

Your response

Question	Your response
<p>Questions for stakeholders that are interested in using 2 GHz MSS</p>	
<p>Question 1: Which service(s) do you wish to provide using 2 GHz MSS spectrum? When do you expect that you could provide these services, and what UK geography would these services cover? Where applicable, please provide evidence to support your response (including but not limited to): business plans, internal market forecasts, board papers, analyst reports, etc.</p>	<p>Ofcom should consider the implementation and deployment of Direct-to-Device (“D2D”) mobile satellite services (“MSS”) throughout the UK in the 1980-2010 MHz and 2170-2200 MHz (the “2 GHz MSS Bands”). The 3GPP standards body already adopted this band as n256 in the 5G NTN standards, and these standards offer clean mechanisms for spectrum sharing and deployment of spectrum for a variety of use cases. D2D services bring numerous benefits to consumers, businesses, and the government of the UK. For example, D2D MSS expands wireless services into unserved and underserved remote and rural communities in efficient and effective ways for the provision of mobile services. Moreover, D2D MSS increases the reliability and resiliency of terrestrial communications services—e.g., when terrestrial networks become congested or unavailable altogether such as during a natural disaster—all while fostering investment and advancement of wireless networks with innovative applications. Ofcom opening the 2 GHz MSS Bands up for emerging applications of MSS such as D2D will provide the citizens, businesses, and government of the UK with another path to innovative, resilient communications.</p> <p>Lynk has a long history in the UK, in fact, performing the world’s first D2D test in the Falkland Islands. Lynk stands ready to further that work to bring its novel D2D Low Earth Orbit (“LEO”) MSS system to the UK and bolster its services with efficient and effective use of the 2 GHz MSS Bands. Lynk’s system deploys 3GPP compliant fronthaul capabilities from satellites (i.e., cell towers in space) to terrestrial mobile networks via terrestrial IMT frequency bands in partnership with Mobile Network Operators (“MNO”). Lynk’s service complements the terrestrial mobile network, unlocking ubiquitous last-mile solutions that will expand mobile coverage to everyone, everywhere in the UK, especially where terrestrial networks cannot reach due to economic or technical constraints.</p>

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	<p>Consequently, Lynk’s system provides instantaneous mobile coverage and added resiliency to the existing MNOs’ infrastructure during emergencies and natural disasters. By creating a standard communications platform that eliminates any risk of cellular network disruption to the end user, Lynk’s system will revolutionize the emergency response landscape by supporting first responders, government agencies, and affected communities across the UK and globally when connectivity is needed most. To enhance the capabilities of Lynk’s services and further complement the terrestrial wireless networks, Lynk’s satellite system will also utilize MSS frequencies to deliver yet another path to innovative, resilient communications for the people, businesses, and government agencies throughout the UK.</p>
<p>Question 2: Please explain any barriers to your deployment of a service and your plans to address them.</p>	<p>Confidential? – N</p> <p>Ofcom should adopt a satellite licensing framework in which multiple Satellite Network Operators (“SNO”) can efficiently and effectively compete in the market. The regulatory framework should avoid auctioning the spectrum and be quick to authorization, otherwise such measures will create an unjustifiably high barrier to entry for newer and/or smaller SNOs and unfairly advantage larger, established SNOs. A merit-based satellite licensing framework most effectively addresses concerns related to pricing, service costs, market concentration, fair competition, optimal spectrum utilization, and the specific needs of diverse users and services, especially in regions with dispersed populations.</p> <p>Although sometimes spectrum auctions offer potential benefits such as transparent pricing and allocation, licensing the 2 GHz MSS Bands through auctions under Section 14 of the WT Act will have negative impacts on the marketplace and competition for a variety of reasons. First, the auction process makes acquiring spectrum and competing effectively more challenging, if not impossible, for new entrants and smaller companies, potentially stifling competition and innovation in the 2 GHz MSS Bands. Historically, auctions failed to promote competition be-</p>

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	<p>yond established players in a market with significant financial resources because those players were able to bid large amounts for spectrum without a clear path to innovate and/or deploy a service in that spectrum. Second, the high costs associated with purchasing spectrum through auctions will ultimately be passed on to the consumers, resulting in higher retail prices. Third, more resources spent on spectrum equals less investment in network infrastructure and service development and deployment. Regulators around the world have stated that auctions can be complex, time-consuming, and resource-intensive. Consequently, the increased expenses and stifled competition will hinder the rollout of MSS services, such as D2D, in a competitive marketplace due to the financial burden associated with the spectrum costs inflated by the auctions.</p> <p>Ofcom's responsibility is to ensure the most efficient and effective allocation and use of the 2 GHz MSS Bands for the maximum benefit of the UK population. The importance of prioritizing specific services, fostering competition, minimizing negative impacts on existing users, and maximizing overall social and economic benefits of spectrum utilization significantly outweighs any presumed benefits of auctioning the 2 GHz MSS Bands in the UK. Ofcom consistently strives to create a regulatory environment encouraging the introduction of innovative communications technologies, such as D2D systems, in a timely fashion while avoiding overly burdensome requirements, which ultimately ensures an affordable, competitive, and seamless environment for the people, businesses, and government agencies in the UK. Hence, Ofcom should adopt a regulatory framework for the 2 GHz MSS Bands that avoids auctioning the spectrum and is quick to authorize applicants.</p>
<p>Question 3: What benefits might be realised by enabling the service(s) you wish to provide through to 2032 (the short term)? Similarly, through to 2045 (the long term).</p>	<p>Confidential? – N</p> <p>See responses to Question 1 above and Question 7 below.</p>

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<p>Question 4: Please explain what you consider would be the appropriate licence period for the service(s) you wish to provide? Please explain why, including providing evidence, such as asset use life, where applicable.</p>	<p>Confidential? – Y / N</p>
<p>Question 5: What is the minimum amount of spectrum you would need to provide your service(s) to deliver a basic service to customers? What additional service features and/or customer numbers could you meet with a larger allocation (please specify the amount of spectrum)? Please include details of any guard bands that you would consider necessary within this spectrum for coexistence purposes.</p>	<p>Confidential? – N</p> <p>To ensure efficient and effective use of the 2 GHz MSS Bands, the UK should utilize the 3GPP standard for 5G NTN as the framework for segmenting the 2 GHz MSS band. The 3GPP standards body already adopted the 2 GHz MSS Bands into the 5G NTN standards as band n256. The 3GPP 5G NTN standard proposes two primary air interface waveforms designed to support different applications while offering clean and clear mechanisms for spectrum sharing and deployment. The 5G NR waveform is for use cases such as mass-market handset and cellular devices (e.g., smart phones) with an established minimum carrier bandwidth of 5 MHz for band n256 (the 2 GHz MSS Bands). The other waveform is 5G NB-IoT, which supports mass market IoT devices (e.g., sensors, cars, and machines) with an established minimum carrier bandwidth of 200 kHz for band n256 (the 2 GHz MSS Bands).</p> <p>Considering that there are a number of satellite operators focused on providing future 5G NR and 5G NB-IoT services, a framework that segments the 2 GHz MSS Bands to support both 5G NTN waveform standards is in the UK's interests. Notably, both 3GPP 5G NTN primary air interface waveform standards are compatible with a band segmentation framework. The first analysis will explore both: the minimum bandwidth required for the 3GPP 5G NR waveform standard, and the minimum bandwidth sufficient for mobile broadband services. The second analysis will consider the minimum bandwidth required for the 3GPP 5G NB-IoT waveform standard.</p> <p>First, the minimum bandwidth for a 5G NR waveform supported service is five (5) MHz, which is the smallest spectrum block that one operator can use. An operator with a five (5) MHz block would deploy 4.5 MHz of utilized</p>

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	<p>spectrum organized into twenty-five (25) physical resource blocks (“PRB”) each nominally being 180 kHz wide, and the operator would reserve a 250 kHz guard band on each side of the utilized bandwidth. For a multi-beam satellite system, the use of a single five (5) MHz block would require fractionating the spectrum in the time and/or frequency domain—e.g., temporal “beam hopping” or fractional frequency re-use, both of which are defined in the 3GPP standard. For example, fractional frequency re-use within the five (5) MHz block is useful for avoiding beam-to-beam interference within an operator’s system while either uniformly, or non-uniformly, distributing capacity across beams. If an operator were to uniformly distribute capacity across satellite beams, the operator may choose to deploy a fractional frequency re-use pattern of three (3), where one-third of all beams use eight (8), or nine (9), co-channel PRBs, resulting in the average beam being capable of supporting approximately 1.5 MHz of effective capacity (i.e., 4.5 MHz divided by 3 equals 1.5 MHz). Depending on the system design and resulting signal to noise ratios of servicing signals, spectral efficiencies for each beam may range between two (2) and four (4) bps/Hz, offering three (3) to six (6) Mbps per beam/cell deployed in this uniformly distributed manner. Consequently, such deployment would be sufficient for light data, messaging, and voice services, but it may not be sufficient for mobile broadband services.</p> <p>To sufficiently support mobile broadband services, one satellite operator would need at least ten (10) MHz of bandwidth. In this case, the satellite operator would deploy nine (9) MHz of utilized spectrum and reserve a 500 kHz guard band on each side of the utilized bandwidth. Deploying a uniform fractional frequency re-use pattern of three (3)—where one-third of all beams use sixteen (16) or seventeen (17) co-channel PRBs—would yield approximately three (3) MHz of effective bandwidth per beam/cell deployed and result in approximately six (6) Mbps to twelve (12) Mbps per beam/cell deployed. Non-uniform fractional frequency re-use patterns could increase these data rates in areas where demand density is higher and reduce these data rates in areas where demand density is lower. Accordingly, a satellite operator authorized a ten (10) MHz or more block of spectrum</p>

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	<p>would open the 2 GHz MSS Bands to mobile data broadband capabilities. Moreover, a satellite operator's use of IMT bands in collaboration with and under the direction of terrestrial mobile network operators ("MNO") for its D2D services in the UK would supplement a satellite operator's authorization in the 2 GHz MSS Bands, further increasing the capacity for the authorized SNO. Because IMT bands will likely continue to be shared between terrestrial networks and D2D service providers on a co-channel basis, necessitating detailed coordination of the shared IMT spectrum and its deployment, the combined use of the 2 GHz MSS Bands with the IMT bands is crucial for deployment and seamless connectivity for the end user.</p> <p>Second, the minimum bandwidth for a 5G NB-IoT waveform supported service is 200 kHz. In this case, the satellite operator would deploy 180 kHz of utilized spectrum and reserve a ten (10) kHz guard band on each side of the utilized bandwidth. Utilizing a uniform temporal "beam hopping" pattern of three (3) would offer sixty (60) kHz of effective bandwidth per beam/cell deployed and result in approximately sixty (60) kbps of throughput per beam/cell (assuming one (1) bps/Hz spectral efficiency). This sufficiently provides for machine-to-machine and IoT use cases.</p> <p>Therefore, while more spectrum authorization is better for the deployment of D2D services, the following option accommodates more operators and different services all while making more efficient use of the 2 GHz MSS Bands. Considering that the minimum bandwidth required for a 5G NB-IoT waveform supported service is 200 kHz, which is multiples less than the aggregate guard bands required for providing mobile broadband services (one (1) MHz per 5G NR carrier), Lynk proposes the following segmentation framework for the 2 GHz MSS Bands:</p> <p>5G NR Operator 1 = 2x9 MHz 5G NB-IoT Operator 1 / Shared Pool or Spectrum Park 1 = 2x1 MHz</p> <p>5G NR Operator 2 = 2x9 MHz</p>

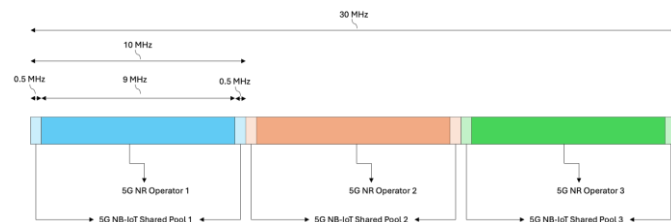
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5G NB-IoT Operator 2 / Shared Pool or Spectrum Park 2 =
2x1 MHz

5G NR Operator 3 =
2x9 MHz

5G NB-IoT Operator 3 / Shared Pool or Spectrum Park 3 =
2x1 MHz



This option establishes a band segmentation framework that accommodates and opens the 2 GHz MSS Bands up to a mix of 5G NR and 5G NB-IoT services where the 5G NB-IoT services are interleaved within the guard bands of the 5G NR block deployments. Each guard band between the three (3) 5G NR operators could accommodate multiple 5G NB-IoT operators' services considering the minimum required bandwidth, which would create a more efficient use of all the spectrum in the 2 GHz MSS Bands. Appropriate adjacent channel leakage ratio ("ACLR") parameters would need to be established for each operator to avoid interference from out of band emissions from any one 5G NR or NB-IoT operator. The 3GPP standards already provide guidance for this. Guard bands are unused frequency spectrum between radio bands designed to prevent interference. NB-IoT can leverage these guard bands for its transmissions, a mode referred to as guard band operation ("NB-IoT in Guard Band"). For NB-IoT in Guard Band, an operator deploys 180 kHz of utilized spectrum per beam/cell and reserves ten (10) kHz on each side of the occupied bandwidth. Examples of this mode are found in the 3GPP Technical Specifications (e.g., TS 36.302) and documents like the GSMA's NB-IoT Deployment Guide, which provide non-binding guidelines for mobile operators deploying NB-IoT networks and refer to the supported deployment modes, including NB-IoT in Guard Band.

The key to efficient and effective use of the 2 GHz MSS Bands is the incorporation and utilization of the 3GPP

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	<p>standard for 5G NTN as the framework for segmenting the 2 GHz MSS Bands. For the provision of D2D services, more spectrum is best, but Lynk’s proposed option illustrates efficient spectrum segmentation with effective spectrum management all while opening the 2 GHz MSS Bands up to competition and a variety of mobile applications, including highly capable D2D services. Additionally, UK and EU alignment on the 2 GHz MSS Bands will further enable efficient and effective use of the spectrum—see responses to Questions 10 and 11.</p>
<p>Question 6: For each service, please explain why you wish to use 2 GHz MSS. Please explain why this is a more suitable frequency compared to alternatives.</p>	<p>Confidential? – N</p> <p>See responses to Questions 1 and 5.</p>
<p>Question 7: To what extent are there economies of scale across the UK and the EU for each service you wish to provide? What is the minimum number of users/devices you would need for each service to be economically viable?</p>	<p>D2D services offer numerous benefits to consumers, businesses, and governments. Ofcom already assessed the following benefits of D2D services:</p> <ul style="list-style-type: none"> A. expanding voice, messaging, and data coverage beyond terrestrial networks to ensure complete outdoor coverage across the UK, as satellite technology evolves; B. providing backup coverage during power outages or network failures caused by natural disasters or severe weather, thereby enhancing the resilience of mobile networks; and C. improving emergency access '999' services through these advancements. <p>Moreover, D2D services increase the reliability and resilience of terrestrial communication services while encouraging investment and innovation in satellite and terrestrial wireless networks. These advantages will create economies of scale in the UK and the rest of Europe and foster a comprehensive marketplace of D2D services for millions of users that will increase competition and benefit the consumer. Ofcom's decision to open up the 2 GHz MSS Bands for emerging MSS applications, such as D2D, will provide citizens, businesses, and government agencies in the UK with an additional avenue for innovative and resilient communication solutions.</p>

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<p>Question 8: For the service(s) you wish to provide in the UK, what is the extent and nature of potential technical coexistence issues with other jurisdictions, particularly the EU? What are minimum satellite beam footprint sizes that you consider feasible, and what cross-border sharing conditions do these facilitate?</p>	<p>Confidential? – N</p> <p>See response to Question 7.</p> <p>Lynk designed its D2D MSS system to operate in the same manner as terrestrial MNOs, including cross-border coexistence that is applicable to Europe. For example, stations operating in the frequency bands 824-849 MHz and 869-894 MHz and located less than seventy-two (72) km from the Canada-U.S. border must adhere to the spectrum sharing arrangement between Canada and the United States of America for cross-border coexistence, which states that the PFD at the ground level produced by a station in the other country's territory shall not exceed -102 dBW/m² in any 200 kHz bandwidth unless the licensees in adjacent cross-border licensing areas and the responsible government agencies agree to a higher acceptable threshold. A similar idea could be adopted for satellite services in the 2 GHz MSS Bands, where the center of an SNO's beam less than seventy-two (72) km away from the border could be coordinated if the relevant threshold cannot be met.</p> <p>Additionally, authorized operators in the 2 GHz MSS Bands should be subject to spectrum management conditions. Fortunately, the 3GPP 5G and 5G NTN standards discussed in the response to Question 5 above offer built-in techniques to support efficient spectrum management and deployment in the 2 GHz MSS Bands, with particular adherence given to the defined out of band emissions and ACLR performance metrics.</p> <p>Ofcom should adopt the implementation of the spectrum management techniques in the 3GPP standards for the following reasons. One, they are existing standards that are successfully utilized for efficient spectrum use by terrestrial IMT operators. Two, 3GPP OFDM waveforms generally offer high spectrum efficiency with limited guard band waste, assuming that the out of band emissions and ACLR performance metrics are sufficiently specified and achieved. Lastly, three, imposing the 3GPP standards, which specify how the spectrum will be used and deployed, minimizes, if not completely eliminates, the need for coordination between authorized operators using the 2 GHz MSS Bands.</p>

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Questions for stakeholders not interested in using 2 GHz MSS	
<p>Question 9: What service(s) do you think could use 2 GHz MSS in the UK? What benefits do you think these services could provide, and how much spectrum do you consider these services require to (i) deliver basic services, and (ii) to deliver more advanced services?</p>	<p>Confidential? – Y / N</p>
Questions for all stakeholders	
<p>Question 10: Overall, to what extent does demand for 2 GHz MSS spectrum to provide services in the UK relate to demand for spectrum to provide 2 GHz MSS services in the EU (and vice versa)?</p>	<p>Confidential? – N</p> <p>See responses to Questions 5 and 7.</p> <p>The demand for the 2 GHz MSS Bands in the UK and the rest of Europe is strongly interconnected. Service models, technical harmonization, and economic viability all point to a consistent approach to spectrum allocation that closely aligns with the underlying market demand. For MSS operators, gaining access in both regions is mutually reinforcing, with demand in one region increasing the value and utility of spectrum rights in the other region.</p>
<p>Question 11: Do you consider there would be any benefits or risks from aligning with the EU regarding the types of 2 GHz MSS services being authorised, as well as the specific operators licensed to operate?</p>	<p>Confidential? – N</p> <p>The UK and EU aligning on spectrum utilization and allocation will result in a number of benefits promoting successful adoption of MSS applications such as D2D in the UK. One, MSS operators allocated spectrum in both regions is mutually reinforcing, where demand in one region increases value and utility of spectrum in the other region. Two, harmonizing the 2 GHz MSS Bands allocations across both regions ensures that D2D deployment in the UK and EU follows a common set of standards and facilitates development of a robust ecosystem of applications and services in both regions. For instance, both regions adopting the 3GPP standards for the 2 GHz MSS Bands will significantly transform the actual adoption and implementation of D2D in the regions with efficient and effective utilization of the spectrum (see responses to Questions 5 and</p>

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	<p>8). Three, alignment between the UK and EU decreases market fragmentation and enhances operational efficiency for MSS SNOs. Four, harmonization simplifies cross-border operations for device manufactures and service providers, including reduced risk of interference concerns and increased economies of scale that ultimately support widespread deployment of D2D and utilization of the 2 GHz MSS Bands. Hence, a coordinated UK and EU strategy for the 2 GHz MSS Bands will not only help operators achieve scale and establish unified UK/EU service offerings but also enhance their competitiveness, ultimately benefiting consumers.</p>
<p>Question 12: Do you have any other points that we should consider for our consultation on future proposals?</p>	<p>Confidential? – Y / N</p>