Vodafone's response to Ofcom Consultation

Mobile Data strategy

January 2014

Mobile Data strategy

Summary

Vodafone welcomes Ofcom taking a long-term view in its preparations for WRC-15. In general we agree with the conclusions reached, but would suggest the following changes to the prioritisation:

- **450-470MHz**: Reduce this band to low priority unless this consultation reveals substantial support by UK stakeholders.
- **470-694MHz**: Raise this band to high priority, for a secondary allocation to mobile at WRC-15.
- **1350-1518MHz**: The assessment for this band will need to be broken down into individual sub-bands. Raise 1427-1518MHz to high priority and reduce 1350-1400MHz to low priority.
- **2700-2900MHz**: Consider reducing to medium or low priority if international support does not increase, or if less than 60MHz (plus guardband) can be released in UK.

We consider that Ofcom's future analysis should additionally consider:

- The potential for spectrum bands above 10GHz,
- The potential impact of integrating broadcast capability into mobile networks,
- The technical and commercial challenges in introducing additional frequencies to handsets, and
- The relative importance of large contiguous blocks of spectrum versus aggregation of smaller blocks.

While we welcome the analysis, we note that it is mobile network-centric, and potentially doesn't give adequate consideration to M2M applications which could have unique requirements.

Finally, although the consultation focusses around spectrum challenges, it must not be forgotten that mobile operators face other challenges in making use of that spectrum, notably property and backhaul costs. Ofcom has a role to play in ensuring that the value of the spectrum which is being made available is not diminished by operators' inability to cost-effectively make use of it.

1. Introduction

Vodafone thanks Ofcom for the opportunity to contribute to its mobile data strategy, which builds on its call for input on future demand for mobile broadband spectrum and consideration of potential candidate bands by WRC-15. The decisions to be taken by WRC-15 under agenda item 1.1 will be fundamental to the future development of mobile broadband – and therefore to almost all citizens and consumers, as mobile broadband services become ubiquitous.

Vodafone welcomes Ofcom taking a long-term view - up to 2030 - in its preparations for WRC-15, because the decisions taken in the short term may need to ensure the availability of spectrum until around that date. If decisions are not taken by WRC-15, there may not be another opportunity until the WRC in around 2023, and these decisions would be unlikely to lead to licence awards much before 2030.

Many studies have found that public mobile is the wireless application that creates by far the greatest economic benefit to citizens and consumers of the UK; this will continue to be the case for the foreseeable future. Agenda item 1.1 should therefore have the highest priority for the Ofcom in its preparations for WRC-15 and at the Conference.

With tablet sales forecast to outstrip laptop sales by the end of 2013[1] and UK mobile retail e-commerce sales forecast to be some £8Bn[2], the transition to a mobile economy is becoming a reality. Vodafone agrees with Ofcom's assessment of the expected growth in demand for data, wherever and whenever the consumer may want it.

Providing the required data capacity will require a two-pronged strategy, namely the provision of additional spectrum bands, and technology innovation to squeeze more bits per MHz of spectrum. Vodafone will work with Ofcom and our vendors so that both prongs will fulfil their role in ensuring UK citizen consumers can obtain the services they desire.

We would be happy to meet to explore the issues and options presented in the consultation.

[1] "Tablet Shipments Forecast to Top Total PC Shipments in the Fourth Quarter of 2013 and Annually by 2015, according to IDC", http://www.idc.com/getdoc.jsp?containerId=prUS24314413

[2] "Tablets to Account for Over 10% of UK Retail Ecommerce Sales", http://www.emarketer.com/Article/Tablets-Account-Over-10-of-UK-Retail-Ecommerce-Sales/1010421#3XBvHwZks6RTRyl0.99

2. Responses to questions

Note: The responses to the questions below should be read in conjunction with the Vodafone response to Ofcom's Call for Input on agenda item 1.1[3].

Q1: Have we correctly identified the future characteristics of mobile data demand?

Vodafone agrees with Ofcom's analysis.

Access to the digital economy is increasingly becoming wireless. Analysts such as IDC[1] report that tablet sales are on the point of outstripping PCs, and that by 2017 the installed base of such devices will usurp PCs. The predominate mode of access to LANs is now wireless, meaning spectrum is consumed even where access into public WANs is ultimately wired. We agree with Ofcom's observations on the difficulty of securing quantitative data about WiFi usage, and to a degree it is a moot point given much of usage of WiFi is on an offload basis from mobile devices.

The growth in mobile broadband utilisation is meteoric. However, consumers don't particularly care about network capabilities; instead it is the presence of compelling applications which is driving consumption of mobile broadband. A couple of years ago it would have been a surprising sight to observe a rail commuter catching up on TV viewing using their iPad or Android device: it is now commonplace. Vodafone bundles access to Sky Sports as part of our 4G service. The model of music commerce is moving away from purchase and download of content, to streaming via services such as Spotify (again, bundled as part of Vodafone's 4G service). Content is being held less on consumer devices, instead being stored within the network via services such as iCloud and Google Drive.

All of these services drive the need for more mobile data, but customer willingness to pay for this increased data throughput is non-linear (albeit the value of mobile spectrum still outstrips that of alternate applications). If operators are to be able to economically serve these demands then there is a need for both more spectrum bands and technological advances to drive more bits per MHz. It cannot be assumed, however, that the value of future spectrum bands will be in proportion to the revenues received from past auctions: to do so would imply that consumer willingness to pay for more bandwidth is linear and that spectral efficiency remains unchanged. Indeed, greater spectral efficiency and provision of additional bands actually diminishes the value of existing holdings.

[3] Vodafone's response to Ofcom's consultation "Future demand for mobile broadband spectrum and consideration of potential candidate bands: World Radiocommunication Conference 2015 Agenda item 1.1", http://stakeholders.ofcom.org.uk/binaries/consultations/cfi-mobile-bb/responses/Vodafone.pdf

Beyond the twin solutions of additional spectrum and technological advances, the only way to go some way towards matching consumer requirements would be to use ever smaller base stations: but there comes a point where this is simply uneconomic for the price that consumers are willing to pay, hence the demand will be unfulfilled. Provided that the spectrum which could be used to serve this demand is being used for some other higher value purpose, then this is appropriate. However, this appears highly unlikely; for example Analysys Mason suggest that mobile broadband usage of 700MHz is worth some four times that of Digital Terrestrial Television[4]. Moreover, other (competing) countries **will** be able to service this consumer need for mobile connectivity, so not addressing the demand for spectrum at the right time at the right cost will leave the UK in a technology slow lane, with consequent impact upon national productivity.

Access spectrum is but one component though. The need for greater throughputs is driving mobile operators to deploy small cell architectures, which in turn presents challenges in backhauling the broadband data stream back to our core architecture. In this context, Vodafone is pleased that Ofcom recently concluded its consultation on the creation of a centrally coordinated function for E-band frequencies[5].

M2M presents its own set of issues. Undoubtedly there will be significant growth in both applications and of data associated with these, as the "Internet of Things" comes to fruition. Some applications will be suitable for implementation over existing communications mechanisms, such as WiFi or LTE. Others will have unique requirements, for example low bit rates coupled with a need for coverage, which will be challenging to achieve via all-purpose networks. As such, an analysis of fulfilling mobile broadband requirements that focusses solely on the conventional mobile networks could well lead to either unsuitable solutions for some M2M applications, or miss the opportunity of using spectrum that is perhaps not ideal for mainstream technologies but well suited to specific M2M applications. Absent knowledge of these applications, we sympathise with Ofcom's inability to carry out this analysis, nevertheless it would have been good to have seen this point acknowledged when examining the attractiveness of specific bands. Our response to this consultation is predominately focussed on mainstream mobile broadband; where we state that we favour a particular frequency band less, in particular due to unlikely support in mainstream terminals, this presents a real opportunity for the bands to be used by more niche M2M applications which do not rely on mass market support.

Q2: Do you agree that there is a prospect of significant continuing growth in demand for mobile data services?

As set out in our recent response to Ofcom's spectrum management strategy consultation[6], Vodafone believes there is no doubt of continuing growth in demand for data services – the only question is how rapidly. It is inconceivable that the trend shown in Figure 2 of the consultation document will not continue.

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[4] "Opportunity Cost of the Spectrum used by Digital Terrestrial TV and Digital Audio Broadcasting", http://stakeholders.ofcom.org.uk/binaries/consultations/aip13/annexes/report.pdf

[5] Spectrum Management Approach in the 71-76 GHz and 81-86 GHz bands", http://stakeholders.ofcom.org.uk/consultations/70-80ghz-review/statement/?utm_source=updates&utm_medium=email&utm_campaign=70-80-ghz-statement

[6] "Vodafone's response to Ofcom Consultation : Spectrum Management Strategy", http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-management-strategy/responses/Vodafone.pdf

The Ofcom consultation on its spectrum management strategy[7] highlighted the very high value generated for the UK economy by wireless broadband, and the correspondingly high consumer surplus and social value created for citizens and consumers. There are a range of predictions for the future growth in data traffic; for example, the Real Wireless study[8] considers three cases for low, medium and high demand. It would be convenient to take a position that because of demand uncertainty the least onerous scenario should be assumed; however to do so would be a betrayal of UK consumers who would be almost certainly be left in the technology slow-lane compared to other nations that grasp the nettle of addressing the need for mobile broadband spectrum.

Given the high potential benefit from wireless broadband to UK and its citizens and consumers, it would be prudent for Ofcom to ensure that the decisions of WRC-15 will enable it to accommodate the higher predictions for growth in spectrum demand. However, at the same time, Ofcom will need to ensure that these decisions do not lead to unnecessary disruption to incumbent users, should the growth be lower than this.

Q3: Have we identified all the challenges in realising future growth in citizen and consumer benefits from use of mobile data services and do you have any comments on the nature or the scale of the challenges we have identified?

This section of the consultation document has identified the main challenges from a network perspective.

In addition, it must be recognised that the plethora of frequency bands being made available will only be of value if mass market terminals support these bands to deliver the mobile data services. This is becoming increasingly challenging with the proliferation of mobile bands across the world, and the reduction of the influence of Europe as a proportion of the global market. Ofcom therefore needs to consider this challenge as a strategic issue, and not just a technical matter.

Q4: Have we correctly identified all the areas where Ofcom has a role in addressing the challenges of growing demand for mobile data services?

Ofcom also has a role in promoting the international harmonisation of both frequency allocations to mobile, and the frequency arrangements within them. These are necessary to facilitate the inclusion of new frequency bands within mobile devices – and, without mobile devices, these new frequency bands cannot satisfy the demand for mobile data services.

To maintain global harmonisation, it is also important that administrations release spectrum bands in largely the same order.

[7] Appendix to spectrum management strategy: Future developments in major spectrum uses, paragraphs A2.3 – A2.5; Ofcom; 2 October 2013.

[8] Techniques for increasing the capacity of wireless broadband networks: UK, 2012-2030; produced by Real Wireless on behalf of Ofcom; Version 1.16, April 2012.

Q5: Do you agree that the main additional area that our mobile data strategy needs to address is in relation to potential future spectrum options?

In assessing future spectrum options, Ofcom needs to consider how the spectrum might be used (i.e. the frequency arrangement). Although this work cannot be completed until after WRC-15, the initial thinking should start beforehand.

Q6: Is Ofcom doing all that it needs to do in other areas identified as being relevant to the mobile data challenge?

Ofcom has largely addressed all of the issues related to the spectrum challenge. As we raised in our response to the wider spectrum management strategy[6], the one glaring exception is an absence of joined up policy making in that the potential release of additional spectrum for mobile broadband will obviously impact the value of existing spectrum; this point appears to have been missed in Ofcom's consideration of Annual Licence Fees (ALF) for 900MHz spectrum.

There are wider non-spectrum issues relevant to the mobile data challenge, however. There is an inter-relationship between spectrum availability and network rollout. On the one hand spectrum is of no use without the infrastructure to utilise it, and on the other availability of some spectrum bands mitigate against the need for a greater (potentially uneconomic) number of base stations. There are a series of policy challenges with respect to efficient network rollout. While some do not come under the direct purview of Ofcom, it could potentially play an influencing / advocacy role:

- **Planning permission.** There needs to be a presumption towards providing planning permission in a timely manner for all base station sites, potentially in a streamlined manner where a tranche of network rollout could be assessed as a single exercise. The efficiency of such an approach should be reflected in planning application fees. There are many land owners willing for operators to install mobile equipment on their land, but this is generally blocked by planning authorities refusing to grant permission for a new site where one already exists.

- **Property costs.** The UK is one of the most expensive places in Europe to roll out mobile infrastructure, with annual site property costs being over 50% higher than the average across Vodafone's European networks and nearly three times higher than in Germany. These high costs act as one of the greatest disincentives to the rollout of mobile coverage in rural areas in particular, because the economic case for investment in these areas is the most challenging. The issue can be divided into various aspects:

    - **Rents**. Vodafone's experience with renegotiating rent for 4G sites is that a bad situation is becoming worse. On both existing and new sites, we are seeing a substantial increase in the amount of rent demanded. Landlords are well aware of the need for mobile operators to roll out 4G quickly and often have a local monopoly by being the only site in the area with planning permission for mobile network infrastructure. This puts these landlords in a very strong position when rent renegotiations are triggered by the need for permission to upgrade to 4G. This should not be misunderstood as some form of David and Goliath scenario with large mobile operators set against individual land owners: the landlords are typically large businesses with numerous sites across the UK. We fear the situation may be repeated as additional spectrum bands are added.

- **Rates**. The current business rate regime appears to be designed to thwart investment. Typically business rates amount to over £2000 per site.

- **Electronic Communications Code**. DCMS is currently reviewing the Electronic Communications Code which needs major reform to address the many times higher rental costs faced by the mobile industry when compared with other UK infrastructure providers.

- **Backhaul.** The ability to provide 4G superfast mobile internet services is very largely dependent on the quality of the backhaul broadband data connection available from and to each mobile site. There are two major challenges to overcome: the physical challenge of getting a high quality fibre connection to masts (particularly in rural areas) and the cost of using third party suppliers, largely BT, for this service. Ofcom needs to ensure that the regulation of next generation access services does not narrowly define them as being for a particular purpose hence preclude their usage for mobile backhaul purposes. Using E-band spectrum is a partial, but not total solution.

Q7: Do you agree with our high-level assessment of likely technology and topology trends and their implications for future spectrum use?

General comments on the assessment

The assessment has identified all of the major current trends in network technology and topology that are likely to have significant implications for spectrum use.

For terminals, it must be stressed that the number of bands is not the only criterion; other important issues include the maximum practicable frequency for semiconductor technology, the feasible number of antenna elements (which is a function of frequency) and the feasible bandwidth and stopband rejection of filters.

Some of these factors are dependent on the specific frequency bands and combinations of bands. We understand that Ofcom has commissioned an independent study on this topic, which unfortunately was not available in time for this consultation. We would be happy to discuss this study and these issues in more detail with Ofcom.

a) The potential demand for spectrum above 10 GHz

The growth in deployment of smaller cells and the increase in capacity of existing cells will substantially increase the demand for spectrum for backhaul above 10GHz.

In the longer term, there is likely to be demand for spectrum above 10GHz for mobile broadband access as it becomes impossible to find more spectrum at lower frequencies – but this is obviously dependent on the outcome of WRC-15 agenda item 1.1. However, there are still some major technological challenges to be solved before it becomes feasible to use spectrum at these high frequencies. Vodafone would therefore be supportive of an agenda item for the Conference following WRC-15, to consider this issue.

b) The potential impact of integrating broadcast capability into mobile networks

The demand for delivery of broadcast content to mobile devices is growing rapidly with the penetration of smartphones. For example, the number of BBC iPlayer mobile and tablet requests is already almost as great as from PCs[9].

Mobile networks also have the potential to efficiently deliver non-linear broadcast content or minority channels to conventional TVs, using UHF spectrum.

c) The technical and commercial challenges of supporting additional frequency bands in mobile devices

Adding additional frequency bands to a terminal inevitably increases its cost and complexity, and may degrade its performance. There are several dimensions to this problem:

1) The total number of bands supported by the terminal.

   For example, there are five variants of the i-Phone 5S, supporting different combinations of frequency band and technology.

2) The number of frequency ranges supported by the terminal.

   Currently, the majority of terminals support two frequency ranges (or part of them): 698-960MHz and 1710-2200MHz. A third range is now appearing in new models: 2300-2690MHz. Each range needs a separate RF chain and antenna, so adding an extra range involves a significant increment in terminal cost.

3) The width of these frequency ranges

   There are limitations in the bandwidth of some RF components, so widening a frequency range may lead to degradation of RF performance – which is seen by the user as worse coverage and reduced talk time.

The incremental complexity in adding an extra frequency range is significantly greater than adding an extra band, and in general the incremental complexity is significantly less for the receiver than the transmitter:

- A new band within, or adjacent to, existing frequency ranges is much more attractive than one that is separated.
- A new band is only likely to be added to mass-market terminals if it is widely available; the benefit is only realised in the markets where it is used, whereas the cost (in terms of extra components and performance degradation) is borne in all markets.
- A band that is outside one of the existing frequency ranges is more likely to be used effectively for downlink-only (e.g. spectrum within 470-694MHz, 1300-1518MHz, 2.7-2.9GHz).

d) The relative importance of large contiguous blocks of spectrum versus aggregation of smaller blocks

Carrier aggregation is a technique to use two or more carriers together, which was first implemented in 3GPP Release 10 and is being developed in subsequent releases. Carrier aggregation provides three main benefits, namely:

[9] BBC iPlayer monthly performance pack, October 2013, http://www.bbc.co.uk/mediacentre/latestnews/2013/bbc-iplayer-oct2013.html

- The aggregation of adjacent channels to provide a single bearer with higher peak bit rate and throughput
- The aggregation of non-adjacent channels or channels in different bands.
- As supplemental downlink channels, to support traffic asymmetry or to enable use of bands where terminal transmissions would be challenging.

Aggregating adjacent channels is obviously only possible in a large contiguous blocks of spectrum. Aggregating non-adjacent channels enables the use of smaller blocks. However, there are significant constraints on the number of channels and the combinations of bands that can be supported, and these constraints are more severe on the uplink. These aspects of carrier aggregation are therefore seen as solutions to spectrum management problems rather than tools of choice.

Large contiguous blocks of spectrum will therefore continue to be valuable to mobile operators, and are likely to result in a better user experience.

Q8: Are there any additional technology or topology trends that we need to consider that could have an effect on spectrum use?

The consultation document captures all of the current trends that are likely to have significant influence on future demand for spectrum for mobile broadband.

However, we note that while the consultation identifies M2M as a significant demand driver, the candidate bands are assessed only on their ability to deliver mobile broadband. The required characteristics of M2M applications may differ, so a band that is unsuitable for consumer broadband could be of value for these applications.

We would also re-iterate the non-spectrum issues identified in our response to Question 6, which impact upon our ability to make use of spectrum.

Q9: Do you agree with the short list of bands we have identified for more detailed consideration?

Yes. All of the bands on the short list have sufficient merit to justify more detailed consideration. The band with least reason for inclusion is 450-470MHz. As is noted in Table 5, there is limited support in Europe for this band, and there does not seem to be any UK-specific reason to support it. See our response to the recent Spectrum Management Strategy consultation[6] for our comments on this band.

Q10: Do you agree with our methodology for prioritising potential bands for mobile data use?

We agree with the general approach analysing costs and benefits. However, as stated in paragraph. 1.11, it is important to note that a mobile allocation and/or IMT identification represents an *option* for future harmonised used of the band, not a *commitment*. Therefore, the methodology should consider the benefits and costs of this option.

The methodology needs to consider three further factors:

1) For some bands, it is expected that not all of the frequency range would be allocated to mobile at WRC-15 (e.g. 1350-1518MHz), or that it would be released for mobile in stages (e.g. 470-694MHz).
2) The opportunity cost of postponing action beyond WRC-15.
3) In some cases, there are alternative decisions that could be taken by WRC-15, which need to be assessed separately (e.g. the possibility of a secondary mobile allocation in the 470-694MHz band).

Q11: Do you agree with our provisional assessment and the results of our band prioritisation?

The provisional assessment is a good starting point for consideration of the priorities for UK at WRC-15. Based on our comments on the methodology in response to Q7 and on individual bands below, we would propose the following modifications to the proposed priorities:

- **450-470MHz**: Reduce this band to low priority unless this consultation reveals substantial support by UK stakeholders.
- **470-694MHz**: Raise this band to high priority, for a secondary allocation to mobile at WRC-15.
- **1350-1518MHz**: Raise 1427-1518MHz to high priority and reduce 1350-1400MHz to low priority.
- **2700-2900MHz**: Consider reducing to medium or low priority if international support does not increase, or if less than 60MHz (plus guardband) can be released in UK.

<u>General comments on the provisional assessment</u>

The assessment will need to be refined to take into account the comments on the methodology. In particular:

- the assessment for 470-694MHz will need to consider the cost/benefit trade-off of a secondary allocation.
- the assessment for 1350-1518MHz will need to be broken down into individual sub-bands.

450-470 MHz

This band has presumably been included in this consultation because it forms part of Ofcom's proposed spectrum management strategy for the next ten years. However, neither consultation document gives a very clear explanation of the expected benefit to UK, given that there would be substantial disruption to existing users.

Vodafone suggests that this band should be reduced to low priority unless this consultation reveals substantial support by UK stakeholders.

470-694 MHz

Vodafone agrees with the conclusion in Ofcom's statement 'Securing long term benefits from scarce low frequency spectrum'[10] that 'the approach most likely to secure greatest benefits from the use of UHF bands in future' is to:

> *'Release the 700MHz band once it is harmonised and co-ordinated for mobile broadband in Europe, whilst also ensuring that the DTT platform has access to a sufficient amount of spectrum'*.

However, we believe that, in the reasoning in the statement and the consultation document that preceded it, Ofcom has not fully appreciated the pace of developments in consumer consumption of multi-media content and the potential for single frequency networks, These developments will reduce the need for DTT for multicast delivery of linear programme content – indeed, this is already happening in several European countries. In this consultation, Ofcom takes a rather UK-centric view of harmonisation. Harmonisation requires alignment between countries of both outcomes and timing. If Ofcom accepts the benefits of a harmonised solution, then it must also accept that the pace of implementation in UK must not be out of step with other countries.

For these reasons, we believe that the status of the 470-694MHz band does need to be reviewed by WRC-15, because the next opportunity is likely to be too late – see our response to Q12. We believe that a secondary allocation to the mobile service at WRC-15 would provide the best reflection of the conclusion in the Ofcom Statement on the UHF Band (it could be argued that a primary mobile allocation and identification of this band by WRC-15 could become a driver for change rather than a means to respond to changes). This would also provide an appropriate status for other developments in use of Bands IV and V:

- TV White Space Devices
- Unicast and on-demand delivery of multi-media content is defined under the Radio Regulations as falling under the mobile service, whether delivered by a DTT system or a mobile network.

1452-1492MHz

This band is available throughout Europe, and is therefore clearly a strong candidate for mobile allocation and identification for IMT. However, it is widely separated from existing mobile bands, and would therefore require a new RF chain in terminals. We believe that the ability for operators

[10] 'Securing long term benefits from scarce low frequency spectrum'. http://stakeholders.ofcom.org.uk/binaries/consultations/uhf-strategy/statement/UHF_statement.pdf, para 6.15

to deploy a 20MHz downlink channel in this spectrum is important to provide the impetus for this band to be generally supported by terminals. Given the importance that Ofcom attaches to maintaining four credible national wholesalers (para 3.28), it is important that a total of at least 80MHz of spectrum is found in this frequency range, to support four 20MHz downlink channels.

1350-1518MHz (excluding 1400-1427MHz)

This frequency range comprises a number of sub-bands, with different utilisation. As discussed above, we believe that at least 80MHz of spectrum needs to be released within this frequency range, and preferably in a contiguous block.

We believe that a contiguous block is preferable because 80MHz represents a bandwidth of 5.4% of a centre frequency of 1472MHz, which is at the upper limit of what is feasible using single terminal filter. If the spectrum was not contiguous, then two filters would be needed, together with associated switches – which would substantially increase the marginal cost of implementing the band in terminals

Vodafone proposes that the 1427-1518MHz band is allocated for mobile and identified for IMT; the frequency arrangement would extend from 1432-1512MHz for supplementary downlink, with guardbands below and above to protect radio astronomy and the mobile satellite service:

- **1427-1452MHz:** The MOD uses this band far less than the 1375-1400MHz band with which it is paired, and it has already advertised shared access to it.
- **1492-1518MHz band**: This band is used far less in other European countries than in the UK, which makes it a good candidate for European harmonisation. Ofcom should investigate the possibility of consolidating the existing use in the upper 2x6MHz, which would not be used for mobile broadband.

1980-2010MHz / 2170-2200MHz

This band is especially valuable for mobile broadband, because it is paired and adjacent to the 2GHz mobile band. There is little prospect of either of the current licensees launching commercial services. Vodafone therefore urges Ofcom to be proactive in the enforcement action against the currently authorised operators, and the subsequent reallocation to terrestrial mobile services.

2700-2900MHz

Vodafone has for some time believed that this band has potential for mobile broadband, probably for supplementary downlink.

This band forms part of a wider band extending up to 3400MHz that is predominantly used for various types of radar application. However, the consultation document suggests that Government is currently only considering re-planning of the radars currently operating up to 2900MHz, which is likely to release only part of this band. Studies undertaken by UK in relation to WRC-15 preparations also suggest that a significant guard band will be needed.

The consultation document notes that this band has ‘limited international support at present’. It is also likely to be actively opposed by several influential countries.

It is therefore with regret that we now suggest that Ofcom should consider reducing this band to medium or low priority for WRC-15 if international support does not increase, or if less than 60MHz (plus guardband) can be released in UK.

3600-3800MHz; 3800-4200MHz

We note and welcome the potential for greater use of spectrum sharing, particularly on a geographic basis.

Annex 6 of the April 2013 Call for Inputs suggested that the 3800-4200MHz band is relatively lightly used in UK, and the geographic usage could well be complementary to the likely deployment of mobile broadband. It already has a primary mobile allocation in Regions 2 and 3 and a secondary mobile allocation in Region 1.

This band therefore looks promising for future identification for IMT, for wider channel bandwidths. If WRC-15 considers it premature to make decisions for developments of IMT to higher channel bandwidths, there needs to be a roadmap towards action at a future conference.

Vodafone operates a satellite earth station at Whitehill in Oxfordshire; as one of the few UK stakeholders with both mobile and satellite interests, we are all too aware of the challenges in ensuring that incumbent users' capabilities are not jeopardised by new users. Assuming international action is taken, there needs to be a debate as to acceptable location of earth stations: it is not realistic for all such installations to be at geographic extremities of the UK in order to maximise the potential for geographic sharing, but on the other hand locating them in major population centres is not spectrally efficient. There is also a significant difference between an earth station containing multiple large dishes and an installation with only one or two uplinks.

5350-5470MHz, 5725-5925MHz

These bands would complete a contiguous band of nearly 800MHz, which is needed for support multiple wide channels for high speed wireless connectivity. So far, attention has focussed almost exclusively on WiFi, and IEEE 802.11ac in particular. The lower of these bands is currently used by earth exploration satellites, and their operators are concerned about the level of aggregate interference from ad-hoc WiFi systems.

It has also been suggested that this band could be used by LTE, for wide bandwidth supplementary downlink channels. This would offer a number of significant benefits from the perspective of coexistence with existing systems:

- The transmission activity would be substantially lower, because much of the traffic would be carried by the main channel in another frequency band.
- The base stations, and their location, could be under the control of a network operator (the terminals would not transmit in this band).
- The number of base stations simultaneously transmitting, and therefore the level of aggregate interference, could be explicitly managed by the network operators.

Q12: Do you agree with the possible timelines we have identified in this section?

The timelines are helpful for planning purposes, and they highlight one important factor that Ofcom need to consider in determining its positions and priorities for WRC-15. Figures 11-14 show the 'medium priority' bands starting to be used in around 2025 and being fully used by 2030; five years seems a reasonable period to bring a new band fully into use.

The ITU World Radiocommunication Conferences (WRCs) following WRC-15 will probably take place in 2019 and 2022/23. These are only six years and two years respectively before it is envisaged that the medium priority bands would first be used. It takes a number of years following a decision by a WRC before the spectrum can be released and brought into use for mobile broadband. A WRC in 2022/23 is too late for this to happen much before 2030.

The decisions on all high and medium priority bands will, in practice, need to be taken no later than the WRC after WRC-15. Ofcom is already contemplating proposing an agenda item for this WRC addressing IMT in bands above 6GHz (the agenda for a WRC is agreed by the preceding one). It is unlikely that WRC-15 will have the appetite for an agenda item for the following WRC that addresses a wide range of frequency bands.

Q13: Do you have any comments on the capacity implications outlined in this section?

The capacity implications are helpful for planning purposes.

Q14: Do you agree with the next steps we have identified for further domestic work based on the proposed priorities?

To reflect Vodafone's comments on Ofcom's prioritisation, Ofcom also needs to consider the following issues:

- The costs and benefits of a secondary allocation to mobile in the 470-694MHz band.
- The potential for consolidating fixed links in the 1512-1518MHz band (paired with 1369-1375MHz).

Q15: How do you think we should adjust our support for international harmonisation based on our proposed priorities?

International harmonisation is fundamental to availability of terminals, and availability of terminals is fundamental to spectrum being effectively for mobile broadband (or, indeed, used at all).

Therefore, support for international harmonisation must be a top priority for Ofcom, and the potential for international harmonisation (both in decisions at WRC-15 and the subsequent release) needs to inform its further work on the prioritisation of bands.

The UK has limited influence at a World Radiocommunication Conference if acting by itself; most of the key decisions are based on proposals by regional groups. The potential for achieving support in CEPT for a European Common Proposal, or known positions of other regional groups should therefore be an important factor in determining UK positions for WRC-15.

3. Representations on the impact assessment

Paragraph 2.8 states that the analysis in the consultation document together with its annexes comprises an impact assessment, as defined in section 7 of the Communications Act 2003. Therefore, the whole of this response constitutes representations on the impact assessment in accordance with Section 7 (7) a) and b) of that Act.