OFFICE OF COMMUNICATIONS

UK Broadband application for licence variation

This document sets out Ofcom's decision on UK Broadband Limited's request to vary its Wireless Telegraphy 3.5 GHz licence

Statement

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Contents

Section 1

Executive summary

1.1 This document sets out Ofcom's decision on the request from UK Broadband Limited ('UK Broadband') to vary its Wireless Telegraphy Public Fixed Wireless Operator 3.5 GHz licence ('3.5 GHz licence') in two ways:

- to allow technology and application neutrality; and
- to increase the permitted power limits.

Consultation on UK Broadband's application for licence variation

1.2 On 18 June 2007 Ofcom published a consultation document[1] (the 'June consultation document') assessing UK Broadband's request and seeking comments from stakeholders on the issues raised.

1.3 The main points included in our assessment of a licence variation to allow technology and application neutrality were:

- UK Broadband's licence did not limit the technologies it may use;
- there appeared to be no reason to refuse the variation of UK Broadband's licence to remove the limitation to fixed applications;
- in our assessment we examined in particular the effects on consumers' interests, the optimal use of the spectrum, competition related issues, the requirement to ensure that licence conditions are objectively justified and other legal considerations. We also examined the timing of the variation.

1.4 The main points in our assessment of the proposal on power limits were:

- there appeared to be no reason to refuse to increase the maximum in-band power level to +29 dBW/MHz except for mobile terminals, which should have a maximum in-band power limit of -5 dBW/MHz; and
- it was not appropriate to consider varying the out of block emission limits in UK Broadband's licence, because of the uncertainty regarding equipment standards and the impact ongoing work within CEPT on the WAPECS Mandate could have on the technical regulatory environment for the 3.5 GHz band.

1.5 Our initial view was that the variation should be made as soon as practicable, subject to the outcome of the consultation. We asked for written views and comments on the issues raised in the consultation document to be made by 27 August 2007.

Responses to the consultation

1.6 We received 26 responses, four of which were submitted on a confidential basis. Just over half of the responses (14) supported the proposal to vary UK Broadband's licence. (One response did not comment on the merits of the case for the proposed variation.) Support was mainly on the basis that competition in the provision of mobile

[1] http://www.ofcom.org.uk/consult/condocs/bb_application/

and nomadic broadband would be enhanced, bringing benefits to consumers, and that the spectrum would be used more efficiently. Most of these responses were from equipment vendors or companies with an interest in providing broadband access. A number of them made the point that the 3.5 GHz band had been identified internationally as suitable for mobile broadband services.

1.7 A smaller number of respondents (seven) had reservations about the technical impact of the variation on other users. Four broadcasters plus JFMG were concerned that the variation would reduce the availability of spectrum in the 3.5 GHz band that is used for programme making and special events. The Satellite Action Planning Regulatory Group asked Ofcom to consider how to protect fixed satellite earth stations in the 3.6 to 4.2 GHz band from broadband wireless access systems operating below 3.6 GHz; its point was supported by Intellect.

1.8 Finally, four of the five mobile network operators (MNOs) opposed the variation for a variety of reasons, including saying that the variation should not be made before Ofcom had clarified the position on the liberalisation of conditions in 2G and 3G licences and/or on the 2.6 GHz award.

Ofcom's decision

1.9 We have carefully considered all responses received. The main conclusions of our consideration are that if the proposed variation were made:

- consumers could benefit from the increased choice and competition that would follow from UK Broadband's ability to offer a wider variety of services and UK Broadband would be able to make better use of the spectrum in responding to new consumer demands;
- competition in the mobile communications market is unlikely to be distorted and competition in the provision of broadband data services is likely to be enhanced; and
- there would be no disproportionate reduction in the spectrum quality of adjacent users, i.e. PMSE in 3.50 GHz to 3.58 GHz and FSS above 3.6 GHz.

1.10 We consider that the continuation of the restriction on mobile use in UK Broadband's licence is not justified and our examination of responses suggests that there are no compelling reasons not to vary the licence as proposed in the June consultation document. We have therefore decided to vary UK Broadband's licence as proposed in the June consultation document. As soon as practicable we will issue an amended licence to UK Broadband.

Matters covered in this document

1.11 This document is structured as follows

- Section 2 summarises the main features of UK Broadband's licence and its licence variation request, Ofcom's assessment of its request in the June consultation document and the responses to the consultation.
- Section 3 considers the main issues that different parties raised in responses to the June consultation. In relation to each issue we summarise the responses and set out our analysis and conclusion.

- Section 4 sets out our decision on UK Broadband's licence variation request.
- Annex 1 lists the names of all non-confidential respondents.
- Annex 2 sets out our assessment of the technical responses on programme making and special events and the response from the Satellite Action Planning Regulatory Group.

Section 2

Background to this statement

2.1 This section summarises the main features of UK Broadband's licence and its licence variation request, Ofcom's assessment of its request in the June consultation document and the responses to the consultation.

UK Broadband's licence

2.2 In June 2003 the Radiocommunications Agency auctioned 15 regional 3.5 GHz Public Fixed Wireless Access Operator licences (the '2003 auction'). The 15 regions together comprised the whole of the UK. UK Broadband (then known as Pound Radio) was awarded a licence for 13 of the regions and subsequently purchased the companies that had won the other two licences. In March 2007, following a request from UK Broadband, Ofcom agreed to the replacement of these three licences with a single UK licence that includes conditions that are effectively identical to those in the licences granted in July 2003.

2.3 UK Broadband's licence authorises the establishment, installation and use of Public Fixed Wireless Access transceivers in the frequency ranges 3480 MHz to 3500 MHz and 3580 MHz to 3600 MHz. The end user terminals are limited to customer premises equipment. The licence also stipulates a maximum equivalent isotropic radiated power (eirp) of +14 dBW/MHz, though the Interface Requirement (IR 2015) with which the licensed equipment must comply says that +21 dBW/MHz may be considered on a case-by-case basis (e.g. for backhaul purposes using narrow beam antennas). The licence does not impose any limitation on the technology that UK Broadband may use.

2.4 The licence is for an initial term of five years renewable at five year intervals up to a maximum 15 years. UK Broadband has informed Ofcom that it wants to exercise its option to extend the term for the second five year period from July 2008. The licence fee payable for each five year licence term is £6.955 m.

UK Broadband's licence variation request

2.5 UK Broadband submitted a request to Ofcom on 6 March 2007 to vary its licence in two ways:

- to allow technology and application neutrality; and
- to increase the allowed power levels to the eirp limits specified by ECC/DEC/(07)02.

Ofcom consultation on UK Broadband's request

2.6 On 18 June 2007 we published a consultation document[2] on UK Broadband's application. The consultation document assessed UK Broadband's request and in doing so

- provided background information on the 3.5 GHz band and UK Broadband's licence;

[2] http://www.ofcom.org.uk/consult/condocs/bb_application/

- set out Ofcom's statutory and policy framework;
- considered UK Broadband's request in the light of Ofcom's statutory and other legal duties; and
- considered the engineering effects of increased power levels, including the potential for interference to other users.

2.7 The main points of our assessment were:

- UK Broadband's licence did not limit the technologies it might use.
- The new broadband services that UK Broadband would be able to introduce should the variation be made could create benefits for consumers, arising mainly from the additional competition exerted on other broadband providers.
- The provision of these new services, on top of UK Broadband's current offering, would lead to a more intensive use of the spectrum. The licence variation would allow UK Broadband to respond dynamically to changing circumstances and offer other new services without being restricted to offering a fixed service to customer premises. This freedom would allow UK Broadband to make better use of the spectrum in responding to new consumer demands.
- There was some uncertainty around the deployments and technologies UK Broadband might choose if the variation were made. Concerns about a weakening of competition following a licence variation seemed unwarranted. We considered a possible range of communication markets[3] and did not envisage a situation where existing market players would be prevented from competing with UK Broadband and where the entry of a new service provider could lead to weaker competition and diminished consumer benefits. On the contrary, making the licence variation would be beneficial and assist the promotion of competition.
- There did not appear to be a distortion to competition.
- There did not appear to be justification for introducing an additional licence fee on grounds of inefficiency in use of spectrum.
- On the question of a state aid arising from the increased value of the licensed spectrum, in the first instance a state aid could only arise where there was a distortion of competition. Further, we would be acting in a manner consistent with the legal duty not to preserve wireless telegraphy licence conditions that cease to be objectively justifiable or proportionate. Our view was that the exercise of that duty could not constitute a breach of EU state aid rules.
- On the question of any difference in treatment between UK Broadband and mobile network operators we considered that there were significant differences in the circumstances of the respective licensees. These different circumstances meant there was no undue discrimination in the existence of different licence conditions between UK Broadband and 2G and 3G licensees.
- Delaying the licence variation could prevent most of the incremental benefits to consumers from the licence variation.

[3] Ofcom's discussion of candidate markets is set out in paragraphs 6.18-6.27 of the June consultation document.

- The reasons why UK Broadband's licence was granted on the terms that it was were no longer valid when viewed against the rapid and significant technological and market developments that had taken place since the 2003 auction.

- No statements or representations were given at the time of the auction or since which would give rise to a 'legitimate expectation' in law that the licence conditions would not be changed during the term of the licence, such that Ofcom would now be prevented on the basis of the principle of legal certainty from changing them. In any case, events at the time of the auction should in principle not be used to prevent the realisation of benefits that would follow from the proposed licence variation. Also, we considered that we had a legal duty not to preserve wireless telegraphy licence conditions which ceased to be objectively justifiable or proportionate unless there were compelling reasons to do so.

- The maximum in-band power level to +29 dBW/MHz was appropriate for all stations except mobile terminals, which should have a maximum in-band power limit of -5 dBW/MHz. We considered that these changes would not reduce the spectrum quality of other authorised spectrum users.

2.8 Our initial view was that the variation should be made as soon as practicable, subject to the outcome of the consultation.

2.9 We asked stakeholders to consider the following question when responding to the consultation:

Do you agree that the case for making changes requested by UK Broadband to its licence has been made? If not, why would it not be appropriate to vary UK Broadband's Wireless Telegraphy Public Fixed Wireless Access Operator Licence by (i) allowing application neutrality and (ii) increasing the permitted maximum in-band EIRP, and why would it not be appropriate to vary the licence as soon as practicable?

2.10 We asked for written views and comments on the issues raised in the consultation document to be made by 27 August 2007.

2.11 We received 26 responses, four of which were submitted on a confidential basis. We also received some time after the closure of the consultation a further confidential response, which we have reviewed and which we consider provides no additional arguments relevant to this issue. The non-confidential responses can be found on our website[4] and those who submitted them are listed in Annex 1. The points raised in responses are considered in the next section of this document.

[4] http://www.ofcom.org.uk/consult/condocs/bb_application/responses/

Section 3

Assessment of the licence variation and responses to the consultation

3.1 In this section we consider the main issues that different parties raised in responses to the June consultation. In order to group together the issues we have followed the sequence set out in sections 5 and 6 of the consultation document. These sections contained Ofcom's preliminary assessment of the proposed licence variation. Where points raised do not fall neatly within that framework we have dealt with them under separate headings at the end of this section.

3.2 When discussing responses we have set out Ofcom's preliminary view, a summary of the responses, our analysis and then our conclusion in relation to that issue. All non-confidential responses are available on Ofcom's website. Certain responses which were initially confidential have been made public with agreement of the respondent after commercially sensitive issues have been redacted.

3.3 The headings under which we consider issues raised in responses are:

- Effects on other spectrum users of increasing the power levels
- Potential benefits for consumers and the UK economy
- Optimal use of spectrum
- Impact on competition
- Increased value of the licensed spectrum
- Discrimination against mobile network operators
- Timing of the licence variation
- Objective justification for licence conditions
- Expectations at the time of the 3.5 GHz and 3G auctions
- International obligations
- Administrative consistency, rationality and procedural fairness
- Credibility of Ofcom's auction regime
- No new auction required

Effects on other spectrum users of increasing the power levels

3.4 UK Broadband's variation request is for (i) the removal of the condition limiting to public fixed wireless access transceivers the radio equipment it may use and (ii) an increase in the maximum permitted power at which equipment may transmit. Its licence stipulates a maximum eirp of +14 dBW/MHz. This limit is subject to the

Interface Requirement (IR 2015) with which the licensed equipment must comply; this says that +21 dBW/MHz may be considered on a case-by-case basis (e.g. for backhaul purposes using narrow beam antennas). In the June consultation document we considered that:

- the +29 dBW/MHz that UK Broadband had requested was appropriate for the in-block eirp for all stations (except for mobile terminals),
- mobile terminals should have a maximum eirp of -5 dBW/MHz; and
- permitting mobile terminals would not lead to any adverse effects on other spectrum users.

We considered that these changes to UK Broadband's licence would not reduce the estimated spectrum quality of other authorised spectrum users.

3.5 The technical impact of the variation on other users was covered in a number of responses from broadcasters and the satellite community. Four broadcasters and JFMG Limited were concerned that the variation would reduce the availability of spectrum in the 3.5 GHz band that is used for programme making and special events (PMSE). The Satellite Action Planning Regulatory Group, which represents European satellite operators and manufacturers, asked Ofcom to consider how to protect fixed satellite earth stations in the 3.6 to 4.2 GHz band from broadband wireless access systems operating below 3.6 GHz; its point was supported by Intellect. O2 agreed that there was a need to specify different eirp limits, depending on the type of station being deployed, and agreed generally with this proposed variation.

PMSE

3.6 The BBC said that the increase in base station power could make four of the 12 channels in the band unusable for wireless video cameras. The effect of mobile WiMAX terminals was less serious but also of concern because of the unpredictability of their use. These comments were supported by other responses from those with an interest in using the band for PMSE. They also pointed out that there were other pressures on spectrum available for PMSE and that the 3.4 GHz to 3.6 GHz band would become increasingly important. ITN suggested that, before making any change to UK Broadband's licence, Ofcom should consider further the impact on the interference environment of such factors as the number of deployments and proximity of use. Sky suggested Ofcom take a cautious approach and either (i) approve a change subject to a reversion to UK Broadband's existing licence should PMSE spectrum quality deteriorate, or (ii) approve the change subject to UK Broadband underwriting any necessary changes to PMSE equipment, or (iii) conduct further testing to ensure greater certainty for users.

3.7 PMSE has use of 120 MHz in the 3.5 GHz band. Of this spectrum 80 MHz lies between the two 20 MHz UK Broadband blocks that are at 3.48 to 3.5 GHz and 3.58 to 3.60 GHz. PMSE use of the band is currently relatively light. It is used primarily for outside broadcast fixed links. Use is for short periods of a day or two at locations scattered throughout the UK, at sporting locations and occasionally for news gathering in large cities. The PMSE community has identified the band as one of those that is likely to be used in future for wireless cameras. It is just one of a number of bands identified for this use; the bands most heavily used for wireless cameras at present are 2 GHz and 2.2 GHz and these are likely to continue to be the most important. 2.6 GHz is also an important band but the current PMSE allocation will be withdrawn with the auction of the band that is planned for the first half of 2008; PMSE

is just one of the possible future uses in the 2.6 GHz band. Any impact that the variation would have on PMSE use of 3.5 GHz should be seen in light of the availability of these other bands for wireless cameras.

3.8 The BBC and JFMG in their analyses concluded that an increase in separation distances would be needed between PMSE users and UK Broadband if the increased power was permitted. It should be noted that the incidence of blocking caused by UK Broadband's use of higher power will depend on the timing and location of the respective use by PMSE operators and UK Broadband. PMSE outside broadcast and news gathering use is not constant at any particular location but short term and occasional. The likely deployment of UK Broadband systems also needs to be taken into account. Since the publication of the June consultation document, UK Broadband has provided a more representative picture of its likely deployments. It may use 29 dBW/MHz with systems using highly directional, beam forming antennas, but it has indicated that the more likely eirp levels would be 23 dBW/MHz; typically 20 dBW/MHz for macro cells and 1 dBW/MHz for micro cells. In addition, the antenna heights for these systems would be, in the main, lower than the 60m above ground used by the BBC and JFMG in their analyses. Therefore, we consider that the maximum calculated separation distances illustrated are not representative of what would actually be required and that the impact on wireless camera use will be less severe than suggested.

3.9 In light of responses to the consultation, we have undertaken a Monte Carlo[5] analysis to compare the statistical probability of interference between the deployments under the current licence conditions and those under the proposed changes. UK Broadband's current licence has one eirp value for all systems, regardless of whether the transceiver is a base station or user terminal. Cell size is normally limited by the terminal station and so where 14 dBW/MHz is used by an externally mounted directional antenna the cell radius would be considerably larger than that determined by the limits applied to mobile stations.

3.10 We set out details of our own technical assessment in Annex 2. The simulation results shown in the table on page 42 are for two receivers, A and B. We consider that it is reasonable to look at the results for receiver A only because receiver B has poor selectivity and would need to be improved to avoid intra service interference. The Monte Carlo modelling shows that the interference suffered in the adjacent PMSE channel for 23 dBW/MHz is less than 0.5%. Where 29 dBW/MHz is deployed the interference rises to 1.31% but this does not take into account the directionality of the antenna used or filtering. We consider that these levels of interference are acceptable.

Satellite earth stations

3.11 The Satellite Action Plan Regulatory Group's (SAP REG) response said that there was ample evidence that adjacent frequency operations between broadband wireless access ('BWA') and fixed satellite service ('FSS') earth stations presented a significant interference issue and urged Ofcom to consider how to protect FSS earth stations in the band 3.6 to 4.2 GHz from interference from BWA systems operating below 3.6 GHz.

[5] Monte Carlo is a term used to describe solutions to mathematical problems which have many variables that cannot easily be solved. It involves randomly selecting a value (from a stated range) for the variables and then using these values for each individual calculation. This process is then repeated a finite number of times to build up a statistical result.

3.12 The SAP REG response noted that the international Fixed Satellite Service (FSS) allocation that extends from 3.4 GHz to 4.2 GHz is not recognised in the UK. In the UK the FSS allocation begins at 3.6 GHz. This means that UK Broadband is not co-frequency with FSS operation. SAP-REG referenced studies undertaken within CEPT[6] and pointed out the differences in eirp between those used in the studies and the proposed increased power levels. We note that the eirp values used in the studies are not an indication of applicable regulatory limits and are used purely as indicative parameters for the technical studies. As we say above in paragraph 3.8, the 29 dBW/MHz figure is one that is unlikely to be used in the majority of UK Broadband's deployments. UK Broadband indicated in its response that it sees benefit in making use of beam forming antennas and these antennas, while able to achieve high eirp values, will do so by pointing the main beam towards the terminal station. This means that it is highly unlikely that 29 dBW/MHz will be used in a omni directional radiation pattern, i.e. the power would not be radiated in all directions. Therefore, a level of mitigation would be included in those high power cases and we consider the conclusions in the referenced studies are not representative of the likely sharing environment.

3.13 We have undertaken our own technical assessment, details of which are set out in Annex 2. A separation distance would be expected under UK Broadband's current licence limits. The results of our assessment, understandably, show a general increase in separation distances for an increase in eirp. There appears to be a marked increase in separation distances between 23dBW/MHz and 29 dBW/MHz but this would be mitigated by the directional properties of the beam forming antennas that UK Broadband has indicated it will use, when operating at the higher power level.

3.14 In the UK the majority of satellite earth station sites that access spectrum in the 3.6 GHz to 4.2 GHz band do so above 3.7 GHz. This is because the band 3.4 GHz to 3.6 GHz is not currently available to satellite earth stations in the UK and many satellite systems do not have capacity below 3.7 GHz. As a result UK FSS earth station operators would be aware that dissimilar systems could operate in the 3.4 GHz to 3.6 GHz band. There are less than 10 satellite earth stations in the UK that currently are recorded as making use of the 3.6 GHz to 3.7 GHz band and some of these share the same geographical location. Also, of those a smaller number of actual earth stations make use of spectrum below 3.625 GHz. As only a very few earth stations actually operate below 3.625 GHz and only three are recorded as operating directly adjacent to 3.6 GHz, there is effectively a degree of frequency offset mitigation between the upper edge if the UK Broadband allocation and actual UK FSS use for the majority of remaining FSS earth stations. This, in addition to the frequency offset UK Broadband would need to employ to meet the licensed eirp Block Edge Mask, gives a further frequency offset between the FSS and UK Broadband use. As UK FSS operators would be aware of the FSS frequency allocations in the UK and the likelihood of dissimilar systems below 3.6 GHz, it is reasonable to assume they would employ suitable low noise amplifiers/low noise blocks (i.e. that have a receiver passband response of 3.6 GHz to 4.2 GHz). Finally, over the past few years Ofcom has seen a modest reduction in the number of licensed C band earth stations, which have access to the 3.6 GHz to 4.2 GHz band.

3.15 SAP REG highlighted the recent decision by the Office of the Telecommunication Authority (OFTA) in Hong Kong not to proceed with the authorisation of BWA systems in the 3.5 GHz band. This is a result of technical compatibility studies and

[6] CEPT Report 100 available from http://www.ero.dk/ - Select >>- "Deliverables" >> "Reports"

test measurements undertaken on behalf of OFTA. There are two reasons why this decision is not directly relevant to the UK situation: Hong Kong recognises the FSS allocation between 3.4 GHz and 3.6 GHz; and, given Hong Kong's much higher population density the likelihood of BWA systems and FSS earth stations operating close to each other is much higher than in the UK.

Conclusion

3.16 Having considered the consultation responses and undertaken technical analysis of the potential for interference we have concluded that there would be no disproportionate reduction in the spectrum quality of users adjacent to UK Broadband.

Potential benefits for consumers and the UK economy

3.17 In the June consultation we considered that granting a licence variation would maximise the potential for benefits to consumers from UK Broadband's bringing innovative services to the market. The launch of new services was likely to increase consumer awareness of mobile and nomadic services and foster an improved understanding of the applications of recently developed technologies. This increased awareness and understanding was likely to create the conditions for a further increase in consumer take-up of these services, including services by other operators in the market. UK Broadband services could therefore have an important role in reducing any delay in the development and launch of wireless broadband services in the UK.

3.18 H3G in its response (pages 6 to 7) said that the consumer benefits were only from the effect of very marginal additional competition and there was no analysis of why UK Broadband was likely to be an effective competitor. We consider that 3G operators and UK Broadband would not necessarily be offering the same services. In that case consumers would benefit from a wider range of similar but differentiated products. It is conceivable, and very often the case for markets that are not commoditized, that products competing in the same relevant market will differ in one or more significant ways, including for example data speed and applications, the breadth of the offer of voice services, the quality of the underlying technology, or the mobile devices available for accessing these services. Consumers could benefit from choice and increased competition if UK Broadband improved or rolled out more extensively its existing services. In addition to the benefits of competition between UK Broadband services and current 3G services (and other possible substitutes) further innovation may be encouraged using WiMAX technology, for example because certain new services may be dependent on the higher data rates that are likely to become possible.

3.19 T-Mobile (on page 1 of its response) said that it was not clear that UK Broadband was committed to delivering any innovative services; it will offer only substitutes for existing services and so the consumer benefit will be limited. We have no reason to believe that UK Broadband will not seek to innovate if the licence variation is made. However, even if we did accept this, we disagree with the conclusion that there would be no benefits from the launch of services that are very similar to those currently offered. Intensified competition in the provision of existing services could benefit consumers, for example by lowering prices; in fact, when competing products and services are very similar price competition can be very intense.

3.20 As for UK Broadband's presumed lack of commitment to innovation, we must have regard in carrying out our duties to the desirability of promoting the development of

innovative services. We consider that the removal of the 'fixed' restriction from UK Broadband's licence will provide the opportunity to launch innovative services and respond to changing market demands. Given the growing demand for mobile broadband services we consider that this opportunity is unlikely to be spurned, particularly as the rights to the spectrum licensed to UK Broadband will remain tradable.

3.21 T-Mobile also suggested (on page 6 of its response) that UK Broadband would target the most commercially attractive areas and existing service providers would have to respond, with the likely consequence that they would reduce higher risk investment. This would result in reduced choice for consumers. Consumers in rural areas would suffer from less choice and less competition. We discuss below in paragraphs 3.56 to 3.57 the argument that revenues in urban areas associated with increased competition would lead to lower investments. Our view is that it is not obvious that the effect on investment would be the one that T-Mobile describes. It is therefore unlikely that rural consumers would be adversely affected by UK Broadband's assumed targeting of urban areas.

Conclusion

3.22 We consider that consumers could benefit from the increased choice and competition that would follow from UK Broadband's ability to offer a wider variety of services if the proposed variation is made. We see no reason why it should not exploit the opportunity that the variation would offer.

Optimal use of spectrum

3.23 In the June consultation we considered that the licence variation would allow UK Broadband to respond dynamically to changing circumstances and offer other new services without being restricted to offering a fixed service to customer premises. It has developed detailed business plans for investing in a national WiMAX network using 3.5 GHz and IEEE 802.16e standard equipment. A key factor in its plans is the timely removal of the limitations in its licence. It considers that if the limitations remain it will be unable to use the most spectrum efficient technologies available and the spectrum will be under utilised. It intends to employ the equipment in three ways. One, it will migrate its existing customers to 802.16e compliant WiMAX equipment, continuing to provide services to end user premises. Two, it will provide nomadic services via a public access WiFi network to WiMAX modems. Three, it will install semi-private base stations in client premises, which would allow access both to the client's staff and to UK Broadband's public access service. In the longer term, varying UK Broadband's licence on the lines proposed would enable it to introduce new services as they became technically and commercially feasible. This freedom would allow UK Broadband to make optimal use of the spectrum in responding to new consumer demands.

3.24 A number of respondents, including O2, agreed with this. Some respondents supporting the variation of UK Broadband's licence pointed to the benefits that would arise from the market entry of a new service provider of mobile broadband services. In particular, one confidential response suggested that a new entrant would be able to deploy the latest technologies and so offer mobility at the bit rate of current fixed services. A minimum speed of 1.5 to 2 Mbps per user might be offered and this would increase the incentives for existing providers to improve their offers. This respondent considered that mobile broadband would use spectrum more efficiently than fixed applications: mobility widens the potential number of applications that can make use of the spectrum, enabling more efficient and economic use.

3.25 However, H3G (on pages 7 to 8 of its response) put forward several points to support its contention that there were no convincing reasons that varying UK Broadband's licence would promote efficient spectrum use:

- the services UK Broadband might offer are already being provided in other bands by using 3G technology;
- there was no reason to assume that it would be efficient in economic terms to allow the incumbent licensee to put the spectrum to whatever was the highest value use for itself and Ofcom had failed to consider whether there were greater social benefits to be gained from use of the spectrum for fixed wireless access; and
- two further issues related to fragmentation of the handset market and higher power limits.

3.26 On the first point, Ofcom considers that with demand for such services likely to increase there is no certainty that the spectrum already licensed or the 2.6 GHz spectrum that Ofcom is planning to award in 2008 would meet the increasing demand for such services[7]. The point also fails to consider the benefits to be derived from increased competition that would result from the opening of further spectrum for mobile services.

3.27 On the second point, we consider that the market is best placed to determine how the spectrum should be used and, as for any licensee, it is for UK Broadband to decide what the highest value use of its spectrum is. In the absence of clear evidence of market failure, we consider it reasonable to expect alignment between value to the spectrum user and economic efficiency. We are not aware of such evidence in this case. If more valuable uses were identifiable we consider that UK Broadband would be likely to have the incentive to innovate directly or to sell the licence to other operators relying on higher value applications and who would therefore be willing to pay more than UK Broadband's valuation of the licence. The variation would not prevent use of the band for fixed wireless access and UK Broadband has said that it will continue to provide its existing services to end-user premises.

3.28 On the first of the two further issues, we consider that the handset market is developing in step with the exploitation of different spectrum bands for mobile/WiFi/broadband access services. Handsets are being produced that are capable of working in a number of bands and we do not consider that allowing this band's use for mobile services will fragment the market. It is, in any case, not our policy to micro-manage spectrum use. On the question of the higher power UK Broadband has requested, this is to enable it to deliver an acceptable level of service to mobile devices and does not signify that it will make less efficient use of the spectrum. The difference in eirp between 3G systems and the systems UK Broadband has indicated it wishes to use, is marginal (in 3G licences the maximum eirp is 58 dBm/MHz for base stations compared with 59 dBm/MHz in UK Broadband's licence).

[7] Annex 12 of the discussion document on the award of the 2.6 GHz band contains information on demand for mobile data services. See - http://www.ofcom.org.uk/consult/condocs/2ghzdiscuss/main.pdf

Conclusion

3.29 We consider that varying UK Broadband's licence on the lines proposed would enable it to introduce new services as they became technically and commercially feasible. This freedom would allow UK Broadband to innovate and make optimal use of the spectrum in responding to new consumer demands.

Impact on competition

3.30 In the June consultation we said that the 3.5 GHz band could be used to provide a number of downstream services and there was a broad range of economic markets that could be relevant when assessing the potential impact on competition of the proposed licence variation. The precise scope of the relevant economic market was an empirical one and could only be fully addressed once relevant services were being offered and consumers' and suppliers' behaviour observed. We identified three potential candidate markets for the assessment of possible competition impacts. We concluded that the proposed variation was likely to facilitate more intense competition, which ultimately would be to the benefit of consumers. The potential for detrimental impacts on competition from making the licence variation was limited. We did not foresee a situation where existing market players would be prevented from competing with UK Broadband and where the entry of a new service provider could lead to weaker competition and diminished consumer benefits. On the contrary, we considered that making the licence variation would assist the promotion of competition.

3.31 Some of the MNOs argued in their responses that the proposed variation would distort competition because UK Broadband had acquired spectrum rights at a lower price and would enjoy more favourable licence conditions than its competitors. They argued that the lack of roll out obligations in UK Broadband's licence and its technology neutrality would give UK Broadband a competitive advantage.

3.32 T-Mobile (on page 6 of its response) argued that granting application neutrality to the 3.5 GHz band would alter the market model and create uncertainty that would deter future investment. UK Broadband would be able to offer services at a much lower cost than the 3G operators because of the lack of rollout obligations and the lower cost of its spectrum. It also argued that the mobile market was already fiercely competitive and operators did not have the flexibility to compete on pricing. It suggested that the variation would adversely impact on consumers: UK Broadband would target the most commercially attractive areas and existing service providers would have to respond, with the likely consequence that they would reduce higher risk investment and choice for consumers would be reduced.

3.33 H3G (on pages 8 to 9 of its response) argued that Ofcom's analysis of the impact of the variation on competition did not take account of the distortions that would be produced. All of the markets Ofcom had identified were already highly competitive. Its analysis assumed that an increase in the number of competitors by one would necessarily increase competition.

3.34 O2 (on page 2 of its response) argued that a competitive distortion was created by the requirement for some licensees to build and maintain networks of a given size, scope and absolute operating cost, while a competitor was free to size its network (and cost base) as it wished. A further competitive distortion would be created by allowing UK Broadband to enter the downstream mobile market with a tradable and technology neutral licence while unreasonably delaying or withholding such rights from mobile operators. It considered that Ofcom had not sufficiently analysed the

impact of licence disparity, given that UK Broadband's spectrum and that held by mobile operators were more similar than suggested in the June consultation document and that they would be in direct competition. It also considered that Ofcom's market analysis was flawed. In particular, Ofcom was wrong to suggest that mobile operators could adjust their tariffs in response to targeted entry, it had no grounds to provide entry assistance, it should take into account the relative whole life costs of networks, and it was non-committal on whether the mobile operators' restrictive licence conditions prevented them responding to competition.

3.35 Orange was concerned by what it saw as Ofcom's limited economic analysis. It believed that operators offering the same services must have similar cost bases. Ofcom had not taken into account UK Broadband's planned roll out of voice services.

3.36 We have examined these points under the following sub-headings: identification of relevant markets, cost differences and pricing flexibility, and the impact on investment.

Competition impact - identification of relevant markets

3.37 O2's view (on page 8 of its response) was that Ofcom had correctly identified that UK Broadband would compete in a downstream communications market, in providing mobile data services and voice services via VoIP. H3G (on page 8 of its response) noted that all of the relevant markets Ofcom had identified were already highly competitive, though it reserved its position on the relevant market for the purpose of assessing competition. We considered, in the June consultation document, the potential for distortions of the competitive process in two candidate relevant markets where the MNOs would compete directly with UK Broadband for the provision of mobile broadband services (i.e. data and voice via VOIP). These relevant markets included all MNOs. This recognised that consumers might view UK Broadband's services and MNOs' services as substitutes, and that UK Broadband, at least to some extent, could increase competition in this market.

3.38 The various responses to the consultation highlight that there is uncertainty around what the precise boundary of the market will be going forward. The reason we considered a third candidate relevant market that did not include the MNOs was to take a precautionary approach, considering the uncertainties around relevant market boundaries and the future services that UK Broadband might choose to provide. We assessed the potential for competition concerns in each of these three alternative markets. Having concluded that the potential for distortion of the competitive process was very limited for each of them, we considered there was no need to come to a firmer view on which definition of the relevant market would be most appropriate.

3.39 Orange argued that Ofcom did not include in its assessment the possible effects from the roll out of voice services by UK Broadband. The market report to which it appears to refer misleadingly suggested that UK regulations barred wireless broadband operators from offering voice services, and it also suggested that UK Broadband planned to roll out mobile voice services over its network. We noted in the June consultation document that while UK Broadband might roll out primarily data services it is clear that broadband services also support VOIP.[8] We also noted that UK Broadband might roll out services it is not currently providing. When we assessed the possible impacts of the licence variation, we considered the possibility of UK Broadband competing with MNOs in the provision of these services.

[8] See Ofcom Research Report: Voice over Internet Protocol (VoIP) http://www.ofcom.org.uk/research/telecoms/reports/voip/ .

3.40 It is noteworthy that a confidential response commented that the service UK Broadband will provide could reach much higher broadband speeds than existing 3G services and therefore be of higher quality. It went on to argue that the difference between UK Broadband's and the MNOs' services would be so significant that they would not be in direct competition in the same relevant market.

Competition impact – cost differences between UK Broadband and the MNOs and MNOs' pricing flexibility

3.41 The argument that the proposed variation would distort competition rests on the likelihood of there being cost differentials between UK Broadband and the MNOs that would have an impact on MNOs' pricing and revenues. We consider below the effect that differences in costs could have on competition, in terms of both fixed costs and variable costs.

3.42 As we said in the June consultation document, differences in fixed costs are less likely to impact competition than differences in variable costs, and in certain instances might have no impact on the competition process at all. The circumstances under which we might expect indirect effects on competition from difference in fixed costs are related to situations where significant profit shocks lead to the exit of (efficient) market players or increase barriers to entry, or there are inefficient capital markets. In this case we consider that possible inefficiencies in the capital market would not be of a scale likely to create conditions for shocks to profits to materially impact competition. As regards the exit of market players and higher barriers to entry, we do not expect that the potential cost savings or any increase in asset value that might accrue to UK Broadband (a new market entrant) could, in an industry where large multinational groups already operate, affect entry and exit to an extent that the competitive process would be negatively impacted.

3.43 Variable costs are far more likely to affect competition directly. We have not reached a firm view on the magnitude of eventual variable costs differences between UK Broadband and the MNOs but we consider that the potential for distortions and negative impacts on competition would be minimal. UK Broadband will continue or start to operate in markets where the incumbents have already established their brand names and retail customer bases. Furthermore, the incumbents that have been operating in the relevant markets for several years have established a direct relationship with consumers that gives them valuable primary information on consumer behaviour and customer needs on a scale that would not be available to a new entrant.

3.44 As a new entrant and relatively small market participant, UK Broadband will have to develop its brand and incur higher costs in order to acquire customers, without benefiting from the economies of scale available to other market participants. Furthermore, while the MNOs have made past investment decisions on rollout and have already reached extensive coverage, UK Broadband will have to decide whether to invest in extending its network reach or pay roaming charges. (For a discussion of roaming charges, see paragraph 3.46 below.)

3.45 O2 said (on page 6 of its response) that any credible analysis would consider the potential impact of cost asymmetry with particular reference to the whole life cost of networks. It seems to argue that if UK Broadband were successful there might be scenarios where its unit costs could be similar to the MNOs'. This suggests that if UK Broadband were not successful, their unit costs would be higher than MNOs' costs. In both of these scenarios, for the reasons set out in this section, we consider the potential for competitive distortions would be very limited.

3.46 O2 appears to base its conclusions on licence asymmetries leading to differences in future costs on the analysis it commissioned from Oxera in relation to the 2.6 GHz award[9]. Ofcom carefully assessed Oxera's analysis in the 2.6 GHz discussion document[10]. We do not intend to repeat this analysis here or to fully rehearse the arguments, but some comments are appropriate. We consider that under a broad range of assumptions that may apply to the industry in question, Oxera's conclusion that low roaming costs would allow a cheap network rollout for UK Broadband is not robust. In essence, Oxera argued that variable costs for UK Broadband would be low since they would rely on roaming to extend their coverage and that cheap access to roaming would be available from the MNOs in competition with each other. We noted in the response to the 2.6 GHz consultation that the conclusion that cheap roaming would be available depends, among other things, on a 'one shot' model of competition where contracts for access to roaming are agreed once and for all between UK Broadband and the MNO that offered the most favourable conditions. This might not be the most appropriate framework within which to analyse this issue. For example, taking account of capacity setting decisions and repeated interactions between potential sellers of roaming access (and the buyer) would significantly change the conclusions of the Oxera study.

3.47 Therefore, the analysis we set out in the 2.6 GHz discussion document implies that it would be wrong to assume that UK Broadband would face low roaming charges, and in particular there appears to be no compelling case that new entrants are likely to roam at low or incremental costs. This undermines O2's argument that incumbents would not be likely to retain flexibility to respond to new entrants.

3.48 T-Mobile argued that cheaper spectrum and lack of roll-out conditions in UK Broadband's licence would distort competition. We note that this analysis assumes that UK Broadband will not roll out an extensive network but only pick selected urban areas for distribution of its services. While this remains only an assumption, we note that consumers might view higher coverage as a premium feature of mobile data and voice services. If so, incumbents would also enjoy an incumbency advantage in this respect. As regards the price paid by UK Broadband in the 2003 auction, we set out in paragraph 3.42 our analysis of potential distortions resulting from fixed cost differentials and concluded that these are unlikely to create concerns for competition in this case.

3.49 In the June consultation document we said that the incumbent 3G MNOs would be in a position to compete with the new entrant, in particular by relying on their pricing flexibility. If UK Broadband were to target its entry into the market geographically they would be able to respond by changing their tariff structures.

3.50 A confidential respondent said that national operators would have to abandon national pricing plans and discriminate between metropolitan and suburban or rural customers. On the other hand, O2 argued that Ofcom was incorrect in saying that MNOs could respond to targeted entry by, among other ways, customising tariffs on a geographical basis. It suggested that this was at odds with Oftel's decision in its 2003 Mobile Access and Call Origination Market Review Decision. T-Mobile also argued that MNOs had less flexibility than UK Broadband. The cost structure differences between a light metropolitan network and a national network would

[9] http://www.ofcom.org.uk/consult/condocs/2ghzawards/responses/o2.pdf - see

[10] http://www.ofcom.org.uk/consult/condocs/2ghzdiscuss/main.pdf - see paragraph 8.34ff

prevent MNOs from offering a competitive price for a service that had a lower quality of service attached to it.

3.51 National regulatory agencies and competition authorities define a market based on the prevailing market conditions at the time the market definition is carried out (taking into account possible developments in the short term). In assessing the potential for competitive distortions, we have considered the current market situation and the likely scenarios following the licence variation. For this reason we do not believe that the prevailing features of the market as observed in 2003 should be treated as evidence that MNOs could not, today and in the future, respond to competition from other players by differentiating tariffs on a geographical basis. That would be for operators to determine given prevailing and future potential market conditions. Moreover it should be borne in mind that market definition is not an end in itself. In defining candidate markets we have identified the likely sets of competitors of UK Broadband after the licence liberalisation and assessed whether potential competition concerns are likely to arise as a result of the licence variation request being granted.

3.52 We also note that varying tariffs is only one possible way to respond to intensified competition; market players could respond with changes to the quality of service offered and further differentiation of products (for example in terms of devices, coverage of the network, or content and applications offered to customers).

3.53 Both T-Mobile and H3G argued that the mobile market was already competitive. H3G said that there was no evidence that UK Broadband was likely to be an effective competitor.

3.54 In carrying out Ofcom's duties we must consider the desirability of promoting competition. Whilst the mobile market has been judged to be effectively competitive in the past, i.e. no MNO has been found to have Significant Market Power, this does not mean that there is no scope for increased competition; that is, the market could be even more competitive. We do not consider that we should refrain from granting a licence variation because the relevant market is currently competitive. This would be to prevent the possible benefits from the injection of additional competition. Given the size of the mobile market, even a relatively small improvement in competition could deliver significant benefits to consumers. It is preferable to leave market forces to determine the level of competitiveness and entry in a market. It would be undesirable not to make a licence variation, and therefore prevent market entry, simply because it appeared that the market was already effectively competitive We note that Commission Directive 2002/77/EC on competition in the markets for electronic communications networks and services prevents the maintenance by Member States of exclusive or special rights (including regulatory advantages) for particular undertakings which affect the ability of other undertakings to provide the same service.

3.55 A confidential response pointed to the possibility that further entry could lead to fixed costs being above the level that a planner would consider optimal in order to maximise aggregate consumer benefits and producer surplus for this industry. In the academic literature this is known as 'too much entry', as in the economy there would be inefficient duplication of costs and the costs associated with more entry would not be more than offset by the increased benefits to consumers. We note that while such an outcome is possible, it is not necessarily the case that 'too much' entry would occur. Indeed there might actually be too few products. This could occur even in relatively competitive markets where products are differentiated, because companies may be unable to take full advantage of consumers' willingness to pay for a service.

An example could be where the expected returns from inducing consumers to switch from competitors' products with the launch of a new service would not cover the additional costs, due to low prices.[11] We also note that under the scenario suggested consumers would be likely to enjoy lower prices and products that better suited their needs, even if from a planner's point of view there might be higher fixed costs and overall lower welfare taking account of both producers and consumers.

Competition impact - impact on investment

3.56 T-Mobile argued that the reduction in revenues in urban areas associated with increased competition could lead to lower investments. This would ultimately result in reduced choice for consumers. Consumers in rural areas would suffer from less choice and less competition. We note that Ofcom does not have a duty to prevent competition from developing in order to preserve incumbent operators' revenues. In particular, as long as we do not identify the possibility of the licence variation significantly distorting competition, the impact on revenues of granting the variation is not relevant.

3.57 It is not obvious that the effect on investments would be the one that T-Mobile describes. One reason is that, while the roll out conditions in the 3G licences set the minimum level of coverage required, further investment above this threshold is a matter for commercial considerations. We consider, in line with recent academic economic literature[12], that the merits for investment are likely to be assessed on the basis of the difference in profits with and without investments. As such, entry by a competitor would not necessarily weaken the incumbents' incentives to invest in a given market. Investment might provide better revenue prospects in an otherwise more competitive environment which would be characterised by lower margins. For example, investing could allow the products of the investor to stand out in terms of quality in a market where there is demand for higher quality and consumers are willing to pay for it. The economic literature discusses this as an 'escape the competition' effect, by which intensified competitive pressures result in the promotion of investments. Another reason is that investments do not necessarily have to be funded with short term revenues. Well functioning capital markets provide a way to fund profitable investments should short term revenues be insufficient to meet the costs of investment.

3.58 A confidential respondent linked the licence variation to a negative impact on investments due to higher borrowing costs. We agree that it might be possible that higher market risk would lead to higher borrowing costs. However, if such an increase in the cost of borrowing were to materialise in this instance this would be because of increased competition. In addition, it is possible that the effect of increased competition in the UK mobile sector will not have a significant impact on the cost of borrowing for a large size incumbent operating in several countries.

[11] Jean Tirole, *The theory of industrial organisation*, MIT press 2003, p288. See also John Vickers, Mark Armstrong, Simon Cowan (1994) "Regulatory Reform: Economic Analysis and British Experience" (e.g. Chapter 4 p.116).

[12] See for example An empirical analysis of the impact of competition on investment is shown in Aghion, et al (2005), "Competition and Innovation: An Inverted-U Relationship," *Quarterly Journal of Economics* 120(2), pp.701-728. Kenneth Arrow set out a theory of how competition benefits innovation in an influential paper published in the 'sixties, Arrow, K. (1962), 'Economic welfare and the allocation of resources for invention".

Conclusion

3.59 We set out in the June consultation document our analysis of competition scenarios following the liberalisation of UK Broadband's licence. We concluded that the licence liberalisation would have the potential of strengthening competition to the benefit of consumers.

3.60 A number of respondents to the consultation have raised several points regarding our analysis and the nature of competition for the provision of mobile broadband, and in particular the competition between UK Broadband and MNOs, and the scale of the benefits that might arise from the liberalisation. We have considered these points in this section; on the basis of our further analysis, having taken account of the consultation responses, we believe that granting the licence variation request has the potential of benefiting consumers and could enhance the dynamic process for the provision of these services.

Increased value of the licensed spectrum

3.61 In the June consultation we pointed out that the UK Broadband licence was already tradable and liberalised, to the extent that it was technology neutral. The proposed variation would liberalise the licence further. If UK Broadband's licence was varied to increase the flexibility of use there were clear indicators that this should promote optimal use of the spectrum. Even if UK Broadband decided not to use the spectrum for alternative uses, it would have an opportunity and incentive to trade spectrum rights so other users could make a more efficient use of them. These considerations suggested that it was unnecessary to introduce an additional licence fee to secure the efficient use of the spectrum.

3.62 In their responses the four MNOs and two other respondents suggested that if UK Broadband's licence were varied it should pay an additional fee to reflect the higher value of mobile spectrum. T-Mobile suggested that international harmonisation of the 3.5 GHz band for mobile services, which is being proposed, would also increase the value of the spectrum. An additional fee could be related to the 1800 MHz mobile fees.

3.63 Orange argued that for Ofcom to fulfil its duty to secure optimal spectrum use it should require UK Broadband to pay an additional fee to reflect the increased value of its spectrum once the variation had been made. An additional fee could be related to the prices paid for 2.6 GHz spectrum in the auction that Ofcom is planning for 2008.

3.64 We have considered the respondents' submissions. In particular we have considered the submissions by O2 and H3G that the proposal would involve the grant of unlawful state aid. We consider that under Article 87 of the EC Treaty, for there to be a state aid there must be a measure which (i) involves a transfer of state resources, (ii) distorts or threatens to distort competition, (iii) favours certain undertakings and (iv) has an effect on Community trade. These criteria are cumulative so that all must be satisfied for a state aid to exist.

3.65 In relation to these criteria we note that the granting of wireless telegraphy licences which are a necessary precondition for access to the market by private companies is not an economic activity but a regulatory one under the Sixth VAT Directive.[13] That position is not changed by the fact that licence fees are charged. The regulatory

[13] Case C-369/04 of the European Court of Justice - Hutchison 3G and Others

activity constitutes the means of fulfilling the conditions laid down by Community law, for the purpose of ensuring the effective use of the radio spectrum. We consider that this case is certainly relevant here. It is clear that if the grant of a licence is a regulatory activity any change to a licence will also be regulatory in nature.

3.66 In the June consultation document and again in the current document we have set out our view that the change to the licence would promote competition. This is relevant to the question of state aid since, in the first instance, a state aid can only arise where there is a distortion of competition. (The duty to promote competition is also one of Ofcom's principal statutory duties.)

3.67 As set out below, we do not consider that the proposals involve any discrimination which favours one licensee over others where those licensees are in similar circumstances. The obligation not to discriminate is a requirement of the EU framework which applies to spectrum regulation irrespective of state aid rules.

3.68 As can be seen from the paragraphs above, the obligations not to discriminate and to promote competition apply to Ofcom under its (EU and UK) legislative duties in any event. We have explained why we are meeting those duties. Further, in that regard, as set out in the June consultation document, we are acting in a manner consistent with what is required by the legal duty not to preserve wireless telegraphy licence conditions that cease to be objectively justifiable or proportionate. That duty is set out in the Wireless Telegraphy Act 2006 in section 9(7) but derives from the obligation on Member States contained in the EU Authorisation Directive 2202/20/EC. Our view is that the exercise of that duty could not, in any event, constitute a breach of EU state aid rules.

3.69 Turning to Ofcom's position in relation to the licence fee, a key legal requirement of spectrum licence fees which are set at an amount greater than for cost recovery purposes is that they must be charged to ensure the optimal use of scarce spectrum resource. (They must also be objectively justified, transparent, non-discriminatory and proportionate in relation to their intended purpose. These requirements of EU law are reflected in sections 12 and 13 of the Wireless Telegraphy Act 2006.)

3.70 Given that a fee would not be appropriate (see below) we do not consider that any licence fees would be forgone by Ofcom (and so for that reason too there would be no transfer of resources under state aid rules). The ability to charge wireless telegraphy licence fees is limited to prescribed cases by sections 12 and 13 of the Wireless Telegraphy Act 2006. (For the same reasons as before because there is not discrimination, there is also no selective advantage.)[14]

3.71 In considering the case for charging additional licence fees to secure optimal use of the spectrum, as Orange suggested, it is relevant that the (tradable) rights to use this spectrum were awarded to UK Broadband using a market mechanism, and not through an administrative process.

3.72 UK Broadband participated in the 2003 auction in order to secure the rights to use the available spectrum for the term specified in the licence conditions that is a term of 15 years. The auction outcome (on the basis of the bids of participating companies

[14] Ofcom notes that the EC Commission state aid decision referred to in footnote 25 of the June consultation document was upheld by the European Court of First Instance in on 4th July 2007 (after our consultation commenced). The case is Bouygues SA v the Commission (Case T-475/04). The case is now on further appeal to the European Court of Justice. That appeal was brought on 18th September 2007 (Case C- 431/07 P). The rulings by the Commission and Court of First Instance have been taken into account in our legal analysis.

and the auction design) determined the fee for the licence for the whole term. The licence fee is payable in three instalments, where the second and third instalments are paid only if UK Broadband does not decide to return the licence to Ofcom after 5 and 10 years respectively from the date of the auction. UK Broadband has informed us that it will seek to activate its option to continue its licence for a further five years from July 2008.

3.73 We currently have no expectation that the licence will continue beyond the stated maximum licence term. The licensed spectrum is allocated to MOD and its agreement to civil use was for a period of 15 years from the commencement of licences.

3.74 As we noted in the June consultation, the 2003 auction was held against the background of what was called in the Information Memorandum 'a complete overhaul of the UK regulatory regime applicable to communications…proposed by the Communications Bill'. The proposed changes were foreshadowed in the Independent Review of Spectrum Management (the 'Cave Review')[15], which contained numerous recommendations to Government on how the spectrum management framework should be changed to keep pace with technology and market developments. One of the recommendations, which the Government formally accepted in October 2002, was that, to foster more flexible and efficient spectrum use, the regulator should aim to minimise the licence conditions necessary. Given that these developments were well publicised, the behaviour of participants in the 2003 auction and of other industry players with an interest in the spectrum may have been influenced by the possibility of more flexible use of spectrum during the 15 year licence term. In that case this possibility would have been reflected (alongside other aspects of the regulatory environment) in the prices paid by winning bidders in the auction. This is the view expressed by some respondents to the June consultation who participated in the auction. In any event we have no reason to believe that the auction did not produce an efficient outcome. Therefore, this licence award produced an allocation of rights that reflected the potential of the licence, and the opportunity costs will already have been reflected in the price paid for the licence. The tradability of the licence should also provide further incentives and opportunities for efficient use of the spectrum over time.

3.75 We consider that introducing a licence fee now during the licence term could create significant issues in a dynamic setting and undermine efficiency.

- Participants in future auctions would be concerned that there could be additional charges not determined by the auction process. The uncertainty around these charges could affect the bidding process and may negatively impact efficiency. It is likely that the prospect of additional charges would lead to bidders in an auction seeking to bid below their true valuations if they perceive a risk that additional fees could be levied in the future. This point is relevant to questions about the credibility of the auction regime that we discuss below in paragraphs 3.110 to 3.111;

- We do not see any requirement to impose an additional fee on UK Broadband for holding this licence in order to secure efficient use of the spectrum. We consider that there are already incentives on the licensee to secure efficient use of the spectrum (taking account of the mechanism through which it was awarded), while introducing an additional fee would create uncertainty and could undermine

[15] http://www.ofcom.org.uk/static/archive/ra/spectrum-review/2002review/1_whole_job.pdf

incentives for efficient behaviour. In particular, the risk of setting the fee too high could impair trade and subsequently efficiency.

3.76 Furthermore, in this particular case, the licence fee would be directly linked to liberalised use of the spectrum (the request by the licensee to make more flexible use of the auctioned spectrum). This could dampen incentives to invest in exploring the potential for innovation and new applications on the licensed spectrum by incumbents in other spectrum bands, as other things being equal, additional licence fees triggered by liberalisation (or requests for liberalisation) would lower the returns from such investments.

Conclusion

3.77 We do not consider that any of the points raised in responses undermines the case we made in the June consultation document.

Discrimination against mobile network operators

3.78 In the June consultation we set out our view that because the circumstances of UK Broadband and the 2G and 3G licensees were different in a number of important ways there was no undue discrimination in the existence of different licence conditions between them.

3.79 The four MNOs that responded to the consultation argued that UK Broadband would be in similar circumstances to themselves but would be treated more favourably. Favourable treatment would include more liberal licence conditions, lack of roll out obligations, higher power and lower spectrum costs. Therefore, varying UK Broadband's licence as proposed would be discriminatory.

3.80 T-Mobile found three major grounds of discrimination: timing of the licence variation; UK Broadband's licence fee; and coverage obligations. It suggested that the timing of the variation should align with 2G and 3G liberalisation and that UK Broadband should pay an additional fee to reflect the changed market value of its spectrum.

3.81 Orange considered that unless 2G spectrum holders were able to change the use of their licences to provide other services using other technologies there should be no change of use by other licence holders to provide mobile services.

3.82 O2 suggested that the circumstances of UK Broadband and MNOs were of sufficiently equivalent utility to leave concerns about discriminatory treatment. It reserved its position on discrimination until Ofcom had brought forward proposals for introducing trading and liberalisation to 3G licences.

3.83 H3G said that Ofcom had not taken account of the potential discrimination arising from the fact that some operators might have bid in the 3.5 GHz auction if the spectrum had been available for mobile use. We consider this point in paragraph 3.100 below.

3.84 The points made on discrimination link with other issues, in particular distortion of competition, spectrum valuation and the timing of the proposed variation. For the sake of clarity we have dealt with these issues under separate headings. Our analysis of the argument that the proposed variation would distort competition and our consideration of spectrum valuation are set out above. Consideration of the timing issue is set out later in this section. We consider here other points on discrimination.

3.85 We set out in paragraph 6.43 of the June consultation document our consideration of the different circumstances of UK Broadband and the MNOs. The main differences we identified were:

- 2G and 3G licences were awarded a number of years earlier than UK Broadband's Licence and MNOs have clear early mover advantages;
- the MNOs and UK Broadband operate in frequency bands with different technical characteristics that make them suitable for different applications, technologies and deployment strategies;
- the 3.5 GHz band licensed to UK Broadband is not subject to international harmonisation measures, in the same way as spectrum used for 2G and 3G services;
- UK Broadband currently provides some services that are different from 2G and 3G operators' and will continue to do so; and
- UK Broadband's licence is limited to a maximum 15 year term, whereas the 2G licences are open ended and 3G licences have a 20 year term.

Therefore we considered that UK Broadband and the MNOs were not in the same position. The situation is also changing in different ways. The Radio Spectrum Committee (RSC) Decision liberalises use of the 900 MHz and 1800 MHz bands and we are consulting on how to implement it[16]. The RSC is also considering a draft Decision on the harmonisation of the 3.4 GHz to 3.8 GHz band that would allow its use for fixed, nomadic and mobile networks. The proposed variation to UK Broadband's licence would be consistent with this. These changes are happening on different timescales and will affect the MNOs and UK Broadband in different ways. They represent a further differentiation in their circumstances.

3.86 One confidential response argued that, in considering the different circumstances of UK Broadband and the MNOs we had not attempted to assess whether the benefits enjoyed by UK Broadband and the MNOs would cancel each other out. It also argued that as the MNOs' first mover advantage was a result of their own efforts it should not be offset against the benefits to UK Broadband of advantageous licence conditions. We consider that the first mover advantage is significant. As we have stated above in paragraph 3.44, UK Broadband will operate in markets where the MNOs have already established their brand names and valuable information on customer needs. UK Broadband will be a new entrant and have to develop its brand and incur higher costs to acquire customers. In drawing a distinction between the MNOs and UK Broadband we do not consider it is relevant that the MNOs' first mover advantage has been created by their own efforts; nor do we consider that drawing the distinction is a matter of balancing the respective advantages of the two.

3.87 O2 suggested that the circumstances of UK Broadband and MNOs are of sufficiently equivalent utility to leave concerns about discriminatory treatment, in particular in relation to cost asymmetries and technology capabilities. We considered the question of cost asymmetries in paragraphs 3.41ff and remain of the view that differences in fixed costs are less likely to impact competition than variable costs and might have no impact at all. On technology capabilities, O2 expected the performance of

[16] http://www.ofcom.org.uk/consult/condocs/liberalisation/

technology that might operate in the 3.5 GHz to improve. This may turn out to be the case. However, we do not consider that this alters the point we were making in the June consultation document that there are differences in the characteristics of the UK Broadband and 3G spectrum bands that make them suitable for different applications, technologies and deployment strategies.

3.88 As stated in the June consultation document, we see no objective justification for imposing a roll out obligation on UK Broadband. Maintaining the roll out obligation in 3G licences raises the question of equal treatment between the 3G operators. Their licence conditions are virtually identical and so the question of undue discrimination might arise if some of them were to be treated differently from others.

Conclusion

3.89 We consider that, taking account of the various aspects of the question of discriminatory treatment between operators who are in similar circumstances, varying UK Broadband's licence in the way proposed would not amount to undue discrimination.

Timing of the licence variation

3.90 We said in the June consultation document that given the intention of UK Broadband to provide innovative services that rely on mobile WiMAX, delaying the licence variation could prevent most of the incremental beneficial impacts to consumers from the licence variation. Such a delay would be likely to result in the reduced provision of mobile broadband services in the UK over the next two to three years. This could in turn lead to further delays and lower take-up of similar deployments that rely on different spectrum frequencies and could be launched from 2010/2011 (including similar uses relying on 2.6 GHz spectrum).

3.91 Some of the MNOs who responded argued that the variation should not be made before the positions on the liberalisation of 2G spectrum, 3G liberalisation and the 2.6 GHz auction were clearer and that decisions on some or all of these matters should be made together. A confidential response argued that the proposed variation should be delayed until the roll out of 3G networks was complete.

3.92 We published on 20 September 2007 a consultation document on the application of liberalisation to the mobile sector, proposing how variation of 2G and 3G licence conditions might be handled. Some MNOs suggest that the UK Broadband variation would be acceptable if on a similar timescale to 2G/3G liberalisation. We consider the two should be examined on their merits. Each has its own set of facts and issues. The issues raised in liberalising 2G and 3G licence terms are more complex than those in the UK Broadband variation and need to be assessed on a different - and longer - timescale. We consider that there are benefits to the consumer that would follow the UK Broadband variation and the opportunity to realise them should be given without delay. An early decision on the proposed variation would also reduce regulatory uncertainty.

Conclusion

3.93 We consider that the proposed variation should not be delayed and should take place as soon as practicable in order to maximise the potential benefits for competition and consumers.

Objective justification for licence conditions

3.94 We described in paragraphs 6.53-6.57 of the June consultation the technology and market developments since the 2003 auction that indicated that the continuation of the restriction on mobile use in UK Broadband's licence was no longer justified. This conclusion was supported by a number of respondents.

3.95 We consider that we have a legal duty, contained in section 9(7) of the Wireless Telegraphy Act 2006, not to preserve wireless telegraphy licence conditions which cease to be objectively justifiable or proportionate, unless there are compelling reasons to do so, such as unfairness to others. We have examined in the current document the various points raised in responses to the consultation that relate to matters, including the impact on competition, discrimination and interference to other radio users, that might provide compelling reasons not to vary UK Broadband's licence as proposed.

Conclusion

3.96 We consider that the continuation of the restriction on mobile use in UK Broadband's licence is not justified and our examination of consultation responses suggests that there are no compelling reasons not to vary the licence as proposed.

Expectations at the time of the 3.5 GHz and 3G auctions

3.97 In the June consultation document (paragraphs 6.61 to 6.63) we carefully reviewed what was said and done at the time of the 2003 auction of 3.5 GHz licences. In summary, we considered that no statements or representations were given at the time of the auction or since which would give rise to a 'legitimate expectation' in law that the licence conditions would not be changed during the term of the licence, such that we would now be prevented on the basis of the principle of legal certainty from changing them.

3.98 Two respondents said that the proposed variations would breach the legitimate expectations of other operators. T-Mobile (on page 8 of its response) argued that it had a legitimate expectation that any liberalisation of the UK Broadband licence would ensure that it would operate on a level regulatory playing field with other market participants. 3G licensees had legitimate expectations that the 3.5 GHz licences could not be used to provide mobile services and any consideration of liberalising the licences should take into account the impact on 3G operators; measures should be put in place to deal with any such effects; and, there should be full consultation before any liberalisation.

3.99 H3G (on page 10 of its response) argued that decisions whether or not to participate in the 3.5 GHz auction in 2003 were based on the understanding that the licence was limited to fixed use and certain power limits. It also argued that bidders participated in the 3G auction in 2000 in expectation that their investment would not be undermined by the regulator allowing others to enter the mobile broadband market on more favourable terms.

3.100 We have reviewed the responses carefully. We believe it is correct to emphasise that administrative law makes clear that a legitimate expectation in law, which prevents a public authority from taking a particular course of action that would be otherwise open to it, can only arise in certain prescribed cases. Not every statement made or thing done can give rise to a 'legitimate expectation' in law. We do not consider that any of the points in the responses has undermined the conclusion that no statements

or representations were given at the time of the 3.5 GHz auction or since which would give rise to a 'legitimate expectation' in law that the licence conditions would not be changed during the term of the licence.

3.101 Neither do we consider that the wording or spirit of the statements made at the time of the 3G auction could or should be construed as to imply that the 3G licensees would be protected from potential competition in the future. Ofcom's position remains as set out in paragraphs 6.58 to 6.65 of the June consultation document.

3.102 In relation to two particular points.

- T-Mobile states on page 8 of its response that it has a legitimate expectation that any liberalisation should be in a manner to ensure that it operates on a level playing field vis a vis other market participants. It also says that it has a legitimate expectation that appropriate measures would be put in place to redress any differential impact on operators arising from any changes to the UK Broadband licence. T Mobile does not in its response provide Ofcom with any evidence or point to any promises which would give rise to these two particular legitimate expectations.

- Certain responses have provided additional weight to the view that some bidders decided to participate in the auction on the understanding that one day the licences might be varied. UK Broadband is the obvious example. BAS LLP, which was involved in the 3.5 GHz auction bidding process, stated in its response that bidders knew that the licence conditions could change during the life of the licence.

Conclusion

3.103 We do not consider that any statements or representations given at the time of the 3.5 GHz auction or since would give rise to a 'legitimate expectation' in law that UK Broadband's licence conditions would not be changed during the term of the licence. Neither do we consider that the wording or spirit of the statements made at the time of the 3G auction could or should be construed as to imply that the 3G licensees would be protected from potential competition in the future.

International obligations

3.104 Ofcom must comply with UK obligations under European law or international agreements where use of spectrum has been harmonised: Ofcom will not agree to remove restrictions from licences or other changes that would conflict with the UK's obligations under international law. At the time of the June consultation document there was no such obligation relating to the 3.5 GHz band.

3.105 A number of respondents pointed out that the variation would be consistent with the position being taken in Europe on use of the 3.5 GHz band. They pointed in particular to three separate elements:

- ECC/DEC/(07)02[17] that designated the band 3.4 GHz to 3.6 GHz for broadband wireless access deployment on a fixed, nomadic or mobile basis;

[17] ECC Decision of 30 March 2007 on availability of frequency bands between 3400-3800 MHz for the harmonised implementation of Broadband Wireless Access systems (BWA)(ECC/DEC/(07)02) see http://www.ero.dk/documentation/docs/doc98/official/Word/ECCDEC0702.DOC?frames=0

- the European Union's WAPECS (Wireless Access Policy for Electronic Communications Services) project, which is developing least restrictive technical conditions for the provision of electronic communications services in certain bands, one of which is 3.4 GHz to 3.8 GHz; and

- the European Common Proposal on WRC-07[18] agenda item 1.4 that supports a primary mobile allocation and an identification for IMT in the band 3.4 GHz to 3.8 GHz. (WiMAX is now part of the IMT family of technologies.)

3.106 In addition to these points we note that the RSC is considering a draft Decision on the harmonisation of the band 3.4 GHz to 3.8 GHz for wireless broadband communications. This would require Member States to allow use of the band for fixed, nomadic and mobile networks. We must comply with UK obligations under European law or international agreements where use of spectrum has been harmonised. At the time of the June consultation document there was no such obligation relating to the 3.5 GHz band. The variation of UK Broadband's licence to remove the restriction to fixed services would be consistent with the Decision under consideration.

Conclusion

3.107 The variation of UK Broadband's licence as proposed would not breach our obligations under international law. The proposed variation is consistent with a number of spectrum management developments in Europe.

Administrative consistency, rationality and procedural fairness

3.108 T-Mobile argued that Ofcom should be aware of the need to comply with the principles of administrative law, i.e. administrative consistency, the duty to act rationally; and procedural fairness. We consider that the issue of what is termed as administrative consistency is the much the same issue as that considered under the discrimination heading. As set out above, we consider that a licence variation would not be discriminatory. Further, given technological changes since the time of the licence award the change in licence terms is entirely rational. This consultation exercise has been held, inter alia, to ensure procedural fairness. T Mobile does not specify in which way Ofcom is failing to consult properly.

Conclusion

3.109 We consider that in examining UK Broadband's request for the variation of its licence we have complied with the principles of administrative law.

Credibility of Ofcom's auction regime

3.110 T-Mobile argued that the variation would signal to bidders in future auctions that conditions might be changed on request and this might encourage speculative bidding. H3G argued that the possibility of post-auction changes would distort valuations and so undermine auction efficiency.

3.111 Our policy is to award licences with the minimum conditions necessary for efficient management of the spectrum. The licence conditions are published as part of the

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[18] World Radiocommunication Conference 2007 of the International Telecommunications Union, which took place in October to November 2007.

information memorandum for each award; they invariably include a provision on licence variation. It will be open to licensees following future awards to request licence variations. We will continue to consider very carefully any request for a licence variation. As in the present case, we will consider variation requests against our statutory duties.

Conclusion

3.112 We do not consider that making the proposed licence variation would undermine the efficiency of future spectrum auctions that Ofcom holds.

No new auction required

3.113 H3G argued on page 5 of its response that if Ofcom decides to extend use of the 3.5 GHz spectrum to include mobile broadband services the licence should be re-assigned in a new auction.

3.114 Ofcom's discretion to make changes to licence terms is set out in paragraph 6 of Schedule 1 of the Act and it is also provided for in Article 14 of the EU Authorisation Directive 2002/20/EC.

3.115 The proposed licence change involves the lifting or relaxing of technical restrictions on UK Broadband's right of use of the frequency bands. These restrictions appear to be no longer objectively justified or proportionate given the rapid developments in technology since the licence was awarded and the fact that we consider that there would be no disproportionate reduction in the spectrum quality of other radio users resulting from the change. Indeed, we note that the core public purpose of licensing rights to use the radio spectrum is to permit use of the spectrum at different frequencies, times and places so that the radio spectrum, which is a scarce resource, can be used efficiently by many people without their use causing harmful radio interference to each other. The fact that this is the case is borne out by the rule that where no harmful interference can arise Member States must under Article 5 of the Authorisation Directive make use subject to general authorisation (licence exemption in a UK context). This change does not involve the grant of a new right of use, in terms of frequency, time or geography.

3.116 Further, as mentioned above and as set out in the June consultation document, Ofcom is acting in a manner consistent with what is required by the legal duty not to preserve wireless telegraphy licence restrictions that cease to be objectively justifiable or proportionate. That duty is set out in the Wireless Telegraphy Act 2006 in section 9(7) but derives from the obligation on Member States contained in the EU Authorisation Directive**.**

Conclusion

3.117 We do not consider that varying UK Broadband's licence as proposed would first require the licence to be subject to a fresh award.

Section 4

Decisions and next steps

4.1 This section sets out our decision on UK Broadband's request to vary its licence to allow application neutrality and to increase the permitted power limits.

4.2 Ofcom has broad discretion to vary licences, subject to acting in accordance with our statutory duties and general legal principles. The duties relevant to this decision are to:

- further the interests of citizens and consumers;
- secure optimal use of the spectrum;
- have regard to the desirability of promoting:
    - efficient management and use of spectrum
    - economic and other benefits arising from the use of wireless telegraphy
    - development of innovative services
    - competition in provision of electronic communications services;
- ensure licence conditions are objectively justified, non-discriminatory, proportionate and transparent.

General legal principles include duties to act reasonably and rationally when making decisions and to take account of legitimate expectations.

4.3 We set out our analysis of UK Broadband's variation request in the June consultation document. Our view that the variation should be made as soon as practicable was subject to the outcome of the consultation. We have considered all responses, in particular those that objected to or expressed reservations about the variation proposed. Our examination of the responses is summarised in the previous section. We have also taken into account the EC intention to make a Decision early in 2008 on the use of the 3.4 GHz to 3.8 GHz band for wireless broadband communications, including mobile and nomadic as well as fixed use, and the fact that the proposed variation would be consistent with it.

4.4 We have a duty not to preserve wireless telegraphy licence conditions that are no longer objectively justifiable or proportionate, unless there are compelling reasons to maintain them. We have therefore decided to vary UK Broadband's licence as proposed in the consultation document. As soon as practicable we will issue an amended licence to UK Broadband.

Annex 1

List of non-confidential responses received

Alcatel-Lucent

BAS LLP

BBC

BT

H3G

Inquam

Intel

Intellect

ITN

ITV

JFMG

Motorola

Navini

NEC

Orange

O2

Samsung

SAP REG

Sinon

Sky

T-Mobile

WiMAX Forum

Annex 2

Technical Assessment

Technical Content of Responses – PMSE Users

A2.1 We have looked at the technical content of the responses to the consultation covering the potential impact from the proposed increase in power, into use by Programme Makers Special Events (PMSE) users. In considering these responses, it is worth noting limits UK Broadband are currently licensed for the following:

Licensed frequency ranges:	3480 MHz to 3500 MHz and 3580 MHz to 3600 MHz	
Maximum permitted in band eirp:	14 dBW/MHz with a potential increase to 21 dBW/MHz[19]	
Out of block emission limits:	0 to 3.5 MHz Beyond 3.5 MHz (where 0 is the block edge)	-43 dBW/MHz -56 dBW/MHz

These limits are current applied to fixed systems.

A2.2 The responses from JFMG and the BBC had detailed assessments of potential separation distances that are considered for the proposed 29 dBW/MHz eirp figure as proposed using the following assumptions:

- BWA antenna height of 60 meters above ground;
- COST 231 propagation model; and
- QEF (Quasi Error Free) figure of -96.1 dBm.

A2.3 As mentioned in paragraph 3.8 of this document, we do not consider that 60 meters above ground is representative of the antenna heights that are likely to be used in the majority of deployments.

A2.4 The QEF figure of -96.1 dBm, which has also been used in the BBC and JFMG assessment, was considered to be pessimistic based on sensitive receiver parameters. In Section 9 of the Digital TV Group "D Book"[20], Table 9-11 Page 19 shows a number of different QEF figures for Gaussian, Ricean, Rayleigh channels at modulation orders of QPSK, 16QAM and 64QAM. For a Gaussian Channel at QPSK, -91.6 dBm (required signal power for 2×10^{-4} post-Viterbi) is quoted and this is the most sensitive figure of the range of QEF figures quoted.

A2.5 We have replicated the assessments shown in the BBC and JFMG responses, using the following adjusted parameters;

i) Receiver minimum input requirement QEF figure of -91.6 dBm (in place of the -96.1 dBm figure quoted)

[19] Interface Requirement IR 2015 Table 2.2, Item 12, Note-2
http://www.ofcom.org.uk/radiocomms/ifi/tech/interface_req/
[20] Available from http://www.dtg.org.uk/publications/books.html (registration maybe required)

ii) Varied eirp figures of 14, 20, 23, 29 and 1 dBW/MHz, noting the comments in paragraph 3.8.

The following results were obtained;

Response results: 29 dBW/MHz, QEF of -96.1 dBm and a Tx antenna height of 60m

	ACS (dB)	C/N QEF (dB)	Prot. Ratio (dB)	QEF point (dBm)	Reqd. FSL (dB)	Interference radius (km)	
						Square Law	COST-231
Rx A, No filter, N+1	48.6	3.1	-45.5	-96.1	119.6	6.51	1.41
Rx A, Filter A, N+1	51.9	3.1	-48.8	-96.1	116.3	4.45	1.12
Rx B, No filter, N+1	32.8	3.1	-29.7	-96.1	135.4	40.13	4.22
Rx B, Filter A, N+1	39.8	3.1	-36.7	-96.1	128.4	17.92	2.6
Rx A, No filter, N+2	60.2	3.1	-57.1	-96.1	108	1.71	0.63
Rx A, Filter A, N+2	68.4	3.1	-65.3	-96.1	99.8	0.67	0.36
Rx B, No filter, N+2	63.8	3.1	-60.7	-96.1	104.4	1.13	0.49
Rx B, Filter A, N+2	68.6	3.1	-65.5	-96.1	99.6	0.65	0.35

Corrected QEF point value (-91.6 dBm), 30m Tx antenna at 14 dBW/MHz (currently licensed limits)

	ACS (dB)	C/N QEF (dB)	Prot. Ratio (dB)	QEF point (dBm)	Reqd. FSL (dB)	Interference radius (km)	
						Square Law	COST-231
Rx A, No filter, N+1	48.6	3.1	-45.5	-91.6	100.1	0.69	0.30
Rx A, Filter A, N+1	51.9	3.1	-48.8	-91.6	96.8	0.47	0.24
Rx B, No filter, N+1	32.8	3.1	-29.7	-91.6	115.9	4.25	0.83
Rx B, Filter A, N+1	39.8	3.1	-36.7	-91.6	108.9	1.90	0.52
Rx A, No filter, N+2	60.2	3.1	-57.1	-91.6	88.5	0.18	0.14
Rx A, Filter A, N+2	68.4	3.1	-65.3	-91.6	80.3	0.07	0.08
Rx B, No filter, N+2	63.8	3.1	-60.7	-91.6	84.9	0.12	0.11
Rx B, Filter A, N+2	68.6	3.1	-65.5	-91.6	80.1	0.07	0.08

Corrected QEF point value (-91.6 dBm), 30m Tx antenna at 29 dBW/MHz eirp

	ACS (dB)	C/N QEF (dB)	Prot. Ratio (dB)	QEF point (dBm)	Reqd. FSL (dB)	Interference radius (km)	
						Square Law	COST-231
Rx A, No filter, N+1	48.6	3.1	-45.5	-91.6	115.1	3.88	0.79
Rx A, Filter A, N+1	51.9	3.1	-48.8	-91.6	111.8	2.65	0.63
Rx B, No filter, N+1	32.8	3.1	-29.7	-91.6	130.9	23.90	2.21
Rx B, Filter A, N+1	39.8	3.1	-36.7	-91.6	123.9	10.68	1.40
Rx A, No filter, N+2	60.2	3.1	-57.1	-91.6	103.5	1.02	0.37
Rx A, Filter A, N+2	68.4	3.1	-65.3	-91.6	95.3	0.40	0.22
Rx B, No filter, N+2	63.8	3.1	-60.7	-91.6	99.9	0.67	0.29
Rx B, Filter A, N+2	68.6	3.1	-65.5	-91.6	95.1	0.39	0.21

Corrected QEF point value (-91.6 dBm), 30m Tx antenna at 23 dBW/MHz

	ACS (dB)	C/N QEF (dB)	Prot. Ratio (dB)	QEF point (dBm)	Reqd. FSL (dB)	Interference radius (km)	
						Square Law	COST-231
Rx A, No filter, N+1	48.6	3.1	-45.5	-91.6	109.1	1.94	0.53
Rx A, Filter A, N+1	51.9	3.1	-48.8	-91.6	105.8	1.33	0.43
Rx B, No filter, N+1	32.8	3.1	-29.7	-91.6	124.9	11.98	1.49
Rx B, Filter A, N+1	39.8	3.1	-36.7	-91.6	117.9	5.35	0.94
Rx A, No filter, N+2	60.2	3.1	-57.1	-91.6	97.5	0.51	0.25
Rx A, Filter A, N+2	68.4	3.1	-65.3	-91.6	89.3	0.20	0.15
Rx B, No filter, N+2	63.8	3.1	-60.7	-91.6	93.9	0.34	0.20
Rx B, Filter A, N+2	68.6	3.1	-65.5	-91.6	89.1	0.19	0.14

Corrected QEF point value (-91.6 dBm), 30m Tx antenna at 20 dBW/MHz

	ACS (dB)	C/N QEF (dB)	Prot. Ratio (dB)	QEF point (dBm)	Reqd. FSL (dB)	Interference radius (km)	
						Square Law	COST-231
Rx A, No filter, N+1	48.6	3.1	-45.5	-91.6	106.1	1.38	0.44
Rx A, Filter A, N+1	51.9	3.1	-48.8	-91.6	102.8	0.94	0.35
Rx B, No filter, N+1	32.8	3.1	-29.7	-91.6	121.9	8.48	1.23
Rx B, Filter A, N+1	39.8	3.1	-36.7	-91.6	114.9	3.79	0.78
Rx A, No filter, N+2	60.2	3.1	-57.1	-91.6	94.5	0.36	0.20
Rx A, Filter A, N+2	68.4	3.1	-65.3	-91.6	86.3	0.14	0.12
Rx B, No filter, N+2	63.8	3.1	-60.7	-91.6	90.9	0.24	0.16
Rx B, Filter A, N+2	68.6	3.1	-65.5	-91.6	86.1	0.14	0.12

Corrected QEF point value (-91.6 dBm), 30m Tx antenna at 1 dBW/MHz

	ACS (dB)	C/N QEF (dB)	Prot. Ratio (dB)	QEF point (dBm)	Reqd. FSL (dB)	Interference radius (km)	
						Square Law	COST-231
Rx A, No filter, N+1	48.6	3.1	-45.5	-91.6	87.1	0.15	0.13
Rx A, Filter A, N+1	51.9	3.1	-48.8	-91.6	83.8	0.11	0.10
Rx B, No filter, N+1	32.8	3.1	-29.7	-91.6	102.9	0.95	0.35
Rx B, Filter A, N+1	39.8	3.1	-36.7	-91.6	95.9	0.43	0.22
Rx A, No filter, N+2	60.2	3.1	-57.1	-91.6	75.5	0.04	0.06
Rx A, Filter A, N+2	68.4	3.1	-65.3	-91.6	67.3	0.02	0.03
Rx B, No filter, N+2	63.8	3.1	-60.7	-91.6	71.9	0.03	0.05
Rx B, Filter A, N+2	68.6	3.1	-65.5	-91.6	67.1	0.02	0.03

A2.6 The results shown indicate the varying separation distances for the different eirp figures that UK Broadband has indicated may be implemented. This shows the changes in these potential separation distances for the revised receiver minimum input requirements.

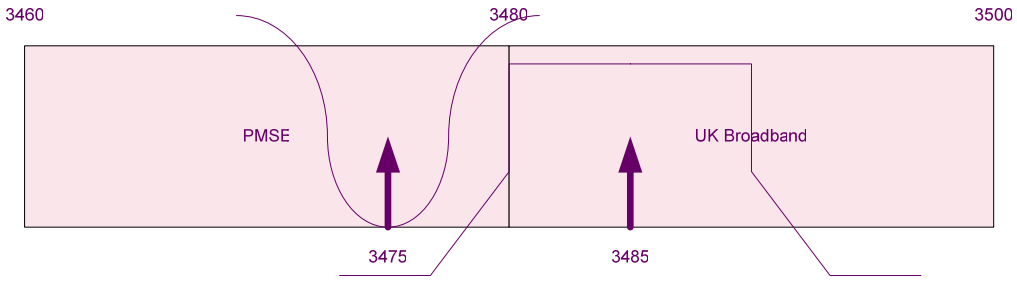
A2.7 As mentioned in paragraph 3.8 the 29 dBW/MHz eirp is a figure that will be used in particular deployment situations and will be mitigated by the more directional properties of the beam forming antennas.

A2.8 Finally the COST-231 model which was used in responses and has been used here for consistency, is documented as being valid for the frequency range 1500 to 2000 MHz. Whilst there is no reason why it could not be used here, its validity at 3.5 GHz is not known.

A2.9 We assessed the impact into PMSE by looking at the statistical probability of interference. The ERO Seamcat tool was used.

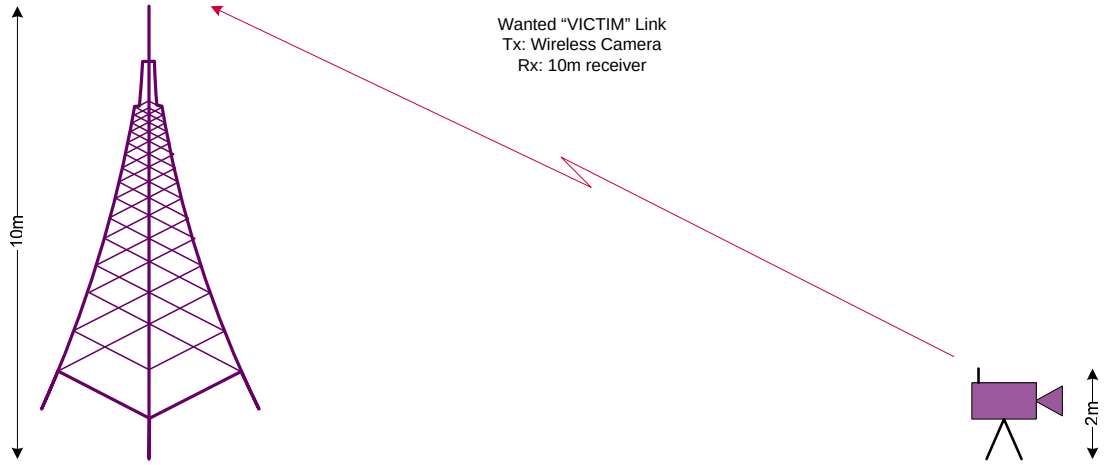
Simulation Parameters:

Band layout:



Victim Link

Frequency	3475	MHz

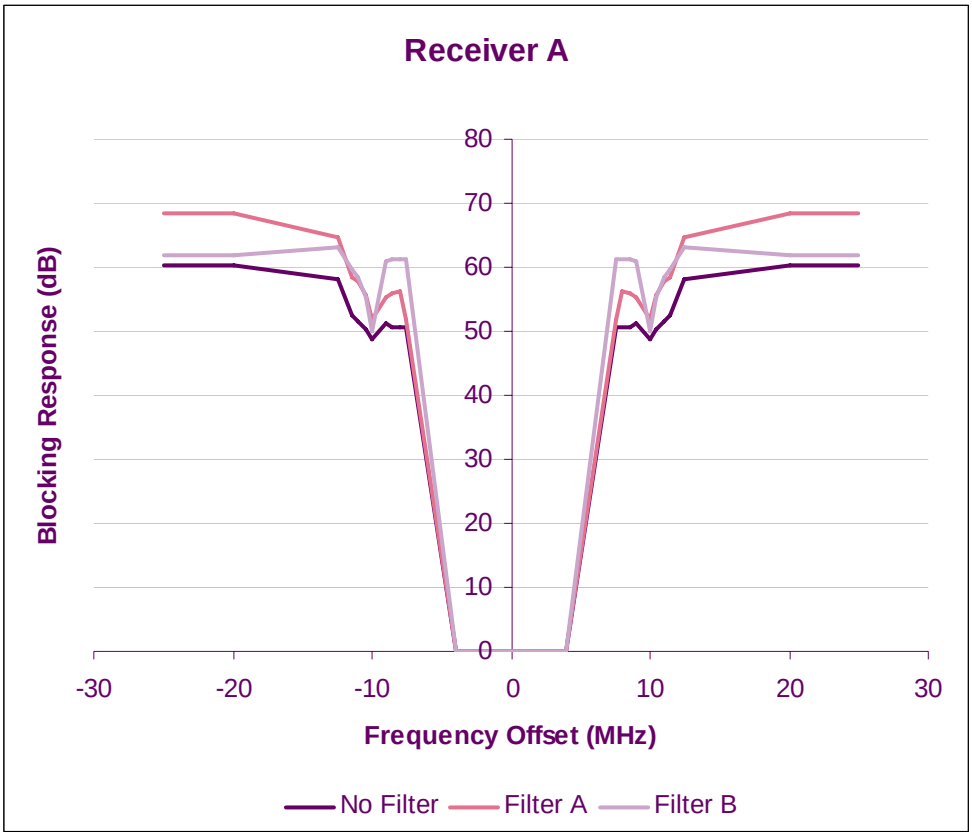


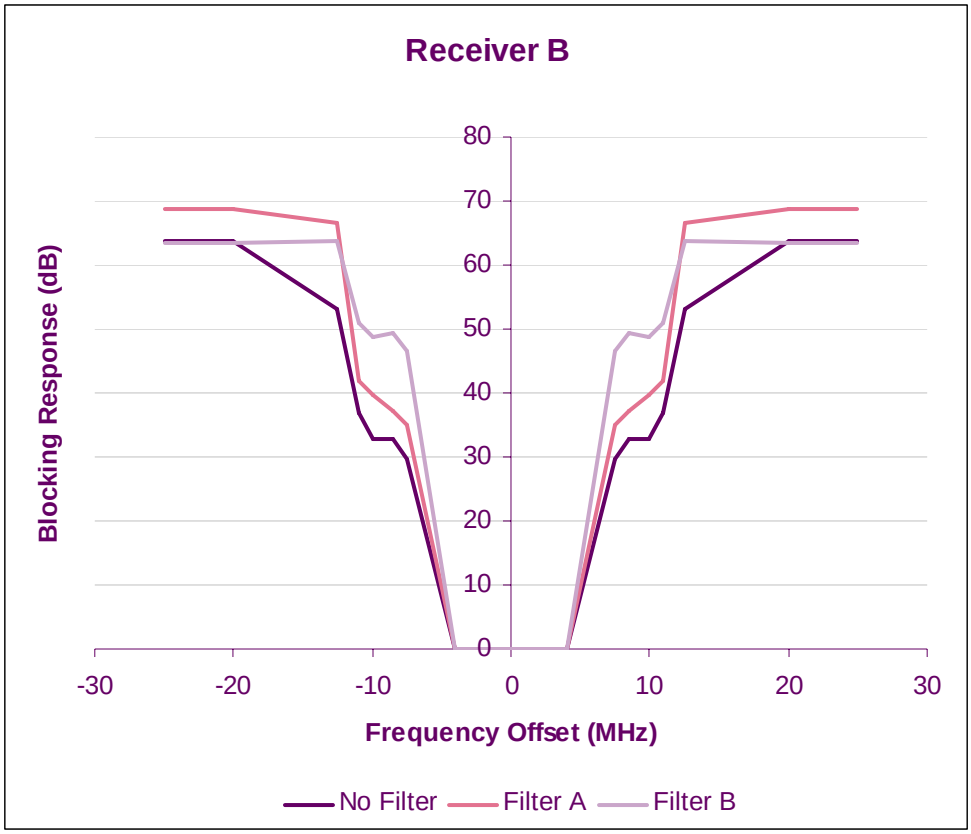
Transmitter	**Wireless Camera**	
Bandwidth	8	MHz
ERP	30	dBm
Antenna Gain	8	dBi Omni-directional
Tx Power	22	dBm
Antenna Height	2	m

Receiver	**Tower**	
Bandwidth	8	MHz
Antenna Gain	8	dBi Omni-directional
Antenna Height	10	m
Sensitivity	-91.6	dBm (QEF Point, Table 9-11, DTG report)
C/(I+N)	3.1	dB (C/N,Table 9-9, DTG report)
Noisefloor	-94.7 (=> -91.6-3.1)	dBm

Blocking response

Figures taken from ERA report 2007-0447





Link Budget

Wireless camera: ERP (dBm) – Protected Sensitivity (dBm) + Antenna Gain at Rx (dBi)

30 – (-99.2) + 8 = 137.2 Maximum Loss (dB),
Using COST-231, assuming outdoor to outdoor use, 137.2dB loss gives a range of 3.33km.

Cell size	3.33	Km

Other parameters required by Seamcat

C/I	3.2	Must be higher than C/I (added 0.1)
(N+I)/N	16.4	Derived from the Seamcat manual
I/N	16.3	Derived from the Seamcat manual
C/(N+I) is the only value actually used in the calculations.		

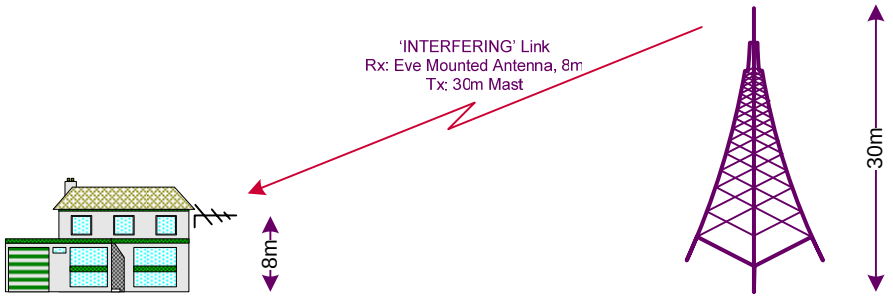
Interfering Link

Frequency	3485	MHz

Transmitter	**Tower**	
Bandwidth	10	MHz
ERP	54 (Before) 69, 63 or 60 (After)	dBm
Antenna Gain	16	dBi Omni-directional
Tx Power	38 (Before) 53, 50 or 44 (After)	dBm

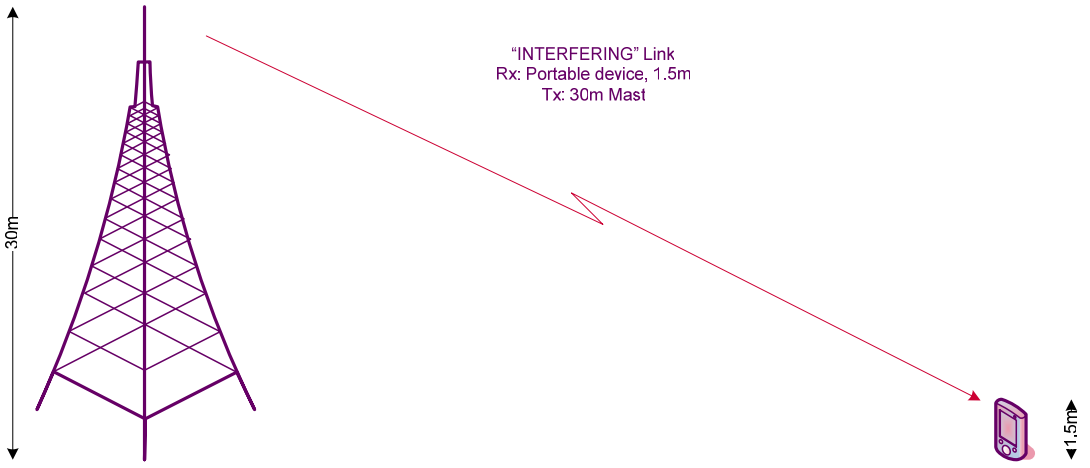
Antenna Height	30	m

Eve



Receiver	**Eve Mounted Antenna**	
Bandwidth	10	MHz
ERP	54	dBm
Antenna Gain	16	dBi Directional
Tx Power	38	dBm
Antenna Height	8	m
Sensitivity	-77.6	dBm
C/(I+N)	19.5	dB
Noisefloor	-97.1	dBm (From manufactures data)

Nomadic/Mobile



Receiver	**Mobile device**	
Bandwidth	10	MHz
ERP	35	dBm (25dBm/MHz)
Antenna Gain	0	dBi Omni-directional
Antenna Height	1.5	m
Sensitivity	-77.6	dBm
C/(I+N)	19.5	dB
Noisefloor	-97.1	dBm (From available manufactures data)

Unwanted emissions masks

The unwanted emissions mask is derived from the block edge mask in the UK Broadband licence applied to a 10MHz channel:

Offset from edge of block	Maximum Permitted Radiated Level
0 to 3.5 MHz	- 43 dBW/MHz
Beyond 3.5 MHz	-56 dBW/MHz

The mask needs to be specified relative to the power transmitted in dBm. First it should be applied to a 10MHz bandwidth emission, then shifted so that it is centred on the 10MHz emission.

Frequency Offset from block edge (MHz)	Spectral Density (dBW/MHz)
0	-43
3.5	-43
3.5	-56
20	-56

Frequency Offset from channel centre (MHz)	ERP in 10MHz channel (dBW)	ERP in 10MHz channel (dBm)
5	-33	-3
8.5	-33	-3
8.5	-46	-16
25	-46	-16

The mask will have the transmit ERP level between 0 and 5MHz offset.
Emission mask in dBm:

Frequency Offset from channel centre (MHz)	ERP in 10MHz channel (dBm)			
	29dBW/MHz	23dBW/MHz	20dBW/MHz	14dBW/MHz
5	69	63	60	54
5	-3	-3	-3	-3
8.5	-3	-3	-3	-3
8.5	-16	-16	-16	-16
25	-16	-16	-16	-16

From this we can obtain the emission mask in dBc:

Frequency Offset from channel centre (MHz)	ERP in 10MHz channel (dBc)			
	29dBW/MHz	23dBW/MHz	20dBW/MHz	14dBW/MHz
5	(69-69) **0**	(63-63) **0**	(60-60) **0**	(54-54) **0**
5	((-3)-69) **-72**	((-3)-63) **-66**	((-3)-60) **-63**	((-3)-54) **-57**
8.5	((-3)-69) **-72**	((-3)-63) **-66**	((-3)-60) **-63**	((-3)-54) **-57**
8.5	((-16)-69) **-85**	((-16)-63) **-79**	((-16)-60) **-76**	((-16)-54) **-70**
25	((-16)-69) **-85**	((-16)-63) **-79**	((-16)-60) **-76**	((-16)-54) **-70**

Link Budget

Uplink ERP (dBm) – {Protected Sensitivity (dBm) + Planning criteria (dB)} + Antenna Gain at Rx (dBi) - Building Penetration (dB)

Planning criteria: 3dB allowance for coverage at cell edge
Building penetration: 15dB (assuming outdoor to indoor use)

Eve:

54 - (-97.1 + 3) + 16 - 15 = 149.1 Maximum Loss (dB)
Using COST-231, 131.7dB loss gives a range of 7.26km.

$$Base\ Station\ Density = \frac{1}{2\pi r^2}$$

$$Base\ Station\ Density = \frac{1}{2 \times \pi \times 7.26^2} = 0.003$$

Nomadic/Mobile:

35 - (-97.1 + 3) + 16 - 15 = 130.1 Maximum Loss (dB)
Using COST-231, 130.1dB loss gives a range of 2.10km.

$$Base\ Station\ Density = \frac{1}{2 \times \pi \times 2.10^2} = 0.036$$

Cell size	7.26 (Eve) 2.10 (Nomadic)	km
BS Density	0.003 (Eve) 0.036 (Nomadic)	km^{-2} ($dens_{active}$)

Interference path

Closest Interferer Mode was used within Seamcat to place the interfering transmitter and victim receiver. This uses a Rayleigh distribution:

$$R(\sigma) = \frac{r}{\sigma^2} \exp\left(-\frac{(r - \min)^2}{2\sigma^2} \right)$$

Where min is the protection distance specified, in this case the default of 0.1km was used.

$$\sigma = \frac{1}{\sqrt{2\pi\, dens_{active} P_{trans} activity}}$$

In this case P_{trans} and activity are both set to one (always on), giving:

$$\sigma = \frac{1}{\sqrt{2\pi\, dens_{active}}}$$

Interference calculations were performed using the C/(I+N) criteria for blocking.

Simulation Results

Note: using the closest interferer mode there was no difference in the results for the Eve and Nomadic scenarios at 14dBW (this is reasonable as the transmitter is not changed).

	14 dBW/MHz	20 dBW/MHz	23 dBW/MHz	29 dBW/MHz*
RxA_NoFilter	0.03%	0.16%	0.34%	1.31%
RxA_FilterA	0.01%	0.07%	0.15%	0.61%
RxA_FilterB	0.02%	0.11%	0.22%	0.95%
RxB_NoFilter	1.60%	6.32%	12.70%	48.09%
RxB_FilterA	0.32%	1.24%	2.51%	10.05%
RxB_FilterB	0.03%	0.15%	0.31%	1.27%

* The figures for 29 dBW/MHz do not factor in the directivity of the beam forming antennas, which UK Broadband has indicated will be used outside urban areas. Therefore the figures would be further reduced by a function of number of beam forming antennas, beam-widths and off axis performance of those formed beamed antennas. Also receiver B has poor selectivity and we consider that it would need to be improved to avoid intra-service interference.

Technical Content of Responses – SAP-REG

A2.10 In their response the SAP-REG organisation indicated the separation distances required for differing arrival angles at a satellite dish, for BWA eirp levels of 30 and 22 dBW. This is where the saturation level the of LNB (Low Noise Block) is reached and this would then place the LNB in non-linear operation.

A2.11 As already noted in the main body of the document, UK Broadband has indicated that it does not see 29 dBW/MHz is a power level that will be used in the majority of deployments. Looking at the assessment undertaken in ECC Report 100[21]

Base Stations/Indoor Terminals

	Base and Terminal Stations		
Arrival angle of BWA signal at FSS E/S	5	15	30
FSS E/S antenna off-axis gain (dBi)	14.5	2.6	-4.9
LNB Saturation Level (dBm)	-50		
Frequency (MHz)	3700		
Separation Distance (km) current eirp (24 dBW = 14 dBW/MHz in 10 MHz)	**5.4**	**1.4**	**0.6**
Separation Distance (km) proposed eirp (39 dBW = 29 dBW/MHz in 10 MHz)	**30.5***	**7.7***	**3.3***
Separation Distance (km) proposed eirp (33 dBW = 23 dBW/MHz in 10 MHz)	**15.3**	**3.9**	**1.6**
Separation Distance (km) proposed eirp (30 dBW = 20 dBW/MHz in 10 MHz)	**10.8**	**2.8**	**1.2**
Separation Distance (km) for indoor terminals (7 dBW = 27 dBm/MHz in 10 MHz)	**0.76**	**0.19**	**0.08**

* No loss included for antenna directionality

[21] ECC Report 100 available from http://www.ero.dk/ - Select >>- “Deliverables” >> “Reports” Section 5.4.3.2, page 55.

Mobile Stations

	Mobile		
Arrival angle of BWA signal at FSS E/S	5	15	30
FSS E/S antenna off-axis gain (dBi)	14.5	2.6	-4.9
eirp (dBm)	25		
LNB Saturation Level (dBm)	-50		
Excess over LNB Saturation Level (dB)	89.5	77.6	70.1
Frequency (MHz)	3700		
Required Separation Distance (km)	**0.19**	**0.05**	**0.02**

A2.12 The above results use a free space path loss model (i.e. no diffraction losses via terrain or clutter). As can be seen, which is understandable, there is a general increase in separation distances for an increase in eirp It is clear that a separation distance would be expected under the current licence limits that UK Broadband are required to comply with. Whilst there does appear to be a marked increase in separation distances between 23 dBW/MHz and 29 dBW/MHz, this would be mitigated by the directional properties of the beam forming antennas (i.e. there would be a greater chance of being off axis of main beam than being in the main beam) that UK Broadband has indicated are to be used, albeit in a limited number of cases.