

## Written evidence submitted by Dr Mark Hilborne and Dr Mark Presley

The space environment has become more congested and contested. The influence of space-based capabilities offered by the increased range of satellites and operators reaches all elements of the UK's critical national infrastructure. Space is key to modern defence and security capability, pivotal to the delivery of public goods and to the growth and prosperity of commercial companies that will be the engine of any economic bounce back from the Covid-19 pandemic. Ensuring access to these capabilities is a critical security function. As such, space is a domain in which states, and potentially other actors, will seek advantage from and within. As the UK sets out its key objectives in space, and tasks Space Command with developing the capabilities to meet them, a critical priority will be to establish an ability to identify threats and hazards to the UK. This drives the requirement for Space Domain Awareness (SDA). Difficult decisions will have to be made as to what space capabilities the UK must own for assured use, access through collaboration with strategic partners and allies, or access from the commercial sector. As SDA is the MoD's number one space priority, a sovereign space surveillance capability, as a key component of SDA, should be central to assuring the security of all other space capabilities, while contributing to the wider network of the US and allies, and the robustness of alliances more widely. It would feed into and draw from emerging commercial sector capabilities and also amplify the UK's voice in international initiatives related to space sustainability. Space is also at the heart of the concepts underpinning Multi Domain Integration (MDI), and within this SDA is a critical element.<sup>1</sup>

As the authors have argued elsewhere, a UK SDA capability can be achieved at a cost that is relatively modest compared to many defence capabilities, and would provide a wider benefit to commercial and civilian space programs, as well as efforts to enhance space regulation and governance. While the Integrated Review has indicated the priority for SDA, it provides little detail. This paper argues that, an SDA capability offers a number of advantages, is cost-effective, and is able to utilise a key UK asset – its overseas territories.

### ***Current systems and challenges***

Space domain awareness, of which space surveillance as the key component is the use of sensors to observe the orbits occupied by satellites and debris. These satellites include military and global communications (including broadband provision), location and timing services for military activities such as navigation and precision targeting, Earth observation for a range of functions including weather forecasting and environmental monitoring. Space surveillance detects and tracks the active satellites that support these services and also the many tens of thousands of pieces of debris that have accumulated over six decades of unregulated activity in space and which pose a hazard to operational satellites. The goal is to produce a continuous catalogue of man-made space objects, to determine the present position and plot their expected trajectories.

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<sup>1</sup> See Joint Concept Note 1/20 (JCN 1/20), Multi-Domain Integration.

The UK currently relies on the US for SDA. Following the departure from the EU, the UK is no longer part of the EU Space Surveillance and Tracking (SST) program. The US system is military in origin, designed to provide missile warning. While it works effectively for tracking satellites in standard orbits, evolving operations and architecture will begin to challenge its effectiveness. For instance, rendezvous and proximity operations (RPO) used for satellite maintenance, refuelling and space based manufacturing will drive a need for more accurate SDA capabilities that can characterise and distinguish these kind of events with very low latency. Similarly constellations or formations of small, and very small nano-satellites will need to be resolved and differentiated from single satellites. As more constellations are proposed, consisting of ever-larger numbers of satellites, this will become a central characteristic in the complexion of orbital space.

The surveillance of space can be achieved in a number of ways. Lower orbits are typically observed using radar, higher orbits using telescopes. Radio Frequency surveillance is part of the mix, as is a growing potential for on-orbit surveillance sensors. The product of all these sensors is processed at an operations centre where a catalogue of space objects (satellites and debris) is created and updated. New objects are added, the orbits of existing objects updated to incorporate natural variations, station-keeping changes or other manoeuvres. Products and services from this process, such as conjunction warnings, re-entry warnings or just an updated catalogue, are then disseminated to satellite operators, regulators, insurers or other users.

Many nations undertake some of this process. The US is the dominant actor. Even so, the system is fragmented and there remain gaps. The lack of terrestrial locations makes observing orbits that pass over the Southern Ocean and South Atlantic particularly scarce. The rapid increase in satellites in lower Earth orbits makes observations of this domain particularly important. Both of these represent relative gaps in the global space surveillance capability.

At the core of any security calculus for the UK's military requirement or for the resilience of the UK's equities in space is an understanding of what is happening in the domain - who is doing what, where and when. This must ultimately offer decision quality understanding of the domain delivered in a relevant timeframe.

### ***Motivations***

There are numerous advantages to a sovereign UK space surveillance system as the key component of SDA. These relate to self-reliance, strengthening alliances and the UK's position within them, while also underpinning the UK's wider aspirations in the space domain, from commercial through to diplomatic. The UK currently has little or no nationally assured space surveillance capability, despite possessing significant pockets of expertise. The departure of the UK from the EU has also ended the involvement of the UK in certain EU space programs – in particular the EU SST program. While the UK will still be able to access data from the EU SST program, and of course enjoys access to high-level data from the US SSA system, this leaves the UK dependent on these other sources. Furthermore, the majority of existing space surveillance sensors are behind military security walls and are often repurposed ballistic missile detection systems. Because of this, not all the space

surveillance data the UK has access to is able to be shared. The US Space Fence, the most capable space surveillance sensor yet, is another military asset and it is not clear whether all the data it collects will be available in the public domain. The UK has access to much of this US sourced data but is not at liberty to share it. While the UK could continue to exploit this privileged access to world-leading space surveillance capability to focus on the defence and security targets of space domain awareness, a truly sovereign UK cross sector space surveillance capability provide the UK with nationally assured access and would also make a vital contribution to allies and partners.

The US Defense Space Strategy recognises the need for a greater global effort on space surveillance and calls for expanded information sharing relationships with capable allies and partners and to align on space policy. A space surveillance operations capability derived from a partnership of civil, defence and commercial contributors would provide the UK with a unique capacity to share data with the US.<sup>2</sup> The UK also has a defence and security capability that has a long tradition and deep expertise in space surveillance and enjoys a strong and well-established relationship with the US that would accelerate the development of expertise, the sharing of space surveillance data and enhance the UK space surveillance capability. The UK is in fact better placed than almost any other state to benefit and enhance ties with other allies in this domain.

Adding a nationally assured, sovereign space surveillance capability would also aid the resilience of allied space surveillance systems by providing diversification of sensors and placement in locations which would offer coverage where there is currently little. This would complicate an adversary's task of undermining the alliance collective capability. In addition it would also strengthen the independent voice of the UK in drawing attention to threats and malevolent behaviour in space, as well as its diplomatic leverage in establishing norms of behaviour in space and measures to improve governance.

Illustrating this point, in April 2020, Russia conducted a direct ascent anti-satellite test – one that was not announced, but identified independently by US space surveillance systems.<sup>3</sup> While the announcements from the US marked a new transparency in identifying activities that previously were considered classified, the UK had no forewarning, and were thus diplomatically at a disadvantage. Similarly, the public criticism by the UK of Russian rendezvous operations, and the possible test of a space projectile in July 2020<sup>4</sup> would have had even greater impact internationally if the events had been independently detected and verified. Furthermore, as the UK leads efforts in the UN to establish norms of behaviour in space, the credibility of a sovereign space surveillance capability would amplify the UK voice and leverage its influence in international fora. The greater our input in these fora, the greater is the likelihood that the domain is shaped in ways that benefit the UK.

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<sup>2</sup> The US Combined Space Operations Centre (CSpOC) does have contributors from the civil and commercial sectors but it is a military organisation under command of US Combined Forces Space Component Command based at Vandenberg Air Force Base.

<sup>3</sup> Nathan Strout and Aaron Mehta, Russia conducted anti-satellite missile test, says US Space Command' *C4ISRNET*, April 15, 2020. <https://www.c4isrnet.com/battlefield-tech/space/2020/04/15/russia-conducted-anti-satellite-missile-test-says-us-space-command/> India tested such a device in April 2019, while China did so in 2007, and possibly a number of times since.

<sup>4</sup> United Kingdom, Ministry of Defence Twitter, @ DefenceHQ (23 July 2020 3:48PM)

The UK has invested significantly in its space capability. On 3 July 2020, the UK committed an initial £500m (of the expected total cost of £6bn) to the next generation of UK Geosynchronous Earth Orbit (GEO) satellite communication Skynet 6A satellites.<sup>5</sup> The impact of the loss of one satellite in GEO will have a significant impact on the capability it delivers. Satellites in GEO tend to be much more costly to build and launch to orbit, have longer operational life spans and, therefore, have returns on investment often measured in decades.

Low Earth Orbit (LEO) satellites are often more resilient because more satellites make up a constellation, they are smaller, have a shorter operational life span and are less costly to launch to orbit. On 19 July 2020, the UK invested £500m in OneWeb, a LEO satellite operator.<sup>6</sup> Also in July, the US Department for Defense invested \$15m in a commercial space surveillance sensor provider (LeoLabs – part of the investment portfolio of UK Seraphim Venture Capital and Airbus) to provide additional resilience to their coverage of this particularly congested orbit.<sup>7</sup> The scramble for pre-eminence in the broadband market in LEO is creating congestion which significantly increases the risk of collision. The great danger is one collision will create a debris cloud that will create multiple other collisions, causing a cascade of debris that would make the orbit unusable. This future scenario is called the Kessler syndrome and it is a potential modern-day tragedy of the commons.

The exposure of UK equities in both GEO and LEO orbits is significant. This, overlaid with the expanding activity of Russia and China, furthers the need for a nationally assured space surveillance capability. Such a capability would be a small premium to pay to assure this investment and act as the foundation for greater resilience. It would inform a greater awareness in defence, with MoD using its access to US surveillance capabilities to interrogate satellites of particular interest. Without space domain awareness, we should be deaf, dumb, and blind in the space domain, and left needlessly vulnerable.<sup>8</sup>

### **Proposals**

A ground-based space surveillance system would make a vital contribution to the issue covered so far: security of the UK's space assets and its military space missions, diplomatic initiatives and commercial activities. To replicate the space surveillance capability that the UK has access to would be unnecessarily expensive and duplicative, even if it did offer

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<sup>5</sup> <https://www.gov.uk/government/news/defence-secretary-announces-boost-for-multi-billion-pound-skynet-6-programme> and <https://www.defensenews.com/global/europe/2020/06/16/british-mod-shortlists-four-vendor-teams-for-its-multibillion-dollar-skynet-satellite-program/>

<sup>6</sup> <https://www.gov.uk/government/news/uk-government-to-acquire-cutting-edge-satellite-network>

<sup>7</sup> <https://www.defense.gov/Newsroom/Releases/Release/Article/2270498/dod-announces-844-million-in-defense-production-act-title-iii-covid-19-actions/>

<sup>8</sup> Dr John Sheldon, in Gabriel Elefteriu, *What do we want from the next Prime Minister? Policy Ideas for new leadership: Space*, (Policy Exchange, 2019), p. 12.

greater resilience. However, there remain gaps in the global space surveillance network that the UK could profitably fill, complementing the existing space surveillance data the UK has access to and in the process, contributing to greater international awareness and understanding of the space environment.

Two key measures that would provide a cost effective nationally assured capability include:

- A cross-sector (civil, commercial and military) space surveillance operations centre that can exploit available sensor data and provide products and services to end users and innovate new products and services. Over time, this would also create unmatched space surveillance expertise and experience.
- Sensors geographically located in British Overseas Territories that offer coverage of parts of the LEO orbital domain that are lacking. A particularly useful location for the sensors would be the Falkland Islands, but could include Ascension Island or Diego Garcia. The costs would be a small fraction of the value of UK equities in space (measured in the many £billions) and an even smaller fraction of the value of the terrestrial capabilities they support (conservatively measured in the many 10s of £billions).

There are other gaps in the space surveillance sensor portfolio that could be filled, such as precision sensors (terrestrially based and on orbit sensors), Radio Frequency (RF) sensors to monitor the increasingly congested RF spectrum and Artificial Intelligence uses for data analysis. However, it is the space surveillance operations centre and geographically located LEO sensors that stand out as two clear examples of gaps in the space surveillance capability to fill and would offer the UK the greatest return in terms of resilience of UK space equities, growth potential, increased expertise and confidence in the UK space industry, as well as a diplomatic dividend in the enhanced reputational position of the UK in international space fora related to space sustainability and norms of behaviour in space.

A UK sensor would not be able to observe all orbits or meet all the varied requirements for space surveillance products and services. A strategically located radar sensor, for example in the Falkland Islands, would detect objects in key sun-synchronous polar orbits, the preferred orbit for launches from the UK. Importantly, data from such a sensor would be a valuable commodity to exchange for other segmented sensor data available from other components of the global space surveillance network – coverage of the southern hemisphere is currently limited. Such a radar sensor would focus on LEO, though telescopes and RF sensors could be added to provide more fidelity to the existing surveillance data on GEO. Added to this, there is an as yet unfulfilled market for the products and services distilled from the available sensor data across all orbits.

Such a system does not need to be military, even if it is to serve defence interests. A military space surveillance sensor has proven not to be able to prioritise support to the civil and commercial requirement, yet there is a growing market for independent, open and commercially available space surveillance sensor data. An open and transparent UK cross sector space surveillance capability could respond to this and make a vital contribution to defence as well as civil and commercial space. Civil and commercial space surveillance sensors can serve the military requirement. There will be a need for the military to apply their own sourced intelligence to the data and that can be easily achieved. The previous veil

of secrecy that was assumed for the vast majority of space surveillance information is unhelpful, and must be overcome if any UK space surveillance capability is to ensure the spectrum of needs of the UK space sector, and be able to do so in a cost-effective manner.

***13<sup>th</sup> July 2021***