Your response

Question	Your response

Question 1: What is the market opportunity for D2D services? What is the nature of the benefits that could be delivered to people and business in the UK and what do you estimate the magnitude of the benefits to be?	In 2023, Sateliot, a GSOA member, contributed to *The Future of Satellite Connectivity: Various Approaches to Direct-to-Device Services*, a report that provided an overview of the D2D ecosystem, including IoT or M2M connectivity. We believe this is an important conceptual consideration for decisions in policymaking, despite the popular focus being on satellite connectivity provided to smartphones. It is also remarkable that 2 different approaches exist, D2D with MSS spectrum and D2D via MS spectrum. Sateliot, with the implementation of the 3GPP NB-IoT NTN standard provides D2D connectivity using the MSS spectrum defined by the standard. The market opportunity for Direct to Device (D2D) services, including Non-Terrestrial Network Internet of Things (NTN IoT), is substantial and growing rapidly in the UK. NTN IoT services form an integral part of the D2D landscape, as they enable seamless connectivity across vast and remote areas, supporting a wide range of use cases. The benefits of NTN IoT under the D2D umbrella are numerous. These services provide enhanced and reliable connectivity, which is critical for businesses and consumers across the UK. NTN IoT can ensure continuous connectivity in areas where traditional terrestrial networks are either unavailable or unreliable, such as remote rural locations, maritime regions, and during natural disasters. This expanded reach enables essential services to operate more efficiently and effectively. Sateliot is a member of the GSMA, and as such, we have signed roaming agreements with various MNOs, who will then offer our NTN IoT services directly to end users. This collaborative model leverages the strengths of both satellite and terrestrial networks to provide a seamless and comprehensive service offering. Our experience in working closely with MNOs to deliver NTN IoT services makes us well-positioned to support the development and expansion of D2D services in the UK. Satellite IoT connections are expected to grow rapidly, from just over 4.36 million in 2021 to more than 29.9 million by 2030. This growth shows the increasing need for reliable IoT services in areas where regular networks don't reach, highlighting the important role of satellite-based IoT in future communication.

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Question 2: Are there any wider citizen or societal benefits that D2D services could deliver that the market might not deliver? What is the nature of these benefits and why might the market fail to deliver them? For example, what role could D2D have in improving the availability of 999 services in the UK?	D2D services, and particularly IoT, have the potential to bring substantial societal benefits, especially when they are built on standardised solutions. History has shown that whenever a standard has been established in a technology, its adoption has rapidly expanded, transforming markets and multiplying its use. The 5G NB-IoT NTN standard, approved by 3GPP in June 2022, is poised to revolutionise the connectivity of IoT devices, driving massive implementation and widespread adoption. Standardisation will reduce costs, making the technology more affordable and accessible to end users. This impact will extend across multiple industries, including agriculture, logistics, and energy, offering businesses in the UK new opportunities for growth, efficiency, and innovation. Therefore, it is essential that the regulator adopts a forward-looking regulatory framework and allocates the necessary spectrum to ensure the UK does not miss out on the benefits of this transformative technology. By supporting standard-based solutions, the government can help unlock the full potential of D2D services, ensuring broad public access and maximum societal impact.
Question 3: Subject to suitable regulatory frameworks being in place, do you have an interest in offering D2D services or expanding an existing service in the UK? Which customer segments, devices and use cases would be served? Would your D2D service complement or compete with services delivered over existing mobile?	Sateliot is highly interested in offering D2D services in the UK, through our NTN IoT solutions, which are a crucial part of the D2D ecosystem. Sateliot advocates for a technology-neutral regulatory framework. Indeed, with a neutral approach, national planning would take into consideration NTN IoT for the MNO terrestrial network extension. This approach ensures that a wide range of D2D services, including those enabled by IoT, are supported and developed in line with the UK's strategic connectivity goals. In terms of customer segments, IoT applications have an impact over diverse industries such as agriculture, oil & gas, logistics, and maritime, where IoT devices connected via NTN can drive innovation, efficiency, and cost savings. The use cases for NTN IoT are numerous and robust, providing clear paths to revenue generation, whereas the business case for handset-based D2D services remains uncertain. Sateliot's solution would complement existing terrestrial mobile networks by extending coverage to areas where terrestrial networks are not viable, thereby supporting MNOs in reaching underserved markets. This complementary approach allows for seamless integration with existing infrastructure, enhancing overall connectivity while maximising the utility of both terrestrial and non-terrestrial networks.

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If you have considered launching or expanding a D2D service in the UK: **Question 4:** What technology and network architecture do you consider appropriate to use to deliver D2D services? For example, what altitude and how many HAPS, LAPS or satellites would be required to deliver an initial service? **We're aware that different technologies and network architectures will have different costs, performance, and spectrum efficiency trade-offs**.	Sateliot considers the use of Low Earth Orbit (LEO) CubeSats as the most appropriate technology and network architecture to deliver D2D services , particularly for Narrowband (NB) IoT. Firstly, LEO CubeSats provide significant cost savings due to their smaller size and lower launch costs. They can be rapidly deployed and scaled, allowing for quicker service initiation and expansion. Their proven technology has already shown successful results in various use cases, including IoT connectivity, which makes them a reliable choice for delivering D2D services. Thanks to our satellites being in LEO, we are able to begin providing services with just a single satellite. As we add more satellites to our constellation, we can further reduce the revisit time, offering even more frequent and reliable coverage. Secondly, LEO satellites provide the opportunity for global service coverage. Unlike HAPS and LAPS, which are limited by their operational range and altitude, LEO CubeSats can offer continuous and seamless connectivity across broad geographic areas, including remote and underserved regions. This makes them ideal for extending D2D services to a global scale, supporting applications that require constant connectivity, such as asset tracking, environmental monitoring, and critical infrastructure management. Furthermore, the deployment of LEO CubeSats aligns well with the growing demand for NB-IoT services, providing a spectrum-efficient solution that can handle a large number of devices with low power consumption. This approach ensures cost-effectiveness while maximising performance, which is crucial for scalable IoT deployments.

Question 5: What capacity (e.g., Mbps/Km_2/MHz) and quality of service (e.g., latency) could be delivered with the D2D service you are proposing? What percentage of the UK landmass could be covered, and would coverage be provided indoors?	Sateliot's service is based on LEO satellites, which provide significant coverage and capacity advantages. With our first 4 already operational LEO satellites, we ensure 100% coverage of the entire UK landmass within a day. Each LEO satellite passes over the region and can achieve full coverage within this timeframe. As we expand our constellation, we will reduce latency and increase capacity. Currently, with our existing 4 satellites, we can offer connectivity approximately twice a day, but by the end of 2026, we aim to achieve near real-time connectivity. Our satellites operate with 200KHz transmission and reception canals, and devices typically transmit in 3.75KHz canals. This configuration allows for the simultaneous connection of around 60,000 devices. IoT messages transmitted via these satellites

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	generally range in size between 50 and 100 bytes, though our system can support messages up to 200 bytes. This bandwidth allocation ensures efficient use of the spectrum, particularly in low-data-rate IoT applications such as environmental monitoring, asset tracking, and wildlife conservation. Regarding the quality of service, our current set-up provides low latency, which will continue to improve as we add more satellites. As we scale our infrastructure, we will also work to ensure improved outdoor coverage, particularly in rural and remote areas where terrestrial networks struggle to reach.

Question 6: To inform our future policy development, which spectrum band would you like to deploy the service in? How much bandwidth would be required to provide the service at launch?	Sateliot's service is designed to operate under the 5G-NB-IoT NTN standard, which was approved by the 3GPP (Release 17) in June 2022. This standard is set to revolutionise the use of IoT devices, leading to widespread implementation across various industries. The 3GPP not only defined the standard but also specified the required spectrum for its operation. Within the S-Band, the frequencies defined by the standard are 1980-2010 MHz for uplink and 2170-2200 MHz for downlink. These frequencies were selected because they are allocated to the Mobile Satellite Service (MSS) across all three ITU regions, ensuring global compatibility and regulatory alignment. The standard defines channels of 200kHz. Our expected demand would require 5 channels, summing a total of 1MHz. Furthermore, we want to highlight that some countries have recognized the strategic importance of this technology. For example, in the Kingdom of Saudi Arabia, the Communications, Space & Technology Commission (CST) has reserved a 5 MHz block within the specified frequencies to prioritise the deployment of NB-IoT technologies. Similarly, the Australian Communications and Media Authority (ACMA) has allocated 5 MHz exclusively for NB-IoT use. This position illustrates a growing recognition of the importance of a dedicated spectrum for NB-IoT services, underscoring the potential benefits of such an approach in fostering a robust and competitive IoT ecosystem. Since NB-IoT operators require minimal spectrum, a single 5 MHz block can support up to five different operators providing this service.
Question 7: What take-up profile do you assume in your planning? For example, the number of active devices, monthly	The UK presents a significant growth opportunity for our company and the services we provide. The primary use cases identified for our services in the UK, ranked by priority, are environmental
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calls made, and data transferred per device. What is the roadmap for enhancing your network to meet anticipated future growth? What additional infrastructure and/or spectrum would be required? When?	monitoring, defence, asset tracking, wildlife conservation, and maritime applications. The growth of IoT devices in these sectors could likely mirror the projected growth of IoT devices in the UK, which the government estimated to reach over 150 million in 2024.[1] Given these opportunities, we expect an increasing number of devices to be used and deployed in new industries, each with different data transmission needs. For environmental and wildlife monitoring, we project the average device to transmit data periodically, with 1-2 MB of data per device per month. In contrast, asset tracking and defence applications are expected to require more frequent communication, with some devices transmitting up to 10 MB of data per month, depending on the level of real-time updates required. Maritime applications are anticipated to have data usage closer to 5 MB per device per month, primarily for vessel tracking and monitoring. As part of our roadmap to support this anticipated growth, we plan to launch additional satellites over the next few years, in addition to the four that we launched just a month ago (August 2024). This expanded infrastructure will significantly enhance our network capacity, reduce latency and allow us to support mass deployment of IoT devices globally by 2026, with an important portion of these devices operating in the UK. In terms of spectrum, we expect that the additional satellites will require increased access to narrowband spectrum to accommodate the growing demand for IoT services. As we scale, we will be needing 1 MHz of spectrum to ensure that we can continue providing high-quality, reliable services to our users.
Question 8: What are the use cases and the benefits these services would deliver? What technology, network infrastructure and frequencies would be required to deliver the service? What are the advantages of using this MSS spectrum compared to other bands?	We appreciate that Ofcom is considering the inclusion of services beyond Direct-to-Device (D2D) communications in the MSS bands. This approach contributes to the efficient use of spectrum and fosters the development of new technologies that will benefit UK citizens. The use cases impacted by the IoT technology are extensive, including maritime operations, agriculture (moving towards a smarter and more sustainable agriculture), smart metering, and the oil & gas industry, among others.

[1] UK Government Office for Science (2021) Trend Deck 2021: Technology, https://www.gov.uk/government/publications/trend-deck-2021-technology/trend-deck-2021-technology

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	Not only does IoT technology positively impact a wide range of industries, but it also offers the advantage of not requiring new infrastructure development within the UK. By utilising the 5G NB-IoT NTN standard, devices can seamlessly connect to existing terrestrial infrastructures where available, or to satellites where terrestrial infrastructure is absent. As it is known to industry, 3GPP´s Release 17 has identified specific UL and DL in the MSS. This follows years of industry inputs and agreement towards making 5G NTN IoT interoperability a reality for the wider technology ecosystem. - 1980-2010 MHz for uplink, and - 2170-2200 MHz for downlink. Among many other reasons, the existing global harmonisation of these radio frequency bands was a key component towards identifying the standard´s UL and DL, allowing a common approach that benefits OEMs and global operators such as Sateliot. We believe that supporting IoT within the specified MSS bands will not only ensure the efficient use of spectrum but also drive innovation and enhance service offerings across the UK.
Question 9: What current, or future, technology developments will offer the opportunity for more efficient use of MSS spectrum? E.g., more spectrally efficient, or greater ability to share spectrum.	Sateliot, like other NB IoT satellite operators, has advocated for dedicating a portion of suitable MSS spectrum to our service typology. In our case, our rationale, as stated in Question 8, responds to the identification of specific UL and DL for an industry standard that we have operationalised for global market servicing. Our recommendation, based on practical experiences in different jurisdictions, would be for the United Kingdom to **dedicate a block of 5 MHz in the MSS bands for narrowband operators**, which will allow for up to 5 operators to share said channels. We understand the UK prioritises competitiveness and end-user price benefits resulting from it - this measure would align with both objectives.
Question 10: Could your existing, or proposed, service coexist with other users of the same frequencies within the MSS spectrum bands? If so, how is coexistence achieved? If not, please explain why sharing is not possible.	When the 5G NB-IoT NTN standard was published in June 2022, the 3GPP also included the conditions of use of this standard, which include the impossibility to share the spectrum bands. Even though the standard does not allow operators to share co-channel simultaneously without meeting specific requirements such as scheduling transmissions (which our system is capable of doing), by reserving a porting of S-Band for NTN NB IoT operations, as

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	previously suggested, multiple operators will be able to use small portions of said dedicated 5MHz. This particular condition should not represent any barrier to the efficient use of the spectrum nor market entry.
Question 11; Do you expect D2D services to be available prior to WRC-27? What services and benefits do you think an authorisation prior to WRC-27 might bring to UK consumers and businesses?	Yes, Sateliot expects D2D services to be available prior to WRC-27. As mentioned earlier, Sateliot launched four commercial satellites in August 2024, and we are ready to start providing commercial services by no later than Q1 2025.
Question 12: Are there any mobile bands that should be prioritised for satellite based D2D?	Sateliot's delivery of D2D IoT NTN capacity is constrained by incumbent (arguably insufficient) usage of MSS (Mobile Satellite Service) spectrum in the S-band. Therefore, these bands should be prioritised for democratising satellite-based D2D services and to ensure competitiveness in spectrum usage for bands that are standard-ready towards massive IoT deployment.
Question 13: Are there existing systems that you consider could be subject to an increased risk of harmful interference from the introduction of satellite based D2D using mobile bands? If yes, are there specific mobile bands that you consider should be avoided to reduce this risk?	Our approach has been consistent internationally – Sateliot does not object to any specific frequency bands, but the selection must account for existing services and potential in-band and out-of-band interference, especially given the largely untested nature of D2D in MS bands. Regulatory actions should be based on technical evidence and preliminary studies, particularly for commercial or emergency related services. D2D through the MS, which relies on Article 4.4 of the ITU RR – originally intended for limited use and operating on a no-protection and no-interference basis – is intrinsically risky in this regard. For instance, during SCS early trials in the U.S., Omnispace reported interference from Starlink’s D2D services, indicating challenges in coexistence between satellite services in similar frequency bands.

Question 14: Do you have any views on how spectrum for D2D services should be authorised? Does this vary by band, or type of NTN? Please explain the reasoning behind your preference.	There is a general concern around using MS bands for MSS servicing systems without prior technical studies at ITU level. We wish to stress that granting country-based licences with this purpose may be premature against future WRC-27 outcomes regarding AI 1.13. Our view is that communication services must be

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	rolled out in accordance with tried and tested technology which can ensure co-existence with existing services. Additionally, spectrum harmonisation across national borders should be a primary consideration in the authorization of spectrum for D2D services. This involves consistent and predictable spectrum allocation and management at least regionally, which is critical for the success of satellite-based IoT services particularly under the 5G NB-IoT NTN standard. If neighbouring countries adopt different regulatory approaches, this could result in significant cross-border interference and operational conflicts. Uncoordinated national decisions could create challenges, particularly in bordering regions where D2D is often needed most. In a world where communication systems are increasingly global, misalignment in spectrum policies could undermine the seamless connectivity that D2D services aim to provide. Moreover, the 3GPP 5G NB-IoT NTN standard is emerging as a key framework for delivering IoT services via satellite. We encourage Ofcom to support spectrum authorization with EU borders, and in line with international standards, as this will ensure compatibility and interoperability with systems deployed in other regions. While we acknowledge that, indeed, different frequency bands and NTNs may require tailored regulatory approaches, we urge Ofcom to avoid fragmentation and to maintain flexibility in spectrum management. Ensuring that spectrum use for D2D services is consistent with regional frameworks will mitigate the risks of interference and maximise the benefits of IoT connectivity for both businesses and consumers in the UK.

Question 15: Are there any other points that you think would be useful in our considerations? In providing your response, please provide as much evidence as possible.	We appreciate that Ofcom is already addressing the 2GHz bands, particularly given that the current licences granted to Inmarsat and Echostar expire in 2027. This exclusive licensing approach revealed limitations in terms of flexibility, hindering the efficient use of the spectrum and making new operators and their innovative technology wait for a very extended period of time. We fully agree with Ofcom that D2D is a critical topic, especially in the context of the WRC-27 discussions and ongoing CEPT studies. In this sense, we would like to highlight the current discussions towards WRC-27 under Agenda Items 1.12 and 1.13. AI 1.12 explores potential new allocations to the MSS in specific bands, including those in 2 GHz, which are intended to support low-data-rate non-geostationary MSS systems. This is particularly
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	relevant for enabling IoT services, for it will further enhance the ecosystem for satellite-based IoT solutions. We are supportive of the positive resolution of this Agenda Item, and would like to encourage the Ofcom to consider joining the support expressed by many CEPT members in this regard. AI 1.13, on the other hand, focuses on potential new allocations for MSS to facilitate direct connectivity between space stations and IMT user equipment, complementing terrestrial IMT networks. This holds immense potential for enhancing D2D services and expanding satellite-based connectivity. We also follow this item closely as IoT devices tend to fall under this category of equipment, the resolution of this Agenda Item may provide guidance for future MSS allocations. We strongly encourage Ofcom to consider our comments and a broader perspective when implementing D2D and related spectral policies, as it moves forward in shaping the future of national telecommunications policy.

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