UK Space Agency and BEIS Space Directorate Response to Ofcom Space Spectrum Strategy

Introduction

The UK Space Agency (UKSA) and BEIS Space Directorate would like to thank Ofcom for the opportunity to comment on the space spectrum strategy refresh. Access to spectrum is vital to all activities in space and a well-defined strategic approach to managing spectrum will be crucial in maintaining existing services and in unlocking potential growth in the sector. As Ofcom have noted, space presents significant opportunities. The global space economy is projected to almost double its current size to reach £490 billion by 2030.

Our priorities are driven by the National Space Strategy[1] (NSS) and its vision to grow the UK space economy into one of the most innovative and attractive in the world[2]. Meeting this vision will require spectrum management that supports traditional priority applications in satellite communications, satellite navigation, earth observation, weather forecasting and climate studies while also enabling new emerging markets like in-orbit servicing, space travel and habitation, and active debris removal. Spectrum will be needed to support safe, sustainable, secure space environment, to respond to space threats such as orbiting debris and support new science and technology, human spaceflight and visiting the moon and Mars. Spectrum is also needed to support the UK's nascent small satellite launch capability. Additionally, space weather sensors are critical to space weather forecasting and we agree that they need a firmer regulatory footing going forwards.

This space spectrum strategy looks 2-4 years ahead. In this timeframe, spectrum pressures are largely coming from growth in the International Mobile Telecommunications (IMT) sector, which includes both terrestrial and satellite 5G. Satisfying these demands will need more sharing of spectrum, but current IMT deployments do not share well with other services. The protection criteria needed to prevent interference to passive services are particularly difficult to meet. Diluting those protection criteria, as implied in the strategy, is not a tenable solution.

Within the space sector, spectrum challenges include managing and facilitating the rapid growth in non-geostationary orbit (NGSO) constellations, which are now delivering satellite broadband. We agree a solution is needed that both enables successful deployments and promotes fair competition between NGSO networks, while respecting filing seniority. This solution should also protect other services sharing this spectrum, including geostationary satellites and fixed links. This issue was the subject of a recent Ofcom consultation and statement which UKSA responded to.

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[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1034313/national-space-strategy.pdf

[2] The NSS prioritises sustainable exploitation of the opportunities in space, the protection and defence of our interests in space, the use space to help solve challenges at home and overseas and on cutting-edge research to sustain the UK's competitive edge in space science and technology.

As well as important science value, there is significant commercial growth in earth observation and space science. These have traditionally been developed and operated in the institutional domain. Fitting these new missions within existing bands, that are already extensively used, will require careful management and puts pressure on the corresponding spectrum allocations.

Future challenges and opportunities are expected to arise in providing connectivity to the Internet of Things (IOT), networks of physical devices, sensors and machines connected to the internet, collecting and sharing data.

In addition to considering issues that need immediate action, we need to keep the longer-term in mind. Largely this will mean being careful to not eliminate options for future growth in addressing short term needs, while putting in place a clear roadmap of actions supporting future development. Missions launching now may have lifetimes of 10-20 years, particularly the earth observation and metsat missions. It is not possible to modify a sensor once launched and this will place constraints on changes to how the spectrum they use is shared.

In the longer term, strategic planning will need to consider several World Radio Conference (WRC) cycles ahead. Revisions to the international radio regulations to enable future developments and reform how satellite networks are managed take time, and we are keen to work with DCMS as UK spectrum policy lead in developing this strategic plan.

Responses to Questions

Question 1 – Sector Trends

Are there other trends in the space sector (or the broader spectrum environment) that we should monitor and/or take account of in our strategy?

The UK Space Agency undertakes its own market studies, sector analysis and development programmes. Its strategic priorities are summarised in the National Space Strategy, the Integrated Review and the spectrum requirements that flow from these.

We were pleased to see this consultation is largely in agreement with our analysis and aspiration.

New technology together with the reducing cost of launch, is driving rapid growth in commercial satellite communications and services based on earth observation.
As outlined in section 3, NGSO deployments of thousands of satellites is perhaps the highest profile growth area, but there are many others which are well covered.

Space is now delivering broadband and 5G services to fixed and mobile consumers, providing connectivity to the Internet of Things (IoT) in partnership with influential parts of the terrestrial industry.

Remote sensing of climate and weather has developed through new commercial growth in providing satellite-based services supporting earth imaging with applications in agriculture, biosphere, transport, civil protection, mapping, land use and earth sciences. The demand for data to support climate science and evidence to justify action to combat global warming is growing. It is important that crucial sensors are not placed at risk of increased interference. When detecting small changes in climatic parameters, even very low levels of interference are significant.

The recognition in the UK national risk register that severe space weather could do serious economic harm to systems in space and on the ground means we have a new requirement, to ensure the continued usability of space weather sensors, which are not yet recognised within the radio regulations.

The growth in space activity has highlighted the need for activities to be sustainable, to deal with space debris and to avoid collisions in space. Better space situational awareness will require improved tracking systems. Technology to rendezvous with and de-orbit debris can also be used to service spacecraft, extend their life, to assemble large structures in-orbit and to return items manufactured in space to earth. Sustainability also relates to spectrum, spectrum use needs to be sustainable.

Finally, the UK has agreed to cooperate with partners in revisiting the moon. This will require international agreement on spectrum use on and around the moon and in the Cis-Lunar environment (between earth orbit and moon orbit), and how systems will share and protect the unique lunar environment.

Question 2 – Priorities

Do we agree with the broad areas Ofcom have prioritized for their work?

As indicated in our introductory text, our priorities are set through the National Space Strategy. A summary of priorities, reflecting how we will deliver the UK's strategic ambitions in space is presented in the UK Space Agency 2021-2022 Corporate plan[3] which was published in December 2021.

Our prioritization around spectrum flows from this. The prioritization presented by Ofcom matches well and we bring out some detailed points below where we may not yet be completely aligned. Our priorities develop from:

- Reassertion of our long-standing position on the protection of spectrum used for science services.

- Continued support for traditional space telecommunications systems remains a priority, in an environment where congestion is rising and sharing needs to be facilitated.

[3] https://www.gov.uk/government/publications/uk-space-agency-corporate-plan-2021-22

- New innovative areas, including inter-satellite links within and between orbits, support for technology that moves between orbital domains, including in orbit servicing will require agility in our approach where systems do not fit well within the existing regulatory framework that focusses on more traditional service definitions.

- Spectrum supporting lunar missions, which includes on and around the moon as well as links between the earth and moon.

The following are specific comments on the presented strategy.

Protection Criteria (§4.3 and §4.4)

With respect to the objectives outlined in §4.3 and §4.4, we support the general principle of efficient spectrum use. However we do not support proposals to use measured performance of satellite equipment in preference to agreed international protection limits criteria which are those applied within ITU and other bodies to study and agree the criteria for sharing spectrum.

Standards are important, they are internationally agreed benchmarks and facilitate reaching global agreement around sharing. We do not believe the UK regulator should seek to redefine internationally accepted limits. These are often the result of delicate compromises. Applying our own, more relaxed protection would have a negative impact on our reputation and risks making reaching international agreement on future sharing much more difficult.

We support increased resilience to space systems but note that the development and life cycles of space systems can be very long, several decades. In general, space systems, within reason, do not seek protection from the emissions outside the bands where they operate, but do require protection from the unwanted emissions into the allocated band from services operating in adjacent bands. We agree that the performance of transmitters, particularly their out of band emissions, does need improvement and look forward to improvements in this area.

We caution the principles presented in §4(3),iii because what is meant by an efficient balance is not defined. The implication is that reducing the protection from interference is more efficient because it allows greater sharing. Assessing this requires balancing the value of protecting one service against that of enabling another. However the metrics used in that judgement are critical to the outcome. Up to now the value at auction or from license revenues have been used as a metric. This has proved difficult to compare against public good metrics, externalities thar are less easy to capture in financial terms.

NGSO (§4.4)

We don’t comment in detail on NGSO here as we have already made a response to the earlier consultation and continue work with DCMS and Ofcom on solving the NGSO challenges and realizing the opportunities. We will provide further feedback we have received on the new processes from stakeholders.

Priority Area Identification (§4.6)

We support the proposed identification presented in §4.6 but would add that this should additionally include facilitating growth and innovation in "New Space" activities and supporting the space science and exploration goals as outlined in the National Space Strategy.

Prioritisation (§4.8 - §4.10)

Our priorities are driven by the National Space Strategy, its 5 goals the 10 point plan. These broadly align with the proposed prioritisation outlined under §4.8. We support the proposals with respect to licensing, filing processes, international engagement, stakeholder engagement and regulatory leadership.

One area where the National Space Strategy and the Space Spectrum Strategy have a different perspective is around the timescales under consideration. The space sector is undergoing a rapid, transformative change. How quickly space systems can adapt to change presents a constraint to how quickly changes in spectrum use can be made and this varies markedly across the sector.

Our UK vision to develop and unlock sustainable growth in our space economy covers immediate action and actions over a much longer term. It is important to lay the foundations for this future growth in good time, bearing in mind that updating international radio regulations can take many years. In practice this means that work towards enabling some of the longer-term elements of the UK vision will translate to more immediate priorities with respect to spectrum. We need to start now working towards regulatory changes to support requirements that may not materialize for many years. In other words, what might not appear as an immediate priority, should be if we are to benefit from growth in new space markets that do not yet exist, or participate in inspirational activities in space science, space travel and revisiting the moon.

Question 3 – Other issues and actions in the next 2-4 years

Other issues and actions that are likely to be important over the next 2 – 4 years

We noted there were no proposals around the cost of making a satellite filing through the UK, so we assume no changes are expected. Linking the cost to sustainability in spectrum use could encourage the use of less congested spectrum or more efficient use of spectrum.

Congestion in the science service bands, particularly S-band and X-band which are used for payload data transfers and telecommand, telemetry and control (TT&C) is a growing problem that requires action. Within the Space Frequency Coordination Group, UKSA are supporting the adoption of Recommended maximum emission bandwidths to allows greater sharing in the frequency domain. We are also considering how specifying a minimum dish

size and more directional antennas on spacecraft would relieve congestion in the spatial domain.

Agile support to emerging missions in active debris removal, in orbit servicing and manufacturing and inter-orbital communications are key priorities to support our ambitions over the next 2-4 years.

Question 4 – Evidence for priority

Evidence supporting specific actions as a high priority:

NSS priorities are to sustainably build on our existing strengths, to develop leadership in high growth areas and to lay foundations for UK leadership in future emerging sectors:

- Existing strengths include satellite manufacturing, resilient positioning, navigation and timing services, satellite communications, broadband mobility in aeronautical and maritime communications and space related professional services.

- Our priority high growth areas include Earth observation, navigation, space domain awareness and satellite broadband.

- Our target emerging sectors are in-orbit servicing, assembly and manufacture, active debris removal, human spaceflight, space based energy and in-situ space resource utilization.

The UK space agency recently published our latest size and health survey[4] outcome which summarizes where the sector is now and where recent growth has occurred. These largely align with Ofcom's assessment[5]. Satellite communications and Satellite broadcasting still dominate but applications in Positioning, Navigation, Timing (PNT) and Earth Observation have grown along with new investment in UK launch and the development of satellite constellations.

On the science side, UK invested £374m per year in the European Space Agency at the 2019 ministerial[6], prioritizing programmes[7] in Space science, Earth observation, telecommunications, exploration, sustainable exploitation of space and resilience against space hazards including severe space weather. This includes building the Lunar Gateway, a new space station orbiting the moon, returning the first samples from Mars, developing new satellites to help us understand climate change, a mission to give an early warning system

[4] https://www.gov.uk/government/publications/the-size-and-health-of-the-uk-space-industry-2021/size-and-health-of-the-uk-space-industry-2021

[5] Much of the detailed evidence we gather from our commercial partners around their future plans is provided in confidence and can't be provided in a public response.

[6]https://www.gov.uk/government/news/uk-invests-in-european-space-agency-programmes

[7] Space 19+ UK committed to £600m space science, £250m telecommunications programme, £180m exploration programme, and £80m safety and security, £200mEarth Observation, £16m satellite navigation innovation, £12m commercial space flight, £30m space technology development

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for solar storms and research in space technology to deliver high-speed mobile technology such as 5G and satellite broadband services around the world and in capabilities to track and remove space junk to prevent collisions in space. In 2020 the UK signed up to the Artemis accords to facilitate human activity on the Moon and Mars.

Translating this to spectrum demands implies increased use of the space service allocations:

Radio Service	**New drivers of spectrum use**	**Evidence**
Fixed satellite service (FSS)	NGSO satellite constellations, High throughput satellites	NSS priority. UK $500m investment in OneWeb, Satellite operators investing in HTS
Mobile satellite service (MSS)	NGSO, Satellite 5G, IOT/Machine to machine	Growth in nano/small satellite sector targeting IOT.
Space operations service (SOS)	In-orbit servicing, manufacture, assembly, UK launch.	NSS emphasis on sustainability and new space activities. Investment in ClearSpace-1, Sunrise and ELSA-D.
Space research service (SRS)	Supporting exploration activities and deep space missions. Lunar / Mars missions.	Recent investments in Goonhilly Earth Station, investment in ESA deep space network and data relay satellites. UK led Vigil Lagrange space weather mission. Lunar Pathfinder, Lunar gateway, ARTEMIS Accords. Exomars
Earth Exploration satellite service (EESS)	Growth in earth observation constellations, greater data download requirements. New active sensors in 45 MHz, P/S/C/X-band. New passive use, including greater use of THz bands.	Large growth in small satellite EO missions, including emerging commercial constellations. UK investment in NovaSAR (3 GHz, £21m HMG), BIOMASS (450MHz, ESA), ICEYE ($136 million round of venture capital fundraising, led by U.K. Seraphim Space) Ice Cloud Imager (THz). UK investment in ESA Earth Observation.
Radiolocation service (RLS)	Space object tracking radars	Stand up of UK SST services. Launch campaign support.
Radio-navigation satellite service (RNSS)	UK satellite navigation.	UK invests around 10m per year in ESA navigation activities to develop commercial applications.

The expected growth in Lunar missions will require greatly expanded communications capacity back to earth. Lunar pathfinder, a UK led mission due to launch in 2024 will provide communications on and around the moon is the first step in the ESA Moonlight programme connecting the earth and moon.

Additionally, both space weather and off-earth spectrum use will need international regulatory agreement to formalize the status of space weather sensors and to coordinate

how spectrum is used around the moon and mars. UK Space agency are actively involved in these negotiations through the ITU process, CEPT and Space Frequency Coordination Group.

Question 5 – Any other, other issues

Do we have any other issues to comment on?

There are emerging innovative space activities that will not fit within the traditional space service definitions as defined in Article **1** of the Radio Regulations. In-orbit servicing and manufacturing and lunar operations are operating under the current service definitions but could benefit from either an expansion of the existing service definition or potentially the development of new service definitions. Space weather has presented a good example of this and the work currently underway in the ITU to deal with space weather by tying it to an expanded met-aids service will be important as a guide to work covering these new activities.

Question 6 – NGSO issues and actions next 2-4 years

There is a pressing need to set out a clear national position on the relevance of international agreements to our national stance. There is some risk that prioritising spectrum sharing and accommodation of other users undermines, or severely undermines, the perceived value of international filings. Greater priority should therefore be placed on recognising the value of being 'first to market' (and therefore recognising the market driver for investment) whilst still striving for technical means to improve sharing.

There is also a pressing need to understand and effectively implement HMG priorities such as national security and national interest, through improved policy and/or legislative direction from which the regulator can determine its strategy.

Finally, there may be a need to specify the requirement for managing inter-orbital and inter-satellite links. Following the establishment of mega-constellations in LEO and the various approaches to inter-satellite communications in that orbit it is highly likely we will see hybrid systems. These will consist of components operating in all orbits and will require some thought on the management of agile comms links between GEO/MEO/LEO in a way we may not have considered to date.

Question 7 – Evidence of NGSO priorities

Evidence on supporting specific actions relating to NGSO communication systems that should be a high priority is set out in the technical annex to the NSS but will be further described by commercial sector responses.

Question 8 – Other comments on NGSO systems

What is important is how the NGSO processes are implemented in practice. This will be crucial to the attractiveness of the UK, to investor confidence and competitiveness. Close liaison between the regulator and the various policy owning departments in HMG will be vital if we are to clearly present our intent in a way an independent regulator can interpret and apply. Examples of the need for close liaison include our overall aspirations for driving standards on space sustainability, supporting emerging markets in debris removal and in orbit servicing and manufacturing and supporting lunar missions.