Vodafone Response to Ofcom Consultation:

Enabling mmWave spectrum for new uses

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

NON-CONFIDENTIAL

Executive Summary

Whilst supporting an expedited release of mm-wave spectrum, we consider that Ofcom's view of the likely usage is at odds with that of the mobile industry: we foresee use cases in fulfilling demand in high footfall areas, for certain Mobile Private Network (MPN) applications and Fixed Wireless Access (FWA), but we do not believe that there is a viable investment case for network densification at the level envisaged by Ofcom. The implication for the spectrum release mechanism is that Ofcom needs make mm-wave spectrum available to those who will use it, but in a way where the cost and complexity of acquisition does not disrupt the fragile business case for deploying it. We believe that the proposals put forward in the consultation, especially the auction, are unduly complicated, and will at best constrain spectrum efficiency, at worst leave the spectrum unused.

Whilst Vodafone's preferred release mechanism is for a national auction of spectrum, we acknowledge that for mm-wave the likely usage levels in the UK can justify a more nuanced approach. We therefore accept the proposal to split the country into high and low demand density areas. Assuming a breakpoint of 40 high density areas, Ofcom has got the demarcation between high and low density areas broadly correct, although we do have some points of difference, notably the need to allow for demand seasonality in defining the areas, the need to join high density areas that are nearly adjacent, the need to incorporate motorways encircling high density areas, and the need to incorporate certain points of interest (for example airports).

We are comfortable with the usage of Shared Access Licences for low density areas, although we believe that the charging structure requires attention, and there is scope to offer longer term licences to align with the duration of those in high density areas. We also agree with setting aside spectrum in high density areas for Shared Access Licences.

We do not agree with Ofcom's proposal to auction the remaining spectrum in high density areas, and believe that a Club Spectrum model offers greater scope for spectrum efficiency. Under this model, Club members would agree to a Code of Practice to mutually coordinate their usage. Where only one member deploys infrastructure, they would be free to utilise all of the spectrum until other club members wished to deploy, at which point the first-mover would constrain their usage so members could use the spectrum equitably. A Club Administrator would oversee operation of the Code of Practice. As this approach would not be exclusionary, we do not believe that the fee for membership should be burdensome. This Club model would inherently be more efficient than the auction proposed by Ofcom, because the propagation characteristics of mm-wave mean that in most locations only a subset of members would deploy: in the Club model all spectrum would potentially still be utilised, whereas in an auction approach the spectrum licensed to networks that had not deployed would lie fallow.

Although we do not agree with the auction approach set out for high density areas, if Ofcom chooses to take this path then it needs to take a sub-national lot-type approach – i.e. the auction should be for the rights to use mm-wave spectrum in **all** of the high density areas, rather than there being auctions of separate lot types for each individual area. Absent this, it is likely that mm-wave holdings will be fragmented and because of

the difficulties in assessing the value of the spectrum, ultimately some may well go unsold or be left in the hands of speculators.

On balance we agree that both 26GHz and 40GHz spectrum should be awarded. Incumbent users in the 26GHz band should be served with notice of licence revocation in high density areas, as should MLL and H3G in the 40GHz band. However, we consider that Ofcom has been unduly binary in insisting that incumbent usage should be cleared in 5 years' time, given that new mm-wave licensees will not at that stage use the spectrum everywhere. Instead, Ofcom should put in place arrangements so that incumbent users can continue to use the spectrum at a given location – either via Local Access Licences or leases from the new licensees – until such a time that the new licensee intends to deploy.

1. Introduction

Vodafone welcomes the opportunity to comment on Ofcom's proposals to make mm-wave spectrum available for mobile and access applications. In general Vodafone supports the award of spectrum via auctions for national licences, but we acknowledge that in this particular scenario the propagation characteristics and likely level of UK roll out could justify a more nuanced approach. We therefore accept Ofcom's approach of distinguishing between high demand/density areas and locations where supply is likely to outstrip demand, but have a series of comments on the award process as proposed.

2. Answers to Ofcom questions

1. Do you have any comments on our assessment of potential use cases, demand and deployment strategies for new uses of mmWave spectrum?

We agree that the principal use cases are likely to be in fulfilling demand for high-speed data in high footfall areas, Fixed Wireless Access (FWA), and localised industrial / Mobile Private Network (MPN) applications.

However, we believe that there is a disconnect between the mobile industry's view on likely deployment scenarios, and that proposed by Ofcom. In its discussion paper on likely mobile industry demand for spectrum[1] , Ofcom puts forward a model whereby mobile network operators will densify networks to the extent of tens of thousands of small cells utilising mm-wave spectrum. Mobile stakeholders have universally rejected this thesis as not reflecting commercial investment reality.

BT stated[2]:

> *"In summary, the availability of mmWave will not avoid the requirement for additional mid-band spectrum to deliver more network capacity. mmWave coverage range is relatively limited and mid-band spectrum (i.e., U6 GHz) would be the more viable and complementary solution to mmWave for capacity provision in many circumstances"*

Three stated[3]:

> *"...it would be impractical to deploy a small cell network at the scale Ofcom assumes. Small cells need to be very precisely located to successfully offload traffic from a macro site and in many cases, it will not be possible to deploy a small cell in the correct location. Even where this was possible, connecting the small cell to an MNO's core network will often be problematic"*

[1] https://www.ofcom.org.uk/__data/assets/pdf_file/0017/232082/mobile-spectrum-demand-discussion-paper.pdf
[2] https://www.ofcom.org.uk/__data/assets/pdf_file/0024/237462/bt.pdf
[3] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/237628/Three.pdf

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VMO2 stated[4]:

> *In its discussion document, Ofcom suggests that in its medium growth scenario, 30,000-50,000 small cells would be required nationally per operator. In its high growth scenario, it says that this increases by potentially more than an additional 10,000 per operator, possibly in excess of 100,000 per operator, by 2035. Under the existing scenario of four MNOs, this suggests between circa 600 to circa 7700 additional small cells, per operator, every year, for thirteen years. Whilst small cell acquisition and deployment may not be as difficult as that for macro cells, there are still considerable financial and practical considerations involved in meeting these growth scenarios.*

Vodafone stated[5]:

> *We do not agree with Ofcom's conclusions that meeting this demand is best accomplished via densifying networks with existing and pipelined (1.4 GHz, 26 GHz) spectrum. We do not believe that such a densification approach is achievable technically, and there is no sensible investment case for introducing up to 50,000 new cells to UK mobile networks, unless consumers are willing to pay considerably more for mobile service*

We have repeatedly made the case for further release of mid-band (upper 6GHz) spectrum for mobile usage, and will not repeat the arguments here. What is clear, however, is that while the mobile industry sees a case for selective usage of mm-wave spectrum, it is not to the degree that Ofcom envisages. This informs the likely commercial value of mm-wave spectrum, which in turn should inform the award mechanism that should be adopted. We are concerned that Ofcom has approached this exercise through a prism of spectrum with commercial worth running to £billions, as was the case for spectrum awarded in the 2018 and 2021 auctions. Without revealing valuations which might prejudice an award process, it is clear from the outcome of benchmark European awards, where mm-wave has typically sold at or near reserve pricing, that we are dealing with spectrum where the deployment costs soak up much if not all of the value. We are concerned that Ofcom's differing view on deployment scale has led to an overly-complicated auction proposal that is not justified by the true worth of the spectrum in question, and that there are better award mechanisms that will result in greater probability of commercial rollout hence more efficient spectrum usage.

If Ofcom truly believes that mobile network operators will deploy at the level of tens of thousands of mm-wave small cells, then the only logical award mechanism is an auction for national licences – the locations that are portrayed as low demand density in the consultation would in fact have multiple network operators seeking to deploy the small cells that Ofcom projects, hence there would be excess demand. At the level suggested by operator responses, however, it is likely that there would not be excess demand in these areas and the low density/high density approach would be viable. Ofcom needs to acknlowledge the inconsistency in its policy thinking on this point.

[4] https://www.ofcom.org.uk/__data/assets/pdf_file/0023/237623/VMO2.pdf
[5] https://www.ofcom.org.uk/__data/assets/pdf_file/0021/237720/Vodafone.pdf

2. Do you have any comments on our proposed overall approach to mmWave spectrum (including our aim to make the 26 GHz and 40 GHz bands available for new uses on the same or a similar timeframe)?

Whilst acknowledging that the ecosystem for 40GHz will significantly lag that for 26GHz, we believe that Ofcom is correct to award the two bands as a single exercise. The evidence of the release of the 3.xGHz band shows that whilst the decision to stagger the award of 3.4GHz and 3.6GHz was correct in light of the need to launch 5G in an expedient manner, the constrained supply at each award inevitably led to higher prices for the spectrum: we do not wish this artificial constraint to be repeated in mm-wave. This said, as we set out in our response to subsequent questions, this need not necessarily mean an early clearance of the 40GHz band.

3. Do you agree with our approach of specifying high and low density areas in the UK, and authorising new uses differently in those areas?

In general, Vodafone's preferred approach is the award of national licences: under the UK's approach to licensing, localised market entrance can be facilitated via the award of Local Access Licences where spectrum is not being used by the principal licensee. However, given the specific characteristics of mm-wave spectrum, where there will be significant geographies where spectrum would be unused by a national licensee, we accept Ofcom's approach of considering the award process for high demand density and lower demand areas separately. In broad terms, we believe that Ofcom has got the demarcation between the two correct. However, we do have comments at the detail level, and we do not agree with the proposed approach to awarding spectrum in the high-density areas.

4. Do you agree with our overall authorisation approach in high density areas for the 26 GHz band (i.e. to grant Shared Access licences on a first come, first served basis for the bottom 850 MHz of the 26 GHz band, (24.25-25.1 GHz), and to auction citywide licences for the rest of the 26 GHz band (25.1-27.5 GHz))?

Shared Access licences

We agree with the proposal to set aside 850MHz for Shared Access Licences at the bottom of the band. Adopting this approach will facilitate market entrance, and also allow Ofcom to directly manage the usage of these frequencies in order to ensure that important adjacent spectrum users such as Earth Exploration are not adversely impacted.

Given the first-come-first-served nature of these licences, we acknowledge that there is a tension between the permitted power levels, deployment scenarios, and the number of potential users that can be

accommodated. However, we believe that Ofcom has erred in only allowing low power usage, as this will require many licences to be issued to achieve anything but a tiny coverage footprint. Whilst not necessarily advocating medium power licensing up to 30 dBm/200 MHz, we encourage Ofcom to review this decision. Further, a constraint that antennas must be below the roofline in urban environments will severely constrain deployment options, so should be re-examined.

We draw Ofcom's attention to our comments on the pricing model for Shared Access Licences in response to Question 14.

Citywide licences

We disagree with Ofcom's conclusions that an auction is merited for high density areas, and a particularly complicatedly designed one at that. We note that Ofcom has reviewed the prospect of a Club model in paras 3.39-3.43, but we profoundly disagree with the conclusions reached that it is unlikely to be feasible. A Club model could exist under existing licensing procedures, as follows:

1. Club members would pay a membership fee, under which they would be awarded a Citywide licence.
2. The Citywide licence would allow deployment in any of the high-density areas.
3. We would expect that the established mobile network operators would likely seek Club membership, but membership would not be restricted to established mobile networks, therefore allowing market entrance.
4. The Citywide licence would contain provisions requiring that licensees coordinate usage with all other Citywide licensees (i.e. Club members), via a Code of Practice that would be established.
5. The Code of Practice would set out that coordination would occur via the Club members only deploying in a given area with consent of an appointed Club Administrator, and only with the technical characteristics set out by that Club Administrator.
6. We are open to whether the Club Administrator is Ofcom itself, or a third party funded by the Club members. For example, DMSL is an existing joint venture between the mobile networks with skillsets (both for DTT mitigation and for the Shared Rural Network management) that encompass radio propagation planning.
7. Where a Club member is the sole deployer at a given location, then they could in principle use all of the mm-wave spectrum made available for Citywide licensees; this would provide an incentive to deploy early. Where a second Club member wished to deploy, then the Club Administrator would instruct the incumbent to restrict their deployment to one half of the frequencies, and subsequently constrain further until in the worst-case situation, deployment would be restricted to 1/Nth of the spectrum available. The spectrum usage approved by the Club Administrator would reflect any need to coexist with incumbent fixed links, and agreed timetable for the deployment of 40GHz, driven by

eco-system availability (in the alternative, the 26GHz and 40GHz bands could be treated as two Club sub-divisions, with the ability to be members of one or both).

8. In the context of 26GHz, once incumbent usage had been cleared this approach would make 2.4GHz available to the first deployer; if all 4 mobile network operators deployed at a given location – a situation that we would consider the exception rather than the norm – then each would be restricted to 600MHz (falling to 480MHz if there was a new entrant). ✂

9. The proposal does not amount to full dynamic spectrum sharing in that we do not envisage equipment directly applying for authorisation to use frequencies. Rather, the Club Administrator would instruct each member which frequencies they were authorised to use at a given location, and the member would configure their equipment accordingly. We have spoken to equipment vendors and they inform us that it will be technically viable for access network equipment to be remotely configured to adjust the frequencies being used.

10. In the scenario that the "flexing down" of frequency usage meant that a Club member did not have authorisation to use all of the frequencies that they considered they needed, then it would be possible for that member to negotiate with other members to restrict their usage hence make more spectrum available – i.e. trading within the Club would be an option.

11. We envisage the Club Administrator would establish forecasting processes, in order that a first deployer would have pre-warning that they may need to flex down their usage in the future.

12. Where a non-Club member wished to use mm-wave spectrum but there was no availability of Shared Access Licences in the area (i.e. the 850MHz had been exhausted), Ofcom could liaise with the Club Administrator to establish whether it was feasible to award a Local Access Licence for the area.

We consider that this approach would result in greater spectrum efficiency than an auction in the high density areas. An auction approach inherently ring-fences spectrum for the winning licensee, meaning that for areas where they do not deploy, the spectrum lays fallow (absent awarding Local Access Licences, and we are not aware that a Local Access Licence has ever been awarded to a mainstream mobile network operator). In contrast, with the Club approach, the spectrum is effectively pooled between the licensees, meaning that if one member isn't using spectrum in a given area, the others can take up the excess. For low and mid-band spectrum, this difference is somewhat moot because with relatively wide propagation footprints, the spectrum will get deployed by all licensees in the majority of locations, and the proportion of areas where one but not others have deployed will be limited. In contrast, for mm-wave the economics of deployment and the short propagation distances mean that it will be common for some but not all licensees to deploy at a given location.

We note that in the event that Ofcom took a national auction licensing approach rather than adopting the high/low density approach, the Club model could still be used amongst the licensees.

The model would also better encourage joint infrastructure investment, assisting with commercial viability and lessening the environmental impact of network densification. For MORAN deployments, the Club model allows network-sharers to specify adjoining spectrum in a manner that has not proven possible in an auction environment. More widely, the Club Administrator could liaise with potential neutral hosts to unlock deployment in a way that may not be possible where the host needs to negotiate with multiple licensees.

As the Club model would sit alongside the availability of Shared Access Licences, with significant capacity available via this avenue, it is unlikely that any prospective spectrum user would be excluded by this model. Similarly, once a Club member, a licensee will always have assured access to a significant amount of spectrum, just not necessarily the entirety of what they would have ideally desired (other than via trading as set out in point 10 above). It therefore follows that under Administered Incentive Pricing (AIP) principles, it is a very debatable whether anyone is an excluded user. We would thus expect that the club membership fee levied by Ofcom could be minor, indeed could be restricted to a commitment to fully-fund the work of the Club Administrator.

We urge Ofcom to work with prospective licensees to refine the proposal that we have set out above, which results in more efficient utilisation of spectrum, capital, and infrastructure assets (and hence would be more environmentally-friendly) than the proposed auction approach. For the avoidance of doubt, although we comment on Ofcom's auction proposals in the remainder of this response, we do not believe that an auction in high density areas will result in the more productive usage of mm-wave spectrum.

5. Do you agree with our overall authorisation approach in low density areas for the 26 GHz band (i.e. to grant Shared Access licences on a first come, first served basis)?

Under the high low/density model, we agree with this approach. We draw Ofcom's attention to our comments on the pricing model for Shared Access Licences in response to Question 14.

Ofcom will need to be extremely alert to hoarding of spectrum in order to ensure that there is efficient usage, and also that spectrum is not used as a tool to foreclose competition. We believe that particular attention needs to be given to the scenario of competitive bids for MPN applications. There are strong parallels with the situation with respect to numbering in the 1990s, prior to the widespread adoption of number portability. At the time, it was common for a series of communication providers to be bidding to provide an enterprise's telephony services, and each to apply to Oftel for a block of numbers to facilitate the bid. Although ultimately only one bidder would be successful, Oftel's numbering resource in the relevant area code would quickly exhaust. The issue was addressed via the introduction of a reservation scheme whereby multiple bidders could reserve the numbering block, with the assignment ultimately being made to the successful bidder. We believe that there is merit in Ofcom considering a similar approach for Shared Access Licences, and suggest that the spectrum team liaise with the numbering team to gain insight into how this could be adopted. Absent this, there is a risk that MPN opportunities are not won based on the most compelling offering, but instead based on who was the first to apply for spectrum via Ofcom.

6. Do you agree with adopting a similar approach to authorising the 40 GHz band as our proposals for the 26 GHz band, if we were to decide to re-allocate the 40 GHz band?

We agree that the same approach should be adopted for 40 GHz as 26 GHz, subject to our observations in response to Questions 9-12 on spectrum clearance.

7. Do you agree with our proposed methodology for identifying and defining high density areas?

8. Do you agree with our proposed cut-off point of 40 high density areas?

With caveats, we accept the methodology and outcome of the approach set out in the consultation, and that the cut-off should be around the 40 high density area level.

We note that overall, subject to our comments on Ofcom's proposed auction design, it is better to over-designate high-density areas than under-designate. This is because if a predicted high-density area proves not to exhibit high demand, then the spectrum will still be available for third party usage via Local Access Licences; in contrast if a low-density area proves to have high demand, there is a risk of spectrum stocks exhausting and not being in the hands of the most efficient user (absent trading).

Ofcom's analysis appears to have used a snapshot of demand, which risks missing seasonal variations. In order not to miss holiday hotspots, we believe the analysis needs to be repeated using data from various times of year.

Whilst acknowledging that there are advantages in Ofcom adopting a mechanistic approach in that it is less subjective and hence less vulnerable to challenge, we believe that there is merit in introducing a "common sense" stage to the exercise. This involves three principal additions to the process adopted by Ofcom:

1. A "smudging" exercise whereby nearby high-density areas are amalgamated. We note that Ofcom has done this within areas at a pixel basis, and also by effectively joining areas that are less than 1km apart into a single area. However, the approach still leaves anomalies – for example in Greater Manchester, all of the boroughs such as Bolton and Stockport are incorporated into a single high-density area, except for Wigan and Rochdale that form separate areas (in the case of Wigan, split into a low-density area covering the suburbs of the east of the borough, and a separate high-density area covering the town of Wigan itself). Coupled with the subsequent auction proposals, this implies that Ofcom believes that there are separable markets for the provision of services utilising mm-wave spectrum in Wigan and Rochdale: we do not consider this credible. We believe this anomaly may have arisen because the greenbelt separating the other boroughs of Greater Manchester is less than 1km wide whereas that separating Bolton/Wigan and Oldham/Rochdale is more than 1km.

   Similar anomalies appear to arise with Leeds/Bradford being separated from Huddersfield; Sheffield

from Doncaster; Greater Birmingham from Wolverhampton; and Cardiff from Newport (if included).

Anomalies such as this could potentially be overcome in a mechanistic way by either widening the consideration of joining the high density areas to e.g. 3-5km rather than 1km, or alternatively that for unitary authorities, rather than using the MTaC dataset, operating at the unitary authority level instead. However, given that this is not a huge exercise, practicably it makes more sense to look at the specifics, recognise where high density areas are not really free standing, and smudge the areas together.

2. Where there are motorways in the vicinity of high-density areas, these should be incorporated fully into the area. For example, the Greater London area should fully incorporate the M25, Greater Birmingham incorporate the M6/M5/M42, and Greater Manchester incorporate the M60. Where the motorways would form the boundary, we suggest a boundary of 500m beyond the motorway in question.
3. We disagree with Ofcom's conclusions that there is no need to address potential demand hotspots outside the proposed high-density areas. In this context, we note that at the least, the following areas need to be added:
    - All of Manchester airport (currently only partial)
    - Gatwick airport
    - Glastonbury
    - Sporting stadia, for example covering all premier league football grounds
    - Principal shopping malls, for example we note that Bluewater and Lakeside/Thurrock are likely to be excluded, as is the Trafford Centre in Greater Manchester (although our proposal under (2) would coincidentally address this).

9. Do you agree with our proposal to clear the fixed links in and around high density areas from the 26 GHz band?

We agree in principle. Option 1 (no clearance) would lead to the band being unduly contaminated and significantly compromise the availability of spectrum for mobile use cases. Option 2 (clearance in all areas) would result in the forced migration of many links where there would be no mm-wave deployment, incurring significant costs and leaving spectrum inefficiently fallow. Option 3 (clearance in/around high density areas) strikes the correct balance.

However, we consider that Ofcom has been unduly binary in opting to clear the incumbent users in high density areas prior to spectrum being *made available* for mobile usage. Instead, the goal should have been for the incumbent users to exit the spectrum prior to it being *used* for mobile. To elaborate, although Ofcom

may make the spectrum in, for example, Greater London available for mobile usage in 5 years' time, this does not necessarily imply that the new licensees would use the spectrum everywhere within that footprint at the 5-year point. Potentially it could be many years later before spectrum is used to the extent that it interferes with a specific 26GHz link. By issuing a 5-year revocation notice, Ofcom is inherently causing spectrum to go unused, unless the new licensee floods the high-density area with mm-wave spectrum at the 5-year point.

We believe that more efficient usage can be yielded by Ofcom issuing a revocation notice, but putting a condition in the new licences that the spectrum be leased to incumbent fixed link users, at a price equivalent to the current licence fees, until such a time that the new licensee wishes to deploy. This could be combined, for example, with a requirement to provide 6-9 months' notice of that deployment. If our proposals around Club spectrum are accepted, then the Club Administrator would manage the liaison between incumbent and Club licensees. We are open to whether the system would operate as a formal lease between the licensee and the incumbent, or instead work on the basis of the fixed link user being issued something akin to a Local Access Licence.

Although Vodafone doesn't necessarily assert that we would exercise the opportunity to retain our fixed links in the 26GHz band beyond the 5-year period, we believe that by adopting this approach it would provide significant flexibility for us to do so. We note that one of the other significant users of 26GHz is Airwave, whose usage will presumably diminish as ESN is fully deployed, but who will not necessarily fully exit within the 5-year period.

10. Do you agree with our estimates of the cost of migrating fixed links into alternative spectrum bands?

No, we do not agree, but the difference is unlikely to be significant enough to change Ofcom's decision making.

We acknowledge that the approach taken by Ofcom of factoring in the age of existing equipment is valid from an impact analysis standpoint (for example if a piece of radio equipment is half-way through its asset life, only half of the cost should be incorporated into the impact analysis, otherwise it would represent betterment on the part of the incumbent licensee). However, when it comes to practicable costs faced by the incumbent licensee, it must be acknowledged that they do face the full equipment cost – the equipment manufacturer does not offer a trade-in scheme, it does not offer the new equipment at a discounted cost due to a past purchase, and given that the 26GHz band is being cleared, there is no scope to trade the obsoleted equipment on the second-hand market to offset the cost. It is therefore important to note that the £800k cost of revocation for the impact analysis of the "Top 40" case should not be conflated with incumbent licensees only facing £800k of expenditure.

We note that Ofcom has used a core case of radio equipment costing £10.5k[6] and having an asset life of 7 years. Vodafone's cost of replacing radio equipment is £✂ and we use an asset life of ✂ years. It should be noted that these figures will tend to understate the costs as they do not allow for the cost of skilled resource to execute the changes, plus the consequences of any service outages that may be imposed.

All of the above assumes that there is availability of a suitable spectrum band to migrate onto. In reality, we face a somewhat binary situation that for a given link, either there will be suitable spectrum available, and we will face these limited costs, or there will not, and we will either need to connect using fibre or an additional hop – and given the difficulty in site acquisition, plus presumably the decision was taken to serve the existing mast via radio link was made for good reason, it is far from clear that either will be possible. In the extreme, then, the "high" cost scenario is actually that service at a mast will need to be discontinued.

We note that the impact analysis has sought to incorporate the scenario of an additional hop being required. However, even in the "high" scenario, Ofcom only assumes the 2% of links will need an additional hop – in Vodafone's case where we expect to need to migrate ✂ links (for the 40 high density area case), that implies that ✂. Ofcom has offered no evidence to demonstrate that this is a reasonable assumption, for example by examining the specifics of the links involved and checking spectrum availability in similar bands.

Whilst we consider that Ofcom should consider these refinements, we do not believe it would impact the decision to choose 40 high density areas, nor to choose clearance Option 3.

11. Do you agree with the proposed approaches we have outlined to manage coexistence between new 5G users and the different existing users in the 26 GHz band? In particular, do you have any views on our proposals to limit future satellite earth stations in this band to low density areas only, and to end access to this band for PMSE users with five years' notice?

We have no comments on the coexistence analysis undertaken by Ofcom. The proposed approaches appear reasonable. ✂

12. Do you agree with our initial assessment on which option for enabling the 40 GHz band for new uses would best achieve our objectives?

13. Do you agree with our analysis of the impact on existing 40 GHz licensees, including our estimates of the cost of moving fixed links under the options involving revocation (options 2, 3 and 4)?

As described in response to Question 2, we are in favour of 40GHz being awarded in combination with 26GHz spectrum. It is unlikely that trading of the spectrum by the incumbent licensees could produce an efficient

[6] £7k capex for the equipment plus 50% overhead for installation

outcome in this case (as any trading would need to be in tandem with Ofcom's award of 26GHz spectrum in order for the acquirer to make an informed choice about the relative levels of spectrum acquired via trade and auction). We therefore agree that Option 1 (status quo) should be discounted.

Given MBNL's extensive usage of the band, and the uncertain demand for mm-wave applications, we do not believe that clearance of MBNL's usage can be objectively justified. We draw Ofcom's attention to our observations on the impact assessment provided under Question 10, and highlight that given the volume of links involved, the issues are likely to be more acute for MBNL in the 40GHz band. We therefore consider that Option 2 (revoke all licences) should be discounted.

Option 4 (revoke half of MLL and H3G's spectrum) would leave the band significantly fragmented. We therefore do not favour this option, however, would not object if this was the consensus preferred option. In this eventuality, we note that mm-wave usage would be excluded from the retained frequencies, so any AIP-based licence fee for the spectrum in question would need to take this into account.

On balance, we favour Option 3 (MBNL retain its usage, revoke MLL and H3G's licences). However, our support of this option is predicated on an assumption that for links in the 40GHz band, Ofcom would adopt the model that we have proposed for incumbent 26GHz links. As such, although MLL and H3G would lose their existing licences, existing links would be grand-fathered into being individual leases from the new licensee(s) in the 40GHz band until such a time that the new licensee(s) wished to use the spectrum. In this situation, we would expect that MLL and H3G would have protracted usage of the spectrum, and the fees for the limited volume of links in use in the band would be somewhat lower than the ALF that existing licensees imminently face for usage of the 40GHz band. Rather than clearance, the situation could therefore be better characterised of the incumbent usage being frozen, with clearance happening at some point in the future, but certainly more than 5 years away.

14. Do you have any comments on our high-level Shared Access proposals (including technical and non-technical licence conditions and proposed approach to setting fees)?

We note the technical aspects of the Shared Access proposals covering low density areas.

As we set out in our response to Question 4, for high density areas we consider that Ofcom has been unduly conservative in restricting licences to be low power only. Ofcom should examine whether it is feasible to issue a higher power variant, somewhere between the current low and medium power licences.

With respect to the non-technical aspects, although we have criticised other aspects of Ofcom's proposals as being overly complicated, we believe that Ofcom has taken too simplistic approach on the topic of pricing mm-wave Shared Access licences.

Structure of mm-wave Shared Access licensing fees

The current pricing model for Shared Access licences seeks to recover Ofcom's administrative costs in a linear way, in proportion to the number of locations, bandwidth issued, and licence length. However, if we compare and contrast a new entrant with a single mast location utilising 80MHz of spectrum for 1 year, with an established operator wishing to deploy 100 masts utilising 800MHz of spectrum for at least a decade, it cannot credibly be argued that established operator causes Ofcom 10,000x as much administrative costs in issuing the relevant licences as the new entrant does. We do not oppose market entrance, but scale spectrum users should not be subsidising the costs of new entrants. In practice, we expect that Ofcom's costs in licensing mm-wave Shared Access licences will be driven by:

1. A cost to on-board an applicant licensee (e.g. issuing the relevant IT accounts, recognising the applicant on Ofcom's finance systems), plus
2. A cost per application (e.g. driven by the fixed costs in processing an application such as invoicing the licensee), plus
3. A cost per location (driven by the costs of checking coexistence with incumbent licensees, which we would hope will be largely automated), plus
4. A bandwidth related cost (which would be relatively limited but aimed at ensuring applicants only ask for what they need), plus finally
5. A recurring cost associated with renewing/maintaining the licence.

We believe that with one caveat – see below - the fees for mm-wave Shared Access spectrum licences should reflect Ofcom's costs of administration. This implies a one-off fee to process the initial application (unless the applicant has a pre-existing licensing relationship with Ofcom), then the ability to batch applications with a per-batch then per-location element to the charging. The renewal fee should reflect Ofcom's costs, and should not be a repetition of the original application costs, because Ofcom is not doing anything with respect to coexistence analysis at that time.

It is appropriate that there should be a bandwidth element to the fees in order to encourage efficient spectrum usage, but we disagree with the idea that it should be linear. Within the bounds of sensible spectrum usage – for example up to 800MHz bandwidth – licensees should pay moderately higher fees for using more spectrum but there seems little justification for e.g. 200MHz to cost twice as much as 100MHz when it causes Ofcom little additional administrative work and causes little risk of exhausting the spectrum. However, applications beyond the agreed sensible level could be suggestive of inefficient usage and certainly would constrain the amount of spectrum available for other applicants. In this situation, we believe that the fees should reflect this concern, i.e. the level of fees should quickly accelerate – for example 1GHz licences could cost 50% more than 800MHz, or even double.

Capex vs Opex model

If we assume for one moment that Ofcom awards Citywide licences in the high-density areas via an auction, this would create an anomaly in the financial reporting of licence acquisition costs. Consider two masts at the opposite end of a street, one falling within the high-density area, one in the low-density area. The high-density area spectrum would have been auctioned, hence accounting convention is to capitalise the cost of that licence and typically to depreciate it over the term of licence until the point in time when ALFs become payable. In contrast, the low-density area spectrum would be acquired via an individual licence for the area with an annual fee, which is typically treated as an operational cost.

This anomaly is not an esoteric internal accounting matter for the licensee, as it ripples through to metrics that are visible to the wider investment community – the cost of the spectrum in the low-density area will be encompassed within an EBITDA[7] metric, whereas the cost of spectrum in the high-density areas will fall below that line. Although this anomaly already exists between spectrum subject to ALFs and those within an initial post-auction licence term, it would be novel for it to be the case on identical spectrum acquired significantly at the same time, with the only distinction being the precise location of usage. We therefore believe that in the event that Ofcom awards the high-density area spectrum via auction, there is merit in it offering a "capex model" for Shared Access Licences – in essence it would be possible to get a mm-wave Shared Access Licence where renewal fees would become payable on the same date that fees become payable for the high-density area licences (i.e. rather than being annually renewable, the application fee would cover all licensing fees up until e.g. end 2038)[8]. This would allow licensees to capitalise the acquisition cost of a mm-wave Shared Access Licence, hence have all mm-wave spectrum accounted for on a similar basis.

Application process

The easiest deployment situation for mobile network operators is to have the surety of nationally licensed spectrum. Whilst acknowledging that there is merit in the high density/low density model. It is imperative that the application process for Shared Access Licences in low density areas does not provide an administrative barrier to deployment. We therefore believe that Ofcom needs to make available a batch model, whereby operators can apply for multiple licences at a time.

15. Do you agree with the overall approach we have set out to coordination and coexistence between new Shared Access users in the 26 GHz band and existing users?

The analysis appears reasonable, and we have no additional comments.

[7] Earnings Before Interest, Tax and Depreciation and Amortisation of assets
[8] Note that in this model, there would need to be a process to make minor changes to licences, for example to move the location to a limited extent should it be necessary to exit a site and find a nearby replacement.

16. Do you have any comments on our initial views in relation to auction design?

As set out in our response to Question 4, we do not believe that an auction is justified for the award of mm-wave spectrum in high density areas. The following comments should not be taken as support for auctioning the spectrum, instead they reflect our observations on the proposals put forward in the consultation.

Geographic vs sub-national lot categories

Whilst appreciating that Ofcom wishes to facilitate market entrance, we consider that the usage of an auction with a potentially vast number of lot types is unduly complicated given the likely value of spectrum involved. We simply do not believe that the level of complexty suggested is commensurate with the likely value of the spectrum in question. It is incredibly unlikely that there is a separable market for the deployment of mm-wave services in for example Wigan or Derby (or indeed any of the locations in the top 40 high density areas identified by Ofcom) which would provide sufficient motivation to formulate an auction design with potentially 120 different lot types[9] .

If Ofcom was to adopt an auction of a single lot category covering all of the high density areas, then even if a potential user had a need for spectrum specifically in one of the high-density areas, this could readily be accommodated either via the shared access component of the spectrum, or via secondary trading. Ofcom's concern appears to be that if the spectrum was auctioned on a sub-national basis, the spectrum could be awarded to the incumbent mobile network operators even though an innovative new entrant valued spectrum more highly for example in Derby (as that new entrant might not value spectrum highly in the other 39 locations). In this situation, however, it would be a mutually beneficial for one of the mobile networks and the new entrant to trade spectrum in Derby (or even a part of Derby). We are puzzled that Ofcom does not have confidence in the market to deliver efficient spectrum trading, as this forms the bedrock of its spectrum policy.

The usage of geographic lot categories massively complicates both the auction itself and the task that prospective bidders face in valuing spectrum. Valuation of mm-wave spectrum is complex enough, with uncertain demand and uncertain build economics. Ofcom is asking prospective bidders to ascertain the valuation of this spectrum on a town-by-town basis, which is not a realistic challenge. ✂

We must also highlight that where Ofcom has historically sought to award spectrum on a regional basis, for example in the 28GHz band, this has ultimately resulted in the market having to clear up the fragmentation via secondary trading to create (near) national licences. There is no track record of successful awards of spectrum on a regional basis.

[9] For each of 40 locations, 2x 26GHz lots (encumbered and unencumbered) plus 1x 40GHz lot

In the event of an auction, we therefore support the usage of a single sub-national category covering all of the top 40 high density areas.

We note that Ofcom seeks to remove some of the complexity of geographic lot categories by allowing prospective bidders to indicate in advance which lot types they are interested in, meaning the other lot types can be consolidated. So, for example, if there was a prospective new entrant in London but only the existing mobile networks elsewhere, then there would be two lot types, i.e. one for London and the other covering the remaining high-density areas. However, this would still leave complexity. History shows us that new entrants enter the bidding process, but fall away after a few rounds of bidding. In our hypothetical London/elsewhere scenario, we would still be left with two lot types each with potentially different outcomes driven by having a different number of bidders in the earlier rounds, even though, having lost the prospective new entrant, the bidders on the different lot types were now identical. This indicates that if Ofcom did go down the route of geographic lot categories – which for the avoidance of doubt we don't support – it needs to devise a mechanism so geographic lots can be collapsed together during the auction itself.

26GHz lot categories

We consider that option c), i.e. two lot categories with re-arrangement for long term contiguity, is the best option. Both options a) and b) would result in short term distortions caused by encumbered spectrum being reflected into long term fragmentation of spectrum holdings (absent secondary trading).

Principal stage auction format

On balance we support the clock format proposed by Ofcom (but not the lot categories).

Assignment stage auction format

We agree the usage of a single round sealed bid auction. In the event of there being geographic lot categories, we see the merit in the stage comprising a series of sequential rounds, one for each location, as it would allow bids to be placed based upon the level of budget that had already been deployed in earlier rounds/locations. However, the exercise would be susceptible to the order in which the geographic locations would be considered, so we seek clarification from Ofcom of how this would be decided. Further, with potentially 120 different geographic/encumbrance/frequency lot category combinations, this shows the level of complexity introduced by Ofcom's thinking – conceivably the Assignment stage could take far longer than the Principal stage ✂.

17. Do you have any comments on the licence duration options we have considered in this section for new licences for the 26 GHz and 40 GHz bands that we would auction?

We can understand Ofcom's concern about getting this exercise wrong, and can only reiterate that the Club model would allow market participants to dynamically vary their holdings, and ultimately for Ofcom to dissolve the Club if the approach was demonstrably failing.

In the context of auctioned spectrum, we would be reluctant to accept fixed term licences. The UK is an exemplar in awarding indefinite licences which reduce the risk of investment in spectrum (albeit with some dangers around Ofcom setting inappropriately high Annual Licence Fees (ALFs) after the minimum term). Fixed term licences could result in reduced investment towards the end of the licence term, because with no security of tenure, any equipment purchased to utilise the spectrum must pay for itself within that licence term. In the extreme, a fixed 10-year licence would make it all but impossible to invest in mm-wave – with an asset life of e.g. 8 years, any equipment deployed after year 2 would be subject to accelerated depreciation; however the peak time for deploying mm-wave spectrum will be more than 2 years after the award, indeed much of the band won't be available for usage until 5 years after the award. In effect, Ofcom would be taking what is already a challenging investment case and making it totally unworkable.

We therefore consider that Ofcom should stick to its established approach of awarding indefinite licences with a 20-year initial term, relying on secondary trading (and the threat of revocation from year 20 onwards) to resolve any efficiencies. Ofcom should have faith in the incentives to trade spectrum when it is efficient to do so. It is unclear clear why there is continued belief that market-based spectrum trading will deliver efficient utilisation in other bands, but not for mm-wave spectrum.

18. Do you agree with our assessment of potential competition concerns and that it may be appropriate to impose a competition measure such as a 'precautionary cap'?

We agree that Options 2 and 3, which revoke MLL, H3G and potentially MBNL's 40GHz holdings, would not result in competition concerns (albeit we do not support Option 2, revoking MBNL's licence).

We consider that Option 1, allowing the 40GHz incumbents to retain their spectrum and use it for mobile access, would present significant competition concerns because even if a cap precluded H3G from purchasing *any* 26GHz spectrum, they would have almost as much mm-wave spectrum as the other MNOs combined[10].

[10] Although we acknowledge that the ecosystem for 40GHz held by H3G would lag the 26GHz one, for the first 5 years the 26GHz band would also face constraints due to the presence of fixed links, which would reduce the timing disadvantage.

Option 4 results in a lesser competition concern than Option 1 as the starting position would be H3G possessing e.g. 22% of available mm-wave spectrum[11]. This would suggest that a safeguard cap would be required (e.g. not to acquire more than 1800MHz of further spectrum).

However, as set out in our response to Question 13, our preference would be an implementation of Option 3, i.e. that H3G's licence be revoked (but with safeguards to allow existing usage to continue for as long as possible).

As we reference above, we believe that the ecosystem for 40GHz will lag that of 26GHz. We therefore believe that it is appropriate to place a safeguard cap on acquisition of 26GHz: in this context we note that ✂. We would therefore suggest that Ofcom might consider a safeguard 1GHz cap on 26GHz.

Vodafone UK
July 2022

[11] e.g. if both MLL and H3G gave up half of their 40GHz holdings, that would result in H3G possessing 1000MHz of 40GHz, out of a total available 2250MHz of 40GHz + 2400MHz of 26GHz.