligence applications in UK spacepower are military/intelligence satellite communications, space-based intelligence, surveillance and reconnaissance (ISR), and space tracking, situational awareness or space domain awareness. Like other areas of British defence capabilities, Britain cannot aspire to be strategically autonomous as it can rely on allies to provide assured access to many critical space infrastructures, but it can aspire to more operational independence with the correct, targeted investments in specific areas. Britain must learn to walk before it can run, as it were, and build competencies in more accessible, impactful, and affordable areas first. I do not make these recommendations with prejudice towards any capability on Earth, rather, *if* significant investments are to be made in space at all, these classes of space technologies would be desirable to invest in.

Even if some may disagree with these recommendations, I hope better ones take their place as a result of discussion and critique. The recommendations begin with the defence sector, moving onto defence organisation, broadening out into allied relationships, and finishing with UK space governance and decision-making.

1. The UK should only aspire to be more operationally independent in space, not strategically autonomous.
2. British spacepower must meet terrestrial needs and priorities.
3. Policymakers must decide which space sovereign capabilities must be maintained, expanded, or acquired.
4. Civilian and military leaders must prepare and adapt to the threats of space warfare.
5. UK military space operations should be rationalised, and spacepower culture needs to be developed.
6. Spacepower relationships with the United States, European Union, NATO and ESA must be maintained and enhanced.
7. The National Space Council must coordinate top space policy objectives and the strategy to meet them.

Reflecting my own areas of expertise, this paper is more orientated towards the military and political elements of space strategy, rather than industrial, commercial, and technical/scientific. No one person or agency can master all elements of space activity equally, just the same as naval warfare experts cannot be expected to provide cutting-edge insights into the latest research agendas in marine science. Grasping the consequences of spacepower on politics, strategy, and infrastructure does not require a scientific background, but it can help. Decision-making in space still requires 'good enough' specialised and relevant technical knowledge but also an ability to ponder the existential questions of politics and strategy which is often the preserve of the humanities and social science rather than the 'hard' sciences. History, politics, strategy, and international relations in space is simply not an education provided to many. Therefore, before getting into the details of the recommendations for UK space strategy, a brief introduction to spacepower is needed as the general level of literacy on the military, intelligence, and political uses of space is quite low outside of niche specialist communities. Readers familiar with that can jump forward to the recommendations.

A brief history of spacepower

Spacepower is 'a diverse collection of activities and technologies in space or to do with outer space... defined by how any actor can use outer space' for the purposes of war, development and prestige.[8] Spacepower's use for military and economic purposes has been around for decades, though that reality is news to many people. Outer space is no vast, empty realm, nor is it that novel an environment for terrestrial politics, security concerns, and military power. Today, many more states are setting up space agencies, reorganising their military forces to better integrate spacepower into their terrestrial systems, and seeking to capitalise on increased opportunities in the global space economy.[9] There are over 2,700 active satellites in orbit around Earth, providing all manner of data and services to terrestrial infrastructure.[10] The UK is one of dozens of states deliberately engaging with space policy and strategy with an effort and profile not seen before, not least with the establishment of the UK Space Agency in 2010 and releasing a raft of space policy documents and military doctrine texts in the years that followed. Increased interest in Whitehall followed years of increased successes in British space industry and science and the emergence of small satellite and commercial 'off-the-shelf' satellite products and applications which British universities and companies took a global lead in developing and exporting.

The recent founding of the US Space Force as a semi-independent corps within the US Air Force crystallised the reality of space as an important military and economic geostrategic environment in world politics and modern strategy in the minds of many. This includes the defence and security policy elites who may previously have not given space infrastructure a second thought. However, many are puzzled to learn that a debate on a US Space Force or Corps is almost as old as the US Air Force itself, or that space was never really a sanctuary from violence.[11] Because satellites in outer space have been useful for making war and securing the state, states have been preparing to attack, neutralise, and harass space infrastructure in the event of major war for many years, and such activities have not been restricted to just the former Cold War superpowers. It is not alarmist or hyperbolic to discuss the military applications of space technologies on the battlefield, nor to prepare for the possibility of space warfare in the larger context of a war on Earth – it is expected behaviour from modern military powers and has been for some time.

Satellites have been deployed in ever-greater numbers for the purposes of communications for military command and control; reconnaissance and surveillance satellites including signals intelligence and imagery; navigation technologies to allow ships to navigate and munitions to better find their way to their targets; early warning satellites using infrared sensors to detect missile launches and powered flight; and corresponding terrestrial satellite control infrastructure and space tracking systems also proliferated to command orbital assets and build a picture of what was orbiting where. The Soviet Union and the United States pioneered these technologies in the first few decades of the Cold War, including anti-satellite (ASAT) weapons based on Earth and in outer space. By the late 1980s, both the USSR and USA had begun to implement space reconnaissance, navigation. and targeting systems into their conventional warfighting platforms.[12] Precision strike weapons, or the reconnaissance strike complex, and over-the-horizon weapons were already emergent in the 1980s. Today's interest in space-based sensor layers, long range precision strike systems including manoeuvrable re-entry vehicles (MARVs) and 'hypersonic' missile systems – and the adaptations and responses to them – are merely picking up where the Soviets and the Americans left off in the 1980s.[13]

By the end of the Cold War, China, India, Japan, and Western Europe had their own independent means of accessing space as well as a spread of sovereign satellite industries and capabilities providing services for warfare and security, economic development, and technonationalist prestige (a normative marker of modernity and power)[14] – following the lead set by Moscow and Washington. Since 1991, the number of states active in space with their own satellites, or space companies registered within them, has grown and so have the terrestrial applications of space technologies to create a large downstream application industry as well as satellite manufacturing.[15] Today, middle and small space powers jostle with the 'big three' space powers – the USA, Russia, and China. China has established itself as a comprehensive spacepower arguably second only to the United States according to most measures, whilst Russia continues to modernise Soviet legacy systems and maintains a large technological and skills base in the space sector. Europe, though politically decentralised, is emerging as a provider of high-end military grade space infrastructure, whilst Japan and India continue to develop and invest in select space technologies including navigation, communications, and Earth observation which have a range of dual-use (civilian and military) purposes. With space technology now essential for modern military and economic power, and therefore political power,[16] it is not for nothing that China, Russia, the United States, and India have fielded dedicated anti-satellite – or counterspace – weapon systems and military formations. The spread of these technologies and infrastructures matter, as they are chipping away at an area that the United States has led in since the end of the Cold War. The American monopoly on reliable space-based navigation systems, reconnaissance, early warning, and command and control has come to an end, with significant repercussions as much for its allies as for other states.

On the economic front, communications and observing Earth from space are now significant industries in the global economy. The global space economy, according to one estimate, was worth around $366bn in 2019.[17] However, a more targeted analysis suggests that the total value of 'goods and services from and for space' was at $166bn in 2016.[18] Despite the dispute in the actual value of the global space economy, what is undeniable is that systems such as Global Navigation Satellites Systems (GNSS) such as the Global Positioning System (GPS), Earth observation constellations like LANDSAT and Planet provide ubiquitous infrastructure that generates direct, indirect, and enabling economic benefits and drivers throughout the terrestrial economy in almost every sector.

According to the UK Space Agency, in 2018 over 40,000 people worked directly in the UK space sector and contributed £5bn into UK GDP directly, whilst 'satellite services' in general supported £300bn worth of UK GDP.[19] This follows an average growth of around 7–10% every year for the past decade or so. Whether selling launch services, providing communications bandwidth, broadcasting television, making components, assembling satellite buses, creating software and devices on Earth that make satellite services usable on Earth, or selling imagery and analytics of events on Earth or in orbit such as with space surveillance and tracking – they are all taxable, high technology and information technology industrial activities. Any major investments in space will have significant military applications and economic impact on industry due to the dual-use (civilian and military) utility of such technologies, high capital investments, and highly skilled workforces involved.

Being able to 'do' spacepower is difficult and expensive, and therefore are markers of prestige or expressions of technonationalism for many polities and leaders, in addition to the capabilities that they bring. Satellite programmes and launch capabilities are part of the way space programmes are used as part of 'recognition games' in International Relations.[20] Whilst crewed space missions and deep space probes may be headline-grabbing prestige and science projects that many people know, developing a heavy-lift launch capability as well as sophisticated navigation, intelligence, or communications satellites are more substantial statements of relative autonomy and expertise in select areas. China's fielding of functionally equivalent military and economic infrastructure in space to that of the United States is no doubt demonstrating Chinese power and prestige; in the same vein India can launch its own heavy payloads into geostationary orbits along with its regional navigation system, NAVIC – a feat only a handful of states can manage. In that sense, India is a more sovereign and autonomous space power than the UK. India has already established a reputation as a reliable launch provider for British space companies. During the Galileo industrial contracts dispute of 2018, questions of prestige and Britain's status as a significant technological power was a present feature in much newspaper reporting and government statements. It was like an echo of Ernest Bevin's insistence on putting the 'bloody Union Jack' on top of the atomic bomb following the abrupt end to US-UK nuclear cooperation in 1946,[21] though Britain's exit from Galileo was a result of its own choice to leave the European Union.

Being a spacepower is therefore not simply a matter of putting generic 'satellites' into orbit or demonstrating technical and engineering skill by landing a robot on the far side of the Moon. It requires targeted investments in specific capabilities that not only provide the state with needed capabilities but also stimulate domestic industry and economic-technological development. Satellites, launch systems, and their related ground infrastructure is the real focus of spacepower, not crewed spaceflight or robotic probes. This is despite their ability to inspire people and have a propagandistic effect. Satellites provide different categories of services to different levels required by different users, and must be placed in specific orbits and altitudes and must use specific radiofrequency spectrum slots. These diverse satellites then place different flight requirements on rockets or Space Launch Vehicles (SLVs), which can loft different masses into different orbital altitudes, with different inclinations, with varying degrees of efficiency. States with very limited resources cannot flourish in space without coherent direction and leadership across multiple government agencies that meet pressing terrestrial needs.

For the sake of a simple introduction, there are four classes of orbital altitudes (above sea level) concerning satellite deployments.[22] Low-Earth orbit (LEO), medium-Earth orbit (MEO), geostationary orbit (GEO), and highly elliptical orbits (HEO, or Molniya orbits). Different satellite service categories tend to go into different areas, as highlighted in the table below. Different orbits provide different views of Earth, different loiter times, and different trade-offs for the type service which they provide. Some constellations utilise several orbits to provide more comprehensive capabilities, such as the SES telecoms constellation with broadcast satellites in both MEO and GEO. A slight variant on geostationary orbit is geosynchronous orbit (still using the GEO moniker), which involves satellites at the equatorial plane orbiting with an inclination, meaning that its position relative to the surface changes a small amount during the day. Looking from Earth, a geosynchronous satellite will do a subtle 'figure 8' dance or meander in the sky, but roughly staying within the same small 'zone' in the sky. By contrast, a geostationary satellite will appear completely motionless in the sky above the equator. HEO or Molniya orbital dynamics involve a very low perigee (lowest orbital altitude above the surface) and a very high apogee (highest orbital altitude above the surface). This allows a satellite to appear to travel more 'slowly' over the surface of one hemisphere as it gains altitude, almost loitering, before losing altitude and zooming around the other hemisphere relatively 'quickly' and returning to the first hemisphere. This is particularly useful for monitoring the poles and extreme latitudes, as satellites loitering at GEO do not have as good a view of the poles and the extreme northern and southern parts of the globe.

The table is not exhaustive, but it gives the general spread of capabilities according to orbits, each of which require heavier lifting capabilities with each higher orbital altitude and greater inclinations.

Table 1: Orbit and Satellite Service Types

	LEO Low-Earth Orbit	**MEO** Medium-Earth orbit	**GEO** Geostationary or Geosynchronous orbit	**HEO** Highly Elliptical Orbit/ Molniya Orbits
Altitude (km)	100–2,000	2,000–24,000	35,786	600–40,000
Orbital period	90 minutes	2–12 hours	24 hours	12 hours
Satellite service types	Communications Imagery intelligence/ Earth Observation Megaconstellations Space surveillance	Global Navigations Satellite Systems (GNSS) Telecoms	Communications Telecoms Terrestrial weather Missile launch detection/ infrared sensors Space surveillance Signals/Electronic intelligence GNSS space-based augmentation systems (SBAS) Regional Navigation Systems	Communications Missile launch detection/ infrared sensors Earth Observation Signals/Electronic Intelligence
Satellite examples	Iridium Keyhole LANDSAT SPOT Digital Globe OneWeb Gaofen Lotos Starlink Kuiper Space-based Wide Area Surveillance System (SWASS) Helios CSO RADARSAT IceEye Sapphire	GPS GLONASS Galileo Beidou SES	Wideband Global SATCOM Skynet Syracuse Sicral Inmarsat SES EUMETSAT Space-based Infrared System (SBIRS) CLIO TRUMPET Geostationary Satellite Situational Awareness Program (GSSAP) Gaofen European Geostationary Navigation Overlay Service (EGNOS) Quazi-Zenith Satellite System (QZSS) Navigate with Indian Constellation (NAVIC)	Molniya Meridian Sirius SBIRS Gaofen

Spacepower is a big subject, and like any geostrategic environment and acquisition effort, it will force tough choices and will require clear prioritisation of limited resources to achieve the best possible impact for Britain's ultimate political and security objectives. Some space projects are so expensive they may entail significant opportunity costs in other areas of spending. Others are far more affordable. The British state needs a clear strategy of what kind of space systems matter most to it, which areas can it rely on for others, and where can it do more in space either in concert or alone. There are no easy answers to these questions, but the rest of the paper attempts to outline constructive steps for the UK to take.

1: The UK should only aspire to be more operationally independent in space, not strategically autonomous

Britain is not exceptional in space. It is like most other European states and has to deal with integration and dependencies on others. Space is simply too expensive for any individual European state to go it alone. This strategic reality will continue to structure British spacepower regardless of the interminable debate on Britain's 'role' in the world, or turgid political speeches on Britain's self-perceived influence in global matters.[23] Brexit will not undo Britain's intertwined past and present with European space integration. European space integration will continue as the EU consolidates the space industries of its member states, and the EU-ESA relationship will continue to evolve as it has done for the past 30 years. The UK cannot hope to wean itself off its military dependencies on the United States as it simply does not have the resources to do so. Therefore any increased 'sovereign' space capability can only hope to improve the operational independence of the UK in select areas, but not overturn its entrenched structural dependencies on North American and European space-industrial and military infrastructures. The UK can look to make itself useful in specific areas, however.

The UK is highly integrated with and dependent on the United States for military and intelligence space services and data, which is part of the larger 'special relationship' in nuclear, missile, and intelligence activities.[24] The UK provides ballistic missile launch warning and tracking, as well as some space situational awareness (SSA, now also referred to as Space Domain Awareness) data from RAF Fylingdales, in North Yorkshire. In turn, the UK receives SSA data from the United States to feed into the Space Operations Centre (SpOC) at RAF High Wycombe which provides the UK Government and MoD with its own analytical capability to determine what is going on in Earth orbit at any given time.

Meanwhile the UK's commercial and scientific/civil space sectors are integrated with *both* ESA and the EU.[25] It is important to note that ESA is not part of the EU, but they do have a complex and intimate political-economic relationship. The UK is a founding member of ESA, and today is the fifth largest single contributor to ESA's budget after the EU, France, Germany, and Italy. British space science, commerce, and increasingly industrial space has been part of a larger European success story in coordinating the civilian and scientific space sectors of Western Europe throughout the Cold War and to the present day.[26] The UK has already recognised space infrastructure as part of Critical National Infrastructure,[27] however most of that space-based infrastructure is not owned or operated by the British state or UK-based companies. In the past, Britain has taken advantage of the International Charter of Space and Natural Disasters to access space imagery to support flood response in the UK due to a lack of its own sovereign means of doing so.[28]

This is a good basis to develop a more operationally independent space capability portfolio. Building on areas of existing expertise or capability have the potential to enhance secure communications, SSA, and ISR, as discussed in recommendation 3.[29] As the example of the UN 'disaster charter' shows, there is ample scope for dual-use applications of such investments given Britain's absence in much space-based infrastructure investment, particularly in imagery, over the past 50 years. Britain cannot completely end its integration and dependencies on others, but it can become a more active, useful, and influential space power within such alliances and partnerships by making the right investments with what little resources it has and by making itself useful to its allies. Doing so will however impose opportunity costs given limited UK resources, therefore clear strategic rationales are needed for any investment.

Building on existing strengths can help stimulate the British space industry, primarily in having satellites in space and building 'downstream' services and analytical capacities. This now includes a potential small satellite launch capability (satellite mass of 200–400kg to low-Earth orbit) following recent UK Government grants for small satellite capability from UK soil, but the UK has no established militarily relevant small satellite capability as yet. In terms of commercial competition for providing small satellite launches into high-inclination polar orbits (in contrast to low-inclination equatorial orbits), New Zealand already has an operational small satellite launch facility for a US company, whilst the European Union and Sweden in particular are also making moves in this regard. The UK may be entering a crowded market.

The UK cannot aspire to be *strategically* sovereign in most areas of space activity due to the high cost of developing space launch capabilities and domestic satellite construction chains from scratch following decades of outsourcing spacepower to allied states and integrating with European partners. The UK needs the services of other states and commercial providers for traditional satellite launches (with payloads of 800kg+ to any orbit including geostationary), SSA, ground control infrastructure, and many components in space technology manufacturing. For example, ESA's launch budget for 2020 was €1.5bn, and its budget for navigation systems came in at €1.1bn. Together, these accounted for almost 40% of its total budgeting[30]. By way of context, the UKSA budget sits at around £374m per year.[31] In 2018–19 the MoD's research and development investment in satellite technologies was £50m.[32] The UK's GNSS was reportedly estimated to cost between £3–5bn for the initial acquisition, approaching the cost of the UK's *Skynet* communications system. Newer areas of investment such as Synthetic Aperture Radar may involve cheaper constellations measured in the millions, rather than billions.[33] Any decision has to be cognisant of the fact that some space capabilities are far more expensive than others.

Building a more sovereign industrial base on a large scale will be a tall order, and the EU has been consolidating 'European' space and defence industry for decades in a concerted effort to meet the needs of the EU's single market and its member states.[34] Its industrial space policy and European Space Strategy are explicit about seeking autonomy for its member states and that EU tax-funded spending should go into the industries of its own member states (which mirrors ESA's own geo-return principles on common spending on its shared space projects). Having decided to leave the EU, Britain will now be outside these policies and strategies and cannot compete for major contractual work that is funded by the EU, even if administered through ESA. Britain still has to learn to co-exist and partner with these economic-industrial structures and transnational political governance mechanisms, now as a third party state to the EU.

Outside the structures of the EU, ESA dominates much of Britain's activities in space science and industry. Most of Britain's civilian space spending goes into ESA's budget, which allows individual European states to coordinate their efforts and match the scale of ambition of China and the United States in space infrastructure development and space exploration. In space science, Europe is a leader and British universities and high technology companies are a major part of Europe's scientific and industrial lead in space exploration and science. This record of success and entrenched space capability should be protected and further enhanced with both ESA and the EU in the years ahead. This builds and enhances the space industrial base that Britain needs if it is to chart a more operationally sovereign future as a spacepower.

2: British spacepower must meet terrestrial needs and priorities

Unclear terrestrial military priorities will translate into unclear defence priorities in space. Space warfare is the continuation of terrestrial politics by other means and any meaningful space capability and investment must support ultimate political objectives.[35] If the UK is unsure about what its military is for, or what policies it is meant to achieve through force of arms or the threat of it, major UK space investments will lack a clear rationale for investment too. The needs and dependencies of military forces from orbital infrastructures shift based on the specific terrestrial goals and missions at hand. Any space infrastructure has to meet certain needs; it cannot satisfy all diverse terrestrial needs equally, imposing opportunity costs. Whether focusing on maritime power projection, a glorified form of gunboat diplomacy with modern deep strike weapons for coercion[36], high intensity land and joint warfare, special operations forces, or light expeditionary operations and garrisoning duties, these missions possess a logistical tail that extends into orbit.[37] The command, control, and communication (C3), information, precision strike, and ISR systems modern military forces rely on space-based systems, especially when on offensive and mobile operations where terrestrial alternatives and backups may be a bit thin on the ground.

Despite recent improvements, including new space policy documents and doctrines, there is still a missing link in British strategy which connects Britain's binary dependencies and integrations in space on the United States and Europe with its terrestrial military requirements and political rhetoric.[38] This may be a task that preoccupies the drafting of the forthcoming full version of the Defence Space Strategy (DSS), in tandem with a mooted National Space Strategy (NSpS). It will be difficult to judge the value of these two 'strategies' for defence if the Integrated Review fails to set out concrete prioritisation in the kind of wars and operations the MoD will prepare itself to fight. Any defence space investment must meet terrestrial force structure needs and policy goals and at present the Integrated Review could range from the most radical transformation of British military power to yet another round of salami-slicing the defence budget. The most recent effort at addressing this missing link is the Integrated Operating Concept which recognises the role of allies, the importance of space technology, and the fact that modern military forces reveal a very large 'footprint' that can be more easily detected, tracked, and targeted by adversaries.[39] Space systems are both the enabling edge of these capabilities as well as the potential methods of responding to them, but as seen below, some methods of responding to adversarial spacepower may involve terrestrial options.

Decisions about terrestrial force structure in the Integrated Review should not be made in ignorance of their impact on space systems either. Though priorities on Earth come first, military strategy cannot ignore what spacepower can provide or what it does to shape terrestrial military power. Spacepower enables reduced force sizes and highly dispersed formations that rely even more on the logistical tail of space-based systems to ensure their survivability, lethality, coordination, responsiveness, adherence to laws of armed conflict and rules of engagement, and general efficiency. A reduced terrestrial military force needs spacepower more to reduce the corresponding losses in the direct combat power that otherwise expendable mass terrestrial platforms provide.

Spacepower complicates the already daunting task facing defence planners with more strained defence budgets, with the needs of space infrastructure and the demands of protecting it only increasing the costs of doing high intensity warfare operations. It not only requires a keen understanding of what space can and cannot offer, but also a clear grasp of the practices of modern warfare and the demands of policy and strategy in *all* terrestrial domains of warfare. Whatever the kind of terrestrial warfare the MoD wishes to prepare for, spacepower will be useful for it. Yet different kinds of space systems are more useful in different kinds of force packages, and in different terrestrial environments. Simply building a satellite system for its own sake is not enough – it needs to be designed to meet specific, complex, and unique terrestrial military needs. Those terrestrial needs need to be outlined for space planners, and space planners in turn need to demonstrate to terrestrial strategists what space can do for them in return.

3: Policymakers must decide which space sovereign capabilities must be maintained, expanded, or acquired

Once a clear terrestrial priority requirement is outlined, three factors should help decision makers come to some sound conclusions about British spacepower priorities: added capability, increased bandwidth and resiliency, and opportunity costs. Any investment in space capability can be judged along these three factors. Added capability refers to a British ability to do something new or additional to what was possible before. Increased bandwidth refers to greater service provision as well as potentially increased resiliency to enemy attack. Opportunity costs refer to the displacing effect any investment has in preventing investments elsewhere due to the limited resources of the British state. Some capabilities might not be as spectacular to invest in but may make more strategic sense to do so, such as expanding the *Skynet* constellation for resiliency and redundancy purposes instead of a new live-video imagery system, which is a new capability but its ultimate value on the battlefield may still be debatable. As with any capability discussion, there are many 'low hanging fruit' given Britain's dearth of capabilities in orbit. Some space investments cost several billion (e.g. GNSS), whilst others may be 'only' hundreds of millions (e.g. small satellite ISR constellations), others can be tens of millions (e.g. ground-based space situational awareness installations and satellite prototypes). With such a small presence *in* space at the moment, Britain should learn to walk before it can run; aiming for proportional investments that make concrete differences on the ground (or the sea and the air) that over time build the skills, industrial capacity, and institutional memory for grander space projects down the line.

Traditionally, Britain has relied on the United States for much of its military and intelligence space infrastructure. Any capability decision in the UK in space *will* impact its allied relationships due to their potential scale and effects on dependencies and usefulness. But the UK will have to take allied capabilities and interests into account because at some point the UK will rely on those allies to help realise and sustain its 'sovereign' capabilities through supporting space infrastructure such as launch, space domain awareness, intelligence analysis, and ground infrastructure. Whilst the 1982 Falklands War is seen by many as the UK's ability to extract the space support it needs from the United States, it still required 'special pleading' from the UK to reassign US satellite tasking to support the naval task force in the South Atlantic.[40] The Thatcher government's Zircon signals intelligence satellite project was partly based on the lessons learned in 1982 from the value of ISR from space for tactical-operational military needs, but also on the 'special relationship' and the misconceived reliability of allied support.[41] Ultimately, however, the project was cancelled and the UK's reliance on the USA for space-based ISR continued. When considering any sovereign capability drives for the UK in space, these issues surrounding the 'special relationship' and whether the Americans will be too busy, overwhelmed, or indifferent to help Britain 'in a pinch' should loom large. The question of allied politics is examined further in Recommendation 6.

SSA and ISR are the most significant added capability potentials that are feasible, draw on some existing UK competency, and do not entail a significant leap in spending (unlike traditional launch vehicles or satellite navigation systems). These capabilities can be increased here for tens of millions of pounds, if not the low hundreds of millions, to include hardware and personnel. They can also take advantage of existing investments and assets. RAF Fylingdales and High Wycombe both provide a basis for SSA, but there is scope for the UK to develop more SSA sensors on the ground and analytical capability by better dealing with the increase in SSA data availability from sources beyond the US military. The UK could utilise SSA in UK territory or in its overseas holdings, particularly in the southern hemisphere. European and commercial SSA provisions are increasing, but there are many gaps and policy hurdles towards sharing all data effectively or gathering enough data in all areas of orbit. The UK can help meet such gaps within the transatlantic allied networks. At present the Fylingdales radar is primarily tasked with ballistic missile launch detection and tracking, as well as supporting American Ballistic Missile Defence missions. This tasking reduces its capacity as an SSA provider. It stands in contrast to the French GRAVES installation, which specifically detects and tracks objects in orbit, the first dedicated military space surveillance system in Europe which has been in operation since 2005.

ISR in the UK is already seeing some experimental development and typifies the 'added capability' and 'increased bandwidth' assets. DSTL's Project Oberon[42] (synthetic aperture radar and signals intelligence small satellite clusters) shows how the UK can be more nimble in acquiring and testing new space-based technologies and techniques with commercial off-the-shelf systems on smaller satellites than the United States and some other European states. Regardless of the type of imagery – including live video from LEO which is currently proposed under the UK-US Artemis programme based on the Carbonite-II satellite[43] – this constitutes a new and added capability for the UK as well as additional bandwidth for ISR tasking. In a time of crisis or war, the UK has to source ISR from allied states and commercial entities. These may not always be forthcoming or timely if they have been prioritised elsewhere or gone to a higher bidder. However, any increased ISR data gathering must be met with a commensurate increase in analytical and dissemination capability on the ground. Whilst the appetite for more ISR data is insatiable, high quality and timely ISR 'products' rather than raw data is what is needed most. UK ISR assets in space not only guarantee some UK priority space-based ISR tasking at times of high demand, but also purchase influence with allies. France and Germany already provide space-based ISR to the United States – something the UK cannot claim to offer.

Not only is this experiment in ISR capabilities potentially useful for UK armed forces and may purchase influence/soft power with allies if shared, but it taps into existing strengths in the UK space sector in small satellite design and manufacture and applying commercial off-the-shelf technologies. The 'sweet spot' of affordability, clear capability gap and need, and supporting commercially viable parts of the UK space sector should be principles to be replicated in future space development and acquisitions projects.

Communications satellites are an existing strength in the UK. The *Skynet* satellites, manufactured and operated by Airbus, form a small constellation of seven satellites in GEO, which provide the MoD, intelligence agencies, and other approved users with secure high-quality fixed and mobile communications capabilities. As an example of 'low hanging fruit', expanding on these systems rather than only renewing them is a way to increase bandwidth for UK and allied needs, as well as building in more resiliency. In addition, bringing the daily operations of these systems back 'in house' for the MoD, rather than outsourced to Airbus operators, is another 'mundane' but significant opportunity to build space operations capacity in the MoD.

Broadband communications for field users and C3 tend to exceed capacity early on in conflicts – more bandwidth is not a poor potential investment, especially when allied partners may wish to complement their own restricted bandwidth with UK platforms for a reasonable fee, quid pro quo, or less tangible soft power influence in return. It remains to be seen at this early stage what role the UK's acquisition of a stake in the OneWeb LEO megaconstellation company will play in defence communications bandwidth, if any. The constellation is not complete, however now that the investment has been made, some good must be made of it for the taxpayer and the British state, or it will simply become an opportunity cost.

SSA, ISR, and expanding *Skynet* will incur fewer opportunity costs relative to the once-proposed UK GNSS Galileo replacement and the £400m stake in OneWeb. SSA and ISR tend to be on a smaller scale (tens of millions of pounds can be spent for tangible returns in capability)[44], whilst *Skynet* is an existing sunk cost (to the tune of several billions of pounds) and expanding it will build on existing strengths and increase resiliency in a valued capability area using proven technological systems. Other technological capability areas, such as GNSS and space-based weapons or kinetic Earth-based weapons are so expensive that they can be readily discounted. It seems the UK Government has accepted that building a Galileo-equivalent system for an initial cost of £5bn was beyond the pale for the marginal capability gained in Position, Navigation, and Timing (PNT), particularly given the continued provision of GPS military signals and the open door to negotiating user access to the secure signals of Galileo.[45]

Recently the UK has announced the UK Space-Based Positioning Navigation and Timing Programme (SBPP) in order to scope out what kind of PNT services *other than* GNSS might be feasible for the UK to invest in. Whilst there are few details are present, I would surmise potential options are augmenting the GPS signal to provide redundant platforms and signal enhancements for GNSS in a similar way – in principle – to space-based augmentation services (SBAS) services such as the European Geostationary Navigation Overlay Service (EGNOS) and the Japanese Quazi-Zenith Satellite System (QZSS).[46] Another option is looking at resuscitating old technologies such as ELORAN (enhanced long-range radio-navigation) which could be both space and ground based. Other innovations might provide alternatives 'in a pinch' for a degraded GNSS environment, but for now the Government's investigation into alternatives to building a GNSS constellation will take its course. Another option is to develop new ground equipment, stations, or receiver technologies designed to work with GPS and other approved GNSS constellations. Whilst these are different to building a GNSS, they may provide reasonable complementary capabilities in terms of redundancies and GNSS enhancements/support. It is not unreasonable to expect that, with a wider understanding of PNT opportunities (as opposed to GNSS alone), the UK may be able to find some new project for its navigation technology industry.

It is the task of senior leaders across Government to decide which of these capabilities best meet the priorities and envisioned force structure of the Integrated Review, as even within the capability types endorsed here for further investment (SSA, ISR, and secure communications), there are many variations within that can be tailored to match specific terrestrial needs. Whether the UK retains a 'heavy' ground warfare combat capability, or retreats from high-intensity conventional land warfare, as suggested in the press,[47] may determine much of the Integrated Review's legacy. Regardless, space investment priorities will be impacted by the decisions made on the future of the MoD's major combat capabilities, for good and ill.

4: Civilian and military leaders must prepare and adapt to the threats of space warfare

Spacepower underpins the high-tech capabilities in all terrestrial domains[48], without which Britain's high technology weapons platforms and other systems cannot work as envisioned and will operate at greatly reduced efficiencies whilst increasing their vulnerability to enemy attack. Satellites are extremely useful for modern warfare and economic power, and so long as this remains the case there will be an incentive to strike or interfere with space systems by developing and deploying anti-satellite (ASAT) technologies and techniques. Space weapons are not merely the products of a mechanistic action-reaction dynamic of one side developing space weapons and the other side feeling they *must* respond in kind.[49] The proliferation and maturation of ASAT weapons and precision-strike capabilities threatens UK and allied forces. China, Russia, and India are progressing with Earth-based kinetic ASATs. It is worth noting here that the United States possesses a LEO-reaching kinetic ASAT capability with its Aegis-equipped destroyers.[50] ASAT techniques include kinetic or explosive weapons, electronic warfare (jamming), and computer network operations (or cyber).[51] This is a risk to UK and allied military operations that they must adapt to in order to deter potential adversaries, and failing that, fight and prevail in conditions of high intensity conventional warfare. The UK can respond by seeking continued access to space services it cannot provide for itself, developing more space-based platforms for increased resiliency and bandwidth as outlined above, and/or develop terrestrial alternatives for 'stop-gap' capabilities. Additionally, 'soft kill' ASAT capabilities such as electronic warfare and computer network operations (or cyber) are also options that are more financially feasible than a 'hard kill' or kinetic ASAT capability. The proliferation of these systems also signals a permissive norm in favour of harassing or destroying satellites in a time of crisis and war and the UK must prepare to operate with a degraded space environment. Whether or not such actions will lead to a nuclear exchange is unknown, though escalation paths and risks are evident in space warfare.[52] But such concerns and risks are hardly unique to space warfare or new to contemporary war planners and scholars of the thermonuclear revolution.

Soft kill counterspace capabilities - such as electronic warfare (jamming) and cyber operations or computer network attacks – are feasible options for the UK to consider in added capabilities. At present the UK lacks any dedicated method of interfering with satellites, but electronic warfare and cyber provide some cheaper, though less reliable, methods of interfering with enemy satellites in wartime. Hard kill capabilities such as kinetic ASAT weapons or space-based ASATs are beyond the UK in several technology areas and in sheer expense compared to soft kill methods, and are also far more politically sensitive. Developing hard kill systems now could jeopardise the UK's new Responsible Behaviour in Space effort at the UN General Assembly to develop consensus on identifying threats and risks to space systems (discussed further in recommendation 7). Such capabilities would also require more elaborate UK SSA capabilities, as well as an increased competence in extremely long range and high altitude missile technology beyond what it has today.

Whilst many space services cannot be directly replaced, some critical space systems can have 'good enough' backups, alternatives, or augmenters in an emergency. ELORAN technologies can be used to increase infrastructural resilience if GPS or Galileo suffer significant problems, as referred to above which could possibly feature in the UK's SBPP investigation. This is useful for fixed terrestrial sites (e.g. ports, railways, airports, autonomous vehicle guidance) in civil emergencies where GNSS services may be degraded. Additionally, terrestrially fixed or based services can help provide more resilience and depth in defensive strategic postures, e.g. a terrestrial communications and positioning network would be useful as a backup to satellites in a Baltic defence scenario. But they will not provide capabilities in offensive missions where local infrastructure is not present and cannot be deployed at short notice. For example, there are more alternatives and stop-gaps to space capabilities available for the British Army in a Baltic defence scenario than for the US Navy and US Air Force in an offensive expedition against hostile islands in the South China sea. The loss of space systems can translate into paralysing effects on terrestrial forces, but these will differ depending on the type of mission and the strategic goals on Earth at any given time.[53]

UK forces must also accept that potentially hostile military forces will be able to mimic what was once a NATO monopoly: precision warfare and forcing dispersion on the enemy, scattering them. What the enemy can see, they may be able to shoot. The space-enabled sensor-to-shooter cycle exists in more military forces today than in the 1990s. British forces must employ a mix of capabilities that deal with the dispersing influence of enemy spacepower that underpins enemy precision warfare and long range strike capabilities. These range from attacking enemy space infrastructure, parrying enemy projectiles with theatre defences and close-in weapons systems or point defences, absorbing blows by fielding more depth and mass (and affordable human and machine losses), as well as adapting to warfare whilst the enemy has persistent over watch capabilities by waging dispersed warfare methods and not being seen until a critical moment.[54] Enemy precision strike capabilities increases the value of not being seen – therefore NATO militaries should learn from their opponents of the last 30 years in how they dealt with their air and space dominance. None of these are a silver bullet and British defence leaders have a difficult task ahead to adapt to the dispersing influence of spacepower which is a concern for all terrestrial forces in all domains.

5: UK military space operations should be rationalised, and spacepower culture needs to be developed

Facing this daunting threat profile, the MoD's main duties in space are divided between UK Strategic Command, which is responsible for Satellite Communications, ISR, and PNT, and the RAF which is responsible for Ballistic Missile Defence, Space Control, and Space Domain Awareness (formerly called SSA). Should UK Space Command take a more operational role, it may make intuitive sense for it to take on board all these missions, and also to build a more space-centric identity that is open to all service personnel. A secondary consolidation issue is which bodies will be in charge of military space acquisition and training, as opposed to operations, echoing concerns over the roles of the US Space Force and US Space Command when it comes to operations versus training. It is also possible for UK Space Command to take a coordinating role, as opposed to direct operations which currently reside with the RAF and Strategic Command. At present, it is unclear how the varied responsibilities in these areas will be decided.

Constant bureaucratic change makes accountability and tracing such decisions difficult. Significant and ongoing changes are afoot in the governance and delivery of UK military space activity. As well as UK Strategic Command, which replaced Joint Forces Command, there is now a UK National Space Council (NSpC), a new Director of Space post at the MoD, and a planned UK Space Command. This is in addition to two major expected documents: the National Space Strategy (NSpS) and DSS. This is not to criticise these changes, rather that monitoring the impact of this bureaucratic churn will be difficult. Bureaucratic reform is not always a good thing, and after the past few years some stability in space governance across Whitehall might be desirable. In the years to come these changes will need to be assessed so that positive reforms can be reinforced but also areas that are not broken are not 'fixed', while time is given for a specialist space cadre to develop within the MoD.

Spacepower culture and literacy needs to be developed in the UK armed forces. Space has been a neglected area of activity for decades, despite British successes in the early Space Age in the 1950s and 1960s.[55] As military space activity has only become a mainstream policy issue in the last few years, the comprehension of spacepower remains poor across the MoD and Whitehall. This is despite the publication of the UK Military Space Primer in 2010, and two new air and space joint doctrines in 2013 and 2017.[56] Despite the solid intellectual foundation UK doctrine currently provides, there are few officers who have spent their entire careers specialising in spacepower and this inhibits the development of spacepower culture and expertise at higher staff levels.[57] Space is its own unique environment and requires unique technical, historical, environmental, and political knowledge. A space-centric perspective is needed within UK military culture to complement land, air, and maritime cultural-technological perspectives, especially when joint decisions must be made with severe opportunity costs given limited resources. Spacepower should not be subsumed into a land-centric, air-centric, or maritime-centric approach to space nor by any of the military services. Due to its joint and ubiquitous nature, spacepower specialists must be holistic in their perspectives and have no cultural bias towards any terrestrial service or combat mission type and help senior decision makers realise how space can meet the priority objectives and needs of the terrestrial military forces as discussed above.[58]

6: Spacepower relationships with the United States, European Union, NATO and ESA must be maintained and enhanced

The starting point for UK strategy in space, as mentioned earlier, is its integrated and dependent nature. Building sovereign capabilities requires first assessing why it is the UK cannot rely on its allies for the capability. Some capabilities have better reasons than others for a UK-only approach, such as the *Skynet* system which provides a secure communications channel for UK forces and intelligence agencies. On successive occasions, however, space ISR was decided to be unnecessary on a sovereign basis as allied capabilities provided what was deemed to be enough for UK needs. If the UK decides to be more active and ambitious in its defence capabilities in space, it opens up more opportunities to enhance and strengthen its position within the binary strategic context Britain finds itself within. The UK will have to navigate the American goliath increasingly preoccupied with the rise of China as a comprehensive spacepower, as well as the emergence of the European Union as a 'hard' space power in its own right. Additionally, allied relationships will help determine what capabilities, if any, need to be developed on a sovereign basis at all (as discussed in Recommendation 3) rather than on a cooperative fashion with allies, or indeed, continuing to rely on allies completely for certain capabilities.

US guidance and cooperation can boost UK space investments by acting as a wider 'strategic enabler' for more 'niche' or additional UK assets that plug into wider allied systems.[59] The US may help more if the UK is willing to spend more in what they deem to be more desirable places and bring more UK assets to the table. For example, the US will allow Japan to host SSA payloads on its next-generation GPS augmentation QZSS assets.[60] Participation in the Schriever Space Wargames and integration in the Combined Space Operations Center mean that the UK is already in a privileged position with the US in terms of spacepower. There is always more room for increasing personnel in these and other activities to build more space competency in the MoD.

That said, the UK is being overshadowed by allied capabilities in space, most notably in the space-based ISR capabilities of France and Germany, with France in particular ramping up space-based capability procurement alongside organisational reform.[61] The most effective way to enable soft power and gain more influence is to possess a hard power foundation in space as outlined above. Failing that, the UK must accept a reduced influence and role in space given increased space investments from other 'middle powers' in the international system.[62] Actions and potential actions build trust and inter-allied respect, quid-pro-quos, and establish precedents for future cooperation and burden-sharing. NATO recently declared space an operational domain.[63] Since 2007's cyber attacks on Estonia, much attention has been paid to the role of cyber warfare in NATO alliance postures. The same needs to be done for spacepower – and hopefully not as a reactionary move *after* some disaster in space. As a key ally of the United States the UK has an important role to play here to bring allied perspectives to both NATO and the US, especially as many smaller members of NATO have less expertise in space than the UK and other 'middle' powers do.

In contrast to NATO, which holds no assets in space of its own, the EU is becoming a 'hard' space power with an incrementally-increasing suite of orbital platforms and operational competencies. The EU has successfully built world-leading space infrastructure, e.g. the Galileo system, Copernicus, as well as inroads into secure government communications (GOVSATCOM) and SST. It already draws upon the ability of Arianespace to provide a 'European' launch capability for most 'European' strategic needs in space.[64] The EU moving towards providing essential military and security-grade space services that previously could only be provided by the United States is a net positive development for military space resiliency.[65] The UK must work with this reality of contemporary astropolitics if it seeks to benefit from its traditionally aligned geostrategic interests with its European allies. The EU is today a significant provider of spacepower, not merely a consumer of it.

As a result, the UK should seek user access to the EU Galileo PRS (military-grade) service for military resilience and redundancy. This is the single-most important step for PNT resilience that the UK can and should make as a backup capability if GPS suffers significant problems. Whilst UK industry can no longer bid for the development and construction contracts for the most sensitive parts of the Galileo system, the EU has signalled that it is still open to negotiate *user access* for the British military and security agencies in the UK.[66] The USA and Norway have already signalled their intent do so.[67] The new US PNT Strategy effectively states that GPS is not enough for guaranteeing PNT services to the US military in wartime.[68] Along with the US and Norway there is no reason that the UK should not seek user access to Galileo's PRS to reach effectively the same settlement the UK has had with the military signals of the American GPS for over 30 years.

The UK should continue to enhance its role within ESA (which is not part of the EU) to reap both soft power benefits and tangible industrial-scientific rewards. The agency acts as a force multiplier of British space industry by enabling it to aspire to build far more complex and ambitious projects through pooling common efforts and resources – 75% of the UK Space Agency's budget goes to ESA, and is returned to the UK on the basis of ESA member industrial geo-return[69] which goes to British universities and companies to participate in large scale, cutting edge space projects. These missions bring significant stimuli to space industry that could not be replicated if Britain did not participate in ESA missions, and a generally larger and more skilled industrial base is needed if the UK has more ambitions in security and defence space capabilities. Britain should continue to seek to increase its contributions to ESA beyond what it already has and seek to attract inward investment from Europe and North America into its space industry.[70]

This should be matched with increased diplomatic activity with other ESA members to augment British influence, particularly in the ongoing discussions over the future of ESA in the EU's new 2021–2027 space programme. The EU may seek to enhance the governance role of the new European Union Agency for the Space Programme in European space policy writ large, to be built out of the European GNSS Agency (GSA). Currently, the UK still lags behind Italy as the fourth largest state contributor to ESA's budget. There is ample scope to increase UK ambition in space industry and science if it wishes to meet the influence of France, Germany, and Italy in European space politics in a major European institution, which lies outside the EU. Buying into scientific and civilian-oriented projects that are mostly funded by the EU (but implemented by ESA as a contractor and procurement agent) on a case-by-case basis, as evidenced by Norwegian and Swiss participation on a regular basis, should also be a hallmark of the post-Brexit NSpS. In terms of industrial, commercial, and scientific partnership, integration, and history, Britain has no other partner like it in space and there is no ready replacement elsewhere on Earth for such deep and beneficial civilian-industrial cooperation and resource-sharing in space.

7: The National Space Council must coordinate top space policy objectives and the strategy to meet them

Space is a place, not a policy issue. In the same way that states do not have a 'sea policy' or 'air policy', it is something of a misconception to have a 'space policy' or a single National Space Strategy (NSpS) that seeks to cover *all* activities in space in any great detail or provide specific goals that go beyond the security and prosperity agendas. No single department nor committee can lead on every activity in space, in the same way it is impossible for one entity to monitor and direct all activities at sea. The new NSpC cannot monitor and coordinate all space activity in detail due to the sheer scale and diversity of activity in space, like any other geographic environment. All sectors of the state, economy, and society use space and must learn to share and coordinate their actions in Earth orbit. The NSpC will have to coordinate with different lead departments depending on whether the space issue at hand is military, security, intelligence, industrial, scientific, diplomatic, and so forth. The NSpC should play a constructive role in moderating and synthesising policy in areas that clearly cut across these areas or those which need high-level political/financial approval. A challenge for the forthcoming NSpS is to provide the general outline of a plan that also has meaning for specific areas of space activity, such as the also-forthcoming DSS, the UKSA's Civil Space Strategy, and BEIS' Industrial Strategy. Space technology is ubiquitous; state and society use and are shaped by spacepower in diverse ways where a 'one size fits all' space policy or strategy document cannot do the ubiquity of spacepower justice.

One such area is in space diplomacy, and coordination across several Whitehall departments is needed to address the many areas of policy it touches upon, including foreign relations, defence, and industry. The UK is right to be active in norm building in space and in trying to increase the predictability and sustainability of the space environment through the Responsible Behaviours in Space effort. At this juncture it is unclear whether the UK will succeed where the EU and US effort in a Space Code of Conduct failed in 2014.[71] When discussing arms control, space governance, space traffic management, and norm building at the United Nations, the Foreign, Commonwealth, and Development Office may be a 'natural' fit given its diplomatic role and civilian character. Yet the press release announcing the effort was a joint statement with the MoD, and called for the prevention of an arms race in outer space and sought to address military regulations in outer space.[72] Such rhetoric may hinder the opportunities to create more norms in everyday, civilian, and accident avoidance issues based on past experience with the EU's Code of Conduct and decades of logjam at the UN on space arms control.

The Russian-Chinese space arms control proposal (the PPWT[73]), whilst flawed in many ways, remains the preferred approach at the UN to military space regulations and they will not wish to see any effort that takes away from the PPWT drive to attempt to legislate against space-based weapons and address some military threats to space systems. Invoking the military in space governance issues can be like touching the 'third rail' and kill any transparency or openness agenda.[74] Persuading others to come around to the UK (and US-EU) preference for norms as opposed to treaties requires concerted diplomatic effort and increased UK presence in space to purchase influence with other space powers, not least the USA and EU. The UK's attempt at the UN General Assembly to identify and codify shared problems may lead to some developments down the line compared to the top-down approach of the US and EU in 2014 and the ongoing Chinese and Russian attempts to pass the PPWT. Whilst such work no doubt is relevant to the MoD and has much insight and expertise to offer for the Foreign Office, such an effort belongs to the world of diplomacy and global governance than defence planning. The NSpC could become a valuable high-level political check, accountability, and coordination mechanism on space issues that are dispersed between the better-equipped departments who take the lead on specific initiatives.

There are many other examples where the NSpC can play an important coordination and oversight role in key dimensions of spacepower. OFCOM provides the lead role in representing the UK at the International Telecommunications Union where radiofrequency spectrum slots for satellites (among many other things) are allocated. UKSA's representation and influence within ESA's negotiation with the United States in scoping participation in the Artemis Programme for lunar exploration would naturally involve UKSA determining what British universities and companies can provide in tandem with collective efforts through ESA to make a substantial European contribution. Yet it should also heavily involve the Foreign Office. The UK recently became one of the first states to sign up to the Artemis Accords, which may set the foundational norms and possibly detailed legal regime for future lunar exploration and in-situ resource utilisation and lunar traffic and infrastructure management.[75] The signing of the Accords is merely the beginning of the process of debating how to govern lunar exploration and local resource extraction, and will require a generations-long effort of diplomats to ensure an equitable agreement between as many participants as possible. The recent acquiring of OneWeb could be a new mobile internet-based communications infrastructure that may be more the purview of BEIS, unless it was to provide military services as SpaceX's Starlink may do for the US Army. In the world of national security, the MoD and Intelligence services rely on the special relationship with the United States and the security elements of British spacepower are not all 'military', whilst civilian intelligence capability uses and provides space services and products.

Conclusion

The UK's Responsible Behaviours in Space effort could touch on all these issues, increasing the need for coordination between departments and the top level leadership in Cabinet, particularly as Brexit forces structural and systemic changes on UK industrial and commercial prospects. This very short and brief list shows how much of a burden there is on any single, overarching 'space policy' or 'space strategy' that does not give itself a clear focus on specific areas or sectors of activities and that tries to ensure Britain gets what its needs from the binary system it remains integrated within and dependent upon.

In that binary context, the UK cannot afford many missteps on the diplomatic and allied fronts, particularly as it has little resource to make up for perceived deficiencies. Rhetoric often exceeds capability in terms of Britain's aspirations in space as a 'sovereign' space power, so it must moderate its language and ambitions to match its financial and technological means. Britain does not seem to want to spend the resources necessary to maintain a spread of capabilities, so hard choices *must* be made and justified with their systemic consequences for war fighting accounted for. A clear defence strategy and an idea as to the type of wars Britain wants to be ready to fight is needed to help outline how space can meet these priorities. The UK can aspire to be more operationally independent, but strategic autonomy requires a degree of economic resource and expertise that exceeds British capability for the foreseeable future. Any significant investment in space however must be weighed against the opportunity costs of investments in other well-deserving areas. Investing in ISR and 'information capabilities' may be desirable, but not at the expense of core firepower packages where all it enables is an incredibly high resolution and real-time picture of how badly British forces are being beaten on the ground. The development of military spacepower is a long and expensive task. It places high demands on a state's economic and technological base, as well as the skills base of its institutions and population. Britain must learn how to walk before running in space, make space investments that build space technologies that meet clear terrestrial warfare priorities by targeting 'low hanging fruit' for investments, are within the financial means of the state, and incrementally develop the spacepower culture of the MoD and institutional practices that enable the strategic decision-makers to interact with space specialists. Making up for a lack of sovereign military-intelligence interest in space over the past 50 years is a generational process, not an event or a single policy announcement.

Spacepower is proliferating around the world. More states and economies are using spacepower, becoming more dependent on it, and are seeking ways of countering their adversaries' use of it too. More states are setting up space agencies, and are modernising their military and economic power with satellite services. That creates as many opportunities for the purposes of war, development, and prestige as it does risks, threats, and challenges. Whilst the UK is right to try to develop policies and strategies to reflect this and will no doubt claim that we are living in some 'new era' or 'new space age', many of these challenges of goals, ambitions, security, interests, and fear are not new in the political and strategic universe. These issues will come back to the perennial question of how much of a priority any single aspect of space activity is for the UK, where to strike the balance between operational sovereignty and strategic allied dependencies and integration, and whether the British state will commit the resources to meet its objectives.

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