Huawei response to the Ofcom consultation on "Our spectrum management strategy for the 2020s"

Summary

Huawei Technologies very much welcomes the opportunity to provide feedback on this important consultation.

Trends

We broadly agree with the major market trends identified by Ofcom in relation to spectrum management.

In addition, we consider that citywide (urban/suburban) "video on the move" consumer and vertical use cases will be a strong driver for the use of mid-bands spectrum by IMT (5G NR) networks and their evolution in this decade. In light of this, we encourage Ofcom to consider the future spectrum needs of mobile broadband in the UK in the 2025-2030 time frame, and to examine options for the availability of nationally licensed mid-bands spectrum – in addition to the 3400-3800 MHz primary 5G band.

Local licensing

We agree that there is likely to be greater demand for local access to spectrum in the future.

We also consider that the huge investments by MNOs over the past decades in the UK's mobile communication network infrastructure, and their experience in managing these complex networks, should be exploited to the greatest extent possible to address the connectivity needs of vertical use cases (local and wide-area), thereby allowing the verticals and businesses to focus on their areas of expertise.

As such, we consider that priority should be given to facilitate the provision of services by MNOs to industrial/business users – where there is demand – using the MNOs' large-scale network assets.

The needs of industrial/business users can be met by

a) obligations on MNOs to provide solutions to these users in the form of customized services (including private networks) via slicing of the MNO's public networks (as currently discussed in some countries), or

b) direct leasing of spectrum from MNOs by these users (as per Ofcom's Local Access Licensing framework introduced in 2019).

We consider that local licensing should be considered as a secondary option, and in cases where industrial/business users' connectivity requirements cannot be addressed by the MNOs' large-scale networks. MNOs themselves should not be excluded from acquiring such local licenses.

We note that many new industrial/business users who might wish to use spectrum in a geographically restricted manner are still at the early stages of quantifying their spectrum needs and forming strategic partnerships, including with the MNOs. With this background, we consider that it is important for regulators to proceed in a measured way and account for the opportunity cost of locally licensing *excessive* amounts of spectrum bands which are harmonised for mobile communication networks.

Inter-service spectrum sharing

We acknowledge that the growing demand for terrestrial mobile broadband connectivity, and the fact that frequency re-planning or clearance of incumbents to allow IMT deployments may not always be possible, mean that increasing levels of spectrum sharing between IMT networks and other services may be inevitable going forward.

As such, the mobile industry has been very active in recent years in establishing efficient inter-service spectrum sharing frameworks at global and European levels in order to allow more extensive use of the scarce spectrum resource.

Ofcom cites the use of automated spectrum management tools, including spectrum management databases with direct connection to equipment/devices, as a means of facilitating inter-service sharing. We acknowledge that such an approach might be helpful in the context of licence exempt equipment/devices. However, we do not consider that such database assisted frameworks are necessary for individually licensed IMT networks, as any restrictions relating to inter-service sharing can be captured in the licence conditions, and implemented by the network – which itself effectively acts as a database.

Intra-service spectrum sharing

We consider that existing spectrum authorisation frameworks based on individual licensing (whether national or geographic) and licence exemption in distinct frequencies respectively, as available today, are sufficient to cater for all foreseen intra-service spectrum sharing scenarios for innovative use cases.

Based on our extensive engagements with verticals, businesses and new potential users of spectrum, we do not see a demand for dynamic/opportunistic access to spectrum in licensed bands. Such users seek a stable and guaranteed access to spectrum in order to allow them to invest in equipment for applications which often require managed QoS which is enabled through licensing, be this at a national or local level.

Where certain users are contented with deploying communications networks with dynamic/opportunistic access to spectrum, the use of licence exempt bands are recommended for this purpose.

Reporting

We are pleased to see that Ofcom is proposing to publish a Spectrum Roadmap, which will be updated periodically. It would also be helpful for Ofcom to regularly report on the number and nature of the issued Shared Access Licences (e.g., at 3800-4200 MHz and 26 GHz) and Local Access Licences (in mobile bands). This would help inform the industry on the level of demand for local licensing in the UK.

Huawei's comments in response to Ofcom's questions

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

We have noted multiple references by Ofcom to the promotion of spectrum sharing throughout this consultation, and would like to share our views in relation to this important topic.

The following provides our views on the co-channel sharing of spectrum from the perspective of mobile communication networks based on IMT technologies specified by 3GPP, including 4G and 5G NR (referred to as "IMT networks" in this document).

We note that the issues of *inter-service* and *intra-service* spectrum sharing often get conflated, and result in misunderstandings. For this reason, we treat these separately in what follows.

Broadly speaking, spectrum sharing should only be considered where there is a clear demand for additional spectrum which could otherwise not be made available, and where the benefits of sharing outweigh the costs. In other words, spectrum sharing – and complex proposals for intra-service spectrum sharing in particular – should not be considered as goals in themselves but must bring tangible net benefits to users of spectrum.

We consider that existing spectrum authorisation frameworks based on individual licensing (whether national or geographic) and licence exemption in distinct frequencies respectively, as available today, are sufficient to cater for all foreseen intra-service spectrum sharing scenarios for innovative use cases. Where there might be demand for dynamic/opportunistic intra-service spectrum sharing, these can already be catered for by using licence exempt bands. Therefore, we do not see a need for additional spectrum sharing frameworks to cater for such dynamic/opportunistic use.

Inter-service spectrum sharing

This refers to the co-channel sharing of spectrum between IMT networks and existing users of other services in a given band (i.e. between different services as defined by the ITU-R: Mobile, FS, FSS, MSS, etc.).

The growing demand for terrestrial mobile broadband connectivity, and the fact that frequency re-planning or clearance of incumbents to allow IMT deployments may not be possible in all cases, mean that increasing levels of spectrum sharing between IMT networks and other services may be inevitable going forward. As such, the mobile industry has been very active in recent years in establishing efficient inter-service spectrum sharing frameworks at global and European levels in order to allow more extensive use of the scarce spectrum resource[1].

We consider that

a) where possible, bands considered for use by IMT networks should be cleared of existing users of spectrum in order to avoid uncertain interference environments, and to allow the delivery of the challenging IMT-2020 QoS requirements specified by the ITU-R;

[1] See for example "ECC Report 303: Guidance to administrations for coexistence between 5G and fixed links in the 26 GHz band ("Toolbox")," July 2019, or "ECC Report 254: Operational guidelines for spectrum sharing to support the implementation of the current ECC framework in the 3600-3800 MHz range," November 2016.

b) where cost-benefit (or other) analysis indicates that clearance of existing users might not be a viable option in order to make room for introduction of IMT networks, sharing of spectrum between IMT networks and existing users of the band could be considered, always subject to least restrictive technical conditions[2];

c) where sharing of spectrum between IMT networks and existing users is the only option available, careful consideration should be given to the sharing objectives and requirements, and their impact on the operation of all parties, and that this should not deter the substantial long term investments needed for the roll out of IMT networks;

d) in order to minimise costs and complexity, spectrum sharing between IMT networks and existing users should be preferably considered first in bands where the geographic locations of existing incumbent users are known, are not ubiquitous, and do not vary with time in relation to the IMT networks. Obvious examples include the Fixed Service and the Fixed Satellite Service;

e) where appropriate, various co-ordination approaches may be applied to facilitate spectrum sharing between IMT networks and existing users. Such approaches can be readily implemented owing to the individually licensed authorisation of IMT networks.

In this consultation, Ofcom cites the use of automated spectrum management tools, including spectrum management databases with direct connection to equipment/devices, as a means of facilitating sharing between different systems. We consider that such an approach may be relevant for inter-service sharing between licence exempt equipment and existing services. Examples include the UK's TV White Space framework at UHF, or the FCC's Automatic Frequency Coordination (AFC) mechanism for WAS/RLANs at 6 GHz. This is because the identities, numbers and locations of the licence exempt users are typically not known, and therefore their coexistence with (and protection of) the incumbents could not be guaranteed with any certainty absent a database assisted framework.

However, we do not consider that such database assisted frameworks are necessary for individually licensed IMT networks, as any restrictions relating to inter-service sharing can be captured in the licence conditions[3], and implemented by the network – which itself effectively acts as a database.

Intra-service spectrum sharing

This refers to the co-channel sharing of spectrum between different IMT networks in a given band.

We note that IMT networks are themselves highly sophisticated spectrum sharing systems: through technologies such as cellular frequency re-use and network slicing, IMT networks allow billions of users and devices to share the same frequencies in the pursuit of a wide variety of use cases and with a predictable/managed QoS[4].

[2] Least restrictive technical conditions mean the imposition of minimal regulatory technical requirements (e.g., emission limits) which would result in an acceptably low probability of harmful interference between radio systems.
[3] And any changes to the licence conditions can be conveyed – if needed, electronically – to the network operators.
[4] Note that 3GPP has also specified Dynamic Spectrum Sharing (DSS) which allows an MNO to dynamically share the resources available in a radio carrier between LTE and NR, thereby providing a useful migration path. This can be categorized as intra-operator/inter-technology spectrum sharing, and should not be confused with intra-service spectrum sharing.

We also note that individual licensing, in all its various flavours including nationwide or geographic, is essential for the delivery of a predictable QoS by allowing IMT networks to manage the number of spectrum users, and to efficiently distribute the radio resource among them in a deterministic manner through efficient MAC protocols. It is precisely for this reason that IMT technologies are designed to operate subject to individual licensing in order to deliver the challenging technical requirements set out by the ITU-R.

We consider that

a) individual national licensing is the preferred authorisation regime for the wide area deployment of IMT networks and the delivery of services with a predictable/managed QoS, including for eMBB, URLLC and mMTC;

b) any desired sharing of spectrum among wide-area/national IMT network licensees should ideally be market-led, and can already be implemented through MOCN[5] technologies specified in 3GPP;

c) where there is a justified demand from parties to deploy private IMT networks within limited geographic areas,

   i. market-led intra-service spectrum sharing should be preferably achieved through *leasing* of spectrum from the individual wide-area/national IMT network licensees, as introduced by Ofcom in its Local Access Licensing framework in mobile bands;

   ii. intra-service spectrum sharing could also be achieved – as a secondary option – through local licensing of frequencies which are not co-channel with those used by wide-area/national IMT networks. It should be noted that local licensing – especially at low-bands and mid-bands – inevitably leads to geographic fragmentation (and artificial scarcity) of spectrum, and should be introduced cautiously and initially in limited bandwidths as informed by market demand. Any local licences should be available to all interested parties, and should not in any way compromise the availability of nationwide licensed spectrum – with large contiguous blocks – for wide-area/national IMT networks;

d) predictable access to spectrum, and a stable interference environment (both co-channel and adjacent channel) are all essential to exploit the reliability, low latency and spectrum efficiency of IMT networks and to incentivize investments in capacity and coverage. This is key both for public and private networks;

e) where certain parties are contented with deploying communications networks with *dynamic*/*opportunistic* access to spectrum, the use of bands that are subject to general authorisation (licence exemption) are recommended for this purpose. Such opportunistic access is, for example, offered by 5G NR–U (New Radio – Unlicensed) which is being developed in 3GPP to be used in licence exempt spectrum;

[5] For radio access network (RAN) sharing, the two most commonly used solutions are known as MOCN (Multi Operator Core Network) and MORAN (Multi Operator RAN). With MORAN everything in the RAN (antenna, tower, site, power) except the radio carriers is shared between two or more operators. With MOCN, two or more core networks share the same RAN, meaning that the radio carriers are shared. The existing core networks could be kept separate. MOCN is the most resource efficient solution as it gives the mobile operators the opportunity to pool their respective spectrum allocations, resulting in improved trunking efficiency. MOCN has been supported since 3GPP Release-6 for UMTS, since Release-8 for LTE, and since Release-15 for 5G.

f) the combination of individual licensing of spectrum (with its various flavours) and licence exempt spectrum (general authorisation) in distinct frequencies respectively, as available today, is currently sufficient to cater for all foreseen intra-service spectrum sharing scenarios for innovative use cases;

g) IMT network deployments take place over time and are based on evolving traffic demands and uptake of use cases. Therefore, spectrum in specific geographic remote/rural areas may not be used by MNO in the early days of network deployment. MNOs' strategies and long-term plans should be considered before concluding on the efficiency of MNO spectrum use.

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

We broadly agree with the major trends identified by Ofcom.

Additionally, we consider that the use of audio-visual communications across the urban and suburban areas of cities – in what we call "video on the move" – will be a strong driver for ever increasing use of IMT (5G NR) networks and their evolutions over this decade. Such use would range from consumer applications such as real-time video communications and video streaming to smart-city/industrial applications such as video analytics and tele-operated driving. Consumer use of high-definition "video on the move" would be facilitated through larger (foldable) smartphones and smart glasses which we expect to be widely available by mid-decade.

Ofcom states that "There will likely be increasing focus on low-power communications services to reduce overall energy consumption" (Table 1). We consider that this may not necessarily be the case. Lower power also means lower coverage and therefore potentially higher levels of network densification which may itself have adverse environmental impacts.

We note that greater energy efficiencies can be delivered through the availability of wide contiguous channels and non-fragmented spectrum (avoiding the need for excessive carrier aggregation) in bands which offer balanced performance in terms of coverage and capacity.

Finally, we note that while the pandemic has had a huge short-term impact on the lives of many across the globe, its mid to long term impact – if any – on our behaviours in using wireless communications is by no means clear, and that this should be accounted for proportionately in formulating spectrum management strategies for the 2020s.

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 agree with Ofcom's statement that "…that the benefit of the technologies that may affect spectrum management is quite uncertain at present and particularly within the ten-year time frame of our spectrum strategy." (Para. A6.3).

We acknowledge that spectrum management – like other fields – can benefit from increased digitalisation and automation. But it is important that such automation does not adversely affect the nature of well-established spectrum authorisation regimes (licensing and licence

exemption), does not result in unnecessary cost/complexity for the users of spectrum, and does not impact the incentives of users to invest in equipment and networks.

Artificial intelligence, automated spectrum management tools and self organising networks

Ofcom states that "…information about a user's requirements in radio resources and time; and previous (learned) actions, might automate decisions on how to allocate further frequency assignments in a spectrum efficient manner. AI / machine learning technology would need to be coupled to some form of database for the management of spectrum allocations." (Para. A6.6)

As we have also outlined in our response to other questions, we consider that the described use of AI and database assisted operation of devices might be helpful in facilitating *inter-service* sharing of spectrum between licence exempt communications equipment and existing users (e.g. TV White Space devices at UHF). However, we do not consider that such measures are needed for IMT networks subject to individual licensing (national or local), at least not in the foreseeable future. This is because any spectrum sharing technical requirements can be captured in the licence conditions, and any changes to these can be conveyed – if needed, electronically – to the network operators.

We again note that IMT networks are themselves highly sophisticated spectrum sharing systems: through technologies such as cellular frequency re-use, active antenna systems, sophisticated scheduling techniques, and network slicing, IMT networks allow large numbers of users and devices to share the same frequencies in the pursuit of a wide variety of use cases and with a predictable/managed QoS.

New technologies such as AI are also already being deployed to enhance and increasingly automate the management of IMT networks, at various levels of the radio protocol stack, in order to improve the distribution and sharing of the radio resource among the diverse users and usages of the network.

Of course, we also note that Ofcom could benefit from the use of AI in improving its own IT systems and licensing processes, and as long as this does not impact the nature of the authorization regime itself, this is entirely a matter for Ofcom.

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?

Mobile broadband

We agree with Ofcom's observation that "increasingly, people also expect to be connected to the internet wherever and whenever and expect a seamless online experience while on the move." (Para. 4.7), and that video is by far the greatest contributor (Para. 4.13) to the growing demand for capacity.

We expect growing demand for "video on the move" (e.g., high-quality audio-visual mobile communications, in-vehicle entertainment including HD video streaming, and mobile

streaming of HD videos) in a variety of popular urban and suburban locations[6]. This growth in consumption of HD video is being facilitated by two factors:

- The emergence of foldable smartphones with larger screens than available today, the ability to watch video via glasses (e.g., AR/VR), or to project videos on larger surfaces/screens, all contribute to growing demand for HD video[7]. For this reason, we expect that 4K and 2x4K video consumption via mid/high-end smartphones will be commonplace by the middle of this decade.

- The launch of 5G has ushered in a trend globally and in the UK for unlimited data plans. This means smartphone users no longer need to ration their mobile data usage, and can experience "video on the move" by staying connected to a mobile network (even when free of charge Wi-Fi access is available).

These will require a combination of coverage and capacity that can only be delivered in an economically feasible manner through the use of mid-bands.

In light of the above, we encourage Ofcom to consider the future spectrum needs of mobile broadband in the 2025-2030 time frame, and to examine options for the availability of nationally licensed mid-bands spectrum – in addition to the 3400-3800 MHz primary 5G band – as a means of catering for the evolution of IMT (5G NR) networks over the coming decade[8]. This could be achieved through a review of Ofcom's Mobile Data Strategy which was published in 2018.

Local licensing

We agree that there is likely to be greater demand for local access to spectrum in the future. However, we consider that local licensing also contributes to the geographic fragmentation of spectrum and should not be considered as a first option – especially if it compromises the availability of large contiguous bandwidths for high performance IMT (5G NR) nationwide networks.

We consider that the huge investments by MNOs over the past decades in the UK's mobile communication network infrastructure should be exploited to the greatest extent possible. As such, we consider that priority should be to facilitate the provision of services by MNOs to industrial/business users – where there is demand – using the MNOs' large-scale network assets in nationally licensed low-bands and mid-bands.

This can be facilitated by either a) obligations on MNOs to provide solutions to industrial/business users in the form of customized services (including private networks) via slicing of the MNO's public networks[9], or b) direct leasing of spectrum from MNOs by industrial/business users (e.g., as per Ofcom's Local Access Licensing framework introduced in 2019).

[6] This is in addition to various video-based vertical applications such as advanced/automated driving or video-based industrial inspection, fault detection and analytics.
[7] In some industrial use cases video could be processed by machines rather than humans and so again the greater resolution could be important.
[8] See Coleago, "IMT spectrum demand: Estimating the mid-bands spectrum needs in the 2025-2030 timeframe," December 2020. https://www.coleago.com/app/uploads/2021/01/Demand-for-IMT-spectrum-Coleago-14-Dec-2020.pdf
[9] For example as currently being discussed in Norway in the context of the auction of the 3400-3800 MHz band.

We consider that local licensing should be considered as a secondary option, and in cases where industrial/business users' connectivity requirements cannot be addressed by the MNOs' large-scale networks. MNOs themselves should not be excluded from acquiring such local licenses. We also note that local licensing would be more spectrally efficient in high-bands (mm-waves) where the poor radio propagation characteristics provide greater isolation between licensees and allows greater frequency re-use. This is in contrast to low-bands (< 1 GHz) and mid-bands (1-7 GHz) which are the sweet spot for wider area mobile macro-cellular coverage, and thereby suitable for wide area licensing.

We also note that many industrial/business users who might wish to use spectrum in a geographically restricted manner are still only at the early stages of quantifying their spectrum needs and formulating their requirements in terms of the nature of their partnership with the MNOs. This should be accounted for in addressing the geographic nature of new spectrum authorisations. The opportunity cost of locally licensing *excessive* amounts of spectrum may far exceed any perceived value creation which industrial/business use might bring.

Ofcom makes a number of proposals regarding the degree of mixing and matching different licence area sizes (Para. 4.36):

1) Ofcom proposes to offer "…licences with different geographic extents in different parts of the country"; e.g. in urban and rural areas. We consider that this might be a reasonable approach, but we caution against mixing national and local licensing on a co-channel basis, as this would inevitably result in complexities in interference management. This would specifically be the case in low-bands (< 1 GHz) and mid-bands (2-7 GHz).

2) Ofcom proposes to adopt "…different geographic authorisation approaches in different frequencies within the same band or in similar adjacent bands". We consider that this would mitigate the drawbacks of co-channel interference in (1) above. We recommend that Ofcom proceeds in a measured and evidence-based manner in light of uncertainties in the spectrum needs of industrial/business users, and avoids local licensing *excessive* amount of spectrum, especially where this is at the expense of large contiguous blocks of nationally licensed spectrum.

3) Ofcom proposes to offer "…Local Access Licences in parallel with national licences". As outlined earlier, we consider this – which is effectively a form of leasing of spectrum from the MNOs – to be an attractive alternative to local licensing.

4) Ofcom proposes to offer "…indoor authorisation in parallel with outdoor licensing". We consider that this might be a reasonable approach where local licences (low power equipment) are involved or at high frequencies where high building penetration loss effectively isolates indoor and outdoor use. We do not consider that this approach can be effective at low/mid-bands or where spectrum is nationally licensed, as the risk of co-channel interference would be unacceptably high.

On the issue of indoor authorisation for IMT networks, we recommend that indoor use could be promoted starting from bands that are not considered suitable for outdoor deployments due to restrictions for the protection of incumbents. These include 3300-3400 MHz and 4500-5000 MHz, which are bands with an existing 3GPP ecosystem.

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 with Ofcom that technical spectrum usage conditions for licence exempt devices developed in CEPT should be technology neutral in order to avoid any regulatory barriers towards innovative new technologies.

However, while *service neutrality* may be welcome in the case of licence exempt generic short range devices (SRDs), we do not consider that service neutrality is beneficial in all licence exempt bands. An example is the use of the 5.9 GHz band which is harmonised for intelligent transport systems (ITS) on a licence exempt basis. We do not consider that the use of this band by, say, WAS/RLAN is appropriate.

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 consider that Ofcom's proposals for improved outreach, reporting, and spectrum information tools will be helpful for the industry and the regulator.

We note that there is room for the wireless industry to better understand the requirements of the verticals, businesses and other new potential users of spectrum. These requirements relate not only to the spectrum needs of the users, but also relate to the economics and to new and emerging business models.

Based on our industry-wide engagements in recent years, we believe it is still early days for many verticals and businesses, as they establish their needs, capabilities, and business partnerships. For example, in 2020, we tracked a total of 228 business/enterprise projects in Europe (more than double the number in 2019). We noted that while 40% of these projects involved private networks (rather than public mobile networks), 74% also involved MNOs.

In view of developing spectrum needs and business plans, we consider that it is important for regulators to proceed in a measured and evidence-based manner and avoid the risk of setting aside *excessive* amounts of spectrum for verticals (or authorising use of said spectrum via local licensing) at frequencies which could otherwise be made available for a diverse range of use cases via high-performance nationwide mobile networks.

It would also be useful for Ofcom to regularly report on the number and nature of issued Shared Access Licences (e.g., at 3800-4200 MHz and 26 GHz) and Local Access Licences in mobile bands. This would help industry better understand the level of demand for local licensing in the UK. The same could apply to Ofcom's other frameworks, such as TV White Space deployments.

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?

Automated spectrum management tools

Ofcom proposes to continue to develop automated spectrum management tools that "…offer a direct interface between devices/networks and a spectrum management database can allow spectrum use to be authorised and modified in near real-time" (Para. 6.17) and that Ofcom is "…planning to use such tools to implement this flexibility in 'shared bands', including the 3.8-4.2 GHz band (Para. 6.19)".

It is not immediately evident why such near real-time flexibility in authorisation – and a direct connection to radio equipment – might be necessary in licensed bands, whether licensing is national or geographic. We address the two examples provided by Ofcom (Para. 6.19):

- Ofcom states that this can allow "…changing the frequency assigned to specific users/devices" citing the example where "…TV White Space devices automatically had their frequency of operation updated as the 700 MHz band was cleared".

  We acknowledge that there might be a case for database connections to licence exempt equipment to enable spectrum sharing with other services (*inter-service* spectrum sharing). Another example of this is the use of Automatic Frequency Coordination (AFC) mandated in the US to mitigate the risk of interference from licence exempt WAS/RLAN (Wi-Fi) equipment to incumbents in the 6 GHz band.

  However, we do not consider that such a mechanism would be required for licensed equipment, including mobile networks. We note that the operation of user equipment in mobile networks is already effectively managed by a database (i.e., the mobile network itself) and any necessary clearance of the band can be readily implemented by the network itself.

- Ofcom also gives the example of this enabling access rights to change over time, allowing users to "…start with opportunistic access, but over time migrate to a higher priority level".

  Based on our extensive engagements with verticals, businesses and new potential users of spectrum, we do not see a demand for dynamic/opportunistic access to spectrum in licensed bands. Such users seek a stable and guaranteed access to spectrum in order to allow them to invest in equipment for applications which often require managed QoS which is enabled through licensing, be this at a national or local level.

  Where certain users are contented with deploying communications networks with dynamic/opportunistic access to spectrum, the use of licence exempt bands are recommended for this purpose.

We are pleased that Ofcom acknowledges that "…introducing this technology can result in additional costs and complexity and not all its functions and corresponding benefits will be relevant in every case" (Para. 6.21). We consider that it is critical for Ofcom to put in place measures that are proportionate and to weigh any benefits against the costs to users and their incentives to invest.

We consider that users would greatly benefit from greater levels of automation in Ofcom's own licensing processes, as a means of cutting down the time between an application for a licence, any required calculations for the management of interference, and the issuance of the licence. However this is entirely different from database assisted real-time changes to the authorisation regime in a band, which we consider to be unnecessary.

International harmonisation

Ofcom states that "…harmonisation does not only arise from the formal decisions of bodies like CEPT and ITU, but can also happen in practice if a number of countries adopt similar stances to particular bands" (Para. 6.26).

We acknowledge that different countries have different requirements for the use of spectrum based on the nature of their local markets and societal needs. We consider that harmonised international allocations of bands – where different countries can authorise use of sub-bands therein (sometimes referred to as the *tuning range* concept) – is critical for delivering economies of scale and low-cost equipment.

We recommend that national regulatory authorities avoid (to the greatest extent possible) any country-specific regulatory technical conditions, as this bears the risk of inflated equipment costs for the end users, or even failure in the deployment and uptake of wireless services in the respective countries.

Spectrum available for innovation before its long-term use is certain

When considered in isolation, such an approach is sensible in facilitating the emergence of new users and innovative new wireless technologies. However, the potential benefits of such action would have to be weighed against the opportunity cost of such action, in particular where there is potential for alternative and more certain use of the band in the future.

It is not immediately clear which bands Ofcom intends to apply this approach to going forward. Elsewhere in the consultation, Ofcom has stated that new users would benefit from the global economies of scale in mobile equipment. This suggests that Ofcom intends to make spectrum available for new users and innovative technologies, which could otherwise be potentially available for IMT mobile networks. If this is the case, we are not convinced that this is a sensible approach. IMT (5G NR) networks are the most innovative and advanced wireless technologies developed to date, and our collective focus should be to ensure that these networks are used to the greatest extent possible in helping with the digital transformation of the UK.

Ofcom lists a number of options at its disposal for "…updating our authorisation approach if and when the future use of the band becomes clearer at a later stage" (Para. 6.39), including the use of databases assisted access to spectrum, frequency agile equipment and shorter notice periods. However, this under-states the huge impact which a change of authorisation approach would have on the users of a band and their incentives to invest. It should be noted that such options are effectively remedial measures to correct a regulatory decision which – in hindsight – had been taken too early.

Instead, it could be more helpful if any spectrum released for new and uncertain use is initially restricted to a small portion of the band, in order to reduce the opportunity costs of such release, and the need for remedial measures, should substantial use not materialise. In this respect, and in the context of the 3800-4200 MHz band, we would recommend that Ofcom

initially issues Shared Access Licences confined to a contiguous block preferably located at the upper portion of the band.

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?

Increase realism in coexistence analysis at a national and international level?

We broadly agree with many of Ofcom's proposals, in particular in relation to the use of realistic equipment characteristics, deployments, and propagation/clutter models.

On Ofcom's proposal to "…consider the use of automated spectrum management tools to support these restrictions on an automatic basis without the requirement of user intervention. This could potentially allow us to implement restrictions whilst also licence exempting devices, for example the database could prohibit new users from accessing spectrum if there were too many users/devices already in that area" (Para. 7.75), we consider that while such an approach might be helpful in the context of licence exempt equipment and unlicensed bands (e.g., the UK's TV White Space devices at UHF, or AFC for Wi-Fi at 6 GHz in the US), it is not necessary for IMT mobile networks, in the sense that the network itself acts as a sophisticated database which efficiently performs the same functions outline above.

Ofcom also states that with automated spectrum management tools "…if interference was worse than we modelled, then we could apply additional restrictions to technical parameters of existing and new deployments at a later stage…" (Para. 7.77). While we acknowledge that databases could be used to relax initial technical restrictions over time, we are not convinced that the prospect of future tightening of technical restrictions is conducive to investment in deployments.

Encourage spectrum users to be more resilient to interference?

We acknowledge that improved transmitter adjacent channel leakage ratio and receiver adjacent channel selectivity can allow spectrum users to be "better neighbours". It is important that any limits set on these parameters account for what is physically achievable and economically viable in practice, and that the limits are least restrictive.

While we acknowledge that improvements in adjacent channel selectivity might be feasible, especially when dealing with older equipment, we note that there is little/no room for improved rejection of co-channel interference which appears as an increase in the noise floor. It is for this reason that co-channel coexistence of different systems at the same time and place is typically not possible, unless the services have extremely undemanding QoS requirements.

Ensure an efficient balance between the level of interference protection given to one service and the flexibility for others to transmit?

We consider that this might be a fair approach in principle. However, we cannot further comment absent any details on how this might be implemented in practice, and specific examples of interfering and victim services. In particular, a comprehensive analysis of how a reduced protection (and degraded performance) for service A may improve the performance of service B is rarely trivial, and is even more complicated when translated to the value (economic or otherwise) of the services.

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

No comment.

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?

No comment.

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

No comment.

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