

Your response

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

<p>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.</p>	<p>The availability of commercial 26GHz network equipment shall be aligned with the availability of both a 3GPP defined standard for the band and the market demand for such products upon licence authorisation.</p> <p>At this moment in time the 26GHz frequency range is covered by 2 proposals in 3GPP.</p> <p>28GHz band: 26.5-29.5GHz 26GHz band: 24.25-27.5GHz</p> <p>The expected product availability for commercial 3GPP compliant 28GHz products is just slightly ahead of that for 26GHz. It is understood that this slight delay (maximum 2 quarters) creates debate on whether there is an opportunity for UK licence holders of 26.5-27.5 to benefit from the 28GHz ecosystem. We shall comment on this in a later question, i.e. regarding the possibility of using 28GHz products/devices for the range 26.5GHz to 27.5GHz.</p> <p>28GHz commercially available network equipment is expected for end 2018. It is certainly true that the 28GHz eco system for the US and Asia will bring benefit to the 26GHz eco-system with significant re-use possibilities in the network equipment and device development areas.</p> <p>The current estimate for 26GHz network equipment is mid 2019, however this is subject to the ongoing consultations and planning by administrations such as OFCOM. Ericsson would welcome OFCOM making an early release of this band and accelerating mmWave 5G availability in Europe.</p>
<p>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?</p>	<p>Ericsson strongly advocates the 26GHz band to be authorised via national exclusive licenced spectrum (with potential to support commercial sub-leasing to other industries). National licences have been key to the success of mobile services. Whilst licence exempt regimes could be considered for other bands for 5G, it is believed that such an approach for this "Pioneer" band would create uncertainty and potential delay 5G service take up.</p> <p>The possibility for local licencing (or other schemes to support industrials usage, e.g. Land boundary authorisation) is an option for the 26GHz band, however Ericsson believes that this should be reserved for consideration when the FULL 26GHz band is released, and the licencing restricted to a small portion of the frequency band (not in the 26.5-27.5GHz range). Frequency ranges with coexistence requirements for FSS may be suitable for such consideration.</p>

<p>Question 2.3: When do you expect to support standalone New Radio in the 26 GHz band in your products?</p>	<p>Ericsson intends on supporting both Standalone and Non-Standalone configurations in all the licenced mmWave bands that we produce network equipment for. Standalone support for the first pioneer mmWave bands (28GHz & 26GHz) is expected in 2019. From then on, there should be no distinction on the availability of standalone vs non-standalone for new bands.</p> <p>Ericsson envisages mobile network operators to make use of both standalone and non-standalone deployments within the same network, depending upon the cluster location and the use cases in question.</p>
<p>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?</p>	<p>n/a</p>
<p>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.</p>	<p><u>Fixed Links</u></p> <p>Ericsson recognises that many of these are operated by Mobile Operators who may have a natural interest in migrating their links to other bands so that this band can be made available for mobile use. However, Ericsson also recognises that there are other users who will have no such incentive. Ericsson recommends OFCOM to consider an incentive proposal at the earliest opportunity to entice users to vacate this band (e.g. through lower licence fees in alternative bands).</p> <p>It is acknowledged that the propagation characteristics of the band may enable coexistence of Fixed Links with 5G. However it is recommended that this option is restricted to single licence holders, and the authorisation scheme is not overly complicated (nor supports the creation of uncertainty) by allow multiple organisations access to the same frequencies.</p> <p>It should be noted however that the current specific frequencies allocated to Fixed links of Mobile Operators may not be conducive for the need for large contiguous 5G licences, so clearance is probably the best way and most simple way forward.</p> <p>It should be noted that without special measures put into place to accelerate the clearance of fixed links, that the full 26GHz band may not be available in the UK until 2022+ (assuming a 5 year notice period for existing licence holders to vacate). It is recommended that OFCOM consult with the Fixed Link industry on the right measures to accelerate this via voluntary means, e.g.</p> <ul style="list-style-type: none"> • A voluntary commitment by the Mobile Network Operators to vacate the band early in order to make available for 5G licences

	<ul style="list-style-type: none"> • An incentivised scheme for non-Mobile Operator fixed link users to vacate by a certain date <p>A moratorium on issuing new fixed link licences in this band is considered a sensible approach to support the development of a new authorisation approach.</p> <p><u>FSS and other Space Usage</u></p> <p>Coexistence with incumbent services (e.g. Earth Exploration Satellite Service, EESS) should be possible by way of clearly defined exclusion zones. Separation from incumbent services and 5G networks in the order of several kilometres should enable 5G deployments in urban/suburban environments with very little impact, due to the incumbent services being typically rural/remotely located.</p> <p>A moratorium on additional usage however in the Space sector should be considered.</p>
<p>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?</p>	<p><u>Fixed Links</u></p> <p>A moratorium on issuing new fixed link licences in this band is considered a sensible approach to support the development of a new authorisation approach.</p> <p><u>FSS and other Space Usage</u></p> <p>A moratorium on additional usage however in the Space sector should be considered.</p>
<p>Question 4.1: What service would be delivered and to which consumer and/or organisations ?</p>	<p>Ericsson sees 5G New Radio (NR) on 26GHz to be another valuable frequency layer in a mobile operator’s existing heterogenous (multi-layered) network. 26GHz deployments on both existing grids and new Small Cell sites, supporting both outdoor and indoor deployments, enabling consumer and vertical enterprise solutions are expected.</p> <p>NR is expected to be deployed on three types of spectrum frequencies (Low, Medium, High) and these three types of frequencies provide different technical characteristics which could be required for the different use cases: eMBB/FWA, mMTC, URRLC, etc. Theoretically the majority of use cases could be implemented over any of these three bands but some are more suitable than others.</p>

In general terms:

- Low Frequencies (below 2GHz) will be suitable for uses cases requiring wide area coverage, including deep indoor and high mobility. Throughput/Capacity is limited by spectrum bandwidth available at those bands. Lower latency, compared to LTE, can be achieved by using Sub-Carrier Spacing >15kHz (e.g. 30kHz, 60kHz). Deployments will be mostly through macro network. NR at low frequencies (compared to LTE) can provide a significant benefit to the UK due to the lower power requirements and hence greater possibilities for rural coverage.
- Medium Frequencies (2 to 6GHz) are flexible to accommodate a variety of uses cases requiring higher throughput, extended capacity, shorter latency compared to low frequencies. Deployments will be through denser network compared to low frequencies.
- Higher frequencies (above 6GHz) will provide very high throughput, extreme capacity, limited coverage, low mobility, and ultra-low latency, the lowest latency due to possible usage of highest Sub-Carrier Spacing. Deployments through ultra-dense network or hotspot. These frequencies are also being considered for Self-backhauling and for Unlicensed spectrum usage as per Work Items in 3GPP Release R16.

The following table summarizes, in light terms, the main technical characteristics.

	Coverage Width	User Throughput	Latency	Mobility	System capacity
Low Frequency (<2GHz)	***	*	*	***	*
Medium Frequency (2 to 6GHz)	**	**	**	**	**
High Frequency (>6GHz)	*	***	***	*	***

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?

26GHz will be just part of a 5G toolset, and the suitability of the spectrum for different deployments will depend very much upon the technical conditions, the authorisation approach, and the eventual size of the allocations to the licence holders. Ericsson recommends ensuring that the proposed authorisation regime supports individual licence holders to acquire up to 800MHz of contiguous spectrum. The larger the frequency bandwidth the greater the ability to overcome some of the propagation challenges of this band.

- a) Yes, Ericsson expects to see 26GHz deployed both on the existing grid in areas of high mobile broadband demand, as well as on small cells (both indoor and outdoor). Studies for London have shown that mmWave spectrum (combined with both 3.4-3.8GHz and existing lower LTE bands such as 800/1800MHz) can
- present a big opportunity to deliver outdoor Gigabit speeds utilizing existing roof top sites
 - potentially solve the capacity issue in outdoor hotspots, removing the challenges of finding sites for small cells

**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?**

- potentially off-load existing 4G bands as well as 3.5 GHz NR, improving end user performance at cell edge (i.e. indoor)
- support a user experience of 100Mbps UL and 1.5Gbps DL in 30% of area with smartphone type devices. Further potential with CPE device with better antenna and higher power

b) Ericsson does not expect to see a widescale deployment of 26GHz for contiguous coverage across rural areas. However, it is expected to see spotty deployments of 26GHz in specific locations to support various industrial use cases both outdoors and indoors.

Additionally, Ericsson expects to see 26GHz utilised for Fixed Wireless Access, and used as a last drop solution for rural communities, suburban estates as well as urban developments.

c) As OFCOM indicated in its consultation paper, there is potential for this band to be used to line road and rail corridors and be used to connect to the car/carrriage and the service redistributed internally (e.g. via on-board repeaters or WiFi). However, the infrastructure investment and lead time for such a deployment would suggest that this would not be one of the first mover use cases for this band.

[With regards to Rail coverage, Ericsson strongly recommends that the UK PLC looks at the communication needs holistically, and look to developing both an architecture and a supportive (partnership) business model between Rail and other key industries (such as mobile telecoms) to meet all needs.

Examples of needs that should be included:

- eMBB Services direct to devices for ALL mobile operators (e.g. through on-board repeaters)
- On board WiFi to passengers
- CCTV Connectivity
- IoT and Preventative Maintenance (supporting a reduction in railway possessions)
- The evolution to FRMCS
- Passenger Information Services
- Drone connectivity (both for Railway operational usage, but also as a potential UK PLC arterial highway for drone traffic to support when beyond line of sight operation is allowed).
- Public Safety requirements in case of disaster track side
- Public safety requirements for the British Transport Police in train

Recent non-railway industry input into the potential future strategy for UK Rail has been made in the Digital Railways ECI (Early Contractor Involvement) Phase 2 work. Similarly the RDG and RSSB have initiated a similar consultation activity (via techUK) to seek input from the communications industry.]

d) The use of this band for Industrial IoT, e.g. factory automation is highly anticipated.

It is envisaged that vertical industries will be supported in a number of ways such as Network Slicing on an MNOs' Public Network, Public Network Extension into Industrial Areas by the MNO, Private Network Deployments into Industrial

	<p>Areas by the MNO, and lastly by the commercial sub-leasing of spectrum by the MNO to industry.</p> <p>It is this last situation which OFCOM needs to ensure is supported by the authorisation regime. A market for "Enterprise LTE" deployments with industry deploying their own networks utilising leased spectrum is already materialising and this is expected to develop further as 5G is developed.</p> <p>e) This band will be both used indoors for specific industrial/enterprise use cases and outdoors for both industry/enterprise use cases and general public services such as mobile offload and fixed wireless access.</p> <p>f) Ericsson does not see this band as being of less or more interest by any individual nation or region in the UK.</p> <p>Specific deployment types may be suited for one clutter type over another, e.g. Macro offload in dense urban, FWA Layers for Urban/Suburban, Factory Automation indoors, etc.</p>
<p>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?</p>	<p>The short answer to this question is both. 5G cell deployment will be use case specific. Sometimes they will be deployed individually, sometimes in clusters. Sometimes in standalone mode, sometimes in non-standalone mode in combination with existing LTE frequency bands. The area of a cell cluster is highly dependent upon the use case in question.</p>
<p>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?</p>	<p>Ericsson recommends ensuring the authorisation proposal does not intentionally fragment the frequency range, and ensuring that subject to market demand, individual licence holders can acquire up to 800MHz of contiguous spectrum. The greater the allocations the more flexible the spectrum will be to meet multiple use cases.</p> <p>Much has been spoken of the very high data rates possible with 5G, for this to materialise it is imperative that supportive contiguous channel bandwidth is made available.</p>

<p>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?</p>	<p>QoS is subject to the use case in question.</p> <p>It should be noted that some use cases will require very high quality of service e.g. reliability / availability, as well as predictability of deployability. Some of the proposed authorisation regimes (e.g. shared coordinated, area defined) may be detrimental to this ideal.</p>
<p>Question 4.6: Will end users be fixed or mobile?</p>	<p>Both, dependent on the use case.</p>
<p>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?</p>	<p>The key characteristic of the 26GHz band is Bandwidth. Clearly compared to other frequency ranges below 6GHz, this band has propagation challenges. However, the urgency for this band to be a 5G mmWave pioneer band is to be able to award very large licences up to 800MHz in size.</p> <p>Recent Ericsson simulations for London have shown that the 26GHz band combined with both the 3.4-3.8GHz range, and/or a low band such as 800MHz can significantly increase the value and potential usage of the 26GHz range. Therefore, the idea of carrier aggregation reducing the reliance on 26GHz, is actually counter to reality, as Carrier Aggregation (both intra-site and inter-site) with 26GHz would enable a greater number of use case / deployment possibilities and thus increase the dependency on 26GHz in the future.</p> <p>With regards to how to structure the 26GHz spectrum, it should be highlighted that the allocation of multiple NON-Contiguous blocks of spectrum to a single licence holder will lead to lower spectral efficiency and the potential for unused spectrum.</p> <p>Key facts to consider here are:</p> <ol style="list-style-type: none"> 1. A single large block of 400MHz will have less overhead than 2 blocks of 200MHz used in Carrier Aggregation 2. Currently in 3GPP Rel 15 and 3GPP Rel 16, there are no 5G-NR + 5G-NR Intra-band carrier aggregation combinations being standardised, this is because the focus on 5G-NR is large contiguous carriers. Any licence holder holding non-contiguous blocks will not be able to use them in a CA scenario for several years to come, and there will then be a dependency upon device support. 3.

	<p>26GHz network infrastructure will be tuneable across the whole of the 26GHz band plan, however, due to the very wide band (3.25GHz) a single radio will be challenged to meet the needs of being a) deployable and b) economic and at the same time c) support 2 non-contiguous blocks of frequency simultaneously at opposite ends of the band. Currently vendors are still determining their 26GHz network equipment capabilities. However, OFCOM should assume (at this time) that any 2 blocks of frequencies spanning >1GHz will not be possible from the same radio equipment.</p> <p>In the case of an early release of 26.5-27.5GHz, and the aspiration of the UK Government and the potential licence holders for large contiguous blocks, there is a clear need to evaluate the potential for the UK to open up the 28GHz band (27.82GHz-29.45GHz) for 5G. Ongoing trials in the UK by Arqiva for 5G-FWA in this band demonstrate the aspirations, and removing restrictions on this band which effectively stop 5G-NR deployment today could alleviate the supply vs demand situation for the top 1GHz of the 26GHz band. It is recommended that OFCOM initiates a consultation on this band in advance of defining a way forward on 26GHz.</p>
<p>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?</p>	<p>Ericsson strongly advocates OFCOM not to consider licence exempt and shared coordinated schemes for the 26GHz band.</p> <p>Ericsson recommends to focus on exclusive National licences for the majority of the full 26GHz band, and the complete 26.5-27.5GHz sub-band. (see earlier answers)</p> <p>Area defined licencing could be considered for a subset of the full 26GHz band (as a second priority after National licencing). In this instance however, there are many different ways it could be implemented, from regional, to local licences, to the extremes of a spectrum authorisation scheme tied to the land boundaries of freehold owners (where no explicit licence would have to be applied for).</p> <p>In the case of defining schemes providing Enterprise / Building owners limited access to spectrum, whilst this provides the opportunity for Mobile Operator independent deployments, it should be noted that this also provides a means of providing additional spectrum to mobile operators when they consider meeting specific SLAs for the enterprise. (e.g. an airport deployment may utilise specific spectrum for Airport operations in addition to the Public MNO spectrum to support the general population using the airport)</p> <p>The 5G Vision includes the need to support a multitude of use cases and in some cases, these use cases come complete with strict Quality of Service requirements such as Reliability, or the predictability of being able to deploy in any location. Authorisation regimes including Shared access or DSA mechanisms will reduce the ability of some of these use cases being achieved, and should be reserved for other bands.</p>
<p>Question 5.2: What</p>	

<p>methodologies could be used to pre-define 'high demand areas' for area defined licences?</p>	<p>Any such methodology to pre-define would by definition preclude needs driven by future innovation.</p> <p>Area defined licences are not recommended by Ericsson for the 26.5-27.5GHz frequency range.</p>
<p>Question 5.3: What mechanism could be used to coordinate cell deployments by different operators in shared spectrum?</p>	<p>Ericsson does not recommend OFCOM to consider "Shared Coordinated" regimes for this pioneer 5G band.</p>
<p>Question 5.4: What methodologies could be used for determining the proportion of spectrum to allocate using area defined licences and coordinated deployment?</p>	<p>Ericsson does not recommend OFCOM to consider "Shared Coordinated" for this pioneer 5G band.</p> <p>Ericsson does not recommend OFCOM to consider "Area Defined" licence regimes for the 26.5-27.5GHz sub-band.</p>
<p>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?</p>	<p>The early release of 26.5-27.5GHz would be beneficial in this 5G Pioneer band to drive an early take up of 5G services (and deployment experience in the UK).</p> <p>However, any such early release should only be performed as part of a clear plan to release the full 24.25-27.5GHz range, the long-term certainty for licence holders of the full "26GHz" holdings, and the commitment of contiguous holdings is key. OFCOM could consider this in various ways, for example:</p> <ol style="list-style-type: none"> 1. Auction the top 1GHz as temporary licences only (taking note that the full implications of having to share the rest of the band may not be understood yet). Allowing early deployment experiences, and the eventual re-tuning of any deployed hardware; or 2. Auction the full band at the outset and then have a secondary auction immediately following for temporary licences in the top 1GHz; or 3. Auction the full band and then allocate temporary licences in the top 1GHz proportionally to the awards of the full band

It is imperative for the UK to secure the most benefit from this band, that subject to market demand (auction outcomes) individual licence holders can acquire very large contiguous holdings (e.g. 800MHz+). Network equipment whilst being tuneable across the complete 26GHz range will commercially not be able to support 2 non-contiguous carriers from opposite ends of the band. Therefore, if the band was proposed to be licenced in non-contiguous awards, the value of the spectrum to the licence holders would be diminished.

As the 28GHz ecosystem (both Network Equipment and Devices) would support a lowest frequency of 26.5GHz, then clearly early commercial deployment of 28GHz in the 26.5-27.5GHz range, is not future proof and would not support reallocation into large non-contiguous holdings. The conclusion therefore is that whilst 28GHz solutions may be available earlier than 26GHz (in the order of 1 to 2 quarters), it is only suitable for test/trial purposes in the 26.5-27.5GHz range.

It should also be highlighted that currently today in 3GPP Release 15 and 16, there are no Intra-band Carrier Aggregation solutions supporting two or more 26GHz carriers, thus confirming that it would be several years before a device eco-system to support non-contiguous carriers would exist.

An even distribution of 1GHz of spectrum (26.5-27.5GHz) across 4 MNOs (excluding any potential industry from other players) would clearly only deliver carrier sizes of 250MHz, which is very different from the ideal 5G experience being discussed both in industry and the UK government (see table).

RF channel bandwidth	Peak data rates
200 MHz	6 Gbit/s
400 MHz	12 Gbit/s
800 MHz	24 Gbit/s
1000 MHz	30 Gbit/s