
# Request for Licence Variation to Enable Technology and Application Neutral Use of 3.5GHz

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# 1. Executive Summary

1.1 UK Broadband, the licence holder for the 3.5GHz[1] bands in the UK, seeks a variation to its spectrum licences to allow it to make optimal use of the spectrum, promote a range of technology and application neutral product offerings and compete on a level playing field.

1.2 Since 2003, there have been dramatic changes in the regulatory environment, in spectrum capabilities, WiMAX technology and in consumer demands which, in our view, warrant the removal of the fixed limitations in UK Broadband's licences.

1.3 On the regulatory front, a more liberalised approach to the use of spectrum has been adopted in recent years focused on technology and application neutrality. Specifically, in Europe, the European Commission is in the process of developing harmonised standards to allow 3.5GHz to be technology and application neutral. This is expected to be implemented in the first half of 2007.

1.4 In the UK, the liberalisation of 3.5GHz in 2007 to permit the provision of technology and application neutral offerings would be consistent with Ofcom's policy objectives and duties, as well as recent consultations and spectrum auctions, and announcements regarding the future auctions of the L Band and 2.5GHz bands.

1.5 On the technology front, consolidated industry efforts have resulted in the development of open interoperability standards and new data optimised technologies that enable 3.5GHz spectrum to be used in fixed and mobile wireless access modes. The net result is that a global WiMAX standard is now a reality. Dual-band, mobile WiMAX equipment capable of operating at 3.5GHz will be available in the European market in 2007 and therefore under the R&TTE Directive, must be made available in the UK as well. It is inevitable and indeed desirable that customers will seek to use such devices in a portable manner. In this environment, absent the requested licence variation, UK Broadband would be seeking to comply with anachronistic licence obligations that, far from encouraging innovation, actively inhibit innovation, technological development and competition.

1.6 Use of these new technologies to deliver these primarily data services will enable UK Broadband to meet the growing consumer demand for unrestricted and affordable mobile broadband (*Personal Broadband).* An immediate relaxation of the restrictions in UK Broadband's 3.5GHz licences would enable UK Broadband to meet evolving consumer requirements via innovative new data services in the UK, which will be lost if the transition to technology and application neutrality is delayed.

1.7 It would be unreasonable, discriminatory and disproportionate not to free UK Broadband of its application restrictions in order for it to compete fairly and effectively with the: (1) new 2.5GHz operators who will be free of application restrictions and (2) mobile operators, who have been free for some time to move into more fixed and nomadic applications.

1.8 In this paper, we introduce the detailed regulatory and market background as well as the quantification of economic benefits which underpin the case for liberalising 3.5GHz at the earliest opportunity. We also examine why allowing the variation would be consistent with Ofcom's duties, aims and vision in respect of its spectrum management policy, the promotion of competition, and in the economic benefits that *Personal Broadband* services will generate for both consumers and the UK economy.

[1] The UK Broadband WTA licences span 3.4 – 3.6GHz but for ease is referred to in this paper as 3.5GHz.

1.9 These benefits are quantified in a study by Europe Economics (attached in Appendix 1) who estimate that the introduction of *Personal Broadband* will generate a consumer surplus of £2.2 billion during the period 2008 to 2016.

1.10 In our view, Ofcom would have no basis to delay or deny granting this Request based on the law, policy position, market trends and anticipated consumer benefits as described herein. Specifically, no market failure would occur if this licence variation were granted.

1.11 In light of this, and UK Broadband's desire for regulatory certainty (in order to be able to commit to investment in *Personal Broadband* services in the UK), UK Broadband requests that Ofcom give due consideration to this Request and that such application be dealt with expeditiously.

# 2. Introduction

2.1 UK Broadband, the licence holder for the 3.5GHz bands in the UK, seeks a variation to its spectrum licences to allow it to make optimal use of the spectrum band, promote a range of technology and application neutral product offerings and compete on a level playing field.

2.2 Licence variation at this time would be consistent with the EU and UK regulatory framework and, in particular, Ofcom's policy objectives and statutory duties. It would also provide substantial benefits to consumers and the UK economy.

2.3 By allowing technology and application neutrality for 3.5GHz, consumers will be able to enjoy competitive high speed access to the internet while on the move. Use of new data optimised technologies to deliver these services will enable UK Broadband to meet the growing consumer demand for unrestricted and affordable mobile broadband (*Personal Broadband). Personal Broadband,* as envisioned by UK Broadband, will be a portable, high-speed broadband service to handheld devices and laptops. In the context of today's market, *Personal Broadband* will primarily be a data service and as such will be far closer to fixed DSL services than HSxPA offerings from the UK mobile operators, both in terms of price and speed.

2.4 An immediate relaxation of the restrictions in UK Broadband's licences would lead to the introduction of vital and valuable innovative new services in the UK. Consumers and the UK economy generally would benefit substantially. From a policy perspective, the removal of artificial licensing restrictions is essential if Ofcom is to achieve its vision for spectrum liberalisation and fulfil its statutory duty to secure the optimal use of the radio spectrum.

2.5 Ofcom is also under statutory duty to promote competition and the interests of consumers (e.g. through choice) and to ensure that it does not favour one form of electronic communications network or service over another. The removal of artificial licensing restrictions would be consistent with these duties.

2.6 Detailed evidence to support these arguments is contained in this paper and is further supported by material set out in the following Appendices:

- Appendix 1: A Study of the economic benefits of *Personal Broadband*.
- Appendix 2: Technical annex requesting a change in allowed power limits at 3.5GHz.
- Appendix 3: A draft Impact Assessment analysis to support the licence variation proposed.

# 3. Regulatory Developments

3.1 In recent years there has been a global trend (felt most strongly in the EU) towards deregulation/liberalisation. That is, the removal of barriers to entry and a greater reliance on market forces and competition in order to maximise user benefits. In spectrum regulation this has led towards a dismantling of traditional regulatory approaches including the "command and control" regime in favour of a more liberalised, market-based approach to spectrum management.

3.2 Markets like the UK which have followed this route have dynamic electronic communications markets characterised by effective competition providing substantial consumer benefits. It is clearly Ofcom's view that this trend towards deregulation and spectrum liberalisation should be continued and to the extent possible, accelerated. UK Broadband fully supports this liberalised approach.

## *Spectrum Management in the UK*

3.3 The wider background to this issue is the continuing development of spectrum management policy in the UK and in the EU. In the UK Spectrum Framework Review ("SFR")[2], Ofcom set out its vision for spectrum management policy as follows:

- *"Spectrum should be free of technology and usage constraints as far as possible. Policy constraints should only be used where they can be justified;*
- *It should be simple and transparent for licence holders to change the ownership and use of spectrum; and*
- *Rights of spectrum users should be clearly defined and users should feel comfortable that they will not be changed without good cause.".*

3.4 Moreover, in Ofcom's Annual Plan 2007/8 published on 12 December 2006, Ofcom includes spectrum liberalisation as one of its key objectives. Ofcom set out a proposed three year strategic framework, with the first of five key areas being *"driving forward a market-based approach to spectrum".* This includes moving forward with the Spectrum Framework Review ("SFR") implementation and spectrum liberalisation, with a key priority for 2007/2008 being *"further liberalising spectrum use in key areas, such as business radio and mobile"*[3].

3.5 Ofcom's proposals for spectrum liberalisation were originally canvassed in the Spectrum Liberalisation consultation document published on 17 September 2004. This consultation document preceded the SFR. Two liberalisation mechanisms were highlighted by Ofcom:

- Applications to vary usage restrictions, with guidelines to be published to set out how variation will be carried out; and
- Amending usage rights to enable more flexibility so that usage can be changed without prior Ofcom approval.

[2] Ofcom's Spectrum Framework Review, section 1.7 (23/11/2004).
[3] Ofcom's Draft Annual Plan 2007/2008, section 6.5 (12/12/2006).

3.6 In its Implementation Plan for the SFR (SFRIP)[4], Ofcom asked for views over the possible timing of any decision to allow for greater flexibility for existing licences, including the 3.5GHz bands.

3.7 In the SFRIP, Ofcom noted the benefits of early liberalisation in relation to efficient spectrum management and the promotion of effective competition in the market. In section 8.52 of the SFRIP ("Options for general approach – existing licences"), Ofcom identified four alternative approaches that it might take towards the removal of restrictions from existing licences. These options are as follows:

- *"Option 1 – allow removal of restrictions that prevent use of spectrum for 3G services (subject to the constraints mentioned in previous paragraph) without a transitional period following conclusion of this consultation*

- *Option 2 - allow removal of restrictions that prevent use of spectrum for 3G services (subject to the constraints mentioned in previous paragraph) after a transitional period has elapsed; this transitional period might last to 2007 (subject to decisions at the time)*

- *Option 3 – allow removal of restrictions that prevent use of spectrum for 3G services (subject to the constraints mentioned in previous paragraph) only after a much longer period has elapsed; this period might last until 2015 (subject to decisions at the time)*

- *Option 4 – do not allow the removal of restrictions that prevent use of spectrum for 3G services"*

3.8 Ofcom analysed these options and then concluded in section 8.55 of the SFRIP as follows:

> *"Ofcom's preliminary conclusion is that options 3 and 4 do not appear to offer an appropriate balance between the relevant considerations identified in the above table. Option 1 has merits. However, it would only provide the existing 3G licensees with very limited notice of the introduction of the new approach to spectrum management. Given the particular circumstances under which they acquired the spectrum (compared to most other licensees to date) in the auction in 2000, and the nascent nature of the provision of 3G services, option 1 risks some short-term disruption to the development of provision of 3G services. This could be damaging to the interests of citizens and consumers. Option 2 appears to offer an appropriate balance between the relevant considerations identified in the table, and seeks to maximise the interests of citizens and consumers. It strikes a balance between the need to minimise any short term disruption to the five existing licensees against other considerations, in particular the need to promote efficient use of the spectrum and to promote competition. Accordingly, this is the approach that Ofcom is presently minded to prefer in relation to the removal of restrictions from existing licences.".*

3.9 UK Broadband generally agrees with this analysis and considers that all existing licences should be aligned in terms of being application and technology neutral from a specific date. We agree with Ofcom's SFRIP statements that such liberalisation should commence from 2007 (i.e. that a *"transitional period might last to 2007"*). This provides a sufficient elapsed period to dissipate any concerns regarding the approach that other parties could have taken with regard to

[4] Ofcom's Spectrum Framework Review Implementation Plan (13/01/2005).

the 3.5GHz auction in 2003. Indeed, as 2007 has already begun, the UK is lagging behind the target set less than 3 years ago, to the detriment of consumers and the economy in an environment of accelerating consumer demands.

3.10 With Ofcom's move to release new spectrum, interested parties are being given the opportunity to enter the market through the acquisition of alternative spectrum (which has either already been auctioned or which Ofcom has announced will be auctioned in the near future). Recent Ofcom spectrum auction announcements relating to:

- 1781.7-1785 MHz paired with 1876.7-1880 MHz;
- L Band 1452-1492MHz; and
- 412MHz,

indicate that these bands have been or will be auctioned on a technology and application neutral basis. Moreover, in the recent consultation document issued for the 2.5GHz and associated bands[5] auction, Ofcom indicates that it favours a similar liberalised approach. Ofcom states (in section 1.5 (b) of the consultation paper), that this spectrum:

> *"…would allow the delivery of high data rate services to fixed, nomadic or mobile devices..".*

In section 1.18 of the same paper, Ofcom states that the UK supports, along with a number of other countries:

> *"…a technology neutral approach towards spectrum usage..".*

3.11 This Request is therefore both timely and appropriate, and would permit an existing entrant to compete with various new entrants on a level playing field and not be disadvantaged by their entry free of usage restrictions.

3.12 The analysis in the SFRIP has become more persuasive with the passage of time. The market has developed significantly since early 2005 and the risk of some short-term disruption to the development of 3G services is minimal if at all. There is no risk of market failure of mobile services and yet potential user benefits are substantial. The requested liberalisation is also consistent with a policy of technology and application neutrality and will further enable a market-based approach.

[5] "Award of available spectrum: 2500-2690 MHz, 2010-2025 MHz and 2290-2300 MHz", Ofcom consultation (11/12/2006).

## *European Spectrum Liberalisation at 3.5GHz*

3.13 In January 2005, the European Commission requested CEPT's Electronic Communications Committee (ECC) to review spectrum bands between 3.4GHz to 3.8GHz[6] with a view to creating harmonised implementation of Broadband Wireless Access systems across the European Union.

3.14 This work recently concluded in November 2006 with the recommendation from CEPT's SE19 and JPT BWA working groups (after undertaking various spectrum sharing, simulation and interference studies) that mobile usage should be allowed within the 3.4GHz to 3.8GHz bands.

3.15 The ECC has recently completed a public consultation[7] on this issue to move from a draft Decision to a final recommendation to the European Commission during the first half of 2007. In response to this consultation, a number regulators including Germany (who recently auctioned 3.5GHz licences in December 2006) expressed full support for liberalisation. This Decision will facilitate a European single market which sits within the context of a global WiMAX roaming market for 802.16e (effectively a mobile standard for WiMAX) devices.

## *Creation of a Single European Mobile WiMAX Market*

3.16 At a Member State level, major European countries are now adopting 3.5GHz for WiMAX wireless broadband services. We believe a single European WiMAX market is being created at 3.5GHz (as indicated by the table below) which will enable roaming of WiMAX 802.16e devices. It would very be detrimental from a policy perspective for UK regulation to lag behind the rest of Europe and not be harmonised with other Member States. Not keeping pace with market developments would mean the UK economy and consumers would be unable to take advantage of the considerable benefits from the creation of a single European mobile WiMAX market. It is within the vision of such a market that UK Broadband seeks to compete on a level playing field to provide *Personal Broadband* services to UK consumers.

3.17 The table below shows the European spectrum holdings at 3.5GHz.

[6] EC Mandate CEPT to identify the conditions relating to the provision of harmonised radio frequency bands in the European Union for Broadband Wireless Access applications (4 Jan 2005).

[7] ECC Decision on availability of frequency bands between 3400-3800MHz for the harmonised implementation of Broadband Wireless Access Systems ECC/DEC/(07)AA (Dec 2006).

**Table 1: European 3.5GHz spectrum holdings**

| Country | 3.5GHz Spectrum Holders |
|---|---|
| Ireland | Clearwire, Irish Broadband, DigiWeb and others |
| Belgium | Clearwire |
| Spain | Iberbanda/Telefonica |
| Austria | WiMAX Telecom |
| Denmark | Clearwire/Danske Telecom |
| Sweden | Savannah Networks, ARE Networks and others |
| Netherlands | Worldmax |
| Poland | Clearwire |
| Bulgaria | Clearwire |
| Norway | Telenor |
| Switzerland | Swisscom Mobile |
| France | Multiple including Altitude Telecom (owned by Illiad) |
| Romania | Clearwire, Mobifon, Equant, Astral and others |
| Croatia | VIPNet, WIMAX Telecom |
| Germany | Clearwire, DBD and Inquam |
| Luxembourg | Skybernet |
| Greece | Craig Wireless, OTE, Cosmo Telco and Q Telecom |

Source: UK Broadband

# 4. Developments in Spectrum Capabilities and Technology since 2003

4.1 In any industry it is important that regulation is sufficiently flexible and adaptable to keep pace with developments in the market. Since the UK Broadband licences were awarded in 2003, the environment within which UK regulation operates has changed dramatically, and it is important to recognise the practical implications of such changes for licensing of the 3.5GHz spectrum. These changes in the market range from spectrum management and technology to consumer requirements.

## *Developments in Spectrum and WiMAX Technology*

4.2 One of the key developments is the increased appreciation within the telecoms industry of the uses available for the 3.5GHz spectrum. The accepted wisdom at the time of the 2003 auction (with the exception of a few) was that 3.5GHz spectrum was usable only for rooftop mounted near Line-of-Sight modems. This perception was driven by the industry view, first, having regard to the physical properties of the spectrum, and secondly having regard to equipment availability at that time.

4.3 The arrival and development of WiMAX technology has stimulated enormous interest and investment in this new generation of technology. For the first time a wide area wireless technology has been designed from the bottom-up to meet the needs of Broadband wireless services. It is not an evolution of a voice centric technology, but a newly created data optimised technology, which arose out of the IT community rather than out of the traditional telecommunications industry.

4.4 The proponents of this new technology realised that a new approach was necessary if they were to achieve a step-change in the capabilities of wireless broadband technology. They also realised that for any wireless service to work, it needs spectrum. In the case of WiMAX, a vast amount of attention has been focused on the 3.5GHz band to the extent that in most parts of the world, with the exception of the US, 3.5GHz is now widely perceived as the “WiMAX band”.

## *Developments in WiMAX Equipment*

4.5 Since the initial licence award in 2003 there has also been a dramatic change in WiMAX equipment availability. This new equipment overcomes many of the problems that previously were considered a barrier to realising the full potential of the 3.5GHz spectrum.

4.6 The background to this lies in the propagation characteristics of 3.5GHz. The developers of WiMAX technology were aware that the propagation characteristics of 3.5GHz required that, all other factors being equal, cells would be smaller than at conventional cellular frequencies (e.g. 2GHz), therefore requiring a greater number of cell sites for network build. Technology developers therefore set about making WiMAX equipment to offset the difference in propagation characteristics, designing equipment as small and lightweight as possible so that it would be economically viable to deploy multiple cell sites. They also made sure that it did not need expensive special telecommunications circuits to connect back into the internet (E1s) but could instead use the now ubiquitous DSL connections. Numerous features were also developed to improve the RF performance, including making WiMAX equipment:

- available in Mast Head format so that no signal is lost along long coaxial cables; and
- available with various forms of “smart antenna” – either using Transmit Diversity, Adaptive Beamforming or MIMO.

These developments all help to offset the difference in propagation and make the equipment more effective at 3.5GHz.

4.7 This approach has captured the imagination of the communications industry and a major new ecosystem has evolved to feed this new market, comprising the standards bodies, the silicon chip vendors, the equipment vendors and the network operators.

## *WiMAX Standards*

4.8 It was only during 2004 that mobile wireless broadband at 3.5GHz became a real possibility with the emergence of the IEEE 802.16e Mobile WirelessMAN standard. This standard quickly gained momentum after being adopted by the WiMAX Forum.

4.9 The IEEE 802.16e Task Group developed an amendment to IEEE Standard 802.16 ("Air Interface for Fixed Broadband Wireless Access Systems"). The amendment covering "Physical and Media Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands," was approved, as IEEE Std 802.16e-2005, by the IEEE-SA Standards Board on 7 December 2005. The effect of this is that we now have an internationally recognised standard for mobile broadband at 3.5GHz.

## *WiMAX Forum*

4.10 The WiMAX Forum has over the last few years been building a worldwide ecosystem for mobile broadband using the 802.16e standard. It has also identified 3.5GHz as one of the two key WiMAX profiles. This encourages investment in this band. There are at least 5 key silicon vendors (Intel, Fujitsu, Beceem, Sequance and Runcom) who are involved in manufacturing WiMAX chipsets. Also British Company picoChip has a leading position in the chips used in base stations.

4.11 These chips are being designed into products by a list of manufacturers that reads like a “Who’s Who” of the communications industry namely, Alcatel, Samsung, LG, Nortel, Motorola, Huawei, ZTE, Siemens and Nokia. Not only are the infrastructure providers developing equipment, but critically certain manufacturers of handheld devices (Motorola, Samsung and Nokia), have announced that these devices will be available at both 2.5GHz and 3.5GHz. The reason for this is that there is minimal incremental cost to create a dual band device compared to a single band only model. Thus, roaming capability is a key feature in the development of WiMAX devices.

## *Investment*

4.12 As the WiMAX ecosystem has evolved, increasingly the traditional players have examined what this new technology is capable of and are now choosing to invest in it. In some cases major equipment vendors, for example, Motorola and Nortel, have publicly announced that they will abandon all future investment in 3G technologies and focus exclusively on WiMAX. On the strength of the fundamental data-centric capabilities of this new technology, its potential for massive cost savings, network operators have announced major network roll-out plans. The

highest profile of those is the Sprint decision to invest US$3 billion in a US wide deployment. Likewise AT&T and wireless entrepreneur Craig McCaw (through Clearwire and other investment vehicles) have announced plans to deploy multi-billion dollar networks in the US and in the rest of the world. In Asia, South Korea is again the wireless leader, with both KT and SKT having already built first generation Mobile WiMAX networks (formerly called WiBro).

## *Consumer Requirements*

4.13 Consumer requirements have also advanced considerably since the 3.5GHz auction in 2003 in parallel with, or as a consequence of, developments in technology. These requirements are due to a number of factors including:

- Growth in the use of broadband content
- Growth in the adoption of laptops
- The availability of networked smart handheld devices e.g. Apple iPhone, the Nokia N800 and Sony PSP

This has led to an increasing consumer demand for high-speed, mobile broadband services for the mass market.

## *UK Broadband Plans for WiMAX*

4.14 Given what is happening in the market place, and in particular the forces gathering for large scale deployment of WiMAX in Europe and the rest of the world, UK Broadband cannot ignore the challenge and opportunity. To do otherwise would put at severe risk the already major investment made in the UK business by PCCW, the parent company of UK Broadband.

4.15 The company has therefore developed sophisticated and detailed business plans with a view to making a significant investment in the provision of a national WiMAX network utilising 3.5GHz and the 802.16e standard.

4.16 A key factor in UK Broadband's decision to proceed with this investment is the timely removal of the limitations in its current licences. This removal will enable UK Broadband to incorporate the most spectrum-efficient technologies yet developed and deployed anywhere in the world (high order modulation, adaptive antennas, beam-forming etc.). If such limitations are instead maintained, the spectrum will be increasingly under-utilised having regard to the developments in WiMAX technology now available.

4.17 As part of its longer term vision, UK Broadband has a number of more immediate plans. In particular, UK Broadband would very much like to transition and upgrade all or part of its current network to WiMAX equipment. We plan to deploy equipment which is compliant with 802.16e, the so called “mobile” WiMAX standard.

4.18 We do not intend to choose the “mobile” over the “fixed” version of WiMAX just because we intend to offer a mobile service. Rather, 802.16e equipment has better performance and has much greater industry support. That is, we expect that even for a fixed service this equipment will be better and cheaper. Nevertheless, the infrastructure that we deploy to support fixed services will be inherently capable of supporting handheld “mobile” devices and services.

## *Distinctive Characteristics of WiMAX*

4.19 One key aspect in which WiMAX differs from conventional cellular mobile products is that WiMAX will naturally be incorporated into the kinds of devices that currently use only WiFi, such as laptops, handheld games consoles, "cordless phones", Apple iPhone type smart phones etc. This is intentional as the designers of this technology have logically sought to maximise the commonality so that the incremental cost of adding WiMAX to WiFi is low. To put it another way, it does not cost a lot more to have both WiMAX and WiFi rather than just WiFi. The consequence of these economies of scope is that there will be a great many mobile WiMAX devices available on the market that UK Broadband does not supply and control. It is also vital to note that such devices are not a remote possibility, but are in the final stages of market readiness preparation. We have assurances from world leading suppliers that 2.5 / 3.5GHz WiFi/WiMAX handheld internet tablet type devices will be available from mid summer 2007. There will also be a plethora of other "basic" fixed modems and simple handheld terminals available from many manufacturers throughout 2007 and 2008.

4.20 WiMAX also differs from cellular mobile products in a second important way. Whereas cellular services are inevitably accessed by a pre-registered SIM (either pre or post paid), WiMAX will follow the WiFi type "ad hoc" model where users can log on for occasional use using their home broadband username and password or by using their credit card. The consequence of this is that UK Broadband would have little knowledge or control over these types of customers.

## *WiMAX Deployment Plans*

4.21 We intend to deploy the 802.16e equipment in three ways. First, we plan to transition all or part of our existing customers from the pre-WiMAX technology to compliant WiMAX. We will continue to provide the same fixed/nomadic service to end-user premises.

4.22 Secondly, we will also use it as part of our ongoing project to connect lamp post mounted WiFi Access Points back to our network and to the Internet. We will provide our customers with the current fixed/nomadic services via desktop and laptop WiMAX wireless modems. We will provide nomadic services via the public access WiFi network. Customers will access the public WiFi by logging on using either their username or using a credit card.

4.23 Thirdly, we intend to install semi-private base-stations onto client premises. These base-stations will broadcast two identities in the manner of many WiFi access points. One identity represents the private company and can be accessed only by the staff of the company where the base-stations are installed and one will represent the UK Broadband "Now" broadband public access service. Many commentators ascribe the success of WiFi to the fact that it was deployed first in multiple private enterprises and see the same model being repeated in WiMAX.

## *The Practical Implications for Licensing 3.5GHz*

4.24 All of the above plans raise several important practical issues which we discuss below. First, the UK Broadband network will almost inevitably become a flexible and multi-purpose network. The equipment that is deployed to provide fixed services will inherently be capable of supporting handheld "mobile" type devices. Handheld mobile type devices will, irrespective of any endeavours by UK Broadband, arise on the UK market. The latest generations of internet tablets and other smart phone devices, designed for the US and global markets will incorporate 2.5/3.5GHz WiFi/WiMAX. Customers may then use their fixed service username and password to log on using their handheld devices. Similarly, rather than paying a regular monthly

subscription, customers may also use a credit card to enable ad hoc occasional use. Given the profusion of self-provided devices and ease of log on, it would become almost impossible to operate under the existing licence contraints.

4.25 Secondly, where private base-stations are deployed on client premises it will often be the case that several base-stations will be installed and handover will be enabled between the private base-stations. The network and devices will be mobile within a single user premises but not outside such premises.

4.26 Thirdly there is the issue of inbound European roaming. Within the terms of its current fixed/nomadic service offering, UK Broadband is in the process of developing international roaming agreements with other European operators. These inbound roamers will not be mobile. It is quite likely that a business traveller would carry a mains or USB powered modem or a laptop with a PCMCIA card or integrated WiMAX modem. All of these devices fall within the terms of UK Broadband's existing licences. Through our roaming agreements we will welcome these users onto our fixed network. However, if a foreign operator enabled its customers to use handheld type devices, it would be impossible for UK Broadband to discriminate between the fixed devices and the mobile ones when these roam onto our network.

4.27 Fourthly, there is the critical issue of the free movement of goods throughout Europe, and specifically, of telecommunications terminal equipment as required by the R&TTE Directive. As WiMAX equipment will be manufactured and sold in other European countries, the UK would be in breach of its European obligations once properly certified equipment is available if this equipment cannot be sold and used in the UK. Even if handheld Mobile WiMAX equipment could be sold, one may find oneself in the anomolous situation where it may be possible to sell the equipment but not use it on the UK Broadband network. It may even be the case that if another operator obtained 2.5GHz spectrum at auction and deployed WiMAX technology then for example 2.5 /3.5GHz WiFi/WiMAX handheld internet tablets could be sold and used on that network but not on the UK Broadband network. This would be unreasonable and discriminatory.

4.28 The net result of these technological developments is that a global WiMAX standard is now a reality. Dual-band, mobile WiMAX equipment capable of operating at 3.5GHz is not something that is merely on the horizon but is "here and now" and available in the market in 2007.

4.29 This new wave of WiMAX equipment will provide fixed and mobile capabilities. Increasingly manufacturers will cease to produce purely "fixed" WiMAX equipment. UK Broadband will of course need to deploy the latest equipment technology in order to be a successful player in a competitive market. In parallel, it is inevitable and indeed desirable that customers will seek to use such devices in a portable manner. In this environment, absent the requested licence variation, UK Broadband will be seeking to comply with what have simply become anachronistic licence obligations that, far from encouraging innovation, actively inhibit innovation, technological development and competition.

4.30 It is imperative therefore that the regulatory environment in the UK should evolve so as to keep pace with technological developments and customer requirements and at the same time remove out-dated restrictions. It must also promote innovation and encourage competition. It cannot be an obstacle to consumer benefits through inflexible regulations.

4.31 To delay in acting to facilitate such liberalisation would be inconsistent with Ofcom's duties to secure the optimal use of spectrum and with its stated priorities of:

- accelerating a market-based approach to spectrum;
- promoting competition in converging markets; and
- enabling services that are important to UK citizens as platforms and services converge.

# 5. Why Now? The Timing for Liberalisation

5.1 UK Broadband considers that a Decision by Ofcom to vary UK Broadband's licences, to allow technology and application neutral use, will confer significant economic benefits to UK consumers and the UK economy. Due to accelerated market developments, such a licence variation needs to occur **as soon as possible in 2007. This would be consistent with Ofcom's analysis and statements.**

## *Driving Forward a Market-based Approach to Spectrum*

5.2 UK Broadband supports Ofcom's aim to move spectrum management from a command and control mechanism to a market-based approach. In general, we consider that a market-based approach will enable spectrum to be used optimally without restrictions on technology and applications, for the benefit of UK consumers and the UK economy.

5.3 Given the rapid pace of technological change in the electronic communications market, it is not reasonable to assume that acquirers of licence rights should be wedded or limited artificially to any one type of technological application. In this respect, our view is that spectrum should not be limited to known technologies and applications of the present day but should, as far as possible, be readily available for use with future applications and technologies as driven by the market. This ensures that regulation is not anachronistic but flexible and keeps pace with technological developments. This approach is consistent with UK and EU policy, as well as global best practices.

## *Liberalising 3.5GHz at the Earliest Opportunity*

5.4 Set out below is a detailed analysis highlighting why the immediate liberalisation (in 2007) is important.

### *Consistent with the European Regulatory Environment*

5.5 In sections 3.13 to 3.17 we explained that the European Commission is presently in the process of creating regulatory policies which will lead, in the first half of 2007, to a harmonised environment where restrictions on 3.5GHz are fully relaxed allowing mobile usage. With the release of 3.5GHz spectrum across Europe, this spectrum is becoming the de facto WiMAX band (as opposed to 2.5GHz). At the same time the liberalised regulatory environment at 3.5GHz is leading to a single market for mobile WiMAX services. Service providers across Europe will be building WiMAX 802.16e networks at 3.5GHz and offering consumers the opportunity to benefit from high-speed portable broadband services to handheld devices and laptops. The European regulatory environment is inexorably moving towards liberalisation at 3.5GHz during 2007 and the UK should be at the forefront of this development. Failure to lead would ultimately harm UK consumers and the UK economy by delaying the clear benefits of liberalisation.

### *3.5GHz is the De Facto Spectrum for WiMAX Services in Europe*

5.6 The 3.5GHz band is the de facto spectrum for WiMAX 802.16e services in Europe. European spectrum holdings at 3.5GHz are detailed fully in section 3.17. If the UK does not liberalise 3.5GHz in step with its European counterparts, UK consumers will be prevented from benefiting from the advantages of roaming with their portable broadband devices onto other European

country networks and vice-versa (although of course, this problem may be mitigated in the longer term with multi-band WiMAX radio components).

## *Economic Benefits of Immediate Liberalisation*

5.7 During 2006, UK Broadband commissioned Europe Economics to undertake a study (attached in Appendix 1) to estimate the likely economic benefits which would result for consumers and for the wider economy from the availability of *Personal Broadband* services at 3.5GHz. In this study, Europe Economics applied similar methodology to that used in its recent report conducted for Ofcom[8] which assesses the economic impact of the use of radio spectrum in the UK.

5.8 The development of new technologies and services, including for example fixed broadband services and electronic consumer goods, suggests that demand for *Personal Broadband* services is likely to be high and that early consumers of these services may enjoy consumer surplus (i.e. services which are consumed at a price below that which consumers are prepared to pay).

5.9 Europe Economics has estimated the potential economic benefits of *Personal Broadband* services. Their study indicates that for the period 2008 to 2016 the value of estimated consumer surplus for *Personal Broadband* users (from the use of the 3.5 GHz band in the UK from 2008 to 2016) is as set out in Table 2 below:

**Table 2: Consumer surplus in the UK Economy**

| Year | Consumer Surplus at 2006 prices (£) |
|---|---|
| 2008 | 9,013,000 |
| 2009 | 73,887,000 |
| 2010 | 148,730,000 |
| 2011 | 235,466,000 |
| 2012 | 301,725,000 |
| 2013 | 338,606,000 |
| 2014 | 355,342,000 |
| 2015 | 362,978,000 |
| 2016 | 363,031,000 |
| **Total** | **2,188,776,000** |

Source: Europe Economics

5.10 This table suggests a rising scale of consumer surplus as "early adopters" are joined by more mainstream consumers. It is assumed that in 2007 the UK Broadband licence is varied, network modifications are undertaken, handheld devices are procured, substantial testing is done and sales efforts are ramped-up.

[8] "The Economic impact of the use of radio spectrum in the UK", by Europe Economics (Oct 2006).

5.11 In summary, findings from this study (which are described in more detail in Appendix 1) indicated that, on a conservative estimate, the introduction of *Personal Broadband* services will have the following economic benefits:

- From 2008 to 2016, the introduction of *Personal Broadband* services will generate for the UK a consumer surplus of approximately £2.2 billion.

- Adding gross linkage and income multiplier effects, the wider contribution to the UK economy is forecast to be £173m to GDP and 1,129 to employment in 2009, rising to a £1,662m contribution to GDP and 10,840 to employment by 2016.

Europe Economics notes that these quantitative findings are consistent with those for other new technologies such as WiFi and probably understate the strategic importance within the EU of developing these technologies, given the possibility of spin-off innovations.

## *Other Benefits of Licence Variation*

5.12 The other key benefits of agreeing to vary UK Broadband's licence so as to allow the delivery of *Personal Broadband* Services at 3.5 GHz include:

- Enhancement of the UK's competitive advantage derived from it adopting a more market-led regulatory approach relative to the rest of the EU and to other countries, reinforcing the reality that the UK is a favourable location for the development and launch of innovative new services;
- The benefits of increased choice and accessibility in the electronic communications market.

- Establishing a useful precedent for further liberalisation of the spectrum management regime, as desired by Ofcom and indicated by the European Commission, particularly where, as here, there is a clear justification on the grounds of economic and consumer benefits.

## *No Market Failure*

5.13 The clear movement away from command and control regulation to a reliance on market forces necessarily includes the removal of artificial restraints on competition. The existing UK Broadband licences contain such restraints which now should be removed. In economic regulatory terms, UK Broadband's request should be granted unless so doing would cause a market failure in the mobile services market, with those making such claims having the burden of proof. It is the firm view of UK Broadband that upon any analysis, a grant of the requested licence variations would not cause a market failure.

5.14 In addition, there can be no legitimate expectation that existing mobile operators would not face additional entry in the future. There is no representation, assertion or other statement by Ofcom, the Radiocommunications Agency or the DTI of which we are aware that can justifiably constitute such an expectation. The 3G Information Memorandum conspicuously avoided any 'future proofing' statements of any kind for the benefit of bidders. Further, the failure of entities to participate in an open auction should not be used to penalise those that did. All market participants have access to technology and policy trends/ information, and make judgments accordingly and must accept the inherent risk of new technologies becoming available. Indeed,

such arguments are clearly self serving "anti-consumer", and cannot be given any real weight several years on from the initial auction of spectrum.

## *Impact of Delay*

5.15 If Ofcom were not to react to this Request in a timely fashion and there were to be a delay in granting the requested variation in 2007 in the way envisaged in the SFRIP, this would have serious negative repercussions for UK Broadband's investment plans. UK Broadband's ability to compete effectively is dependent upon its move into mobility and without this its business model would be an anachronism, confined to a silo of yesterday's technology.

# 6. The Legal Context

6.1 Ofcom is under a statutory duty to consider this Request and, in doing so, to act to secure efficient and sustainable competition as well as not favouring one form of electronic communications network or service over another. Moreover, in imposing, and continuing to impose, terms or limitations on wireless telegraphy licences, Ofcom is obliged to impose only those that are objectively justifiable, proportionate and not such as to discriminate unduly against licensees. Therefore, whilst clearly Ofcom have the usual discretion available to UK regulators, these duties are constraining. Indeed, Ofcom should grant this Request absent compelling reasons to the contrary (i.e. a grant would be unlawful or cause a market failure which obviously would not be the case).

6.2 The mobile operators have been free for some time to move into more fixed and nomadic applications and, with the advent of Fixed Mobile Convergence, are now doing so. Yet a fixed wireless provider such as UK Broadband seeking to apply its network and technology to mobile applications in an equivalent way cannot do so currently because of the existing licence conditions. This is not only discriminatory and anti-competitive; it is also against the interests of consumers.

6.3 Ofcom also has a duty to:

- ensure the optimal use of spectrum (section 3(2), Communications Act 2003);
- promote a wide range of services (section 3(2)(b), 2003 Act);
- encourage investment and innovation in relevant markets (section 3(4)(d), 2003 Act); and
- encourage development of electronic communications apparatus capable of being used with ease and without modification by the widest possible range of individuals (section 10(1)(a)).

6.4 Ofcom's plans to auction 2.5GHz later this year would involve the granting of licences to winning bidders which would be technology and application neutral. It would therefore be unreasonable, discriminatory and disproportionate not to free UK Broadband of its service restrictions in order for it to compete fairly and effectively with those licensees. Otherwise UK Broadband would be placed at a real competitive disadvantage in this fast-evolving market.

6.5 We would also add that in the context of Ofcom's licensing policy and statements made in the SFRIP, we would have expected Ofcom to mention in the Consultation Document, and certainly in the pre-Auction Information Memorandum, the very real likelihood (if by then it has not already occurred) of 3.5GHz licence conditions being relaxed to allow mobile services.

6.6 Granting the licence variation would enable UK Broadband, at long last, to make full and efficient use of the spectrum it holds. This would lead to the introduction of vital and valuable innovative new services in the UK, providing substantial economic benefits for UK consumers.

# 7. Request for Increased Power Levels

7.1 To deliver *Personal Broadband* services, UK Broadband intends to use the latest data optimised standards-based WiMAX 802.16e technologies. This standards-based equipment utilises increased power levels which are consistent with new European level recommendations.

7.2 In Appendix 2, we present the detailed case for increasing the allowed power levels at 3.5GHz. In summary, the key conclusions presented in Appendix 2 are that the requested increase in power levels would:

- Align UK regulations with European level recommendations in the form of CEPT's **ECC /DEC/(07)AA**[9], **ECC REC(04)05**[10] **and ECC Report 100**[11] for flexible usage modes of BWA.
- Enable the use of WiMAX 802.16e technology and will enable the UK economy and consumers to take advantage of the considerable benefits resulting from the creation of a single European mobile WiMAX market.
- Enable the use of the latest generation of spectrally efficient antenna array technologies which are currently available with WiMAX 802.16e.
- Have no adverse impact on neighbouring spectrum users following extensive co-existence studies by CEPT SE19[12] Enabling technology neutrality in the 3GHz band was the primary goal when specifying the block edge mask defined in ECC REC(04)05, hence co-existence between systems in adjacent spectrum is expected to be independent of technology deployed.

[9] ECC Decision on availability of frequency bands between 3400-3800 MHz for the harmonised implementation of Broadband Wireless Access systems (BWA).
[10] Guidelines for accommodation and assignment of multipoint fixed wireless systems in frequency bands 3.4-3.6 GHZ and 3.6-3.8 GHz.
[11] CEPT ECC Report 100 (Compatibility studies in the band 3400- 3800 MHz between Broadband Wireless Access (BWA) systems and other services).
12 CEPT ECC SE19(06)74.

# 8. Conclusion

8.1 We consider that the benefits to the UK economy and consumers of licence variation are significant. Moreover, we believe there are no legal or policy impediments to the grant of the requested variation.

8.2 We have demonstrated in this paper the clear quantifiable economic and consumer benefits of allowing the licence variation requested at the earliest opportunity. We believe that liberalising 3.5GHz will be consistent with the UK and European regulatory environment and will address the growing demand for mobile broadband services.

8.3 The true motivation of any opponents to the proposed variation will be wholly self serving i.e. to avoid increased competitive pressure rather than an outcome that generates significant benefits for consumers in the UK. Before any weight is given to such opposing arguments, a market failure must be demonstrated to be likely to be caused by the requested licence variation.

8.4 Allowing the variation would be consistent with Ofcom's duties, aims and vision in respect to its spectrum management policy, the promotion of competition, and in the economic benefits that *Personal Broadband* services will generate. Moreover, the liberalisation of 3.5GHz will not only be consistent with recent spectrum auctions (1781.7-1785 MHz/1876.7-1880 MHz and 412MHz) and announcements regarding the future auctions of L Band and 2.5GHz bands but also consistent with European liberalisation of this band.

8.5 Our assessment therefore is that the impact of making the licence variation requested will be to provide significant benefits for UK citizens and for the UK economy generally. The early implementation of *Personal Broadband* services in the 3.5GHz band is forecast to meet the growing demand for these services. Such forecasted demand, based upon the desire for indispensable broadband content and services from laptop and handheld devices, can be met by liberalising 3.5GHz at the earliest opportunity, leading to significant quantifiable economic benefits.

8.6 In light of this and UK Broadband's desire for regulatory certainty (in order to be able to commit to investment in *Personal Broadband* services in the UK), UK Broadband requests that Ofcom give due consideration to this Request which is consistent with its policy and duties, and that such Request be dealt with expeditiously. Delay would be prejudicial not just to UK Broadband but to the benefits for competition and consumers i.e. the UK market.

# Appendix 1: Economic Benefits of 3.5GHz Liberalisation

# An assessment of the economic benefits of Personal Broadband services

## Report by Europe Economics

**Europe Economics**
**Chancery House**
**53-64 Chancery Lane**
**London WC2A 1QU**
**Tel: (+44) (0) 20 7831 4717**
**Fax: (+44) (0) 20 7831 4515**
**www.europe-economics.com**

**23 November 2006**

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# EXECUTIVE SUMMARY

## Introduction

1.1 This study has been undertaken by Europe Economics for UK Broadband to estimate the likely economic benefits which could be obtained for consumers and for the wider economy of Personal Broadband services. This study assesses the impact of Personal Broadband in the UK and, under limited assumptions, of similar services if applied in EU markets over the next ten years.

1.2 In this study we apply the methodology which we have used to assess the economic impact of the use of radio spectrum in the UK for Ofcom.[1]

1.3 The aim of the study is to provide policy makers and regulators currently discussing the costs and benefits of different regulatory approaches with information about the likely scale of economic benefits which may be derived from Personal Broadband services. This can provide decision-makers with a guide to the economic benefits which may be obtained from such services or alternatively which may be threatened (or foregone) due to inappropriate regulation.

1.4 The conclusions of this study relate to market conditions in Europe and would not apply to markets with different geographical or regulatory conditions.

## Personal Broadband services

1.5 For the purposes of this study, Personal Broadband is defined as wireless broadband data services delivering a flat rate, fat pipe internet connection to consumers using WiMAX 802.16e over the 3.5 GHz spectrum band. Personal Broadband will be delivered to a range of devices including handheld smart-phones, laptops and consumer electronic devices.

1.6 It is estimated that Personal Broadband services using the 3.5 GHz spectrum will be able to operate from 2008 (when WiMAX 802.16e terminal devices will become available) at a quality and richness which will be unavailable from other service providers until the availability of 2.5 GHz spectrum will potentially enable similar services to launched by 2010 or 2011.

## Methodological Background

1.7 In estimating the benefits of new services, economists typically measure the consumer surplus which will be generated by these services.

[1] Europe Economics "The Economic impact of the use of radio spectrum in the UK".

1.8 Consumer surplus is defined as the difference between the price which consumers pay for services and that which they would be willing to pay. This methodology has also been applied by regulators. In general such an approach provides a conservative estimate of the economic benefits of new services.

1.9 Personal Broadband services will also have direct economic effects, for example in generating extra employment and direct investment. In considering the benefits of high technology services, economists have also considered strategic impacts, for example in establishing centres of innovation and wider impacts on the economy.

1.10 To consider the wider effects we have used Office of National Statistics Input and Output tables to consider linked effects through a multiplier analysis and to estimate the effects of Personal Broadband services in the UK.

## Our findings

1.11 We have found on a conservative estimate that the introduction of Personal Broadband services will have the following economic benefits:

- From 2008 to 2016 following the introduction of Personal Broadband services, the findings point to a conservative estimate for the UK of a consumer surplus from Personal Broadband services over an eight year period, 2008 to 2016, of £2.2 billion;
- Adding gross linkage and income multiplier effects, the contribution to the UK economy is forecast to be £173m to GDP and 1,129 to employment in 2009, rising to a £1,662m contribution to GDP and 10,840 to employment by 2016.
- If Personal Broadband services were introduced to eight EU Member States, Germany, France, Italy, Spain, Belgium, the Netherlands, Ireland and Austria, then the total consumer surplus for these eight EU countries amounts to roughly £10.5 billion (around €14 billion) from 2008 to 2016.

## Conclusions

1.12 We find that the introduction of Personal Broadband services is likely to have significant economic benefits for consumers in the UK and the wider EU.

1.13 These quantitative findings are consistent with those for other new technologies such as WiFi and probably understate the strategic importance to the EU of developing these technologies, given the possibility of spin-off innovations.

# 1 INTRODUCTION AND BACKGROUND

## Introduction

1.1 This report has been commissioned by UK Broadband to consider the economic benefits which could be derived from Personal Broadband services.

1.2 In this section we outline the purpose and scope and structure of the report and describe briefly the nature of and likely uptake for Personal Broadband services.

## Purpose and scope of the report

1.3 The report aims to review the possible economic benefits of Personal Broadband services in the UK and in the wider EU.

1.4 In doing so it reviews:

- ✓ The likely benefits to consumers in the UK and wider EU of such services;
- ✓ The strategic economic benefits to the UK and EU from such services;
- ✓ The direct economic benefits (for example in employment and investment) of such services to the UK and EU.

1.5 The report will provide quantitative evidence for the regulators and policy makers that the introduction of Personal Broadband services may confer significant economic benefits.

1.6 Where regulators are the impacts of regulatory decisions (in line with best practice) this evidence will be useful towards measurement of the costs and benefits of different approaches. For example where there may be discussions about spectrum flexibility and the use of 3.5 GHz licences, this report will provide evidence about the potential benefits which may be foregone to the UK and EU economy if Personal Broadband services are not introduced.

1.7 Similarly, where there are wider discussions at European level in relation to the regulatory treatment of BWA services about possible flexibility in use of the spectrum and the standardisation of use of the spectrum, this study will provide evidence of a portion of the possible costs of inappropriate regulation.

## Europe Economics

1.8 Europe Economics is a medium sized, growing, economic consultancy owned by its staff. We have a successful history of providing specialist economic regulatory advice and analysis in the electronic communications, energy, water and pharmaceuticals markets.

1.9 Current clients include the public bodies such as the European Commission, (DG Internal Market, DG Transport and Energy and DG Health and Consumer Affairs), the European Parliament, Ofcom, Ofgem, the Financial Services Authority and Comreg and private sector clients such as UK Broadband and the Association of Convenience Stores.

## Structure of this report

1.10 This report is structured as follows:

- Section One (this section) introduces the report and provides background on the development of Personal Broadband services;
- Section Two sets out the methodological background including a consideration of the approaches to estimating economic benefits and their application to Personal Broadband services;
- Section Three outlines our methodology for this study;
- Section Four provides the results of the study implementing the methodology;
- Section Five provides conclusions and recommendations.

## Personal Broadband services

1.11 This study examines the likely impact of Personal Broadband services. These services use WiMAX 802.16e technology to provide consumers with a wireless broadband data services delivering a flat rate, fat pipe internet connection to consumers using 3.5 GHz spectrum.

1.12 In the UK the main provider of these services will be UK Broadband, the largest Broadband Wireless Access (BWA) operator with the licence rights for the 3.4 to 3.6 GHz spectrum.

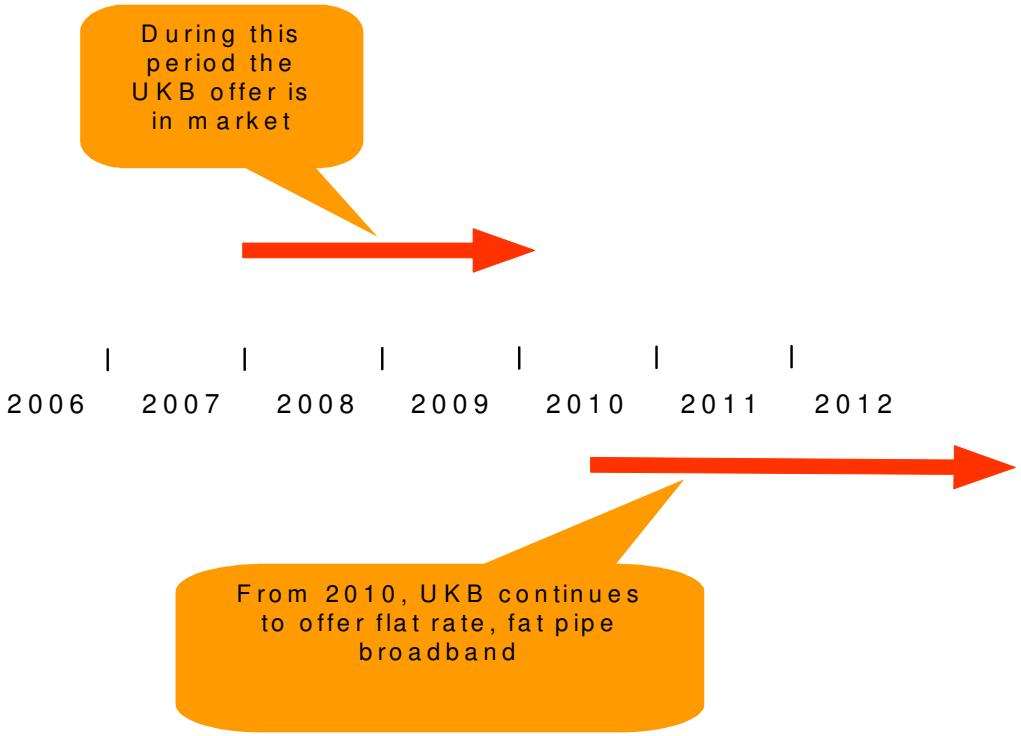
1.13 Personal Broadband services are wireless internet broadband services which can offer consumers the advantage of wide-ranging geographical access to broadband "on the go".

1.14 Services which could be facilitated by Personal Broadband could include laptops and hand-held devices supporting wireless broadband voice and data applications including email, corporate VPN, news and entertainments and information research.

1.15 It is assumed that such services will be provided in the UK by UK Broadband (UKB) from 2008 onwards whereas operators using the 2.5 GHz spectrum will not be able to provide these services before 2010 or 2011.

1.16 This is illustrated by Figure 1: The timetable for Personal Broadband services below.

**Figure 1: The timetable for Personal Broadband services**




## The likely demand for Personal Broadband services

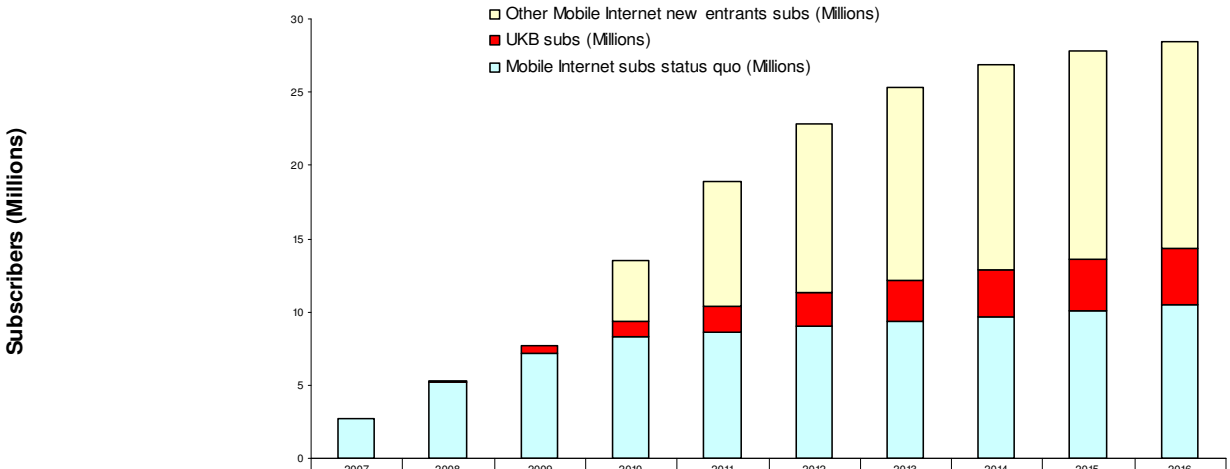
1.17 The earlier implementation of Personal Broadband services in the 3.5 GHz band is forecast to lead to the development of demand for these services in advance of those across other technologies.

1.18 Such a demand is forecast to be based upon a desire for the applications of wireless Personal Broadband services, for example hand-held devices which may allow consumers the advantages of a data rich fat pipe broadband connection "on the go".

1.19 Intuition and the evidence from the growth of antecedents such as fixed broadband services and the rapid growth and development of portable electronic consumer goods suggests that demand for such services is likely to be high and that the first movers into this market may enjoy an initial period of producer surplus and that a proportion of early consumers of these services may enjoy consumer surplus (i.e. services which are consumed at a price below that which consumers are prepared to pay).

1.20 The forecast pattern of demand for Personal Broadband services is shown in Figure 2 below.

**Figure 2: The forecast demand for Personal Broadband services**




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| Other Mobile Internet new entrants subs (Millions) | 0.00 | 0.00 | 0.00 | 4.05 | 8.51 | 11.59 | 13.17 | 13.99 | 14.21 | 14.10 |
| UKB subs (Millions) | 0.00 | 0.10 | 0.51 | 1.11 | 1.73 | 2.31 | 2.78 | 3.20 | 3.58 | 3.90 |
| Mobile Internet subs status quo (Millions) | 2.73 | 5.20 | 7.21 | 8.29 | 8.63 | 8.98 | 9.33 | 9.68 | 10.04 | 10.45 |

Source: UK Broadband and Forester Research

1.21 According to Figure 2, UK Broadband is the only operator able to offer flat rate, fat pipe wireless broadband in the 2008-2009 before other WiMAX-based operators enter the market using 2.5GHz.

## Relevant regulatory developments

1.22 The development of Personal Broadband services may depend upon an appropriate regulation which allows on the one hand for predictable regulation and on the other for a technology neutral approach which will allow operators in the 3.4 to 3.8 GHz frequency band to compete without problems of interference from other technologies.

1.23 In this respect key ongoing regulatory developments include:

- The European review of the electronic communications framework;
- The review by Ofcom of its spectrum framework;
- The process of European regulatory standardisation being undertaken at the CEPT and at ETSI.

1.24 For the purposes of this study we have assumed an appropriate technology neutral regulation which facilitates the development of Personal Broadband services.

## Geographic and market conditions

1.25 The successful development of BWA services such as Personal Broadband may also depend upon favourable geographic and market conditions.

1.26 In this respect the economic benefits described in this study for Personal Broadband services in the UK and the EU may not be available in other markets.

# 2 METHODOLOGICAL BACKGROUND

## Introduction

2.1 The benefits of new services such as Personal Broadband can be categorised in a variety of ways. In this note we summarise how existing research has evaluated the benefits of similar technologies in the past and discuss the methodologies most suited for application to Personal Broadband.

2.2 One of the most widely applied methods for quantifying the benefits of a particular product or service is to estimate consumer and producer surplus arising from the product, which we will discuss in detail below.

2.3 Since ICTs in general and broadband specifically are enabling technologies, it is also important to capture the value of the services, processes and innovations that they enable. In addition, the introduction of a new flow of output in the economy leads to direct improvements in employment and GDP. These in turn flow to other firms that are linked to the supply chain, for example, to manufacturers of equipment.

## Typical methodologies

2.4 There are typically two ways to quantify the economic value of a new service:

- The first is to express benefits to consumers and firms, i.e. the expected turnover and employment in ways that are useful in understanding the extent of the contribution to the economy – for example, as a proportion of the telecommunications market. These estimates can also be used to calculate indirect linkage effects that arise in supplying firms, and multiplier effects that arise from the expenditure of the income created for employees.

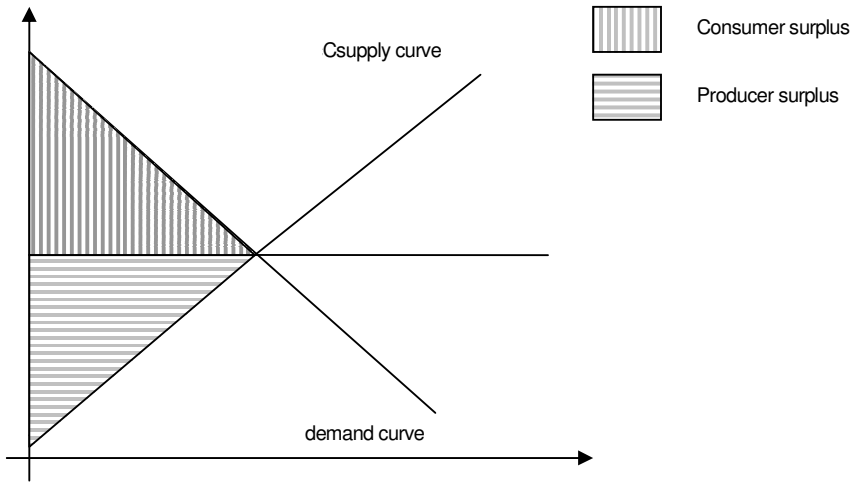
- The second approach is to estimate economy level impacts. This can be done using existing econometric research on macro-levels impacts of previous technologies such as ICTs and broadband. This category of research looks at how trends in, for example, output, employment and productivity, are linked to the diffusion of enabling technologies. We can then extrapolate what the likely effect of Personal Broadband might be as a contributor to these technologies. We also consider direct effects such as employment and investment and indirect effects.

### Estimating the benefits to consumers and firms

2.5 There are two standard measures of economic welfare generated from a specific product: consumer surplus and producer surplus. Consumer surplus measures the difference between the maximum price that a consumer would be willing to pay and the market price which he pays i.e. the net benefit derived by that consumer.

2.6 Producer surplus, on the other hand, measures the difference between the lowest price that the producer would have been willing to receive for the product and the market price i.e. the net benefit derived by the producer.

2.7 The market demand and supply curves are calculated by aggregating the willingness to pay and the minimum selling price for the product for all consumers and producers. The graph below illustrates typical demand and supply curves and the corresponding measures of welfare: consumer and producer surplus.




2.8 Typically the demand curve is derived from survey responses which ask consumers directly about their willingness to pay.

*Previous research*

2.9 There have been a number of relevant studies and academic papers in reference to the methodology for estimating the benefits of new services such as broadband.

2.10 Goolsbee (2006) use individual level data on willingness to pay for broadband from a survey of 100,000 people. Their survey includes broadband users and consumers who do not have access to a broadband service. The broadband service is described and respondents are asked how much they would be willing to pay for it. The data is collected in bands, for example, "below $5 a month", "$5-$15" etc. The demand curves constructed from the survey results for each region are summed up to provide the market demand curve.

2.11 Goolsbee (2006) also expresses the demand curve with a mathematical equation by fitting the data on a log-linear or quadratic function using econometrics. The point elasticity of demand for broadband calculated at the sale price of $40 ranges from -2.15 to -3.76 for the different regions, with an average of -2.75. This elasticity appears to be consistent with the previous research quoted in the paper.

2.12 Marginal revenue and marginal cost functions are then calculated using estimated price and quantity information, along with assumptions of a constant marginal cost and a Bertrand oligopoly model. Once the curves have all been estimated, it is a simple exercise to calculate the consumer and producer surplus implied.

2.13 An alternative approach, used by Kridel et al (2000), is to use transaction data to estimate the demand curve. Kridel at al (2000) use data from a survey of 32,000 respondents. The survey records usage and expenditure data on the Internet. An econometric discrete choice model is then estimated, including other household demographics that might influence demand, such as age and income. Using this model, they find price elasticities ranging from -1.075 at the price of $29.95 to $1.793 at the price of $49.95.

2.14 A final highly simplified approach which has been used in previous literature simply assumes the shape of the demand curve rather than estimating it. Crandall and Jackson (2001) use current price and quantity to determine a point of the demand curve for broadband. They then assume a linear demand curve with an elasticity of -1 to determine consumer surplus. No reasons are given for choosing an elasticity of -1 rather than any other number, although some sensitivity analysis is provided on changing the elasticity to -1.5. They then simulate shifts of the demand curve that increase the diffusion of broadband from current rates to 50% or 94% and estimate the changes in consumer surplus that would arise from such diffusion.

2.15 In addition to demand curves, supply curves are also required for the analysis of producer surplus. These can be derived from cost information from producers. In addition, it is important to understand the market structure: is the supplier going to be the only one? Is the market competitive? This helps determine the equilibrium conditions for the market and therefore the boundaries of the consumer surplus and producer surplus areas.

**Estimating economy level impacts**

2.16 In estimating economy level impacts, economists also examine direct and indirect benefits.

*Direct benefits*

2.17 The direct impacts that Personal Broadband has on the economy are fairly straightforward to estimate.

2.18 They include the contribution to GDP via turnover, and employment, both over the longer terms and in terms of one-off effects such as the employment created in construction and setting up the service.

2.19 Estimates of contributions to local and national government via taxes can also be included in direct effects. These effects can be expressed as a proportion of sub-sector and sector level turnovers in order to demonstrate the magnitude of the impact implied.

2.20 There are in addition, several kinds of indirect effects which we describe below.

*Indirect effects*

2.21 Indirect benefits can include indirect employment and output effects for example using multiplier analysis to consider the likely impact on the wider economy.

2.22 These additional economy level benefits can be hard to quantify and capture, especially since Personal Broadband has not yet been implemented. However, a substantial literature exists on the benefits of ICTs and of broadband. Personal Broadband is an extension of these technologies, and therefore this research can be used to get an indication of the likely benefits.

*Previous research*

2.23 In a report completed earlier this year, the US Department of Commerce found that broadband access enhances economic growth and performance. They used a panel data-set for a range of communities between 1998 and 2002, and found, using econometrics, that communities where mass market broadband was available experienced a faster growth in employment and in the number of business, particularly in the IT intensive sectors. The regression controls for a variety of demographic and community level variables that may influence employment and number of businesses independently of the availability of broadband.

2.24 Table 1 below identifies the key results from this paper.

**Table 1: Economic impacts of broadband from the US Department of Commerce report**

| Economic Indicator | Results |
|---|---|
| Employment (jobs) | Broadband added about 1 – 1.4% to the growth rate, 1998 – 2002 |
| Business Establishments (Proxy for number of firms) | Broadband added about 0.5 – 1.2% to growth rate, 1998 – 2002 |
| Housing Rents (proxy for property values) | More than 6% higher in 2000 in zip codes where broadband available by 1999 |
| Industry Mix | Broadband added about 0.3-0.6% to share of establishments in IT-intensive sectors 1998-2002 |
| | Broadband reduced share of small (<10 employees) establishments by about 1.3 – 1.6%, 1998- 2002 |

2.25 Another paper by Crandall and Jackson (2002) concerns changes in consumer choices arising from broadband (e.g. shopping, commuting, entertainment and healthcare) where benefits are estimated to be $500 billion to US GDP in 2006. Heaney and Williamson (2004) also emphasize the importance of telecoms innovation in realising the benefits of ICT innovation. They suggest that telecoms innovation could act as a bottleneck to the ICT and the economy, estimating that telecoms innovation currently accounts for 15 to 30% of the total impact of ICT in increasing GDP growth. In net present value terms they estimate this figure as a contribution to UK GDP of £400 billion. This can also be compared with the 2003 CEBR report which uses a UKMOD, a model of the UK economy, to estimate that by 2015, the productivity benefits of broadband could result an increase in UK GDP of £21.9 billion. They also estimate that the UK fixed investment would be £8 billion higher and annual government borrowing £13 billion lower than it would be without the forecasted growth in broadband connections.

## Ofcom studies assessing economic benefits

2.26 Ofcom has already undertaken a number of studies which estimate the economic benefits of new services.

# 3 OUR APPROACH

## Introduction

3.1 In this study we will look to apply the techniques described in the previous section to estimate the economic benefits which can be derived from Personal Broadband services. In doing so we also follow methodologies from previous studies undertaken by Ofcom in relation to estimation of the economic benefits of new services and the methodology which we have used to assess the economic impact of radio spectrum in the UK.[2]

3.2 However, in this study in order to provide a more cautious quantification of economic benefits, we do not provide an estimation of producer surplus.

## Our estimation of economic benefits

3.3 We have seen that there are different methods to estimate benefits including consumer surplus analysis, multiplier techniques and econometric techniques. In general ex ante assessments may use consumer surplus and multiplier techniques whilst ex post assessments may rely on econometric techniques such as regression analysis.

3.4 For the purpose of this study, which is an ex ante assessment, we provide the following analysis:

- A detailed quantification of the likely net economic benefits that EU and UK consumers will derive from the introduction of Personal Broadband services which include a data card and a handheld device;
- A quantification where possible (and qualitative analysis where this is not possible) of the likely wider effects of Personal Broadband services on UK and EU competitiveness;
- A quantification where possible (and qualitative analysis where this is not possible) of the likely structural market effects of Personal Broadband services in the UK and EU;

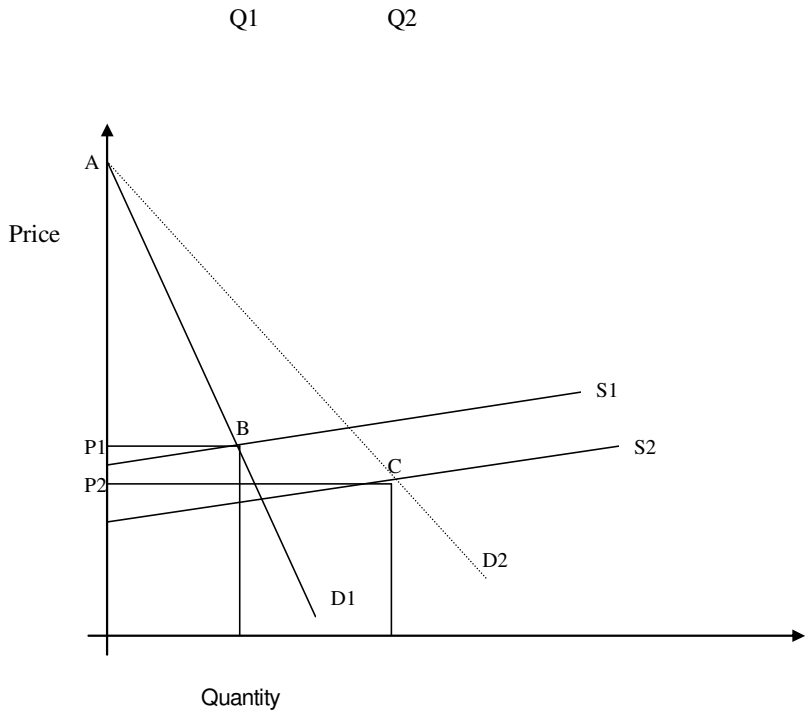
## Consumer surplus analysis

3.5 In estimating the likely net benefits of Personal Broadband services our main approach will be to identify the consumer surplus which will be generated by these services in the UK. This would involve estimating the current demand and supply curves. We would then look at how we expect the demand and supply curves to change as a result of the widespread availability of Personal Broadband. This allows us to estimate the change in consumer surplus, which indicates the benefit to consumers.

[2] Europe Economics: "The Economic impact of radio spectrum in the UK."

3.6 Figure 3 overleaf illustrates the theoretical point where we can see the impact of shift in the demand curve with the consequent change from B to C :

**Figure 3: Consumer surplus analysis**




3.7 Given the scope and the time span of the study we have opted to estimate consumer surplus using data on the price elasticity of demand. This methodology is very useful when data are limited as it allows us to estimate consumer surplus using only two variables, i.e. expenditure and price elasticities.

3.8 The elasticity of demand with respect to price (price elasticity for brevity) can be defined as the percentage change in the quantity demanded given a 1 per cent change in price. If we denote with Q the quantity demanded and with P the price of Personal Broadband then the price elasticity can be defined as $e = \frac{\frac{dQ}{Q}}{\frac{dP}{P}} = \frac{dQ}{dP}\frac{P}{Q}$.

3.9 Paragraph 3.9 below illustrates how this parameter can be used to estimate consumer surplus.

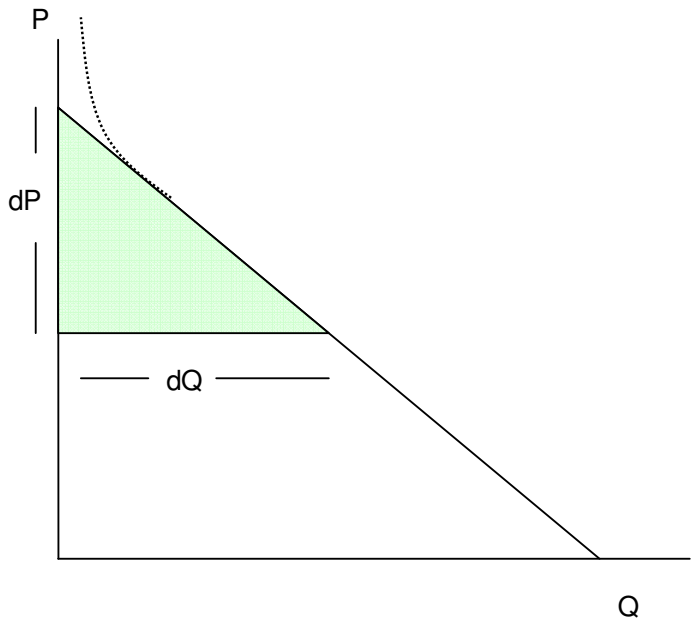
3.10 Consumer surplus is represented by the shaded area in Figure 4. The area of the triangle is clearly equal to $\frac{dQ \cdot dP}{2}$. Using the definition of elasticity we can get that consumer surplus is also equal to $CS = \frac{QP}{2e}$.

3.11 This methodology gives the exact value of consumer surplus if the demand is perfectly linear.

3.12 However it is likely that the linear approximation is not valid at very high prices. If the demand is linear once price reached a threshold then quantity demanded is identically equal to zero. Of course, we cannot observe demand at very high prices but it is likely that, at least, for products like Personal Broadband which are very innovative and can potentially be very useful for some niche customers, even at very high prices, the demand would not be zero.

3.13 Therefore we might be (slightly) underestimating consumer surplus by using this methodology. This slight underestimation is illustrated by the dotted line in Figure 4.

**Figure 4: Price elasticity of demand and consumer surplus**




## The Data

3.14 A problem that we faced in trying to estimate consumer surplus is that it is impossible to estimate an elasticity in a market that is not yet in existence and therefore we have to rely on similar products for which a market is already in place.

3.15 In the previous section we quoted a paper by Golsbee (2006) that attempted an estimate of the elasticity for broadband services.

3.16 However the data on which the paper is based come from a survey that was run in 1998. Given that a number of changes have been introduced in the broadband market since then we preferred to rely on a paper that, although published earlier, is based on a survey run in the USA in 2002[3] of estimates for the elasticity for cable modem demand at different prices.

3.17 This is shown in Table 2 below.

**Table 2: Price elasticity at different prices**

| Monthly price in US$ | 20 | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|---|
| Monthly price in 2006 £ | 12.04 | 18.06 | 24.08 | 30.10 | 36.12 | 42.14 |
| Elasticity | -0.53 | -0.59 | -0.75 | -0.98 | -2.25 | -3.34 |

*Source: Rappoport et al. (2004)*

3.18 Data on predicted turnover have been supplied to us by UK Broadband as well as data on the expected number of subscribers from 2008 to 2016.

3.19 These data are based on the company business plan and on Forrester estimates. By dividing turnover by the number of subscribers we can obtain an estimate of average price

3.20 As price elasticities have been estimated for 2002 we taken into account inflation to have them expressed in 2006 prices, to do this we have used data on the consumer price index from the US Bureau of Labor Statistics.

3.21 Figures on expected turnover are in nominal terms and, therefore, we have to take into account both future inflation and the discount rate.

3.22 Future inflation is estimated as the average change in CPI in the different countries over the last ten years. The discount rate is the official discount rate of the Bank of England (4.75%) and the European Central Bank (4.25%). US$ and Euros have been converted in GBP using the official exchange rate on 27/09/2006.

3.23 As prices are varying over the time span we have used the point elasticity estimate that was as close as possible to the price for the given year e.g. if monthly price was £13 we used an elasticity of -0.53, while if monthly price was £17 we used an elasticity of -0.59 and so on.

[3] Rappoport P., Taylor L., and Kridel D., Willngness to pay and the demand for broadband service, 2004

**Direct economic effects**

3.24 Our approach has been to use available estimates (those used in the Heaney and Williamson study) of the contribution to GDP made by ICT or by broadband, and adjust this by calculating the proportion that Personal Broadband would represent in ICT or total broadband expenditure, and, therefore, the proportion of the GDP benefits that we can attribute to Personal Broadband.

3.25 This is naturally a second-best solution, and assumes that the Personal Broadband has roughly the same proportionate value as other kinds of broadband or ICT.

3.26 However, in light of the uncertainties about any data which could prove otherwise, this appears to be the safest assumption to use.

3.27 It is possible that some extra-economy level benefits are not captured in this calculation. These include possible improvements in international competitiveness, first mover advantage with respect to Europe etc. These benefits would be extremely difficult to quantify, and we would suggest developing these points at a qualitative level and relying on the direct and indirect economy wide benefits as a core of the benefits for this report.

3.28 This reinforces the conservative nature of our quantification of economic benefits.

**Indirect employment effects**

3.29 There are the standard linkage effects that arise from the business that UK Broadband would create for the other firms in the supply chain.

3.30 This can be estimated using details of the expected procurement budget. For example, if the top supplier would receive business worth $1 million, and this represents 10% of his turnover, we can calculate that Personal Broadband would be responsible for 10% of the supplier's turnover and employment. If we perform this calculation for, say, the top 5 suppliers, we can arrive at an average ratio of procurement expenditure to external jobs created. This can then be applied to the remaining procurement budget to get an estimate of the total job creation via linkage effects.

3.31 In addition to linkage effects, the expenditure of UK Broadband employees gives rise to income for other firms, creating a ripple effect throughout the economy. This effect can be estimated using a standard widely accepted national multiplier of 1.1.

3.32 We caveat these results appropriately as the UK Treasury view is that if this employment were not created by UK Broadband it would have been created by other firms in the economy eventually.

3.33 However, the boost to employment and GDP, even if considered short-term, is important. We have adjusted the figures to arrive at net job creation wherever possible.

### Indirect output effects

3.34 Although Personal Broadband specifically, and ICTs more generally, provide direct benefits to end users, the large majority of the benefits are likely to come from indirect effects, or the extra output, innovation or time savings that it enables.

3.35 Innovations in communication technology enable firms in many ways, for example, to realise productivity gains, work flexibly, offer new products and services, make quicker and more efficient business decisions and reduce transaction costs. Some of this is no doubt captured in consumer surplus.

3.36 In this report we do not differentiate between individual consumers and corporate consumers. The price that a consumer is willing to pay arises from the benefits that he thinks he can get out of the product, whether direct or indirect.

3.37 In this sense any perceived indirect benefits will already be calculated in the measure of consumer surplus.

3.38 However, the new uses of an emergent technology develop rapidly over time and the consumer surplus is likely to be conservative as consumers themselves do not know how new innovations will allow them to extend the use of the technology.

## Data requirements for the study

3.39 The data requirements for the study are set out in Table 3 overleaf.

3.40 From this table we can see that different levels of analysis require different levels of data and, in summary that the more complete the data set provided the more robust the analytical tool.

3.41 In particular this comment concerns the assessment of willingness to pay underpinning the demand curve for Personal Broadband services.

**Table 3: Data requirements for the study**

| Variable | Notes |
|---|---|
| Marginal willingness to pay information for a survey of consumers | This would be important for estimating a robust demand curve and therefore consumer surplus. However, if data is not available, a less robust demand can be constructed from assumptions of elasticity. |
| Expected number of consumers for each year | This is essential information, and is required to estimate consumer surplus regardless of our choice of methodology |
| Expected sale price (compatible with the the estimated demand above) | |
| Estimates of marginal costs (once product has been launched)<br>Specifically,<br>What is the marginal cost per hour of service provided?<br>What is the marginal cost per customer? (this should include any costs of setting up the service, customer acquisition costs, and if equipment is provided, the equipment costs) | This is needed to estimate the supply curve and therefore producer surplus and profit. We expect marginal cost to be close to zero and flat. |
| Expected numbers of competitors providing similar product | This is needed to specify market structure and the resulting behavioural assumptions which determine how equilibrium can be specified from the demand and supply curves. |
| How much demand is "new" (would 3G offer a similar service? If so, when?) | This is needed to establish the counter-factual and therefore the net impact of UN Broadband. |
| Likely contract structure: (i.e. are the contracts annual, or pay-per-use?) | This would help determine which metric to use. For example, should price and quantity be defined per customer per year, or by number of user minutes per day? |
| Expected turnover for this proposed business | To assess contribution to economy |
| Turnover and number of employees for existing business | To estimate the ratio of employment to turnover to apply to the new turnover in order to estimate employment |
| Value of investment | To assess contribution to economy |
| Construction expenditure forecast | To estimate the one-off construction employment |
| Procurement projections (major suppliers and procurement expenditure per suppler, plus total expected procurement budget) | This would be useful in order to estimate linkage effects – the extra employment that arises in other supplying firms. |

## Assumptions about market trends and forecasts

3.42 Market data and forecasts have largely been provided by research undertaken by Forester International.

3.43 To provide reassurance about the robustness of the assumptions underpinning our analysis of consumer surplus we have sourced these assumptions where possible outside UK Broadband.

# 4 OUR FINDINGS

## Introduction

4.1 In this section we present our findings in relation to the analysis of consumer surplus and of the wider direct and indirect economic benefits of Personal Broadband services.

## Consumer surplus from Personal Broadband services in the UK economy

4.2 A key part of our analysis has been to estimate the value of the consumer surplus which may be generated by Personal Broadband services in the UK. The methodology underpinning this analysis is described in the previous section.

4.3 We report findings for the period 2008 to 2016 which as shown in the introduction and background is likely to be the period during which providers of these services in the 3.5 GHz band will have a first mover advantage in providing Personal Broadband services (i.e. before providers in the 2.5 GHz band can also provide these services.)

4.4 Table 4 reports the value of estimated consumer surplus for Personal Broadband users (from the use of the 3.5 GHz band in the UK from 2008 to 2016)

**Table 4: Consumer surplus in the UK Economy**

| Year | Consumer Surplus at 2006 prices (£) |
|---|---|
| **2008** | 9,012,576 |
| **2009** | 73,886,982 |
| **2010** | 148,729,693 |
| **2011** | 235,465,503 |
| **2012** | 301,724,579 |
| **2013** | 338,606,037 |
| **2014** | 355,341,637 |
| **2015** | 362,978,232 |
| **2016** | 363,030,624 |
| **Total** | **2,188,775,862** |

*Source: Europe Economics*

4.5 This table suggests a rising scale of consumer surplus as "early adopters" are joined by more mainstream consumers. This reflects not only an increasing demand for Personal Broadband services as consumers and also applications manufacturers "catch on" to the possibilities of broadband "on the go" but also the possibility that as such services become established and more refined there may be opportunities for suppliers to increase prices.

4.6 The findings point to a conservative estimate for the UK of a consumer surplus from Personal Broadband services over an eight year period, 2008 to 2016, of £2.2 billion.

## Consumer surplus from similar services in eight EU countries

4.7 To have an approximate idea of the impact of similar services in the rest of Europe we applied the same methodology to eight other European countries (Germany, France, Italy, Spain, Belgium, The Netherlands, Ireland and Austria), where presently either 3.5GHz is already held by operators or the spectrum band is to be imminently auctioned.

4.8 To obtain an estimate of the number of subscribers we calculated the share of UK subscribers to UK population and then applied the same share in the other countries. These estimates must be treated with more caution but provide an indicative signal of the scale of likely benefits.

4.9 Limitations in our approach are that

- First of all our price elasticity estimates come from the USA and have been applied to the UK assuming that these two markets are not particularly different[4]. Differences between the USA and other EU countries are clearly more pronounced.

- Secondly we relied on forecasts for UKB broadband turnover and subscribers and extrapolated these to the other EU countries.

4.10 Our estimates provide an answer to the question: what would be consumer surplus over the period 2008-2016 if Personal Broadband services similar to those supplied by UK broadband would be present in these European countries?

4.11 Table 5 shows the estimates of consumer surplus for these countries.

**Table 5: Consumer Surplus in eight European Countries**

| Country | Consumer Surplus at 2006 prices (£) |
|---|---|
| **Germany** | 3,082,149,905 |
| **France** | 2,276,439,496 |
| **Italy** | 2,173,880,023 |
| **Spain** | 1,510,661,634 |
| **Belgium** | 388,121,185 |
| **The Netherlands** | 616,691,788 |
| **Ireland** | 151,905,702 |
| **Austria** | 306,369,570 |
| **Total** | **10,506,219,304** |

*Source: Europe Economics calculations*

[4] This is also the reason why we did not include any Eastern European country in our estimates.

4.12 We calculate that total consumer surplus for these eight EU countries amounts to roughly £10.5 billion from 2008 to 2016.

## GDP and multiplier effects of Personal Broadband

4.13 In this section, we calculate the effect on GDP and employment that UK Broadband is forecast to have. We use company turnover data provided by UK Broadband to compute direct effects, and then use the ONS (UK Office of National Statistics) Input-Output tables to calculate multiplier effects. Since the turnover increases rapidly each year, we have calculated the effects for two years: 2009, when the service will still be at the stage when it is getting established, and 2016, when we expect the market to have reacted and stabilised.

### Direct Effects

4.14 The forecast turnover for 2009 is £104.9m, rising by a factor of 10 to £1007m in 2016. This is the direct contribution made to GDP. We can use the sector averages for the Telecommunications sector to arrive at direct employment effects.

4.15 Table 6 below summarises both sets of direct effects.

**Table 6: Direct GDP and Employment Effects**

| Year | GDP (£000) | Employment |
|---|---|---|
| 2009 | 104,851 | 416 |
| 2016 | 1,007,2002 | 4032 |

## Indirect Effects

4.16 Two types of GDP and employment effects arise from direct employment and turnover: linkage effects and induced effects.

*Linkage effects*

4.17 Linkage effects refer to the jobs created in the supply or distribution chain. An example would be jobs in a wireless handset manufacturing firm which provides the physical equipment to UK Broadband. The jobs of those employed in the manufacturing firm will be directly affected if there is a change in demand from UK Broadband.

4.18 Since UK Broadband policy is to outsource a large proportion of products and services, we expect the linkage effects from UK Broadband's operations to be higher than the average firm in the Telecommunications sector in the UK. However, in the absence of specific data, we use the average figures and note that the employment created via linkage effects is likely to be underestimated by these figures.

*Induced effects*

4.19 The second effect is the induced employment or the income multiplier effect that arises due to expenditure of the incomes that employees in UK Broadband earn. This additional expenditure creates further jobs as the money is spent on goods and services – a ripple effect.

4.20 The method that we consider to be the most suitable for assessing linkage effects in the absence of specific supplier data is to use multipliers derived from Input-Output tables. Input-Output tables provide a complete picture of the flows of products and services within an economy for *all* sectors in an economy. Specifically, the tables detail the flows between various industries and also between industries and the final demand sector. Such linkages can then be used to estimate the extent to which any given industry contributes to the various final demand sectors.

4.21 The main concept behind the multiplier is the recognition that the various sectors that make up an economy are interdependent.

4.22 One can manipulate the Input-Output table to estimate different types of multipliers depending on whether there is an interest in output, employment or income effects. The constituent component of the multipliers is the Leontief Inverse matrix. This is derived from the symmetric industry-by-industry use matrix and shows how much of each industry's output is required, in terms of direct and indirect requirements, to produce one unit of a given industry's output.

4.23 We derive output effects from the Leontief inverse tables, and then use industry level output-employment ratios to determine employment effects.

4.24 The estimates of employment and income thus derived are for gross employment rather than net new employment i.e. the figures are over-estimated as they do not adjust for factors of production which might have been displaced from other productive uses. We note therefore that these figures should be viewed as short-term, gross impacts on the economy.

4.25 In the long term the Treasury view is that no single firm has a lasting impact on the economy since it is substitutable to some degree by other productive enterprises. In addition, we would like to note that these figures are based on economy wide averages, and on forecast revenues. Therefore, they should be interpreted as rough, ballpark figures rather than precise to the last digit.

4.26 We use the most disaggregated version of the Input-Output tables available, which provides us with 138 sectors within the economy. The direct GDP contribution from UK Broadband is most suitably categorised under the Telecommunication sub-sector. Tables 7 and 8 below summarises the results from the calculations based on the Input-Output tables for 2009 and 2016 respectively. The output and employment effects include both direct and linkage effects.

**Table 7: Linkage effects 2009**

| Summary of linkage effects, 2009 | Output (£mil) | Employment |
|---|---|---|
| Telecommunications | 110 | 440 |
| Other sectors | 47 | 586 |
| Total | 157 | 1,026 |

**Table 8: Linkage effects 2016**

| Summary of linkage effects, 2016 | Output (£mil) | Employment |
|---|---|---|
| Telecommunications | 1,055 | 4,224 |
| Other sectors | 456 | 5,631 |
| Total | 1,511 | 9,855 |

4.27 To this, we can add the income multiplier effects, based on a standard national income multiplier of 1.1. Tables 9 and 10 below summarise the gross estimates arising from both linkage and income multiplier effects, including direct effects, in 2009 and 2016 respectively.

**Table 9: Summary of linkage and income multiplier effects 2009**

| Summary of linkage and income multiplier effects, 2009 | Output (£mil) | Employment |
|---|---|---|
| Telecommunications | 121 | 484 |
| Other sectors | 52 | 645 |
| Total | 173 | 1,129 |

**Table 10: Summary of linkage and income multiplier effects 2016**

| Summary of linkage and income multiplier effects, 2016 | Output (£mil) | Employment |
|---|---|---|
| Telecommunications | 1,160 | 4,646 |
| Other sectors | 502 | 6,194 |
| Total | 1,662 | 10,840 |

4.28 Table 6 (on page 27) shows that the direct contribution forecast to be made by UK Broadband to the economy is approximately £104m in 2009, rising to £1007m in 2016. The forecast additional employment figures for these years are 416 and 4032 respectively. Adding gross linkage and income multiplier effects, the contribution to the economy is forecast to be £173m to GDP and 1,129 to employment in 2009, rising to a £1,662m contribution to GDP and 10,840 to employment by 2016.

# 5 CONCLUSIONS

5.1 Using recognised methodologies of consumer surplus analysis and estimation of linkage effects this study has sought to quantify the likely economic benefits of Personal Broadband services between 2008 and 2016. For the purposes of this study, Personal Broadband is defined as wireless broadband data services delivering a flat rate, fat pipe internet connection to consumers using WiMAX 802.16e over the 3.5 GHz spectrum band. Personal Broadband will be delivered to a range of devices including handheld smartphones, laptops and consumer electronic devices

5.2 Our findings are that the introduction of Personal Broadband services are likely to lead to significant economic benefits to the UK and, if such services are introduced in other EU countries to the EU economy.

5.3 In terms of consumer surplus these appear to be of the scale of over £2 billion in the UK and upwards of €14 billion in the EU (if measured across eight of the largest EU markets where 3.5GHz spectrum is either already held by operators or the spectrum is to be imminently auctioned). In direct benefits the introduction of Personal Broadband services could contribute over £1 billion to GDP and over 10,000 jobs in this highly skilled innovative sector.

5.4 Our findings demonstrate that Personal Broadband services on the 3.5 GHz band may represent a significant and growing proportion of the benefits accrued from the use of radio spectrum in the UK.

5.5 Further the strategic impact to UK competitiveness of such services should not be underestimated. Not only is the introduction of Personal Broadband services likely to generate high skilled employment but also it will create spin offs for the UK in innovation which our competitors may not enjoy for some time.

# Appendix 2: Background Information Regarding Request for Higher Transmit Power in the 3.5 GHz Licence

# Background Information Regarding Request for Higher Transmit Power in the 3.5 GHz Licence

## 1. Executive Summary

1.1 In this document, UK Broadband details the rationale behind the request to increase the power levels allowed in its 3.5GHz[1] licence.

1.2 In summary, we believe that this request is well founded, because:

- This aligns UK regulations with European level recommendations in the form of CEPT's **ECC /DEC/(07)AA**[2], **ECC REC(04)05**[3] **and ECC Report 100**[4] for flexible usage modes of BWA.
- The increased power levels will enable the use of WiMAX 802.16e technology and will enable the UK economy and consumers to take advantage of the considerable benefits resulting from the creation of a single European mobile WiMAX market.
- It will enable the use of the latest generation of spectrally efficient antenna array technologies which are currently available with WiMAX 802.16e.
- As detailed in the CEPT SE19 studies[5] [&] [4], we believe that this power increase will have no adverse impact on neighbouring spectrum users.
- The change to a single national licence removes cross border coordination between regional operators, allowing higher power without the risk of interference between operators.

[1] The UK Broadband WTA licences span 3.4 – 3.6 GHz but for ease is referred to in this paper as 3.5 GHz
[2] ECC Decision on availability of frequency bands between 3400-3800 MHz for the harmonised implementation of Broadband Wireless Access systems (BWA)
[3] Guidelines for accommodation and assignment of multipoint fixed wireless systems in frequency bands 3.4-3.6 GHZ and 3.6-3.8 GHZ
[4] CEPT ECC Report 100 (Compatibility studies in the band 3400- 3800 MHz between Broadband Wireless Access (BWA) systems and other services)
[5] CEPT ECC SE19(06)74

## 2. Our Proposed Changes

2.1 UK Broadband requests that its 3.5 GHz licence is altered so that the required EIRP limits are those specified by CEPT ECC DEC/(07)AA, for flexible usage modes of BWA (including Fixed wireless access (FWA), Nomadic wireless access (NWA) and Mobile wireless access (MWA)). The corresponding sections of the licence should therefore be amended to read as detailed below in Tables 1 and 2.

Table 1. - Maximum Permissible EIRP

**Maximum Permissible EIRP**

The Licencee shall ensure that the Radio Equipment conforms to the following EIRP limits:

| | Maximum EIRP per MHz |
|---|---|
| Conventional 90 deg sector | **+ 23 dBW/MHz** |
| Narrow sector or adaptive antenna | **+ 29 dBW/MHz** |

Table 2. - Block Emissions

10 Permissible Out of Block Emissions

The Licencee shall ensure that Out of Block Emissions from the Radio Equipment, measured at the antenna output, shall conform to the following:

| Frequency offset break points for the CS mask | Definition (% of the size of the assigned block, Note) |
|---|---|
| A | 20% |
| B | 35% |

Note: X% of the smaller of adjacent blocks, if blocks are of unequal size

| Frequency offset | CS Transmitter Output Power Density Limits (dBW/MHz) |
|---|---|
| ¦¤F=0 | -36 |
| 0<¦¤F<A | -36 - 44¡¤(¦¤F/A) |
| A | -77 |
| A<¦¤F<B | -77 - 12¡¤((¦¤F-A)/(B-A)) |
| ¦¤F¡ÝB | -89 |

2.2. The corresponding sections of the licence should also be altered to refer to ECC DEC/(07)AA and ECC REC (04)05 rather than to the Ofcom IR2015, in order to reflect European harmonisation.

# *3. Arguments in Support of the Proposed Changes*

## Alignment with European Regulation

3.1 The primary benefit of this approach is that it aligns UK regulation with Europe as recommended by CEPT's ECC DEC/(07)AA and REC (04)05. This will mean that equipment designed for the European market can be readily deployed in the UK. Moreover, Mobile WiMAX 802.16e European consumers will be able to roam onto a *Personal Broadband* network in the UK built using the same standard.

## Enabling Usage of WiMAX Equipment

3.2 WiMAX (802.16e) has now become the de facto technology of choice for Broadband Wireless Access networks. While there are many other proprietary pre-WiMAX technologies available, none of these will achieve the global economies of scale that WiMAX will and therefore their costs will be too high to allow the development of a successful *Personal Broadband* business. The current maximum EIRP (14 dBW/MHz) will not allow the usage of WiMAX cost-effectively without this change and prevent UK Broadband from building a successful *Personal Broadband* network.

3.3 WiMAX uses a different underlying technology to that employed in UK Broadband's current TD-CDMA network. For a given maximum base-station transmit power, TD-CDMA has a better link-budget, meaning that the cell coverage will be larger with TD-CDMA than with WiMAX. There are two main reasons for this:

- TD-CDMA has higher processing gains (12 dB versus 3 dB); and
- TD-CDMA has a higher turbo coding gain (rate one third, versus rate half coding)

This means that to fully exploit the benefits of WiMAX technology, higher transmit powers are required to achieve the same level of coverage as TD-CDMA systems.

3.4 To increase the WiMAX link budget, base station manufacturers are either increasing the transmitter power or developing systems using antenna array technologies.

## Enabling Usage of Spectrally Efficient Adaptive Antenna Equipment

3.5 Antenna array technologies focus the transmitter power over a narrower area than a conventional passive antenna and while this has numerous benefits it does result in an increase in the EIRP.

3.6 By focusing the transmitter power over a much narrower area, the signal travels further and this means that fewer cell sites need to be built in order to cover a given service area. Secondly, by focusing the signal only in the direction in which it is required, less interference is radiated towards

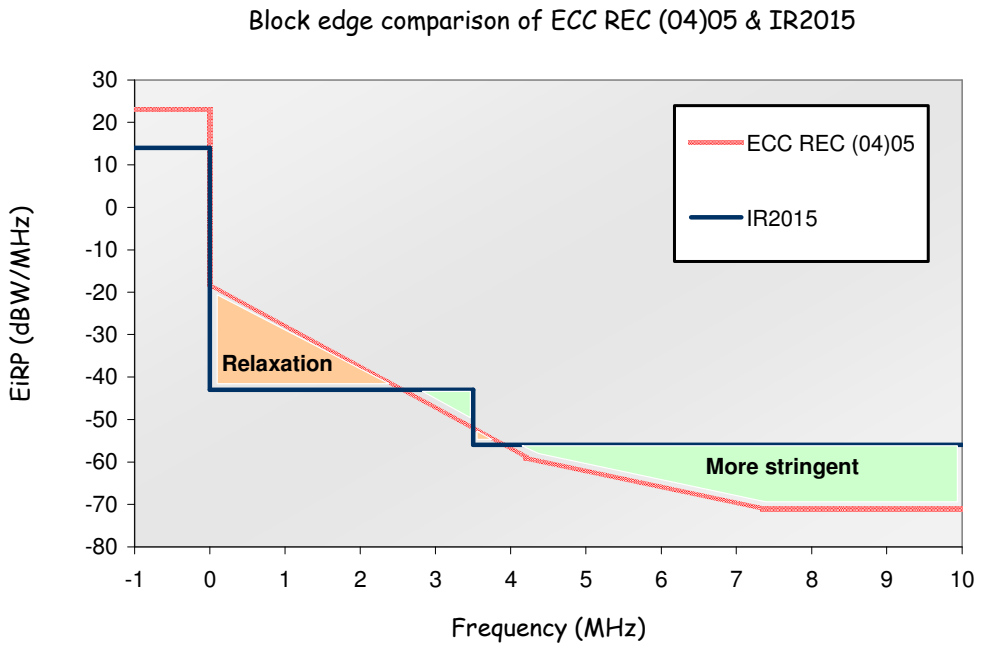
other users. However, the full benefits of transmit power are difficult to realise within the peak EIRP limit in the current licence.

3.7 Mobile wireless access (MWA) services require higher base station powers to compensate for low antenna gains used in mobile terminal devices and to overcome indoor penetration loss.

## Impact on Neighbouring Spectrum Holders

3.8 UK Broadband requests that the 3.5GHz licences are changed, such that the block edge requirements are compliant with the recommendations in CEPT ECC (04)05.

Figure 1. - Block edge comparison of ECC REC (04)05 versus IR2015




3.9 Overall, ECC REC(04)05 has the effect that of tightening the out of band emission levels for the majority of the frequency range, with the exception of frequencies immediately adjacent to the block edge. For frequencies within 3 MHz of the block edge the out of band emission will be relaxed. This enables the transmission of higher in band powers without sacrificing the total carrier bandwidth; thus improving spectral efficiency. The current block edge requirements are very difficult to achieve without severely limiting useable carrier bandwidth. Currently only 16 MHz of each 20 MHz allocation can be used, therefore, making the use of the spectrum less efficient.

3.10 It is our understanding the original out of band emission limits were set assuming analogue systems would be used in the bands adjacent to the 3.5 GHz licence. With broadcast services switching over from analogue to digital systems, the levels of protection needed by the services in the adjacent

frequency bands should be reduced. A typical analogue FM transmission requires a carrier to interference ratio (CIR) of approximately 27 dB. However, digital systems such as GSM require a CIR of 9 dB, (roughly an 18 dB improvement). It should also be noted that for high bandwidth systems (10 MHz or greater) the overall interference will be reduced from that currently allowed, as the out of band emission becomes more stringent beyond 3 MHz of the block edge.

3.11 CEPT ECC SE19 has carried out extensive coexistence studies[7] using the block edge mask defined in ECC REC(04)05. This block edge requirement was originally conceived assuming *technology neutrality* (in both bands). The SE19 studies concluded that co-existence between adjacent bands and 3.4 GHz to 3.8 GHz (at the power levels defined in CEPT ECC (04)05), was technically acceptable. From this body of evidence, we would suggest that the probability of interference to adjacent systems from increased power levels at 3.5 GHz, is minimal.

3.12 The benefit of improved spectral efficiency in the 3.4 GHz spectrum should outweigh the small risk of any interference in adjacent systems. It is UK Broadband's expectation that the future systems deployed in the adjacent bands will be based on ECC/DEC/(07)AA.

## Single National Licence

3.13 In 2003 the original 3.5 GHz spectrum licences were designed with the assumption that the UK would be covered by 15 regional licences. With the adoption of a single national licence at 3.5 GHz there is little need for coordination at the regional borders or a need for regulatory control of interference levels within the UK.

[7] CEPT ECC Report 100 (Compatibility studies in the band 3400- 3800 MHz between Broadband Wireless Access (BWA) systems and other services)

# Appendix 3: Draft Impact Assessment Analysis for Proposed Licence Variation

Europe Economics

# An impact Assessment of a variation to the spectrum licences of UK Broadband Ltd to allow for mobile usage in 2007

# Executive Summary

In this document Europe Economics, an independent economic consultancy considers the likely impact of a licence variation to allow for mobile usage in the 3.5 GHz spectrum compared to other regulatory options concerning the future licensing of 3.5 GHz services.[1]

In this study, following impact assessment methods, we discuss the background to this issue and the rationale for a change in licensing these services. We then set out relevant policy objectives and consider the range of available policy options at a national level.

In light of an initial assessment of the likely impacts of a wide range of policy options, there appear to be two main practical policy options: One option where Ofcom could wait until 2009 before granting licence variation or another option where it could act now to vary now the current licences for UK Broadband in order to allow it to provide new *Personal Broadband* services.

A more detailed qualitative and quantitative review of the costs and benefits of these two options and a final analysis of these costs and benefits, when compared with Ofcom's policy objectives, points strongly to the conclusion that a decision to move towards immediate licence variation would have the greatest net benefits for the UK.

[1] The UK Broadband WTA licences span 3.4 – 3.6GHz but for ease is referred to in this paper as 3.5GHz.

# 1 Introduction and background

## Purpose and scope of this document

1.1 In this document, Europe Economics, an independent economic consultancy reviews the possible impacts of different regulatory options in relation to the future licensing of 3.5 GHz services. In particular, we consider the relative costs and benefits of varying licensing to allow for mobile usage in this spectrum compared to a delayed variation option.

1.2 This analysis has been undertaken for UK Broadband. UK Broadband, the sole holder of licences for the 3.5GHz[2] spectrum bands has requested that Ofcom varies its licences as soon as possible to allow it to provide *Personal Broadband* services by the end of 2007. *Personal Broadband* will be a portable, high-speed broadband service to handheld devices and laptops.

1.3 Ofcom's guidelines on Impact Assessment[3] recommend that when Ofcom is deciding upon an important regulatory issue it should make an Impact Assessment of different regulatory options. In light of this guidance, this document is intended to facilitate Ofcom's consideration of this issue.

## Europe Economics

1.4 Europe Economics is a medium sized, growing, economic consultancy owned by its staff. We have a successful history of providing specialist economic regulatory advice and analysis in the electronic communications, energy, water and pharmaceuticals markets.

1.5 Current clients include the public bodies such as the European Commission, (DG Internal Market, DG Transport and Energy and DG Health and Consumer Affairs), the European Parliament, Ofcom, Ofgem, the Financial Services Authority and Comreg and private sector clients such as UK Broadband and the Association of Convenience Stores.

## The structure of this document

1.6 For ease of reference and to ensure consistency of approach, this document is structured according to the Impact Assessment methodology as set out below:

- Introduction and background. It explains the purposes and scope of this document, impact assessment methods and the background to the decision about licence variation which includes current licence requirements and market developments;

[2] The UK Broadband WTA licences span 3.4 – 3.6GHz but for ease is referred to in this paper as 3.5GHz
[3] Ofcom: "Better policy making: Ofcom's approach to Impact Assessment". (July 2006).

- The rationale for flexible usage in the 3.5 GHz spectrum. In this section we consider the rationale for regulators to allow flexible usage of this spectrum;

- Policy objectives. We review the range of Ofcom's policy objectives in this area;

- Policy options. We consider the range of policy options available to Ofcom in this area;

- Impact assessment. We assess the relative costs and benefits of the different policy options;

- Conclusion. We draw conclusions from the Impact Assessment concerning the relative costs and benefits of the different options.

## Impact Assessment methods

1.7 In the "Communication from the European Commission on Impact Assessment", impact assessment is defined as "the process of systematic analysis of the likely impacts of intervention by public authorities."[4] This process typically includes the following steps:

- Identification of the rationale for regulatory intervention;

- Consideration of the policy objectives of such intervention;

- Consideration of the policy options available;

- Analysis of the costs and benefits of the different options;

- Consideration of the optimum policy.

## Licensing and *Personal Broadband*

1.8 Currently, UK Broadband is the only holder of licences to operate services in the 3.5 GHz spectrum band in the UK. Licence requirements include restrictions which (if strictly interpreted) may prevent UK Broadband from providing *Personal Broadband* services in the UK. These restrictions are both technical (power limits) and substantive (the limitation to fixed services) in nature. UK Broadband plans to offer customers a new type of communications service called *Personal Broadband*. This will be a portable, high-speed broadband service to handheld devices and laptops.

[4] COM (2002)276

## The development of Ofcom's policy towards spectrum liberalisation

1.9 The development of Ofcom's policy on this issue has occurred over a number of consultations and policy statements. These include:

- The *Spectrum Liberalisation consultation Sept 2004;*
- *The Spectrum Framework Review: November 2004;*
- *The Spectrum Framework Review Implementation Plan (SFR: IP): 13 January 2005;*
- *Ofcom's Statement on Spectrum Liberalisation: 26 January 2005;*
- *Spectrum Usage Rights Consultation April 2006.*

1.10 Over these documents we can see a clear trend towards allowing mobile usage in the 3.5 GHz band, with 2007 emerging as a relevant timing for such a move. This would also align with the proposed implementation of Ofcom's other proposals for 2G and 3G.

## Latest developments

1.11 In its Annual Plan for 2007/8, Ofcom suggests the following priorities:

1. ***Accelerating the development of a market-based approach to spectrum****: continue to develop a secondary market in spectrum trading; release more spectrum to allow new services to develop; and represent the UK on international bodies to further Ofcom's aim of securing the optimal use of spectrum.*

2. ***Promoting competition and innovation in converging markets****: promote competition in fixed-line telecoms, broadband, television and radio markets; secure competition and investment in next generation networks; assess how wireless platforms will contribute to convergence; and identify potential new sources of market power that might emerge through convergence.*

3. ***Enabling services that are important to UK citizens as platforms and services converge****: review how Ofcom protects viewers and listeners through content regulation; promote access and inclusion in the availability and use of communications services; and maintain diverse and high-quality content in public service broadcasting.*

4. ***Improving industry compliance and empowering consumers****: make enforcement more targeted and effective; ensure that consumers can switch providers quickly and easily; and help people acquire the skills, knowledge and understanding to use communications services effectively.*

5. ***Moving towards more consistent legal and economic frameworks****: Ofcom will begin preparatory work to examine where it is desirable to move towards greater consistency between legal and economic frameworks which govern different communications platforms.*

1.12 A priority for 2007/2008 is "further liberalising spectrum use in key areas, such as business radio and mobile". Such a priority does not specify whether the reference to "mobile" relates to non-3G and 3G mobile usage restrictions or to the plans in the SFR:IP for 2G and 3G or to all of these.

## European Union spectrum policy development

1.13 In its recent consultation on the future of European and national spectrum regulation, the European Commission has supported greater harmonization of national spectrum regulation, including greater flexibility and harmonisation in licensing of spectrum.

1.14 Paragraph 5.1 of EC Regulatory Framework consultation[5] states that, *"owners of spectrum usage rights should not be unduly constrained but, subject to certain safeguards, have the freedom to provide any type of electronic communications service ("service neutrality") using any technology or standard under common conditions," ("technology neutrality").*

1.15 Within the Conference of Postal and Telecommunications Administrations (CEPT), EU Member States (and others) are harmonising technical operational and regulatory requirements for the provision of services within radio spectrum to allow for greater inter-operability of services across national boundaries.

1.16 In November 2006, the CEPT's SE19 technical group (after undertaking various spectrum sharing, simulation and interference studies) recommended that mobile usage be allowed within the 3.4GHz to 3.8GHz bands.[6]

## European Spectrum Holdings at 3.5GHz

1.17 Alongside these regulatory trends EU countries are now adopting 3.5GHz for WiMAX wireless broadband services. Recent auctions in France and Germany for 3.5GHz have released spectrum on a technology and application neutral basis and in 2007, Italy is scheduled to conduct an auction at 3.5GHz.

[5] Review of the EU Regulatory Framework for electronic communications networks and services.

[6] CEPT: ECC SE19 (06)74 Nov 2006

1.18 Current 3.5GHz spectrum holders in European markets are set out in Table 1 below.

**Table 1: European 3.5 GHz spectrum holders**

| Country | 3.5GHz Spectrum Holders |
|---|---|
| Ireland | Clearwire, Irish Broadband, DigiWeb and others |
| Belgium | Clearwire |
| Spain | Iberbanda/Telefonica |
| Austria | WiMAX Telecom |
| Denmark | Clearwire/Danske Telecom |
| Sweden | Accelerated Wireless |
| Netherlands | Worldmax |
| Poland | Clearwire |
| Bulgaria | Clearwire |
| Norway | Telenor |
| Switzerland | Swisscom Mobile |
| France | Multiple including Altitude Telecom (owned by Illiad) |
| Germany | Clearwire, DBD and Inquam |

*Source: UK Broadband*

## Conclusions

1.19 In this section we have considered the background to this study of the impact of licence variation to allow for mobile usage in the 3.5 GHz spectrum. We have seen that UK Broadband aims to provide *Personal Broadband services,* and that its current licence contains substantive restrictions, which may prevent it from doing so.

1.21 We have also seen that there is a trend at UK and European level towards allowing mobile usage in the 3.5 GHz spectrum, as this spectrum is auctioned to operators.

# 2. The rationale for licence variation

## Introduction

2.1 In this section we consider the rationale for allowing mobile usage of the 3.5 GHz band. This includes consideration of the general rationale for licensing and this applies under the specific and changing market and technological conditions for providers of services in the 3.5 GHz band. We conclude with a summary rationale for varying the licence to allow mobile usage.

## Licensing within the European framework

2.2 In using licences, regulators typically seek to ensure the provision of essential services, to monitor market performance and, where a licence grants rights, to define and limit those rights. To be consistent with the European regulatory framework, licensing has to be:

- ✓ Transparent;
- ✓ Non- discriminatory;
- ✓ Proportionate;
- ✓ Objective.

2.3 Further, licences should not be used to unduly restrict the development of competition or distort the internal market. In this respect licensing should be the least market restrictive mechanism possible.

## Licensing within Ofcom's policy objectives

2.4 Licensing should also be consistent with Ofcom's policy objectives and aims of wider regulatory policy. (These are explored in more detail in the next section).

2.5 In a context of rapid technological change, where new previously unforeseen possibilities for product innovation are occurring, we can note that this implies that licensing should be:

- Responsive to market developments;
- Technology neutral;
- Pro- competitive, where possible;
- Likely to ensure optimal value in the use of the spectrum.

## The current licences for UK Broadband

2.6 UK Broadband acquired all the geographic licences for the 3.5GHz band through the auction of 3.5GHz in 2003.

2.7 At the time, there were no standards for mobile technologies at 3.5GHz and therefore the accepted wisdom was that 3.5GHz was only suitable for fixed wireless access. Therefore, a restrictive interpretation of the current licences held by UK Broadband would suggest that these only allow for the provision of "fixed" services.

## Relevant technological and standardisation developments since 2003

2.8 In common with other spectrum bands, rapid technological development is creating new and previously unanticipated opportunities for innovation in the 3.5GHz spectrum. In particular, it is creating market opportunities for providers to offer WiMAX services.

2.9 Over the last four years, a number of significant developments have occurred:

- The IEEE 802.16e Task Group has developed an amendment to IEEE Standard 802.16 ("Air Interface for Fixed Broadband Wireless Access Systems"). The amendment covering "Physical and Media Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands," was approved, as IEEE Std 802.16e-2005, by the IEEE-SA Standards Board on 7 December 2005. The effect of this is that there is now an internationally recognised standard for mobile broadband at 3.5GHz;

- The WiMAX Forum has been building a worldwide framework for mobile broadband using 802.16e standard;

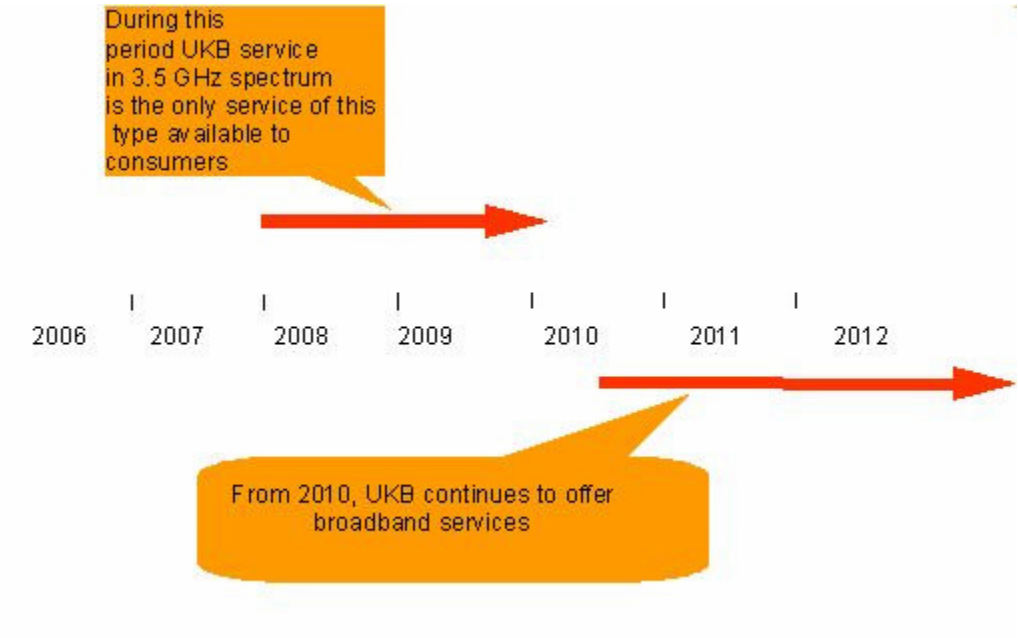
- The development of smart antenna technologies including MIMO over the same period has made WiMAX 802.16e a reality at 3.5GHz.

## Personal Broadband and the WiMAX market

2.10 With the significant development of the 802.16e standard and the evolution of smart antenna technologies at 3.5GHz, UK Broadband plans to offer customers a type of communication service called *Personal Broadband*. UK Broadband describes this service as likely to be a portable, high-speed broadband service to handheld devices and laptops.

2.11 A key perceived advantage for *Personal Broadband* services is that they could be provided in the UK from 2008 onwards, whereas operators using the 2.5 GHz spectrum will not be able to provide these services before 2010 or 2011. This is due to the requirement for operators using of 2.5 GHz spectrum to undertake post auction network build. This is illustrated in Figure 1 overleaf.

**Figure 1: The timetable for Personal Broadband services**




*Source: UK Broadband*

## Conclusions: a rationale for mobile usage in the 3.5 GHz spectrum

2.12 In light of the above, the rationale for allowing mobile usage in the 3.5 GHz spectrum appear to be as follows:

- ✓ Such an approach allows for innovation to occur in the market;
- ✓ Liberalisation of the 3.5 GHz spectrum at this time is non discriminatory in respect that other spectrum are also being opened up;
- ✓ Such a liberalisation will allow for greater competition in the market;
- ✓ Such a liberalisation will also allow for a more optimal use of spectrum;
- ✓ Such a liberalisation is technology neutral.

# 3. Relevant Policy Objectives

## Introduction

3.1 In this section we consider policy objectives and regulatory principles which may be relevant to licence variation in the 3.5 GHz band.

## Headline duties, objectives and principles at national and European level

3.2 Ofcom's principal statutory duty is set under the Communications Act 2003 which states that:

*"It shall be the principal duty of Ofcom, in carrying out their functions:*

*(a) to further the interests of citizens in relation to communications matters; and*

*(b) to further the interests of consumers in relevant markets, where appropriate by promoting competition".*

3.3 Ofcom's specific duties[7], which fall into six categories, include a duty of ensuring the optimal use of the electro-magnetic spectrum.

3.4 The Regulatory Principles which guide the interpretation of the way in which one should implement these duties include the following:

- *Ofcom will regulate with a clearly articulated and publicly reviewed annual plan, with stated policy objectives.*
- *Ofcom will intervene where there is a specific statutory duty to work towards a public policy goal which markets alone cannot achieve.*
- *Ofcom will operate with a bias against intervention, but with a willingness to intervene firmly, promptly and effectively where required.*
- *Ofcom will strive to ensure its interventions will be evidence-based, proportionate, consistent, accountable and transparent in both deliberation and outcome.*
- *Ofcom will always seek the least intrusive regulatory mechanisms to achieve its policy objectives.*
- *Ofcom will research markets constantly and will aim to remain at the forefront of technological understanding.*
- *Ofcom will consult widely with all relevant stakeholders and assess the impact of regulatory action before imposing regulation upon a market.*

3.5 Ofcom is also guided by the European regulatory framework for electronic communications. Headline objectives of the European electronic communications framework as set out in the Framework Directive include:

[7] Source: Ofcom website.

- *Deregulation;*
- *Regulatory harmonisation and greater inter-operability between national markets;*
- *Promotion of competition in the market;*
- *Promotion of innovation and relative EU competitive advantage;*
- *Technology neutrality- market led development.*

3.6 Relevant principles of EU regulation which can also apply to UK regulatory policy mention that:

- *Regulation should be objective, proportionate, transparent and non-discriminatory;*
- *Regulation should be consistent with (EU) Treaty obligations;*
- *Regulation should be evidence based. (EU Better Regulation Agenda).*

## UK Spectrum policy objectives

3.7 From the sequence of consultations and policy statements issue (See Section One for further details) we can derive the following key policy objectives in relation to spectrum:

- The duty to promote competition in the market where appropriate;
- The duty to act in the interests of users;
- The objective of a market-driven approach to spectrum management;
- A desire to move towards mobile usage in the spectrum; and
- A desire to align this change with other changes for the 2G spectrum.

3.8 In its Annual Plan for 2007/8, Ofcom has placed driving forward a market based approach to spectrum as a key policy objective. Further, in the Spectrum Framework Review Implementation Plan, a decision to allow mobile usage in the 3.4-3.6 GHz spectrum is proposed for 2007.

## Conclusions

3.9 In light of the above, there are strong arguments for concluding that allowing an early licence variation is in line both with Ofcom's immediate policy objectives and duties and wider policy trends.

3.10 For example, it may be argued that prima facia such a decision appears to be consistent with the principal statutory duty, both in allowing consumers and citizens to enjoy the benefits of *Personal Broadband* services and in promoting competition in mobile broadband services. Further, such a decision appears to be in line with the regulatory principles which guide Ofcom's regulation, in particular its bias against intervention, in this respect as licence restrictions are a significant regulatory intervention in the market.

3.11 A decision to allow mobile usage in response to the rapid technological and market development could be seen as an indicator that Ofcom was "at the forefront of market and technological understanding" in its thinking.

3.12 Other relevant considerations include whether such a decision will act towards ensuring the optimal use of the spectrum. In this context we can see that Ofcom's stated policy of aligning measures with the 2G spectrum is intended to create a co-ordinated policy for spectrum de-regulation in the interests of users. This suggests that Ofcom is seeking to ensure technological neutrality through setting an appropriate balance in its decision making across spectrum bands to foster a level playing field for operators. In this respect, if liberalisation of one spectrum band were delayed compared to another spectrum, then it could be argued that the regulatory intervention had created a market distortion and a lack of technological neutrality. Such a development would appear to be inconsistent with Ofcom's duties and objectives, not only in restricting competition but also in creating a regulatory lag - where a regulation which was out of date compared to the commercial opportunities is now available due to technological change stifled innovation and investment.

3.13 European spectrum policy objectives are also of relevance here, particularly the aims to deregulate (including moving away from licence restrictions), to promote competition and to ensure technology neutrality. Moves at the European level in the CEPT to remove licence restrictions and allow for the usage of the 3.4-3.6 GHz spectrum for WiMAX services suggest that similar moves are essential if the UK is to meet its traditional policy objective of being in the vanguard of market liberalisation in Europe.

# 4. An initial review of available policy options

## Introduction

4.1 In this section we consider the practicability of different policy options in relation to the timing of any licence variation for the provision of services in the 3.5 GHz band.

4.2 We consider the range of different policy options and then select those which appear to merit more detailed impact assessment for consideration in the next section.

## The range of policy options

4.3 There appear to be a wide range of policy options in relation to this issue. These options relate to consideration of whether such a decision about allowing mobile usage should or should not be made, and when such mobile usage should be granted, as set out below:

- Ofcom has posited a timetable for mobile usage in the 3.5 GHz spectrum in 2007;
- Ofcom could decide to implement liberalisation after the measures 2G re-farming have been decided[8];
- Ofcom could decide to delay licence variation until 2012 or 2015;
- Ofcom may also decide not to allow mobile usage in the 3.5 GHz spectrum at all.

## Initial Assessment of options

4.4 Before setting out a detailed impact assessment of these options, we consider them briefly to identify which of the options are very unlikely to be the optimum policy. This allows us to provide a proportionate and targeted assessment of impacts.

4.5 In the previous section we identified relevant policy objectives in relation both to the development of spectrum policy and wider policy goals. We set out below an initial review of some of the policy options listed in relation to the development of policy in this area, allowing us to exclude some options from more detailed consideration.

[8] See the SFR-IP Section 9

***A decision not to allow mobile usage***

4.6 A decision not to allow mobile usage at all in the 3.5 GHz spectrum would appear to represent a significant change of policy compared with the timetable already posited for such a move.

4.7 Such a decision would also appear to be inconsistent both with other stated spectrum policy aims, as discussed in the previous Section and Ofcom's wider policy objectives. It would, for example, appear to be difficult to reconcile such an approach with technology neutrality, given liberalisations in other areas, or with the promotion of competition in the market and a market-driven approach to spectrum.

4.8 It can be argued that such a change in regulatory policy would also bear significant costs in increased regulatory uncertainty for market players, and, arguably, may prove unsustainable in the longer terms, given the trend for wider European deregulation of this spectrum.

4.9 Meanwhile, the benefits of such a policy change, possibly in providing some reassurance (and less competition) for established operators would appear to be at the expense of consumers.

***Market developments and the timing of mobile usage***

4.10 As we have seen other policy options concerned the different timetables for a decision to grant licence variation to allow mobile usage.

4.11 However, it can be argued that, in practice, market and regulatory developments in other spectrum bands limit the scope of possible timetables for licence variation.

4.12 This is due to the stated Ofcom objective of aligning developments in the 3.5 GHz band with those in the 2G spectrum band.

4.13 In this respect, it is notable that by 2009, it is likely that the 2.5 GHz spectrum will have been released and that operators using this spectrum will be providing services to consumers.

4.14 Further, developments in other EU markets and emerging regulatory harmonisation at European level in the treatment of 3.5 GHz services both suggest that, if mobile usage were delayed beyond 2009 in the UK, this may put the UK out of step also with other EU markets and with the emerging European regulation. Such a protracted delay would be hard to reconcile with the UK's traditional position as a member of the leading group of EU liberalising countries.

4.15 Finally, any delay in mobile usage for the 3.5 GHz spectrum beyond 2009 may be seen as inconsistent with of technology neutrality, given that the 1700MHz

and 412MHz auctions have already taken place and that the L Band and 2.5GHz auctions are about to take place.

## Conclusions

4.16 In light of the above brief analysis it appears to be unlikely that Ofcom will either not grant mobile usage for the 3.5 GHz spectrum or take a policy decision to delay mobile usage beyond the implementation of the 2G re-farming.

4.17 Both of the above options appear to be clearly out of line with Ofcom's regulatory objectives and stated policy.

4.18 This then appears to leave two main policy options which merit a more detailed regulatory impact assessment.

### Option One: Delay of mobile usage until 2009

4.19 Ofcom could also make a decision to delay mobile usage, i.e. a variation in the licence of UK Broadband until 2009, after the measures for 2G re-farming take effect.

### Option Two: Allowing mobile usage in 2007

4.20 Ofcom can agree to the request for a licence variation from UK Broadband to allow it to provide *Personal Broadband* services in 2007. This will involve two modifications to the existing licence:

- The removal of 'fixed' requirements in the licence;
- Technical changes in the current licence power limits.

# 5. Impact assessment of the main policy options

5.1 In this section we consider briefly the likely impact (i.e. the costs and benefits) of the main policy options described in Section 4.

5.2 We note that Impact Assessment methods require the quantification of these impacts where possible and that also an analysis of distributional impacts and impacts to consumers may be undertaken. In the assessment below we have been able to quantify the economic benefits which could be derived from the introduction of *Personal Broadband* services, and have provided a qualitative consideration of distributional impacts and impacts on other operators.

### Option One: Delay mobile usage until 2009

5.3 The other main policy option is that Ofcom decides to delay mobile usage until after 2009.

5.4 Such an option would have the apparent benefits of providing some certainty for operators, particularly 2G and 3G operators, and of allowing Ofcom to observe market development as measures in other spectrum bands are implemented.

5.5 However, there are also significant costs from such an approach. These include:

- Delay in allowing licence variation would remove the possibility for the introduction of *Personal Broadband* services in the UK. This would deprive UK customers of the choice to use these services and would mean that the UK would forego economic benefits (see later in this section) of consumer surplus of £2.2 billion in the UK over eight years. Adding gross linkage and income multiplier effects, the contribution to the economy is forecast to be £173m to GDP and 1,129 to employment in 2009, rising to a £1,662m contribution to GDP and 10,840 to employment by 2016.

- Delay in allowing mobile usage would be contrary to Ofcom's stated policy objectives and proposed timetable. For example, such an approach would appear to be inconsistent with Ofcom's duty to promote competition where appropriate. Such a delay could therefore undermine regulatory certainty in the sector increasing regulatory risk and possibly setting a precedent which may reduce the potential value of spectrum to be auctioned.

- Further, it can be argued that a delay could also put the UK at a comparative regulatory disadvantage compared to other EU markets where operators using the 3.4-3.6 GHz spectrum may not face fixed restrictions to licences. An example here is the German market where these restrictions have not been imposed on operators.

- In this respect such a restriction would also run counter to moves at European level (in the CEPT) to allow for mobile usage in this spectrum band

and more broadly towards move towards the deregulation of electronic communications services. This may act to prevent the UK from deriving the full benefits of the internal market for these services.

## Option Two: Mobile usage in the 3.5 GHz band in 2007

5.6 Under this option Ofcom would accept the request from UK Broadband for licence variation in 2007. As we have seen this approach has the significant benefit that it is in line with Ofcom's policy objectives and statements that moves towards mobile usage in this spectrum should be aligned with moves towards greater flexibility in the 2G spectrum band — which are now ongoing.

5.7 Such an approach would also have a number of significant economic benefits to the UK.

- The earlier implementation of *Personal Broadband* services in the 3.5 GHz band is forecast to lead to the development of demand for these services in advance of those across other technologies.

- The evidence from the growth of antecedents such as fixed broadband services and the rapid growth and development of portable electronic consumer goods, suggests that demand for such services is likely to be high and that the first movers into this market may enjoy an initial period of producer surplus with a proportion of early consumers of these services also enjoying consumer surplus (i.e. services which are consumed at a price below that which consumers are prepared to pay.)

- Europe Economics has estimated the potential economic benefits of *Personal Broadband* services. The study indicates that for the 2008 to 2016 period the value of estimated consumer surplus for *Personal Broadband* users (from the use of the band in the UK from 2008 to 2016) is as set out in Table 2 below:

**Table 2: Consumer surplus in the UK Economy**

| Year | Consumer Surplus at 2006 prices (£) |
|---|---|
| **2008** | 9,012,576 |
| **2009** | 73,886,982 |
| **2010** | 148,729,693 |
| **2011** | 235,465,503 |
| **2012** | 301,724,579 |
| **2013** | 338,606,037 |
| **2014** | 355,341,637 |
| **2015** | 362,978,232 |
| **2016** | 363,030,624 |
| **Total** | **2,188,775,862** |

*Source: Europe Economics*

- This table suggests a rising scale of consumer surplus as "early adopters" are joined by more mainstream consumers. The findings point to an estimate for the UK of a consumer surplus from 2008 to 2016, of £2.2 billion. Europe Economics has also calculated that there will be significant potential GDP and multiplier effects. Adding gross linkage and income multiplier effects, the contribution to the UK economy is forecast to be £173m to GDP and 1,129 to employment in 2009, rising to a £1,662m contribution to GDP and 10,840 to employment by 2016.

- The strategic advantages of an early innovation in such services in the UK as compared to other countries, for example in the establishment and maintenance in the UK of a skilled workforce;

- Positive effects on other mobile internet providers- i.e. increased competition between services offered on different spectrum bands;

- Benefits to consumers of greater choice and of new high quality mobile internet services introduced earlier than would otherwise be the case.

5.8 Further, a decision to accept the request would set a positive precedent for potential acquirers of spectrum that the value of this spectrum would be maintained as technological change would create new potential uses for the spectrum i.e. that Ofcom would ensure the appropriate adaptation of restrictions imposed on the licence in light of market developments.

5.9 Potential competitors to *Personal Broadband* services have argued that a licence variation now may undermine investments made by 3G operators. However, considerable time (for such a rapidly changing market) has now elapsed after the award of the 3G licences reducing the plausibility of any claims for protection for 3G operators.

5.10 Whilst it could be argued that there may be impacts on the profits and employment of operators competing with *Personal Broadband* services, such effects are the natural consequences of a more competitive market.

## Conclusions

5.11 In this document we have considered the possible impacts of a variation in the licence of UK Broadband to allow for mobile usage in the 3.5GHz spectrum bands. In doing so, we have followed Impact Assessment methods which require consideration of the likely costs and benefits of different policy options.

5.12 We have seen that the rationale for licence variation is to ensure that licences adapt to changing market and technological conditions and allow for the introduction of innovative new services, in this case *Personal Broadband* services, which could bring substantial benefits to the UK economy.

5.13 A review of relevant policy objectives shows that Ofcom has a clear duty to promote competition in the market wherever appropriate and to ensure the

optimal use of spectrum. Further, Ofcom has aimed to ensure a market driven spectrum management and has posited 2007 as a possible date for allowing mobile usage in the 3.5GHz spectrum. This movement towards mobile usage in this spectrum is consistent with trends in European regulation.

5.14 Given the existing proposal by Ofcom for possible mobile usage in the spectrum in 2007 there appear to be two main policy options worthy of analysis - the first to allow such usage in 2007, through a variation in the licence of UK Broadband, the second to delay such a licence variation until 2009.

## A summary of the costs and benefits of the policy options

5.15 From our analysis in the previous section we conclude that the costs and benefits of the two main options in relation Ofcom's policy objectives are set out in Table 3 overleaf. This suggests that Option Two, moving now towards a licence variation is the optimum policy for each of Ofcom's key policy objectives.

**Table 3: The costs and benefits of the main policy options in relation to Ofcom objectives**

| Policy objectives | Policy Option two (delay until 2009) | Policy Option Two (mobile usage in 2007) | Assessment |
|---|---|---|---|
| A market driven approach | This policy restricts market development for two years preventing innovative new services- and economic benefits though it can be argued that market stability is strengthened. | This option allows development of new products in line with technological development and provides significant economic benefits- | Policy Option Two is most consistent with this approach allowing the market (i.e. the operator) to use the spectrum in the most efficient way and allowing innovation to take place. |
| Promotion of competition | This option stifles competition for mobile internet services- though it can be argued it promotes stability | This policy promotes competition for mobile internet- though some operators may argue it may jeopardize other investments | Policy Option Two is most consistent with the promotion of competition, allowing greater competition across spectrum bands |
| Technology neutrality | Delay in allowing mobile usage may restrict the ability for operators in the spectrum using WiMAX technology to compete with others using different technology. This may distort market outcomes. | This policy- by aligning flexibility in this area with measures in the 2G spectrum is technology neutral. | Policy Option Two is most consistent with this objective, allowing development of services across spectrum bands |
| Regulatory certainty | This policy is against stated policy objectives and will create uncertainty for potential acquirers of spectrum. | This policy is in line with Ofcom's stated policy objectives and therefore provides certainty. Further, for potential acquirers of spectrum it provides reassurance that Ofcom will allow them to respond to market developments | Policy Option Two appears most likely to generate regulatory certainty in particular for potential investors in spectrum. |

## Final assessment

5.16 This qualitative assessment of the likely costs and benefits of the two main policy options, in respect of Ofcom's policy objectives is supported by the findings of our quantitative research of the likely economic benefits from the provision of *Personal Broadband* services. The findings from our study point to an estimate for the UK of a consumer surplus from 2008 to 2016, of £2.2 billion. Adding gross linkage and income multiplier effects, the contribution to the UK economy is forecast to be £173m to GDP and 1,129 to employment in 2009, rising to a £1,662m contribution to GDP and 10,840 to employment by 2016.

5.17 In light of this analysis we conclude that Option Two, licence variation in 2007 appears to be the policy most likely to be consistent with Ofcom's objectives.