Written evidence submitted by Airbus

1. Introduction

1.1 Airbus is the largest space company and third largest defence company in the UK, with activity across the portfolio of defence and space services. This includes:

- 1.2. being the UK's No1 space manufacturing and system prime company leading on and contributing to numerous European Space Agency and commercial missions and programmes;
- 1.3. operating the Skynet 5 satellite constellation to provide all secure Beyond Line of Sight satellite communications for UK military operations world-wide;
- 1.6. manufacturing Zephyr, a high-altitude platform station for persistent surveillance and communications, for the UK MOD;
- 1.7. being the sole owner of Surrey Satellite Technology Ltd (SSTL), the world's leading manufacturer of advanced small satellites for more than thirty years, delivering to short schedules and tight budgets;
- 1.8. being one of the only UK companies certified to provide 'high grade' encryption technologies to our armed forces enabling secure voice and data sharing across multiple air land and sea networks without fear of cyber-attack;
- 1.9. provision of high-definition imagery and video from space delivering rapid information to the war fighter in support of military decision making;
- 1.10. being the first supplier in the world to provide secure laser services in space.

1.11. Investment in future skills is key to what Airbus does; Airbus has trained in excess of 1,000 apprentices in the last ten years, holds collaboration agreements with more than 20 British universities and spends £340 million per year on UK R&D, making Airbus a champion of UK innovation and skills.

2. How can defence industrial policy ensure that investment and innovation in the private space sector is harnessed to align with the UK's defence requirements?

2.1 The UK's space ecosystem is fragile, but it works. It works as it has three primary components:

- 2.1.1 A steadfast institutional customer in the European Space Agency (ESA), which is supported by the UK government and funds important scientific and technology development missions;
- 2.1.2 A supportive government customer in the UK, which backs ESA and supports UK industry, including through the MOD;
- 2.1.3 An anchor UK space prime in Airbus, which inherited and consolidated the national crown jewels in space from its predecessors, GEC-Marconi and British Aerospace, amongst others.

2.2 Defence and civil space are inextricably linked, and the UK enjoys the benefits of a very strong space sector. Ultimately, commercial investment in this area follows government spending.

2.3 Without the elements listed above, Airbus simply would not be able to do significant high value business in space in the UK, could not sustain the critical mass necessary to employ 3,500 employees in our space division, and could not afford to continue to invest hundreds of millions of pounds in R&D.

2.4 Put simply, the way to harness private sector innovation and investment to support defence requirements is to invest in the supporting technologies the committee has identified in its questions, and to do so as part of a wider Defence Space Strategy and National Space Technology Strategy. Most importantly, the upcoming National Space Strategy must not forget the importance of telecommunications, of which the UK, through Airbus, has already captured 25 per cent of the global market.

2.5 Airbus proposes the creation of a Space Research Advisory Board, reporting to the National Space Council, which will focus on bringing together the parties and organisations that are currently working on space research in isolation e.g. DSTL, UKSA, RAL Space, Innovate UK, for knowledge sharing. The advisory board should define the most advantageous national requirements needed to elevate the UK's standing. The board should also be the focal point for both domestic and external customers (from overseas) and, finally, the board should create the relevant processes and efficiencies to save HMG both time and resource, such as national roadmaps which could be linked to the Space Growth Partnership to encompass industry, academia and government.

3. How should the UK Government seek to further develop its strategic relationships and interoperability with allies?

3.1 Most importantly, the UK can work with allies to share space data to improve the attribution of risky manoeuvres in space, and to set norms of behaviour.

3.2 From an industrial perspective, Airbus is a global company with incredibly interlinked European industrial supply chains supporting collaborative projects, part of which is our substantial UK industrial presence. Space requires a level of collaboration between industry and government, with strong government support both as an institutional customer and as a supporter of R&D.

3.3 International collaboration is enhanced with trusted allies, such as Five Eyes and NATO countries. The real benefit to the UK is sharing the cost of research and interoperability across systems delivering greater resilience to UK capability. Having large scale programmes international by design opens up long term roadmaps and sharing of international challenges. UK companies must partner with international partners in a spirit of collaboration.

3.4 The UK has only developed an industrial base with a significant involvement in 25 per cent of the world's telecommunications satellites through international collaboration, primarily through the European Space Agency. Due to the scale of the global space industry and the addressable market, international collaboration is essential in taking a commercially viable industrial stake in projects.

3.5 Skynet is designed to be interoperable. The US and NATO are the two largest users after the UK, which demonstrates the truly global nature of this national asset; the UK should continue to leverage its expertise in this area.

3.6 The UK can benefit from exploiting existing relationships developed with international partners in other domains. For example, the relationship with Australia through which BAE Systems will manufacture Type 26 frigates on Australian soil could be leveraged in space, because the British frigates, along with all Royal Navy vessels, use Airbus-operated sovereign British satellite communications systems. This opens up a very positive opportunity to deepen our relationship with Australia on space. Airbus is offering a version of the UK's Skynet system to fulfil Australia's requirements for a sovereign military satellite communications system, JP 9102.

3.7 The UK Space Agency and the Australian Space Agency have signed a Space Bridge agreement. This is an important mechanism through which to encourage collaboration and the sharing of ideas, formalising the space relationship between the UK and Australia to lead to joint missions, sharing of capabilities and research collaboration. The agreement is a high level declaration of intent, opening the door to the development of the two countries' space industries. The signing of more such agreements to develop international governmental and industrial ties would be a very positive development.

3.8 Having international partnerships with the Five Eyes community, in particular, gives the UK an opportunity for global leadership. US dominance in space is not good for choice or resilience.

3.9 Another positive space relationship is that with France. Both countries have mature space industries focusing largely on telecommunications, and both enjoy sovereign milsatcom systems (Skynet and Syracuse). A potential area for shared requirements could be on-orbit protection, which could lead to shared capability development.

3.10 It is also important for the UK to champion standardisation across commercial technologies, which is most relevant in telecommunications and optical communications. The UK is in a strong position to do this, housing a huge amount of the global expertise and industrial capacity.

Where can the UK most effectively develop and deploy its own sovereign defence capabilities, with particular regard to:

4. Communications

4.1 Communications is currently the UK's only sovereign government space capability.

4.2 The UK's ability to sustain a genuinely world-leading sovereign milsatcom system, assuring UK national communications against a range of threats, including nuclear electromagnetic pulses and ground-based jamming, is only possible because of five decades of joint government and industry investment in this area, not least through the European Space Agency's investment in telecommunications research in the UK.

4.3 Without ongoing commitment to joining up and funding the research, manufacturing and services elements of this sovereign capability, there is a risk the UK loses its ability to protect its own communications against all global threats. It is therefore imperative that the link between the operator and manufacturer of the Skynet system, with both roles currently undertaken by Airbus, is not broken.

4.4 The Service Delivery Wrap programme, which is currently out to tender, will be a watershed moment in the post-PFI period for Skynet. The service element must be undertaken by expert operators working with 'space architects', housed at Airbus, who are able to ensure the integrity and future proofing of the whole end-to-end milsatcom infrastructure. It is also extremely important that this work is a protected 'strategic imperative' and entirely on-shored with companies with a longstanding commitment to the UK.

4.5 After SDW, the UK's Skynet Enduring Capability (EC) programme will define and build the UK's government satellite communications into the 2040s, addressing future threats such as advanced jamming techniques and anti satellite weapons. EC is also responsible for developing the Secure Telemetry, Tracking and Command (STT&C) system vital to the sovereign operation of all Skynet 6 satellites. It is vital that the EC programme is imaginative, innovative, and the best of British, and that it takes into consideration the technology of 2040, not 2020.

4.6 Development work should begin as soon as possible with the UK's only manufacturer of large satellites, Airbus. Without Airbus leadership in Skynet, the UK will be unlikely to continue to manufacture large satellites in 2040. Put simply, the UK space manufacturing base will be gutted, and work will go elsewhere.

4.7 The multi-decade approach to Skynet has been one of the major factors that has allowed Airbus, on behalf of the UK, to assume a prime contractor role which has then created a supplier ecosystem around it to the benefit of the UK's technological base and broader economy.

4.8 It is the only company in the UK that manufactures satellites from a hundred kilograms up to several tonnes, at our sites in Stevenage, Portsmouth and Guildford. Airbus has supported our UK armed forces for the last 15 years by delivering and operating the Skynet military communications system – a unique programme which has also generated £1 billion of exports to thirteen countries including the US and NATO. Almost all the preceding Skynet satellites were also built by Airbus.

4.9 This depth of experience and knowledge means that Airbus has the skilled employees to draw on to respond to the evolving threat based secure, resilient, and sovereign earth observation and communications solution for the UK MOD. For defence, we believe we have the vision and commitment to deliver an evolving threat-based, secure, resilient and sovereign earth observation and communications solution for the UK government.

5. Space Situational Awareness

5.1 The UK is currently highly reliant upon other nations to provide space surveillance data. Airbus currently receives SSA data from the US Space Force's 18th Space Control Squadron and the UK Space Operations Centre at High Wycombe.

5.2 The introduction of specific UK capabilities, for example in ground and space based sensors (ideally established in collaboration with Commonwealth partners) as well as enhanced understanding through data processing and analysis, could lend great weight and credibility to both our own sovereign aspirations and the role we aspire to play with our allies and partners.

5.3 Localised situational awareness is becoming increasingly important. This can be achieved through new sensors either on or near critical satellites, including small cameras or radar warning receivers. This will encompass both the physical threat and threats in the electromagnetic spectrum.

5.4 The government should consider the development and deployment of a Space Traffic Management (STM) system. The STM system should seek to support safer operations in space and measures to avoid unnecessary pollution of the space environment with new debris. This includes improving the cataloguing and custody of objects in space to include smaller objects for better collision avoidance. The UK should consider leading this work as a concerted international effort.

6. PNT (Position, Navigation, Timing) services, in the context of the UK's exit from the EU's Galileo and EGNOS programmes

6.1 PNT is a truly essential enabler of force in the modern era, not least for autonomy, naval power, sixth generation combat aircraft, and manned-unmanned teaming. Given the UK is no longer part of Galileo, there is an exciting opportunity to consider UK Global Navigation Space Systems (GNSS) ambitions alongside the importance of providing a resilient space-based global PNT solution.

6.2 Using new technologies and LEO constellations, it is possible to deliver high precision navigation data that could deliver decimetre global accuracy positioning. The UK has already taken a stake in the global LEO race, giving it the opportunity to become a world leader in PNT technology and dual-use small satellites.

6.3 The UK government has already identified GPS, one of the GNSS available to the UK, as highly susceptible to both accidental and deliberate interference yet it is critical to services such as telecommunications, financial transactions, and transport in order for them to operate. A London Economics report[1] estimated the economic impact to the UK of a five-day disruption to GNSS would be £5.2 billion. Consequently, the Blackett Review into satellite-derived time and position, recommends that: 'Loss or compromise of GNSS-derived position, navigation and timing should be added to the National Risk Assessment in its own right, rather than as a dimension of space weather alone.' [2]

6.4 Given the UK is now no longer able to access the secure signal from the EU's Galileo GNSS, then the national reliance on one foreign owned and operated system surely raises the risk level. While the UK government, through the UK Space Agency, has sought to investigate a national replacement to Galileo through two separate programmes[3], the government must do so at pace. A unique LEO-based UK PNT

[1] London Economics 'The economic impact on the UK of a disruption to GNSS' 2017. Available at https://londoneconomics.co.uk/blog/publication/economic-impact-uk-disruption-gnss/

[2] https://www.gov.uk/government/publications/satellite-derived-time-and-position-blackett-review

[3] The UK GNSS programme and now the UK Space-based PNT programme (SBPP)

contribution could lend the West additional resilience and accuracy to support the US and European systems.

6.5 Alongside this, the Cabinet Office has an established committee that is examining the nation's reliance on position, navigation, and timing data. The UK needs a 'system of systems' approach that includes signals both from space and the ground. Accuracy, access and reliability will be paramount and any new system should seek to deliver a system with a high degree of certainty. An assured service is vital, as apart from the MOD, almost all other users are dependent on an open system which remains subject to direct interference and spoofing. To this end, Airbus is developing a receiver that is designed to detect spoofing, which is important for a wide range of sectors, not just defence.

7. Intelligence, Surveillance and Reconnaissance

7.1 The UK government has a very limited capability to provide global EO services. The lack of a national EO programme is a missed opportunity for the UK and reduces our global standing; we are the only permanent member of the UN Security Council not to have a national EO constellation. The MOD is entirely reliant on the US and commercial providers to provide data. Consequently, there is no freedom of action, as the UK is 'at the back of the queue' when requesting data from other countries, nor could the UK sustain a truly 'UK Eyes Only' mission, using data from space.

7.2 There is a strong case for the UK to create its equivalent to the National Reconnaissance Office within UK Space Command to lead on ISR from space. This must be integrated with wider defence, national and international ISR capabilities and linked to other information and intelligence sources.

7.3 With the retirement of the Sentinel aircraft, the demand for advanced capabilities such as Moving Target Indicators will only increase. With synthetic aperture radars (SAR) in Low Earth Orbit, space assets can offer this type of capability with increased survivability. SAR allows the ground to be seen in outstanding detail, regardless of darkness or poor weather conditions.

7.4 Airbus Intelligence UK is already providing world-leading EO services, including as the operator of Vision-1, the UK's first sovereign <1m resolution optical imaging satellite. It acquires imagery for the MOD as part of the ARTEMIS programme. Airbus Intelligence is also involved in the operation of the SSTL-built NovaSAR mission.

7.5 Airbus hopes to see a number of Earth Observation and ISR demonstrator projects scaled up and fully funded, so that they may become full projects. This includes Oberon, a cluster of spacecraft with ultra-high-resolution SAR payloads, which will also be able to collect radio frequency signals.

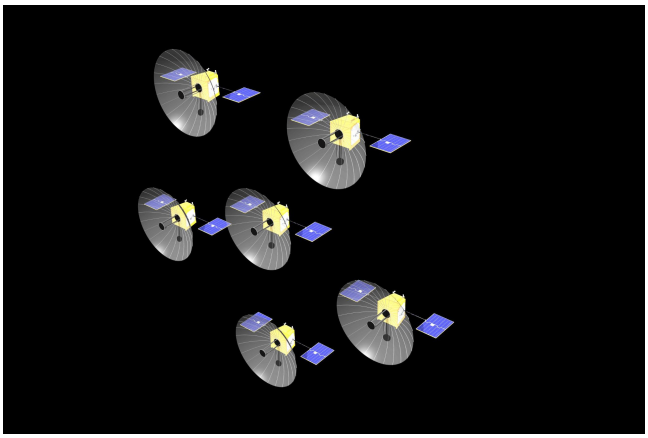

Image: Oberon cluster

7.6 The Airbus Zephyr is also a key future ISR capability. This is a High Altitude Platform Station (HAPS) operating on the stratosphere, at about 70,000 feet, with a wingspan roughly equivalent to an A320, but weighing less than two airline seats. Zephyr's design, development and manufacture is firmly rooted in Airbus UK's operations – It is a 'GREAT BRITISH' product that has scope to be exported and operated across the world, with the Ministry of Defence as the first customer.

7.7 It delivers surveillance and communications capabilities, ranging from voice and data communications (both line of sight and beyond the line of sight), and 24/7 monitoring of land, coast or sea using optical, infra-red, radar, multispectral or electronic intelligence payloads.

7.8 It is the only proven HAPS, and holds the world record for the longest powered flight in history. After taking off on 11th July 2018 in Arizona, USA, Zephyr-S logged a maiden flight of over 25 days, the longest duration flight ever made.

7.9 Emerging technologies such as HAPS should be fully embedded in future concepts of operations and in the 'digital backbone'.

8. How vulnerable are our space assets to deliberate attack, both physical and otherwise, and what steps can be taken to improve their resilience (with regard both to defence capabilities and other critical national infrastructure)?

8.1 The UK's Skynet military communications satellites are designed to operate within a high threat environment, and are equipped with world-leading anti-jamming capabilities and nuclear hardening to protect against orbital electromagnetic pulses.

8.2 Jamming is a form of electronic attack that interferes with RF communications by generating noise in the same frequency band and within the field of view of the antenna on the targeted satellite or receiver. Even if jamming is used from the Earth's surface, Skynet will continue to deliver resilient communications to the UK's armed forces and those of the UK's allies. Skynet has been tested as part of US resilience testing, or war games. To this day, it has not yet been successfully jammed.

8.3 In 2007, the Chinese government deliberately fired an Anti-Satellite Missile (ASAT) at one of their own defunct weather satellites (Fengyun 1C) and destroyed the satellite. This created a debris cloud of over 3,000 pieces which continues to grow, affecting satellite orbits today[4]. This single event is probably the best example of the devastating effect that counterspace weapons have on the space environment.

8.4 Since then, there has been a significant increase in test firings of such missiles by China, Russia and more recently India[5] and both the Russians and Chinese have engaged in on-orbit behaviour that could be interpreted as aggressive. In 2014, a Russian satellite called 'Luch' manoeuvred around the geostationary belt and came close to both French and Italian military communication satellites. More recently from July 2017 to December 2019, a Chinese satellite SJ-17 made a series of manoeuvres in the geostationary belt and conducted a series of space rendezvous with a number of other Chinese satellites; these manoeuvres took SJ-17 past the UK MOD's Skynet 5A satellite. There is speculation that ASATs could reach GEO, but Airbus is more worried about these co-orbital threats.

8.5 The most significant immediate threat is accidental interference in services as space assets move around the GEO belt. When operators, mostly national governments, do not share information on planned space manoeuvres, disruption can occur. As an example, one national actor moved a satellite 40 degrees in the GEO belt and did not inform any other space actors in advance. This sort of incredibly risky manoeuvre makes the development of space norms incredibly important.

8.6 There is a need for an international discussion around collision avoidance, data sharing, debris mitigation and codes of behaviour, to ensure transparency of action, more timely understanding and management for real risks and more proactive cooperation. The UK is well placed to lead this action, given the in-country expertise in this area. The FCDO has already made progress with some of this work in the UN, with its resolution to agree responsible behaviour in space. We are optimistic that the National Space Strategy will address this issue and how the UK should seek to mitigate the risk, but this has yet to be published.

8.7 There is also concern around the use of lasers to disrupt space assets. Currently, lasers can be used to disrupt satellites with optical devices onboard. There is a growing use of lasers to communicate in space through inter-satellite links, rather than through radio frequency means. Airbus has proven this concept in space, and has established the SpaceDataHighway service using the Airbus-owned and -operated European Data Relay System. This type of technology will have profound defence implications, with improved latency allowing data to be passed from deployed assets to one another and to HQ as part of a Combat Cloud.

8.8 In the future, lasers may also be used to ablate the surface of a satellite until its direction of travel is affected and speed is reduced. Eventually, its altitude will drop and it will disintegrate. The technology for this is incredibly immature. It also has benign applications, with laser-based space debris removal one day becoming a possibility, and lasers are also used for ranging satellites.

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[4] https://swfound.org/media/9550/chinese_asat_fact_sheet_updated_2012.pdf

[5] https://swfound.org/media/207057/swf_indian_da-asat_aug2020.pdf

8.9 This effect is also possible naturally. Orbital decay is caused by drag generated by the Earth's atmosphere affecting satellites that are in orbit near to the Earth's surface. This drag causes a reduction in speed and altitude, pulling the satellite into the thicker atmosphere until it re-enters the atmosphere completely. The factors affecting this orbital decay relate to the thickness of the atmosphere (which is a dynamic variable), the shape of the spacecraft and the speed by which it is moving and consequently the factors combine to make orbital decay not predictable. The RAF and the UK Space Agency provides a warning service to the wider government which then coordinates any response in the unlikely event that an object was to land on the UK or its overseas territories; it takes roughly six minutes for a satellite to pass over the UK.

8.10 One must also not overlook the importance of ground stations. Skynet has a number of primary and backup ground stations, both in the UK and overseas. The option of having a number of secure options for where to land data is incredibly important.

9. What should be the priorities of the new Space Command, and how will its structures facilitate integration across all military domains and co-operation with commercial space operations?

9.1 The new Space Command needs to establish itself quickly to ensure the momentum generated by the Space Directorate is not lost and that the MOD can capitalise on the investment outlined in the Integrated Review. Spending 2-3 years establishing a command structure without moving any programmes forward should not be considered a success.

9.2 The first priority must be to bring all current space programmes under one command, as this will allow the MOD to exploit the synergies that exist across them. The current stove piping is creating unnecessary risk and cost to the MOD, and this impacts decisions to progress programmes which creates delay and uncertainty. As an example, the Artemis programme has made little progress despite announcements by two secretaries of state for defence; Airbus has invested £5 million in the build at risk to keep the project moving forward and to sustain key skills. Expanding the MOD's space capability and knowledge is critical to the UK's National Space Strategy and the MOD must understand the advantages offered to them by space-based technology.

9.3 Therefore, the MOD must address its lack of suitably qualified and experienced personnel (SQEP). The creation of a career structure that can support all three services, across all ranks, will be essential to ensure the MOD truly understands the space domain. As part of both the Skynet programme and RAF's Artemis programme, Airbus was committed to supporting the development of military personnel, but the MOD has struggled to recruit and train people, and consequently these posts are vacant.

9.4 Despite the very welcome uplift in the defence budget the UK government will need to continue to target its investment into those areas that offer operational advantage and support our allies. Consequently, Airbus believes there is unlikely to be sufficient funds to sustain a large number of UK space manufacturing companies with production lines to fill over the long term. The only nation in the

world with enough income to sustain multiple companies is the US, which invests $24 billion per annum in space for defence, compared to £264 million for the UK.

9.5 There is an urgent need to review the UK doctrine for the military use of space, as well as a review of the law on the use of force and implication of international humanitarian law on the military use of outer space. Too much focus remains limited to launching satellites from UK territory.

10. How can the Ministry of Defence ensure that it attracts, develops and retains high calibre space specialists in both policy and operational roles?

10.1 The military space sector requires a broad spectrum of engineering skills, and particularly physicists. Unfortunately, the demand for these skills is high and supply is low.

10.2 Government and industry are all competing for the same people so it is important that investment is made now in delivering strong space focused graduate and apprentice programmes that will ensure there are sufficient space skills for the future.

10.3 One way to do this would be to establish national guidelines for space to enable a structured training and career path for the military space sector. This would enable government and industry to share the cost and burden of training live space operators, securing a future talent pool for all to benefit from.

10.4 Long term acquisition life cycles also lead to 'peaks' and 'troughs' in skills requirements which poses a challenge for industry to ensure critical skills are maintained for the long term benefit of UK defence. In the military space domain, service contracts to deliver military capability through space systems provide essential continuity and the means to sustain sovereign space skills. A greater focus on service provision is one tool which can be used to address skills challenges, and reduce the risk of capability erosion.

10.5 It is not necessary, or indeed possible, for the MOD to house all operational space personnel. Operations are inextricably linked to the development cycle for hardware and software, and so it is important that the engineers designing and building space architecture are embedded in operations.

10.6 If all of the space services roles are moved into government, the UK may struggle to retain specialist milsatcom design system engineers who previously moved from manufacturing to operations to retain and develop knowledge. Without the protection of the link between services and manufacturing in milsatcom, these skills could now be lost between milsatcom builds.

10.7 The UK may need a skills retention programme equivalent to Seedcorn, the programme run by the MOD to retain aircrew maritime patrol competencies, to support future milsatcom capability. Even then, significant risks would remain. The labour market for advanced engineering skills is far more flexible on the global level. Engineers could simply leave and go elsewhere, dealing a huge blow to sovereign capability.

13th July 2021