Consultation response form

Your response

Note: question numbers are aligned to relevant sections in the call for inputs document. As such, there is no question 1.

Question 2.1: What are your planned timelines for commercial availability of network equipment and devices for the 26 GHz band? When will equipment for testing and trials be available? Please specify the specific mmWave tuning ranges supported and their timing.	Confidential? – N Starry is a fixed wireless broadband provider that has developed its own innovative wireless broadband technology for the mmW bands. Our equipment is available now, and we currently operate in the 37-38.6 GHz band in the U.S. We have authority from the U.S. Federal Communications Commission to test our technology and business model in 18 cities across the U.S., and we currently have an active deployment in the Boston, Massachusetts area. We have made a technological decision to rely on mass-market 802.11ac radios, which enables us to manufacture relatively low cost equipment that is available now. Because our baseband radios operate in the 5 GHz band and we up-convert the signal to mmW, we can quickly and easily alter the antenna front end to operate in the 26 GHz band.This is true for any spectrum band, in any Time Division Duplexing configuration, generally between 24 GHz and 44 GHz. Fundamentally, we believe Ofcom should pursue a technologically-neutral approach to facilitate a multitude of technologies flourishing in the mmW bands.
Question 2.2: Given the 3GPP studies into NR-based operations in licence-exempt spectrum, when (if ever) do you expect to support licence exempt operation and/or coordinated sharing in the 26 GHz band in your products?	Confidential? – N Starry firmly believes that mmW bands are naturally suited for coordinated sharing and license exempt-type operations. The frequencies propagate poorly over long distances and are unsuitable for wide geographic-area licensing. Even in a dense network deployment, we believe there will be opportunities to share the spectrum, either on a coordinated or a license-exempt basis.

	Because we have developed our own solution largely built off of the 802.11 standard, we believe that from a regulatory perspective, Ofcom should create a regulatory environment that is technically neutral and designed to achieve its own goals, rather than those of a single international standards body.
Question 2.3: When do you expect to support standalone New Radio in the 26 GHz band in your products?	Confidential? – N Starry's technology relies on the 802.11 set of standards. We do not intend to incorporate the 3GPP standard into our equipment. As discussed above, because we are not relying on the global wireless industry standard, we are able to develop and deploy equipment now, years before the global standard is finalized. Furthermore, given the nascent state of "5G," we encourage Ofcom to take an expansive view of the potential for a multitude of 5G technologies and services to evolve and flourish, bringing new innovation and investment to the U.K. and other economies around the world.
Question 3.1: Are there any other aspects related to the existing use of 26 GHz not covered in this CFI that you believe need to be considered?	Confidential? – Y/N
Question 3.2: What options for the existing services in the 26 GHz band do you believe need to be considered to allow for the introduction of new 5G services? Please give as detailed a response as possible along with all relevant information and explain how you would see any potential option you provide working in practice.	Confidential? – Y/N
Question 3.3: Should a moratorium be placed on issuing new licences in the 26 GHz band for existing services? E.g. to ensure that the 26 GHz band is not unnecessarily encumbered prior to the development of a new authorisation / licensing approach for 5G services?	Confidential? – Y/N
Question 4.1: What service would be delivered and to which consumer and/or organisations?	Confidential? – N The mmW bands provide a unique opportunity; many bands are largely greenfield space in which regulators can create a policy and regulatory framework that facilitates innovation in new technologies and services. Regulators can build off of strategies that have worked - and tweak those that have not - to create

	the optimal mix of mmW spectrum policies. We encourage Ofcom to take an expansive view on the types of technologies and services that could operate in these bands over time, and not restrict their policy and regulatory perspective to only certain categories of activities or services.
Question 4.2: Where in the UK would the 26 GHz spectrum be used to deliver services? For example, will deployments be focussed on: **a) Areas of existing high mobile broadband demand?** **b) Rural areas?** **c) Rail and road corridors?** **d) Specific types of enterprise or industrial sites?** **e) Indoors or outdoors?** **f) Specific nations or regions of the UK?**	Confidential? – N Starry, with or without partners, is exploring pursuing fixed wireless consumer and business broadband.
Question 4.3: Where 5G cells are deployed, are they expected to be individual cells or as clusters of cells required to give wider areas of contiguous coverage? What would be the area of a typical contiguous coverage cell cluster?	Confidential? – N Starry's network architecture is fixed point-to-multipoint. We generally locate our network infrastructure on building rooftops or other vertical infrastructure above physical clutter. Our base stations cover up to 120-degree sectors, and we typically collocate three base stations at the same rooftop location, providing 360-degree coverage. We are able to cover an area extending approximately 2 km from each base station, and up to 10 km in free space. Generally, mmW bands face substantial propagation challenges relative to lower frequency bands. Among other issues, mmW frequencies do not travel through obstacles and are subject to substantial reflection and refraction. As a result, these bands are not well suited for wide-area licensing.
Question 4.4: What capacity and bandwidth (i.e. Channel Bandwidth in MHz) would be required at each cell to meet initial capacity requirements? How will this change over time?	Confidential? – N Starry suggests a minimum bandwidth of at least 200 megahertz. One of the benefits of mmW bands is the ability to provide extremely high capacity services because of the substantial bandwidth available. Channels of at least 200 megahertz will facilitate a wide variety of very high capacity use cases. If Ofcom prefers smaller channel sizes, we suggest a minimum of 100 megahertz, which will allow users to aggregate

	channels to wider bandwidths. Keeping the channel size scaled to units of 100 megahertz will also aide in international harmonization. For instance, the U.S. Federal Communications Commission is generally utilizing 200 megahertz channels.
Question 4.5: What quality of service is required? How sensitive is the service being offered to variations in radio interference from other operator's 5G cells and other spectrum users?	Confidential? – N Starry believes there is a high-degree of natural interference protection in the mmW bands. Systems tend to be interference limited based upon the characteristics of the receivers. In mmW bands, due to the substantial directionality of the spectrum, fixed deployments can coexist among each other, even in the same or overlapping bands in the same geographies. Further, even as between fixed and mobile systems, we believe there is also a high-degree of natural interference protection. In a mobile context, infrastructure will be deployed in a dense manner close to the ground, with the higher-power base stations pointed downward. While there is the potential for reflections to hit fixed receivers at some height, we believe that potential is limited. In addition, Ofcom could take simple steps to enhance sharing between different types of services. For instance, using a beaconing system to help receivers identify transmissions and to potentially coordinate operations between different users and even different technologies.
Question 4.6: Will end users be fixed or mobile?	Confidential? – N Within Starry's architecture, end users are fixed. We believe that initial implementation of 5G across the wireless sector will also focus on fixed end users, while additional research and development is done to develop the technology sufficient for a mobile implementation.
Question 4.7: What are the characteristics of 5G at 26 GHz which make this band particularly suited to the service you plan to deploy? What other spectrum bands could be used as an alternative, or in preference to, the 26 GHz band? To what extent could carrier aggregation and other techniques reduce your reliance on 26 GHz?	Confidential? – N The mmW bands generally offer access to a substantial amount of bandwidth to serve high-capacity and low-latency applications. Starry uses this spectrum to reduce the cost of deploying last-mile broadband access. As a result of lower capital costs, we are able to provide a service that competes with the speeds and quality of fiber, at a fraction of the cost.

	We technically can operate between 24 and 44 GHz, and generally see only slight variations between bands between these frequencies.
Question 5.1: Should Ofcom consider licencing options other than the 3 examples set out above (licence exempt, shared coordinated and area defined) for the 26 GHz band? If so, what other options do you consider should be included?	Confidential? – N Starry supports licensing approaches that maximize the number of potential uses and users. 5G technology and services are still in their infancy, and we believe it is in Ofcom's interest to encourage investment and innovation from a wide variety of potential users and providers. We believe a substantial amount of the spectrum can and should be made available on a shared coordinated basis. This can be achieved in several ways. One way is as Ofcom proposes - utilizing a hybrid scheme that sets aside some spectrum for coordinated sharing, and allows opportunistic use of geographically-licensed portions of the band. We suggest that, at a minimum, Ofcom make half of the 1000 megahertz of spectrum under consideration available on a coordinated shared basis in all areas. Another way is to make all of the spectrum available on a shared basis, using new tools and techniques to facilitate sharing. For instance, Ofcom could permit only fixed deployments above a certain height and mobile below that height. In addition to the natural interference protection this may provide, Ofcom could use a database to coordinate all users, or rely on other solutions like beacons used to coordinate access and timing between different users and even different technologies. Additionally, we suggest Ofcom consider license-exempt access everywhere spectrum is unused. As Ofcom acknowledges, different uses have different spectrum needs. We believe opportunistic use on a license-exempt basis will maximize the efficient utilization of spectrum.
Question 5.2: What methodologies could be used to pre-define 'high demand areas' for area defined licences?	Confidential? – N Starry suggests that Ofcom utilize the smallest areas possible, generally located around the areas most likely used for

	mobile. That will tend to be very dense business districts and event venues. Alternatively, those areas could be dynamically identified and assigned based upon actual demand. Spectrum Access System technologies are becoming incredibly advanced, and should have the capability to manage spectrum access in near real time. Ofcom could develop a scheme that provides “area” licenses on a specific needs basis, when rivalry for the spectrum exists at a particular granular location at a specific time.
Question 5.3: What mechanism could be used to coordinate cell deployments by different operators in shared spectrum?	Confidential? – N Ofcom could utilize a variety of tools to coordinate sharing among different users in shared spectrum. One technique, as discussed, is beaconing or sensing. By utilizing a beacon-based system, Ofcom could build off of the substantial success of listen-before-talk in the WiFi context, and leverage a similar timing technique in this band. Ofcom could also consider more traditional coordination using a third-party frequency coordinator. This could include Spectrum Access Systems that are capable of leveraging data analytics and cloud computing to maximize the number of users in any given area in any time. Finally, Ofcom could utilize a hybrid approach that relies both on beaconing/sensing and database systems. Sensing and beaconing could be used to coordinate activities at the edge of the network, driving coordination at a micro level. Databases could be used to plan deployments at the outset and to provide a macro-level view of the spectrum environment.
Question 5.4: What methodologies could be used for determining the proportion of spectrum to allocate using area defined licences and coordinated deployment?	Confidential? – N It is difficult to determine an optimal division of spectrum rights between different access schemes (and inherently different providers) in advance of actual demand. Some of the sharing techniques discussed could make this decision for Ofcom based upon actual spectrum demand and on narrower time slices.

	Alternatively, if Ofcom believes it needs to make a predetermined amount of spectrum available for area-defined licensing, it should permit opportunistic use of the area-defined license areas by fixed users on a coordinated basis, and any user on a license-exempt basis.
Question 5.5: Do you agree that the 26 GHz band should be released progressively? What risks do you envisage with such an approach and how can these be best mitigated?	Confidential? – Y/N

September 22, 2017

/Via Email/

Re: ***Call for Inputs on 5G Spectrum Access at 26 GHz and Update on Bands Above 30 GHz*, July 2017**

Starry, Inc. respectfully submits this supplemental letter for Ofcom's consideration in the above captioned *Call for Inputs* (*CFI*). Starry applauds Ofcom's early consideration of the optimal spectrum policy for making the 26 GHz band available for a variety of future wireless services and technologies, including 5G. We are encouraged by Ofcom's recognition of the potential for making this spectrum available to meet a multitude of different market needs, technologies, and services.

As described herein, Starry, a wireless broadband provider and innovative leader in fixed millimeter wave (mmW) technologies, strongly urges Ofcom to act swiftly to establish a technologically neutral policy platform that will make spectrum available using a hybrid spectrum access strategy. As one of the few operators in the world with an active fixed 5G deployment, we believe our experience and perspective can be valuable to Ofcom as it considers proposals for making the 26 GHz band available to support 5G technologies and services.

Millimeter Wave is an Opportunity for Innovation in Fixed Wireless Broadband

Starry set out to solve a substantial problem in societies across the world – the lack of reliable, competitive access to true broadband. The solution lies in dramatically reducing the cost of deploying high-quality broadband, which Starry achieves through its own fixed wireless broadband technology and network architecture.

Starry is a unique broadband provider – we developed our own innovative fixed wireless system from the ground up, which gives us maximum control and insight into the development of this new "5G" technology. This also allows us to keep our costs of network deployment incredibly low. The result is that we can offer a broadband service at speeds competitive to fiber, at a fraction of the cost.

Starry has an active deployment in the Boston, Massachusetts area, and authority from the U.S. Federal Communications Commission to test its system and business model in 17 additional U.S. cities.[1] Our technical architecture includes two key components: Starry Beam, the network-node, which communicates using mmW spectrum to Starry Point, the at-premise transceiver. We can also pair this system with Starry Station, our smart in-home WiFi hub.

Starry Beam utilizes an active phased array for point-to-multipoint consumer internet access. The system leverages a hybrid approach to beamforming, which pairs native 802.11 functionality with additional software and our proprietary active phased array antenna structure. By utilizing mass-market 802.11ac baseband technology in our infrastructure, we have created a highly-efficient and extremely low-cost internet delivery system using mmW bands. Key metrics of our system include: 5.5 Gbps over 120-degree sector[2] with an upgrade path to 802.11ax baseband that will enable 45-50 Gbps in each sector; and approximately 2 km range per sector in near-line-of-sight conditions and 10 km in free space.

We are in the unique position of operating one of the only 5G networks in the world – as a startup – because of our decision to leverage mass-market 802.11 baseband radios, instead of wireless industry-developed 5G NR. The mobile wireless industry-led standards process is valuable, and will help drive down costs over time at scale. However, it is not the only approach to using mmW spectrum, and we believe that the advent of 5G should bring with it an opportunity for a multitude of new technologies and services to evolve and flourish. It is with this backdrop that we suggest Ofcom pursue a technologically-neutral spectrum policy for the 26 GHz band – and all mmW bands – that facilitates

[1] Starry Spectrum LLC, Experimental License, Call Sign WI2XEB (https://apps.fcc.gov/els/GetAtt.html?id=184921&x=).

[2] Each Beam is one, 120-degree sector.

innovation and investment from a diverse set of technologies and services, to the benefit of consumers and business in the U.K. and across the world.

Respectfully Submitted,

Starry, Inc.