Virgin Media O2 response to Ofcom's 2023 consultation:

Enabling mmWave spectrum for new uses:

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

Non-Confidential Version

May 2023

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EXECUTIVE SUMMARY

Virgin Media O2 ("VMO2") welcomes the opportunity to respond to Ofcom's second consultation on enabling mmWave spectrum for new uses: "*Making the 26 GHz and 40 GHz bands available for mobile technology*"[1]. As we set out in our response to Ofcom's first consultation in May 2022, the market context for this award is very different to all previous awards of IMT spectrum in the UK. In consultations on prior awards of low and mid-band spectrum, we had firm plans for nationwide deployment of major spectrum bands, starting as soon as the award completed. However, our planning for mmWave spectrum is at a much earlier stage, and we do not yet have firm opinions regarding when and where we will deploy such spectrum. Much will depend on factors outside our control, including how quickly demand for 5G data develops, and the pace at which the European technology ecosystem for mmWave bands matures.

What is clear, is that at some point in the future, perhaps on a ten-year time horizon, mmWave spectrum will have a role to play in our network, providing additional capacity and exceptional speeds in traffic hotspots in major urban centres. However, we do not anticipate needing or deploying mmWave in areas where customer 5G needs can be met in full using other spectrum. In that regard, the approach of urban 'exclusive' licensing, and first-come-first served licensing elsewhere, is welcome.

Our response is in two parts. The first part, our Main Response, discusses a series of key issues concerning the design and packaging of the licences, and the auction design. The second part addresses Ofcom's specific questions.

We provide here a summary of key points from our Main Response:

- **Competition measures.** VMO2 strongly disagrees with Ofcom's intention to proceed with an auction of 26 GHz and 40 GHz spectrum without any precautionary spectrum caps. We urge Ofcom to revisit this decision, which we believe is inconsistent with its commitment to preserving multi-operator competition in the UK mobile market. Our view remains that a prudent precautionary cap, which would not constrain any currently known business case, would be 1,000 MHz per operator per band. If Ofcom still thinks this too tight, we would also support a more relaxed cap, such as 1,000 MHz at 26 GHz, and 2,400 MHz across all bands.

- **Sub-national lots.** We agree with Ofcom's proposal to combine all high density areas into sub-national lots. Our expectation is that any potential demand from non-national operators for spectrum in specific geographic areas can be met through acquisition of licences on a site-by-site basis under the proposed shared access regime. The inclusion of additional lots for specific high density areas is therefore unnecessary and would introduce unwelcome complexity into the award design.

[1] https://www.ofcom.org.uk/__data/assets/pdf_file/0015/255030/03-23-statement-and-consultation-mmwave.pdf

- **Reserve prices.** We support Ofcom's approach of setting reserve prices with regard to international benchmarks and local conditions. Given the large amount of spectrum available and uncertainty about demand, we request that that Ofcom choose the lower limit of its reserve price range to set starting prices. This would result in the reserve price for the 26 GHz lots being set at £0.5m, and the 40 GHz lots at £0.25m per lot.

- **Main stage auction design.** We support Ofcom's choice of a clock auction format for this award but propose some modest adaptions to the detailed rules. These include additional bid retention rules and extension rights to provide bidders with protection against the risk of losing eligibility points unintentionally. Given the complexity of the bid processing rules, we also urge Ofcom to provide early access to auction software, complemented by tests cases, so bidders can run their own tests of the system.

- **Assignment stage design.** As it did for the 3.7 GHz award, we urge Ofcom to build into the assignment round rules scope for bidders to engage in industry negotiations over assignment positions. [✂]

- **Licence duration.** Given the reality of uncertain MNO demand, we believe that the interplay between the timing of the award and the licence duration needs more thought. Ofcom's original proposal for a 10 year licence starting 2023 was supposed to stimulate interest in the spectrum but allow for reallocation to correct inefficiencies before the mmWave ecosystem in mobile reaches maturity. This may be contrasted with the conventional mobile licence, which would last 20 years and have a renewal option, an approach that provides no break for reallocation, but does provide investment continuity and scope for trading. We fear that Ofcom's new proposal for a 15-year licence starting 2024 is a compromise position that negates the benefits of either approach without providing any upside itself. The licence is too long to allow for a reallocation before the mmWave market takes off, but too short to provide good incentives for trading and investment through the 2030s. Put differently, Ofcom is proposing to undertake an auction at a time of uncertainty, and leave bidders with uncertainty as to their rights for the use of the spectrum in the long run.

  As a general rule, buyers seek certainty in order to value investments, and sellers tend to secure sales and efficient pricing if common value uncertainty can be minimised. Accordingly, we have concluded that the best option would be for Ofcom to revert to selling conventional 20-year licences followed by annual renewal for a fee. To minimise the risk of dynamic inefficiency, Ofcom should rather look to precautionary competition measures that eliminate high-risk, extreme asymmetric allocations, rather than short licence terms that may undermine investment incentives.

Ofcom will be aware of the current commentary from both Three and Vodafone about a possible combination of their assets in the UK. In the past, Ofcom has decided not to proceed with spectrum awards when a merger process is underway, owing to the uncertainty over supply and demand this creates amongst bidders. In addition, VMO2 would view any merger agreement between Vodafone Group and CK Hutchison regarding their UK assets as constituting a single bidder group, based on the rules used in previous awards to manage bidder association and prevent collusion.

It follows that, should such a merger be announced in the near future, Ofcom would need to re-assess its timeframe for this award. Allowing for a merger clearance, we might expect this award to happen in a 2025-2026 timeframe[2]. Given the uncertainty created by a merger we believe such a delay is acceptable; especially given that this spectrum allocation will not have any near-term impact on competition, and a delay will give MNOs more time to study the emerging ecosystem. For avoidance of doubt, a delay of this nature would not impact our position on licence term or competition measures.

[2] We note that the PSSR award was put on hold during the O2/Hutchison merger process and even though the merger was blocked in 2016, the award did not take place until 2018.

MAIN RESPONSE

COMPETITION ASSESSMENT

VMO2 strongly disagrees with Ofcom's decision to proceed with an auction of 26 GHz and 40 GHz spectrum without any precautionary spectrum caps. We urge Ofcom to revisit this decision, which we believe is inconsistent with its commitment to preserving multi-operator competition in the UK mobile market. Our view remains that a prudent precautionary cap, which would not constrain any currently known business case, would be 1,000 MHz per operator per band. If Ofcom still thinks this too tight, we would also support a more relaxed cap, such as 1,000 MHz at 26 GHz, and 2,400 MHz across all bands.

There are, however, still many other aspects of Ofcom's competition assessment that we agree with:

- We agree that it is a lower likelihood outcome (but possible) that a highly asymmetric allocation will emerge from this auction, as there is expected to be interest from multiple bidders, including the MNOs.

- We agree that if a highly asymmetric allocation emerges, it would not generate immediate competition concerns, given that mmWave is not expected to be an important part of the mobile business case this side of 2030.

- We agree that there is significant uncertainty as to what role mmWave spectrum will play in delivering mobile and related business cases beyond 2030. Indeed, in our opinion, the situation is so uncertain that the long-term possibilities range from a landscape where mmWave is a modest part of mobile networks (the more likely scenario, as things stand) to one where mmWave carries a substantial amount of mobile traffic in the most congested areas (less likely but not implausible).

Ofcom draws a very different conclusion from these points than we do. Ofcom's position is that because an asymmetric outcome is "unlikely" and because it is uncertain if an asymmetric outcome would generate competition concerns, no competition measures in the auction are necessary.

We strongly disagree. Just because an outcome is unlikely is not an adequate justification to take no action to preclude it. Ofcom's reasoning sets an unduly high bar for precautionary caps aimed at preventing allocation outcomes that could cause harm in the long term. In prior awards for 4G and 5G spectrum, Ofcom has set precautionary caps aimed at preventing a single operator from acquiring more than ~37% of total mobile spectrum holdings. Those measures were linked to more immediate concerns about asymmetry in spectrum holdings and the risk that this could constrain competition. Nevertheless, the same arguments apply here in case access to a critical mass of mmWave spectrum becomes a crucial element of the mobile business case during the lifetime of these licences. Put differently, Ofcom should be thinking about the potential competitive landscape 10 years from now, not just over the next 5 years.

The fact that Ofcom is proposing to set a licence term of only 15 years rather than grant indefinite licences, implies to us that Ofcom recognises that there may be a need for a reallocation of mmWave

spectrum in the long term. However, licence term lengths are a poor tool for addressing inefficiency in spectrum allocation. Without any certainty over renewal, a 15-year licence starting 2024 will make trading less and less attractive through the 2030s, exactly when mmWave use may be taking off and efficient transfers are most needed.

We request that Ofcom revisit its competition assessment, with a focus on the following four questions:

(1) Could a highly asymmetric allocation outcome cause long-term harm to competition?

Our view is that there is real potential for long-term harm to competition, i.e. on a 7-12 year time horizon, if ownership of mmWave spectrum is concentrated in the hands of just one or two operators. The amount of spectrum available in the 26 GHz and 40 GHz bands, and therefore the potential volume of mobile network capacity, dwarfs what is available in existing mobile bands. Our concern is that if one or two operators end up with outsize control of this resource, they might gain a non-replicable competitive advantage in the mobile market after 2030. This could happen if there is a movement towards intense densification of urban mobile networks after 2030, for example owing to a decision by Ofcom not to release further mid-band spectrum for IMT uses post-WRC23.

(2) Is there any countervailing evidence that a highly asymmetric allocation could bring benefits?

We see no countervailing evidence that extreme concentration could be beneficial. Ofcom appears to be concerned (paragraph 8.36) that imposing a spectrum cap, even at a high, precautionary level, could preclude a bidder from pursuing a business case in the auction that requires very large quantities of mmWave spectrum. However, this concern appears to be entirely hypothetical. We are not aware of any business case that could justify a bidder pursuing huge quantities of mmWave spectrum other than a speculative play on the spectrum becoming scarce and highly valuable in the future, i.e. after 2030. No such business case has been highlighted during this consultation process. Moreover, manufacturers have been very clear that the mobile ecosystem will not support deployments of more than 800-1,000 MHz per operator in the short-to-medium term.

(3) How likely is it that the auction will produce an outcome that is not dynamically efficient?

We are concerned that the risk that this auction produces an outcome that is not dynamically efficient, is unusually high. In the last two UK mobile spectrum auctions, MNOs demonstrated a willingness to reduce demand in core 5G bands (e.g. Vodafone at 700MHz in the 2021 award). This points to both decreasing marginal returns and a strong willingness to optimise existing spectrum assets rather than purchase new ones. The risks of low demand are exacerbated for this award, as MNOs cannot expect much benefit from deployment in the near-term, and therefore, valuations will be disproportionally based on uncertain long-term benefits. When a business case is uncertain, the likelihood that some operators over-estimate value and other operators under-estimate value is high. Accordingly, even if the auction delivers an allocation that maximises static efficiency, it is quite likely that it will not be

dynamically efficient. It is a plausible scenario for the auction that there is very little demand even at low reserve prices.

Ofcom makes this same point when considering licence duration at paragraph 12.16:

> "*Given the particular characteristics of mmWave spectrum and the uncertainty about the spectrum requirements for future use cases … we consider there is a* ***risk that the initial allocation of citywide licences would not reflect the most efficient allocation of mmWave spectrum in the longer term****. We therefore consider that auctioning indefinite licences may preclude efficient allocation of the mmWave spectrum over time*." [our emphasis]

We see inconsistency here between Ofcom's recognition that an auction is unlikely to deliver a dynamically efficient outcome and its position that a highly asymmetric allocation is so unlikely that the associated risks can be ignored. Ofcom is relying on the presence of multiple well-funded MNOs competing for spectrum, to remove the risk of an asymmetric outcome. Yet, asymmetric outcomes can and do happen in spectrum auctions, even in the presence of well-funded bidders. Ofcom should note that in the recent Spanish 26 GHz auction, Telefonica secured 1,000 MHz of spectrum (the maximum permitted), whereas its chief competitors, Orange and Vodafone, secured only 400 MHz each. MasMovil did not participate at all. [✂] In the absence of a precautionary cap and with low reserve prices, similar behaviour by bidders in Ofcom's proposed mmWave auction could lead to a much more asymmetric outcome.

(4) If the allocation is not dynamically efficient, how easily can inefficiency be corrected?

We are concerned that the tools available to the market and to Ofcom for addressing dynamic inefficiency in mmWave spectrum allocation would be inadequate in the case that ownership is highly concentrated. In contrast, we have greater confidence in the ability of the market to address inefficiencies when the initial allocation outcome turns out to be too plural than is economically efficient.

The primary tool for realising dynamic efficiency gains over time, is spectrum trading. However, as discussed above, Ofcom's proposed 15-year licence starting 2024 would make trading less and less attractive through the 2030s, exactly when mmWave use may be taking off and efficient transfers are most needed.

As Ofcom recognises, there is also abundant evidence that MNOs find it difficult to conclude trades where the outcome could enable a rival to be a more effective competitor. For example, Ofcom may consider how difficult it was for Telefonica UK (O2) to conclude deals to buy spectrum from other operators in the mid-late 2010s, even though it was obvious that certain other MNOs had excess capacity and O2 was short of capacity. We do not think it coincidence that it became easier for O2 to conclude such deals after the 2018 2.3 GHz auction, once we had secured the critical mass of spectrum necessary to dispel near-term market concerns that we could run out of network capacity. As Ofcom notes at paragraph 7.71-7.74, the limitations of spectrum trading are also illustrated by the failure to date of

Vodafone, H3G and BT to conclude a deal that could defragment the 3.4-3.8 GHz band, even though it is obvious that doing so would be efficient overall.

For related reasons, at paragraph 7.6, Ofcom concluded (correctly in our view) that existing licences at 40 GHz should be revoked:

> "*We consider that we cannot rely on trading to achieve an efficient allocation in this band, and that liberalising the incumbents' licences would be less likely to secure an efficient allocation than an award*."

Ofcom reinforced this point at paragraph 7.60 of the consultation, when it said:

> "*However, as set out in the May 2022 Consultation, there may be particular barriers to trading which could prevent industry from reaching an efficient allocation in the case of mmWave spectrum*. "

Conversely, if a new business case emerged that required very large amounts of mmWave spectrum, we are quite optimistic that operators would find mutually beneficial ways to realise these synergies, for example through spectrum pooling. The UK MNOs have a track record of effective collaboration, for example through network sharing arrangements and the Shared Rural Network, where there are mutually beneficial solutions. This point reinforces our view that Ofcom should not put much weight on the downside risks of denying a hypothetical business case that needs huge volumes of mmWave spectrum.

Another tool for addressing an undue concentration of mmWave spectrum is regulatory intervention, but this would need a very strong rationale, such as an adverse finding in a competition investigation. We do not consider this a practical remedy for multiple reasons. Firstly, it is most unlikely that action would be taken quickly enough to address the problem, given that competition issues would likely emerge gradually over time, intervention would require a heavy evidentiary burden and any spectrum reclamation would likely draw legal challenge. Secondly, Ofcom has shown a marked reluctance to intervene in mobile spectrum markets, for example it did not support any spectrum remedies for the BT/EE merger. Indeed, there is a risk that Ofcom's very decision not to impose precautionary caps creates an institutional bias against future intervention because it would de facto be recognition that it made a mistake.

The one remaining tool available to Ofcom (and the one that has been most important to date) is its ability to identify and release new spectrum bands. However, with respect to mmWave spectrum, Ofcom's room for manoeuvre here may be limited. Unlike other European countries which have opted to release only part of the 26 GHz band, Ofcom proposes to release the entirety of the 26 GHz and 40 GHz bands. Consequently, Ofcom doesn't have any other spectrum in its pipeline that it could release to help operators who in the future find that they have too little mmWave spectrum. No alternative high-capacity bands have currently been identified and there is no certainty that such bands will emerge in the next 15 years given the dependence on global ecosystems. Indeed, as other European countries are planning to take a more incremental approach to releasing 26 GHz and 40 GHz and (based on precedent) will likely intervene to some extent to ensure every MNO secures a

critical mass of such spectrum, the UK might be alone for many years in needing more spectrum.

As we set out in our previous response, other countries worldwide have adopted precautionary caps when releasing mmWave spectrum. The exceptions are the United States, which did not apply any caps, and countries where the supply of mmWave spectrum was severely constrained (such as in Italy, Greece and Croatia). Regulators have typically set band specific caps of 800-1,000 MHz. This is illustrated in **Table 1Error! Reference source not found.**, which we have updated from our previous response to incorporate the latest awards of 26 GHz in Estonia and Spain.

Table 1: Spectrum caps adopted for 26 GHz 5G spectrum awards

Country	Total amount of spectrum (MHz)	Cap (MHz)	% of total
South Korea	2,400	1,000	42%
Italy*	1,000	400	40%
Finland	2,400	800	33%
Greece	1,000	400	40%
Taiwan	2,400	800	33%
Denmark	2,850	1,650	58%
Thailand	2,700	1,100	41%
Slovenia	1,000	800	80%
Croatia	1,000	400	40%
Brazil (national)	1,000	1,000	100%
Australia	2,400	1,000	42%
Spain**	2,800	1,000	36%
Estonia	2,400	800	33%

*Under the club model, licensees can access up to 1,000MHz in areas where other licensees are not using the spectrum.

** Spain allocated 2,400 MHz nationwide, plus an additional 400 MHz on a regional basis.

In response to the previous consultation, VMO2 proposed a precautionary cap of 1,000 MHz per band, i.e. 1,000 MHz across the two 26 GHz categories, and 1,000 MHz at 40 GHz. It remains our view that this is the right level of precautionary cap, sufficiently large that it would not preclude any operator from pursuing any currently known business case for mmWave, while also ensuring there is space for at least three operators in each of the 26 GHz and 40 GHz bands. However, we are open to alternatives.

Our view is that a precautionary cap regime must achieve the following:

(1) Preclude the possibility that two entities together secure more than 2,000 MHz of the 26 GHz spectrum; and

(2) Preclude the possibility that either one or two entities together secure all or most of the available mmWave spectrum (i.e. 26 GHz and 40 GHz together).

The first objective is necessary because there is uncertainty whether a European ecosystem for 40 GHz will develop in the medium-long term, given the focus of EU countries on the 26 GHz band. The 40 GHz band is also an inferior substitute for 26 GHz, and it remains to be determined to what extent the weaker propagation of the 40 GHz band will impact its commercial potential relative to 26 GHz.

The second objective is necessary in order to avoid a situation emerging in the next 5-15 years where one or two operators have monopolised exclusive access to mmWave spectrum, and there are no good alternatives available for a third or fourth operator that wish to maintain a competitive network.

Our proposed 1,000 MHz cap per band would deliver these requirements. An alternative, laxer measure that would also deliver these requirements would be to keep the 1,000 MHz cap at 26 GHz but replace the cap at 40 MHz with a cap of 2,400 MHz across 26 GHz and 40 GHz. This alternative approach would satisfy Ofcom's desire to allow a bidder to pursue a very large block of mmWave spectrum at 40 GHz (i.e. an amount of spectrum in excess of known business cases), while maintaining room for at least three auction winners.

SUB-NATIONAL SPECTRUM LOTS

We agree with Ofcom's proposal to combine all high density areas into sub-national lots. Our expectation is that any potential demand from non-national operators for spectrum in specific geographic areas can be met through acquisition of licences on a site-by-site basis under the proposed shared access licensing regime. The inclusion of additional lots for specific high density areas is therefore unnecessary and would introduce unwelcome complexity into the award design. If Ofcom nevertheless decided to propose breaking out some high density areas of the UK into standalone bidding regions, we urge Ofcom to minimise the number of standalone regions. Put differently, it should only create a separate geographic bidding unit if it is convinced, based on information obtained at consultation, that there is viable independent demand for that region (or sub-group of regions) that could not be satisfied instead via the shared access spectrum or through competition for a single sub-national lot. Geographic licensing introduces the risk of resulting sub-optimal fragmented holdings (as evidenced following the 28 GHz award for regional Broadband Fixed Wireless Access licences, run by The Radiocommunications Agency in 2000).

The creation of separate geographic bidding units would also introduce material risk for MNOs, who strive to offer a consistent nationwide service in busy areas but could find themselves with varying quantities of mmWave spectrum. An outcome in which we won uneven quantities of 26 GHz spectrum in different urban areas could mean we would have to develop a series of network roll-out plans instead of a single national strategy for urban areas. [✂] Accordingly, if Ofcom did change its mind and propose to explore the regional lot route, it is important that it consult on its specific proposals for regional lots, so MNOs have the chance to review and respond.

In relation to high density areas, whilst we welcome Ofcom's move to expand the set of these areas that it initially proposed (by opting for the top 80 areas set out in the May 2022 Consultation, rather than the top 40, and ensuring that some specific high-footfall locations are included in full, for example Airports and Ports) we are concerned that there are several 'large urban' areas and important locations that are excluded as a result of Ofcom's chosen methodology.

The excluded areas that we would like to see included in the sub-national lots are:

- Dense urban areas: Telford, Eastbourne, Grimsby, Maidstone, Blackburn, Worthing, Bedford, and St Helens.

- Airports. All top 19 airports. Specifically, Ofcom has excluded 3 of the top 19 Airports (Belfast International, Cardiff, Nottingham) within its re-defined high density areas. We think these should be included.

- Ports. All top 13 ports. 5 of the top 13 Ports with the highest passenger volumes are excluded (Holyhead, Harwich, Fishguard, Immingham/Grimsby, Milford Haven). Holyhead is the second busiest port in the UK.

- Key 'Staycation' areas which experience high traffic demand: Newquay, Clacton, St Ives, Scarborough, Skegness, Keswick, Windermere, Bridlington, Portrush, Isle of Sheppey, Mablethorpe, North Somercotes, Filey and Ulrome. We can supply Ofcom with shapefiles/polgyons which define these seasonal 'hotspot' areas.

RESERVE PRICES

We have reviewed Ofcom's proposal for the 26 GHz and 40 GHz reserve prices and support its approach in setting these prices. A number of mmWave awards in other countries have produced outcomes with either no competition or unsold spectrum, potentially owing to inappropriately high reserve prices. Therefore, it is important that Ofcom adopt a precautionary approach to setting reserve prices to avoid unsold lots in this award.

Reserve price range

Ofcom has set the range for reserve prices at £0.25m to £2m per lot. This range has been defined as a result of an international benchmarking analysis and an assessment of each benchmarks' applicability to the UK market.

We support the range proposed by Ofcom for the following reasons:

- Ofcom's choice only to include European benchmarks is appropriate. The volatility in non-European country benchmark suggests there might be additional factors influencing prices in those countries that are not relevant to the UK.

- Spectrum awards where all lots went unsold do not accurately reflect market demand. We therefore support their exclusion from the final set of benchmarks.

- The method of deriving the UK equivalent value benchmark accounts for all major differences in awards across countries and is in line with best practice.

- The range has been set at a modest level relative to the benchmark for final prices, consistent with best practice of taking a precautionary approach to setting reserve prices.

In summary, the final set of benchmarks stands as a reasonable set of data points for comparison.

Setting the reserve price

We request that Ofcom choose the lower limit of the reserve price range to set their starting prices. This would result in the reserve price for the 26 GHz lots being set at £0.5m, and the 40 GHz lots at £0.25m per lot.

Our request to set reserve prices at £0.5m for the 26 GHz and £0.25m for the 40 GHz band is based on the following reasoning:

- The complete set of benchmarks introduced by Ofcom shows that over a third of countries awarded the mmWave spectrum at reserve prices. Since this analysis, there have been two further awards of mmWave spectrum in Europe, in Estonia and Spain, and both the auctions closed at reserve price (in Spain some spectrum went unsold). This indicates that the actual market value for the spectrum could have been below starting prices, and that the regulator might have been better off setting reserve prices at a lower level in order to enable price discovery. Setting reserve prices at the lower limit of the price range is a precautionary approach that can prevent unsold lots.

- Spectrum supply in the UK is significantly larger than in benchmark countries. A larger supply of spectrum typically leads to lower prices. As the UK is the first European country to assign this amount of spectrum in one award, we suggest Ofcom set the reserve prices as low as possible, allowing the market to determine the spectrum's true value. If 26 GHz and 40 GHz are indeed substitutable, then given the large supply in this award, it is likely that marginal valuations will be lower than in more constrained awards in the benchmark group.

- The lower and upper 26 GHz are imperfect substitutes. The lower 26 GHz is the inferior substitute owing to initial coordination challenges with existing fixed links. When starting both bands at the same price level, a lower reserve price for 26 GHz will create more room for the market to determine the price differential between the two sub-bands.

- We support Ofcom's proposal to set the 40 GHz reserve price at 50% of the 26 GHz minimum price. Although there are no good benchmarks available for the value of 40 GHz vs 26 GHz, it is obvious that the 40 GHz band lots have lower value, owing to relative ecosystem immaturity. Therefore, it makes sense to start this band at a meaningful discount to 26 GHz.

- If there is sufficient demand, price levels will rise regardless of the starting price.

In summary, we support Ofcom's conservative approach in setting reserve prices and propose Ofcom set reserve prices at the lower end of its own range.

AUCTION DESIGN – MAIN STAGE

VMO2 supports Ofcom's decision to use a clock-type auction format for this award. The specific clock auction design selected by Ofcom is new to the UK, although we understand that the rules are similar to those adopted in past and forthcoming 5G spectrum auctions in Australia, Canada, the United States and Slovenia. Our understanding is that the format has performed adequately in those contexts. Therefore, we are inclined to support the proposed auction design, although we do have some reservations about the complexity associated with the bid processing rules at the end of each round.

In the following paragraphs, we set out our comments and requests for clarification on various aspects of the rules. In particular, we highlight the following:

- We are concerned about the risk that a bidder who fails to submit a bid on time, for reasons that may be outside their control, could lose eligibility, even in a situation where repeating their previous round bid at the same price would have been sufficient to preserve eligibility. We propose an additional bid retention rule to mitigate this risk.

- We think it is important that Ofcom grant extension rights to bidders to protect bidders and mitigate the risk that the integrity of the auction is damaged owing to bidders failing to bid on time. This is particularly relevant given the potential for Ofcom running rounds as short as 15 minutes. Extension right rules previously used for the 2013 Combined Award could apply here.

- We support Ofcom's proposal for asymmetric eligibility points. However, under Ofcom's proposed weights and rules, there appears to be a risk that a bidder could, unintentionally, lose ½ or 1 point of eligibility when attempting to switch in or out of 40 GHz, if they are partially retained. This arises because the activity with processed bids could, under certain circumstances be ½ or 1 point less than the activity at clock prices. We propose a minor rule to address this discrepancy.

- We note that the round-by-round bid processing rules for this format are unusually complex. They are new to UK bidders and it is important to the success of the auction that bidders understand them and have confidence that Ofcom is implementing them correctly. Such confidence can be achieved by Ofcom providing early access to auction software, complemented by tests cases, so bidders can run their own tests.

- We support Ofcom's intention to use small bid increments. We have a preference for shorter rounds rather than larger increments as a way of managing the pace of the auction.

Bidding language

There appears to be a subtle, but material change in the language used to express bids between Ofcom's rules and those originally developed by the US FCC for similar clock auctions. In those other countries, bids in each category were expressed in the form of a change to existing demand e.g. -2 to decrease demand by 2 lots; 0 to maintain demand, and +2 to increase demand. In contrast, Ofcom proposes that bids be expressed for total demand. Hence, for example, a bidder that wants to reduce demand from 8 to 6 lots in a category would submit a bid of 6 lots under Ofcom's rules and a bid of -

2 under the FCC rules. Our understanding is that in the auction system back-end, both bids are processed as a request to decrease demand by one or two lots at the relevant price point, so they are functionally equivalent.

While this rule change does not appear to have an impact on bid processing, we are concerned about the impact on bid submission. Under the FCC rules, a bidder that wants to reduce demand must actively submit a decrease bid. Hence, a bidder that fails to submit a set of bids in a new round would by default be submitting a zero change bid in every category, so would be maintaining their demand at the clock price. In contrast, under the Ofcom rules, a bidder must actively resubmit their prior quantity of demand to maintain demand. Hence, a bidder that fails to submit a set of bids in a new round would by default be submitting a zero bid at the clock price, which would be treated as a request to drop all their demand.

We see pros and cons of both approaches. We do not like the US approach because, if the clock price is rising, a bidder that fails to submit in a bidding round could be on the hook to pay a higher price even though it has not explicitly submitted a bid accepting that price. We are not even sure if this approach would be enforceable under UK law. On the other hand, if the clock price in a category does not change across rounds, we think it is a good feature of the FCC rules that prior bids are maintained unless actively changed. We see a problem with the UK rules in that a bidder could be active in a category where there is no excess demand for many rounds but obliged every round to resubmit the same bid. If the bidder ever missed a bidding round (for whatever reason), they would be at risk of losing demand and eligibility unintentionally if another bidder moved new demand into the band.

Accordingly, we are inclined to support Ofcom's bidding language but request that common sense additions to the bid submission and processing rules are made to protect bidders in certain situations when they fail to make a bid.

Specifically, we request the following addition to the rules:

- **Bid retention.** In the event that a bidder (that has not been disqualified) fails to submit a set of valid bids in a round, we propose that their prior rounds bids, where relevant, would remain valid at the price previously submitted. Under this rule, a bidder that previously submitted, say, a maintain bid for 6 lot at price 150, would be processed as having again submitted a bid for 6 lots of 150. If the clock price had not changed from the prior round, this would be processed as a maintain bid, and the bidder would be protected against losing demand or eligibility. If, however, the clock price had increased from prior round, this would still be processed as a decrease bid at price 150, and the bidder would lose demand and eligibility if the posted price was higher than 150.

- **Extension rights.** A bid retention rule protects a bidder from losing demand and eligibility in situations where the price has not increased beyond their prior bid level. It does not protect a bidder that fails to submit in a situation where clock prices are rising. Given the possibility that round times are short and failure to submit may be due to technical issues or innocent error, we think it prudent that Ofcom introduces a measure to reduce risks for bidders. The established tool in this case is to grant a limited number of round duration extension rights to

each bidder, which are deployed automatically if a bidder fails to bid in normal round time. We discuss this request further below.

We understand that, in the US version of the clock auction, there is an option for proxy bidding, which could play a similar role to our proposed rule additions. With proxy bidding, bidders can pre-specify demand decisions to certain prices within categories and the EAS will bid automatically for them if no manual bid is received. However, a downside of this approach is that it does not allow bidders to pre-specify switch preferences across bands, owing to the complexity this would add.

We also request that Ofcom provide an explanation for its decision to use different bid submission rules to those used by other regulators. This would assist bidders in analysing the proposed merits of this novel aspect of the auction rules.

Activity rules

VMO2 generally supports Ofcom's proposed approach to activity rules for the clock auction. However, we have one clarification question, and we have also identified a potential concern with bid processing that flows from the proposal (which we support) to use a 1.5:1 eligibility points ratio between the 26 GHz and 40 GHz bands.

We support the following proposals with respect to Activity Rules:

- **Eligibility points-based activity rule.** We welcome the adoption of an eligibility points-based activity rule to manage activity and eligibility throughout the main stage. This approach is familiar to UK bidders and provides continuity from past auction formats. The key feature of this rule is that bidders must be sufficiently active in every round to maintain eligibility to bid at a similar level in the next round. This rule is fundamental to price discovery, which we consider an essential feature for auctions of mobile spectrum.

  It is an essential feature of the auction that bidders be able to switch demand between the two 26 GHz categories, and also between 26 GHz and 40 GHz. Spectrum categories that cover the same geographic region are potential substitutes, so bidders must be able to shift their demand across categories in response to changes in relative prices over multiple auction rounds.

- **Same points weighting for 26 GHz bands.** We support the proposal to use the same eligibility weightings for lots in the two 26 GHz categories. The Lower band is the inferior substitute owing to initial coordination challenges with existing fixed links, but once clearance is complete, they should have identical value.

- **Lower points weighting for 40 GHz.** We support the proposal to use a lower eligibility weighting for lots in the 40 GHz category. Given the uncertainty over the mobile ecosystem, and weaker propagation of this band, it is clearly an inferior substitute and likely to remain so for the foreseeable future. As we discussed in our previous submission, a bidder that opts to switch some or all of its demand from 26 GHz to 40 GHz may demand more 40 GHz spectrum. To accommodate this, a lower eligibility weighting is needed. Also, if the 26 GHz and 40 GHz bands were set with an equal eligibility ratio, there is a possibility in a competitive auction that

bidders might be tempted to 'park' demand in 40 GHz for gaming purposes. Ofcom's proposal to adopt a 1.5:1 eligibility points ratio for 26 GHz:40 GHz appears reasonable.

- **Multiple bids within rounds.** We support allowing bidders to submit multiple bids within the same category provided that they are directionally consistent. This rule provides more flexibility to bidders without adding significant complexity.

- **All or Nothing bids.** We support bidders having an option to designate decrease bids as All or Nothing bids. A downside of allowing All of Nothing bids is that it adds complexity to bidding and to bid processing. However, we think the rule will help bidders manage their exposure to ending up with an unwanted split assignment, and this may be important in realising an efficient auction outcome. We think this benefit outweighs the downside of adding complexity.

- **Eligibility silos by region.** As discussed elsewhere, VMO2 prefers that each sub-band be made available as a single sub-national category of lots. However, if Ofcom decided to break out some regions into separate categories, then we support the proposal that each distinct region have its own eligibility 'silo'. For example, if London was carved out of the sub-national lots, then bidders should be able to switch between the Lower 26 GHz, Upper 26 GHz and 40 GHz London lots, but not to use points associated with London to switch into other regions. Lots in different regions are not substitutes, so allowing bidders to switch across regions could lead to unwanted gaming.

We also have one point of clarification. We understand that next round eligibility is based on processed demand, not demand at clock prices. This is different from the hybrid SMRA, where a set of bids that reduces activity and eligibility is always committing. Ofcom should clarify that, in the clock auction, a decision to drop eligibility will only apply if the corresponding decrease bid(s) are processed.

We have one concern that flows from the interaction of this rule with the proposal to use an asymmetric eligibility points ratio between the bands. We have identified a potential circumstance in which a bidder's processed activity could be either ½ point or 1 point below its submitted activity at the clock price. We are concerned that the current rules, unless amended, could expose a bidder that is attempting to switch between the 40 GHz and 26 GHz bands to an inadvertent loss of eligibility.

Consider the following example. In round n, Bidder A is active on 6 lots in the 40 GHz band and submits a decrease bid for 6 lots at 40 GHz and an increase bid for 4 lots at 26 GHz Upper. This is an eligibility points neutral move. However, suppose its decrease is partially denied and it is retained on 4 lots at 40 GHz. This frees up 2 points so only 1 lot of its increase bid at 26 GHz Upper will be processed. Consequently, Bidder A's processed activity will be only 5.5 points, not 6 points, a ½ point reduction in eligibility going into round n+1.

We understand that in other jurisdictions using similar clock formats where different eligibility points for different categories have been used, this issue has been addressed by using activity requirements below 100%. We think such a measure in the UK auction would be an unnecessarily big change and may introduce other concerns, such as gaming.

Instead, a simpler fix would be to amend the eligibility limit rule, such that a bidder's next round eligibility is the higher of their activity at the clock prices and at the posted prices. In this case, paragraph A9.48 would be amended as follows:

> *A9.48 For round 2 and each round following that, the eligibility limit for the round will be equal to* ***the higher of (a)*** *the sum of the eligibility points associated with the bidder's processed demand in the previous round****; and (b) the sum of the eligibility points associated with the bidder's demand at the clock prices in the previous round****.* [our additions in **bold**]

With this rule change, in our example, Bidder A would preserve an eligibility of 6 points in round n+1, enabling him to continue to attempt his switch move to 26 GHz Upper, or attempt to switch back to 40 GHz. For avoidance of doubt, if Bidder A opted only to submit maintain bids in round n+1, then his eligibility would drop to 5.5 points in round n+2. We note that this rule change would have no impact on the closing rule, so when attempting such a switch, the bidder would (as normal) need to weigh the risk that the auction would close on them if a partially processed switch resulted in an allocation in which there was no excess demand in any category.

Lot size, minimum spectrum requirements and spectrum caps

In our previous response, we said that Ofcom should select a lot size that corresponds with the base unit of demand which bidders for exclusive licences will use to assemble larger blocks, but no smaller than this. Our provisional view then was that 100 MHz lots was the appropriate unit for the 5G mobile business case. We have revisited this position based on latest information from vendors regarding the emerging mobile ecosystem for mmWave spectrum. Our review remains that 100 MHz blocks are an acceptable building block but we now anticipate that mobile operators will likely want to acquire spectrum in units of at least 200 MHz. Accordingly, we would be comfortable with units of either 100 MHz (as Ofcom proposes) or 200 MHz.

In its response, BT/EE suggested that "*there should be a mechanism for a guarantee of not winning less than a total of 400 MHz*". Ofcom disagreed, on the basis that a minimum spectrum requirement (MSR) could "*introduce complexity in the design and gaming risks, as well as the risk of unsold spectrum when it would be efficient to allocate it*." We agree with Ofcom's reasoning. To the extent bidders may wish to avoid winning very small quantities of spectrum (e.g. 100 MHz), this would be better addressed by increasing the lot size to 200 MHz than by introducing a MSR or similar mechanism.

As discussed above, we think it important that Ofcom introduce precautionary spectrum caps for this award. We see no objection from an implementation perspective. There is precedent for implementation of spectrum caps in these types of auctions. For example, caps were used in the Australia 26 GHz auction and the Slovenia 5G auction. As these auctions demonstrate, it is reasonably straightforward to incorporate caps into the activity and processing rules. The additional complexity is minimal, and, unlike an MSR, precautionary caps set at a substantial level (as we propose) do not generate meaningful gaming risk.

The precautionary caps that we proposed above could be implemented in the following manner:

- Bidder initial eligibility would be constrained, such that a bidder cannot exceed the maximum activity level compatible with the caps. For example, if this was 1,000 MHz at 26 GHz and 1,000 MHz at 40 GHz, and 100 MHz lots are used maximum initial eligibility would be set at 10*1.5 + 10*1 = 25 points. If instead, Ofcom imposed a 2,400 MHz global cap combined with a 1,000 MHz cap at 26 GHz, maximum initial eligibility would be set at 10*1.5 + 14*1 = 29 points.

- In the EAS, bidders would be prevented from submitting bids that exceeded band or category specific caps, even if they had sufficient eligibility. For example, suppose there is a 1,000 MHz cap at 26 GHz, a bidder that is active on 4 lots at 26 GHz Lower, 4 lots at 26 GHz Higher would not be permitted to submit any combination of Increase bids for more than 2 lots, unless offset by a corresponding decrease bid.

- In bid processing, there would be an additional check on any increase bids to ensure that they did not violate the spectrum cap. For example, suppose a bidder was bidding for 4 lots at 26 GHz Lower, 4 lots at 26 GHz Higher and 4 lots at 40 GHz. Suppose the bidder submits an increase bid for 8 lots at 26 GHz Lower and Decrease bids for zero lots in the other bands. The bid should be accepted for processing, as it is eligibility reducing and it does not violate a 1,000 MHz spectrum cap at 26 GHz. However, in processing, the increase bid would only be partially accepted if the bidder was retained on 3 or 4 lots at 26 GHz Higher, so as not to violate the cap.

These are only modest changes to the activity and bid processing rules.

Bid processing and the queue

We have reviewed Ofcom's description of the bid processing rules and the supporting examples. These are by far the most complex element of the proposed auction rules, and very different from any previous spectrum auction conducted by Ofcom. Having reviewed the rules, we are broadly satisfied that they should work and the fact that similar queuing rules have been used elsewhere gives comfort. However, we are concerned about the potential for implementational error, especially given that the queue operates in the background of each round, so is essentially a black box for bidders. To promote confidence in the new format, it is important that Ofcom provides software so that bidders can run their own tests of the processing algorithm. Also, when testing using the Ofcom system, we need to see how ties are broken at each iteration of the processing algorithm because tie break decisions may impact subsequent bid options and our ability to replicate test cases.

Specifically, we request the following:

- Early access to a version of Ofcom's EAS that we can run ourselves. So we can (a) replicate Ofcom's tests and (b) run our own tests. We need this access at least 3 months before the auction (ideally longer), so there is time for Ofcom to address resulting questions from bidders and make adjustments to the software if necessary.

- Reasonably exhaustive test cases prepared by Ofcom that showcase all the different aspects of the bid processing rules, including various combinations of increase and decrease bids across multiple bidders, All or Nothing bids, and spectrum caps (if applicable). These test cases

could then be used by bidders to verify the software and as a reference to develop alternative tests.

We set out later in this section of our response, our preferred specifications for this software and test cases.

We also have some clarification questions regarding the queuing rules. We understand that if two bids of the same type for the same category are submitted at the same price point, the order in which they are processed will be determined at random. We request that Ofcom clarify that the resulting queue order from a tie break remains valid for the remainder of that round. Furthermore, we request that Ofcom confirm that the tie break result does not carry over into any following rounds, even if bid requests are unchanged.

Information policy during the main stage

Ofcom proposes a partial information disclosure regime in the main stage, including:

- Disclosure of the identities of the participating bidders, but no information about their deposits and initial eligibilities.
- Provision of aggregate demand data for each category after each round. No information about the breakdown of demand by bidder.
- Information about each bidder's own processed demand after each round and winning demand after the final clock round, but no information about other bidder's demand.

VMO2 supports Ofcom's proposed approach which we think strikes an appropriate balance between bidder's need for demand information to realise price discovery and the possibility that some bidders might attempt to exploit access to more granular information to engage in gaming.

In some past auctions, Ofcom has opted to obscure the exact level of demand by category, by publishing ranges. For the avoidance of doubt, our view is that such an approach would not be appropriate for this auction format. Bidders need to know the exact level of excess demand by category in every round so they can make informed decisions about the potential for their demand to be retained when attempting to switch between categories.

In previous awards, Ofcom has published the full bid set for the award, once the process is complete. This is helpful in ensuring transparency and maintaining bidder confidence about the conduct of awards in the longer run. It would be helpful if Ofcom could confirm that it intends to continue with this practice for the mmWave award.

Round scheduling, bidding increments and bidding units

Once the auction is underway, round scheduling and bid increments are the key tools available to Ofcom to influence the pace of the auction. We recognise that it is sensible for the auctioneer to retain some discretion over these aspects of the auction rules. At the same time, Ofcom recognises that for internal governance reasons, bidders benefit from having reasonable certainty over how prices will progress each day, so they can forecast when they will hit valuation, budget or strategic

decision thresholds. Ofcom's approach of granting itself wide discretion in the auction rules but tempering this by providing pre-auction guidance as to how it will exercise this discretion in a bidder-friendly manner, strikes a middle ground between these conflicting needs.

At paragraph A9.22. Ofcom says that it expects to set rounds that last between 15 to 45 minutes, but that it may choose different durations. We have a general preference for shorter rounds rather than larger bid increments. Nevertheless, we are concerned that 15 minutes is rather short and may introduce an unacceptable risk of bidders failing to submit bids on time, unless bidders are allowed extension rights (see below). We prefer that Ofcom start with rounds that are at least 30 minutes in length and only drop below this if all bidders are comfortable moving at a faster pace. Ofcom further says that it intends to provide bidders with at least 15 minutes notice before the start of a round. We request that Ofcom clarifies that this would mean that bidders will always receive round results at least 15 minutes before the start of the next round.

We welcome Ofcom's comments at paragraph 9.66 that it intends to use "*small bid increments*". We agree with Ofcom that, in the context of a clock auction, this will improve price discovery by giving bidders more accurate excess demand information, making it somewhat easier for bidders to assess the likelihood of bids being accepted fully or partially. To reiterate, we prefer shorter rounds (and extension rights) over larger bid increments as a tool for speeding up a slow auction.

We are concerned that in some of Ofcom's examples, it has used percentage price increments (e.g. 10% per round) rather than uniform absolute price increments (e.g. £100,000 per round). We think that returning to fixed percentage increments would be a retrograde step, introducing the possibility that, in a competitive auction, per round or per day increments could be overly large at the point when bidders face critical decision points and governance thresholds are reached. We request that instead, Ofcom use price increments that are a percentage of the reserve prices rather than the previous round, as it did in the 700 MHz and 3.7 GHz auction.

Based on the proposed starting prices, we think that initial increments of £50,000 or £100,000 per lot per round would be appropriate. Unless there is significant excess demand, such uniform increments might be maintained for the duration of the auction. Nevertheless, we are comfortable with Ofcom retaining some discretion over what percentage to use and whether and how to vary this based on demand conditions.

Ofcom says that it will provide more information on its intended approach to price increments closer to the auction (e.g. in the bidder guidance), and that it will take account of comments from bidders at this time. We are comfortable with this approach provided we have an opportunity to comment on the bidder guidance.

We understand from paragraph 19.35 that bids must be specified in whole thousands of pounds. We support this level of granularity, which simplifies bidding and avoids spurious accuracy. We request that Ofcom clarify our understanding that this constrains the percentage price points at which bids can be submitted for processing in any give round.

We further request that Ofcom confirms that the following examples are correct:

- In round n, opening price for 26 GHz Lower is £1,600,000 per lot and clock price is £1,700,000. A bidder may submit increase or decrease bids at £1,600,000 (0%), £1,601,000 (1%), £1,602,000 (2%), £1,603,000 (3%), etc… It is possible for a bidder to submit bids at any integer percentage price point from 1% up to 100% in this round, as these all correspond to amounts in whole pounds.

- In round n, opening price for 26 GHz Lower is £1,600,000 per lot and clock price is £1,750,000. A bidder may submit increase or decrease bids at £1,600,000 (0%), £1,601,000 (0.67%), £1,602,000 (1.33%), £1,603,000 (3%), etc… It is not possible for a bidder to submit bids at the 1% or 2% price points in this round, as these are not amounts in whole pounds.

- In round n, opening price for 26 GHz Lower is £1,600,000 per lot and clock price is £1,760,000. A bidder may submit increase or decrease bids at £1,600,000 (0%), £1,601,000 (0.625%), £1,602,000 (1.25%), £1,603,000 (1.875%), etc… It is not possible for a bidder to submit bids at the 1%, 2% or 3% (etc..) price points in this round, as these are not amounts in whole pounds.

Given the complexity of the bid processing rules, we believe it would be helpful for all involved if Ofcom adopts absolute bid increments for every lot in every round that sub-divide easily by 100, rather than use percentage bid increments based on the posted price. This will make it easier to verify automated bid processing rules. We observe that if Ofcom were to only use bid increments from the following limited menu – £50,000; £100,000; and £200,000 – processing complexity would be minimised. Our current thinking is that a starting fixed increment of £100,000 for the 26 GHz categories and £50,000 for the 40 GHz category would be appropriate.

Extension rights

We request that Ofcom include provision in the rules for bidders to be granted a limited number of extension rights, as it did for the clock stage of the 2013 Combined Award. In a clock auction context, extension rights provide bidders with some protection against the risk that they fail to submit a bid in normal time, for example owing to technical problems or innocent error. This helps safeguard the integrity of the auction, as the efficiency of the auction allocation may be undermined if bidder demand was lost owing to bid submission error as opposed to an active decision to drop demand. It will also give Ofcom somewhat more flexibility in scheduling short rounds, as Ofcom knows there is a fallback of round extension if a bidder fails to submit, and therefore more time to resolve issues without having to resort to extraordinary measures, such as suspending the auction.

Extension rights have been widely used in past clock auctions, in particular the clock stages of combinatorial clock auctions. They are a tried, tested and effective tool for reducing risk for bidders and the auctioneer of auction failure owing to missing bid submission. We recognise that extension rights were not adopted in the FCC version of the clock auction. Our understanding is that they were deemed unnecessary in that format because the default in the FCC rules is that a bidder that fails to bid is deemed to have submitted a maintain bid at clock prices for their entire demand. We also understand that in US auctions, bidders have an option to submit proxy bids that are submitted automatically on their behalf in case they fail to submit manually. In contrast (as discussed above),

under the UK rules, the default is that a failure to bid is treated as a decrease bid at clock prices for a bidder's entre demand. Accordingly, extension rights are needed under Ofcom's version of the rules.

For the Combined Award, Ofcom adopted the following rules for extension rights:

- In the event that a bidder who was eligible to submit a decision and had one or more extension rights left failed to submit its decision during a round, the round was automatically extended for that particular bidder and one of its remaining extension rights was deducted. The EAS gave that bidder a revised deadline for submitting its decision. The revised deadline was 30 minutes later than the original round deadline.

- The extension period lasted at most 30 minutes, but could terminate earlier once all bidders for which the round had been extended had successfully submitted their decision. The extension period applied to individual bidders, although more than one bidder could trigger an extension simultaneously:

    - Bidders who were eligible to submit a decision during the round but failed to do so and still had extension rights left, had an extension and one of their extension rights was deducted for the following rounds;

    - Bidders who were eligible to submit a decision during the round but failed to do so, but did not have any extension rights left, did not have an extension and they were unable to take any further action during the extension period;

    - Bidders who were not eligible to submit a decision during the round did not have an extension and did not have any extension rights deducted in that round;

    - Bidders who had submitted a decision already during the round could not take any further action during an extension period (they were told that the round had been extended and that they should wait for the announcement that the extension period had ended) and did not have any extension rights deducted in that round.

- The endowment of extension rights was as follows:

    - Each bidder started the auction with two extension rights for the Primary Bid Rounds. Each time the bidder failed to submit a bid in a Primary Bid Round before the deadline and an extension period was triggered for that bidder, the number of extension rights available for that bidder in subsequent Primary Bid Rounds was reduced by one.

    - Each bidder had an extension right for the Supplementary Bids Round.

    - Additional extension rights could be granted either to all bidders or to individual bidders at Ofcom's absolute discretion. Additional extension rights could only be granted in the periods between rounds, and thus could not be granted during a round.

We request that Ofcom adopt the same extension rules for the upcoming award of mmWave spectrum as were implemented for the UK 4G auction. These rules will offer bidders some protection against the risk that they fail to submit a bid in normal time and their adoption is especially important if no

bid retention rules are implemented. We note that adoption of such extension rules would not introduce complications to the auction design, nor would they provide bidders with opportunities for gaming.

Requirements for training version of the EAS

We support Ofcom's decision to provide a stand-alone version of the auction software to applicants prior to the mmWave spectrum auction. As Ofcom acknowledges, early access to this software should play a crucial role in bidders' preparation for the auction by allowing them to run internal mock auctions, familiarise themselves with the peculiarities of the auction rules, and test the auction software. Given the complexity of the bid processing rules, we see early access to such software as playing a crucial role in cementing bidder confidence in the new auction design.

We see three main use-cases for this stand-alone version of the software:

i. Testing the software's implementation of the auction rules;

ii. Running internal mock auctions to develop bid strategy; and

iii. Running internal logistics tests.

Each of these use cases requires slightly different functionality. For example, for the purpose of testing the software's implementation of the rules, it is important that the software offers some degree of transparency as to the results of calculations performed, rather than operate as a black box. The recursive nature of the bid processing algorithm makes this particularly important, since an error at one step will have knock-on effects on all subsequent calculations. To develop bid strategy, other features would be helpful. For example, it would be useful if the auctioneer had the ability to rewind the auction to a prior round of an auction, in-play, such that bidders can test the impact of slight changes to the set of bids submitted. Meanwhile, to run internal logistics tests, the software should allow bidders to bid in an environment that is as close to that of the live auction as possible. Among other things, this means that bid submission procedures should be identical to those of the production environment.

To help bidders best prepare themselves for the auction, the stand-alone version of the software should cater to all three use cases outlined above. To achieve this, we request that the stand-alone version of software have additional functionality as described here.

We request that the auctioneer has the ability to:

- Add or remove bidder accounts to simulate different participation scenarios, without having to request Ofcom to update the bidder profiles.

- Modify bidder account parameters, such as starting eligibility and spectrum caps, to allow for different bidding scenarios, again, without having to request Ofcom to update the bidder profiles.

- Modify other auction parameters, such as the round schedule and bid increments, both before the auction and while it is underway.

- Run an auction both according to a pre-set round schedule or manually (option to run rounds that are only a few minutes long), allowing bidders to avoid unnecessarily wasting time waiting for rounds to finish.

- Rewind an auction in progress to some previous round, allowing for testing the impact of different sets of bids in a given round.

- Save an auction's 'database', so that previous scenarios and mocks can be revisited.

- Reset the auction software to the start of an auction without waiting for Ofcom's intervention.

- Download all bids submitted and processed in a round for independent verification of results produced by Ofcom's software.

- View the outcome of each iteration of bid processing for a round, including rankings and values used for tie-breaks.

- Run the assignment stage and upload principal stage results for testing different scenarios during the assignment stage without going through the principal stage.

Additionally, we request that bidders have the ability to:

- Submit bids exactly as will be done in the live auction, allowing for practice of bid submission procedures.

- Enter bids via a file upload to speed up simulations and avoid manual bid submission each round.

- Download round results in a format identical to that which will be generated by the live auction software, enabling the development, and testing of their own bid tools.

- Request the extension of a round in progress, even if this functionality is not adopted in the final version of the rules.

- Select their own login credentials.

In addition to the above, we request that Ofcom provide bidders with detailed testing scripts and the corresponding expected results. The test cases should be reasonably exhaustive to showcase all the different aspects of the bid processing rules, including various combinations of increase and decrease bids across multiple bidders, All or Nothing bids, and spectrum caps (if applicable). These testing scripts will help bidders thoroughly test the software's functionality, minimising potential issues during the live auction. It will also help bidders better understand the auction rules, which have not been used in the UK before, and increase their confidence in the system, ultimately contributing to a successful auction.

AUCTION DESIGN – ASSIGNMENT STAGE

VMO2 has two major comments, plus a number of clarification questions regarding the proposed Assignment Stage rules.

Industry negotiation vs assignment round bidding:

For each assignment round, Ofcom proposes to adopt a second price, sealed bid process with no information provided to bidders about the allocation outcomes for individual bidders. This is a tried and tested format that works well in situations where (a) the value of expected assignment positions is expected to be modest relative to the value generated in the main stage of the auction; and (b) bidders do not have strong preferences to be next to specific other bidders, for example owing to network share arrangements. However, if these conditions do not hold, then a process of industry negotiation (with a backstop of an auction) would be more likely to realise an efficient assignment.

For this award, we think that these conditions broadly hold for the initial allocation of 26 GHz Lower and Upper, but not for the long-term allocations of the entire 26 GHz and 40 GHz bands. Therefore, we urge Ofcom to allow for industry negotiation for these rounds, as it did for the award of 3.7 GHz spectrum. Under this approach, sub-groups of bidders may request contiguous spectrum but cede positional priority within the relevant band to other winning bidders (if any) not in the sub-group. If bidders cannot reach agreement, the assignment bidding stage proceeds as proposed by Ofcom.

We are advised by vendors that the current generation of equipment at 26 GHz for microcell mobile deployment has an IBW of 1,400 MHz. It is unknown whether this range will be extended in the future. **[✂]**

[✂]

[✂]

[✂]

[✂]

Treatment of unsold lots in assignment round

Under Ofcom's rules, lots can only go unsold if there is a category that never received enough demand to cover supply at the opening price level. Although Ofcom proposes to use modest reserve prices, they are non-trivial, and it is possible that bidders would have been willing to buy more had the price been lower. If this happened, the lots would lie unused for some time and Ofcom would ultimately need to consult on a further award process, which would be burdensome if only a few lots were unsold. To reduce this risk further, we propose that Ofcom grant itself discretion to integrate unsold lots into the Assignment Round. Under this approach, if there were unsold lots, bidders that already won lots in the relevant category would be granted additional bid options that include one or more unsold lots. These bids would have to at least cover a minimum price for the spectrum, which could be an amount set at Ofcom's discretion, but ideally discounted from the reserve prices, in order to encourage take-up. By making the decision to adopt this element of the process discretionary, Ofcom can mitigate any risk that bidders might try to game the availability of unsold lots.

Clarification questions:

1. **26 GHz bid options**

   A9.86 (ii) says, in relation to the assignment round for the upper 26 GHz band: "*Bidders who have won both 26 GHz lower lots and 26 GHz upper lots, but have not won the uppermost portion of the 26 GHz lower lot category could only bid for assignments in the remaining part of the band*." We request Ofcom clarifies that "remaining" means any spectrum above that assigned to the bidder that won the top slot in 26 GHz lower, and below any winners of 26 GHz Upper who did not also win 26 GHz lower. Hence, if there is only one such bidder, they would be automatically assigned specific frequencies and would not need to bid.

   For example, suppose that two bidders, B and C win spectrum in both 26 GHz categories. Suppose B wins 3@26L and 5@26U; and C wins 3@26L and 3@26U. No other bidders win split awards.

   Please can Ofcom confirm the following interpretation of assignment bid options is correct:

   - **26L assignment bid round.** Bidders C and D will be assigned to the top 6 lots of 26L. They must compete with each other for their position in this range.
   - **26U assignment bid round.** Bidders B and C will be assigned to the bottom 8 lots of 26U Suppose Bidder C wins the top 3 lots in 26L. In this case, Bidder C will be assigned to the bottom 3 lots and Bidder B to the 5 lots immediately above Bidder C. No bidding is required.

   We note that our interpretation does appear to be confirmed by Ofcom's example in Table A9.8, but we request confirmation.

2. Position of unsold lots

Ofcom proposes that any unsold lots in the 26 GHz Lower and Upper band be positioned in contiguous blocks at the lower and upper boundaries of the band respectively. We support this approach given that it is integral to the rules promoting contiguity.

What is Ofcom's proposed approach to 40 GHz unsold lots? Our understanding is that they would be grouped together but there is no proposal for their position. Would this be determined by bidder's bids?

3. **Scheduling of assignment rounds.** Ofcom proposes to run 26 GHz Lower and 40 GHz in parallel, so before other 26 GHz auctions. What would Ofcom's approach be if there is only one winning bidder in 26 GHz Lower, and no bidding is required. Would it run 40 GHz before 26 GHz Upper, or bring bidding on 26 GHz Upper, forward?

4. **Deposits.** According to paragraph A9.107, Ofcom proposes to grant itself the power to make a deposit call and specify a deadline for the relevant bidders to make any additional deposits. We request that Ofcom provide more detail about the notice available to bidders to increase deposits. In particular, will this be the same process as for previous auctions? Deposit calls are important in ensuring that bids in the auction are real.

5. **Information at end of auction.** Paragraph A9.120 says that "*The auction ends with the completion of the grant stage*" and that no information about results will be communicated until this time. Are we correct in understanding that this means there could be a significant gap between the conclusion of the Assignment Stage and publication of results?

   More generally, it would be helpful if Ofcom could clarify exactly what information will be made public when at each stage of the award process. This will be helpful for bidders when they plan their own announcements and financial disclosures. Also, does Ofcom intend to publish full bid data at some point after the auction? For avoidance of doubt, VMO2 supports publication.

AWARD LICENCE DURATION

As we stated in our response to the first consultation, Ofcom's proposal to award mmWave spectrum in 2024, would oblige operators to bid for spectrum that they anticipate deploying in the long term, but do not yet need. Bidders would have to navigate huge uncertainties, for example concerning the equipment and device ecosystem, the quantities of spectrum actually required to meet rapidly growing but uncertain levels of demand, the locations where mmWave deployment is needed, and the potential for 40 GHz to emerge as an effective substitute for 26 GHz. The winners of an auction undertaken against this background would be those that are most optimistic about the long-term prospects for mmWave. These winners may not in fact be the most efficient long-term users, once deployment cases are better understood.

In carrying out its duties, Ofcom is required to secure the optimal use of the electro-magnetic spectrum for wireless telegraphy, and maintain this over time[3]. As previously discussed, a concern with this award is that even if an auction can deliver an allocation outcome that maximizes static efficiency, it is quite likely that the outcome will not be dynamically efficient, because the use case is nascent and expected to evolve over time. In our prior response, we proposed that Ofcom address this risk by delaying the award of exclusive use licences until at least 2026, with licenses commencing 2028, on the basis that MNO business cases would hopefully be firmer at that point, and there would be lower risk of the auction failing to deliver a dynamically efficient outcome. On this basis, we expressed comfort with a fixed licence term of 15 years covering the period 2028-2043, which would provide an opportunity for the industry to revisit allocations in the mid 2040s.

Ofcom's revised proposals in this consultation are quite different from the licence term we described. It now proposes an auction and 15-year licence term staring in Q1 2024/25, which means licences would terminate in 2039. This is a very poor fit with the anticipated investment cycle for mmWave, which is likely to involve only modest activity this side of 2030 and (hopefully) accelerated deployment thereafter. If there were a merger announcement in the mobile sector, we would expect the award might be delayed until 2025/26, in which case the licence would presumably run to 2040. The delay would be welcome, given the extra time it would afford to MNOs to observe the nascent mmWave ecosystem and develop our business case. However, an extra year is not nearly enough to align with the investment cycle.

We have three specific objections to Ofcom's proposal for a 15-year non-renewable licence:

1. Ofcom intends to proceed with the award at a time when mobile business cases are very uncertain, which means there is a very high risk that the allocation is not dynamically efficient and would need to change during the licence term if benefits for the UK economy and society are to be maximised.
2. We expect that demand for trading of mmWave spectrum to be strongest in the early 2030s, as (hopefully) the business case solidifies. However, under Ofcom's plan, at this point, there would only be 6-8 years left of the licence term, a short period from an investment perspective and one that will likely deter efficient trades.

[3] Communications Act 2003 s3(2)(a)

3. If, as we all hope, 26 GHz becomes an established part of the mobile ecosystem during the 2030s, then mobile operators will need certainty that they will be able to retain access to a critical mass of spectrum in this band. Ofcom's standard approach of 20-year licences and then annual renewal for a fee would provide this certainty. It's a good approach provided the initial allocation of spectrum is reasonably efficient.

If Ofcom is committed to an award in 2024, then we prefer that it award 20-year licences, with a high certainty of renewal for a fee, as proposed by BT. The longer licence term is necessary to avoid a situation where the licences expire in the 2030s, which would create undue uncertainty for investment and is likely to weaken incentives for efficient trades necessary to address anticipated changes in the dynamic efficiency of mmWave spectrum allocation over time. This is most important for the 26 GHz band, where the ecosystem development path is clearer, and arguably less so for 40 GHz, where there is much more uncertainty.

Although 20 years is better than 15 years for a licence starting in 2024, the fixed term nature of the licences is not a good solution to the broader problem that an auction now is unlikely to deliver an allocation of spectrum that remains efficient over time. It simply provides an opportunity for a one-off course correction many years in the future. As we discussed under competition measures, we have low confidence that an MNO that acquired an unduly large share of mmWave spectrum in 2024 would subsequently sell excess spectrum to a rival operator that could use it better. The lesson of recent years is that in a competitive market with few players, MNOs prefer to trade with each other only when their interests are reasonably aligned, and that is often not the case.

To our mind, there is an obvious way of reducing the risk of future efficiency problems: precautionary spectrum caps set at a level sufficiently high that no current business cases are blocked, but not so high that the spectrum could be monopolised by one or two bidders. The same logic that drives Ofcom to proposes a relatively short, fixed licence term should also encourage it to set caps that will ensure a reasonably diverse initial ownership structure for mmWave spectrum in general and (owing to its superior ecosystem prospects) the 26 GHz band in particular. We submit that prudent competition measures are a lower risk intervention than short licence terms that could upset investment incentives just when mmWave spectrum use is at a time when it is maturing.

ANNEX: RESPONSE TO SPECIFIC QUESTIONS

Question 1 (section 3): Do you have any further comments on the approach we are minded to take to authorising the 40 GHz band?

Given the time that will be required to clear the bands of existing use, we welcome Ofcom's decision to start the statutory process to revoke all the existing block assigned licences in the 40 GHz band, and to reallocate the band for new uses, including mobile. This will provide operators using both licensed and shared use spectrum, with full access to spectrum in all likely deployment areas from 2028, by which time the mmWave mobile ecosystem and business case will, hopefully, be well developed.

Question 2 (section 5): 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.

We are surprised that Ofcom's methodology for identifying which fixed links around high density areas are deemed likely to suffer interference from new users within high density areas, results in a number of links being identified which are a considerable distance (up to 28 km) away from the border of the nearest high density area polygon.

We provide below, 9 examples of such links, identified by their licence number, along with their distance from the nearest high density area polygon:

- 0587155/2, 26.2 km
- 0820758/1, 32.1 km
- 1004125/1, 29.4 km
- 1032299/2, 35.2 km
- 1109515/2, 27.0 km
- 1113603/1, 28.6 km
- 1120024/1, 22.4 km
- 1133624/1, 21.6 km
- 1159603/1, 21.6 km

We request that Ofcom provides clarification to further explain and justify its methodology, along with the results derived from it.

We note that Ofcom is assuming a 28 dBi BTS antenna gain on the mobile bore site and the fixed link facing back straight back with a 36 dBi antenna gain. We see this scenario as being highly unlikely in practice. In the real-world, obstacles in the environment will also block interfering signals over long distances. We note at A16.8 that Ofcom uses two types of propagation model (P.1411-11, and the free space path loss (FSPL) propagation model). For the FSPL propagation model, it is evident that Ofcom uses absolute worse-case free space path loss, for distances beyond 2 km. However, we observe that in the real world, often hills will block signals, as will buildings, and also trees. In our view, the approach being taken by Ofcom is unnecessarily conservative. It practice, the predictions will not be accurate and the interference predicted by new mobile use, will not be evident.

Question 3 (section 7): 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 agree.

Question 4 (section 9): Do you have any comments on the proposed rules of our auction?

Yes. Please see the Main Response for our comments.

Question 5 (section 9): 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.

No. VMO2 operates a nationwide mobile network. We aim to offer the best possible experience for our customers in all parts of the UK. We support Ofcom's proposal to combine all high density areas into sub-national lots. From a deployment perspective, for a national operator, geographic licensing is, at best, an inconvenience and, at worst, a potential source of spectrum fragmentation and service holes that could create engineering problems for our network teams for many years to come.

Without a national holding, or at least a holding which covers all high density areas, we, as a mobile business, cannot construct a viable offer to the market. Our business is not geared to offer services to consumers across parts of the UK, and not in the remaining areas. If a mobile operator cannot develop a UK wide solution, then the incentive to roll out diminishes very quickly.

As set out in more detail in our main response, we strongly support Ofcom's proposal to combine all high density areas into sub-national lots. Our expectation is that any potential demand from non-national operators for spectrum in specific geographic areas can be met through acquisition of licences on a site-by-site basis under the proposed shared access regime. The inclusion of additional lots for specific high density areas is therefore unnecessary. It would also introduce unwelcome complexity into the award design and create risk for national operators

If Ofcom did change its mind and propose to explore the option of regional lots, this could materially impact our views on the auction design, spectrum packaging and competition measures, given the greater risk for our business. Accordingly, our view is that Ofcom would need to re-consult on the award process, so MNOs have the chance to review and respond to specific proposals for regional lots.

Question 6 (section 9): Do you consider it appropriate to have one or two 26 GHz lot categories?

We support the proposal to have two categories of 26 GHz spectrum for the purposes of bidding in the main stage of the auction. Given the extent of restrictions of use for the lower part of the band in the initial period, it is reasonable to suppose that bidders may value the lower and upper parts of the spectrum differently even though they are close substitutes, and hence it is important that the auction mechanism allow bidders the ability to express this in their bids for allocations. Our support for two categories is also linked to our support for Ofcom's assignment rules that prioritise assigning

contiguous spectrum blocks, to the maximum extent possible for the initial period and for all bidders for the remainder of the licence. Please see our main response for our views on detailed aspects of the proposed main stage and assignment bidding rules.

Question 7 (section 10): Do you agree with our proposed approach to coordinating Shared Access users in the 26 GHz band? If not, please give reasons.

We agree.

Question 8 (section 10): 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.

Question 9 (section 10): 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?

VMO2 views Option 1 (award winners expected to do detailed coordination, on the basis of coordination procedures set out by Ofcom) as being the most appropriate method for coordinating with existing fixed links licensees. As a Mobile Network Operator, we are used to developing and using coordination tools in relation to our network deployments, whilst also complying with various procedural requirements. As Ofcom highlights, Option 1 would have the advantage of allowing award winners to start each individual new deployment without waiting for Ofcom to respond to their coordination requests. We see this as being a crucial right of deployment for licenced spectrum acquired through the auction process. Making Option 1 available, provides an effective coordination method that can be used flexibly for the benefit of both existing and new licensees. In addition, coordination activities can be based on interference modelling and/or real world interference measurements, as opposed to other options which involve the use of rather blunt tools.

We do not support Option 3. It would dilute the rights of licensees to deploy, and would also be a slower process, as licensees would have to wait for Ofcom's approval before deploying spectrum.

We do not support Option 4. It is simply prohibitive. It would prevent any medium power mobile deployments in the lower part of the 26 GHz band (25.1-26.5 GHz) by winners of that spectrum.

We support Ofcom publishing the information set out in Option 2a (maps to aid coordination). We agree that this is likely to be useful information to assist with coordination. We note Ofcom's observation that it would be required to make a judgement about the potential mmWave base station deployment height and technical characteristics (which remain uncertain). We further note that

Option 2a is not, in itself, a coordination method. We therefore support the information being published, alongside Option 1 being made available as a coordination method.

In relation to Option 2b, whilst we support Ofcom publishing exclusion zones for Radio Astronomy Sites, we do not support exclusion zones for fixed links in and around high density areas. As stated above, Option 1 is the most suitable method for coordination with existing fixed links in and around high density areas, as it provides for flexibility and the use of more sophisticated analysis. This results in an efficient balance between the level of interference protection given to one service and flexibility for others to transmit. This is one of the stated aims of Ofcom's Spectrum Management Strategy.[4]

Question 10 (section 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.

Question 11 (section 10): 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.

Question 12 (section 10): Do you agree with our proposed approach to international coordination? If not, please give reasons.

We agree.

Question 13 (section 11): 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.

We strongly disagree with Ofcom's statement at 11.17 in the consultation that:

"…in appropriate cases, the existing fixed link users might be granted access to the relevant spectrum for fixed link services through a Local Access licence."

Given Ofcom has clearly stated that mobile is the optimal future use of the 26 GHz and 40 GHz bands, and has taken the decision to revoke exiting licences and clear incumbent fixed links from these bands, we do not understand the rationale for such a proposal and find it very concerning.

[4] S3.58 https://www.ofcom.org.uk/__data/assets/pdf_file/0017/222173/spectrum-strategy-statement.pdf

We strongly disagree with Ofcom's proposal to allow other users to access the awarded spectrum through the proposed extension of Ofcom's existing Local Access licensing framework. Whilst Ofcom's current Local Access licensing framework provides a way for other users to access existing mobile spectrum which has already been awarded, in locations where the award licensee is not using the spectrum, its application in that respect is very different for a number of reasons.

The market in which existing mobile spectrum can be accessed, is mature. As we have already stated, the market context for mmWave spectrum is very different. It is nascent and we do not yet have firm opinions regarding when and where we will deploy such spectrum. Indeed, at 11.28 a) in the consultation, Ofcom itself states that:

"*There may be entirely legitimate reasons for spectrum remaining unused – the licensee may be waiting for a suitable commercial opportunity or until the technology it wishes to use is ready;".*

However, emerging from this uncertainty, there is potential for rapid geographic rollout of mmWave spectrum. If that happens, it is imperative that MNOs have certainty in respect of their right to deploy spectrum that has been acquired through auction and that they can deploy rapidly without unnecessary restriction or complexity. Extending Ofcom's existing Local Access licensing to auctioned mmWave spectrum dilutes these rights and risks slowing down MNO deployments in high density areas, if licences have been issued to third parties in the same areas that MNOs may wish to deploy.

The existing local access licensing framework was also designed to enable access to spectrum licensed on a national basis to mobile network operators. This is confirmed in Ofcom's 2019 statement on Enabling wireless innovation through local licensing, which stated:

"*Where spectrum is licensed on a national basis to mobile network operators and is not being used in every location, we think it is appropriate to enable access to this spectrum for new users*"[5].

Ofcom is clear that the local access licence enablement was appropriate where spectrum is licensed on a national basis to mobile network operators. However, Ofcom's proposal to award mmWave spectrum only on a sub-national basis, provides a very different context. Ofcom was also clear about the geographical locations in which the spectrum was likely to be available to share, stating:

"Given the nature and extent of existing use of licensed mobile spectrum we anticipate that spectrum is only likely to be available to share in remote areas…"[6]

Given these very different situations, in which mmWave spectrum for auction will only be available on a sub-national basis, and only in high density areas, it is not appropriate for Ofcom to extend the application of Local Access licensing to auctioned mmWave spectrum.

Furthermore, and perhaps most obviously, Ofcom proposes to set aside 650 MHz of mmWave spectrum for Shared Access use, in high density areas, available on a first come first served basis, using

[5] s.1.11 https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

[6] s4.2 https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

it's Shared Access licensing framework. Given the proposal to make this spectrum available for other users to access, we do not see a further need to enable access to auctioned spectrum through extending the Local Access licensing framework, as the shared access spectrum acts an effective substitute.

We have serious concerns that Ofcom's proposed extension of its existing Local Access licensing framework, acts as a further disincentive to acquire mmWave spectrum at auction, due to the impact on rights to deploy, the introduction of delay, and associated complexity.

Question 14 (section 12): Do you have any comments on our proposal to award fixed term licences with a 15 year term?

We disagree with the proposal for licences of only 15 years, starting in 2024/25 (or even 2025/26, if there is a delay in the award owing to a merger announcement). For the 26 GHz band, in particular, the mobile industry requires licences that will run well into the 2040s, so there is no breakdown of investment incentives in the 2030s, at the point that mmWave use is (hopefully) maturing. If Ofcom is set on awarding exclusive licences commencing in the next two years, then we prefer 20 years licences with expectation of renewal for a fee. Please see our main response for further explanation of our position.

Question 15 (section 13): 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 are concerned by Ofcom's choice of transmit power levels for the spectrum to be auctioned. The proposed technical licence conditions only provide for a somewhat limited power for base stations. There are only low-power and medium-power base station options, with no high-power base station option available for auctioned spectrum. Ofcom states that the maximum total radiated power (TRP) per antenna is 30 dBm / 200 MHz. By way of comparison, our existing 3.4 GHz licence allows a TRP of 44 dBm / 5 MHz. When translated to a 200 MHz bandwidth, that equates to 60 dBm / 200 MHz. This means there is a 30 dB (x1000) difference in transmitted power spectral density between this mmWave spectrum and existing 3.4 GHz spectrum used today, that is a very big difference.

Furthermore, the difference between 'medium-power' and 'low-power' as set out by Ofcom, is only 5 dB, with low-power defined at 25 dBm / 200 MHz. Noting also that the UE power is defined at 23 dBm, we see that the 'medium' base station power per 200 MHz is only 7 dB higher than the UE power. As a result, we conclude that this mmWave spectrum will only be suitable for 'hotspot' use i.e. in limited circumstances.

At 13.22 in the consultation, Ofcom sets out its reasoning on transmit power level. Ofcom chooses a 'representative value of 65 dBm/800 MHz EIRP' as its starting assumption. VMO2 understands that 65 dBm EIRP looks representative from a sub-6 GHz perspective, given that system bandwidths are much smaller (i.e. between 5 and 20 MHz). However, Ofcom is applying the same overall transmit power to a system with an assumed 800 MHz bandwidth. Thus the power spectral density is diluted

substantially. As a minimum, we would expect the 65 dBm EIRP to apply to a single spectrum lot (i.e. 65 dBm/100 MHz EIRP). This would increase power spectral density by 9 dB.

We are also concerned that Ofcom assumes a peak antenna gain of 29 dBi in its calculations. However, Ofcom itself notes in Table 10.3 of the consultation, that average antenna gain towards the horizon is 16 dBi, a factor 13 dB less than worse case peak. We see a distinct risk here that Ofcom have derived maximum base station transmit power based upon a peak antenna gain that might not be achievable in actual deployments. It could be argued that this 'antenna gain' factor should be combined with the first 'power spectral density' i.e. add the 9 dB to the 13 dB to derive a new power level. Either way, we have two factors which, if taken into consideration, would allow the transmit power to be increased.

We are concerned that Ofcom has been overly conservative with its setting of transmit power. We note that typical vendor equipment has 'high-power' radios specified to deliver 59 to 62 dBm EIRP. If we assume a 20 dB antenna gain then the TRP would be 39 to 42 dBm, which is about 10 times higher than the limits that Ofcom proposes. Our conclusion is that Ofcom's proposed level is about 10 dB lower than where it should be, in terms of transmit power limits.

Question 16 (section 13): Do you have any comments on our proposed licence conditions relating to antenna elevation?

We note at 13.38 in the consultation, Ofcom says it understands that a restriction on antenna pointing could restrict future licensees' ability to use the spectrum for integrated access and backhaul ("IAB"), which could be an important use case for mmWave spectrum. We agree. We also agree with Ofcom's initial view that applying a less stringent requirement to future UK licensees where they use the relevant spectrum for providing IAB could enable this type of use case. Ofcom states that, to the extent that it can enable this type of use while ensuring compliance with the relevant framework and appropriate protection of satellite services, it would consider making an exception to the restriction on antenna pointing for IAB. We support this approach. However, Ofcom must ensure that any exceptions that it makes to licence conditions, do not inadvertently enable current incumbent licensees to 'game' the system and replicate their existing fixed point-to-point links, given that Ofcom has clearly stated that mobile is the optimal future use of the bands, and has taken the decision to revoke exiting licences and clear incumbent fixed links from these bands.

Question 17 (section 14): 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.

Yes, we agree.

Question 18 (section 14): 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 300km2 area in order to comply with the EESS protection requirements?

We have no further comments.

Question 19 (section 14): 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.

Question 20 (section 14): 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.