Vodafone Response to Ofcom Consultation:

"Supporting the UK's wireless future: Our spectrum management strategy for the 2020s"

Introduction

Vodafone welcomes the opportunity to respond to Ofcom's consultation on its spectrum management strategy for the 2020s. We support measures to maximise the efficiency of spectrum usage, embracing innovation in both licensing and technology. Therefore, we agree with most of the themes set out by Ofcom in the consultation.

However, spectrum cannot be considered in a policy vacuum: Ofcom's goals should be to provide a regulatory environment that encourages sustainable investment to provide compelling communications services that underpin the UK's post-Brexit economy. Spectrum innovation is a strategy to achieve this, not a goal in and of itself.

Ofcom needs to take care not to conflate spectrum utilisation with spectrum efficiency. Maximising spectrum efficiency means that we achieve the best social and economic outcomes for the UK, from the finite spectrum available. It is not a given that this equates to gaining maximum usage of spectrum, in terms of every available Hz being used at every point in time. For example:

- It could be that allowing opportunistic first-come-first-served usage of spectrum excludes higher value applications that have longer investment cycles; market measures may not overcome this if the higher value is social rather than economic. There is a need to focus not just on the immediate benefit, but long term too.
- The investment case for scale widespread networks may be predicated on serving a suite of applications. However, if some of those applications are instead served by users accessing spectrum directly at lower charges than those imposed on the scale network, then the investment case for the scale network risks being undermined, meaning the remaining applications can no longer be implemented, damaging welfare overall.

Ofcom cannot carry out a command and control exercise, picking and choosing which applications and users it considers have the best socio-economic business case to be provided spectrum. However, it must at least ensure that spectrum is accessed on equitable terms, with no special treatment given to particular classes of users, and everyone paying their way fairly. Being a market entrant should not confer special treatment.

Although Vodafone supports innovation in spectrum licensing, Ofcom must be wary of being blinded by the allure of innovation for innovation's sake. For example, end equipment dynamically accessing a database to determine whether it can use specific frequencies may be a great use of technology, but only if there is a demand for such dynamic access, reflecting the reality of using spectrum. If the reality is that in order to serve an application, an antenna needs to be deployed that requires site acquisition, planning consent and build taking 18 months, then either dynamic database-driven access to spectrum would be unsuitable, or in the least such a model would need a way of pre-booking the spectrum. Absent this, per our first bullet above, spectrum innovation could be value-destructive, if lower value micro-applications fill the spectrum blocking higher value macro-applications that were undertaking the exercise of building their networks.

Ofcom needs to balance complexity in spectrum licensing with the benefits accrued. To illustrate, we agree with Ofcom that its activity on white space devices provided useful experience in database-driven utilisation of spectrum. However, we question whether the majority of the applications considered in that trial really needed the complexity of dynamic queries to a highly granular database of spectrum usage, compared to the ability of the deployers to log onto a system – for example via an API – to check utilisation in an area and apply for a licence that would be system approved. The former may be a more exciting use of technology, but this should not matter to the policy making process – what Ofcom should consider is whether the benefits of instantaneous access to spectrum is justified versus having something which is cheaper and quicker to deploy. If databases are used, then Ofcom needs to give careful consideration to market structure – is there a benefit of having competition in the provision of such databases, and if so is dynamic competition required (i.e. a choice of multiple databases by the applicant), or would a competitive franchise award to provide the database result in similar benefits for less complexity? Once again, competition is not a goal in and of itself; competition is a tool that can be used to deliver the best societal and economic outcomes.

In this response, we have answered the questions raised by Ofcom. However, the questions are somewhat leading – for example Question 8 follows 101 paragraphs of text that range from an assertion that Ofcom will continue to use market mechanisms to increase efficiency of spectrum use, through how it could use automated tools, to proposals to use more realistic scenarios in modelling, culminating with the question "*do you agree that spectrum users should be good neighbours?*". Clearly, nobody is going to respond to this question asserting, "*No, we should be noisy neighbours and complain about a pin being dropped over the fence*"; the structure of the consultation will solicit the response that Ofcom wants. But by bundling up so many issues, Ofcom does not provide an opportunity to challenge material in the preceding paragraphs.

For example, while supporting market mechanisms, we are increasingly concerned that although auctions result in efficient usage of spectrum, they also serve to take substantial sums of money from UK consumers - £3.7Bn over the last decade[1]. Similarly, there is evidence to suggest that annual licence fees based on these auction outcomes actually discourage the trading of spectrum so diminishes the efficiency of spectrum usage. We understand that Ofcom is intending to review the operation of the UK mobile market, and so we will feedback on these matters as part of that exercise, since the present consultation appears to take current charging mechanisms largely as a given.

[1] For the avoidance of doubt, although mobile network operators pay spectrum fees, the mobile market is extremely competitive so unquestionnably a common cost such as this is rippled through to retail pricing and borne by mobile consumers.

Answers to questions

Question 1: Do you have comments on the overall approach to the review?

Vodafone believes Ofcom's approach is correct.

We would have liked to either have seen the strategic spectrum management objective of "*continued improvements in wireless communications*" or alternatively of *"sustained improvements in the efficiency of spectrum use"* recognise the need to create an environment that encourages sustainable investment in networks making use of spectrum. Absent this, there is a risk that the focus on utilising spectrum to the full ignores the wider picture of what is needed to provide compelling services for UK enterprises and consumers. Whilst recognising that many of these factors – access to power, sites etc. – fall outside the remit of Ofcom, Ofcom needs to take into account the implications of the wider deployment environment in creating an efficient spectrum licensing framework. The existence of such issues is acknowledged in Section Two of the consultation, but we do not see a great deal of evidence that the ramifications for spectrum policy are properly thought through in the strategy.

We also believe that Ofcom is wrong to not make explicit mention of the need to improve the environmental efficiency of spectrum usage. The UK has ambitious targets to reduce CO_2 emissions, so it is strange that the eco-efficiency of spectrum usage scarcely merits a mention in the strategy. Vodafone stands ready to play our part, by halving our environmental impact by 2025 whilst increasing consumption of our services[2]. Ofcom should subject new spectrum usage to careful scrutiny as to whether they could increase greenhouse gas emissions. For example, if a requirement to provide dedicated spectrum for an application results in greater emissions when compared to utilising an existing network, the cost-benefit analysis should factor in the cost of those emissions rather than solely focusing on spectrum efficiency considerations. We note that Ofcom recognised environmental considerations in examining the external context[3], but believe that this should have been front and central to the strategy, being an objective in its own right.

We note Ofcom's position that this strategy review should focus on over-arching themes rather than addressing specific sectors or bands[4]. We support this, but acknowledge that inevitably it results in abstract constructs rather than specific proposals. Noting that Ofcom is producing a roadmap of when it will consider specific sectors and bands, it would have been useful to set out that roadmap as part of this consultation exercise, rather than leaving it for subsequent consideration.

[2] See https://www.vodafone.com/our-purpose/planet/reducing-emissions-in-our-operations
[3] Section Three of the consultation
[4] Paras 2.24-2.25 of the consultation

Question 2: Have we captured the major trends that are likely to impact spectrum management over the next ten years?

We believe that Ofcom has identified the majority of the key themes.

Under "*changing application demands*", attention might have been drawn to the increasing personalisation of communications. For example, whereas in the past consumption of television services would have been on a broadcast basis, increasingly this is evolving to consumers expecting to watch content at a time and place that suits them. Today's teenagers rarely watch broadcast television at all, with content consumption via social media applications dominating. This has implications for communications networks (in the widest sense), and hence the spectrum that they consume.

In recognising that "*technology can develop in unpredictable ways*", we think that Ofcom is linking technology and commercial trends without evidence. We agree that nobody can accurately predict the future. This is both from a technology and business model perspective. However, it is a flawed leap of logic to assert that new technologies will likely result in persisting niche players. Larger companies can innovate, and market mechanisms also result in larger companies acquiring smaller innovators. We do not question that there will be niche players, rather we query the suggestion that unpredictable technology development *inevitably* leads to a more fragmented eco-system (at least at scale). Recent evidence actually speaks against this proposition, with Amazon, Apple, Facebook and Google becoming global giants that acquire technology innovators. In any case, technology innovation over the last decade has been overwhelmingly at the application level in existing networks, underpinned with improvements in mobile network and access network efficiency facilitating the required higher data rates. With respect to the assertion that *"Having the right spectrum available for these users at the right time will enable innovation"*[5], we agree with and support this, but this cannot be at the expense of incumbent users, and ultimately Ofcom's goal should be that spectrum is available to all consumers, rather than favouring a particular business model.

We believe that usage of higher frequency spectrum will increase, continuing an inextricable expansion up the frequency bands that has been going on for decades. However, this must be combined with a recognition of commercial viability. It is unlikely that a spectrum model that requires antennas to be placed on every streetlight will pass business case tests any time soon, outside ultra-urban environments. Therefore, whilst consideration of 100GHz+ is a useful research area that could yield niche applications, it cannot be a substitute for providing adequate stocks of lower frequency spectrum within the timeline covered by this spectrum strategy.

[5] Table One of the consultation

Question 3: Could any of the future technologies we have identified in Annex 6, or any others, have disruptive implications for how spectrum is managed in the future? When might those implications emerge?

We believe that deployment of the technologies set out in Annex 6 are aspects that Ofcom should monitor, and where suitable exploit, in its spectrum management processes. However, at this stage we believe that it is stretching things a little to assert that they will have disruptive implications to the licensing of spectrum. For example, self-healing networks will affect how licensees deploy their spectrum, potentially increasing efficiency; but they do not take away the requirement for a bedrock of assured access to spectrum in order to offer reliable services. Likewise, blockchain/distributed ledger technologies could open up new avenues to managing licences when compared to traditional databases[6]; but this provides a new avenue for fulfilling a requirement rather than disrupting the presence of that requirement itself.

Question 4: Do you agree that there is likely to be greater demand for local access to spectrum in the future? Do you agree with our proposal to consider further options for localised spectrum access when authorising new access to spectrum?

We are not convinced, but neither do we assert that demands for local access to spectrum will not increase.

It is important to stress that end users' requirement to access spectrum is, always has been, and always will be, localised. Inherently a user wishes to use their mobile phone, their Wi-Fi tablet, their GPS system or their car key fob where they're currently located. The consideration is how it's best to aggregate the demands of multiple users, and aggregate the demands of individual users as they move around. At the extremes, we can aggregate demand across all users and multiple applications across all locations, per public mobile service, or we can award spectrum to a specific enterprise at a specific location via an individual licence. Sometimes we pick an approach as "best fit", recognising that it is not totally optimal and plugging efficiency gaps: for example it is unlikely that any mobile operator would serve every geographic location using mid-band frequency spectrum (2.x GHz, 3.x GHz), but national licensing is still the best approach, so long as there is an ability for unused frequencies at specific locations to be brought into service via Local Access licences.

The questions, therefore, are whether there are technology or commercial shifts that are fundamentally changing the demand for access to spectrum, and whether there are technology or commercial shifts that change how demand for access to spectrum is best fulfilled?

We consider that it is indisputable that there is increased demand for spectrum, whether due to applications requiring greater bandwidth (hence more spectrum), or more applications requiring access to spectrum, notably in the industrial sector.

[6] Recognising the issues identified by Ofcom during its trial of the technologies for number management.

Whether these technology and commercial shifts point to spectrum being awarded on a more local level is a moot point, however.

- Technological developments such as database-driven access could point to more pinpointed awards of spectrum being the best way forward – this is a vertically structured approach where each end-user's application has access to its own spectrum.
- Conversely the advent of 5G technologies, and in the future 6G, point to networks that can be tailored to the requirement of individual applications, with network slicing providing multiple applications the connectivity they require, with a limited number of networks requiring access to more spectrum.

Ofcom does not need to back a particular technology horse, but it must be aware that there is a coexistence tension. Pinpointed access to spectrum is not practicable for a national scale network rollout, and if multi-service networks cannot have access to sufficient suitable spectrum, then the aspiration of meeting all (or the majority) of users' requirements is compromised. Similarly, if Ofcom awards all spectrum via national auctions, then (absent sharing structures such as Local Access licences), those users that feel their needs are ill-served by multi-service networks would rightly argue that they are being neglected.

Similarly, Ofcom does not need to back a particular commercial horse, but as set out in the introduction to this response, it must ensure that its licensing efforts remain commercially neutral. Users of multi-service networks must not be punished by having to pay more for spectrum than those securing access to spectrum directly – and ultimately it is end-users who pay for all spectrum that's awarded for a fee, not intermediaries such as mobile network operators.

It is also worth noting that past attempts at local licensing have left a less-then-ideal outcome. For example, regional 28 GHz licences have subsequently been traded to form [almost] *defacto* national licences needed by national network operators. It might be argued that this is an efficient outcome and a demonstration of the secondary market working effectively, but in reality it means that the licensees have a patchwork quilt of licences with the inability to operate links between the regions (absent striking local per-link lease deals).

In summary we believe that Ofcom is correct to consider further options for localised spectrum access, but this must be implemented in an equitable manner and cannot be at the expense of national awards of spectrum where needed.

Question 5: Do you agree with the actual and perceived barriers identified for innovation in new wireless technologies, and our proposed ways of tackling those?

We agree, although we do think that in most cases, the barriers are perceived rather than actual.

International agencies such as CEPT do seek to write their standards in as technology-neutral a manner as possible, but ultimately when it comes to coexistence studies, there needs to evidence and contributors are certain to provide evidence supporting their own product/application – it is not their role to assist others,

indeed it may be contrary to their business interests to do so. As such, we support Ofcom's aspirations, but are not optimistic regarding how achievable this is.

We support Ofcom's proposals to ensure that companies are aware of the flexibility that generic technical conditions provide them, but have some concerns about the funding of such outreach activities. It would be unfortunate if incumbent spectrum users were expected to fund – via licence fees – Ofcom activity to encourage new entrant competitors.

We also believe that Ofcom should itself be flexible in ensuring that licence terms do not block innovation by incumbent spectrum users. For example, mobile network licences are inherently framed to be terrestrial, i.e. both network mast and user terminal are connected to the earth. However, what matters from a spectrum management perspective is the relevant frequencies are being used at a given location and do not interfere with third party usage, not whether the transmitter or terminal is connected to the ground. We welcome Ofcom's activity to examine whether, for example, deployment of mobile terminals on drones is feasible and if so to stretch the term "terrestrial" to accommodate this. However, extending this, we believe that licensees should not be restricted to terrestrial *transmission*, so long as it can be demonstrated that third parties aren't adversely impacted.

Question 6: Do you agree with Ofcom's proposals to improve our outreach and reporting activities, and spectrum information tools? a) Are there additional ways that Ofcom could better engage with existing and future users and providers of wireless communications? b) Please explain any specific areas where you believe more or better provision of information could provide value to stakeholders

We are broadly supportive. Anything that can improve engagement and information for spectrum users is positive, but once again, we must highlight that the ultimate goal is fulfilment of user application requirements, and direct access to spectrum is but one way to achieve this – it is a tool rather than a desired goal in its own right. To date, we have found that Ofcom has been even-handed in highlighting to those seeking access to spectrum that there are choices between mechanisms to access spectrum directly, or indirectly by instead consuming services provided by existing users of spectrum. We welcome the efforts that the Ofcom team makes to keep abreast of the latest technology and service capabilities, in order that they can speak in an informed manner to applicants.

On specific items:

- We fully support the proposal to publish a Spectrum Roadmap. From the context at para 5.37 we assume that this is planned to be an annual exercise, but would welcome clarity on this and any requirements you may have of licensees.
- In the short term, we believe that Ofcom could do more to keep the Spectrum Information System up to date – for example, we are aware that at time of writing, Shared Access licences awarded a month ago are not reflected, meaning a clear view of spectrum availability is not possible. In the

longer term, given the system can at best be described as "creaky", we absolutely welcome modernisation.

Question 7: Do you agree that it is important to make more spectrum available for innovation before its long-term use is certain? Do you have any comments about our proposed approach to doing this?

We see the benefits of the UK being at the leading edge of innovation, and guardedly support Ofcom's proposed approach. It can take a long time to fully complete international harmonisation, and anything that shortens the time before devices can be used is to be welcomed, particularly if that also provides empirical evidence to improve the harmonisation exercise. Set against this, for every technology success story there will be a series of failures, and it is incumbent on Ofcom to ensure that spectrum does not become contaminated with the radio equivalent of space junk. This will require a robust compliance regime to clear out users that do not vacate once the "grace period" for innovation has expired; removal of licences is not sufficient without enforcement, nor should it be left for subsequent licensees to identify where spectrum is being illegally used.

Question 8: Do you agree that it is important to encourage spectrum users to be 'good neighbours' to ensure more efficient use of the spectrum? Do you agree with our proposals to: a) increase realism in coexistence analysis at a national and international level? b) encourage spectrum users to be more resilient to interference? c) ensure an efficient balance between the level of interference protection given to one service and the flexibility for others to transmit? Do you have any comments on which of these will be the most important?

As we highlight in the introductory comments to this response, it is difficult to conceive that anyone would answer negatively to this question.

We support increased realism in coexistence analysis, indeed would highlight that we already take this approach. For example, filters on our network equipment are generally considerably better than assumed in coexistence analysis in setting licence conditions. This means that our spectrum usage can be "sweated" when taking a view on the positioning of our masts, and of sharing with third parties (whether via Ofcom Local Access Licences, via assigning spectrum to Mobile Private Networks, or via leasing of spectrum in non-mobile access bands). Similarly, we very much take account of terrain and clutter, rather than relying on free space models. The *quid pro quo* of this, however, is that where Ofcom takes a more realistic modelling approach it might not yield as much spectrum efficiency as you may expect, because the difference between theoretical and real-world models is already being exploited downstream by spectrum licensees.

We agree that spectrum users should be as resilient as possible to interference, but this desire must be tempered with practicality. To steal Ofcom's "*good neighbours*" analogy, if next door's resident is a pensioner with a hearing aid who has lived there for fifty years, it ill-behoves us to demand that it's their problem to deal

with the issue of a house being built next door and the residents installing an outdoor Jacuzzi with mega-bass sound system directly against their fence.

We cannot expect that existing spectrum users proactively remediate their equipment against potential future adjacent usage, but conversely existing spectrum users cannot expect to be able to use equipment with poor filtering capability in perpetuity. Ofcom is quite right at para 7.83 to highlight the linkage with the proposed Spectrum Roadmap, which could provide a mechanism to forewarn existing users. We also agree with Ofcom's proposals at 7.99-7.101 that incumbents must be able to justify why their usage should be protected.

Nevertheless, there are areas where Ofcom needs to play fair by existing users. A good example is the 3.8-4.2GHz spectrum band, which is currently occupied by satellite and Shared Access licence holders. We note Ofcom's aspiration that a database approach could be used in this band and note that the Shared Access licences forewarn about this. As we have stated, we have some reservations about usage of dynamic access mechanisms, but notwithstanding this, it would be most unfair if satellite users of the band – many of whom had to relocate from the 3.6-3.8GHz band in order that it could be used for mobile – now have to make modifications to their equipment to incorporate database interrogation. We would expect that in this context, playing fair would mean that the areas around existing ground stations would simply be ring-fenced in the databases.

The example provided at Figure 7 of the consultation serves to illustrate where Ofcom has conflated spectrum usage with spectrum efficiency. The example compellingly shows that by reducing the throughput of Service A by 7%, it is possible to double the throughput of Service B. This is not necessarily an efficient outcome, however. If Service A is overwhelmingly more valuable than Service B – in either economic or social terms – then it is quite possible that A's 7% loss damages the economy more than B's 100% gain. Alternatively, if the 7% loss in throughput in Service A is such that it can no longer meet its users' needs so becomes obsolete, once again the overall impact can be negative. Unfortunately, it is not possible to take a myopic spectrum view on these things; there is a need to acknowledge the wider application context.

We welcome Ofcom's proposals to make technical details of interference assessments more accessible (within the confines of ensuring protection of commercially- and national security-sensitive information). Ofcom has an enviable reputation for understanding the interference mechanisms between spectrum users, but there is never a monopoly of knowledge, and opening the analysis to wider scrutiny can only increase its rigour.

Question 9: Are there any other issues or potential future challenges that should be considered as part of this strategy?

As we set out in our introductory comments, we are concerned that the strategy's scope considers spectrum in a vacuum. Spectrum in and of itself does not provide compelling, innovative services – investment in infrastructure that uses spectrum does.

There is need for financial stimulus to encourage investment in innovation by UK companies. For example, access to spectrum for innovation is to be welcomed, but if all of this innovation were by multi-national companies with industrialisation not then happening in the UK, then that would do little to stimulate our post-Brexit economy.

Beyond innovation, practicable implementation requires removal of barriers to deployment of spectrum, for example access to suitable sites. Much of this falls outside Ofcom's remit, but it must be aware of this wider environment in considering spectrum strategy. As we have already said, there is little point in having instantaneous database-driven access to spectrum licensing, if it takes 18 months to acquire and get consent to build a transmitter site, indeed such immediate spectrum access could be counterproductive if it removes investment certainty.

Question 10: Do you agree that continued use of our existing spectrum management tools (as set out in sections 4-7) will be relevant and important for promoting our objectives in the future, in light of future trends?

As we set out in our introductory comments, whilst supporting market mechanisms to incentivise spectrum efficiency, we believe that there is a need to review whether the existing approach is achieving the policy goals sought by Ofcom and Government, or whether there is a danger of them amounting to a tax on mobile users (which, effectively, means a tax on everyone) and a constraint on investment. We will elaborate on this point in the forthcoming review of mobile markets.

Question 11: Is there anything else we should be considering doing, or doing differently, to promote our objectives?

Our earlier comments have addressed this question.

Vodafone UK
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