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Response to Ofcom's Consultation Document on:
**Improving consumer access to mobile services at
3.6 to 3.8 GHz**

(Issued by Ofcom on 6 October 2016)

BT plc and EE Ltd
7 December 2016

Executive summary

1. BT/EE agrees that the 3.6 – 3.8GHz band is valuable for future mobile and has a role in providing wide spread coverage of 5G services in the UK. In particular high power mobile use will now place a value on this band. This cannot be fully unlocked under Ofcom's 'Retain' Option, which is likely to limit the mobile use of the band mainly to small cell deployments, more so if further fixed link and satellite Earth station sites were to be licensed.
2. However, BT's existing services in the band produce significant value for the UK economy and it is important to be able to retain their operation, by ensuring continued protection from interference in appropriate cases. BT uses the band globally for satellite services, and will require high value services to continue to be protected from interference at its Earth station at Madley in Herefordshire. This cannot be guaranteed under Ofcom's 'Remove' option, which we do not consider to be a proportionate solution.
3. This means that neither of Ofcom's proposed options, i.e. to either retain all services in the band (option A) or to effectively remove all services in the band (option B), would maximise the net value to UK consumers and citizens from this band. Ofcom needs to find a more efficient sharing scenario for the 3.6 - 3.8 GHz band; that is likely to be somewhere in between the two extreme options presented in the consultation document.
4. We believe market mechanisms have an important role to play in finding the most efficient sharing scenario between Option A and B. We suggest that Ofcom should urgently evaluate the option of conducting a reverse auction in the 3.6 - 3.8 GHz band in which participation by existing users would be voluntary, prior to a forward auction awarding 3.6 - 3.8 GHz for mobile subject to the restrictions necessary to protect existing users who had opted to stay. The purpose of this mechanism would be to understand the value of the 3.6 - 3.8 GHz band to existing users and use that information to create intermediate scenarios comprising some existing uses as well as both low power and high power mobile deployment.
5. We believe that a reverse auction, providing incentive for existing users to vacate the spectrum where the use is not the most efficient, is preferable to relying on trades in the secondary market and more appropriate than relying on increasing administrative incentive pricing. Some existing users have no realistic or cost-effective alternative and for them, AIP would simply tax existing use without encouraging clearance. Other users may vacate the band as a result of higher AIP, but this would happen later than needed for 5G mobile and the secondary market would have to overcome serious coordination challenges in order to efficiently allocate the benefits of such clearance.
6. It is also essential that existing spectrum be normalised within the process not outside. If, for example, UK Broadband wish to have their licence conditions amended to reflect new mobile licences that may be awarded by a forward auction in 3.6 – 3.8 GHz, they should participate in the reverse auction and compete for the spectrum on an equivalent basis in the forward auction. If they do not participate in the reverse auction, their licence conditions should not be changed.

1. Introduction

BT/EE welcomes this consultation document, and are pleased to have the opportunity to comment on these proposals. Ofcom's consultation is very timely given the focus on this band in the context of European and UK discussions around the future 5G spectrum options and the proximity to other spectrum that Ofcom plans to auction soon. We have a strong interest in future mobile, including potential availability of this band for 5G, as well as a priority of ensuring the possibility for continued interference free operation of important satellite services delivered by BT using our Earth stations located in Madley in Herefordshire that use the 3.6 – 3.8 GHz spectrum band.

2. The value of existing services in the band

As Ofcom notes in the consultation, the 3.6 - 3.8 GHz band is currently used by fixed links and by satellite services for space to Earth reception. BT and other satellite operators in the band currently use the band to receive satellite signals that provide a wide range of communications services. Our satellite earth stations at Madley receive in the 3.6 - 4.2 GHz band ('C-band') as well as other bands. BT uses its earth stations to carry broadcasting, critical and high value voice and data traffic for UK {Confidential: ✂ } consumers and businesses including to areas of the world where fibre is not available as well as for aircraft landing control systems, high availability and disaster relief services. BT uses the C-band extensively for satellite services in the UK, across Europe and the rest of the world. Existing contracts typically run for three to five years and in some cases up to 10 years.

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BT has no control over what frequencies are allocated to us from the satellite operators, therefore we are not able to exclude specific frequencies in the C-band spectrum and believe strongly that an option should be retained for individual earth stations to continue to have protected use of the full band. The loss of C-band (or a significant part of it) would be detrimental to our ability to support the critical and high value services we provide.

Under Ofcom's 'Remove' option, after an interim period, existing users within the band would no longer be protected from undue interference. In the Consultation, Ofcom claims that:

*"Satellite service operators are generally able to provide the same service by using the same frequencies but from a different location or by adopting technical mitigations against undue interference (i.e. shielding). In most cases, the satellites they connect to can be reached from almost anywhere in the UK and sometimes using different frequencies."*¹

We agree with Ofcom that some satellite operators may be able to continue providing services by using the same frequencies but from a different location or by adopting technical mitigations against undue interference (i.e. shielding). Indeed there may be scope for consolidation of some smaller satellite earth stations to less densely populated areas of the UK. However in the case of BT's site at Madley, the size of the dishes mean that technical mitigations such as shielding or relocating would not be feasible. Without suitable protection for satellite, the high value services that BT provides would almost certainly suffer severe degradation in quality or cease to work. Operation of BT's satellite Earth stations at Madley on an unprotected basis would therefore not be appropriate. Ofcom's 'Remove' option ("Option B") represents an intervention to remove BT's high value services with no evidence to demonstrate that these represent an inefficient use of the spectrum.

¹ Ofcom, The Consultation, Para 9.15

Notwithstanding our views on satellite use, we agree with Ofcom that this band has significant value for mobile use, that we want to see unlocked, which we explain in more detail below.

3. Benefits of high powered mobile use of the band

The 3.4 - 3.8 GHz band has been identified by regulators and industry across Europe as a key band for the rollout of 5G services. In a recent opinion paper the Radio Spectrum Policy Group (RSPG) wrote that:

*"The RSPG considers the 3400-3800 MHz band to be the primary band suitable for the introduction of 5G use in Europe even before 2020, noting that this band is already harmonised for mobile networks, and consists of up to 400 MHz of continuous spectrum enabling wide channel bandwidth. This band has the possibility to put Europe at the forefront of the 5G deployment"*²

This is a significant development since Ofcom published its October 2015 Statement on the "Public Sector Spectrum Release." In EE's response to Ofcom's May 2015 Statement and consultation on "Public Sector Spectrum Release: Award of the 2.3 and 3.4 GHz spectrum bands", EE noted that it considered the 3.4 GHz band to be particularly suitable for deployment of LTE in a small cell layer due to the propagation characteristics of the spectrum. This spectrum would provide additional capacity within an existing LTE ('4G') coverage layer provided primarily by 800, 1800 and 2600 MHz spectrum.

As Ofcom acknowledges in the 3.6 - 3.8 GHz Consultation, the wider 3.4 - 3.8 GHz band has since emerged as a key band for the launch of 5G in Europe. This is evidenced by the draft RSPG opinion on spectrum aspects for 5G, which notes the possibility that 5G could be launched in this band before 2020.³ As a result of this development, we now believe it less likely that there will be significant LTE deployment in this band in Europe and more likely that operators will deploy 5G radio equipment as a complement to 4G radio networks.

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Maintaining all incumbent use of the band in accordance with Ofcom's 'Retain' option is likely to limit use of the 3.6 - 3.8 GHz band for mobile to small cell deployment in many areas. This is because the aggregation of all of the exclusion zones that are likely to be required to avoid interference with incumbent users, particularly in densely populated areas, would make macro cell deployment practically impossible. As a result, under the 'Retain' option, this spectrum has much less value as part of a '5G coverage band'.

A key source of value for existing mobile operators arises from the costs that can be avoided from deploying an additional spectrum band for capacity on existing sites rather than having to invest in additional sites, where these additional sites might come in the form of new macro sites or capacity small cells. If the 3.6 – 3.8 GHz band were to be restricted entirely to low power, so that it could only be deployed on small cells, there would be much less (if any) cost avoidance achieved by its deployment on existing sites, as the small cell covers only a limited area. Other options now and in the future would provide significant capacity at these sites (existing mobile spectrum, LAA/LWA, 3.4 - 3.6 GHz spectrum, future mmWave spectrum).

Ofcom's 'Remove' option would create the opportunity for mobile operators to roll out 5G services on the macro network and extract significant cost savings in the process, but as explained above

² RSPG16-031 FINAL

³ http://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf

would also eliminate high value existing use. BT/EE consider that there is significant scope to use the band more efficiently through increased sharing in the band, and Ofcom can facilitate this through a market mechanism as explained below.

4. A market mechanism to facilitate efficient sharing

As outlined above, neither of Ofcom's proposed options to either retain or remove all services in the band are likely to maximise the net value to UK consumers and citizens from this band. Rather, Ofcom needs to find a more efficient sharing scenario for 3.6 - 3.8 GHz that is likely somewhere in between the two extreme options presented in the consultation document. We note that in the Consultation Ofcom states that it is interested in hearing of any other possible solutions, which might allow availability for mobile use including 5G in the 3.6 - 3.8 GHz band across the UK while maintaining sufficient certainty for at least some existing users to continue to invest and use the band⁴. BT/EE believe that market mechanisms can help facilitate the most efficient sharing scenario between Ofcom's Option A and Option B.

Scope for efficiency improvements through the secondary market

In the consultation Ofcom suggests that in order to incentivise efficient use of the band it may consider allowing existing users to accept a lower benchmark spectrum quality if they wish to come to a commercial or technical agreement with new users of the band for mobile services. In addition to this, Ofcom also state that it would be likely to review fees for existing users taking into account the extent to which mobile deployments would have been denied access to the band, in line with its pricing framework.

Whilst we agree that increased fees to reflect the opportunity cost from mobile use would be expected to incentivise some, but not all⁵, fixed link and satellite operations to move out of the band or relocate to less populated areas, this is likely to be a prolonged process. The process of revising fees and phasing them in would take several years. Existing users who would react to increased AIPs by relinquishing their use may not do so until the full fees are charged.

There would also be very serious coordination challenges to overcome. Imagine that low-power licences have been awarded to a number of mobile operators whilst increased AIP fees have been applied to incumbent users. Any commercial agreements to increase allowed power in mobile licences by satellite or fixed links users vacating the band or accepting lower protection will involve negotiations between multiple parties, including several mobile operators and existing users in the band. This is further complicated by the fact that where existing users are clustered, and there is overlap between exclusion zones, the gains from each trade are likely to vary depending on whether other existing users in the localised area move out of the band. For example if there are two satellite earth stations with overlapping exclusion zones, the value to mobile operators of reaching a commercial or technical agreement with one of the satellite users is likely to be heavily dependent on reaching a similar agreement with the second satellite operator (i.e. the gains from one trade will depend on one or more other trades taking place). Likewise the mobile operators would have to agree to share the costs of "buying out" incumbent users. The result of this is that in some cases, not only will there be multiple parties in negotiations, but there will be an interdependency between the various commercial agreements. Such a series of independent, bilateral deals are very unlikely to happen in practice.

⁴ Ofcom, The Consultation, Para 9.3

⁵ We don't believe increased AIPs will have any incentive effect in situations where the current users have nowhere else to go and have existing long-term contracts and investments in place. In those case, increased AIPs will simply function like a tax.

We therefore do not believe that it is realistic to rely on the secondary market to speed up the process of clearing any inefficient current use and reassign frequencies to mobile in given locations.

Facilitating efficient sharing through an incentive auction

We consider that these coordination problems could be overcome by Ofcom conducting a reverse auction in the 3.6 - 3.8 GHz band for existing users who may be prepared to relinquish their licences prior to a forward auction of spectrum suitable for mobile with appropriate licence conditions to reflect any necessary restrictions to protect existing users who have chosen to stay. This would be a means of repurposing spectrum by encouraging licensees to voluntarily clear their spectrum, or in the case of satellite give up protection on receive links, in exchange for a share of the proceeds from an auction of new licences to use the repurposed spectrum. If the reverse auction has been successful in vacating some or most of the existing users in the band, high power licences suitable for mobile could be awarded in large parts of the UK.

Prior to the auction, Ofcom should confirm the size of the necessary exclusion zones around each existing satellite and fixed links user where high-power mobile use cannot be tolerated and the conditions under which lower power small cell use could be tolerated within these exclusion zones. This is a piece of detailed technical work that will be required for any sharing solution, i.e. any solution other than Ofcom's 'Remove' option. Hence this work should be started immediately.

Participation in the reverse auction would be entirely voluntary and provide an opportunity to arrive at an efficient level of ongoing use from incumbent users whilst also enabling the ability for Ofcom to assign licences for mobile use in this band without delay and at high power where possible. The reference point for such an 'incentive auction' is of course the US FCC's ongoing incentive auction to facilitate the potential reassignment of spectrum currently used for terrestrial TV broadcasting to mobile. The US incentive auction is complex as a result of its aim to work out through the reverse auction not only if broadcasting spectrum should change use but if so how much, the need to repackage any relinquished spectrum and remaining TV use after the reverse auction and the forward auction assigning spectrum to mobile on a state by state basis. In the case of the 3.6 – 3.8 GHz band in the UK, we believe an incentive auction would be simpler. The decision being presented to incumbent users would be a binary choice: participate in the auction for the opportunity to name your price to relinquish your licence (or continue operation with the protection afforded today) by a certain date. The aim would be to establish the efficient set of geographical areas that need to continue to have restrictions on mobile use. We believe that existing users can value their continued operation and hence efficiently price relinquishment should they wish to participate in a reverse auction. Ofcom would need to assess which auction format would be most likely to promote an efficient reverse auction but it is possible that a relatively simple sealed bid format could be suitable.

After receiving bids for clearance, Ofcom would run the forward auction to determine if the total compensation requested was less than the amount new mobile users would be willing to pay such that it would be able to honour all compensation bids. The auction design would need to include an allocation key to decide which relinquishment bids from the reverse auction would be accepted if the sum of compensation bids exceeded the amount new users had bid in the forward auction or another mechanism for potentially re-running the reverse auction. This would serve to provide existing users with an incentive to minimise their bids. Following the reverse auction, Ofcom would confirm exclusion zones around the remaining users and proceed to award licences suitable for mobile with specified geographical exclusion zones. These can be valued by MNOs and other bidders so as to make efficient bid decisions in a forward auction.

BT/EE suggest that the reverse auction could also include the spectrum currently held by UK Broadband in the 3.6 - 3.8 GHz band. UK Broadband has access to 42% of the 3.6 - 3.8 GHz band, however the current licence conditions reduce the value for mobile due to the coordination requirements and the power level restrictions at 53 dBm/MHz (equating to 60dBm/5MHz). Those requirements and restrictions may not be necessary in many parts of the UK if a sufficient number of other existing users opt to relinquish their licences through the reverse auction. An incentive auction would provide an opportunity for UK Broadband to effectively trade its spectrum and if it wished, bid in the forward auction to convert this to higher value licences suitable for 5G mobile deployment. If Ofcom decided to progress with an incentive auction, we believe Ofcom should state that it did not intend to consider licence variation requests from UK Broadband in relation to its 3.6 – 3.8 GHz spectrum outside of that process. This would increase the likelihood that if there was scope to increase the power limits or reduce the coordination, such changes were implemented in a timely way that would not delay the possibility of high-power use of that spectrum. Notwithstanding the above proposals, we agree with Ofcom's proposal that UK Broadband's licence in the 3.6 to 3.8 GHz band should be brought under the Mobile Trading Regulations as a precautionary measure that allows Ofcom to assess competition effects of any proposed trade ex-ante.

In order to enable existing users to decide whether to participate in the reverse auction, Ofcom will need to be clear on their future operating conditions should they choose to stay as well as, in the case of fixed links, the possibility to re-accommodate them on other frequencies. Ofcom would also need to outline the future licence fees regime and should vary these by geographical location of the satellite earth station to reflect the fact that in more densely populated areas the value to mobile, and therefore opportunity cost, is generally higher⁶.

Legal basis for an incentive auction

We recognise that conducting an Incentive Auction may require minor amendment to the Wireless Telegraphy Act. There is precedent for such amendment, the Digital Economy Act 2010 allowed Ofcom to pay auction proceeds to third parties in specified circumstances. If Ofcom and Government acted without any delay there is an opportunity to include the necessary changes in the Digital Economy Bill going through the Houses of Parliament at present. We note that Government has previously stated its intention to introduce legislation to allow for incentive auctions and therefore there should be political will to make the changes.⁷

6. Our responses to the consultation questions

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

Fixed Satellite Service

BT operate numerous services in the C-band frequency range which covers all of 3.6 – 3.8 GHz. These services provide critical connectivity for corporate and government customers who do not have any other form of connectivity into countries where terrestrial infrastructure is limited. This includes WAN connectivity for Galileo (EU GPS system). Any interference into these systems across

⁶ If it wished to do so, Ofcom could consult further on the methodology it would intend to follow for setting such AIPs, ahead of an award of relevant benchmark spectrum in 3.4 - 3.8 GHz without fettering its discretion to set actual levels after the award. This would be similar to the approach Ofcom took to setting fees for mobile operators 900 and 1800 MHz spectrum licences where it first consulted on its intended methodology in 2011 including the intention to rely to some extent on prices to be paid in the auction of 800 MHz and 2.6 GHz prior to the auction of 800 MHz and 2.6 GHz spectrum taking place in 2013.

⁷ Connectivity, Content and Consumers; Britain's digital platform for growth", July 2013.

Europe, would mean 10 years of design work becoming redundant, and require an alternative high availability network to be designed, bringing the service rollout to halt. In addition to Galileo, EGNOS (pan-European satellite navigation system) uses the C-band for providing connectivity. EGNOS is a service which provides critical safety of life applications such as flying aircraft or navigating ships through narrow channels.

BT also use these frequencies for reception of BT Sport TV services for sporting events, for example the around the world yacht race and Americas cup, which are downlinked to our Madley communications centre, and provided to a large number of customers throughout the UK over BT's terrestrial infrastructure. Any additional interference to these services can result in loss of connectivity for these customers.

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From the satellite services perspective, the C-band is a small frequency range that is unique in making high availability satellite services technically viable due to its suitability for reception of small strength signals from satellites and resilience to rain fade. The use of this entire frequency band for satellite services should be retained whilst exploring ways in which 3.6 – 3.8 GHz could be shared with mobile subject to the continuing protection of existing earth stations where that is the most efficient use.

Globally, C-band capacity also provides an invaluable resource for supporting disaster recovery deployments. BT's large (32m) antennas at Madley have supported UK agencies in providing initial communications to disaster zones in areas such as Vanuatu, Pakistan and Indonesia.

We would highlight that if satellite services are altogether excluded from the UK, because Ofcom will not continue to guarantee protection from interference or introduces fees that make such services unviable, then the UK economy will suffer as satellite operations will be moved outside of the UK.

The earth station at Madley, which was established at the very advent of satellite communications and has developed into a renowned centre of excellence for satellite communications, is an important asset for BT and the UK and has potential to accommodate additional applications in future.

Fixed Service

We note from Ofcom's online register of licences that there are five existing licensees operating fixed links in the 3.6 – 3.8 GHz sub-band, with two of these mostly operating in more remote parts of the UK and three in more densely populated areas of South East England.

BT does not itself operate any fixed links in this band. We note that Ofcom's consultation shows predicted interference from a link from the BT Tower in London and assume this is just an illustration of a past scenario or a hypothetical future one.

Given the relatively low number of existing fixed links (27 in total, some over the same paths) and the very small number of licensees, we recommend that Ofcom urgently studies the feasibility of re-accommodating those links that would affect mobile use in more heavily populated areas within other spectrum that Ofcom manages. We further recommend, in view of the fact that there are many other spectrum bands available for fixed links, and indeed other channels outside the 3.6 - 3.8 GHz sub-band, that Ofcom does not authorise new assignments for fixed links in the 3.6 - 3.8GHz band.

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?

We agree that there is growing demand for capacity on mobile networks, and that additional spectrum bands will be needed. We also recognise that the 3.6 - 3.8 GHz band has been identified as a target candidate band for mobile expansion. As Ofcom note in the Consultation, the 3.4 - 3.8 GHz band as a whole represents an attractive opportunity because it is harmonised across Europe for mobile and has sufficiently large bandwidth for 5G.

There is strong momentum towards the introduction of 5G towards the end of the decade both to offer capacity to meet consumer demand but also to deliver new services for which 5G access may be a key enabler. There is now considerable activity in international bodies to complete standardisation of first generation 5G systems within the next 2 years. Further, there is already significant industry activity to realise operational 5G mobile systems in the next 2-3 years, most notably in Korea, Japan and the USA, with interest growing worldwide, including Europe.

This industry activity to develop and realise plans to deploy next generation mobile systems requires spectrum of sufficient bandwidth to be made available in bands of suitable propagation characteristics to support wide rollout of new 5G capabilities. The 3.4 - 3.8GHz bands are expected to possess these characteristics and the release of this spectrum can support the wide provision of 5G services requiring even higher network performance, to the benefit of UK consumers and economy.

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?

Yes, we agree that Ofcom should make the 3.6 - 3.8GHz band available to mobile and 5G services on a shared basis, but with the possibility to continue operation of existing high value services, with continued protection from interference in appropriate cases.

As explained above, we suggest Ofcom urgently consider the use of an incentive auction to establish the most efficient sharing scenario between existing use and new mobile use of this band. Ofcom should encourage UK Broadband to participate in the reverse auction, opening the opportunity that 200 MHz in the 3.6 – 3.8 GHz band could be made available for mobile subject to defined geographical exclusion zones.

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

We consider that the rights and obligations of UK Broadband, including coordination requirements and fees should be reviewed, taking into account the status of their existing use and the conclusions reached on the remaining 3.6 – 3.8GHz band. The 3.4 – 3.8GHz band is now widely recognised as one of the bands that are of interest for 5G mobile in Europe. UK Broadband Ltd already has access to 124 MHz (31%) of this spectrum, with indefinite tradable licences. We do not know the exact detail of the UK Broadband network deployments, but understand this to be of very limited geographical extent. This suggests that the spectrum might have higher value to others where it is not currently being used, and that a trade, effected by the reverse auction proposed above, might lead to more efficient use of the spectrum. We believe that the secondary market for mobile spectrum, facilitated by a reverse auction, could be important to secure optimal use of the spectrum in the 3.6 - 3.8GHz

band and Ofcom should ensure that the appropriate conditions are in place to handle this opportunity.

It is essential that existing spectrum of UK Broadband be normalised within a reverse auction process, not outside. If, for example, UK Broadband wishes to have their licence conditions amended to reflect those of the licences that would be awarded in a forward auction of 3.6 – 3.8 GHz band, UK Broadband should participate in the reverse auction and compete for spectrum in the forward auction on an equivalent basis. If they do not participate in the reverse auction, their licence conditions should not be changed.

Notwithstanding the above, we agree that UK Broadband's licence in the 3.6 - 3.8 GHz band should be brought under the Mobile Trading Regulations as a precautionary measure.

Finally, if Ofcom did not take up the suggestion of a reverse auction it should consider requiring UK Broadband to re-bid for the location of its existing spectrum if it enters an auction of 3.6 - 3.8GHz in the same way as Ofcom has decided it would require for the 3.4 – 3.6 GHz auction in order to minimise the risk of fragmented assignments in the 3.4 – 3.8 GHz band.

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? Please refer to annex 5 for further details.

We broadly agree with the methodology used to analyse the sharing potential but question whether the data used is up to date (for example the BT Tower link we understand is a hypothetical illustration rather than a link in operation). We also note that the consultation mentions that there were 34 fixed links in the band in August 2016 and used in the analysis, whereas our own more recent search of Ofcom's online WTR showed slightly fewer links (27).

We consider that in some cases, e.g. satellite Earth stations at ground level with smaller dish sizes, there may be potential to substantially shrink coordination zones by site shielding. The technical and commercial feasibility of this should be assessed. We also consider that clutter modelling in addition to simple terrain models may be helpful in any more detailed interference assessment as well as identifying how much of the 3.6 - 3.8GHz band would be simultaneously used from each site and whether that would change over time.

BT has done some initial modelling around the Madley earth station site which we would be happy to discuss with Ofcom. As part of this exercise we have looked at what proportion of premises would fall within coordination zones for various mobile base station power levels (corresponding to high power macrocells and lower power smaller cells). We have also studied interference levels under both long term (steady state) and short term (anomalous) propagation conditions. These studies suggest that in the scenario of high power mobile macrocells, the short-term interference propagation effects are the most significant in terms of the distance over which the Earth station could receive unwanted interference. If measures can be applied to mitigate these effects, or the modelling assumptions can be made more accurate, the sharing potential improves considerably.

In the case of high power mobile base stations our preliminary investigations suggest that short-term interference propagation considerations will dominate over the effects of long-term interference mechanisms. Lower power base stations would require considerably smaller separation distances.

Whilst we recognise that these modelling studies will provide guidance on the necessary protection zones around the Earth stations, we believe that testing will be needed to determine the specific nature and effect of any possible interference from a mobile network into the satellite receivers. In the case of sites with multiple C-band antennas, these tests must also consider the effect of multipath interference due to the reflection of signals off metal structures such as other large satellite antennas.

The sharing potential would be improved with more accurate modelling that takes into all available interference mitigation factors, such as real rather than reference antenna patterns, polarisation discrimination, clutter, shielding, base station loading and antenna down tilt. All this is consistent with studies published by the ITU⁸ and the Transfinite modelling referenced in the consultation, but we emphasize the need to look at this in more detail for all sites and specific Earth station configurations. We would be happy to look at the various BT antennas at Madley to understand these effects in greater detail and consider whether any mitigating assumptions or measures could be used in future to improve potential for sharing with future mobile.

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

As explained in section 4 above, we consider that neither of the two extreme options that Ofcom has proposed will secure the optimal use of the 3.6 – 3.8GHz band for the UK and a much more nuanced solution is needed. This is likely to be somewhere between the two options.

The “Retain” option would unduly limit the benefits that could be realised from use of the band for future mobile, including 5G.

The “Remove” option would not safeguard the benefits of the existing high value services, including those provided through our Madley satellite Earth station facility, for which protection from interference is required.

A solution that does not remove the possibility for existing high value services to continue operating with protection from interference would be consistent with the original EC harmonisation measure⁹ which clearly indicates that the requirement to designate and make available the band for terrestrial electronic communication networks is “on a non-exclusive basis” and “without prejudice to the protection and continued operation of other existing use in this band”. It would also be consistent with the relative status of mobile service and fixed satellite service international allocations in the 3.6 - 3.8GHz band in the ITU Radio Regulations.

We also note that ECC Report 254 (to be published shortly) provides guidance on enabling administrations to protect incumbent use of the band, whilst also facilitating its use by new entrants.

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

The difference in benefits between the two options that Ofcom has put forward is in essence the value of the 3.6 - 3.8 GHz band to mobile unencumbered by existing use versus the benefits to mobile if existing services were to be protected. The impact of existing use, for example in terms of exclusion zones or power limits, therefore needs to be clearly understood.

⁸ See : http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-S.2368-2015-MSW-E.docx

⁹ See Article 2 (1) of <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0276&from=EN>

Impact of protection of existing use

As mentioned in response to Q5, continued protection of earth stations will require exclusion zones for mobile base stations to be established around these sites.

In summary the potential loss of benefit to mobile will depend on many factors including where the protected Earth stations are located, the difference in value of low power mobile base stations deployable over larger areas compared to high power base stations deployable over more restricted areas, the mitigation effects that can be implemented or factored into modelling and predictions, and other factors.

We recommend that given the potential impact on future mobile use new Earth station sites are not authorised in areas close to high population density.

Cost to existing services if interference protection is removed

In terms of the costs to existing services if protection from interference was removed, we cannot comment on systems operated by other parties. However, for BT, if satellite operations at Madley were not protected this would affect high value contracts running to millions or even tens of millions of pounds (per annum) that BT delivers, and thus remove the significant benefits that businesses, citizen consumers and Governments derive from the capability delivered by satellite, that cannot be replicated with fibre connections.

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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?

We believe market mechanisms have an important role to play in finding the most efficient sharing scenario between the extreme options of "Remove" and "Retain". As outlined in section 4, we suggest that Ofcom should urgently explore the option of conducting an incentive auction in the 3.6 - 3.8 GHz band, providing an opportunity to arrive at an efficient level of ongoing use from incumbent users whilst also enabling the ability for Ofcom to assign licences for mobile use in this band without delay.

This may encourage Earth stations to be consolidated at existing sites away from urban areas and lead to more efficient future use of this spectrum band. However, we caution against excessive levels of annual incentive pricing (AIP) where services have no realistic options to move as this may result in satellite services unnecessarily moving to other countries to the detriment of the UK economy.

With regard to BT's Earth station at Madley, we have considered options for screening the antennas. However, this would not be possible or practicable as the main antenna dishes measure 32m in diameter, reaching over 50 metres above ground level, and they are spread over a distance of 1 Km. Any metallic screening could also cause increased multipath interference through the entire site.

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

We note that there has been little progress in other European countries with regard to the licensing of mobile networks in this band so far. The few cases we are aware of (Norway, Greece and the Netherlands) have maintained protection for their incumbent C-band Earth stations.

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