Higher power limits for licence exempt devices

Understanding the Scope for a Power Increase at 2.4 and 5 GHz

Consultation

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Section 1

Executive Summary

Introduction

1.1 This consultation seeks input on the potential effect of increasing the allowable power levels for certain licence exempt devices in certain geographical areas in order to facilitate new services. This could bring about greater flexibility of use, and therefore improved spectrum efficiency, as well as enhancing services such as higher speed broadband to rural communities.

1.2 In the Spectrum Framework Review (SFR) it was noted that the key reason for limiting power in Licence Exempt (LE) spectrum is to reduce interference, however, in rural areas there are likely to be fewer users and hence a lower probability of interference. Therefore, there exists the possibility to increase power levels without causing excessive interference.

1.3 A key element in making any decision is the efficiency of use of spectrum, which is often measured in economic terms. The other considerations when contemplating a change in LE spectrum regulation are:

- The social benefits of providing broadband access in rural areas where DSL provision is not widespread.
- The effect on Crown users of the bands such as the MoD.
- The risks of interference
- The alignment with international standards and regulation.

1.4 A study was commissioned to take evidence from industry, examine the technical issues and model the economic effects. The report on this study is available at http://www.ofcom.org.uk/research/technology/overview/ese/exempt/ and evidence from this report is used as part of this consultation.

Rural policy

1.5 Providing enhanced services in rural areas could aid important social goals and improve the quality of life in these areas. There have been many initiatives aimed at achieving this using wireless over the last few years which have had mixed success. The changes proposed here may improve the economics of wireless provision in rural areas. Equally, these changes do not prevent existing licence holders, such as at 3.4 – 4.2GHz providing services in these areas.

Evidence from industry interviews

1.6 In gathering evidence to form the views expressed here interviews were conducted with existing and potential service providers. Interviewees expressed different views on the extent of the benefits for a WBA operator of higher power at 2.4 and 5.xGHz. Comments ranged from “marginal” to “making a significant difference to the business case”. In addition, interviewees had different opinions on whether the main benefit would be in access or backhaul. The views largely depended on the size of operator and the urban or rural nature of the business they were considering. Many of those

interviewed expressed concern that higher power devices might be used in urban areas where they might cause significant interference.

1.7 Other views expressed were for more spectrum to be made available to users for BFWA services in the 5GHz bands and for the information contained within the 5.8GHz registration database to be made available in order to enable voluntary co-ordination between users.

The economic value of increased power

1.8 The broad technical conclusions from the research project, opinions from industry interviews and economic results from modelling indicate potential benefits if:

- A power increase to 10 Watts at 2.4GHz and to between four and 25 Watts at 5.xGHz is allowed.
- A change to setting limits on conducted power and the use of directional antenna were allowed to facilitate point to point links in rural areas.

However such changes must guard against:

- Interference in areas where higher powers are allowed.
- The migration of higher power devices to areas where they are not permitted, possibly causing interference.

1.9 We note that the draft ECC Recommendation ECC/REC/(06) 04 is currently out for public consultation[1] and it is recommending a maximum 4W EIRP[2] be allowed within the 5.8GHz band (5725 – 5875MHz) for BFWA services. Although there seems to be general stakeholder support for this increase the economic analysis carried out in the study commissioned by Ofcom suggests that this increase may only make a minor difference to the business case in rural areas.

Limitations due to Crown and other users

1.10 The MoD makes significant use of the majority of the 2.4GHz band. In the 5.xGHz bands MoD has use in Bands A and B and the majority of Band C.

1.11 MoD has further indicated a willingness to examine whether higher power could be allowed in the bands where it has significant usage but has no resources to devote to this work for the foreseeable future. However, the MoD have agreed to allow a higher power of 4W in the 5.8GHz band (5725 – 5850MHz) as proposed in ECC Recommendation (06)04 as there is a considerable body of technical work presented as evidence in ECC Report 68 supporting this Recommendation.

1.12 As a result of the restrictions on the bands where there is significant MoD use, for the moment we can only consider the recommendations on the use of significantly higher powers in bands not used by the MoD, namely in the top 33MHz of the 2.4GHz band. Such a segmentation of the 2.4GHz band might bring advantages in ensuring lower

[1] http://www.ero.dk/B0C782C7-5F34-4AC8-A211-8C50FD46A0F6?frames=no&

[2] This increase in EIRP to 4W will also include changes to the mask for E.I.R.P. Spectral Density Limits in the Elevation Plane mandated in the current UK IR2007. The new mask being proposed is in accordance with the more relaxed levels shown in Annex 3 of ECC Recommendation (06) 04.

power rural systems and other rural users can select channels where they will not receive interference from higher power systems.

The extent of areas considered

1.13 As part of their study, the consultants examined the impact of allowing higher powers over increasing geographical areas. Broadly, their conclusions were:

- The benefits grow as the geographical area is expanded from rural through suburban and into urban. However the additional benefits in urban areas are relatively small as there is typically already widespread connectivity available.

- The interference also grows as the area over which higher power is used expands, but based on their estimates the cost of interference always remains substantially smaller than the benefits. However, they cautioned that calculating the costs of interference is very difficult in urban areas because of a lack of information on WiFi deployment density and hence the risk that their calculation of interference is incorrect grows as the area where higher power is allowed is expanded.

1.14 These observations lead the consultants to conclude that higher powers could be restricted to rural areas with low risk of interference, but low benefits. As the area over which they are permitted expands the benefits grow but equally so does the risk that the interference estimation is incorrect. There is no single clear-cut boundary point suggested by the evidence.

Example licensing approaches

1.15 In the 2.4GHz band if the areas over which higher powers are used is limited then a mechanism of appropriately licensing devices according to geographical area is required. In this document we set out some possible approaches.

- A licence requirement with registration scheme with geographical exclusion zones similar to the one already used for the 5.8GHz band which provides the maximum flexibility but places the onus on users of higher power equipment to deploy it appropriately.

- To operate under the existing licence exemption with a requirement for the higher power devices in the 2.4GHz band to be location aware and control their power accordingly without user intervention.

1.16 These two licensing approaches and an overview of regulation using radiated rather than conducted power are set out at Section 5 below.

Options for consultation

1.17 In the 5.8GHz band the options are limited by MoD issues as to whether or not to increase the power to 4W EIRP in the currently available spectrum as proposed in the ECC Recommendation. We intend to implement the ECC recommendation in accordance with draft IR2007 which is attached in Annex 7. There are no other changes proposed and we intend to maintain the existing fees and registration requirement for this licence class in the band.

1.18 In the 2.4GHz band there is insufficient evidence to point to a single preferred outcome and so we are consulting on a range of options. For convenience we have

encapsulated these into the decisions and scenarios given below, although other options could be considered.

- Option one – maximise benefits. Under this option we would allow higher powers of 10W at 2.4GHz throughout the UK in the band 2450-2483MHz. With no geographical restrictions devices need not be location aware. No registration requirements would be placed on users.

- Option two – minimise risks. Under this option we would restrict higher power operations to hamlets, villages and rural towns. Devices would be required to be location aware and only transmit at higher powers if they were in appropriate areas.

- Option three – a balance between risks and benefits. Under this option we would restrict higher powers to all areas except large and major urban conurbations. Devices would not need to be location aware but a mandatory registration scheme would operate and users would need to adhere to a code which required them to work collaboratively to resolve interference issues.

1.19 We are seeking opinion on which of these options, if any, is preferred.

Section 2

Industry interviews

Industry consultation on the benefits of higher power and associated costs of interference

2.1 Our consultants (Scientific Generics) held a number of interviews and discussions with key players who are active in the provision of wireless broadband in rural regions. This concentrated on gathering views from two key stakeholder groups in this area:

- Operators – Wireless Internet Service Providers (WISPs) involved in the practical deployment of wireless broadband technology in the UK, including large operators, smaller commercial providers and community-based groups.
- Equipment vendors – international equipment vendors, exploring how their roadmaps relate to increased power in the UK.

2.2 The interviews held covered:

- The need for a power increase or other regulatory relaxations.
- Identification of the benefits that might arise from increasing power.
- Identification of any losses associated with increasing power as a result of increased interference.
- Highlighting the relevant technologies of most interest.

2.3 This section summarises the interviewees' views on the key benefits of increasing power for broadband wireless in rural areas, for example increased range or take-up, as expressed by the interviewees. More detailed feedback from interviewees is given in the Scientific Generics report[3].

Benefits of higher power at 2.4GHz

2.4 Rural community operators would like to deploy longer range 2.4GHz links using higher power via directional antennas, as 2.4GHz customer premises equipment (CPE) is significantly cheaper than 5.xGHz CPE. They felt that a power increase at 2.4GHz in rural areas could improve the business case. In addition, respondents suggested that higher power at 2.4GHz could improve the economics of backhaul provision for community operators. However, high quality backhaul is critical to providing services with QoS and interviewees reported interference where 2.4GHz spectrum used for backhaul is shared with consumer WLANs.

Benefits of higher power at 5.xGHz

2.5 Interviewees expressed different views on the extent of the benefits for a wireless broadband access (WBA) operator of higher power at 5GHz, ranging from "marginal"

[3] http://www.ofcom.org.uk/research/technology/overview/ese/exempt/

to “making a significant difference to the business case”. In addition, interviewees had different opinions on whether the main benefit would be in access or backhaul. The views largely depended on the size of operator commenting and are detailed in the consultants’ report.

2.6 There was general agreement that the services which would be provided were higher power allowed would be the same as those currently offered. Some operators expressed the view that mobility could be a key driver for market growth, for example based on a ‘triple play’ of broadband connectivity, voice, and remote desktop access (i.e. access to corporate systems) for nomadic users.

2.7 There was also widespread agreement from interviewees that the business case for rural WBA is marginal, particularly for residential users where it is difficult to compete with ADSL. Profitability depends on service adoption by small and medium enterprises (SMEs) and small offices / home offices (SOHO) who adopt more expensive services and therefore boost revenues.

Interference issues at 2.4GHz

2.8 Commercial operators operating in urban areas (particularly hotspot operators) were concerned at the prospect of changes in the 2.4GHz band. Whilst the economics could be slightly better in some cases (e.g. not needing repeaters to boost coverage), interviewees felt that there could be capacity loss overall due to the risk of increased interference. This is because they felt everyone would increase power in order to minimize the interference they experienced. Some believed that higher power at 2.4GHz would be likely to “wipe out” the existing benefits obtained in this band.

2.9 Interviewees suggested that the main problem is that if higher power is allowed for rural areas, it will also be used in urban situations. If necessary, assigning structure and boundaries to the regulation would be critical. Interviewees felt that it would also be important to consider Health & Safety issues related to allowing increased power in public areas.

2.10 The impact of interference will be highly dependent upon the technology employed for WBA. If the WBA system is based upon 802.11b/g technology then devices will likely coexist relatively well with similar systems. However, dissimilar devices are more likely to interfere with one another.

Interference issues at 5.xGHz

2.11 Interviewees feel that there is little risk of inter-operator interference at 5.8GHz for modest power increases (e.g. 4W EIRP), due to the current low level of WBA deployment. In addition, interviewees suggested that making more channels available would reduce interference risk between WBA systems.

2.12 For satellite systems, interviewees reported that the SE 38 sharing study shows that sharing with satellite is feasible for 4W EIRP and an assumed sidelobe performance (which they felt should be specified for 5.8GHz in the regulations). For radar systems, interviewees suggested that whilst an increase in antenna gain should scale (with the current DFS threshold), an increase in conducted power would require a corresponding decrease in the DFS threshold.

Section 3

Co-existence and interference issues

International Framework

3.1 The subdivision of the radio spectrum into specific frequency bands and the allocation of those bands to various radio services is a process that occurs globally in the ITU, at the European level in CEPT and the EU, and nationally, through regulatory decisions made by Ofcom. The fundamental reason for international co-ordination of radio use has, historically, been the risk of harmful interference between use in one jurisdiction and use in another, given that radio emissions do not stop at national borders.

3.2 The ITU Radio Regulations (ITU-RR) define those uses for specific spectrum bands that will have international recognition under the Radio Regulations. The allocation of frequencies in the world is divided into three Regions; Region 1, 2 and 3. The United Kingdom falls within Region 1. Within each frequency band, radio communications services are allocated on the basis of 'primary' and 'secondary' service, either on a worldwide or Regional basis. Allocation of secondary services shall not cause harmful interference to allocations of assigned primary services. (Article 5 of the ITU RR).

3.3 The ITU allocation of the frequencies considered here are shown in Tables 3.1 to 3.3 and the relevant footnotes are reproduced in Annex 8.

International Region		
Region 1	**Region 2**	**Region 3**
2 300-2 450 Primary: FIXED Primary: MOBILE Secondary: Amateur Secondary: Radiolocation Footnotes: 5.150 5.282 5.395	2 300-2 450 Primary: FIXED Primary: MOBILE Primary: RADIOLOCATION Secondary: Amateur Footnotes: 5.150 5.282 5.393 5.394 5.396	
2 450-2 483.5 Primary: FIXED Primary: MOBILE Secondary: Radiolocation 5.150 5.397	2 450-2 483.5 Primary: FIXED Primary: MOBILE Primary: RADIOLOCATION 5.150 5.394	

Table 3.1 – ITU-R Regulations relevant to the 2.4GHz band

International Region		
Region 1	**Region 2**	**Region 3**
5 150-5 250 Primary: AERONAUTICAL RADIONAVIGATION Primary: FIXED-SATELLITE (Earth-to-space) 5.447A Primary: MOBILE except aeronautical mobile 5.446A 5.446B Footnotes: 5.446 5.447 5.447B 5.447C		
5 250-5 255 Primary: EARTH EXPLORATION-SATELLITE (active) Primary: RADIOLOCATION Primary: SPACE RESEARCH 5.447D Primary: MOBILE except aeronautical mobile 5.446A 5.447F Footnotes: 5.447E 5.448 5.448A		
5 255-5 350 Primary: EARTH EXPLORATION-SATELLITE (active) Primary: RADIOLOCATION Primary: SPACE RESEARCH (active) Primary: MOBILE except aeronautical mobile 5.446A 5.447F Footnotes: 5.447E 5.448 5.448A		
5 470-5 570 Primary: MARITIME RADIONAVIGATION Primary: MOBILE except aeronautical mobile 5.446A 5.450A Primary: EARTH EXPLORATION-SATELLITE (active) Primary: SPACE RESEARCH (active) Primary: RADIOLOCATION 5.450B Footnotes: 5.448B 5.450 5.451		
5 570-5 650 Primary: MARITIME RADIONAVIGATION Primary: MOBILE except aeronautical mobile 5.446A 5.450A Primary: RADIOLOCATION 5.450B Footnotes: 5.450 5.451 5.452		
5 650-5 725 Primary: RADIOLOCATION Primary: MOBILE except aeronautical mobile 5.446A 5.450A Secondary: Amateur Secondary: Space research (deep space) Footnotes: 5.282 5.451 5.453 5.454 5.455		

Table 3.2 – ITU-R Regulations relevant to the 5GHz bands A and B

International Region		
Region 1	**Region 2**	**Region 3**
5 725-5 830 Primary: FIXED-SATELLITE (Earth-to-space) Primary: RADIOLOCATION Secondary: Amateur Footnotes: 5.150 5.451 5.453 5.455 5.456	5 725-5 830 Primary: RADIOLOCATION Secondary: Amateur Footnotes: 5.150 5.453 5.455	
5 830-5 850 Primary: FIXED-SATELLITE (Earth-to-space) Primary: RADIOLOCATION Secondary: Amateur Secondary: Amateur-satellite (space-to-Earth) 5.150 5.451 5.453 5.455 5.456	5 830-5 850 Primary: RADIOLOCATION Secondary: Amateur Secondary: Amateur-satellite (space-to-Earth) 5.150 5.453 5.455	
5 850-5 925 Primary: FIXED Primary: FIXED-SATELLITE (Earth-to-space) Primary: MOBILE Footnotes: 5.150	5 850-5 925 Primary: FIXED Primary: FIXED-SATELLITE (Earth-to-space) Primary: MOBILE Secondary: Amateur Secondary: Radiolocation Footnotes: 5.150	5 850-5 925 Primary: FIXED Primary: FIXED-SATELLITE (Earth-to-space) Primary: MOBILE Secondary: Radiolocation Footnotes: 5.150

Table 3.3 – ITU-R Regulations relevant to the 5GHz band C

Usage of the bands

3.4 The bands under consideration in this consultation are widely used by the MoD. Table 3.4 sets out the position

	2.4GHz	5GHz Band A	5GHz Band B	5GHz Band C
Usage	MoD 2.400 - 2.450MHz Ofcom managed 2.450 - 2.483MHz	Ofcom/MoD 5.150 – 5.250MHz MoD 5.250 – 5.350MHz	MoD	MoD 5.727 – 5.850MHz Ofcom 5.850 – 5.875MHz

Table 3.4 MoD usage of the bands

3.5 Military usage includes fixed, telemetry and mobile services and long-range airborne telemetry links which are particularly carefully protected. Some of this use is by both the RAF and the USAF for training purposes. There may be increasing use of the 2.4GHz band for Unmanned Aerial Vehicles (UAVs). The Cave Audit of Public

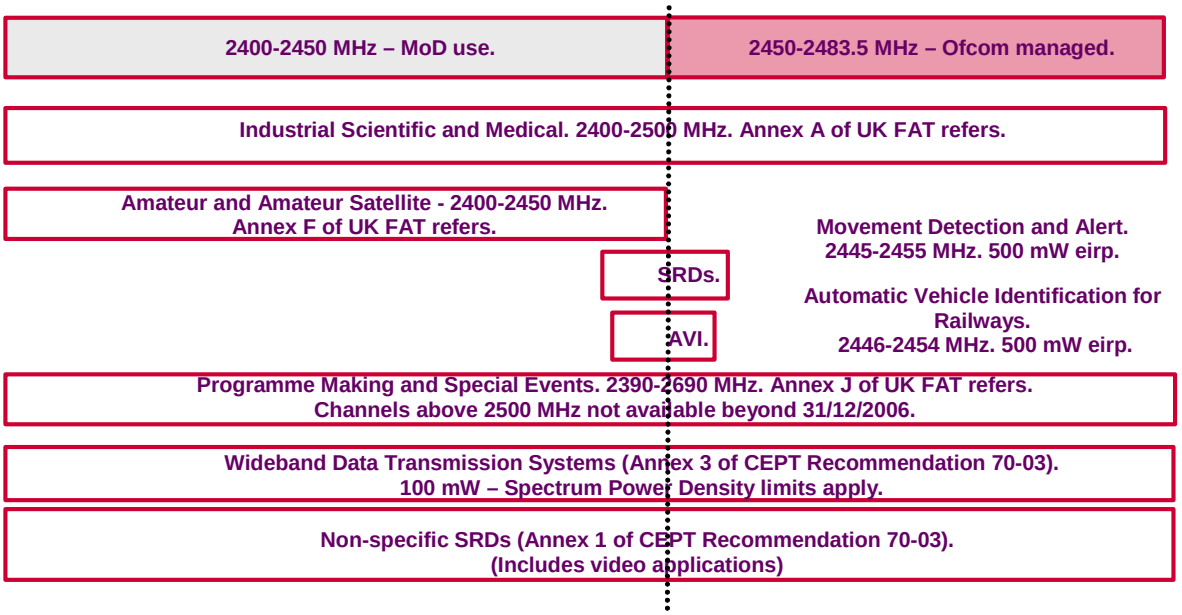
Spectrum Holdings[4] also states that future generations of Radio Relay equipment are expected to be designed so that they can operate across this band. The MoD's BOWMAN Personal Role Radio uses the 2.4GHz band.

3.6 There are eight different radar types at 5GHz, two of which can be operated in either a fixed frequency or frequency hopping mode.

3.7 MoD has indicated a willingness to examine whether higher power could be allowed in the bands where it has usage but has no resources to devote to this work for the foreseeable future. Hence, for the moment we are only considering the use of higher powers in bands not used by the public sector, namely in the top 33MHz of the 2.4GHz band. However, the MoD have agreed to allow a higher power of 4W in the 5.8GHz band (5725 – 5850MHz) as proposed in ECC Recommendation (06)04 as there is a considerable body of technical work presented as evidence in ECC Report 68 supporting this Recommendation. For completeness, and because it may be possible to increase power in other parts of the 2.4 and 5GHz bands in due course, this section contains details of all possible interference issues at both 2.4GHz and 5GHz.

Coexistence issues at 2.4GHz

3.8 The bandplan for 2.4GHz is shown below.



3.9 Each of the key services that might suffer interference were higher power use allowed throughout the band is considered below.

[4] http://www.spectrumaudit.org.uk/final.htm

Programme Making and Special Equipment (PMSE)

3.10 PMSE is a service that uses analogue or digital video transmission equipment for outside television broadcast purposes, such as sporting events or news coverage. The equipment is mobile and often transmits at high power.

3.11 The administrative manager for PMSE usage, the Joint Frequency Management Group (JFMG) has provided information showing that the number of applications for licences is beginning to decline despite the growth in PMSE in general. The decline is believed to be because of the increased potential for interference broadcasters are likely to suffer due to rising numbers of other civil systems such as ISM devices, SRDs and WLANs.

3.12 Since usage is declining in these bands it is expected that costs of interference incurred by PMSE operators who continue to use this band will be relatively low.

Wideband data systems

3.13 Existing wideband data transmission systems in the 2.4GHz band mostly uses Bluetooth or WiFi . Equipment categorised as wideband data must comply with EN 300328 and is limited to 100mW EIRP. Coexistence between high power WBA and Bluetooth is unlikely to cause significant interference due to the introduction of Active Frequency Hopping in Bluetooth V1.2.

3.14 WLANs are already deployed throughout the UK without any guarantees of protection against interference, and indeed some interference issues have been noted in dense areas. There is an increased possibility of interference if higher power levels are allowed. This is mitigated to some degree since it is expected that WBA systems would use a similar medium access control (MAC) to WLANs and hence they would share spectrum ‘politely’.

3.15 It is expected that residential users of WLAN would be relatively unaffected because the typical user only takes advantage of a small proportion of the capacity available. Business users are much more likely to be operating in an environment where there is a high density of traffic and all WLAN channels are in use. In this scenario there is more likely to be a conflict over radio spectrum resources.

3.16 From the modelling work undertaken it is expected that outdoor WBA would suffer interference from an indoor WLAN over a longer range than vice versa. Commercial WBA operators are unlikely to want to use 2.4GHz for WBA-type services in non-rural areas or near business parks because of the risk of interference from other WLAN users of the band. Evidence from operators supports this hypothesis.

3.17 In most instances interference with WiFi can be mitigated and the consultant’s report contains a full analysis of this issue.

Short Range Devices (SRDs)

3.18 The Short Range Device area is comprised of a number of markets for a wide range of diverse applications. SRDs vary enormously in their applications and technical characteristics such as frequency, power, bandwidth and modulation techniques. It is therefore necessary to consider the interference potential for each SRD market sector. This is complicated by the fact that reliable market statistics are very difficult to collect. Each key sector is considered in the following paragraphs.

3.19 Video senders are commonly used for connecting set-top boxes, VCRs and DVD players to multiple television sets around the home. They usually use analogue modulation and problems with interference from WLANs have been reported. It is anticipated that video senders in the future are likely to be based on IEEE802.11 WLAN equipment. No reliable market information regarding the installed base or sales of consumer video senders could be found however the general feeling is that this could be a competitor to WLANs as the major growth area in this band.

3.20 Non-Ultra Wide Band Consumer Devices and "Toys" – There is a drive among large chipset manufacturers to produce low cost, high volume SRDs that can achieve high data rates. Markets for these devices are likely to include the home computing /multimedia entertainment market and can therefore expect to find applications in the 2.4GHz band.

3.21 The following have been considered but have little impact on the 2.4GHz band: automotive applications, asset tracking and tracing, wireless applications in healthcare (usually carried by other systems e.g. WLAN), access control and machine to machine (M2M) communications.

3.22 The sharing situation with SRDs is difficult to assess with certainty because of the diversity of applications and the lack of market information regarding the number of devices in use.

3.23 One mitigating factor is that many SRDs are narrowband. Therefore, SRDs are likely to interfere with WBA over a longer range than vice versa. WBA operators will therefore aim to co-ordinate with SRDs wherever possible.

Radio Frequency Identification (RFID)

3.24 RFID is a widely used technique for tagging and tracking goods. There is predicted to be considerable growth of RFID devices in the future.

3.25 Most RFID systems are passive and operate at 13.56MHz. However, active systems are also growing. 2.45GHz is a relatively popular band for active systems because of its worldwide availability. Due to the need for tags to be very low cost, active 2.45GHz systems represent a very small minority of all tags and present little interference potential.

3.26 Interference caused to the RFID system is possible, particularly if high powered WBA equipment is sited nearby. In these cases, manual or automatic selection of a different channel could mitigate the problem. Bringing the tag and reader closer together or re-orienting the tag and/or reader can also help to overcome the interference.

3.27 Due to the relative ease of mitigation in most circumstances and the low use of 2.4GHz for RFID, costs of interference are expected to be relatively low.

Automatic Vehicle Identification (AVI)

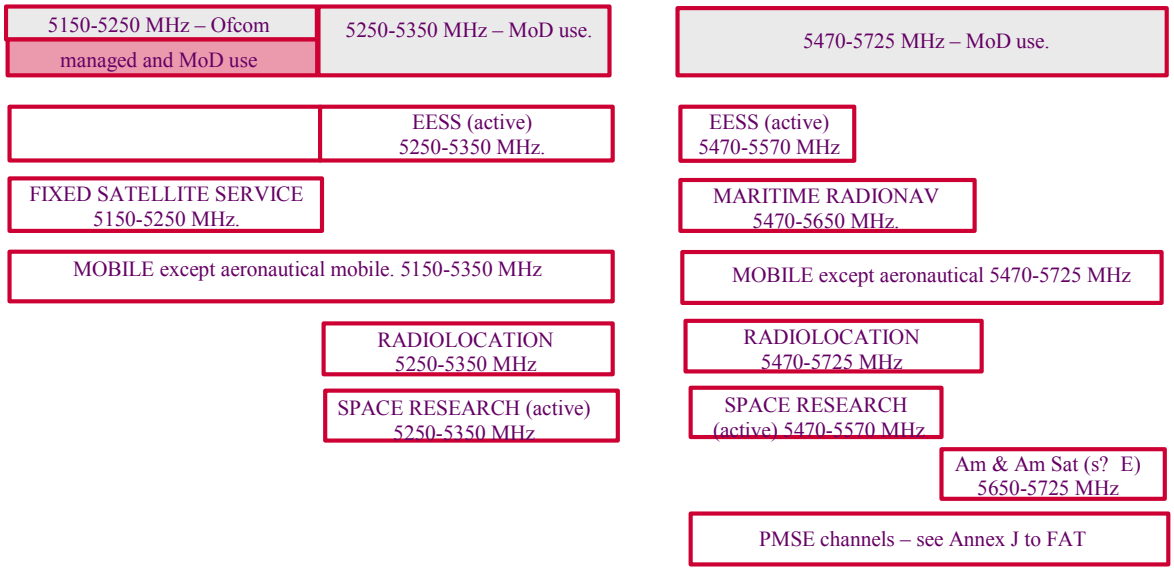
3.28 AVI (Automatic Vehicle Identification) is a specific form of RFID used for monitoring rail rolling stock. If information about the stock is required off-board then the reader will be at the track side. If there is a need for on-board system to know its precise location then the rolling stock may carry the reader. AVI systems in Europe must comply with EN 300 761 'Electromagnetic Compatibility and Radio Spectrum Matters

Short Range Devices; Automatic Vehicle Identification for Railways Operating in the 2.45GHz Frequency Range'.

3.29 As with RFIDs the relative ease of mitigation in most circumstances and the low use of 2.4GHz for AVI suggests that costs of interference will be relatively low.

Coexistence issues at 5.xGHz

3.30 The bandplan for 5.xGHz bands A and B is shown below.



3.31 A range of UK, European and International regulations applies to particular equipment usage in the 5GHz band. For example, the technical parameters for WLANs are set out in UK IR2006 and European Norm 301893, and dynamic frequency selection and transmit power control are specified in ITU-R M.1652. Full details of all relevant regulations are provided in the consultants' report.

3.32 Each of the key services that might suffer interference is considered below.

Band A (5150-5250MHz)

3.33 Aeronavigation – it is believed that there are no plans to use this spectrum for this application

3.34 Fixed satellite service – the lower part of band A is used for Mobile Satellite Service (MSS) feeder links. These are mostly LEO satellites.

3.35 Mobile - this band is used by IEEE802.11a WLAN equipment. Use is limited to indoors to minimise interference to MSS feeder links. Equipment must conform to EN301893 which includes Transmit Power Control (TPC) and Digital Frequency Selection (DFS) requirements. Furthermore, equipment must conform to ECC Decision (04)/08. EIRP is limited to 200mW and maximum mean EIRP spectral density is limited to 0.25mW/25kHz in any 25kHz band.

3.36 Modelling suggests that there is limited potential for increased power in these bands due to the possible interference to the satellite usage.

Band A (5250-5350MHz)

3.37 EESS – there are EESS radars operating in this band such as the Canadian Radarsat and European Envisat. It is considered by the EESS community that the U.S. decision to allow outdoors WLANs in this band will render it unusable for EESS over the U.S. and Canada. Note that Radarsat-2 operates between this band and band B at 5.405GHz. If higher powers were allowed then mitigation might be needed. Possible mitigation techniques are discussed in the consultants' report. A live information feed to network operators regarding the expected location of satellites would enable networks to change frequency or cease operation during the infrequent and short period of time for which they are in the main beam of the SAR. Such a mitigation technique could keep to a minimum any costs associated with interference from FWA to EESS.

3.38 Radiolocation – the MoD has radars operating in this band. There are eight different types two of which can be operated in either a fixed frequency or frequency hopping mode. DFS has been shown through several studies and tests to mitigate the impact of interference. However, further research is required to determine whether DFS can be modified to detect frequency hopping radars.

3.39 Mobile – this band is used by IEEE802.11a WLAN equipment. Use is limited to indoors to minimise interference to EESS. Equipment must conform to EN301893 which includes TPC and DFS requirements. Furthermore, equipment must conform with ECC Decision (04)/08. EIRP is limited to 200mW and maximum mean EIRP spectral density is limited to 10mW/1MHz in any 1MHz band.

3.40 Active space Research – It is believed that this band has not been used for sensor applications on any planetary missions. ESA have confirmed that it has not used this band for this application but could in the future for Mars missions. It is assumed that protection can be afforded to devices by providing protection zones around ground stations.

Band B (5470-5725MHz)

3.41 Radiolocation – as for Band A

3.42 EESS (5470-5570MHz) – There is believed to be only one device on board an EESS which uses this band. This is the altimeter on the Topex-Poseiden mission. This is a joint CNES and NASA mission to map the ocean topography (sea level height changes). ESA does not have EESSs operating in this band. It is possible that there will be future use of this band by ESA if the outdoor WLAN use in the U.S. prevents the 5250-5350MHz band being used. Mitigation techniques may be further developed and applied to enable future sharing between EESS and FWA in this band

3.43 Maritime Radionavigation (5470-5650MHz) – The maritime radar application includes shipborne weapons systems radars and Vessel Trafficking System (VTS) radars. The military services here are likely to be highly sensitive to interference but information is not available in the public domain.

3.44 Mobile – this band is used by WLANs including IEEE802.11a WLAN equipment. Indoor and outdoor use is allowed. Equipment must conform to EN301893 which includes TPC and DFS requirements. Furthermore, equipment must conform to ECC Decision (04)/08. EIRP is limited to 1W and maximum mean EIRP spectral density is limited to 50mW/1MHz in any 1MHz band. Interference is possible between higher

power devices and W-LAN type equipment although this may be mitigated if the higher power equipment uses similar protocols.

3.45 Active Space Research (5470-5570MHz) –ESA have confirmed that it has not used this band for this application but could in the future for Mars missions. It is assumed that protection can be afforded to devices by providing protection zones around ground stations.

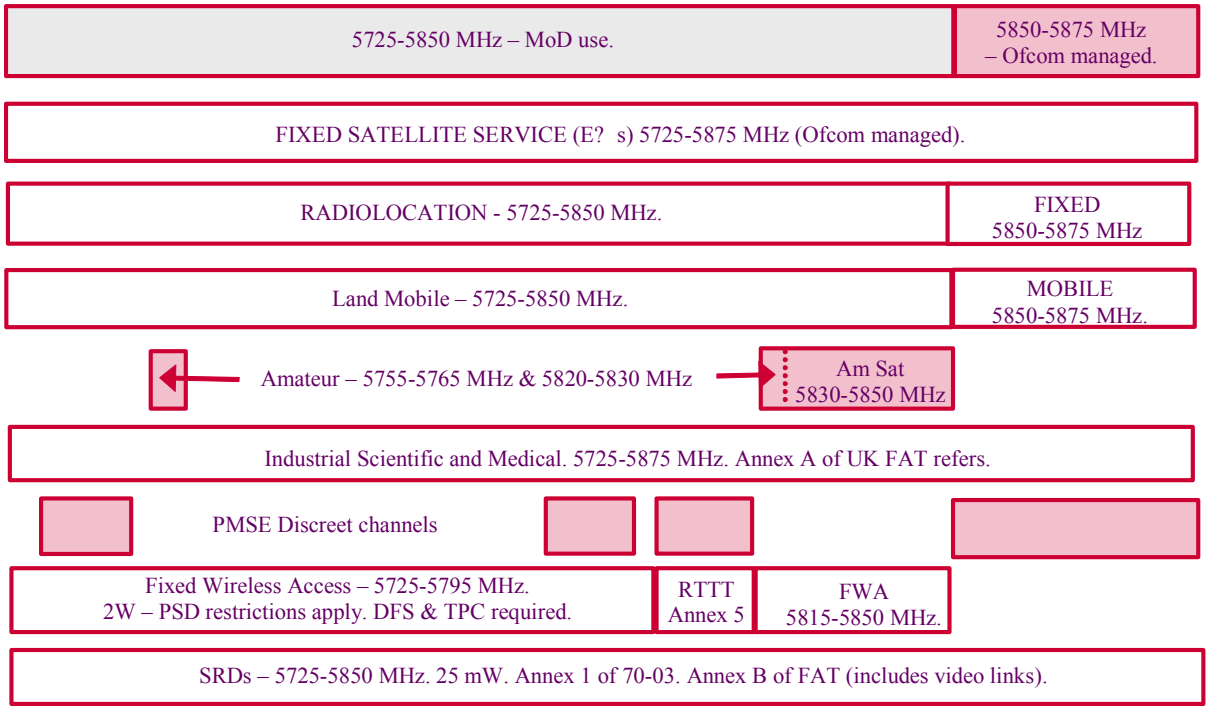
3.46 Deep Space Research (5650-5725MHz) – ESA ground stations exist for communications in this band in Spain, Australia and the USA. It is assumed that protection can be afforded to devices by providing protection zones around ground stations. Since there are believed to be no ground stations in the UK cost of interference from high power WBA should be zero.

3.47 Amateur and Amateur satellite (5650-5725MHz) – Amateur users of this band use the spectrum on a secondary basis and therefore should avoid interference with primary users of the band. High power amateur systems are likely to cause interference with FWA before FWA interferes with amateur. Also, amateur use is limited. For these reasons the cost of interference from FWA is expected to be very low.

3.48 PMSE - analogue or digital video transmission equipment for outside television broadcast purposes, such as sporting events or news coverage. The main application in this band is electronic news gathering and outside broadcast (ENG/OB). The equipment is mobile and often transmits high power. There are few wireless cameras operating in this band. It is understood that programme makers using this band do not expect to suffer interference from WLANs in the band despite there being an allocation for outdoor systems operating up to 1W . It is thought that sharing has not been a problem because of the low number of outdoor WLANs. Note that this is in contrast to band C where programme makers expect that they may suffer interference from FWA. Sharing between WBA and PMSE requires co-ordination to avoid interference. Although there are some WLANs operating in this band the number of systems deployed has not yet resulted in interference problems. However, a much larger deployment with higher power devices could generate significant costs for the PMSE community.

Band C (5725-5875MHz)

3.49 The bandplan for 5.8GHz band C is shown below.



3.50 Fixed Satellite Service - All satellites operating in this band are geostationary. Satellites located over Europe and western Asia between 45° West and 90° East are potentially susceptible to interference from FWA in the UK. The majority of satellites operate above 5850MHz. Below 5850MHz as long as the effects of aggregate interference could be mitigated against by encouraging the use of directional antennas then large deployments of BWA networks can be allowed in the UK as the potential for interference is low. However, this is not the case above 5850MHz where the numbers of higher power BWA devices that can be deployed in the UK is lower before there is a risk of interference occurring to the most sensitive satellites.

3.51 Radiolocation – the MoD has radars operating in this band. There are eight different types, two of which can be operated in either a fixed frequency or frequency hopping mode. The other six types are fixed frequency. DFS has been shown through several studies and tests to mitigate the impact of interference from existing WBA services to radar although some doubt still remains that DFS does not adequately recognise frequency hopping radars. In addition, care would have to be taken when specifying DFS thresholds if WBA devices that achieve high EIRP through use of high antenna gains were allowed.

3.52 Amateur (5755-5765MHz and 5820-5830MHz) – Amateur user of this band is on a secondary basis and therefore should avoid interference with primary users of the band. The use of amateur radio is relatively limited and the high power amateur systems are likely to cause interference with WBA before WBA interferes with amateur.

3.53 Amateur Satellite (5830-5850MHz) – Amateur satellite use is on a secondary basis and therefore should avoid interference with primary users of the band.

3.54 Road Transport Traffic Telematics (RTTT) (5795 -5815MHz) - The band 5795-5815MHz is for use by road-to-vehicle systems, in particular road toll systems. Some Road Toll systems are already operated within this band in the UK. Estimating the

likely costs of interference from WBA services to RTTT devices is difficult as there is little certainty regarding the numbers of RTTT systems that will be deployed in the future. The use of DFS could be investigated further but without appropriate mitigation interference is likely to occur in a congested environment to RTTT devices from higher power WBA networks.

3.55 PMSE – Programme makers primarily use this band for ENG/OB use, similar to the use in band B. Unlike band B, however, they expect that they may suffer interference from the higher power FWA services. Hence, they are migrating equipment to the band 5850-5925MHz. One programme maker has a long term national licence in the RTTT band (5795-5815MHz). They operate in the band with the expectation that they will not suffer interference from WLANs or FWA. Previous studies have shown that due to the nature of their use PMSE users need guarantees that the likelihood of interference to their services would be minimal when they set up for outside broadcasts. This would not be the case if higher power WBA services were allowed to have co-channel usage in their bands. This is why PMSE use has been migrated above 5850MHz. This indicates that the risk of interference occurring to PMSE services operating in RTTT bands is high if BWA services were allowed to operate in this band.

3.56 SRD – SRD use of this band is very low because of the relatively high cost of developing and manufacturing equipment at this frequency compared with other SRD bands. The only application believed to have been proposed for this band is wireless video senders for relaying information to set-top boxes around the home. As any usage of this band by SRDs at the moment is very low and likely to be indoors the potential of interference to SRDs is thought to be low

Summary of co-existence and interference issues

3.57 A significant number of studies have been undertaken which examine sharing between WLANs or FWA and other users/services. The key areas where interference might occur have been identified as:

- 2.4GHz: Business WLAN users (who are expected to be those suffering the greatest economic loss).
- 5GHZ band A (5150-5250MHz). Note that we currently have no proposals to increase power levels in this band. If there were, costs associated with interference with the Globalstar service might be high.
- 5GHZ band A (5250-5350MHz): Note that we currently have no proposals to increase power levels in this band. If there were there could be costs associated with interference with Envisat and Radarsat. Sharing with radiolocation systems is possible using DFS but interference may occur with frequency hopping radars.
- 5GHz band B: Note that we currently have no proposals to increase power levels in this band. If there were PMSE might suffer significant costs of interference if there are no steps taken to co-ordinate WBA and PMSE use. Sharing with radiolocation systems is possible using DFS but interference may occur with frequency hopping radars.
- 5GHz band C: Key areas of possible interference include to the satellites operating in this band, to RTTT and PMSE services in the UK. According to the work performed by the ECC, an increase to 4W is not expected to cause significant interference to any of these as long as device numbers stay below around 100

million across Europe[5]. Although difficult to predict, it seems likely that device numbers will be below this level.

3.58 In summary, for the bands where we are currently considering increased power, the only significant area of interference is expected to be to business WLAN users.

Q1: Have all the possible victims of interference been correctly identified and quantified as far as possible?

[5] More details are provided in the consultants' report.

Section 4

The value of increased power

Introduction

4.1 In this section we set out the case for increased powers in a range of areas. Much of this material is based upon work conducted for us by Scientific Generics and other consultants. More detail on the modelling work is available in the consultants' report[6] and supporting Annexes. This work provides a valuable insight on the key drivers behind the benefits and costs at stake if higher power were allowed. It also highlights the complexity and the uncertainties inherent to such modelling exercise. We intend to use the consultants' estimates to stimulate the discussion around the potential of higher power in LE spectrum.

4.2 In this section, firstly we describe the benefits by establishing the value to the band users of increased power. This is predominantly due to fewer cells being needed for the same coverage and hence lower costs. Then we consider the impact of any interference that might be caused to other users of the band and quantify its cost where possible. Finally, we bring these two together to get an indication of the overall benefit to the UK of increased power.

Benefits arising from higher power

4.3 Several scenarios consisting of differing power levels have been modelled, as set out in Table 4.1. All scenarios assume that residential users are provided with a 1Mbit/s SDSL WBA service and business users with a 4Mbit/s SDSL WBA service. The WBA architecture is assumed to be point-to-multipoint.

Frequency (GHz)	Higher power scenario
2.4	1W EIRP
2.4	10W EIRP
2.4	80W EIRP
5.8	4W EIRP
5.8	25W EIRP
5.8	200W EIRP

Table 4.1 Higher power scenarios

4.4 The economic benefit in each scenario is the increase in consumer surplus generated by deploying WBA in financially viable cells which can otherwise only be served with broadband satellite.[7] The calculated benefit arises from the fact that having wireless broadband available at a significantly lower price than satellite increases demand for wireless broadband. Since the number of subscribers increases with higher power, calculated consumer surplus also increases with power.

4.5 The net benefit of each higher power scenario is estimated as the Net Present Value (NPV) of the net consumer surplus over the 2005-2010 period, appropriately discounted, where the net consumer surplus is calculated by subtracting the

[6] http://www.ofcom.org.uk/research/technology/overview/ese/exempt/

[7] Note that the producer surplus is assumed to be insignificant due to the competitiveness of the market and is therefore not included in the economic benefit.

consumer surplus under the current regulation scenarios at 2.4 and 5.8GHz from the consumer surplus under the higher power regulation. Under the assumption that residential consumers pay £35 per month for 1Mbit/s SDSL (and no installation charges) and the business consumer pay £150 per month for 4Mbit/s (and no installation charges) the net benefit for the above higher power scenarios is estimated as follows:

Frequency	Scenario	Cell radius	Net benefit (GBP, million)
2.4	1W EIRP	3.50	188
2.4	10W EIRP	7.25	443
2.4	80W EIRP	16.50	539
5.8	4W EIRP	4.25	85
5.8	25W EIRP	7.25	238
5.8	200W EIRP	16.50	288

Table 4.2 Net benefit (NPV of consumer surplus for 2005-2010)

4.6 The increase in consumer surplus is greatest for the highest power scenario at 2.4GHz. This is because it allows the largest cells to be deployed. In contrast increasing power to 1W at 2.4GHz or to 4W at 5.8GHz has a more modest impact because propagation restricts the cell range more than at 2.4GHz.

4.7 At both 2.4GHz and 5.xGHz benefits grow rapidly as power is initially increased, but then start to level off for further power increases. Because higher power levels will result in increased interference, our view is that the most appropriate scenarios to consider are those relating to the points where the benefits start to level off. These are 10W at 2.4GHz and 25W at 5.xGHz. However, as previously mentioned we are unable to consider power increases beyond 4W at 5GHz at present since this will require further MoD study. This is why subsequent analysis concentrates on the 2.4GHz band.

4.8 The modelling work shows that the level of benefits varies depending on the geographical area over which higher powers are allowed. For example, a high proportion of the total benefit is derived from business subscribers of which a high proportion arises from areas of medium-sized towns such as Chichester and Chesterfield. These businesses are more than 2kms from a BT exchange and are outside the range for 4Mbit/s services and therefore may benefit from WBA.

4.9 The distribution of the benefits according to geographical area for an increase to 10W at 2.4GHz is shown in the graph 4.1 below. This graph shows how the cumulative net benefits increases as the geographical area expands.

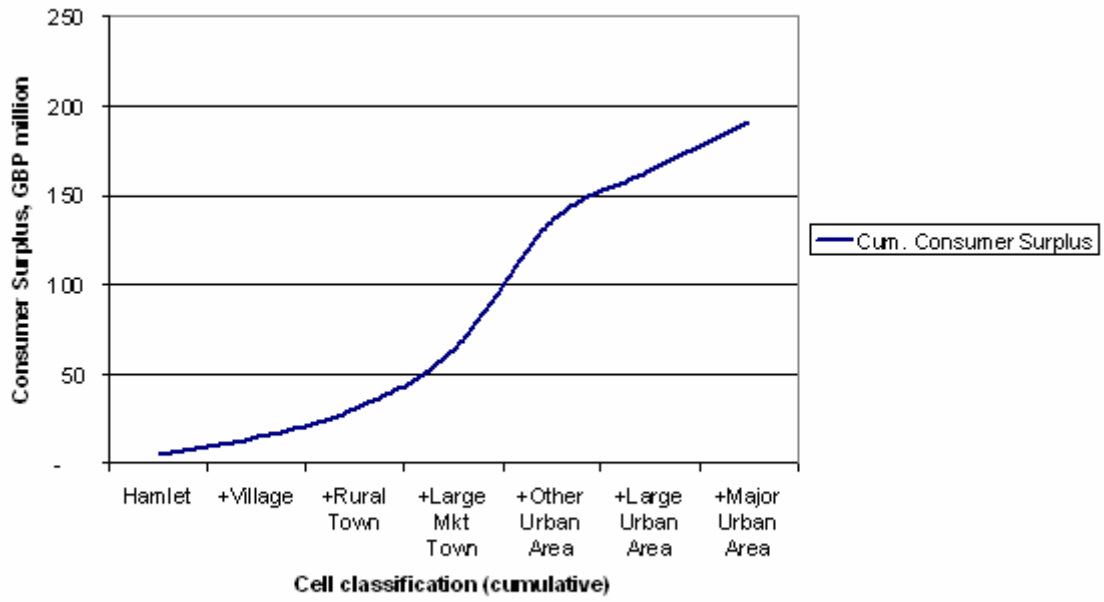


Figure 4.1 - Benefit arising from a power increase to 10W at 2.4GHz (single sector)

4.10 The results of the modelling can be seen in Figure 4.1. The graph shows that the cumulative net benefit first increases slowly as the area expands from hamlet to rural town, then increases fast as the area expands further to include large market town and other urban areas, and finally increases slowly again as the area expands further to include large and major urban areas.

4.11 Note that this figure is for the single channel scenario considered in Section 6 and therefore shows a lower net benefit than Table 4.3 where the modelling is for the whole 2.4GHz band.

4.12 In this chart, the geographical characterisations are those used by the Office for National Statistics and the Department for Environment, Food and Rural Affairs in the rural/urban definitions of census areas and the rural/urban classification of local authority areas[8]. To help illustrate this, Figure 4.2 shows how these different area classifications are distributed across England.

[8] See http://www.statistics.gov.uk/geography/nrudp.asp and http://statistics.defra.gov.uk/esg/rural_resd/rural_definition.asp

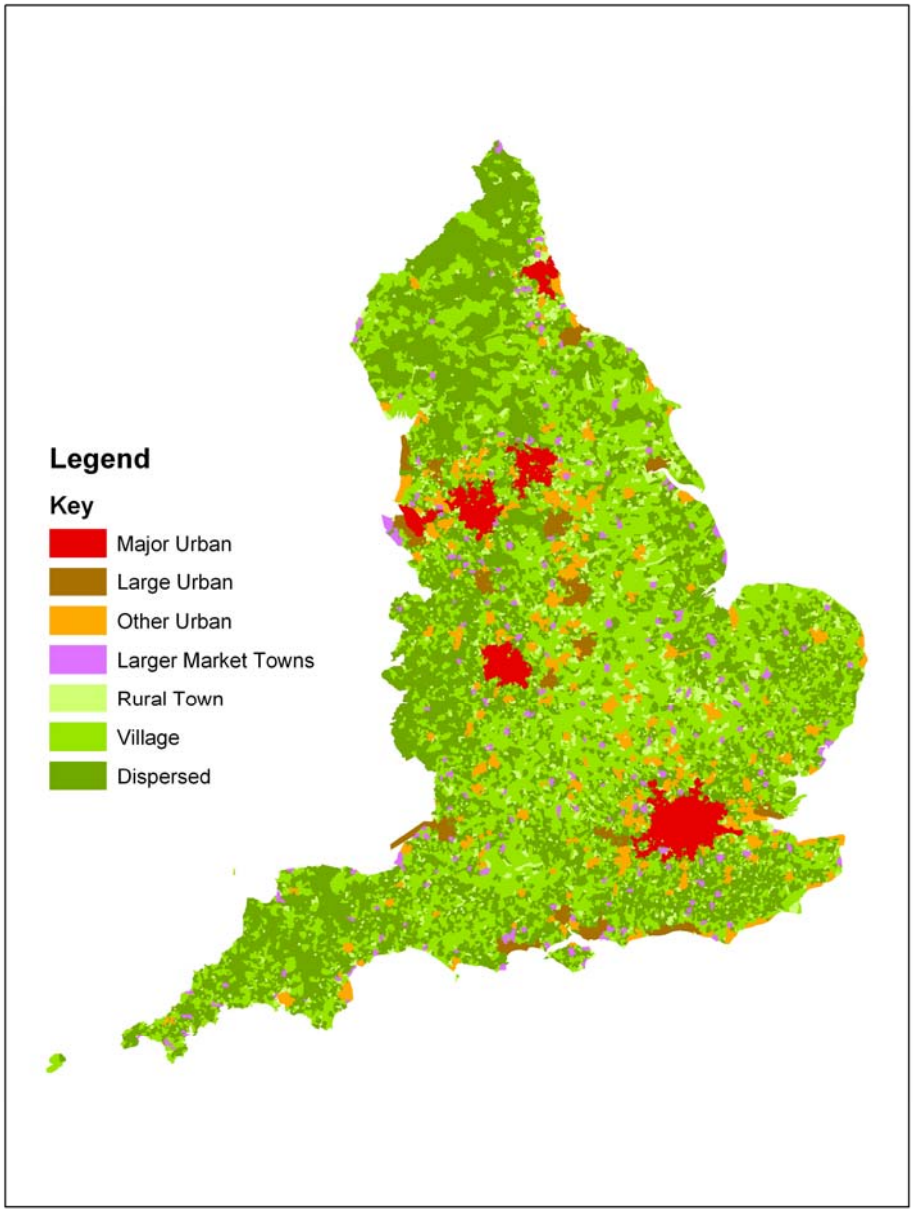


Figure 4.2 – Distribution of different geographical areas in England

Costs Arising from Higher Power

4.13 The possible interference cases were discussed in the previous section. At 2.4GHz, the most significant area of interference was identified as with WLANs. WLANs present a significant potential cost because of the popularity of these devices. Proliferation of WLAN devices is likely to continue in the future with technology developments that will enable them to be used for audio and video streaming applications.

4.14 Using the same scenarios as the benefits model the consultants have estimated costs of interference from high power WBA into WLAN, ranging between £600,000 at

current 100mW power levels to £18m at 80W EIRP. This is the cost of mitigation borne by business users in changing equipment to 5.2GHz WLAN to avoid interference with WBA at 2.4GHz assuming that the only costs are those of acquiring new wireless equipment. Interference costs for residential users are expected to be significantly less than this. For the scenario we consider most appropriate, namely 10W at 2.4GHz, the costs are estimated from the table below.

Allowed power	**1W**	**10W**	**80W**
Number of Employees suffering from capacity loss	25,496	133,841	181,182
Cost of Mitigation at £100 per employee	£2,549,613	£13,384,058	£18,118,200

Table 4.3 Interference scenarios at 2.4GHz.

4.15 The consultants could not fully ascribe the costs of interference on a geographical basis due to a lack of easily available data regarding the location of WLANs. However, in their view, the costs were minimal for the most rural three geographical areas and were felt increasingly across the more urban areas.

4.16 There may be other costs not fully accounted for here such as the loss of functionality before migration and the charges of IT professionals to diagnose, implement and test a change over. Views are sought on the actual costs to affected businesses and how likely it will be that these interference cases will occur as the existing 2.4GHz channels become congested.

4.17 At 5GHz the key interference was with fixed satellites. Interference with FSS depends on the specific characteristics of each satellite. The location of the geostationary satellite, antenna characteristics and receiver parameters impact the level of aggregate interference from WBA users in Europe that is likely to affect services. Below 5850MHz there are only a few satellites that could be impacted. For the most sensitive satellites the number of WBA devices that can be deployed without satellite operators incurring losses is quite low. If very high powers such as 80W were allowed at 5GHz it has been estimated that satellite operators could incur losses of £29m if aggregate interference impact services. However, for the power increases proposed to 4W, no significant interference is expected.

Comparison of costs versus benefits

4.18 On the basis of the assumptions made and acknowledging the limitations inherent to any interference cost estimation in LE spectrum, the modelling work shows that the benefits are likely to be greater as the geographical area grows and to exceed the costs regardless of the geographical area selected. However, this conclusion is contingent on the costs of interference being accurately characterised.

4.19 Ofcom believes that the consultants' work offers valuable insights on the benefits and interference costs that would be generated if higher power are allowed and suggests that there might be a case to allow increased power. As part of this consultation Ofcom is keen to hear the views of interested parties regarding these findings.

Q2: Have the costs and benefits been correctly captured? In particular, are the costs of interference to WLANs appropriately assessed?

Section 5

Specifying geographical areas and power limits

5.1 As discussed earlier, while increased powers in rural areas could bring welcomed benefits, if higher power devices were used in urban areas this could increase congestion and reduce utility. Therefore, a mechanism of appropriately licensing devices according to geographical area is required. In this section we set out two possible approaches to addressing this interference issue though alternatives would be considered. The two example approaches are:

- A registration scheme which provides the maximum flexibility but places the onus on users of higher power equipment to deploy it appropriately and resolve any resulting interference.
- A requirement for devices to be location aware and control their power accordingly without user intervention.

5.2 These are described in more detail below. We also discuss a possible change in the mechanisms by which power levels are specified.

Licence exemption

5.3 In the United Kingdom, Ofcom is responsible for the authorisation of civil use of the radio spectrum and achieves this by granting Wireless Telegraphy licences under the Wireless Telegraphy Act 1949 (the “1949 Act”) and by making regulations exempting users of particular equipment from the requirement to hold such a licence. Under section 1 of the 1949 Act, it is an offence to install or use equipment to transmit without holding a licence granted by Ofcom, unless the use of such equipment is exempted. Under s1A of the 1949 Act, where Ofcom is satisfied that use of equipment is not likely to involve undue interference with wireless telegraphy, Ofcom may make regulations under s1 of the 1949 Act exempting users of particular equipment from the requirement to hold such a licence. This proposal is for equipment that is exempt from s1 of the 1949 Act.

Registration scheme to restrict high power service providers to rural areas

5.4 This option requires the registration on a central database of any devices operating at higher powers. This is done by the provider of the service for base stations and by the equipment user for all other equipment.

5.5 The conditions for allowing a particular deployment would be:

- Provision of location, power and contact details to a publicly accessible database.
- Acceptance of responsibility to resolve interference problems with lower power devices.

5.6 The implementation of registration scheme would be similar to the light licensing approach currently adopted at 5.8GHz. This would require an easy way of registering

a new site and the ability of others to search the database and contact registered users.

5.7 The advantages for this system is that it:

- Does not require any modifications to equipment (other than higher power) and so would be relatively low cost.
- Is simple, cheap and rapid to implement.
- Allows users to judge where the use of higher powers is inappropriate since users will likely not deploy equipment where they expect interference could occur, resulting in an obligation on them to resolve the issue.

5.8 However it has the following disadvantages all of which generate additional costs that detract from the overall benefit a power increase would bring:

- It may be difficult or in the worst case near-impossible to enforce.
- Users may not resolve interference issues sufficiently rapidly, leading to time-consuming negotiation and potentially litigation.
- Some users may not be aware of the need to register devices and so may inadvertently transmit illegally.

Location-aware devices

5.9 An alternative solution may be to require high power equipment to be ‘location-aware’ and constrained for use in pre-defined areas of the country only. An example of an embodiment of the location-aware feature is a device containing a GPS receiver, a database which defines the permitted areas of operation, and a control mechanism which permits transmission according to the location.

5.10 The advantages of this are:

- It is readily enforceable.
- It does not require any negotiation or dispute resolution between users.
- Users will be unable to transmit illegally without realising that they are doing so.
- Assuming that the area is correctly defined, the risk of interference is very low.

5.11 There are a number of potential problems that may arise with this solution and as before the costs detract from the potential benefits:

- The customised equipment is expected to be relatively costly.
- There would need to be a mechanism by which the information in the geographical database could be relayed to manufacturers and operators. There should also be a mechanism for updating the database in equipment already deployed.
- The system would have to be secure to prevent the controls being overridden.

Q3: Are there any other mechanisms that could be used to restrict device operation to appropriate areas? Of the schemes set out which should be preferred?

Moving from radiated to conducted power limits

5.12 There are two main ways to regulate power – by the power of the electrical signal applied to the antenna (known as "conducted power") and by the level of emission measured at some distance from the antenna (known as "radiated power"). The two types of measurement will differ according to the type of antenna used.

5.13 If omni-directional antennas are used the two approaches achieve the same outcome although conducted power limits would be 2.14dB lower than radiated power limits[9]. However, if a user then swaps to a directional antenna, the outcome is very different. If conducted power is used then the same level of power is delivered to the antenna which now focuses this power into a narrow beam, achieving much greater range in the direction of the beam. If radiated power is used then the user has to reduce the power delivered to the antenna such that the signal received in the direction of the beam was no greater than before the antenna was replaced. Clearly, in the latter case, there is little incentive to use a directional antenna.

5.14 It could be argued that the conducted approach is fairer. When moving from the omni-directional antenna to the directional one, the coverage area, and area of interference, stays broadly the same in size. It simply changes in shape from being approximately circular to becoming an elongated oval.

5.15 The conducted approach is clearly beneficial for users wishing to deploy backhaul links in these bands. By allowing increased range when using directional antennas, longer, and hence more valuable links can be deployed. Conducted power also encourages the use of smart antennas which could bring significant spectrum efficiency gains.

5.16 The relative merits of the two approaches are summarised below.

5.17 Advantages of radiated power:

- Certainty on the worst case interference effects.
- Increasing antenna gain reduces interference footprint.
- Understood in Europe.

5.18 Advantages of conducted power:

- Longer range systems possible for similar size of interference footprint when compared to radiated power.
- Simplicity of regulation (no need to certify complete system).

5.19 In practice, directional antennas may cause interference over a larger coverage area than non-directional antennas. This is because directional antennas tend also to

[9] This difference in power levels is due to the fact that omni-directional antennas have a gain of 2.14dB over a theoretical isotropic antenna.

focus the beam vertically, so that less energy is radiated upwards and downwards compared to a non-directional antenna. This is known as elevational gain.

5.20 From the interference point of view increasing elevation antenna gain increases the area of interference zone, whereas increasing azimuthal antenna gain has negligible effect on the area of the interference zone.

5.21 Therefore ideally regulation should be neutral to azimuthal gain but should account for elevation gain. However differentiating between these two is not possible as the antenna only has to be mounted differently to reverse them. Most antennas including patch, dish and sector antennas achieve gain by narrowing both azimuth and elevation beamwidth. One approach to offset this disadvantage and ensure that the coverage area remains broadly unchanged when directional antennas are used is to require the conducted power to be reduced as antenna gain is increased but at a lower rate. For example, in the US the conducted power must be reduced by 1dB for every 3dB increase in antenna gain above 1W EIRP in the 2.4GHz band. We would suggest a similar approach here.

5.22 Such an approach based on conducted powers with some compensation for gain is broadly neutral in interference terms and it encourages beamforming by allowing higher EIRPs where it is used.

5.23 A change from radiated to conducted powers is not required to allow higher power in rural areas, however, this may be an appropriate time to consider whether such a change would be beneficial.

Q4: Should we move from specifying radiated power to specifying conducted power?

Section 6

Options for the introduction of higher power

The reason for a range of options

6.1 As discussed earlier, most of the 2.4GHz and 5GHz bands are wholly or jointly used by the MoD, who are generally unable to consider higher power usage at present due to a lack of resources. Given this constraint there are only two areas where higher powers currently appear possible:

- In the upper part of the 2.4GHz band which is not owned by the MoD.
- In the 5GHz band where the MoD has indicated that the increase to 4W proposed by the ECC would be acceptable.

6.2 In the case of 2.4GHz there is insufficient evidence to point to a single preferred approach to higher power and we are consulting on a range of options. For convenience we have encapsulated these into three scenarios given below, although variations on these options could be considered.

6.3 In the case of the 5GHz band it is the combination of the MoD's intention and the ECC recommendation that will shape the options.

Options for increased power at 2.4GHz

6.4 The consultant's report identifies three high-level criteria that would define a higher power option: the increase in power, the geographical area, and the approach to interference. Since the report shows that at 2.4GHz the benefit-interference combination is likely to be maximised at 10W (see paragraph 4.7), we have selected this level for the power option.

6.5 The options are therefore formed from the combination of the two remaining variables:

- The geographical extent over which higher powers are allowed. This could be any point from rural to dense urban.
- The method used to control device location. This could range from no control, through use of a registration scheme to location-aware devices.

6.6 The matrix of options formed through these two variables could be large. For guidance, we have set out below three possible options that seem to have some merit – others are clearly possible. In addition, there is a "do nothing" option where no change in current regulation is made.

Option one – maximise benefits.

6.7 Under this option we would allow powers of up to 10W EIRP (or 6.7W if conducted power is specified) throughout the UK in the band 2450-2483MHz. With no

geographical restrictions devices need not be location aware and no registration requirements would be placed on users.

6.8 The advantages of this option are:

- According to the business case modelling this would maximise the benefits.
- It would be simple, non-intrusive and require minimal regulation.
- Little investment would be needed in devices or regulatory tools.

6.9 The disadvantages of this option are:

- There is a risk that the costs of interference might be higher than anticipated.
- With no registration or control over devices it would be difficult to subsequently change the regulations regarding higher power should this prove necessary.

Option two – minimise risks.

6.10 Under this option we would restrict the use of 10W EIRP (or 6.7W if conducted power is specified) to hamlets, villages and rural towns. Devices would be required to be location aware and only transmit at higher powers if they were in appropriate areas.

6.11 The advantages of this option are:

- There is a very low risk of interference being experienced.
- It would be possible to change the geographical area over which emissions were allowed by updating the database of allowed areas.

6.12 The disadvantages of this option are:

- The benefits are relatively small compared to the first option.
- Device costs might be high and it might take some time for suitable devices to become available.

Option three – a balance between risks and benefits.

6.13 Under this option we would restrict 10W EIRP operation (or 6.7W if conducted power is specified) to all areas except large and major urban conurbations. Devices would not need to be location aware but a mandatory registration scheme would operate and users would need to operate according to a code which required them to work collaboratively to resolve interference issues.

6.14 The advantages of this option are:

- Most of the benefits are achieved for a low level of risk of interference.
- It would be possible to change the regulations if needed by contacting users.
- The costs of implementation to the service providers are relatively low.

6.15 The disadvantages of this option are:

- Significant regulation may be needed to ensure that the registration option works.
- The benefits are not maximised.

Blends of options

6.16 These options only represent a few of the possible ways that the band might be regulated. For example, it would be possible to adopt the geographical area specified in option 3 but with the location awareness specified in option 2. We would be happy to consider any mix of these options, or indeed other approaches.

Summary

6.17 In our view, each of these options could be implemented. There is no clear-cut winner, although a balance between benefits, risks and costs is often preferable. We are seeking opinion on stakeholders' preferred options.

Q5: For 2.4GHz which of these options do you favour? Are there other viable options that should be considered? Or should regulations be left unchanged?

Options for increased power at 5GHz

6.18 We intend to implement the ECC recommendation in accordance with the attached draft IR2007. We also intend to provide general access to the details of registered usage at 5.8GHz by adding these uses to the spectrum register. We believe this will facilitate self-coordination amongst users. There are no other changes proposed and we intend to maintain the existing fees and registration requirement for this licence class in the band.

Q6: For 5GHz should Ofcom increase the power to 4W EIRP at 5.8GHz in accordance with ECC Recommendation and as set out in the draft IR2007? Should Ofcom open the database for public access to facilitate coordination?

Annex 1

Responding to this consultation

How to respond

Ofcom invites written views and comments on the issues raised in this document, to be made by **5pm on 20 September 2006**

Ofcom strongly prefers to receive responses as e-mail attachments, in Microsoft Word format, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 2), among other things to indicate whether or not there are confidentiality issues. The cover sheet can be downloaded from the 'Consultations' section of our website.

Please can you send your response to mike.parkins@ofcom.org.uk.

Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Mike Parkins
Floor 2
T&SO
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Fax:0207 981 3052

Note that we do not need a hard copy in addition to an electronic version. Also note that Ofcom will not routinely acknowledge receipt of responses.

It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views, and how Ofcom's proposals would impact on you.

Further information

If you have any want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Mike Parkins on 0207 783 4686.

Confidentiality

Ofcom thinks it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt (when respondents confirm on their response cover sheer that this is acceptable).

All comments will be treated as non-confidential unless respondents specify that part or all of the response is confidential and should not be disclosed. Please place any confidential parts of a response in a separate annex, so that non-confidential parts may be published along with the respondent's identity.

Ofcom reserves its power to disclose any information it receives where this is required to carry out its legal requirements. Ofcom will exercise due regard to the confidentiality of information supplied.

Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use, to meet its legal requirements. Ofcom's approach on intellectual property rights is explained further on its website, at www.ofcom.org.uk/about_ofcom/gov_accountability/disclaimer.

Next steps

Following the end of the consultation period, Ofcom will carefully review the responses. For the proposals at 2.4HGz if there is a clear way ahead we will move to publish a statement, likely in the first quarter of 2007. If the responses received are mixed, we may conduct further study, and potentially consult further.

For our proposals for the 5.8GHz band, subject to responses to this consultation, we would like to implement the proposed changes as soon as practically possible. It is our intention to publish a statement later this year setting out our plans in this area and include in this statement date by which applications for licences under the new arrangements would be accepted by Ofcom

Publishing information on 5.8GHz will require Ofcom to change current legislation as licensing information is considered confidential. Section 170 of the Communications Act makes a provision for Ofcom to establish a register of licensing information and in December 2004 Ofcom made the Wireless Telegraphy (Register) Regulations 2004, which did this. Initially these regulations were restricted to licences that were made tradable in December 2004 although at that time Ofcom outlined its intention to extend the scope of this register to a wider range of licence classes. The publication of 5.8GHz information forms part of this process.

If Ofcom decides to proceed with the publication of information on 5.8GHz licences Ofcom is required to give statutory notice of at least one month prior to making new, or amending existing regulations. It would be our expectation to give such notice at, or shortly after, publication of the statement. The regulations that will require amendment are Statutory Instrument 2004 No. 3155: The Wireless Telegraphy (Register) Regulations 200410.

Please note that you can register to get automatic notifications of when Ofcom documents are published, at http://www.ofcom.org.uk/static/subscribe/select_list.htm.

Ofcom's consultation processes

Ofcom is keen to make responding to consultations easy, and has published some consultation principles (see Annex 2) which it seeks to follow, including on the length of consultations.

If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk. We would particularly welcome thoughts on how Ofcom could more effectively seek the views of

10 http://www.opsi.gov.uk/si/si2004/20043155.htm

those groups or individuals, such as small businesses or particular types of residential consumers, whose views are less likely to be obtained in a formal consultation.

If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Vicki Nash, Director Scotland, who is Ofcom's consultation champion:

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Ofcom
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149 St. Vincent Street
Glasgow G2 5NW

Tel: 0141 229 7401
Fax: 0141 229 7433

Email vicki.nash@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened version for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will normally allow ten weeks for responses to consultations on issues of general interest.

A2.6 There will be a person within Ofcom who will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. This individual (who we call the consultation champion) will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why. This may be because a particular issue is urgent. If we need to reduce the amount of time we have set aside for a consultation, we will let those concerned know beforehand that this is a 'red flag consultation' which needs their urgent attention.

After the consultation

A2.8 We will look at each response carefully and with an open mind. We will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency, we will publish all consultation responses in full on our website, www.ofcom.org.uk, unless a respondent specifies that all or part of their response is confidential. We will also refer to the contents of a response when explaining our decision, without disclosing the specific information that you wish to remain confidential.

A3.2 We have produced a cover sheet for responses (see below) and would be very grateful if you could send one with your response. This will speed up our processing of responses, and help to maintain confidentiality by allowing you to state very clearly what you don't want to be published. We will keep your completed cover sheets confidential.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their cover sheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses in the form of a Microsoft Word attachment to an email. Our website therefore includes an electronic copy of this cover sheet, which you can download from the 'Consultations' section of our website.

A3.5 Please put any confidential parts of your response in a separate annex to your response, so that they are clearly identified. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title: Higher power limits for licence exempt devices

To (Ofcom contact): Mike Parkins

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

What do you want Ofcom to keep confidential?

Nothing	☐	Name/contact details/job title	☐
Whole response	☐	Organisation	☐
Part of the response	☐	If there is no separate annex, which parts?	

If you want part of your response, your name or your organisation to be confidential, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response. It can be published in full on Ofcom's website, unless otherwise specified on this cover sheet, and I authorise Ofcom to make use of the information in this response to meet its legal requirements. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name Signed (if hard copy)

Annex 4

Consultation questions

Q1: Have all the possible victims of interference been correctly identified and quantified as far as possible?

Q2: Have the costs and benefits been correctly captured? In particular, are the costs of interference to WLANs appropriately assessed?

Q3: Are there any other mechanisms that could be used to restrict device operation to appropriate areas? Of the schemes set out which should be preferred?

Q4: Should we move from specifying radiated power to specifying conducted power?

Q5: For 2.4GHz which of these options do you favour? Are there other viable options that should be considered? Or should regulations be left unchanged?

Q6: For 5GHz should Ofcom increase the power to 4W EIRP at 5.8GHz in accordance with ECC Recommendation and as set out in the draft IR2007? Should Ofcom open the database for public access to facilitate coordination?

Annex 5

Impact assessment

A5.1 The analysis presented here, when read in conjunction with the rest of this document, represents a Regulatory Impact Assessment ("RIA") as defined by section 7 of the Communications Act 2003 (the "Act") for each of the options proposed in connection with the possibility of higher power limits for licence-exempt devices. You should send any comment on this RIA to Ofcom by the closing date for this consultation. Ofcom will consider all comments before deciding which option to pursue.

A5.2 RIAs provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy making and are commonly used by other regulators. This is reflected in section 7 of the act, which means that Ofcom will generally carry out RIAs where proposals would be likely to have a significant effect on businesses or the general public, or where there is a major change in Ofcom's activities. In accordance with section 7 of this Act, in producing the RIA in this document, Ofcom has had regard to such general guidance as it considers appropriate, including related Cabinet Office guidance.

Policy Objective

A5.3 This regulatory impact assessment (RIA) estimates the costs and benefits of the potential change to higher power in licence exempt spectrum in geographically restricted areas. Overall, the proposed changes will decrease the amount of regulation in that they will reduce some of the restrictions on using the 2.4GHz and 5GHz band, although under some options the complexity of specifying the rules of usage may increase.

A5.4 For this consultation Ofcom's specific duties fall into two relevant areas:

- Ensuring the optimal use of the electro-magnetic spectrum
- Ensuring that a wide range of electronic communications services - including high speed data services - is available throughout the UK

A5.5 In addition this consultation also contributes to aid important social goals and improve the quality of life in rural areas by enabling the provision of enhanced services in these areas.

Options

A5.6 At 2.4GHz we could either do nothing, or increase the allowed power levels in certain geographical areas. Increasing powers might allow benefits to be realised but also might increase the potential of interference. To help guide discussion we have set out the following three options although others could be envisaged.

- **Option One – Maximise benefits**. Under this option we would allow powers of up to 10W EIRP (or 6.7W if conducted power is specified) throughout the UK in the band 2450-2483MHz. With no geographical restrictions devices need not be location aware and no registration requirements would be placed on users.

- **Option Two – Minimise risks**. Under this option we would restrict the use of 10W EIRP (or 6.7W if conducted power is specified) to hamlets, villages and rural towns. Devices would be required to be location aware and only transmit at higher powers if they were in appropriate areas.

- **Option Three – A balance**. Under this option we would restrict 10W EIRP operation (or 6.7W if conducted power is specified) to all areas except large and major urban conurbations. Devices would not need to be location aware but a mandatory registration scheme would operate and users would need to operate according to a code which required them to work collaboratively to resolve interference issues.

A5.7 At 5GHz we could do nothing or increase power levels to 4W as set out in the ECC proposal.

Costs and benefits

A5.8 The following stakeholders might gain from higher power levels:

- Rural businesses and residents who can access additional services.

- BFWA providers and other service providers operating in areas where higher powers are allowed.

A5.9 The following might suffer increased interference:

- MoD as a significant user of most of the bands

- A range of existing users including satellite operators, programme makers and special equipment users (PMSE), other users of the licence-exempt bands such as home users of WLAN systems.

A5.10 A team of consultants modelled the potential costs and benefits by examining the gain in consumer and producer surplus from those using higher power, offset by the cost to any users suffering interference. Their key findings for 2.4GHz are shown below:

Option	Benefits	Costs of interference	Costs to Ofcom	Overall increase in benefits
1 – Maximise benefits	£190m	£13m	Minimal	£177m
2 – Minimise risks	£50m	Near zero	Minimal	£50m
3 – Balanced approach	£150m	Difficult to quantify, perhaps £5m - £10m	£0.2m to establish a database	Around £140m

Table A5.1 – Costs and benefits for various options at 2.4GHz

A5.11 As can be seen, the estimated benefits are positive for all options, and greatest for the first one. However the model only contains a limited analysis of the cost of interference. It is based on the assumption that the effect of interference is due to a capacity reduction at 2.4GHz and a migration the lowest number of users to 5GHz to restore sufficient spare capacity. It assesses equipment costs only and excludes the lost time and productivity that occurs before and during migration. Further there are risks to be taken into account. This table seems thus to suggest that there is not one option which is visibly superior to another and that any decision would have to carefully balance benefits, costs and risks associated to these options.

A5.12 At 5.8GHz, the consultants judged the value of an increase in power to 4W to be £85m. The interference costs were judged to be negligible. Hence, there is an overall net positive impact of £85m.

Summary and recommendations

A5.13 The economic case, as modelled, shows that there is a net benefit expected to the UK, with the size of the benefit depending on the area over which increased power is allowed. Aware of the limitations inherent to any complex modelling work in licence-exempt spectrum, we are seeking views in this consultation on whether the size of the benefit merits the risk of a possible increase in interference.

Annex 6

Glossary

ADSL - Asymmetric Digital Subscriber Line

AVI - Automatic Vehicle Identification

BFWA – Broadband Fixed Wireless Access

BWA – Broadband Wireless Access

CPE - Consumer Premises Equipment

DFS – Digital Frequency Selection

DSL – Digital Subscriber Line

DTI – Department of Trade and Industry

EIRP - Effective Isotropic Radiated Power

EESS - Earth Exploration Satellite Service

ENG/OB – Electronic News Gathering/Outside Broadcast

FAT – Frequency Allocation Table

FSS - Fixed Satellite Service

GPS – Global Positioning System

ISM – Industrial Scientific and Medical

ITU - International Telecommunication Union

JFMG – Joint Frequency Management Group

MAC – Medium Access Control

MSS – Mobile Satellite Service

PMSE - Programme Making and Special Events

QoS – Quality Of Service

RFID - Radio Frequency Identification

RLAN - Radio-based Local Area Network

RTTT - Road Transport Traffic Telematics

SDSL – Symmetric Digital Subscriber Line

SME - Small or Medium sized Enterprise

SOHO - Small Office / Home Office

SRD – Short Range Devices

TPC – Transmit Power Control

UAV - Unmanned Airborne Vehicle

VTS – Vessel Trafficking System

WBA - Wireless Broadband Access

WiMAX - Worldwide Interoperability for Microwave Access

WLAN - Wireless Local Area Network

Annex 7

Proposed Interface Requirement

UK Radio Interface Requirement 2007

Fixed Broadband Services operating in the frequency range 5725-5850 MHz

(Version 1.1)

98/34/EC Notification Number: 2003/204/UK

Published 2006

References

ERC/DEC/(99)23 ERC Decision of 29 November 1999 on the harmonised frequency bands to be designated for the introduction of High Performance Radio Local Area Networks (HIPERLANs)
ETSI EN 301 489 Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 17; Specific conditions for Wideband data and HIPERLAN equipment
Draft ETSI EN 302 508 Broadband Radio Access Networks (BRAN); 5.8GHz fixed broadband data transmitting systems; Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive

Foreword

A7.1 The Radio Equipment and Telecommunications Terminal Equipment Directive 1999/5/EC (R&TTE Directive) was implemented in the United Kingdom (UK) on the 8 April 2000 by the Radio Equipment and Telecommunications Terminal Equipment Regulations, Statutory Instrument 2000 No. 730. In accordance with Articles 4.1 and 7.2 of Directive 1999/5/EC, this UK Radio Interface Requirement contains the requirements for the use of Fixed Broadband Radio Systems operating in the frequency range 5725-5850MHz.

A7.2 Nothing in this UK Radio Interface Requirement shall preclude the need for equipment to comply with Directive 1999/5/EC.

A7.3 It is required by the Wireless Telegraphy Act 1949 that no radio equipment is installed or used in the UK except under the authority of a licence granted by or otherwise exempted by regulations made by the Secretary of State. It is a condition of such a licence or exemption regulations as appropriate that the equipment must meet the minimum requirements specified in this UK Radio Interface Requirement for the stated equipment types and for the stated frequency bands.

A7.4 The requirements given in the main body of this UK Radio Interface Requirement will apply in the use of Fixed Broadband Radio Systems operating in the frequency range 5725-5850MHz, in the UK. Fixed Broadband Radio Systems share this frequency range with military radars, satellite E-S links, ENG OB links and RTTT systems. Therefore mitigation techniques may need to be employed to avoid harmful interference to those services. The harmonised standard, which currently is under development (EN 302 508) contains such techniques (DFS and TPC), but as yet hasn't been adopted. In order to allow the market to develop, guidance on the conditions under which such equipment is deemed to comply with the R&TTE Directive is given.

A7.5 This UK Radio Interface Requirement will be revised as necessary, for example to follow:

- current technology developments for reasons related to the effective and appropriate use of the spectrum in particular maximising spectrum utilisation;
- changes to the available spectrum allocated for short range, broadband, wireless communications; or
- publication of a Harmonised standard by ETSI.

A7.6 All UK Radio Interface Requirements notified under Directive 1998/34/EC will be published and will be made available free of charge from the Ofcom (Office of Communications) Contact Centre and/or the Ofcom website. The addresses of both the Contact Centre and the website are given at the back of this document.

A7.7 Further information on this UK Radio Interface Requirement can be obtained from the technical enquiry contact given at the back of this document.

Minimum Equipment Requirements for Operation within the UK

A7.8 The minimum requirements in this document are made for reasons related to the effective and appropriate use of the radio spectrum, in particular maximising spectrum utilisation.

A7.9 This UK Radio Interface Requirement gives a high-level description of how the spectrum in the UK is used for Fixed Broadband Radio Systems operating in the frequency range 5725-5850MHz. It does not prescribe a technical interpretation of the 'essential requirements' of Directive 1999/5/EC.

A7.10 This UK Radio Interface Requirement therefore stipulates the minimum requirements necessary to allow Fixed Broadband Radio Systems operating in the frequency range 5725-5850MHz to be licensed in the UK. Table 2.1 contains the relevant equipment parameters. These, together with the 'essential requirement' detailed in Article 3.2 of the Directive 1999/5/EC, constitute the minimum equipment requirements for the operation of Fixed Broadband Radio Systems in the frequency range 5725-5850MHz within the UK.

A7.11 The technical parameters specified in the UK Radio Interface Requirement are applied to achieve the desired level of compatibility for Fixed Broadband Radio Systems and other radiocommunication services while promoting enterprise, innovation and competition.

A7.12 This UK Radio Interface Requirement provides the necessary technical information that facilitates access to spectrum allocated to Fixed Broadband Radio Systems in the UK. It is not the intention of this UK Radio Interface requirement to duplicate or impose any additional 'essential requirements' of the Directive 1999/5/EC on products. Any specified parameters within this document are for the purpose of identifying product options and not as a national product requirement.

Table A7.1: Minimum Equipment Requirements

Frequency range (MHz)	**Service**	**Power**	**Duplex**	**Additional Technical Requirements**	**Additional Technical Requirements (informative)**
5725-5850[11] [12] [13] (Band C)	Fixed	Max EIRP 4W with a PSD not exceeding 23dBm/MHz[14]	TDD	DFS. and TPC required.	See Annex A for channel plan details. See draft EN 302 508 for guidance to manufacturers and notified bodies on what the UK deems acceptable test methods for equipment declarations and/or testing.

[11]Licences shall be issued on a non-protection and non-interference (to other primary users) basis.

[12]Co-ordination and site-clearance considerations may impose additional restrictions on the maximum radiated power allowed on specific frequencies, directions and locations.

[13]The frequency range 5795-5815 MHz shall not be used and should be notched out to protect RTTT devices.

[14]The e.i.r.p. spectral density of the transmitter emissions should not exceed the following values for the elevation angle θ (degrees) above the local horizontal plane (of the Earth):

For sectorised (e.g. P-MP Central or Base Station) and Omni-directional deployments:

−7 dB(W/MHz) for $0° \leq \theta < 4°$
−2.2 - (1.2*θ) dB(W/MHz) for $4° \leq \theta \leq 15°$
−18.4 - (0.15*θ) dB(W/MHz) for $\theta > 15°$

For P-MP Customer Terminal Station and P-P deployments:

−7 dB(W/MHz) for $0° \leq \theta < 8°$
−2.68 -(0.54*θ) dB(W/MHz) for $8° \leq \theta < 32°$
−20 dB(W/MHz) for $32° \leq \theta \leq 50°$
−10 - (0.2*θ) dB(W/MHz) for $\theta > 50°$

Examples are provided in ECC Report 68 to demonstrate that these limits can comfortably be achieved using typical antenna radiation pattern envelopes.

Document history

Draft	Date	Changes
1.00	**19/12/03**	**Deleted Draft and added EU notification number.**
1.1		**Updated to in-line with ECC Recommendation (06) 04 and draft EN 302 508**

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Annex 8

Relevant footnotes from ITU-R Regulations

2.4GHz

5.150 - Bands can be used for ISM.

5.282 - The amateur-satellite service may operate subject to not causing harmful interference to other services. Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated.

5.393 - Applies only to the band 2 310-2 360MHz.

5.394 - In the United States, the use of the band 2 300-2 390MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services. In Canada, the use of the band 2 300-2 483.5MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services.

5.395 - Applies only to the band 2 310-2 360MHz.

5.396 - Applies only to the band 2 310-2 360MHz.

5.397 - Different category of service: in France, the band 2 450-2 500MHz is allocated on a primary basis to the radiolocation service (see No. 5.33). Such use is subject to agreement with administrations having services operating or planned to operate in accordance with the Table of Frequency Allocations which may be affected.

5GHz

5.150 - Bands can be used for ISM.

5.282 - The amateur-satellite service may operate subject to not causing harmful interference to other services. Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated. The use of the band 5 650-5 670MHz by the amateur-satellite service is limited to the Earth-to-space direction.

5.446 - *Additional allocation*: in the countries listed in Nos. 5.369 and 5.400, the band 5 150-5 216MHz is also allocated to the radiodetermination-satellite service (space-to-Earth) on a primary basis, subject to agreement obtained under No. 9.21. In Region 2, the band is also allocated to the radiodetermination-satellite service (space-to-Earth) on a primary basis. In Regions 1 and 3, except those countries listed in Nos. 5.369 and 5.400, the band is also allocated to the radiodetermination-satellite service (space-to-Earth) on a secondary basis. The use by the radiodetermination-satellite service is limited to feeder links in conjunction with the radiodetermination-satellite service operating in the bands 1 610-1 626.5MHz and/or 2 483.5-2 500MHz. The total power flux-density at the Earth's surface shall in no case exceed –159 dB(W/m2) in any 4 kHz band for all angles of arrival.

5.446A - The use of the bands 5 150-5 350MHz and 5 470-5 725MHz by the stations in the mobile service shall be in accordance with Resolution 229 (WRC-03) in the Radio Regulations Volume 3.

5.446B - In the band 5 150-5 250MHz, stations in the mobile service shall not claim protection from earth stations in the fixed-satellite service. No. 5.43A (see Radio Regulations Volume 1) does not apply to the mobile service with respect to fixed-satellite service earth stations.

5.447 - Additional allocation: in Israel, Lebanon, Pakistan, the Syrian Arab Republic and Tunisia, the band 5 150-5 250MHz is also allocated to the mobile service, on a primary basis, subject to agreement obtained under No. 9.21. In this case, the provisions of Resolution 229 (WRC-03) do not apply.

5.447A - The allocation to the fixed-satellite service (Earth-to-space) is limited to feeder links of nongeostationary-satellite systems in the mobile-satellite service and is subject to coordination under No. 9.11A in the Radio Regulations Volume 3.

5.447B - Additional allocation: the band 5 150-5 216MHz is also allocated to the fixed-satellite service (space-to-Earth) on a primary basis. This allocation is limited to feeder links of non-geostationary-satellite systems in the mobile-satellite service and is subject to provisions of No. 9.11A. The power flux-density at the Earth’s surface produced by space stations of the fixed-satellite service operating in the space-to-Earth direction in the band 5 150-5 216MHz shall in no case exceed –164 dB(W/m2) in any 4kHz band for all angles of arrival.

5.447C - Administrations responsible for fixed-satellite service networks in the band 5 150-5 25MHz operated under Nos. 5.447A and 5.447B shall coordinate on an equal basis in accordance with No. 9.11A with administrations responsible for non-geostationary-satellite networks operated under No. 5.446 and brought into use prior to 17 November 1995. Satellite networks operated under No. 5.446 brought into use after 17 November 1995 shall not claim protection from, and shall not cause harmful interference to, stations of the fixed-satellite service operated under Nos. 5.447A and 5.447B.

5.447D - The allocation of the band 5 250-5 255MHz to the space research service on a primary basis is limited to active spaceborne sensors. Other uses of the band by the space research service are on a secondary basis.

5.447E - Additional allocation: The band 5 250-5 350MHz is also allocated to the fixed service on a primary basis in the following countries in Region 3: Australia, Korea (Rep. of), India, Indonesia, Iran (Islamic Republic of), Japan, Malaysia, Papua New Guinea, the Philippines, Sri Lanka, Thailand and Viet Nam. The use of this band by the fixed service is intended for the implementation of fixed wireless access systems and shall comply with Recommendation ITU-R F.1613. In addition, the fixed service shall not claim protection from the radiodetermination, Earth exploration-satellite (active) and space research (active) services, but the provisions of No. 5.43A do not apply to the fixed service with respect to the Earth exploration-satellite (active) and space research (active) services. After implementation of fixed wireless access systems in the fixed service with protection for the existing radiodetermination systems, no more stringent constraints should be imposed on the fixed wireless access systems by future radiodetermination implementations.

5.447F - In the band 5 250-5 350MHz, stations in the mobile service shall not claim protection from the radiolocation service, the Earth exploration-satellite service (active) and the space research service (active). These services shall not impose on the mobile service

more stringent protection criteria, based on system characteristics and interference criteria, than those stated in Recommendations ITU-R M.1638 and ITU-R SA.1632.

5.448 - Additional allocation: in Azerbaijan, Libyan Arab Jamahiriya, Mongolia, Kyrgyzstan, Slovakia, Romania and Turkmenistan, the band 5 250-5 350MHz is also allocated to the radionavigation service on a primary basis.

5.448A - The Earth exploration-satellite (active) and space research (active) services in the frequency band 5 250-5 350MHz shall not claim protection from the radiolocation service. No. 5.43A does not apply.

5.448B - The Earth exploration-satellite service (active) operating in the band 5 350-5 570MHz and space research service (active) operating in the band 5 460-5 570MHz shall not cause harmful interference to the aeronautical radionavigation service in the band 5 350-5 460MHz, the radionavigation service in the band 5 460-5 470MHz and the maritime radionavigation service in the band 5 470-5 570MHz.

5.450 - Additional allocation: in Austria, Azerbaijan, Iran (Islamic Republic of), Mongolia, Kyrgyzstan, Romania, Turkmenistan and Ukraine, the band 5 470-5 650MHz is also allocated to the aeronautical radionavigation service on a primary basis.

5.451 - Additional allocation: in the United Kingdom, the band 5 470-5 850MHz is also allocated to the land mobile service on a secondary basis. The power limits specified in Nos. 21.2, 21.3, 21.4 and 21.5 shall apply in the band 5 725-5 850MHz.

5.452 - Between 5 600MHz and 5 650MHz, ground-based radars used for meteorological purposes are authorized to operate on a basis of equality with stations of the maritime radionavigation service.

5.453 - Additional allocation: in Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Cameroon, China, Congo (Rep. of the), Korea (Rep. of), Côte d'Ivoire, Egypt, the United Arab Emirates, Gabon, Guinea, Equatorial Guinea, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, the Libyan Arab Jamahiriya, Japan, Jordan, Kenya, Kuwait, Lebanon, Madagascar, Malaysia, Nigeria, Oman, Pakistan, the Philippines, Qatar, the Syrian Arab Republic, the Dem. People's Rep. of Korea, Singapore, Sri Lanka, Swaziland, Tanzania, Chad, Thailand, Togo, Viet Nam and Yemen, the band 5 650-5 850MHz is also allocated to the fixed and mobile services on a primary basis. In this case, the provisions of Resolution 229 (WRC-03) do not apply.

5.454 - Different category of service: in Azerbaijan, the Russian Federation, Georgia, Mongolia, Uzbekistan, Kyrgyzstan, Tajikistan and Turkmenistan, the allocation of the band 5 670-5 725MHz to the space research service is on a primary basis.

5.455 - Additional allocation: in Armenia, Azerbaijan, Belarus, Cuba, the Russian Federation, Georgia, Hungary, Kazakhstan, Latvia, Moldova, Mongolia, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the band 5 670-5 850MHz is also allocated to the fixed service on a primary basis.

5.456 - Additional allocation: in Cameroon, the band 5 755-5 850MHz is also allocated to the fixed service on a primary basis.