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Vodafone Response to Ofcom's Consultation:

Call for inputs on 5G spectrum access at 26 GHZ and update on bands above 30 GHz

Introduction

Vodafone welcomes the opportunity to contribute to Ofcom's Call For Inputs on the topic of 5G mm-wave spectrum.

It could be argued that the consultation is premature in that this is nascent technology. Vodafone doesn't subscribe to this view and consider that Ofcom is correct to explore the topic, however we would caution that at this stage - pre-technical trials and pre-international standardisation - many of the questions asked in the consultation are at a level of detail where it is not possible to respond. Whilst the conclusions and licensing models described by Ofcom appear sensible, we would urge caution to ensure that precipitous/irreversible decisions aren't taken.

Answers to questions

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.

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?

Question 2.3: When do you expect to support standalone New Radio in the 26 GHz band in your products?

Vodafone considers that these questions are best addressed by network and terminal equipment vendors, and in particular chipset manufacturers. ✂

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?

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.

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?

In the UK, Vodafone has historically used the 26GHz band (amongst others) for backhaul from our mast sites where it is not practicable to use fibre. ✂.

Nevertheless, we see little justification for a moratorium on the deployment of additional links – anyone seeking a licence to utilise 26GHz must be fully aware of its future, unless they live in a vacuum. If they are content to deploy with the risk of subsequently needing to vacate (either because of direct spectrum management action or licence-fee incentives), then it would be an inefficient usage of spectrum to prevent them from doing so in the interim period before mobile 5G usage. Further, there is considerable uncertainty as to when there will be scale deployment of 5G services in the 26GHz band, and considerable scope for sharing spectrum due to the propagation characteristics, meaning it would be premature to block deployments at this stage via a blanket moratorium.

Usage of the lower part of the band in other European markets will also inevitably impact upon the development of the ecosystem hence timing of when there is need for any clearance. For example the lower part of the band is used extensively for fixed links in Spain and Germany: if this means clearance there takes time, it will mean the market for devices will be smaller, which could constrain device availability and consequent utility of the band for 5G in the UK will be lowered. In summary, whilst it is positive that the UK be at the forefront of 5G development, there is little merit in incurring large costs to be significantly ahead of other markets.

As and when 26GHz is to be used for 5G services, then there are two principal options as to incumbent users of the band, namely to force migration under Ofcom's spectrum management powers, or to provide incentives to free up the band via licence fees. At this stage Vodafone favours the latter: under conventional Administered Incentive Pricing (AIP) for Annual Licence Fees, the licence holder would be charged the value in the application they're blocking – this should provide necessary incentives to migrate to another band if it is the most economically efficient outcome. In this context however, we would note that due to the propagation characteristics of mm-wave spectrum, it is far from obvious that there is any need for a total clearance of fixed links from the band.

Ofcom should signal to existing licensees and new applicants that they will continue to charge a fair market value for spectrum (and that this value may increase for the 26GHz band) , as this may well lead to a limiting

of demand for incumbent applications in the band analogous to Ofcom imposing a moratorium, without having to impose such a regulatory straitjacket.

Question 4.1: What service would be delivered and to which consumers and/or organisations?

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?

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?

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?

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?

Question 4.6: Will end users be fixed or mobile?

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?

Applications

Ofcom has broadly identified the main use cases for the spectrum in question. Users could be both fixed and mobile, according to application (we note that in the IoT space, usage of mobile technologies is not necessarily related to the need to be mobile, rather the ease of unified wireless connectivity). At this stage there are various elements that are unknown;

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As such, Ofcom's licensing regime must be flexible and there seems little reason to make final decisions now.

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Standalone or Carrier Aggregation

We note that the consultation raises the prospect of Carrier Aggregation as an alternative to usage of a contiguous block of 26GHz. Carrier Aggregation is an important approach; indeed, early deployments of 5G technology will use 4G (LTE) carriers as an anchor band, with the 5G band providing capacity. Only in subsequent deployments will 5G be standalone. Whilst carrier aggregation can deliver the same peak performance as contiguous blocks, devices will be limited by number of carriers that can be aggregated even in mmWave bands and hence contiguous blocks will still be preferred.

However, Vodafone doesn't entirely understand how Carrier Aggregation would be an alternative to the usage of 26GHz (or mm-wave more generically). The suggestion appears to be that by aggregating other frequency bands, the need for 26GHz spectrum could be negated. But what bands do Ofcom envisage? Clearly mobile operators can and will aggregate spectrum in sub-10GHz bands, but even aggregating all of these would not provide capacity approaching that envisaged for mm-wave spectrum. As such, if there is a need for this capacity – ✂ – then some form of mm-wave spectrum appears to be the best solution.

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?

Question 5.2: What methodologies could be used to pre-define 'high demand areas' for area defined licences?

Question 5.3: What mechanism could be used to coordinate cell deployments by different operators in shared spectrum?

Question 5.4: What methodologies could be used for determining the proportion of spectrum to allocate using area defined licences and coordinated deployment?

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?

Vodafone considers that Ofcom has identified the correct licensing options and would be correct to take a progressive approach (so long as this does not result in fragmentation). At present, it seems that the upper part of the band is less utilised than the lower part which contains fixed links, and this upper part also presents greater scope for geographic sharing with incumbent applications. Additionally, the upper part of the band offers greater scope for using equipment common to the 28GHz band which is being favoured for early 5G deployments in the USA and Korea. Therefore, Vodafone believes that Ofcom would be best to concentrate initial efforts in the upper part of the band. Further, taking a progressive approach allows Ofcom to establish a market value which could be used in setting an appropriate AIP for users of the remainder of the band.

The example given in Figure 4 appears at this stage to represent an overall framework that could provide the flexibility of lightly-licensed spectrum combined with the certainty of exclusive spectrum: we consider that

Ofcom would be ill-advised to make any of the band licence-exempt at this stage (or indeed mix licence-exempt with "exclusively" licensed at any time). The devil in Figure 4, however, will be in the detail:

- There will need to be a process to define what constitutes a "high demand" area. While decisions around this are premature at the present time, it seems better to err on the side of over-declaring the number of areas that are considered high-demand, so long as the appropriate incentives are in place to allow licensees to sub-allocate spectrum, and licence conditions are framed so as not to prohibit this.
- The number of Area Defined Licences will need to be defined, in particular with respect to the likely required bandwidth. Once again, decisions around this would be premature at this stage.
- The consultation is unclear whether Ofcom's approach would be n licences that allow usage in the Areas concerned, or alternatively n licences being issued at each location (to be clear, whether e.g. there'd be n licences each of which allow usage in London, Birmingham, Manchester etc., or whether there'd be n licences in *each* of London, Birmingham, Manchester etc.). Vodafone strongly advocates the former approach; although it is acknowledged that individual licences for each area could facilitate local initiatives, the practicality of deploying networks is that national scale is required. In the UK, the 28GHz licences were issued on a per-area basis and have overwhelmingly been consolidated into national usage – it could be argued that the market has dictated this consolidation, but it has been at significant inefficiency and cost versus issuing the licences nationally in the first place.
- For shared/coordinated use spectrum, consideration will need to be given as to what amount of spectrum it is reasonable for a licensee to consume. It would be wrong to allow a single user to consume the entirety of the band in a given location, but at the other extreme it would also be wrong for the amount allowed to be so small as to be unusable. A very small block allocation (e.g. 56 MHz) may lead to a single user in the middle of the band limiting availability of contiguous spectrum. A larger block of 560 MHz may overprovision the spectrum, limiting number of users and inefficient allocation of spectrum.
- The mechanism for coordination is unclear. At the one extreme, the ECoP coordination approach used for 1.8GHz concurrent licences would not be scalable for 5G mm-wave operation. At the other, the approach taken for TV White Space (TVWS) devices where the devices themselves contact a database is unduly burdensome. Clearly we do not wish to continue with an approach similar to existing fixed link coordination, whereby stakeholders manually apply for licences and Ofcom staff run the application through a model before issuing or rejecting. It seems likely that a compromise solution will be that there is a computer system into which prospective licensees can enter the parameters of their system, and this system then determines whether interference is likely – in effect this could alternatively be considered an automated version of Ofcom's current link-licensing approach, or a TVWS system with deployed systems being *a priori* approved as a whole rather than

dynamically as each device is added. However, we urge Ofcom to await the outcome of 3GPP's studies in this area prior to finalising any policy.

- Knowledge of the propagation characteristics of the band should improve dramatically in the next 12-18 months, which in turn will better refine coexistence models, impacting upon how sharing will work. Also, EIRP approaches may require a rethink. The technology will utilise narrow beam-steered antennas with up to1024 antenna elements; therefore, instantaneous EIRP in a given direction may be high whilst average radiated power is low. It is too early to determine an appropriate EIRP as studies are also being presented to IEC on how to interpret mMIMO antenna arrays for EMF validation, and a 5G working group for IEC (in bands above 6GHz) is yet to begin.
- Ofcom's consideration of sharing may need to extend beyond existing models which essentially assume a first-come-first-served model. Current database approaches check whether new applications can be deployed, and if the spectrum is already in use no deployment is permitted. Vodafone certainly wouldn't advocate evicting existing users, but in this situation there may be a role for the database to show what the blocking application is and facilitate commercial negotiation.

Conclusions

Vodafone is supportive of Ofcom's efforts to move forward the policy debate on licensing of the 26GHz band, and there is a need to make some spectrum available for small scale service launches. However, we believe that this is possible using the upper part of the band as an initial deployment, and would caution against premature clearance of the lower part which could lead to spectrum inefficiently lying fallow.

We acknowledge Ofcom's thinking on licensing approaches. Whilst these seem reasonable at a high level, the devil will be in the detail and we urge Ofcom to work with fellow regulators to adopt a common approach. In particular, the technology trials underway will provde a far better understanding of the propagation characteristics, hence show the degree to which the spectrum can be shared versus requiring exclusive licences. Vodafone looks forward to working with Ofcom in developing the detail.

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