Spectrum Policy

Enabling opportunities for innovation

Ofcom consultation on Shared access to spectrum supporting mobile technology

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1 Introduction

I am grateful for the opportunity to comment on Ofcom's proposals on enabling opportunities for innovation in its consultation on Shared access to spectrum supporting mobile technology. I welcome the efforts by Ofcom to make spectrum within recognised mobile bands available for players who cannot compete in auctions for exclusive use of released spectrum.

Unfortunately, the proposals in this consultation do not live up to the ambition of the title. The spectrum being made available in this consultation for 'innovation' must fall within two specific categories of deployment, which seem to be address applications that are already well defined, but for which Ofcom has been lobbied by 'challenger' players seeking market entry. The two categories are too narrow for many truly innovative applications - in particular those requiring low latency, often called Industry 4.0 or the Tactile Internet.

Last month, Ofcom published a report 'Supporting the expanding role of wireless innovation in UK industry', which analysed 'the increasing role wireless technology is playing in a number of different industries – alongside other technology developments – to enable greater productivity, lower costs and improve quality of service'. This identified that wireless will play a major role in transforming industry. Many industrial applications require low latency. However, the technical conditions mandated by Ofcom in this consultation (the frame structure) are incompatible with low latency, without good justification.

The practical usability of the 3800 – 4200 MHz band will be constrained by the availability of complete sets of components for this frequency band, and for some applications by their support in the user population of smartphones. This will put the UK several years behind countries like Germany that are making spectrum available for similar purposes within the 3400 – 3800 MHz band, for which components are already available and smartphones supporting the band are already becoming available.

The consultation also proposes that medium power licences would be restricted to fixed service applications only, which will preclude may potential innovative mobile applications. However, there is no difference in the coexistence conditions between a fixed network where the location of the access points are not defined and a mobile network. Indeed, a mobile network is likely to be more benign, because the terminals will typically be at a lower height above ground level. Therefore, there is no technical justification for this restriction.

The technical licence conditions contain a number of anomalies, inconsistencies and errors. These appear to be largely the result of copying information from other documentation or between frequency bands, without considering its appropriateness to these licences.

2 Demand and supply for shared spectrum in different frequency bands

The three bands considered in this consultation have very different characteristics:

The 3800-4200MHz band

This band has nearly 400MHz available in much of the UK. Ofcom proposes a maximum channel bandwidth of 100MHz (and many users will not need this much), so it can support several users at a location. It is supported by 5G New Radio (band n77), but is not supported by LTE (and probably never will be). Chipsets are becoming available for this frequency range, but it is challenging to produce RF components that cover the full frequency range of band n77 – 3300 – 4200MHz. Instead, it is likely that initial implementations will only support the 3300 – 3800MHz range (band n78), which is where the current market demand lies. It will soon be possible to produce bespoke NR devices for operation within the 3800 – 4200MHz range (probably supporting only a part of Band n77), but it is likely to be at least five years before the penetration of 5G NR smartphones supporting band n77 will be high enough for applications like neutral host in-building coverage.

2390 – 2400MHz band

This band is only 10 MHz wide. As Ofcom currently proposes a minimum channel bandwidth of 10MHz, it can support only one user at a location, and there would be unused areas between different locations. This band is supported by both LTE and 5G New Radio, and is already implemented in the majority of current smartphone models.

1800MHz spectrum

This band is already supported by GSM and LTE, but cannot be supported by 5G New Radio because its minimum channel bandwidth is 5MHz. Ofcom only one licence in the available bandwidth, so it can support only one user at a location, and there would be unused areas between different locations. The band is supported for GSM and/or LTE by all mobile phones.

The differences in availability of equipment mean that initial demand is likely to be focused on the 2390 – 2400MHz band. However, under Ofcom's current proposals, only one user is possible at only location. I therefore suggest that the only channel bandwidth for 2390 – 2400MHz outdoor low power and medium power licences should be 5MHz, to allow two licences.

3 Responses to questions

Question 1: *Do you agree with our proposal for a single authorisation approach for new users to access the three shared access bands and that this will be coordinated by Ofcom and authorised through individual licensing on a per location, first come first served basis? Please give reasons supported by evidence for your views.*

I agree that the three bands should have a common authorisation approach for shared access. Ofcom's proposals already have substantial differences in technical conditions for out-of-band emissions, and some other differences would enhance the utilisation of spectrum – for example a channel bandwidth of 5MHz for 2390 – 2400MHz outdoor low power and medium power licences (see section 2 above).

One potential application for shared access is to provide LTE coverage within railway carriages (see questions 2 and 12). This cannot be licensed on a per (fixed) location basis, but would be compatible with this. Ofcom should consider how this sort of application can be facilitated, either through a specific class of licence or by allowing applications outside of the current two licence classes.

***Question 2**: Are there other potential uses in the three shared access bands that we have not identified?*

Ofcom has not considered the following potential applications for these three shared access bands:

- Low latency applications of 5G, such as Industry 4.0, interactive VR/AR and the 'tactile internet'.
- Medium power licences for mobile applications – for example in ports and chemical plants.
- Provision of LTE within railway carriages on a neutral host basis, as a complement to WiFi.

These applications are precluded by unjustified restrictions in the technical licence conditions – see questions 11 and 12.

***Question 4:** What is your view on the status of equipment availability that could support DSA and how should DSA be implemented*?

There are many different types of DSA, and many different types of device into which it can be incorporated. Some types of DSA require functionality in user devices, whereas others only require functionality in network elements. Some applications will use bespoke devices that can readily support DSA, whereas other applications will rely on a global ecosystem for devices. The suitability of different types of DSA will depend on how rapidly the spectrum usage environment changes. It is likely that the usage of the three bands by incumbents and primary users will only change slowly, which would enable a relatively straightforward implementation of DSA.

LTE and 5G networks have an operations and maintenance (O&M) system that controls the operating frequency of each base station, and which could interface with the DSA database. This may be sufficient for a slowly changing environment and for most purposes (though it would involve a short break in operation while the frequency is changed, which may be incompatible with critical applications).

DSA in the CBRS band has now been authorised in USA by the FCC, and is being implemented by operators of LTE networks. It is therefore likely that this functionality will become available for LTE networks in other frequency bands. However, Ofcom should be mindful that the areas and duration of CBRS licences and their technical conditions differ to its proposals, and that applications may therefore emerge in UK that do not benefit from synergy with CBRS.

It is at present unclear what the demand for local access licences in 3.8 – 4.2GHz will be, and therefore the extent to which DSA will be needed to maximise spectrum utilisation and coexistence. Ofcom should therefore be cautious about mandating DSA. Its implementation of DSA should not require any network functionality that is not implemented for CBRS (though the parameters used to generate the database can be different). It should be particularly cautious about any mandating any functionality for user devices that is not already part of a global ecosystem.

***Question 5:** Do you agree with our proposal for the low power and medium power licence? Please give reasons supported by evidence for your views.*

The two licence categories are based on specific applications, and may therefore not be suitable for new innovative applications. The principle is reasonable for initial assignments, but the definition of the categories needs further refinement as proposed in the answers to other questions.

Question 6: *Are there potential uses that may not be enabled by our proposals? Please give reasons supported by evidence for your views.*

The restriction of medium power licences to the fixed service is unjustified, when deployments for mobile use would have similar characteristics for co-existence.

Provision of LTE within railway carriages on a neutral host basis, as a complement to WiFi, is not currently possible. See questions 2 and 12.

Question 7: *Do you agree with our proposal to limit the locations in which medium power licences are available? Please give reasons supported by evidence for your views.*

The proposal to limit the locations for medium power licences is based on assumptions on the trade-off between supply and demand for access to spectrum. This is likely to be very different between the 3800 – 4200MHz band and the other two bands, based on the amount of spectrum and the availability of equipment supporting it. The categories E1, E2, F1 and F2 in ONS2011 Census Output Area together represent around 10% of the total number of Areas, and therefore around 10% of the population of England. It is unlikely that demand for the full bandwidth of 3800 – 4200MHz band will extend to the 90th percentile of population. It may therefore be beneficial also including census output areas D1 and D2 in parts of the country where a large portion of the 3800 – 4200MHz band is available.

The census output areas are defined for demographic analysis, and correspond to around 125 households; some areas have convoluted shapes. This could give rise to anomalies on the borders of urban areas, where the base station is within a rural category of census output area that is adjacent to an urban category.

Question 9: *Do you agree that our standard approach to non-technical licence conditions is appropriate? Please give reasons supported by evidence for your views.*

Paragraph 4.28 states "Licences will be available for locations within the United Kingdom ***and territorial seas***."*(my emphasis).* However census output areas are only defined for land.

Question 11: *Do you agree with the proposed technical licence conditions for the three shared access bands? Please give reasons supported by evidence for your views.*

I do not agree with the following conditions:

<u>Frame Structure</u>

As discussed in section 1 of this response, many potential applications of 5G require low latency. However, Ofcom has mandated frame structures that preclude this – the preferred frame structure in Figure 7 has an inherent latency of 6ms and the alternative frame structure has an inherent latency of 2ms. 5G New Radio has frame structures with 'mini slots' that can achieve far lower latency. The discussion of TD-LTE frame structures in paragraph 5.16 is irrelevant, because TD-LTE is not supported in the 3800 – 4200MHz band.

I assume that the rationale for mandating frame structures is to maximise utilisation of spectrum. However, the statutory duties of Ofcom under the Communications Act 2003 include securing the optimal use of the electro-magnetic spectrum for a wide range of electronic communications

services. This cannot be achieved if a major category of applications is excluded (especially if the demand for the spectrum is unclear).

I therefore suggest that there should be no restriction on frame structure in part of 3800 – 4200MHz band, perhaps initially the upper 100MHz. The licence fee could be higher, to reflect the potentially lower spectrum utilisation and the potentially more complex coordination

Restriction of medium power base stations to fixed service

There is no justification for restricting medium power base stations to the fixed service. The coexistence conditions for fixed and mobile services are very similar, given the technical licence conditions proposed in the consultation document.

The following issues also need to be addressed:

'Telefonica time'

The technical licence conditions in effect define a new time reference for the UK – 'Telefonica time'. Paragraphs 5.16 (3800 – 4200 MHz) and 5.41 (2390 – 2400 MHz) include the following statement "…the frame must start at a common reference time so that frames are aligned with Telefónica and transmissions synchronised". The rationale for the 2390 – 2400 MHz is clear, but for the 3800 – 4200 MHz it is not. However, this may be a 'cut and paste' error, because 5.16 also states "… the frame must start at a common reference time so that frames are aligned with other licensees and transmissions synchronised".

It is unclear how these requirements can be implemented, because base stations may not have the capability to synchronise from off-air signals, and anyway it will not always be possible receive an off-air signal from other networks. If Ofcom wishes networks to be synchronised, it may need to define an absolute time reference that all networks must synchronise to, for example based on UTC.

Definition of Maximum mean EIRP density

In the table in paragraph 5.14, the maximum mean EIRP density has the form "Min(Pmax – X, Y)". However, for the proposed maximum inband EIRPs, the value of "Pmax – X" is always less than "Y". Therefore, the definition of maximum mean EIRP density can be simplified to "Pmax – X".

Question 12: *Are there other uses that these bands could enable which could not be facilitated by the proposed technical licence conditions? Please give reasons supported by evidence for your views.*

1) Low latency applications of 5G, such as Industry 4.0, interactive VR/AR (for example in tourist attractions) and the 'tactile internet'. These are precluded by the mandated frame structures. They would probably use 3.8 – 4.2 GHz band.
2) The use of medium power licences for mobile applications – for example in ports and chemical plants. The area of these facilities is generally too large to reasonably cover using low power base stations, and they are usually in areas where demand for spectrum from other users will be low.
3) Provision of LTE within railway carriages on a neutral host basis as a complement to WiFi (this may be needed because some services such as SMS are not supported by WiFi, and voice-over-WiFi is not supported by many phones). This is precluded because shared access licences are limited to specific geographic areas, but could co-exist with them because of the high shielding of railway carriages. This application would use the 1800MHz or 2390-

2400MHz band, because the band must be supported by the great majority of mobile phones.

Question 13: *Do you agree with our proposed coordination parameters and methodology? Please give reasons supported by evidence for your views.*

There are a number of anomalies in the proposed propagation models and associated assumptions, which Ofcom should rectify:

Use of ITU Recommendation P.452

ITU Recommendation P.452 is primarily intended for distances measured in kilometres, such as would be the case for deployment of UK Broadband wide-area networks. It needs to be treated with considerable caution for the shorter site separation distances associated with the transmission parameters proposed in this consultation, especially for low power base stations. Ofcom should consider other techniques for coordination, perhaps using a planning tool for mobile networks.

Antenna Patterns

In paragraph 5.51, an omnidirectional antenna pattern with 0dBi gain is an isotropic radiator – I.e. it radiates equally in all directions. There is no reason to reference Recommendation ITU-R F.1336 for this pattern (indeed, it may give incorrect results because this is outside the intended range of the equations).

In paragraph 5.52, Recommendation ITU-R F.1336 is referenced for an omnidirectional antenna. However, for omnidirectional antennas this Recommendation only defines the radiation pattern in elevation, and it appears from the consultation that none of the co-existence scenarios described will need to take the radiation pattern in elevation into account.

Height of indoor base stations

Ofcom proposals assume that indoor base stations are at a height of 5m irrespective of the actual height or floor that they are deployed on. This may be a reasonable assumption for coexistence with other shared spectrum users, but it is not appropriate for coexistence with incumbents – for a tall building, the floor on which an indoor system is deployed could make the difference between an obstructed path and line-of-sight to the incumbent system.

Use of most recent versions of ITU Recommendations

Ofcom should use the most recent versions of ITU Recommendations:

- ITU/R Recommendation P.452-16, dated 2015
- ITU/R Recommendation F.1336-5, dated 2019

and not the superseded versions dated 2001 and 2014 respectively.

Need for receiver performance considerations

It is unclear why receiver performance needs to be taken into account when considering the impact of new sharers from existing users operating in adjacent channels, as described in paragraphs 5.68 and 5.69; there is no equivalent regulatory analysis for exclusive licences of mobile spectrum, where the impact would be greater.

In any case, if the base stations of different users are synchronised and have the same frame structure, as Ofcom proposes, there will be no interference between base stations – because they all transmit at the same time and receive at the same time.

Question 14: *What is your view on the potential use of equipment with adaptive antenna technology (AAS) in the 3.8-4.2 GHz band? What additional considerations would we need to take into account in the technical conditions and coordination methodology to support this technology and to ensure that incumbent users remain protected?*

The technical licence conditions for the 3800 – 4200MHz band provide an incentive for the deployment of equipment with AAS technology for point-to-multipoint or mobile systems, because it will typically improve the link budget for each of several simultaneous users while complying with technical licence condition for average EIRP.

The impact of this on incumbent users will depend on the scheduling of traffic by the AAS in the time and spatial domains, and the characteristics of the incumbent use. However, the impact is unlikely to be sufficient to warrant the added complexity in modelling AAS in coexistence analysis.

Question 15: *Do you agree with our proposal not to assign spectrum to new users in the 3800-3805 MHz band and the 4195-4200 MHz band?*

The characteristics of a low power shared access base station are very similar to a terminal operating within the 3.4 – 3.8GHz band. Ofcom has not found it necessary to impose a guard band between licences in the 3.4 – 3.8GHz band. The qualitative discussion in Annex A5 does not provide a justification for the exclusion of low power shared access base stations from 3800 – 3805MHz.

Therefore I suggest that assignments in the 3800 – 3805MHz frequency range should be allowed for low power indoor base stations.

Question 16: *Do you agree with our fee proposal for the new shared access licence? Please give reasons supported by evidence for your views.*

For the low power licence class, Ofcom could consider a discount for adjacent areas, to reflect the fact that additional effort to coordinate these adjacent areas will be lower. As discussed in Question 11, Ofcom should consider assigning part of the 3800 – 4200 MHz band without any mandated frame structure, with possibly a higher licence fee.

Question 18: *Do you agree with our proposal for the Local Access licence? Please give reasons supported by evidence for your views.*

Ofcom's proposals for Local Access licences would require MNOs to provide information to Ofcom on their future deployment plans, which are very commercially sensitive. There is a risk that this information could 'leak' into the public domain or be used for other purposes:

- There is a risk that Ofcom could be forced to release this information under the Environmental Information Regulations 2004 (which has much narrower ground for refusal than the Freedom of Information Act 2000).
- Environmental campaigners could make bogus applications to seek information on future deployments.

- Commercial players could make bogus applications to seek insight into MNOs' future business plans.
- MNOs might be concerned that Ofcom could use this information for other purposes, to their detriment.

Question 19: *Do you have any other comments on our proposal?*

It is difficult to see why an applicant would need spectrum within a particular part of a mobile band for technical reasons. Therefore, in cases where an applicant has not obtained the support of an MNO, it should be sufficient for the application to state the frequency band that is being requested. Ofcom could then contact the MNOs with spectrum in that band. This would increase the change of a successful assignment and also reduce the 'leakage' of commercially sensitive information on future deployments.

A key feature of 5G is the support of new 'vertical' applications. Some of these applications may require large spectrum bandwidths and would not be limited to urban areas. Some of these applications might only be provided by one or two MNOs (as is currently the case with ESN), but it is too early to know which MNOs might choose to support particular verticals, or be awarded a contract to do so. Ofcom should therefore not be surprised if MNOs are reluctant to relinquish access to their spectrum at the present time; three years is beyond the horizon for predicting the development of many of these verticals.

Question 20: *What information should Ofcom consider providing for potential applicants in the future and why would this be of use?*

It is difficult to see what useful information could be provided to third parties that would not compromise the confidentiality of MNOs' future business plans.

As Ofcom has found in the past through 'Sitefinder', detailed information about current deployment of MNO networks can also be used for unintended purposes.

Question 21: *Do you agree with our proposal to have a defined licence period and do you have any comments on the proposed licence term of three years?*

It is possible that spectrum may be sought for short term events such as sporting competitions and music festivals. There is no reason why applications could not be made for any period up to three years, with the same fee.

Question 22: *Do you have any other comments on the proposed Local Access licence terms and conditions?*

There may be a need for agreement between the MNO and Local Access Licensee that go beyond what is normally contained in a WT Act licence – for example conditions for site sharing. These could be included in a separate agreement between the two parties. Given that the MNO has agreed to relinquish access to spectrum, any spectrum trade should require its consent (there could be a condition that this consent should not be unreasonably withheld).

Question 23: *Do you agree with our fee proposal for the new local access licence? Please give reasons supported by evidence for your views.*

In order to minimise the risk of bogus applications being made in order to gain information on MNOs' future business plans, the fee should be payable on application. This is consistent with Ofcom incurring its costs in the investigation of the feasibility of a licence, not the administrative process of granting it. See the response to Q18.