Improving consumer access to mobile services at 3.6 to 3.8 GHz

Response of Access Technologies
December 11, 2016

Summary

Alphabet's Access initiative welcomes Ofcom's consultation regarding the expanded spectrum access for mobile services in the 3.6 to 3.8 GHz band.[1] Key points of our response are as follows:

- We agree that this band and the linked 3.4 to 3.6 GHz band are of increasing relevance to current 4G and future 5G mobile services. Enhanced access to these bands will provide industry as well as UK citizens and consumers with more and better options for broadband services.
- However, Ofcom should not adopt a narrow view of what constitutes a permitted 'mobile service'. In particular, a mix of mobile and fixed access, plus backhaul/fronthaul and fixed links, are increasingly supported by mobile-derived technology, and Ofcom, consistent with its duties, should enable the market to decide the appropriate mix of services in the 3.6 to 3.8 GHz band.
- We also recognise that, although the band is lightly used compared to some other bands, it may not be feasible to displace existing services: as Ofcom points out, for example, satellite operations have little control over which frequencies they use and specific technical reasons for operating in this range. As a result, Ofcom's characterisation of the 'remove' and 'retain' options offers too stark a choice. A middle way is needed to allow existing services to continue, at least for an interim period, while enabling enhanced mobile access across the band.
- Ofcom's coexistence analysis is based on extreme worst-case assumptions. These assumptions have led Ofcom to an excessively stark view of the policy choices available. While it is true that a high-power wide-area coverage macrocell or a small cell operated from the top of the BT Tower could in theory cause interference over a wide area, neither of these are representative of likely use in the band, and suitable spectrum management techniques combined with the relatively sparse occupancy of frequencies in this band would allow such cases to be managed efficiently, taking account of the actual characteristics of existing systems rather than hypothetical worst-case parameters.
- A suitable middle way for coexistence would be a database-driven sharing arrangement, providing existing users with greater certainty of protection and maximising the opportunity for mobile services without wastefully extended exclusion zones. UK Broadband would also benefit from faster, simpler, and more certain access to its licensed spectrum compared with the current coordination procedure.
- Such a database-driven sharing scheme would be consistent with Ofcom's Spectrum Sharing Framework[2] and drive opportunities for innovation in technology and

[1] Ofcom, *Improving consumer access to mobile services at 3.6 to 3.8 GHz* (6 Oct. 2016), https://www.ofcom.org.uk/__data/assets/pdf_file/0035/91997/3-6-3-8ghz-consultation.pdf (*Ofcom Consultation*).

[2] *See* Ofcom, *A Framework for Spectrum Sharing* (14 Apr. 2016), https://www.ofcom.org.uk/__data/assets/pdf_file/0032/79385/spectrum-sharing-framework.pdf (*Ofcom Spectrum Sharing Framework*).

business models, tapping into the growing international ecosystem for mobile shared spectrum opportunities in this band and serving unmet consumer demand.

Responses to consultation questions

Question 1: Do you have any comments on the use of the 3.6 to 3.8 GHz band by existing services?

As Ofcom points out,[3] the band is relatively lightly used by both fixed links and satellite earth stations compared with other bands. In the case of future deployments of fixed links, there are plenty of other bands to choose from as set out in Ofcom's fixed links spectrum strategy,[4] although most of these are at significantly higher frequencies, entailing shorter ranges and greater impact of atmospheric effects, so there may be specific applications for which those are inadequate substitutes.

Even where there are other options, however, both existing systems and any proposed new systems in the band are legitimate users under the existing allocations. Ofcom should not focus exclusively on relocation of existing applications and technologies, but instead should offer the least restrictive conditions possible while managing harmful interference, thereby maximising spectrum efficiencies and the potential for market-driven benefits for the citizen-consumer. At the very least, existing usage needs an appropriately long transition period to plan and recoup existing investments, so there will inevitably be a need to share spectrum amongst mobile and other applications.

Question 2: Do you agree with our identification of a trend towards the use of mobile in the 3.6 to 3.8 GHz band?

It is clear that 'mobile' use will become more significant in this band and the adjacent 3.4 to 3.6 GHz band, given the Radio Spectrum Policy Group (RSPG) opinion[5] and work in ECC PT1 to ensure the technical conditions are appropriate for potential harmonization of 3.4 to 3.8 GHz for 5G. Internationally, including in the US and Japan, there is significant momentum in the use of the band for LTE.

However, it is imperative that Ofcom does not define 'mobile' narrowly: the band should be fully application- and technology-neutral, allowing the market to decide on the most appropriate mix of uses, including but not limited to the following:

- Mobile access,
- Fixed wireless access (point-to-point and point-to-multipoint), and

[3] *Ofcom Consultation,* ¶ 1.3.

[4] Ofcom, *Fixed wireless spectrum strategy* (11 July 2016), https://www.ofcom.org.uk/consultations-and-statements/category-1/call-for-inputs-fixed-wireless-spectrum-strategy.

[5] RSPG, *Strategic Roadmap Towards 5G For Europe - Opinion on spectrum related aspects for next generation wireless systems (5G)* (9 Nov. 2016), http://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf.

- Backhaul and fronthaul for mobile networks.

These applications can all be accommodated within one band while respecting existing users as necessary, given flexible regulatory conditions. This would allow operators to determine the most appropriate network topology.

As Ofcom notes,[6] the most likely usage of the band for mobile will be focused on capacity and speed requirements in dense areas rather than nationwide coverage, suggesting considerable potential for geographical sharing. The band is particularly well suited to the trend towards densification of mobile networks via indoor and outdoor small cells, striking a good balance between capacity (provided it is made available in wide enough bandwidths) and coverage for both outdoor and indoor applications. Indeed, Ofcom has noted in its consultation on 3.4 to 3.6 GHz that this band is not an 'effective means of extending existing levels of mobile coverage',[7] so it would be inconsistent to base the policy for 3.4 to 3.8 GHz spectrum on the extreme limiting case of wide-area macrocells.

While we appreciate that this consultation relates to 3.6 to 3.8 GHz (3GPP band 43) and that Ofcom has consulted separately on its plans for 3.4 to 3.6 GHz (3GPP band 42), it is imperative that Ofcom considers the future of these bands collectively, given both the RSPG opinion and factors such as:

1. The expectation of very wide bandwidths per operator (even hundreds of MHz, as Ofcom notes[8]) to maximise the potential of this band for 5G in light of the high data rate requirements for IMT2020.
2. Facilitating LTE solutions that span the 3.6 GHz 'boundary', such as the 3.55 to 3.70 GHz CBRS initiative in the US. Such solutions are supported by specifications produced by the Wireless Innovation Forum,[9] and we expect the conclusion in December 2016 of a 3GPP Work Item defining a new Band 48 for 3.55 to 3.70 GHz which will be widely supported on mobile devices. Additionally, a broad coalition of mobile operators and technology providers is supporting this initiative via the CBRS Alliance.[10]
3. Calls from international operators, such as those in the Global TD-LTE Initiative,[11] to treat bands 42 and 43 collectively.
4. International spectrum awards such as that in progress in Ireland and assignments to operators in Japan and elsewhere cover the entire range.
5. If, due to geographic or other restrictions, Ofcom's regulations make it impossible to deploy systems that cover both segments of this band, costs will increase and incentives to invest will decrease.

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[6] *Ofcom Consultation*, ¶ 6.7.

[7] Ofcom, *Award of the 2.3 and 3.4 GHz spectrum bands - Competition issues and auction regulations*, ¶ 1.6 (21 Nov. 2016), https://www.ofcom.org.uk/__data/assets/pdf_file/0026/93545/award-of-the-spectrum-bands-consultation.pdf.

[8] *Ofcom Consultation*, ¶ 6.8.

[9] *See* Wireless Innovation Forum Specifications, http://www.wirelessinnovation.org/specifications (last visited 28 Nov. 2016). WInnForum members and observers include representatives of the mobile, satellite, and defence communities.

[10] *See* CBRS Alliance, http://www.cbrsalliance.org/ (last visited 28 Nov. 2016). CBRS Alliance members include AT&T, Qualcomm, Intel, Nokia, Ericsson, and Access Technologies (Alphabet).

[11] Global TD-LTE Initiative, http://www.gtigroup.org/ (last visited 28 Nov. 2016).

A piecemeal approach to the 3.4 GHz to 3.8 GHz frequency range risks fragmentation and a loss of benefits.

Question 3: Do you agree with our high level proposal to make 116 MHz within the 3.6 to 3.8 GHz band available for mobile and 5G services, bearing in mind our statutory duties and the high level trends we have identified?

In general, we agree that this band should be made available to a wider range of services, including but not limited to mobile technology, whether 4G or 5G, mobile or fixed. We support Ofcom's identification of this band as high-priority for mobile services in its Mobile Data Strategy.[12] We expect that existing users will recognise this trend and accept that mobile use will enter the band in some form.

However, the central spectrum policy question hinges on *how* and *when* such mobile services are introduced to and authorised in the band. Ofcom's identification of two policy options relating to existing user authorisations, characterised as 'retain' and 'remove', creates too stark a choice, and a middle way must be found, which we discuss in our response to Question 6.

Question 4: Do you agree with our general approach regarding spectrum currently licensed to UK Broadband?

We agree with the general approach, noting that fees should only be applied as and when the band is directly substitutable for existing mobile spectrum bands, taking full account of the impact of existing users and the availability of widespread mobile devices supporting the band. At this stage, device and network equipment availability are not the same across the entire 3.4 to 4.2 GHz range.

We expect that a database-driven approach will provide UK Broadband and other users of the band with a faster, simpler, and more certain method for deploying new base stations than is available under the current coordination procedure. It should also allow for tighter reuse of the spectrum while providing greater certainty of spectrum quality for existing users, allowing three-dimensional, high-resolution coordination that takes full account of the substantial impact of clutter (buildings and trees) and terrain at these frequencies as well as the actual, rather than hypothetical worst-case, characteristics of new and existing systems.

Question 5: Do you agree with our assumptions, methodology, and conclusions with regards to potential coexistence between mobile and existing fixed links and satellite earth stations?

We have several concerns with the basis of the coexistence calculations. In general Ofcom overestimates the burden of coordination significantly, and has adopted excessively worst-case scenario assumptions. This has led Ofcom to the stark 'retain' or 'remove' options,

[12] Ofcom, *Mobile Data Strategy update* (30 June 2016), http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-data-strategy/statement/update-strategy-mobile-spectrum.pdf.

which consider little opportunity for sharing between mobile services, with reduced spectrum quality even in the 'retain' option. This is unnecessary.

Fixed Satellite Service (FSS) interference protection criteria have generally been developed during earlier eras of spectrum use without regard to their opportunity costs and negative impact on modern shared spectrum opportunities, leading to pessimistic coexistence predictions. Perhaps even more importantly, clutter losses are high in the 3.6 GHz to 3.8 GHz band, and some FSS sites operating in the band are significantly better protected by foliage and buildings than simple propagation analysis might predict.

While the analysis is described as 'high resolution',[13] it does not adequately capture the impact of clutter, which would allow very dense reuse of these frequencies and additional opportunities for shielding existing systems. For example, we have collected over 2 million propagation measurements in built-up environments, and median excess path losses are over 30 dB at 200 metres and greater than 50 dB at 400 metres (see chart below). This indicates a substantial opportunity for additional spectrum sharing.

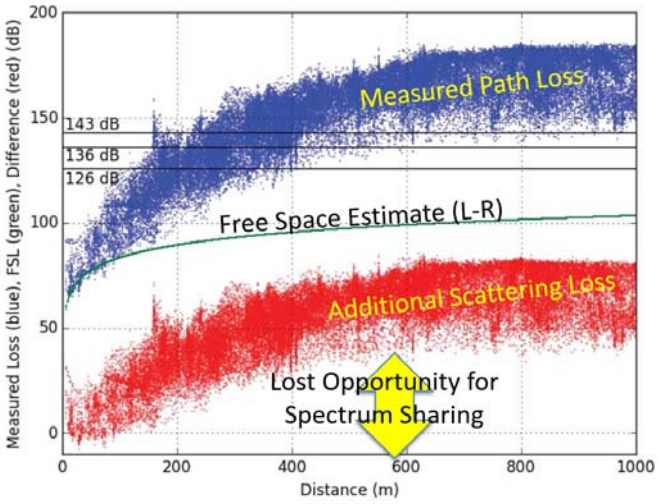

Chart 1: Propagation Loss Measured in Mountain View, California

Measurements of propagation losses through individual materials indicate that single walls, floors, and windows exhibit propagation losses of 30-50 dB, suggesting scope for many systems to coexist even within a single multi-tenanted building with light-touch coordination procedures, and that such systems will cause little interference to systems beyond the building in most cases. Protecting for the worst case is intrinsically inefficient.

Aside from the details of the propagation calculations, the scenarios on which Ofcom has based its decisions are excessively worst-case. A small cell high in the BT Tower with line of sight to most of London is not a representative deployment. Similarly, in real deployments, outdoor small cells are specifically sited to be deep in the urban canyon environment, where they have substantial shielding. Assuming that there is no such shielding appears designed

[13] *Ofcom Consultation*, ¶ A5.6.

to show extreme behaviour and is, again, not an efficient basis for policy regarding established systems. On the other hand, Ofcom has not considered the full range of relevant use cases, such as factoring in how future LTE and 5G technologies will allow a flexible mix of mobile and fixed access and backhaul/fronthaul to support network virtualization.

Even where there is potential for interference from a proposed system, actual interference can be avoided through appropriate modifications to the authorised system parameters such as power, frequency, and antenna patterns. As the information provided by Ofcom shows, in most parts of the country, very large portions of the band are unoccupied, so in most cases interference could be avoided rather simply.

As a point of comparison, initial Federal Communications Commission's calculations with respect to the US CBRS band suggested that 40% of the US population would be denied service. More careful calculations indicate that its availability includes 95% of the continental US.[14]

A database-driven approach can allow the burden of coordination to be very low compared to the benefits gained. Indeed, the coordination process can be fully automated and will avoid the loss of spectrum efficiency resulting from the worst-case scenarios which Ofcom is considering and relying on for its policy proposals.

Question 6: Do you have a view on any of the two options we identified?

We are concerned that the options identified by Ofcom — 'retain' and 'remove' — present an unnecessarily stark view of the policy choices available. These options are based on conservative coexistence analysis, which adopts worst-case scenario assumptions and overestimates the burden of coexistence significantly. This is not representative of likely use of the band. The 'retain' and 'remove' options provide little opportunity for sharing between mobile services, with reduced spectrum quality even in the 'retain' option, and a better solution must be found.

As stated in our response to Question 3, such a solution should:

- Provide existing users clarity as to how the interference environment they face will change over time. As long as satellite and fixed services continue to be allowed, we do not believe it is sufficient simply for them to be asked to accept reduced spectrum quality without the explicit ability to understand and track the level of interference they must work with.
- Maximise the opportunity for new users to innovate in mobile technology-based broadband wireless infrastructure and enable incremental investment in this band, taking full account of international trends in this band.

[14] Compare *In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Notice of Proposed Rulemaking, 27 FCC Rcd. 15594 (2012), *available at* https://apps.fcc.gov/edocs_public/attachmatch/FCC-12-148A1_Rcd.pdf, and *In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd. 3959 (2015), *available at* https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-47A1.pdf.

- Maximise spectrum efficiency, avoiding excessively conservative exclusion zones but ensuring that coexistence arrangements are adequate to protect the interests of existing users for as long as they retain authorisation.

As explained further in our answer to Question 8, a multi-tier database-driven framework would meet these requirements and bring significant benefit to citizen-consumers.

Question 7: Do you have any quantitative evidence on the costs and benefits associated with the options? This includes costs for existing users and/or consumers of existing services associated with potential changes, and benefits to UK consumers in gaining access to mobile service in this band.

We have no quantitative evidence on the costs and benefits associated with the two options identified by Ofcom. However, we see ample opportunity for benefits to UK consumers from new deployment models enabled by spectrum sharing, including:

- Co-investment and partnership models of network investment that would enable operators to extend their services further than before, including deep into buildings.
- Vertical industries self-providing infrastructure for specialist applications using 4G/5G technology.
- Shared multi-operator systems that reduce costs and increase flexibility in a wider range of buildings and venues.
- Hybrid, flexible network deployments comprising a mix of mobile access, fixed access, and wireless backhaul and fronthaul.

Question 8: Do you have any other suggestions that would allow widespread 5G availability using the 3.6 to 3.8 GHz band across the UK while allowing certainty for at least some existing users to continue to provide the benefits currently provided by use of the 3.6 to 3.8 GHz band?

Instead of adopting either the 'retain' option or the 'remove' option, both of which are based on unrealistic assumptions about usage of the band, Ofcom should opt for a middle path: a multi-tier database-driven access system, which provides existing users with clarity regarding the levels of incoming interference that their systems will face and new users with the greatest opportunity to make use of spectrum where and when it is available. Although the incumbent uses are largely static, the basic nature of mobile operations is dynamic, and therefore aggregate interference considerations change with time. Database-driven approaches can track such dynamic uses and provide incumbents with protection at all times.

We support a broad mix of spectrum allocation methodologies, including exclusive licences, licence-exemption, and shared spectrum. Furthermore, there needs to be an appropriate mix of these methodologies to support the widest range of innovation opportunities. In mobile access, almost all spectrum that is currently usable for mobile technology is exclusively licensed, and there is a growing need for shared spectrum — as well as additional exclusively licensed spectrum — to support varied models of mobile access. Ofcom should show leadership now by enabling such models in the UK.

A multi-tier, database-driven approach facilitates both licensed and licence-exempt access to the spectrum, facilitating the widest possible range of innovative business models with low barriers to entry, protection of investment, and opportunities for co-existence in networks. This will enable a wide range of providers to meet both well-established use cases for mobile broadband and new use cases for 5G systems deployed by and for vertical industries and innovative service providers. Ofcom missed an opportunity for such innovation in its 2.6 GHz award by not designing the auction to enable concurrent spectrum access.[15] Now is the opportunity to rectify this. Innovation opportunities include:

- Enabling mobile operators to extend the coverage and capacity of their systems more rapidly and cost-effectively via sharing and lower-cost deployment models.
- Allowing businesses and public buildings to improve mobile service for all operators in a single technology deployment without wasteful deployment of multiple systems or a reduction in choice amongst providers.
- Enabling specialist systems, such as those for critical applications and special applications, to take advantage of international economies of scale for mobile equipment.

In April 2016, Ofcom started to consider such a tiered sharing structure in its call for input on the 3.8 to 4.2 GHz band.[16] We refer to Google Inc.'s previous response on that issue[17]. The 3.6 to 3.8 GHz band (and its 3.4 to 3.6 GHz neighbour) is even more suitable for tiered sharing due to the large and growing international ecosystem for LTE equipment and the nature of the band's existing users. It is curious that Ofcom has apparently not even considered this approach amongst its policy options given the considerations in its Spectrum Sharing Framework which lead to a clear requirement for more spectrum sharing.[18] As Ofcom highlights, 'new sharing opportunities will result in benefits for citizens and consumers from better and potentially new wireless services.'[19] This is just such an opportunity.

Question 9: Do you have any comments in relation to these proposals?

We have no further comments at this time.

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[15] Ofcom, *800 MHz & 2.6 GHz Combined Award* (09 May 2012), https://www.ofcom.org.uk/spectrum/spectrum-management/spectrum-awards/awards-archive/completed-awards/800mhz-2.6ghz.

[16] Ofcom, *3.8 GHz to 4.2 GHz band: Opportunity for Innovation* (14 Apr. 2016), http://stakeholders.ofcom.org.uk/binaries/consultations/opportunities-for-spectrum-sharinginnovation/summary/condoc.pdf.

[17] Google Inc., *Google's response to Ofcom's Call for Input: "3.8 GHz to 4.2 GHz band: Opportunities for Innovation"* (June 2016), https://www.ofcom.org.uk/__data/assets/pdf_file/0022/80752/google_inc.pdf.

[18] See Ofcom Spectrum Sharing Framework.

[19] Ofcom, A Framework for Spectrum Sharing, https://www.ofcom.org.uk/consultations-and-statements/category-2/spectrum-sharing-framework (last visited 30 Nov. 2016).