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Vodafone Response to Ofcom Consultation:

Enabling mmWave spectrum for new uses

Making the 26 GHz and 40 GHz bands available for mobile technology

Introduction

Vodafone welcomes the opportunity to comment on Ofcom's proposals for the award of mm-wave spectrum.

We are broadly supportive of the approach proposed, with the exception of the idea of awarding 15-year fixed term licences. We disagree with the use of fixed term licences generically, and for the specific characteristics of the mm-wave bands – a challenging investment business case coupled with deferred access to much of the spectrum – there is a risk that a fixed term licensing regime will destroy any commercial value in the spectrum.

We also provide comments on the proposed auction structure, and have concerns that Ofcom is proposing an experimental approach when more-established alternatives are available and suitable.

Answers to questions

1. Do you have any further comments on the approach we are minded to take to authorising the 40 GHz band?

Vodafone has no further comments above those we made to the previous consultation.

2. Do you agree with the method that we have outlined in annex 16 for identifying which licences authorising the use of fixed links around high density areas will be subject to revocation on the basis that the authorised links would be likely to suffer interference from new users in the high density areas? If not, please give reasons.

The analysis appears reasonable.

3. Do you agree that the licence fee for fixed links that we allow to remain in the 40 GHz band should be the same as the fee in place for the 26 GHz band? If not, please give reasons.

We consider that as a proxy, the approach appears reasonable. In reality the "excluded user" in the continued provision of fixed links in 40GHz in low-density areas will be the ability to issue new Shared Access Licences in the band, so a more appropriate metric would be set by taking the Shared Access Licence fee multiplied by volume of licences typically excluded. However, in practice, Ofcom will have no evidence of how many such prospective licences will be excluded. Replicating the 26GHz fees means that the licensees will be subject to similar fees to those experienced by other fixed link users, so taking this as a proxy is justified on the basis of equitability.

4. Do you have any comments on the proposed rules of our auction?

Vodafone welcome the overall simplification of the lot categories compared to the previous proposal. However, given that the proposed lot structure is now similar to that used in other multiband auctions recently run by Ofcom (2.3/3.4 and 700/3.6), we believe there is little justification in moving away from the clock/SMRA hybrid approach successfully adopted in those awards. The speed advantage is not sufficient justification in our view, as lower lot complexity allows faster rounds anyway.

We would also advise that the proposed system of fractional eligibility points is unconventional and would suggest that the points ratio between 26 GHz and 40 GHz should either be 1:1 or 2:1.

We support the use of either 100 MHz or 200 MHz lots sizes, but believe that there is more advantage in using 200 MHz lots. This reduces the risk of a lower budget bidder holding on to a minimal 100 MHz for a prolonged period while another bidder has to accept something odd-sized like 700 MHz or 900 MHz.

Complications with intra-round bidding

Having studied the proposed mechanism, we are concerned about the high complexity of the intra-round bids (a worked example that required correction by Ofcom is perhaps a symptom of that complexity).

There are two types of intra-round bids: "simple" (which appear anything but) and "all-or-nothing" (which again don't exactly give all or nothing). We are not aware of a clock auction with this level of intra-round complexity having been run before, although some recent FCC auctions come close. We are wary when auction designers propose complicated "experiments" in areas where there are already successful working models.

We have also identified at least three problems that could arise with the intra-round bids being proposed.

i) Unexpected breach of budget because an increase of demand in one band is accepted, while a decrease in another band is only partially accepted.

Example: The prices for 26GHz and 40 GHz lots are both 150. A bidder has budget 600 and wants to secure 400 MHz with a preference for 26 GHz. The bidder specifies 4 lots of 26 GHz (upper category).

The clock price for the 26 GHz categories increases to 160. The bidder attempts to switch to four lots of 40 GHz, but because of processing order and the "no excess supply" rule is not able to reduce demand for 26 GHz below one lot. This however frees up 4.5 eligibility points, meaning that the resulting processed bid is one 26 GHz lots @ 160 and four 40 GHz lots @ 150, which is a budget breach.

It seems that the only way for a bidder to control this is via an "all-or-nothing" bid, and their optimum tactic - to try to get their own band switch processed first - is to submit an all-or-nothing bid for 0 lots at a

price of 150. But if another bidder also reduces demand at the 150 price point, and is processed first, that might prevent an efficient band switch happening at all. It is not clear what happens next … see iii below,

ii) Unexpected loss of eligibility because a decrease in one band is only partially accepted and then an increase in another band can only be partially accepted and the points don't match.

Example: The prices for 26 GHz and 40 GHz lots are 150 and 100 respectively. A bidder has budget 600 and specifies 4 lots of 26 GHz (upper category).

The clock price for the 26 GHz categories increases to 160. The bidder attempts to switch to six lots of 40 GHz, but because of processing order and the "no excess supply" rule is not able to reduce demand for 26 GHz below one lot. This frees up 4.5 eligibility points, meaning that the resulting processed bid is one lot of 26 GHz @ 160 and four lots of 40 GHz @ 100, which is a loss of half an eligibility point.

Again there doesn't seem to be any way to control this other than via an all-or-nothing bid. Giving both bands one point per lot would avoid this problem. Or providing a 2:1 points ratio between 26 GHz and 40 GHz would avoid it when switching from 26 to 40, though not necessarily when switching back again.

iii) Infinite loop where an "all-or-nothing" bid is made repeatedly, is repeatedly rejected (because it would lead to unsold spectrum) but then the clock price can't move forward.

In the examples above, the all-or-nothing bid at 150 would be rejected in the attempted round of switching. The "posted price" at the end of the round would remain at the "opening price" and so in the next round, the bidder attempting to switch could try the same bid again. There needs to be some sort of special closing rule to prevent this, but we can't see provision in the rules for it.

Effective (but unknown) standing high bids

The current proposal seems to introduce standing high bids indirectly, because of the mechanism to reject intra-round bids that might lead to unsold spectrum. However, no bidder can tell for sure how many standing high bids they have (it depends on what bids someone else may be making at the same time). This is less desirable than explicitly allocating standing high bids after each round, as is done in the clock/SMRA hybrid.

The clock/SMRA hybrid does have a speed disadvantage in that there may be several rounds at the same clock price while bidders shuffle down the ranking order for standing high bids (and each in turn gets a chance to reduce or shift their demand). However, this speed issue can be addressed by running the rounds faster towards the end of the primary stage. Less thinking time is needed when the lot format is simple, and bidders are simply repeating standing high bids in most rounds.

Exit bids as an alternative

Vodafone Group operators have previously participated in (and replied to consultations on) clock auctions with "exit bids". These constitute a "best and final offer" for marginal lots whose point total is less than or

equal to the reduction in eligibility that happens during a round. Note that no such exit bid is called for when moving eligibility around between bands.

Exit bids are conceptually a lot simpler, do not require such detailed processing mechanics, and generally only need to be considered at the very end of the clock rounds. They are **only** considered when the bidder has already been awarded the package they reduced to during that round. An exit bid then becomes an extension of that package (to a strictly larger package) and is won in its entirety, or not at all.

Some auctions we have participated in only call for "best and final offers" to be placed when it is known that there would otherwise be excess supply, and only for the bands with excess supply. And only bidders who reduced demand in that round are invited to place them.

However, problems can arise if exit bids might cause a bidder's budget to be exceeded, as an efficient exit bid might then not be placed at all (or may need to be withdrawn in a subsequent round) risking unsold spectrum.

We show an example below, together with a modification which reduces the risk of unsold spectrum even with budget constraints. The bidder has a budget of 510 and is only interested in one category,

Clock Price	Bidder Demand	Exit Bids
100	5	
120	4	None possible as even an exit bid at 100 would exceed budget
130	3	120 exit bid is possible within budget
140	3	120 exit bid must be withdrawn to stay within budget

If several bidders at once are facing similar budget constraints, then unsold spectrum may result.

Proposed modification: a bidder can make an exit bid at **any** price up to the round price where eligibility was reduced (and can reduce the exit bid in subsequent rounds, rather than withdrawing it completely), **provided** the total sum offered for the resulting package does not fall below the previous highest offer for the package.

Clock Price	Bidder Demand	Exit Bids
100	5	
120	4	Exit bid at 30 allowed (total package bid is 5 @ 510)
130	3	Exit bid at 90 allowed (total package bids are 4 @ 480; 5 @ 510)
140	3	Exit bid for 30 can be withdrawn (total package bid is 4 @ 510). Or exit bids can be reduced to 80 and 10 respectively (4 @ 500; 5 @ 510).

Given that this mechanism encourages exit bids to be placed whenever there is a demand reduction (and to be retained for as long as possible) it reduces the risk of unsold spectrum.

We also note that some auction designs allow secondary auctions/stages to handle unsold spectrum, and in our view this is a viable alternative too. A secondary stage may be needed if switches of demand across categories result in temporary unsold spectrum, and no subsequent exit bids ever appear for that spectrum.

Right of Reply

The clock/SMRA hybrid has another very desirable feature. In any round, a bidder's bid package across all bands will either be accepted in its entirety OR there will be at least one more auction round. This is also true of a clock auction with exit bids, but appears **not** to be true of Ofcom's current proposal: it could lead to the auction suddenly stopping with a bidder awarded an incomplete package and no right of reply.

Given all these considerations, we believe the clock/SMRA hybrid is the preferable model. The potential speed advantage of a clock auction no longer seems to be compelling. However, if Ofcom decides to proceed with a clock auction, we would prefer a simpler format with exit bids on eligibility reduction (subject to the pricing rules described above) and/or a secondary stage if there is any unsold spectrum.

5. Do you have an interest in bidding for specific high density areas in this award? If so, please provide evidence that you have a credible intention to do so.

Vodafone does not have an interesting in bidding for specific/individual high-density areas in the award.

6. Do you consider it appropriate to have one or two 26 GHz lot categories?

In line with our earlier response on this issue, Vodafone supports approach c), i.e. having two lot types with a reorganisation once the revocation period for fixed links concludes.

We note that in the consultation at para 9.43, stakeholders are asked to comment on the migration process. Firstly, we support BT's proposals that successful bidders for only one lot type are placed at the extremities of the band so that they can be excluded from the migration exercise. We also believe that a six-month migration period is achievable. Whilst the licensing structure set out at para 9.41 would achieve Ofcom's goals, we question whether the same outcome could be achieved by each licensee being awarded only two rather than three licences:

1. An initial licence covering the frequencies assigned in the initial assignment stage round, with expiry date 5 years 6 months after the issuing of the revocation notice to fixed licensees, containing a requirement to coordinate usage with the final licensee during the last 6 months of the licence term, and
2. A final licence covering the frequencies assigned in the final assignment stage round, with commencement date 5 years after the issuing of the revocation notice to fixed licensees, containing

a requirement to coordinate usage with the initial licensee during the first 6 months of the licence term.

By definition these licences would be "exclusive"[1], other than for the 6-month migration period where they would become concurrent. In line with previous spectrum trade scenarios, Ofcom would subsequently tidy up the final licence terms by removing the time-spent coordination requirements.

7. Do you agree with our proposed approach to coordinating Shared Access users in the 26 GHz band? If not, please give reasons.

We believe that the approach is reasonable.

8. Do you agree it would be appropriate to coordinate Shared Access users in the 40 GHz band in a similar way to the 26 GHz band if we make it available in 5 years time (noting we would consult on the detail of this coordination). If not, please give reasons.

We agree in principle, but do not believe that there is any reason to make decisions at this time: Ofcom's policy could be set according to acquired experience in the meantime.

9. Which of the proposed options for coordinating award winners and existing licensees during the (5-year) revocation period do you think would be most appropriate? Do you think alternative approaches to coordination would be more appropriate?

We do not believe that Option 1 is appropriate: incumbent users would be at risk should new licensees not have sufficient rigour in their coordination procedures, and it would impose coordination costs on the new licensees.

Option 4 would potentially result in very inefficient usage of spectrum, sterilising spectrum in areas where there is no incumbent usage.

Option 2a is superficially attractive, but we acknowledge the reservations that Ofcom sets out at paragraph 10.86 around incomplete information on deployment characteristics. Further, we do not believe that there is yet sufficient maturity of plans for prospective licensees to provide information on these characteristics to Ofcom.

We are therefore left with Options 2b and 3, and suggest that a hybrid between the two may be worthwhile considering. Option 2b represents the least effort on Ofcom's part, but conversely leaves marginal

[1] "Exclusive" in the loose sense, acknowledging that Ofcom is at liberty to over-license using Local Access Licences as it sees fit.

coordination decisions in the hands of the new licensees, thus presenting some of the risks of Option 1 for incumbent licensees. Conversely Option 3 provides greater certainty for incumbent licensees, but introduces additional workload for both Ofcom and the new licensees. Under a hybrid approach, Ofcom could publish link locations and separation distance vectors (per Option 2b), but take a deliberately conservative approach in calculating the distance vectors. Where a proposed deployment fell outside the specified distance vector, then the new licensee would be free to deploy without coordination or Ofcom involvement. However, (per Option 3), where a proposed deployment fell within the specified distance vector, the new licensee would be required to coordinate with Ofcom. We believe that this approach would have the advantage of minimising the interaction needed with Ofcom while protecting incumbent users, and hence should be considered.

In the event that Ofcom proceeds with Option 3, we note that some potential licensees may be able to coordinate internally for the 40GHz band – for example Three and/or BT could coordinate their usage directly with MBNL rather than via Ofcom. Superficially this could provide a competitive advantage in that this would allow them to more frictionlessly rollout usage of the band while it was still encumbered with fixed links. However, in practice we expect deployment of 40GHz to lag that of 26GHz, so taking into account the revocation period on the incumbent 40GHz licences, we are minded to conclude that this is a hypothetical rather than practical issue. Therefore, the requirement to coordinate via Ofcom could be removed in these circumstances.

10. Do you agree with our proposal to protect the radio astronomy site at Cambridge (42.5-43.5 GHz) from new mobile users using the 40.5-43.5 GHz band using technical assignment coordination? If not, please give reasons.

We agree in principle, but believe that Ofcom needs to better explain the implications for prospective licensees in the Cambridge high-density area. For example, we note that at para 10.103, Ofcom sets out that this could affect licensees at 40.5-42.5GHz as well as 42.5-43.5GHz because all licensees would need to limit their emissions, but the text does not go on to explain whether the limitation would be uniform across the band or whether it would be more extreme in the upper part.

If it is more extreme in the upper part, then this may well affect the relative valuation of the frequencies, but absent more information it isn't possible for us to assess whether this differential is to the extent of justifying different lot types for the 40GHz band. If it is uniform, then it would affect the valuation of 40GHz relative to 26GHz spectrum, but absent further details we're unable to assess how serious an issue would be caused.

11. Do you agree with our proposed approach to coordinating at the boundary of high and low density areas? If not, please give reasons.

We agree with the proposals, but note that in many/most cases spectrum set aside for Shared Access Licences in the high-density area will be available at the boundary so no applicant should be outright excluded. Even where this spectrum has already been used, then if there is an application for a Shared Access Licence in the 50/100m "exclusion" zone, Ofcom could liaise with the high-density award licensees regarding whether they have deployed in the area. In practical terms, it is highly unlikely that all licensees will have deployed to the edges of the high-density area, hence there may be a possibility for a licence to be issued[2]. We therefore consider that it will only be in very extreme cases that it will not be possible to issue a Shared Access Licence.

12. Do you agree with our proposed approach to international coordination? If not, please give reasons

We agree with the proposals, but would not expect any practical impact on deployment. In the event that Ofcom becomes aware of circumstances that could affect deployment (e.g. the existence of radio astronomy sites in the low countries), then we would expect that potential bidders are made aware of this at the earliest possible opportunity.

13. Do you agree with the non-technical conditions that we propose to include in the award licences to be issued following the award of the 26 GHz and 40 GHz bands? If not, please give reasons.

On the whole, we agree with the proposals.

We continue to be disappointed at Ofcom's apparent unwillingness to embrace the club spectrum model, which undoubtedly would allow the most efficient usage of spectrum by allowing deployers to use the maximum amount of spectrum, using frequencies that would otherwise lie fallow unless all licensees chose to deploy in an area.

However, we do consider that a club model can readily work within the existing framework. Under this system, those award licensees who choose to cooperate could provide deployment information to a neutral third party, who (in a competition compliant manner) could indicate to deployers where additional spectrum beyond their licence was unused/not planned to be used. The deployer could then apply to Ofcom for a Local Access Licence, and under a pre-agreed MoU, the cooperating licensee would consent to this being awarded. The main issue to be addressed with such a model is around ensuring that a mechanism is found

[2] We note that it is a moot point whether a licence issued in such circumstances would be considered as a Shared Access Licence (as it is outside the high-density area) or a Local Access Licence (as it is being facilitated by an "exclusive" licensee forbearing from deploying in a given location to allow third party usage).

to secure contiguous spectrum, but we do not consider this to be insurmountable, particularly if Ofcom were to introduce a negotiation stage into the assignment rounds of the auction.

14. Do you have any comments on our proposal to award fixed term licences with a 15 year term?

We totally disagree with Ofcom's conclusions on this aspect, which risk destabilising the already extremely fragile business case for usage of these bands.

For decades, Ofcom has relied on market mechanisms for incentivising the most efficient usage of spectrum, in particular trading. Yet with the proposals for a fixed term 15-year licence, Ofcom demonstrates that it lacks confidence in the auction delivering the most efficient outcome, and in the ability of the market to trade spectrum thus addressing any changes in valuation that might occur. Note that the proposals to re-award the spectrum indicates that Ofcom thinks there is not just a risk of an inefficient outcome (which could be addressed by Ofcom retaining an option to re-award), but instead a certainty that this will occur (as Ofcom intends to strip licensees of their rights at the 15 year point up-front).

A 15-year fixed term would be bad enough for any spectrum licence, but when compounded by a spectrum band with uncertain deployment economics and an inability to deploy for 5 years in many locations, it risks rendering the spectrum worthless. ✂.

We strongly believe that the inflection point should be 20 years after the award, rather than 15 years, given the delayed availability of the spectrum (or, to put it another way, 15 years after most of the spectrum becomes available for usage). The licences should be perpetual, rather than fixed term. However, Ofcom should instead stress the importance of the clause in licences that allows it to revoke them for spectrum management purposes. This means that at the 15-year point, Ofcom would carry out a review to consider if there is evidence that the spectrum hasn't been used efficiently, with the power to invoke the revocation clause to facilitate a re-award of the spectrum if and only if required. Ofcom should plan for success of the market, with a contingency for dealing with failure should that arise – in contrast to the current proposal that both assumes the market will fail, and contributes to that failure by damaging deployment economics.

15. Do you agree with the proposed technical licence conditions for award licences and local access licences in the 26 GHz and 40 GHz bands? If not, please give reasons.

We acknowledge the conditions, which appear reasonable.

On the issue of synchronisation, we favour Option 2 (i.e. no mandated synchronisation, but a requirement for licensees to mitigate interference between their networks).

We note the linkage introduced at para 13.15 between whether transmissions are low or medium power, and whether antenna height is restricted to 10m. We acknowledge the reasons why Ofcom has adopted this approach. However, we seek confirmation that for award licences, this situation does not preclude operation

of a mast on a low power basis (e.g. serving a stadium) which exceeds 10m, but instead means that above this height it will be treated as medium power hence require coordination (subject to the decision taken on the coordination approach). Similarly, it does not preclude a Shared Access Licence site operating at low power levels with antennas above 10m, just that where the height exceeds 10m it will be treated as medium power for the purposes of licensing, coordination and fees. If our interpretation is correct, then we believe that for Shared Access Licences in particular, Ofcom's coexistence analysis should factor in the actual intended transmit power, in order that spectrum is not needless sterilised where a lower power deployment has a mast greater than 10m.

16. Do you have any comments on our proposed licence conditions relating to antenna elevation?

We note the restriction on elevation being below horizontal in order to protect space station receivers. We accept this as a starting position, but believe that the situation should be kept under review with respect to the availability of integrated access and backhaul (IAB) devices.

17. Do you agree with our proposal to make available channel sizes of 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz? If not, please give reasons.

We agree with these proposals.

18. Do you have any further comments on the proposal to limit low power outdoor deployments in 24.45-25.05 GHz to three base stations in any 300km^2 area order to comply with the EESS protection requirements?

We believe that the proposal strikes the right balance between rights of Shared Access Licence holders and incumbent EESS users.

(We note that the wording of this question is slightly misleading, in that the proposal is three transmit antennas/base stations per licence in order to achieve the power flux density within a given 300km^2 area – not three base stations in the whole area)

19. Do you have any further comments on the proposed level of fees for the Shared Access licences in the 26 GHz and 40 GHz bands?

We have no further comments on the level of the fees. We draw your attention to our response to Ofcom's Call For Inputs on "*Evolution of the Shared Access Licence Framework*", in particular the answer to Question 7 of that consultation, which addressed the need for bulk invoicing.

20. Do you have any further comments on the proposed extension of the Shared Access licensing framework (including its standard non-technical licence conditions) to the 26 GHz and 40 GHz bands?

We have no further comments.

Vodafone UK
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